Chemical Composition of Sedimentary Rocks in Colorado, Kansas, Montana Nebraska, North Dakota South Dakota, and Wyoming

GEOLOGICAL SURVEY PROFESSIONAL PAPER 561

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Compiled by

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With an introduction by

WILLIAM W. RUBEY

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A compilation of 2,842 analyses published before 1958

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Compiled by THELMA P. HILL, MARIAN A. WERNER, and M. JULIA HORTON

ABSTRACT

The compilation of published chemical analyses of sedimentary rocks of the United States was undertaken by the U.S. Geological Survey in 1952 to make available scattered data that are needed for a wide range of economic and scientific uses. About 20,000–25,000 chemical analyses of sedimentary rocks in the United States have been published. This report brings together about 2,850 of these analyses from the Northern Rocky Mountains and the Great Plains region.

The samples are arranged by three successive criteria: (a) general lithologic character; (b) locality; and (c) geologic age, formation, and relative stratigraphic order. Both a stratigraphic index of the geologic formations represented by the analyses and an index of commercial uses are provided.

The analyses are classified into groups and into categories. The groups (A through F_2) are based on a modified form of the system proposed by Brian Mason in 1952 in which the relative abundance of the three major components of sedimentary rocks is considered. The components are (a) uncombined silica, (b) clay ($R_2O_3 \cdot 3SiO_2 \cdot nH_2O$), and (c) calcium-magnesium carbonate. The common- and mixed-rock categories are based on the degree of admixture of these three major components with other components, such as sulfate minerals, phosphate, and iron oxide. In most of the analyses, the three major components amount to 90 percent or more, and these analyses were placed in a "common-rock" category. In a few analyses, however, the three major components make up only 50–90 percent of the rock, and the analyses were placed in a "mixed-rock" category. Analyses in which the three major components amount to less than 50 percent were placed in an arbitrarily lettered group according to the admixed substance that makes up most of the rock analyzed. These analyses (containing less than 50 percent of the three major components) were also called "special-rock" category.

Maps show distribution of sample localities by States, and triangular diagrams show the lithologic character, classification group, and geologic age.

The many analyses assembled here may not adequately represent the geochemical nature of the various rock types and formations of the region because the analyzed samples were chosen mainly on the basis of possible economic use of the rocks sampled, rather than at random. Maps showing the areal distribution of localities from which the analyzed samples were taken indicate that many of the localities are in areas where, for economic or other reasons, special problems attracted interest. Sampling biases are of several kinds, and they tend to cancel one another.

Several generalized but noteworthy relationships became apparent from the compilation. Most of the analyzed rocks tended to be fairly simple in composition—mainly two-component mixtures of the three major components (uncombined silica, the clay molecule, and calcium-magnesium carbonate) or a mixture of the three major components and a fourth component, such as phosphate, gypsum, salt, or iron oxide.

A comparison of the number of analyses assembled here with rough estimates of the relative thickness of rocks of different lithologic types and geologic ages showed that the available analyses were far from equally representative of the sedimentary rock column of the region. Possibly, future analytical work will correct the worst deficiencies of the existing data.

INTRODUCTION

By W. W. RUBEY

PROJECT BACKGROUND

The project of compiling published chemical analyses of sedimentary rocks of the United States was undertaken by the U.S. Geological Survey in 1952. Decision to undertake the project came largely as an outgrowth of suggestions made by a group of geochemists, geologists, geophysicists, and biologists who were called together for a conference on May 27, 1950, by L. H. Adams and M. A. Tuve, of the Carnegie Institution of Washington. The conference dealt with the geochemical problems of sedimentary rocks. The group pointed out that a knowledge of the composition of sedimentary rocks comparable to that of the composition of igneous rocks, which had been available for several decades, would be extremely helpful in many scientific fields. As a result of this and other conferences on the subject, the National Research Council in 1951 established a committee, under the chairmanship of G. E. Hutchinson, on the chemical composition of sediments. The committee's purpose was to encourage individual investigations which would lead to a better balanced knowledge of the composition of sedimentary rocks. As well as presenting the recommendation that ultimately led to establishment of the project represented by this report, the committee encouraged investigations of deep-sea sediments and of Precambrian sedimentary rocks, for available chemical information on both these materials is also inadequate. Better knowledge of the geochemistry of sedimentary rocks must, of course, depend in part upon new chemical analyses, but a wise choice of the rock types for which new analyses are most needed would call for the systematic assemblage of the vast amount of information that is now widely scattered through a diverse literature; this alone would be a major undertaking.

The scientists who met under the auspices of the Carnegie Institution and the members of the National Research Council Committee were interested primarily in the more theoretical aspects of the geochemistry of sedimentary rocks. The U.S. Geological Survey is concerned with theory because of the direct bearing that theory has on many major geological problems; however, the Survey is also concerned with the utilization of sedimentary rocks for economic purposes, such as building stone, glass sand, and ceramic and cement materials. Because of its dual interest, the U.S. Geological Survey undertook the major task of compiling the many published analyses, to the end that information would thus be made more readily available for the entire range of use.

Before a decision was made to undertake compilation of these analyses, an appraisal of the probable magnitude of the task was made. From several random samples of the literature, an estimate was obtained that about 20,000–25,000 chemical analyses of sedimentary rocks of the United States have been published, and that perhaps 90 percent of these analyses are in reports of the various State geological surveys and associated State universities, the U.S. Bureau of Mines, and the U.S. Geological Survey. The other 10 percent are widely scattered through many scientific technical journals.

ANALYSES SELECTION

The selection of analyses for inclusion in a compilation such as this involves selective judgment of the kinds of rocks, nature of samples, and completeness of analyses. The criteria established are discussed in detail on pages 7–8. Selection in this study was not based on the known or inferred quality of the analysis, except that the minimum requirement for the total components be between 95 and 102.5 percent. A few samples were included because of their unusual composition or because of their relation to other samples, even though they did not meet all the criteria for inclusion.

Analyses were taken from reports published prior to 1958, and open-file reports of the U.S. Geological Survey were regarded as published. No analyses were taken from unpublished theses or from files of the U.S. Geological Survey, State surveys, or private firms. Unpublished supplementary information on a published analysis is cited as written communication.

ARRANGEMENT OF ANALYSES

Arrangement of the 20,000–25,000 analyses so that users having different interests could easily find particular analyses or types of analyses constituted a problem. Among the most generally useful facts about an analyzed sample are (a) its lithologic character, (b) the geographic locality from which it came, (c) the geologic formation from which it was collected, and (d) the commercial use or uses to which it has been or may be adapted. The special interests of the particular user of this information, however, govern the relative significance among data. Actual or potential commercial use was certainly the chief consideration of those people who selected most of the rocks whose analyses are assembled for this report. Nevertheless, a classification and arrangement of analyses primarily based on use would be more confusing than helpful because the information on commercial uses is extremely uneven from one report to another; several rock types (such as clays) have more than one use, and use for a given deposit may even change from time to time as regional mining develops and industrial processes are modified.

Because of the wide range of theoretical and practical interests in the analyses, the analyses are arranged by three successive criteria: (a) general lithologic character, (b) locality, and (c) geologic formation or stratigraphic order; a separate index is given of all known commercial uses. In this plan of organization, all samples of one lithologic type are grouped together, the samples of each group are then divided as to the State and county from which they were collected, and, finally, the county groups are subdivided according to stratigraphic position. This system of arrangement gives less emphasis to geologic formation and geologic age than is desirable for certain uses of the data. Several attempts to use other plans of arrangement showed that any arrangement chosen must be a compromise that falls short of the ideal for some purposes. To offset the disadvantage of the particular system selected here, separate indexes are given for stratigraphic names and for geologic ages that are represented by the selected analyses, and these indexes are analogous to the separate index of commercial uses.

CLASSIFICATION OF SEDIMENTARY ROCKS

Analyzed materials seemingly could simply be classified according to the common lithologic terms applied to them (such as sandstone, shale, limestone) in the original reports from which the analyses were taken. Nonetheless, experience in this compilation showed that such an ideally simple basis of lithologic classification is practicable only for the purer rock types. Nature seldom draws distinct boundaries between different rock types; and for mixed rocks the lithologic nomenclature has, of necessity, grown extremely diverse and to some extent contradictory. In the literature, for example, argillaceous chalky rocks of nearly identical composition are variously reported as chalk, limestone, chalk-marl, marl, and shale. As a result, a system of classification based solely on the lithologic terms used by the original authors would cause the closely similar rock types to fall into seemingly quite different categories. For purposes of the present compilation, a more nearly uniform and objective system of classification that depends primarily upon the chemical analyses themselves was adopted. Such a system indicates the relations of the three main components of sedimentary rocks (sand, clay, and carbonate minerals) and the degree of admixture of these major components with other materials such as sulfate minerals, phosphate minerals, and iron oxide. The relations of the three main components are expressed in terms of groups. The degree of admixture with other materials is expressed as categories.

GROUPS

Much has been written during the past 50 years about various systems of classification of igneous rocks; but there is no uniform agreement as to the best all-purpose system. In some ways, classification on the basis of chemical composition is simpler for igneous rocks than for sedimentary rocks, because the various types of igneous rocks can be adequately characterized in terms of a relatively small number of standard or normative minerals that, at least in theory, crystallized together under conditions of approximate chemical equilibria. But many sedimentary rocks are made up largely of fragmental materials—grains of minerals formed in environments totally different from that in which detrital-sediment accumulation occurred. Thus, there are no known rules of consanguinity comparable to those for igneous rocks (and possibly for many metamorphic rocks) to govern the mineral assemblages in sedimentary rocks. Furthermore, clay minerals are a major constituent of many sedimentary rocks, and the mineralogy and chemical compositions of these minerals are very complex. This complexity greatly handicaps efforts to establish a rational basis for a chemical classification of detrital sediments.

A satisfactory system may someday be devised for the classification of all sedimentary rocks in terms of a few theoretical minerals that are arbitrarily defined on the basis of chemical composition. Formulation of some such system, in fact, may well be one of the scientific uses of a comprehensive compilation of sedimentary analyses. Because no such classification was available at the time this compilation was made, some other basis for the chemical classification of sedimentary rocks was required.

Attempts to use several possible methods of classification showed that a system similar to that used by Mason (1952, p. 130–131) combines, as effectively as any other, the desirable elements of maximum simplicity and geochemical significance. (See fig. 1.) The system used here—a modification of Mason's—treats all sedimentary rocks as if they were mixtures of three ideal components: (a) quartz (uncombined silica), (b) an arbitrarily defined clay molecule ($R_2O_3 \cdot 3SiO_2 \cdot nH_2O$), and (c) total carbonate calculated as ($CaCO_3 + MgCO_3$). Actually, most sedimentary rocks can only be approximately classified as being mixtures of these three components. Silica is a major constituent of all the commoner clay minerals, and as a result the most abundant types of mudstones have chemical compositions that fall somewhere between the composition of the two theoretical components—uncombined silica and $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$. Similarly, the analysis of a clean well-sorted sandstone that includes significant amounts of feldspar grains contains much Al_2O_3, and it thus appears in the system of classification used here as a mixture of uncombined silica and $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$. If the sand grains include many particles of calcic plagioclase and of ferromagnesian minerals, the analysis of the rock then shows significant amounts of Al_2O_3, Fe_2O_3, CaO, and MgO, as well as SiO_2, and in the classification system this sandstone may appear as a mixture of all three components. Thus this compositional diagram is only roughly analogous to the common sand-mud-lime diagram. Nevertheless, when these qualifications are kept in mind, the three somewhat hypothetical components of the diagram afford a useful basis for classifying the chemical analyses of a great many sedimentary rocks.

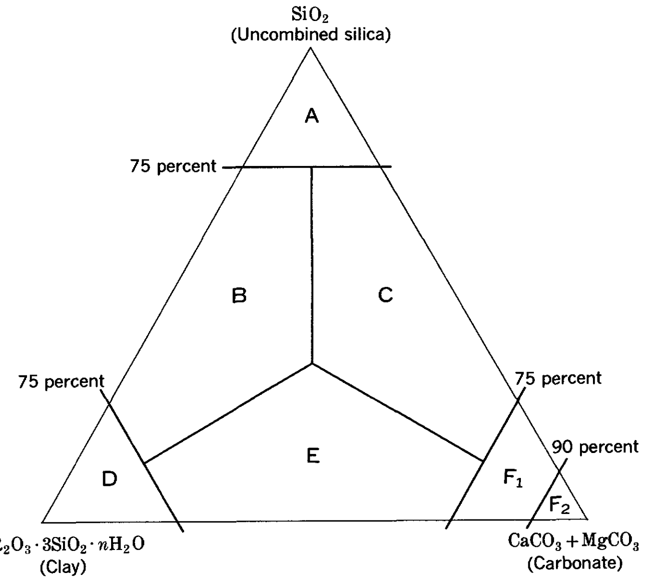

FIGURE 1.—Composition of sedimentary rocks showing the seven fields into which the chemical analyses are grouped.

Perhaps the conventionalized clay molecule ($R_2O_3 \cdot 3SiO_2 \cdot nH_2O$) used in this report is too simplified to serve most effectively in this arbitrary classification. The clay corner of the composition diagram would be more useful if it represented not only R_2O_3, SiO_2, and H_2O but also the alkalies, K_2O and Na_2O, and that part of the MgO and CaO which is not found in carbonates. The difficulty, however, is that many published analyses do not include the alkalies and CO_2 but are otherwise useful and should be included. The classification system should also be capable of placing in the same groups these analyses and similar ones in which the alkalies and CO_2 have been determined.

The three-component diagram becomes more useful for classifying large numbers of analyses when it is subdivided into several fields that correspond to different mixtures of the three components. Convenient groups are arbitrarily defined as follows:

A. Silica group	Uncombined silica, more than 75 percent.
B. Mixed silica and clay group	Uncombined silica and clay, each less than 75 percent; uncombined silica and clay, each more than carbonate.
C. Mixed silica and carbonate group.	Uncombined silica and carbonate, each less than 75 percent; uncombined silica and carbonate, each more than clay.
D. Clay group	Clay, more than 75 percent.
E. Mixed clay and carbonate group.	Clay and carbonate, each less than 75 percent; clay and carbonate, each more than uncombined silica.
F. Carbonate group	Carbonate, more than 75 percent.
F_1 (common carbonate)	Carbonate from 75 to 90 percent.
F_2 (high-purity carbonate).	Carbonate, more than 90 percent.

The few samples that plotted on the boundary lines of the fields defined were arbitrarily placed in an adjacent field according to the judgment of the compilers. These judgments were based on such factors as composition of associated samples, if any, and geological association.

Samples that contained 33 percent (or more) calcium-magnesium carbonate were given an additional notation to indicate the calculated ratio of calcite to dolomite as follows:

Notation	$\frac{CaCO_3}{(Ca, Mg)CO_3}$ *molal ratio*	CaO/MgO *weight ratio*
Calcite	0. 9:1. 0	26. 43: ∞
Magnesian calcite	0. 5:0. 9	4. 173:26. 43
Calcareous dolomite	0. 1:0. 5	1. 700: 4. 173
Dolomite	0 :0. 1	1. 391: 1. 700

Organic matter had been determined separately in relatively few of the analyses assembled in this report. In the calculations for most of the analyses, the classification system used in this report has tended to include the undetermined organic matter in the clay fraction. For this reason, if organic matter is given separately, it is added to the clay fraction.

A detailed explanation of the successive steps by which the classification is applied to individual analyses is given in the section "Calculations for Classifying Analyses."

Assignment of an analysis to a compositional group is determined by calculating the three main components from the analysis to 100 percent. These calculated figures are not given in the tables.

CATEGORIES

The categories are based on the degree to which the three main components used to define the groups are admixed with other materials. The categories are defined by the following amounts of the three main components:

Percent	*Category*
>90	Common rock
50–90	Mixed rock
<50	Special rock

The special-rock categories are designated according to the kind of material admixed with the three main components.

The boundaries of the special-rock category were not always strictly followed. Several analyses that would fall into the mixed-rock category were included in the special-rock category because the composition of the sample is either unusual or of interest for other reasons. Such analyses can be found more easily when they are listed with other analyses of similar character, rather than with analyses grouped on the basis of the three main components. Some of these special-rock analyses that do not meet the definition of the special-rock category also do not meet the general criteria for inclusion in the compilation. (See p. 7–8.)

The relation of the three general categories to one another is clarified by the use of a four-cornered tetrahedron that represents a four-component classification system. (See fig. 2.) The base of the tetrahedron may be taken as the triangular diagram of figure 1, its three corners being, respectively, 100 percent uncombined silica, 100 percent clay, and 100 percent calcium-magnesium carbonate. The apex of the tetrahedron is then 100 percent of some component, or components, other than uncombined silica, clay, or calcium-magnesium carbonate. The interior of the tetrahedron—the volume above the basal triangle—represents those rocks composed partly of the three components (uncombined

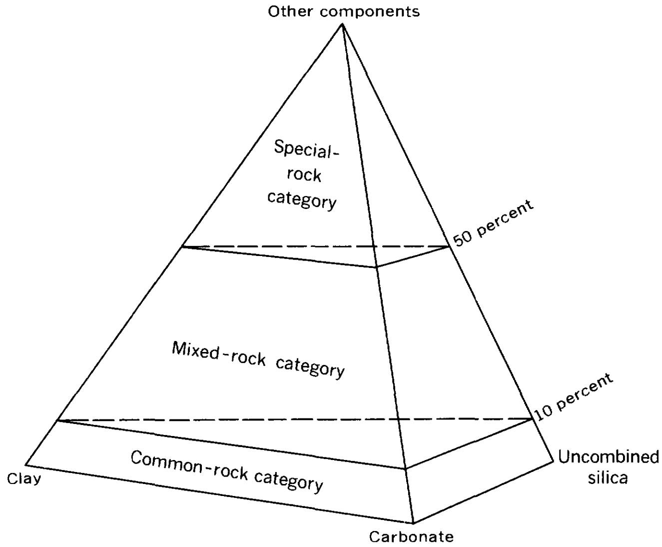

FIGURE 2.—Tetrahedron illustrating three categories of rock compositions: (a) common-rock samples consisting of more than 90 percent uncombined silica, clay and calcium-magnesium carbonate, (b) mixed-rock samples that include one or more additional components, and (c) special-rock samples in which other components such as gypsum or phosphate rock make up more than 50 percent of the sample.

silica, clay, and calcium-magnesium carbonate) and partly of one or more additional components.

For example, the location within the tetrahedron of an analysis consisting of 19 percent uncombined silica, 19 percent clay, 57 percent calcium-magnesium carbonate, and 5 percent calcium sulfate is determined by recalculation of the composition to that of the basal triangle: 20 percent uncombined silica, 20 percent clay, and 60 percent calcium-magnesium carbonate. The analysis is located at this point on the basal plane and then projected toward the apex of the tetrahedron for a distance equivalent to 5 percent (the amount of calcium sulfate in the analysis). The point representing the sample will fall within the volume designated as "Common-rock category" in figure 2.

An analysis that shows 15 percent uncombined silica, 30 percent clay, 15 percent calcium-magnesium carbonate, and 40 percent calcium phosphate is recalculated to the composition of the basal triangle—that is, 25 percent uncombined silica, 50 percent clay, and 25 percent calcium-magnesium carbonate. The sample is located at this point on the basal plane and then projected toward the apex for a distance equivalent to 40 percent (the amount of calcium phosphate in the analysis). The point representing the analysis will then fall in the upper part of the volume designated as "Mixed-rock category" in figure 2. If the analysis had shown 60 percent calcium phosphate, the point representing it would have fallen in the lower part of the volume designated as "Special-rock category."

In the table of analyses that make up most of this report, each sample that falls into either the common-rock or the mixed-rock category has a classification notation indicating the calculated percentages of the three components—uncombined silica, clay, and calcium-magnesium carbonate. For example, the numbers "11, 18, 68," following the designation "class" are to be read as 11 percent uncombined silica, 18 percent clay, and 68 percent calcium-magnesium carbonate. The total, 97 percent, indicates that this analysis lies 3 percent above the basal plane of the tetrahedron and thus falls within the common-rock category.

If the class numbers total less than 90 but more than 50 (the analysis thus falling in the mixed-rock category), the analysis identification number at the head of the analysis column and in the descriptive notes is preceded by an asterisk; for example, *25. The descriptive note for each of these analyses includes a statement regarding the constituents other than the three main components that cause the analysis to be in the mixed-rock category. Analyses in the common- and mixed-rock categories are not given separately in the tables but are included in normal sequence according to location, group, and so forth.

A few otherwise satisfactory analyses do not include determinations of SiO_2 but give only the percentage of material that was insoluble in acid. For such analyses the general procedure was modified by the assumption that the amount of material insoluble in acid is an approximate measure of the SiO_2 content. Such analyses are indicated by the enclosure of the first two numbers of the class notation in parentheses. By use of the same example as that of the preceding paragraph, the notation would then become "(11,18) 68."

SPECIAL-ROCK CATEGORY

Components other than uncombined silica, clay, and calcium-magnesium carbonate make up more than half the rock of the samples in the special-rock category.

The analyses of rocks in the special-rock category fall into the upper part of the tetrahedron (fig. 2), but the apex of the tetrahedron represents a different material for each group in the special-rock category. To keep the nomenclature of the classification scheme simple and reasonably consistent, the different special-rock categories are designated as "groups" by analogy with the use of that term for the different mixtures of the three main components of the basal plane of the tetrahedron.

Group H (more aluminous clays): In order to classify a large number of analyses by a three-component system based on amounts of uncombined silica, clay, and calcium-magnesium carbonate and yet not obscure rocks of unusual or economically significant composition, a clay molecule was chosen with a SiO_2/R_2O_3 molecular ratio of 3. The choice of this ratio means that when analyses of clay or ferruginous matter have a SiO_2/R_2O_3 molecular ratio of less than 3 and are classified under this system, they are found to show various amounts of excess Al_2O_3 and excess Fe_2O_3. Such analyses are further examined to determine whether these more aluminous components amount to more than 50 percent. If they do, they are placed in a high-alumina special-rock category and subdivided according to the weight-percent ratio of silica to alumina determined in the analyses. The silica-alumina weight-percent ratios of assumed constituents are as follows:

Conventionalized clay	1.768
Kaolinite minerals	1.178
Bauxite minerals	0

These ratios lead to the following divisions of group H:

Group Hk: Kaolinlike clays (kaolinlike minerals, no bauxite). SiO_2/Al_2O_3 weight-percent ratio from 1.178 to 1.768. 2.178 $(Al_2O_3)+H_2O$ (however determined) >50 percent.

Group Ha: High-alumina clays (kaolinite minerals predominant, bauxite subordinate). SiO_2/Al_2O_3 weight-percent ratio from 0.371[1] to 1.178. $Al_2O_3+SiO_2+H_2O$ (however determined) >50 percent.

Group Hb: Bauxite and bauxitic clays (bauxite minerals predominant, kaolinite minerals subordinate). SiO_2/Al_2O_3 weight-percent ratio <0.371. $Al_2O_3+SiO_2+H_2O$ (however determined) >50 percent. Group Hb is not represented in the analyses given in this report.

Other groups are:

Group Na (rock salt): Analyses that include materials containing more than 50 percent NaCl.

Group G (gypsum): Analyses of rocks containing more than 50 percent gypsum ($CaSO_4 \cdot 2H_2O$) or anhydrite ($CaSO_4$).

Group S (sodium and magnesium sulfate, miscellaneous sulfate-, carbonate-, and nitrate-bearing material): Analyses mostly of materials containing more than 50 percent of sodium and magnesium salts.

Group P (phosphorite): The phosphate mineral in phosphorite is calculated as fluorapatite ($9CaO \cdot 3P_2O_5 \cdot CaF_2$). The analyses of phosphorite that contain 21.1 percent P_2O_5 or more correspond to those containing 50 percent fluorapatite or more. A few analyses reporting a little less than 21.1 percent P_2O_5 are included in table 24 because the samples are part of a sequence of analyzed samples containing more than 21.1 percent P_2O_5. Other analyses that indicated a content of less than 21.1 percent P_2O_5 are calculated in the regular manner for uncombined silica, clay, and calcium-magnesium carbonate.

Group Fe (iron-rich rocks): Most analyses of iron-rich rocks in this report contain more than 50 percent ferric oxide or ferrous oxide.

Group Mn (manganese-bearing rocks): Several analyses contain less than 50 percent manganese oxides; even so, they were listed in this category on the basis of potential economic value or special interest.

Group M (miscellaneous): In some, but not all, components other than uncombined silica, clay, and calcium-magnesium carbonate make up more than half the rock. Analyses of coal and the ash of coal make up most of the group. The rest of the analyses—those of oil shale, weathered igneous rock, nodules, and baritic sinter—are included in this group because they do not meet the criteria for inclusion in either the common- or mixed-rock categories.

[1] SiO_2/Al_2O_3 weight-percent ratio for a mixture of equal amounts of bauxite minerals and kaolinite minerals.

DISCUSSION

No grading was made of the analyses into categories of superior, good, and fair. This separation would require the wisdom of Solomon, and it might prevent the user of the report from making his own assessment. The date of original publication of the analyses affords the user a generalized means by which the reliability of such analyses can be appraised. Wherever available, the analyst's name is given as an additional basis by which the quality of the work may be judged. A critical selection of truly superior analyses of sedimentary rocks can probably best be made after the present, more inclusive compilation has become available. Distribution of analyses by State, by classification groups, by category, or by other characteristics is given in tables 29–33.

The user should note that the published analyses, despite their large number, are probably not truly representative of the composition of all sedimentary rocks of the region. Most of the analyzed rocks were selected because they are (or were thought to be) of special economic interest and are, hence, probably of rather unusual chemical composition. For example, limestone that contains 95 percent or more $CaCO_3$ is grossly overrepresented in the published analyses; natural limestone analyses show a wide range in $CaCO_3$. But this geochemically unrepresentative or biased nature of the published analyses does not necessarily detract from the potential usefulness of these analyses for other purposes; in fact, there is a great variety of uses to which these analytical data may be put. Carbonate rocks of unusual purity were specially selected for analysis, which affords the potential manufacturer of lime, industrial fluxes, and other mineral commodities valuable information on localities where the best source materials for his particular purpose can most readily be obtained.

The geologist or geochemist interested in estimating the average composition of the earth's materials probably cannot find the gross averages of thousands of published analyses of unusually pure limestones particularly useful for his purpose. Careful observance, however, of the areal distribution and thickness of different rock types and of different geologic formations represented by the published analyses should enable the geologist or geochemist to make closer estimates of average compositions than most of those now available (or at least enable him to discover which rock types and formations are most in need of new analytical data).

Several noteworthy questions and facts about sedimentary rocks resulted from the compilation, but only a few can be mentioned here. One possibly significant relation became apparent when the 2,362 classified analyses of this report were plotted on triangular diagrams (figs. 3–9). A very large proportion of all the analyses fall not within the central region of the diagram, as might reasonably be expected, but within about 5 percent of the exterior boundaries of the triangle. This result means that many samples of uncombined silica and clay mixtures contain very little calcium-magnesium carbonate, and that many samples of clay and calcium-magnesium carbonate mixtures contain very little uncombined silica, and so on.

The somewhat unexpected relation just mentioned is closely analogous to an empirical observation also referred to previously—that a very large proportion of the classified analyses of this report fall into the common-rock category and that relatively few fall into the mixed-rock category. (See figs. 1, 2.) Plotted on the composition tetrahedron, the analyses tend to group mainly along and near its edges and exterior faces, and not in the center. The tendency of the analyses to group at certain places in the tetrahedron can be partly explained by the predominantly economic interest that governed the selection of certain rock types for analysis. This bias of sample selection accounts readily enough for the concentration of analyses of silica sand (group A) and of high-calcium limestone (group F_2). But the concentration of analyses along the edges between the corners of the tetrahedron and near its basal plane is not so easily accounted for by this explanation. Also, exclusion from this compilation of those analyses having summations less than 95 percent probably tended to eliminate the incomplete analyses of rocks of more complex composition. This explanation, however, probably accounts for only a small part of the empirically observed grouping.

This relation, then, is probably not an artifact resulting from systematic bias in the choice of analyzed samples or in the classification system used; rather, the grouping relation is largely a result of natural sedimentation processes that tend to make these environments favorable for deposition of sand and unfavorable for the deposition of clay and carbonates. The reverse is also true. Thus, the environments of sand, clay, and calcium-magnesium carbonate deposition may, to a measurable extent, be mutually opposite. If so, the data of this compilation stand as a tribute to the good judgment of geologists who, years ago, adopted the familiar sand–clay–calcium-magnesium carbonate diagram. The validity of these relations will be substantiated or weakened as the compilation of analyses of rocks of other regions progresses.

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GENERAL INFORMATION

CRITERIA FOR INCLUSION OF ANALYSES

The chemical analyses of sedimentary rocks were taken from many publications, and as a result the constituents determined, as well as the methods used for determination, vary widely. Uniformity seemed desirable in presenting the analyses in this report, and several general rules were formulated. The information concerning some of the analyses included is probably inadequate for certain purposes. However, a more critical selection from this large number of analyses can be made by the reader.

TYPES OF SAMPLES

Sedimentary, metamorphic, and igneous rocks.—The precise dividing line between sedimentary and metamorphic rocks is not a sharp one in nature, and different authors do not always clarify in their published literature which way this dividing line lies from a given analyzed sample; nevertheless, the usage of the individual author was followed wherever possible. Slightly altered rocks are generally included; considerably altered rocks are not. An "altered" rock is included if the "alteration" is interpreted to be due primarily to sedimentary or diagenetic processes, rather than to metamorphic or hydrothermal processes. In general, Precambrian sedimentary rocks have been greatly modified by pressure, heat, and circulating fluids; only those that seem from the description to have been slightly modified are included. If a sample is part of a series (as an igneous rock and its weathered and partly weathered products), the complete series or representative samples from the complete series are included. "Marble" is sometimes applied as a trade name to any carbonate rock that will take high polish, and for this reason analyses of some rocks called "marble" are also included. Analyses of some rocks of doubtful origin, or ones that have undergone an unknown amount of metamorphism, are included if the rock is of special economic interest.

Washed and purified samples.—Analyses of washed and purified samples are included if no more than 10 percent of the material was removed during the processing.

Weathered samples.—Analyses of weathered samples are included if the samples are parts of series—for example, the original rock, its partly weathered product, and the resulting soil. Also, analyses of redeposited weathered material are included, but unless the samples are a part of a series, as above, analyses of weathered material at its source are not included.

Coal and oil-shale samples.—Coal analyses are generally excluded; however, analyses of coal and oil shale are included if analyses of the ash are also available. If the number of such analyses is large, a selection of representative analyses is given.

Pure samples.—Analyses of hand-picked samples of a certain color or of "pure" composition are not included. Analyses of samples thought to be representative of a part of a formation or a member are included.

Concretions and nodules.—Concretions and nodules may be typical of some formations or they may be of scientific interest. Analyses of such samples are included.

ANALYSES OF SAMPLES

Completeness.—No selection based on the known or inferred quality of the analyses was made except that the totals be in the range from 95 to 102.5 percent. Selection and grading of analyses based on quality and completeness are left to the reader. A few analyses are included that do not precisely meet the standards outlined above—such as, if the sample (a) is part of a series, (b) is the only one of a given formation, (c) is of particular economic or scientific interest, or (d) contains constituents not commonly determined, or if (e) the sample information includes a spectrographic analysis. If a large number of incomplete analyses included complete spectrographic analyses, a few of these incomplete analyses were selected to show the upper and lower limits of various constituents in both the chemical and spectrographic analyses.

Insoluble residues.—An analysis that records more than 25 percent of the rock as insoluble in acid, and that does not report SiO_2 separately, is not included.

Totals.—In general, an analysis is used if the total is within the range of 95 to 102.5 percent. In some analyses the percentage of a readily calculated constituent that had not previously been determined brings the total within these limits. For example, in some limestone and dolomite analyses CO_2 was not determined, and the analysis total is accordingly too low to meet the 95-percent criterion. However, analyses of limestone and dolomite are included if the CO_2 calculated from the determined CaO and MgO brings the total within the 95-percent limit. In a few published analyses, the individual totals fall between 95 and 102.5 percent, but the actual sums of the constituents are less than 95 percent or more than 102.5 percent; these analyses are not included.

Data on sample locality and formation.—Only analyses that contain reasonably adequate information concerning locality and formation are included. If this information is not available in the original publication, an effort was made to obtain it from the appropriate State Survey or from individuals who are familiar with the area. The source of such additional information is cited as a written communication.

EXPLANATION OF TERMS AND ARRANGEMENT OF TABLES

References.—In the descriptive notes of an individual table, the first page number given in the reference indicates the page on which the analysis is found in the cited report. If more than one reference is given for an analysis, the first given is generally the reference from which the analysis is taken. References other than the first supply additional information on the descriptive notes or on the analysis itself.

Identification numbers and code numbers of analyses.—Each analysis is assigned two numbers. The first is an identification number that serves to relate the analysis and the sample description in the tables. These identification numbers run in sequence through each table. An asterisk preceding this number indicates that the sample is in the mixed-rock category. (See p. 5.) The second number is a code that identifies the sample in permanent files and gives some information on the locality and rock type represented by the analysis. This number appears only in the column headings of the analytical tables. The code number $5F_27$–21 is translated as follows:

5 Colorado. (See p. 195 for State codes.)
F_2 High carbonate group. (See p. 4 for definition of groups.)
7 Boulder County. (See p. 195–196 for county codes.)
21 Position of analysis in sequence of analyses from Boulder County.

Lithology.—The rock name given to a sample is that used in the original reference. Where the reference gives no name, or where the compilers felt there was some doubt as to the accuracy of the name, a name was supplied on the basis of either the position of the analysis in the classification system or the compilers' interpretation of the original publication. The name supplied by the compilers appears in parentheses and is followed by the name, if any, given in the reference.

Treatment of stratigraphic nomenclature.—Because the stratigraphic nomenclature used in this report is from many published sources, the names and ages do not necessarily reflect the latest usage of the U.S. Geological Survey. The formal geologic names have not been capitalized in accordance with the "Code of Stratigraphic Nomenclature" (Am. Comm. on Strat. Nomenclature, 1961). The age and formation of each sample is given in the descriptive notes as reported in the published source of the analysis, except for some samples for which the reported assignment is so out of date as to be misleading and better information could be obtained conveniently. The age is not repeated if more than one analysis of the same formation appears on the same page.

Chemical analyses.—The lists of constituents in the tables were simplified as much as possible by the use of footnotes to indicate that the entry shown as SiO_2 was reported in the original published analysis as insoluble matter; that the figures for CaO and MgO are derived from an original analysis in which $CaCO_3$ and $MgCO_3$ were reported; or that an oxide figure was calculated from an original report of the element if the element amounted to more than 0.05 percent, and similar information. The analyses are thus brought into a superficially similar form.

Minor elements such as arsenic, vanadium, selenium, and others were determined chemically for a few samples that were also analyzed spectrographically. Analyses for such minor elements are listed with the spectrographic analysis and are identified as chemical determinations by means of a footnote.

Spectrographic analyses.—Spectrographic analyses of minor constituents are given only for those samples for which chemical analyses of major constituents are also available. Some incomplete chemical analyses have been included if spectrographic analyses are available, but if a great many incomplete chemical analyses and accompanying spectrographic determinations are available, a selection was made. This selection shows the upper and lower limits of each constituent analyzed. The methods of spectrographic analysis and the constituents looked for vary considerably from one laboratory to another, and no attempt was made to evaluate the spectrographic data.

Mineralogy.—The word "mineralogy," as used in this report, indicates that information on the mineralogy of the sample is available in the original publication.

Nil, None, Trace.—The words "nil," "none," "trace," "slight trace," and similar terms are used in accordance with the original publications. These terms may have different meanings to different chemists, and it thus seemed unwise to attempt reduction to a more nearly uniform nomenclature.

Punctuation and footnotes.—Additional information not available in the original publication but relating to the locality, formation, or rock name is in parentheses if it was supplied by the compilers. Information supplied by others is cited as written or oral communication. Parentheses are also used in the tables of analyses to indicate those amounts not included in the total; a footnote for such amounts gives further information. Also, parentheses are used for some references to aid clarity where more than one reference is cited. Each set of facing pages with chemical analyses and accompanying descriptive notes are considered as a unit, and the footnotes, numbered accordingly, apply only to that unit.

Reported use of rock.—Generally, the information on the actual or potential economic use is given only if it is stated in the original publication. No effort was made to equate the different terms used nor to bring the information up to date.

ANALYSES

The 2,842 analyses compiled are presented in tables 1–27 of this report. The tables are arranged in sequence according to classification groups: the common- and mixed-rock categories, and the special-rock category. For groups A, C, and E, each table lists the analyses by States in alphabetical order and contains all the analyses in the group. For groups B, D, F_1, and F_2, each of which contains several hundred analyses, the analyses for each State (or group of States) are given in a separate table. The tables for these groups are alphabetically arranged by State(s). Each group, special-rock category, is in a separate table.

TABLE 1.— Analyses of samples from Colorado, Kansas, Montana, Nebraska, South Dakota, and Wyoming containing more than 75 percent uncombined silica (Group A) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado								Kansas				
	1	2	3	4	5	6	7	8	9	10	11	12	13
	5A18-1	5A18-2	5A18-3	5A18-9	5A30-1	5A36-1		5A47-1	15A4-1	15A4-2	15A4-3	15A10-2	15A10-1
SiO_2	95.4	98.70	98.7	98.2	96.7	93.11	89.14	90.2	85.74	97.15	98.54	96.45	96.90
Al_2O_3	4.09	.95	.98	.55	.09	5.56	5.32	.82	[1] 6.84	[2] 1.44	[3] .72	2.76	2.03
Fe_2O_3	.18	.25	.09	.16	.13	1.15	1.10	2.58	[4] .79	.20	.172	[5] .37	[5] .67
MgO	......	......	......	......	......	.10	.10	.51	1.11	......	.07	......	......
CaO	.04	.04	.05	.035	.055	.32	.31	3.2	.49	......	.03	......	......
Na_2O	1.08	.74	.80	.75	.86	......	......	......	1.16	[6] .67	.02	......	......
K_2O	......	......	......	......	......	......	......	......	2.19		.09	......	......
TiO_2	......	......	......	......	......	......	......	......	[7] .38	......	[8] .09	......	......
P_2O_5	......	......	......	......	......	......	......	......	.01	......	.018	......	......
CO_2	......	......	......	......	......	......	......	2.56	......	......	......	......	......
S	......	......	......	......	......	......	......	......	......	......	Tr.	......	......
SO_3	......	......	......	......	......	......	......	......	Nil	......	.009	......	......
Organic matter	......	......	......	......	......	......	......	.04	......	......	......	......	......
Ignition loss	......	......	......	......	......	[9] (4.45)	4.26	......	[10] 1.12	[11] .54	[12] .34	......	......
Total	100.8	100.68	100.6	99.7	97.8	100.24	100.23	99.9	99.83	100.00	100.10	99.58	99.60
Class	88, 12, 0	97, 3, 0	97, 3, 0	97, 2, 0	96, 1, 0	......	78, 21, 1	86, 8, 6	73, 22, 0	94, 5, 0	97, 3, 0	91, 9, 0	93, 7, 0

	Kansas												
	14	15	16	17	18	19	20	21	22	23	24	25	26
	15A11-1	15A11-2	15A11-3	15A11-6	15A11-4	15A11-5	15A15-39	15A17-1		15A27-1	15A33-1	15A33-2	15A33-3
SiO_2	99.13	[13] 98.60	99.23	97.33	[14] 97.75	[14] 92.28	84.64	98.72	97.75	91.36	88.09	97.10	86.98
Al_2O_3	.16	.52	.22	1.89	1.61	1.25	5.90	[3] .72	[5] 1.23	3.71	3.50	1.26	3.71
Fe_2O_3							1.95	.123	.163	.54	1.35	.06	1.89
MgO	.01	Tr.	Tr.	.09	Tr.	......	......	.03	.05	.35	1.08	.10	1.13
CaO	Tr.	.10	.02	.11	.45	Tr.	......	.01	.02	.25	.69	.00	1.08
Na_2O	......	......	......	......	......	......	......	.01	......	1.30	1.01	......	1.20
K_2O	......	......	......	......	......	......	......	.03	......		1.47	......	1.49
TiO_2	......	......	......	......	......	......	......	[8] .08	[8] .19	1.06	......	......	......
P_2O_5	......	......	......	......	......	......	......	.007	.009	......	......	......	......
BaO	......	......	......	......	......	......	......	.013	......	......	......	......	......
S	......	......	......	......	......	......	......	Nil	......	......	......	......	......
SO_3	......	......	......	......	......	......	......	.027	[15] .030	......	.00	.00	.00
ZnS	......	......	......	......	......	4.08	......	......	......	......	......	......	......
Ignition loss	.20	.40	.50	.77	......	......	3.48	[12] .34	[12] .54	1.40	2.21	1.52	2.08
Total	99.50	99.62	99.97	100.19	99.81	[16] 97.61	95.97	[17] 100.11	99.98	99.97	99.40	100.04	99.56
Class	99, 1, 0	98, 2, 0	99, 1, 0	94, 6, 0	95, 4, 0	90, 4, 0	72, 24, 0	97, 3, 0	......	84, 12, 1	80, 14, 2	95, 5, 0	78, 16, 1

	27	28	29	30	31	32	33	34	35	36	37	38	39
	15A37-1	15A37-2	15A37-3	15A37-4	15A49-1		15A63-1	15A63-2	15A69-1	15A72-25	15A74-2	15A74-1	15A74-3
SiO_2	97.28	98.02	97.81	98.24	97.61	94.97	97.80	97.08	98.00	86.79	87.00	95.40	96.30
Al_2O_3	.96	.81	.73	.57	[3] 1.18	[3] 2.59	......	......	.52	4.44	4.01	1.33	1.28
Fe_2O_3	[5] .80	[5] .26	[5] .35	[5] .35	.29	.55	[5] .84	[5] .72	.06	2.09	1.59	.29	.24
MgO	.04	.06	.05	.04	.06	.18	......	......	.06	......	.00	.11	.10
CaO	.13	.08	.18	.06	.04	.10	......	......	.04	......	1.10	.06	.08
$Na_2O + K_2O$	......	......	......	......	......	......	......	......	......	......	3.30	......	......
H_2O-	......	......	......	......	......	......	......	......	......	......	1.00	......	......
TiO_2 [8]	......	......	......	......	.10	.23	......	......	......	......	......	......	......
P_2O_5	......	......	......	......	.007	.002	......	......	......	......	......	......	......
S	......	......	......	......	.002	.018	......	......	......	......	......	......	......
SO_3	......	......	......	......	.028	.022	......	......	.00	......	......	.00	.00
Ignition loss	.73	.81	.80	.72	[12] .54	[12] 1.09	......	......	1.18	3.37	2.00	2.3	1.60
Total	99.94	100.04	99.92	99.98	99.86	99.75	98.64	97.80	99.86	96.69	100.00	99.5	99.60
Class	95, 5, 0	96, 3, 0	96, 3, 0	97, 3, 0	95, 4, 0	......	97, 2, 0	96, 2, 0	97, 3, 0	77, 20, 0	78, 17, 1	93, 6, 0	94, 5, 0

[1] Includes MnO_2.
[2] Reported as R_2O_3, includes alumina but not iron oxide.
[3] Includes undetermined manganese.
[4] Total iron.
[5] Total Fe (Clarke, 1915, p. 220).
[6] Reported as other (chiefly alkalies).
[7] Includes ZrO_2 and V_2O_5.
[8] Includes ZrO_2 and V_2O_5 if present.
[9] Not included in total.
[10] 140° - 1,000° C.
[11] At 1,000° C.
[12] 105° - 1,000° C.
[13] 98.00 percent (Haworth and others, 1904, p. 79).
[14] Insoluble siliceous residue.
[15] Total sulfur.
[16] 99.58 in text.
[17] 100.09 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1. Douglas County. Triassic(?) or Permian(?), Lykins formation. NE¼ sec. 34, T. 6 S., R. 69 W., Kassler quarry. (Vanderwilt and others, 1947, p. 263.) Silica sand, white, fine-grained, soft. Small tonnage indicated. Possible use: Window glass if washed.
2. Douglas County. Upper Cretaceous, Dakota sandstone. NE¼ sec. 11, T. 7 S., R. 69 W., Molding Sand quarry. (Vanderwilt and others, 1947, p. 263.) Silica sand. Use: Not suited for glass manufacture.
3. Douglas County. Dakota sandstone. SW¼ sec. 12, T. 7S., R.69W., Helmer quarry. (Vanderwilt and others, 1947, p. 263.) Silica sand, white, fine-grained, soft. Iron-stained streaks eliminated by hand sorting. Use: Window glass.
4. Information as in sample 3. (Presumably another sample from same area.)
5. Jefferson County. Lykins formation. SW¼ sec. 27, T. 6 S., R. 69 W., Little quarry. (Vanderwilt and others, 1947, p. 264.) Silica sand. Estimated tonnage. Use: Glass bottles. Possible use: Window glass if washed.
6. (Las Animas County.) Dakota sandstone. (T. 27 S., R. 60 W.), 3 miles southeast of mouth of Apishapa Canyon. Analyst, Stokes. (Stose, 1912, p. 11.) Clay, from transitional beds at top of formation. Geologic maps. Possible use: Refractories.
7. (Same sample as 6. Analysis calculated by compilers to include ignition loss.)
8. Park County. Oligocene, Antero formation. Tps. 10 and 11 S., Rs. 74 and 75 W., and Tps. 12-16 S., Rs. 75 and 76 W., South Park. Analyst, Schroeder. (Johnson, 1937, p. 1229, 1234, 1235.) (Chert) white or light-gray; fragment of silicified algal colony; originally algal limestone. Description of organism which built colony. (For other analyses of algal limestone in Colorado see sample 94 group B, samples 1 and 3 group C, samples 7 and 20 group F_1, and samples 16 and 70 group F_2; of this compilation.)

Kansas

9. Barber County. Permian, Whitehorse sandstone or Marlow formation. Sec. 4, T. 32 S., R. 13 W. Lab. No. 1816. (Swineford, 1955, p. 122, 10, 11, 27, 125-127, 141, pl. 18.) Sandstone, light-red, cross-bedded. Index and geologic map, generalized columnar section. Petrographic description, photomicrograph, X-ray diffraction data. Use: Building stone.

10-11. Barber County. Lower Cretaceous, Cheyenne sandstone. T. 31 S., R. 15 W. Analyst, Runnels. Index map. Possible use: Glass or foundry sand.
- 10. Center sec. 18. (Rose, 1950, p. 96, 89, 94.) Sandstone, 24 ft channel sample. Typical sample of Cheyenne sandstone.
- 11. Secs. 17-19, DH 7-10; Comanche County. NW¼ sec. 27, T. 31 S., R. 16 W., DH-11. Lab. No. 50141. (Nixon and others, 1950, p. 76, 46, 50, 54, 56, 58, 62, 63, 68, 77, 79, 82, 83.) Sandstone, composite of DH 7-11. Analysis of fraction passing 20 and retained on 100 mesh; estimated tonnage. Logs of drill holes, percentages of iron. For DH-10: Mineralogy, physical properties. For Cheyenne sandstone: Photomicrographs; V, Cr, Cu, and Ag found in extremely small quantities by qualitative spectrographic analysis.

12-13. Chautauqua County. Pennsylvanian, Stranger formation, Tonganoxie sandstone member, and Lawrence shale, Ireland sandstone member (R. T. Rnnnels, written communication, 1953) reported as Buxton formation and as St. Peter sandstone. S½SE¼ sec. 19, T. 34 S., R. 13 E., town of Niotaze. Analyst, Steiger. Lab. No. 2227. (Burchard, 1906, p. 463, 462, 470, 471; Clarke, 1915, p. 220.) Sandstone, about 12 ft thick. Physical properties. Use: Not suitable for glass sand.
- 12. Lab. No. 8. Sandstone, light yellowish-brown.
- 13. Lab. No. 7. Sandstone, white.

14-16. Cherokee County. Mississippian, probably Warsaw limestone or Keokuk limestone (R. T. Runnels, written communication, 1953). (T. 34 S., R. 24 E.) town of Galena, Bonanza shaft. Analyst, Schneider; collector, Jenny. Lab. No. 1205. (Clarke and Hillebrand, 1897, p. 253.)
- 14. Chert, altered.
- 15. Chert.
- 16. Chert, blue, unaltered.

17. County, formation, locality, collector, and reference as in samples 14-16. Analyst, Eakins. Lab. No. 1208. Jasperite.

18-19. Cherokee County. (Warsaw limestone or Keokuk limestone) reported as Upper and Lower Burlington. Galena. Analyst, Robertson. (Haworth and others, 1904, p. 83, 76.)
- 18. Martin and Hughes mine. Lab. No. 517. Chert, light-drab, porous; in fissures of primary chert.
- 19. Lab. No. 518. Chert, dark-brown, hard, somewhat granular and earthy; small crystals of blende; in fissures of primary chert.

20. Cloud County. Dakota sandstone. Center NE¼SW¼ sec. 32, T. 8 S., R. 2 W. (McMillan and Wilson, 1948, p. 8, figs. 1-4.) Clay, gray, yellow, sandy; auger drill hole A-12; depth 17-20 ft. Index maps, generalized columnar section; log of auger drill hole. (For another analysis from same measured section see sample 52, group B of this compilation.)

Kansas--Continued

21-22. Comanche County. Cheyenne sandstone. Sec. 27, T. 31 S., R. 16 W. Analyst, Runnels. (Nixon and others, 1950, p. 76, 46, 54, 56, 68, 77, 79.) Sandstone, 30 ft channel sample; 1.8 percent by weight has grain size of less than 1 micron; chemical analysis of clay from 1 micron fraction of sand also given. Estimated tonnage. Index map. Possible use: Foundry or glass sand. For Cheyenne sandstone: V, Cr, Cu, and Ag, found in extremely small quantities by qualitative spectrographic analysis.
- 21. Lab. No. 50132. Analysis of fraction passing 20, retained on 100 mesh.
- 22. Lab. No. 50133. Analysis of fraction passing 100 mesh.

23. Ellsworth County. Dakota sandstone, Terra Cotta clay member. SE¼ sec. 29, T. 15 S., R. 7 W. Analysts, Thompson and Runnels. Lab. No. El-20-W5. (Plummer and Romary, 1947, p. 139, 5, 10, 42, 43, 132, 138, 141, 142, pl. 1.) Kaolinitic silt, also reported as highly siliceous fire clay, nearly white, some yellow stain, smooth, very fine grained; 6.8 ft thick. Almost all material passes 200 mesh. Index map, outcrop map; detailed measured section, correlated columnar sections. Mineralogy, ceramic tests, physical properties. Possible use: Structural products, refractories, pottery.

24-26. Graham County. Pliocene, Ogallala formation. (Frye and Swineford, 1946, p. 63, 38, 39, 65, pl. 4.) Quartzite. Estimated tonnage, physical tests. Index map, outcrop map. Use: Building stone, road material, railroad ballast, concrete aggregate.
- 24. Sec. 31, T. 7 S., R. 22 W., 3 miles northeast of Hill City. Quartzite, gray to greenish-gray, weathers dull, rusty-red; even-textured, medium to coarse-grained; average thickness about 8 ft. Bulk density, 2.38. Soluble in HCl, 4.90 percent. Photomicrograph.
- 25. Sec. 34, T. 8 S., R. 22 W. Quartzite, gray-green, medium-grained, somewhat cavernous. Bulk density, 2.41. Soluble in HCl, 3.62 percent.
- 26. Sec. 13, T. 8 S., R. 23 W. Quartzite, green; medium fine-grained to conglomeratic. Bulk density, 2.37. Soluble in HCl, 5.62 percent.

27-30. Greenwood County. Stranger formation, Tonganoxie sandstone member and Lawrence shale, Ireland sandstone member (R. T. Runnels, written communication, 1953) reported as Buxton formation and as St. Peter sandstone. SE¼ sec. 13, T. 28 S., R. 12 E., near Fall River. Analyst, Steiger. Lab. No. 2295. (Burchard, 1907, p. 382, 380; Clarke, 1915, p. 220.) Sandstone, about 20 ft thick, from different beds in same measured section. Possible use: Glass sand.

31-32. Kiowa county. Cheyenne sandstone. Secs. 9, 10, 15, 17, and 18, T. 30 S., R. 16 W. Analyst, Runnels. (Nixon and others, 1950, p. 76, 46, 50, 54, 56, 58, 60, 61, 68, 77, 79-82.) Sandstone, composite of DH 1-6. Estimated tonnage. Index map, logs of drill holes, percentages of iron. Possible use: Foundry or glass sand. For DH-4: Mineralogy, physical properties, sieve analysis. For Cheyenne sandstone: Photomicrographs; V, Cr, Cu, and Ag, found in extremely small quantities by qualitative spectrographic analysis.
- 31. Lab. No. 50140. Fraction passing 20 and retained on 100 mesh.
- 32. Lab. No. 50139. Analysis of fraction of sample 31 passing 100 mesh.

33-34. Montgomery County. Stranger formation, Tonganoxie sandstone member and Lawrence shale, Ireland sandstone member (R. T. Runnels, written communication, 1953) reported as Buxton formation and as St. Peter sandstone. T. 34 S., R. 13 E. Analyst, Steiger. (Burchard, 1906, p. 463, 462, 470, 471; Clarke, 1915, p. 220.) Sandstone. Physical properties. Possible use: Glass sand.
- 33. Sec. 13, near town of Havana. Lab. No. 2295. Sandstone, pinkish-brown.
- 34. Sec. 36, 2 miles north of town of Caney. Lab. No. 2222. Sandstone, light yellowish-brown.

35. Norton County. Ogallala formation. Sec. 15, T. 5 S., R. 21 W. (Frye and Swineford, 1946, p. 63, 38, 39, 67-70, pl. 8.) Quartzite, green to gray-green; medium- to coarse-grained, cross-bedded; bulk density, 2.39. Maximum thickness, 12 ft. Soluble in HCl, 2.78 percent. Estimated tonnage. Index map, outcrop map, physical tests. Possible use: Railroad ballast, road material, building stone, concrete aggregate.

36. Ottawa County. Dakota sandstone. NW¼ sec. 5, T. 9 S., R. 2 W. Auger drill hole A-22. (McMillan and Wilson, 1948, p. 15, figs. 1-4.) Clay, gray; 1.5-7 ft below surface. Index maps, generalized columnar section, log of auger drill hole. Possible use: Ceramic products.

37-39. Phillips County. Formation, reference, and use as in sample 35. Quartzite. Estimated tonnage. Index map, outcrop map; physical tests.
- 37. Sec. 4, T. 1 S., R. 19 W., 3-4 miles west of town of Woodruff; quarry. Quartzite, green to gray-green; medium-grained to conglomeratic; lenses 5-6 ft thick in sand and gravel. Bulk density, 2.63.
- 38. Sec. 7, T. 5 S., R. 17 W. Bulk density, 2.39. Soluble in HCl, 5.2 percent.
- 39. Sec. 23, T. 5 S., R. 19 W. Bulk density, 2.39. Soluble in HCl, 3.60 percent.

TABLE 1.—Analyses of samples from Colorado, Kansas, Montana, Nebraska, South Dakota, and Wyoming containing more than 75 percent uncombined silica (Group A) common and mixed rock categories--Continued

	Kansas							Montana				Nebraska	
	*40	41	42	43	44	45	46	47	48	49	50	51	52
	15A80-1	15A82-1	15A103-1	15A103-2	15A103-3	15A103-4	15A103-5	25A1-2	25A1-1	25A14-1	25A29-1	26A10-2	26A18-1
SiO_2	[1] 71.75	96.50	97.59	98.00	97.94	97.50	98.71	[2] 88.1	[2] 87.3	91.8	[2] 88.2	[2] 81.32	[2] 81.30
Al_2O_3	......	.78	......	......	......	1.62	......	3.0	5.1	4.31	.8	.75	.73
Fe_2O_3	4.74	.32	[3] .33	[3] .37	[3] .63	[3] .43	[3] .19	2.5	3.0	.28	2.1	3.87	3.85
MgO	.80	.06	......	......	......	None	......	......	......	.10	......	[4] .61	[4] .63
CaO	1.43	.44	......	......	......	.10	......	......	......	.06	......	[4] 5.34	[4] 5.33
Na_2O	......	......	......	......	......	......	......	......	......	.08	......	.16	.16
K_2O	......	......	......	......	......	......	......	......	......	.69	......	.29	.34
H_2O-	......	......	......	......	......	......	......	......	......	......	......	1.08	1.08
P_2O_5	......	......	......	......	......	......	......	3.2	1.6	......	1.8	[4] 1.64	[4] 1.63
Mn_3O_4	12.08	......	......	......	......	......	......	......	......	......	......	......	......
SO_3	4.86	.00	......	......	......	......	......	......	......	......	......	......	......
Organic matter	......	......	......	......	......	......	......	......	......	......	......	1.06	1.06
Ign. loss	[5] 4.24	1.32	......	......	......	......	......	1.6	2.3	......	2.1	......	......
Total	99.90	99.42	97.92	98.37	98.57	99.65	98.90	98.4	99.3	97.3	95.0	96.12	96.11
Class	66,13,2	95,4,1	97,1,0	98,1,0	97,2,0	94,6,0	99,0,0	(80,15)0	(75,23)0	84,14,0	(84,9)0	(76,12)5	(76,12)5

	Nebraska				South Dakota		Wyoming						
	53	54	55	56	57	58	59	60	61	62	63	64	65
	26A28-5	26A42-3	26A55-1	26A55-3	40A24-1	40A52-1	49A1-1		49A1-2		49A7-1	49A11-1	49A19-1
SiO_2	[2] 81.28	[2] 81.32	95.76	95.76	98.50	87.050	99.04	99.04	97.92	97.92	94.76	95.46	97.81
Al_2O_3	.75	.74	.48	.49	1.34	6.560	......	......	......	1.03	2.99	2.69	......
Fe_2O_3	3.86	3.86	1.81	1.81		.640	.73	.07	2.01	.20	.23	.18	......
MgO	[4] .62	[4] .62	.16	.16	Tr.	1.243	......	......	......	.13	......	.06	......
CaO	[4] 5.34	[4] 5.36	.24	.25	.11	.950	......	......	......	.47	.21	.14	......
Na_2O	.15	.16	......	.07	......	3.008	......	......	......	......	.13	.25	......
K_2O	.27	.33	......	.01	......						.41		
H_2O+	......	......	......	......	......	......	......	......	......	......	......	......	.37
H_2O-	1.09	1.09	......	......	......	......	......	......	......	......	......	......	
P_2O_5	[4] 1.64	[4] 1.64	......	......	......	......	......	......	......	......	......	......	......
Organic matter	1.07	1.06	......	......	......	......	......	......	......	......	......	......	......
Ign. loss	......	......	......	......	......	1.800	......	.89	......	.25	1.10	1.18	......
Total	96.07	96.18	98.45	98.55	99.95	101.251	99.77	100.00	99.93	100.00	99.83	99.96	98.18
Class	(76,12)4	(76,12)5	93,6,1	93,6,1	96,4,0	78,22,0	98,2,0	......	96,4,0	......	89,10,0	91,9,0	98,0,0

	Wyoming												
	66	67	68	69	70	71		66	67	68	69	70	71
	49A23-4	49A24-2	49A24-56	49A24-54	49A24-18	49A24-48							
SiO_2	[6] 84.14	83.10	89.75	83.66	93.37	89.54	CO_2	None	......	......	......	......	......
Al_2O_3	[7] 5.79	6.02	.38	1.94	1.16	2.12	MnO	......	......	Tr.	Tr.	......	......
Fe_2O_3	[8] 1.21	Tr.	.06	.22	Tr.	Tr.	SO_3	......	0.28	0.05	0.06	0.31	Tr.
MgO	.41	.21	.14	.21	.05	Tr.	Cl	......	......	.03	.27	[9] .08	Tr.
CaO	.13	.80	.56	.76	.29	1.71	Org.matter	......	......	......	......	[10] .85	......
Na_2O	.99	2.18	.26	1.20	.11	1.12	Ign. loss less H_2O	1.21	......	......	......	......	......
K_2O	.50	.87	.12	.42	.02	.30							
H_2O	5.56	6.73	9.36	11.60	4.17	5.13	Total	[11] 100.16	100.19	100.71	100.34	100.41	99.92
TiO_2	.22	......	......	......	......	......	Class	73,23,1	72,23,0	89,11,0	80,17,0	91,8,0	86,11,0

Semiquantitative spectrographic analyses

[C=1-5 percent; D=0.1-1 percent; E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. Li, Be, Co, Ga, Ge, As, Cb, Cd, In, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, Pb, and Bi looked for in all samples but not detected]

	47	48	50		47	48	50		47	48	50
B	F	E	F	V	E	E	F	Zn	E	ND	E
Na	F	E	ND	Cr	E	F	ND	Sr	ND	F	F
Mg	E	D	D	Mn	E	E	E	Zr	F	E	E
Ca	C	C	C	Ni	E	F	E	Mo	F	F	F
Ti	E	E	E	Cu	G	G	G	Ag	ND	ND	G

[1] Includes insoluble.
[2] Insoluble. For samples 51-54 reported as insoluble (siliceous) matter.
[3] Total Fe (Clarke, 1915, p. 220).
[4] Calculated from reported $MgCO_3$, $CaCO_3$, and (or) lime phosphate.
[5] Reported as moisture and volatile.
[6] "Soluble" silica, by 5 percent Na_2CO_3 solution, probably about 0.7 percent judged by analyses of similar material.
[7] Includes P_2O_5. P_2O_5 probably about 0.4 percent judged by analyses of similar material.
[8] FeO probably absent.
[9] Reported as NaCl.
[10] Reported as C, 0.78 percent; H, 0.07 percent.
[11] 100.03 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

*40. Rice County. Upper Cretaceous, Dakota sandstone. (T. 20 S., R. 10 W.), 3 miles north and 2 miles east of town of Raymond. Analyst, Whitaker. (Whitaker and Twenhofel, 1917, p. 474.) (Analysis shows 12.1 percent Mn_3O_4; suggests 4.4 percent gypsum, 2.8 percent more SO_3 than required for gypsum.) Manganese "wad," dark-brown to black, friable, soft. Surface sample.

41. Rooks County. Pliocene, Ogallala formation. Sec. 10, T. 6 S., R. 19 W. (Frye and Swineford, 1946, p. 63, 39, 62, 71, pl. 8.) Quartzite, green to brownish-green; fine-grained to conglomeratic; in lentils. Bulk density, 2.39. Soluble in HCl, 5.10. Estimated tonnage. Index map, outcrop map; physical tests. Possible use: Railroad ballast, riprap, road metal.

42-45. Wilson County. Pennsylvanian, Stranger formation, Tonganoxie sandstone member and Lawrence shale, Ireland sandstone member (R. T. Runnels, written communication, 1953) reported as Buxton formation and as St. Peter sandstone. Analyst, Steiger. (Burchard, 1906, p. 463, 462, 470, 471; Clarke, 1915, p. 220.) Sandstone. Physical properties. Possible use: Glass sand.

42. Sec. 20, T. 29 S., R. 14 E. Lab. No. 1. Sandstone, grayish-white.

43. Secs. 20 and 21, T. 29 S., R. 14 E. Lab. No. 2. Sandstone, grayish-white.

44. T. 29 S., R. 14 E., 5 miles southwest of town of Fredonia. Lab. No. 4. Sandstone, yellowish-brown.

45. T. 29 S., R. 15 E., 1.5 miles southeast of Fredonia. Lab. No. 3. Sandstone, light-gray, micaceous, porous; grains angular; coarser than other sandstones in vicinity; cross-bedded; 6 ft exposed.

46. County, formation, analyst, name and use as in samples 42-45. (T. 30 S., R. 16 E., town of Neodesha.) Lab. No. 2222. (Clarke, 1915, p. 220.)

Montana

47-48. Beaverhead County. Permian, Phosphoria formation. NW¼SW¼ sec. 23, T. 9 S., R. 9 W., near Sheep Creek Canyon. Spectrographic analyst, Mortimer. Index, outcrop map; generalized columnar section. (For other analyses from same measured section see samples 1-3 group B, sample 1 group D, and samples 15-18 group P; of this compilation.)

47. Lab. No. ERC-51. (Swanson and others, 1953b, p. 18, 2, pl. 1.) Sandstone, cherty; bed C-12; 7.2 ft thick, 5.2 ft from top of member; trench sample.

48. Lab. No. LAT-78. (Swanson and others, 1953b, p. 16, 2, pl. 1.) Mudstone and chert; bed E-10; 10.2 ft thick, 1.9 ft from top of member; trench sample.

49. Fergus County. Upper Cretaceous, Eagle sandstone (U. M. Sahinen, written communication, 1957). Sec. 23, T. 17 N., R. 18 E., about 3 miles southwest of town of Hilger. (Robertson, 1950, p. 66, figs. 1, 2.) Silica sand, light-gray; grains slightly rounded; loosely consolidated. Channel sample across 7 ft of lower part of exposure. Index map, generalized geologic map; screen analysis. Possible use: Molding sand, green or amber glass.

50. Madison County. Phosphoria formation. SE¼NE¼ sec. 35, T. 5 S., R. 1 E., near Jack Creek. Spectrographic analyst, Mortimer. Lab. No. RWS-103-47. (Swanson and others, 1953b, p. 5, 2, 7, pl. 1.) Chert and quartzite; bed 21; 8.6 ft thick; 47.5 ft below top of formation. Trench and outcrop sample. Index, outcrop map; generalized columnar section.

Nebraska

51-54. (Pleistocene.) Analyst, Aughey. (Aughey, 1876, p. 246; Aughey, 1880, p. 267.) Loess.

51. Buffalo County. (T. 8 N., R. 15 W.) bluffs near town of Kearney.

52. Clay County. (T. 7 N., R. 5 W.) near town of Sutton.

Nebraska--Continued

53. Douglas County. (T. 15 N., R. 14 E.) near town of Omaha.

54. Harlan County. (T. 2 N., R. 19 W.), Republican Valley, near town of Orleans.

55-56. Lancaster County. Dakota sandstone. (T. 10 N., R. 6 E.)

55. Robber's Cave, near town of Lincoln. (Burchard, 1907, p. 382, 381; Condra, 1908b, p. 195.) Sand, iron-stained. Most of sand caught on meshes 30, 40, and 50. Possible use: Green or dark glass, if washed.

56. (May be same as sample 55.) Near Lincoln. Analyst, Borrowman. (Condra, 1908b, p. 44, 42, 43.) Sand, light-yellowish or brownish color; angular to rounded quartz grains coated with iron oxide. Possible use: Low-grade glass.

South Dakota

57. Fall River County. Pennsylvanian, probably Minnelusa sandstone. (T. 7 S., R. 5 E.) town of Hot Springs. (Carpenter, 1888, p. 168.) Sandstone, reddish. Use: Building stone.

58. Pennington County. Lower Cretaceous, Fuson shale. (T. 1 N., R. 7 E.), Rapid City. (Todd, 1902, p. 104, 103.) Clay, light-gray, compact, conchoidal fracture. Possible use: Refractories.

Wyoming

59. Albany County. Pennsylvanian, Casper formation. Sec. 25, T. 16 N., R. 73 W., 3 miles east of town of Laramie. (Osterwald and Osterwald, 1952, p. 62.) Glass sand, white, friable, soft. Thickness, 2-4 ft; overburden, 0-10 ft thick. Partial stratigraphic (measured) section. Use: Glass.

60. Probably another analysis of sample 59. (Haugh, 1942, p. 63.)

61. Information as in sample 59.

62. Probably another analysis of sample 61. (Haugh, 1942, p. 63.)

63. Fremont County. Upper Cretaceous, Fox Hills sandstone. (T. 27 N., R. 98 W.), St. Mary's Peak. Analyst, Brewster. Lab. No. 98. (Hague, 1877, p. 155; King, 1878, table 7A.) Sandstone, steel-gray, compact, bedded.

64. Laramie County. Dakota sandstone. (T. 16 N., R. 69 W.) outlying ridge north of Wahlbach Spring. Analyst, Brewster. Lab. No. 99. (Hague, 1877, p. 41; King, 1878, table 7A.) Sandstone, yellowish-brown, fine-grained, even textured.

65. Sweetwater County. Upper Cretaceous, Laramie formation. (T. 18 N., R. 101 W.), Black Butte. Lab. No. 96. (King, 1878, table 7A, p. 336, 337.) Sandstone. Description of Black Butte area.

66. Weston County. Upper Cretaceous, Mowry shale, upper part. Sec. 7, T. 48 N., R. 65 W., near town of Thornton. Analyst, Fairchild; collector, Rubey. Lab. No. C-870. (Rubey, 1929, p. 157.) Siliceous shale, weathered.

67-71. Yellowstone National Park. (Recent.) Upper Geyser Basin.

67. Artemisia Geyser. Analyst, Whitfield; collector, Weed. (Clarke, 1915, p. 223.) Siliceous sinter.

68-69. (Allen and Day, 1935, p. 145, 232.) Siliceous sinter, air-dried. Index map.

68. Biscuit Basin, 50 ft from Mustard Geyser.

69. Near Daisy Geyser.

70-71. Analyst, Whitfield. (Weed, 1889a, p. 670.) (Minor differences in constituents and amounts, see Clarke, 1915, p. 223.)

70. Emerald Spring. Siliceous gel, light-pink, bouyant. Air dried.

71. Old Faithful Geyser. Sinter, white, compact.

TABLE 1.— Analyses of samples from Colorado, Kansas, Montana, Nebraska, South Dakota, and Wyoming containing more than 75 percent uncombined silica (Group A) common and mixed rock categories--Continued

	Wyoming												
	72	73	74	75	76	77	78	79	80	81	82	83	84
	49A24-76	49A24-7	49A24-8	49A24-6	49A24-20	49A24-4	49A24-75	49A24-55	49A24-26	49A24-23	49A24-24	49A24-15	49A24-21
SiO_2	94.0	92.64	79.56	95.84	86.10	93.88	86.9	85.40	83.35	88.48	88.60	92.26	85.85
Al_2O_3	......	Tr.	[1] .46	Tr.	1.96	1.73	3.6	.62	.90	.88	1.60	1.18	1.94
Fe_2O_3	1.0	.60	Tr.	2.68	.717	.14		.10	.10	Tr.		Tr.	
MgO	......	Tr.	1.78	......	Tr.	.07	......	.20	.09	Tr.	Tr.	.06	.30
CaO	......	1.03	1.54	......	.28	.25	......	.76	.92	.18	.95	1.48	1.85
Na_2O	......	......	......	......	......	.28	......	.84	.98	......	......	......	......
K_2O	......	......	......	......	......	.23	......	.21	.21	......	......	......	......
H_2O	5.3	......	......	......	[2] 2.00	3.37	8.00	12.42	13.90	10.40	[3] 3.75	4.97	[2] 4.00
MnO	......	......	......	......	......	......	......	Tr.	Tr.	......	......	......	......
SO_3	......	......	......	......	......	.20	......	.05	.05	......	......	None	......
Cl	......	......	Tr.	......	......	[4] .18	......	.14	.15	......	......	Tr.	......
Ignition loss	......	6.25	13.42	1.50	10.20	......	......	......	......	......	5.25	......	5.75
Total	100.3	100.52	[5] 96.76	100.02	101.26	100.33	98.5	100.74	[6] 100.65	99.94	100.15	99.95	99.69
Class	93, 7, 0	92, 7, 2	79, 12, 6	93, 7, 0	82, 19, 1	91, 8, 0	81, 18, 0	84, 14, 0	82, 17, 0	87, 13, 0	86, 13, 2	90, 8, 0	83, 13, 4

	85	86	87	88	89	90	91	*92	*93	94	95	96	97
	49A24-10	49A24-11	49A24-9	49A24-14	49A24-5	49A24-77	49A24-78	49A24-81	49A24-82	49A24-79	49A24-80	49A24-17	49A24-3
SiO_2	87.14	87.56	83.83	90.85	94.40	90.10	95.4	87.10	89.00	90.0	87.3	92.72	85.08
Al_2O_3	1.67	1.65	......	.83	.79	Tr.	......	......	......	2.6	2.2	1.77	......
Fe_2O_3													2.65
MgO	.23	.46	......	Tr.	None	......	......	......	......	......	......	Tr.	Tr.
CaO	.49	.55	......	.46	None	......	......	......	......	1.6	......	.56	1.67
$Na_2O + K_2O$	.68	.48	......	......	......	......	......	......	......	......	......	......	......
H_2O	9.79	9.30	11.02	7.90	5.02	8.00	2.5	10.60	8.00	5.0	10.3	4.81	[7] 10.67
$MgCl_2$	......	......	4.00	......	......	......	......	......	......	......	......	......	......
Total	100.00	100.00	98.85	100.04	100.21	98.10	97.9	97.70	97.00	99.2	99.8	99.86	100.07
Class	84, 14, 0	85, 14, 0	84, 11, 0	89, 10, 0	93, 7, 0	90, 0, 0	95, 0, 0	87, 0, 0	89, 0, 0	86, 11, 3	84, 16, 0	90, 10, 0	80, 17, 3

	98	99	100	101	102	103	104	105
	49A24-16	49A24-19	49A24-1	49A24-22	49A24-13	49A24-12	49A24-53	49A24-52
SiO_2	92.67	93.60	83.1	85.75	90.28	89.72	98.26	98.24
Al_2O_3	1.42	1.06	[8] 1.2	2.20	2.82	[8] 1.02	1.76	1.62
Fe_2O_3		Tr.			Tr.			
MgO	......	Tr.	......	Tr.	.07	Tr.	......	......
CaO	.66	.50	......	.85	.30	2.01	.18	.18
H_2O+	5.22	4.71	[10] 13.6	[9] 6.25	3.95	[11] 7.34	.20	.10
H_2O-				[2] 5.75	1.86			
SO_3	.17	[12] Tr.	......	......	......	Tr.	......	......
Total	100.14	99.87	97.9	100.80	99.28	100.09	100.40	100.14
Class	90, 9, 0	92, 8, 0	81, 17, 0	82, 17, 2	85, 14, 1	88, 10, 0	95, 5, 0	96, 4, 0

By spectroscopic examination

	73	74	75	76	81	82	84	101
Li	......	......	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Na	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
K	......	......	......	Tr.	Tr.	Tr.	Tr.	Tr.
Ca	......	......	Tr.	......	......	......	......	......
Sr	Tr.	......	......	......	......	......	......	......

[1] Also reported as 0.046 percent by Peale (1873, p. 154).
[2] At 110° C.
[3] At 100° C.
[4] Reported as NaCl.
[5] 97.76 in text.
[6] Less O equivalent to Cl, 0.03 percent. Total, 100.62.
[7] Reported as loss on ignition, water, and organic matter.
[8] Includes FeO.
[9] Reported as ignition loss.
[10] Includes organic matter.
[11] Corrected (Clarke, 1915, p. 223).
[12] Reported as S.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

72-80. Yellowstone National Park. (Recent.) Upper Geyser Basin.
- 72. Near Black Sand Geyser. Analyst, Endlich. (Peale, 1883, p. 413.) Pealite, pinkish, translucent in places; conchoidal fracture; hardness, 6.5-7. Index maps.
- 73. Giant Geyser. Analyst, Endlich. (Peale, 1873, p. 154.) Geyserite, white, red, layered, opalescent. From lower layer of cone, much older than sample 74.
- 74. Giant Geyser. Analyst, Endlich. (Peale, 1873, p. 158, 154.) Typical specimen of geyserite; covered with pearly beads; from top of cone.
- 75. Giant Geyser. Analyst, Endlich. (Peale, 1873, p. 153, 154.) Pealite, milky-white, amorphous, dull, subconchoidal fracture; hardness, 6-6.5; bulk density, 2.4903.
- 76. Spring near Grotto Geyser. Analyst, Peale. (Peale, 1873, p. 156.) Geyserite, greenish-gray, dull; conchoidal fracture; hardness outside, 3; hardness inside, 6.
- 77. Solitary Spring. Analyst, Whitfield. (Weed, 1889a, p. 670; Weed, 1889b, p. 357; Weed, 1891, p. 168.) (Minor discrepancies occur in naming of constituents and their amounts when more than one version of the analysis is found in the literature.) Sinter, white, opaque, light, porous.
- 78. Three Crater Group, Muddy Spring 24. Analyst, Leffmann. (Peale, 1883, p. 412, 408.) Geyserite, red, uneven fracture; hardness, 4. Index maps.
- 79. Locality, 100 ft from Tortoise Shell Spring. (Allen and Day, 1935, p. 145, 232.) Siliceous sinter, air-dried. Index map.
- 80. Near Tortoise Shell Pool. (Allen, 1934, p. 378, 379.) Siliceous sinter, silica entirely opaline.

81-86. Yellowstone National Park. (Recent.) Lower Geyser Basin.
- 81. Between Fountain Geyser and Mud Puffs. Analyst, Peale. (Peale, 1873, p. 158, 146.) Geyserite coating on wood, light-pink, beaded, translucent, vitreous.
- 82. Great Fountain Geyser. Analyst, Peale. (Peale, 1873, p. 145.) Geyserite pebbles; up to 3.0 inches in diameter, concentric layering.
- 83. Surprise Geyser. Analyst, Whitfield; collector, Weed. (Clarke, 1915, p. 223.) Siliceous sinter, incrustation from margin of crater.
- 84. From back of Twin Buttes. Analyst, Peale. (Peale, 1873, p. 146, 158.) Geyserite, rusty-brown, vitreous, conchoidal fracture, irregular composition; hardness, 5.5-6.
- 85. Analyst, Austen. (Peale, 1873, p. 158.) Geyserite. Bulk density, 1.97.
- 86. Analyst, Hitchcock. (Peale, 1873, p. 158.) Geyserite.

87. Yellowstone National Park. (Recent.) Lower Geyser Basin or Upper Geyser Basin. Analyst, Peale. (Peale, 1872, p. 187.) Geyserite, white, cauliflower-like form; hardness, 5; bulk density, 1.866.

88-89. Yellowstone National Park. (Recent.) Excelsior Geyser Basin. Analyst, Whitfield; collector, Weed. (Clarke, 1915, p. 224.) Incrustation of siliceous sinter.
- 88. Incrustation, compact, opaline; from bottom layer.
- 89. Incrustation, from top layer.

Wyoming--Continued

90-92. Yellowstone National Park. (Recent.) Gibbon Geyser Basin. Index maps.
- 90. Spring 25, near Opal Spring. Analyst, Leffmann. (Peale, 1883, p. 411, 409.) Geyserite, white, laminated, uneven fracture; hardness, 5.
- 91. Spring 66. Analyst, Endlich. (Peale, 1883, p. 414.) Pealite, white, conchoidal fracture; hardness, 5.5. Much altered deposit from site of old spring.
- *92. Pearl Geyser 70. Analyst, Leffmann. (Peale, 1883, p. 412, 409, 410.) (Analysis suggests deposit is opal with 10.6 percent H_2O.) Geyserite, greenish-gray, yellowish-white and pearly, irregular fracture; hardness, 6.

93-95. Yellowstone National Park. (Recent.) Heart Lake Geyser Basin. Analyst, Leffmann. Index maps.
- *93. Deluge Geyser, from outer basin. (Peale, 1883, p. 412, 409, 410.) (Analysis suggests deposit is opal with 8.0 percent H_2O.) Geyserite, light-pink, laminated, rosettelike projections or nodules on surface; hardness, 5.
- 94. Rustic Geyser, outer basin. (Peale, 1883, p. 410, 412.) Geyserite pebble, chalky-white surface, porcelainlike inside; irregular conchoidal fracture; hardness, 5.5.
- 95. Rustic Geyser. (Peale, 1883, p. 410, 412.) Geyserite. When fresh, translucent; when dry, white, opaque; hardness, 5.5-6.

96-99. Yellowstone National Park. (Recent.) Norris Geyser Basin. Analyst, Whitfield; collector, Weed.
- 96. Coral Spring. (Clarke, 1915, p. 223.) Siliceous sinter.
- 97. Minute Man Geyser. (Clarke, 1915, p. 224.) Black coating.
- 98. Vixen Geyser. (Clarke, 1915, p. 223.) Sediment.
- 99. (Clarke, 1915, p. 224.) Opal.

100-102. Yellowstone National Park. (Recent.) Shoshone Geyser Basin.
- 100. Bronze Spring. (Leffmann, 1883a, p. 105.) Geyser deposit in convoluted layers with bronze surfaces; powder, fawn-colored; hardness, 5.5.
- 101. Geysers of Shoshone Lake. Analyst, Peale. (Peale, 1873, p. 157, 158.) Geyserite, grayish-white, dull, amorphous, irregular composition; hardness, 5.5.
- 102. Platform near Union Geyser. Analyst, Chatard; collector, Weed. (Clarke, 1915, p. 224, 223.) Incrnstation of siliceous sinter.

103. Yellowstone National Park. (Recent.) Asta Spring, Hillside Group. Analyst, Whitfield. (Weed, 1889a, p. 670; Clarke, 1915, p. 223.) Moss sinter. Much of sinter composed of moss stems; other parts have spaces filled with friable white silica and light-gray opal. Bulk density, 1.7122.

104-105. Yellowstone National Park. (Recent.) Roaring Mountain. (Allen and Day, 1935, p. 400, 232, 399.) Surface deposit, siliceous, thin, covers mountain side. Index map, mineralogy.
- 104. From south end of mountain, 250 ft above base.
- 105. From mouth of steaming fumarole.

TABLE 2.—Analyses of samples from Colorado containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by county and stratigraphic position]

	Colorado											
	1	2	3	4	5	6	7	8	9	10	11	12
	5B1-1	5B6-1	5B6-2	5B7-1	5B7-2	5B7-3	5B7-9	5B7-5	5B7-10	5B7-4	5B7-6	5B7-8
SiO_2	65.40	62.20	57.76	74.67	61.05	60.31	63.309	60.31	63.92	54.30	61.30	62.55
Al_2O_3	16.91	14.19	18.65	14.54	20.18	16.61	14.380	15.76	15.90	15.02	15.03	16.00
Fe_2O_3	2.69	2.6	3.75	1.66	3.47	2.33	6.270	5.69	4.10	9.48	4.67	5.55
FeO	......	......	......	......	......	1.70	.859	......	......	......	......	......
MgO	Tr.	None	.29	.63	1.14	2.46	2.570	2.21	2.26	2.86	2.23	1.90
CaO	1.65	5.28	2.80	.65	1.14	2.91	1.810	2.20	2.53	4.08	2.45	2.04
Na_2O	.32	.34	Tr.	.15	Tr.	.99	2.190	.78	2.23	.43	.18	Tr.
K_2O	1.40	.63	2.75	1.59	2.18	2.95	1.280	2.63	.25	2.64	3.54	2.79
H_2O+	......	......	......	......	......	[1] 4.52	......	......	......	......	......	......
H_2O-	3.42	1.71	3.52	.70	1.76	[1] 1.15	[2] 2.053	1.94	1.52	1.68	.77	1.36
CO_2	......	......	......	......	......	2.81	......	......	......	......	......	......
SO_3	Tr.	Tr.	Tr.	......	Tr.	.12	......	Tr.	......	Tr.	Tr.	Tr.
Ignition loss	7.36	13.34	9.68	5.50	9.09	[3] 1.34	5.223	7.72	6.79	9.11	9.62	7.33
Total	99.15	[4] 100.3	[5] 99.20	100.09	100.01	100.20	99.944	99.24	99.50	99.60	99.79	99.52
Class	32,62,3	34,56,9	21,70,6	47,49,2	21,72,4	28,58,6	31,60,0	26,63,5	31,59,4	17,70,6	29,58,9	28,63,4

	13	14	15	16	17	18	19	20	21	22	23	24
	5B7-11	5B7-7	5B7-12	5B7-13	5B7-14	5B7-15	5B16-1	5B16-2	5B17-3	5B18-4	5B18-5	5B18-6
SiO_2	66.31	61.38	62.23	62.54	65.97	69.16	60.97	69.27	83.95	64.73	72.35	67.04
Al_2O_3	13.69	15.80	17.65	19.53	16.02	19.82	15.67	13.51	[6] 8.92	19.36	14.64	17.60
Fe_2O_3	4.41	5.50	2.35	3.32	4.28	1.53	5.22	3.74	.48	2.19	2.16	2.05
FeO	......	......	......	......	......	......	.35	1.02	.13	......	......	......
MgO	1.58	2.55	.62	.82	1.47	Tr.	1.60	1.09	.97	1.97	1.01	.98
CaO	2.28	2.53	.82	.82	1.46	.99	2.77	2.29	.12	.81	.81	1.48
Na_2O	1.19	1.05	.67	Tr.	.18	Tr.	.97	1.70	.06	Tr.	Tr.	.22
K_2O	2.22	1.82	1.38	1.53	1.80	1.98	2.28	3.14	3.09	.48	2.94	.61
H_2O-	1.68	1.85	1.60	1.66	.22	.60	[7] 9.83	[7] 4.19	[8] 1.90	.37	.29	2.99
P_2O_5	......	......	......	......	......	......	.19	.45	None	......	......	......
MnO	......	......	......	......	......	......	[9] Tr.	[9] Tr.	......	......	......	......
SO_3	......	Tr.	......	......	......	Tr.	......	......	......	......	Tr.	Tr.
Cu	......	......	......	......	......	......	......	......	Tr.	......	......	......
Ag	......	......	......	......	......	......	......	......	.04	......	......	......
Pb	......	......	......	......	......	......	......	......	Tr.	......	......	......
Ignition loss	6.40	7.87	12.13	9.08	8.13	6.58	[10] .31	[10] Tr.	[10] None	10.42	6.04	5.32
Total	99.76	[11] 100.35	99.45	99.30	99.53	100.66	100.16	100.40	99.66	100.33	100.24	98.29
Class	37,53,4	27,63,5	28,66,3	24,70,3	33,59,6	32,65,2	27,64,1	41,50,0	68,28,1	28,66,6	44,50,4	34,61,1

	25	26	27	28	29	30	31	32	33	34	35	36
	5B21-1	5B21-2	5B21-3	5B21-4	5B21-5	5B22-1	5B22-2	5B23-1	5B23-2	5B23-3	5B25-1	5B28-1
SiO_2	66.00	59.66	58.18	59.34	84.60	63.4	72.56	61.08	65.44	71.02	60.81	67.09
Al_2O_3	10.94	17.33	14.42	10.91	9.50	21.1	17.86	13.15	7.46	14.06	16.22	17.67
Fe_2O_3	2.51	3.66	6.63	9.14	.27	1.3	1.14	3.20	1.14	5.94	3.88	2.88
MgO	2.45	2.03	4.89	3.08	1.0	.7	.90	3.86	7.30	2.47	.47	Tr.
CaO	2.80	1.47	3.13	2.63	......	Tr.	.49	5.59	5.76	1.26	2.64	2.20
Na_2O	Tr.	.25	.31	.59	.50	......	.73	.62	Tr.	.79	.85	Tr.
K_2O	1.47	1.70	2.29	2.12	.07	......	Tr.	3.54	1.45	.65	2.20	1.85
H_2O-	3.78	3.11	3.50	3.05	.09	......	.57	1.20	.32	1.32	1.37	1.44
SO_3	1.14	.82	......	1.28	......	......	Tr.	Tr.	.42	Tr.	......	.20
Ignition loss	8.95	9.15	6.53	7.76	3.88	11.4	6.83	9.39	11.02	3.89	9.38	7.22
Total	100.04	99.18	99.88	99.90	[12] 99.9	97.9	101.08	101.63	[13] 100.31	101.40	97.82	[14] 100.55
Class	44,44,9	25,65,6	25,63,3	30,58,6	68,30,2	25,72,1	40,58,3	34,49,11	51,26,18	39,57,0	28,61,6	33,62,4

[1] H_2O+ above 100° C; H_2O- at 100° C.
[2] Reported as loss by drying.
[3] Reported as organic matter.
[4] 100.35 in text.
[5] 99.30 in text.
[6] Includes TiO_2.
[7] Reported as H_2O (ignition).
[8] Reported as H_2O by ignition.
[9] Clarke, 1915, p. 268.
[10] Reported as CO_2.
[11] 100.29 in text.
[12] 100.52 in text.
[13] 100.21 in text.
[14] 100.51 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1-5. Upper Cretaceous. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

1. Adams County. Laramie(?) formation. T. 1 S., R. 67 W., 1 mile west of town of Brighton. Lab. No. 4. (Butler, 1915, p. 342, 153, 154, 318, 319.) Clay, yellow, brown, and green. Fine-grained to sandy, thin to thick beds; medium-hard, 50 ft exposed, overburden, 1-2 ft. Possible use: Brick.

2. Bent County. Dakota sandstone. T. 23 S., R. 52 W., 4 miles south of town of Las Animas. Lab. No. 12. (Butler, 1915, p. 342, 155-157, 318, 319.) Clay, gray, medium-fine, sandy, massive, medium-hard; 5 ft exposed, overburden, 1 ft. Possible use: Brick, earthenware, vitrified and unvitrified floor and roofing tile, sewer pipe.

3. Bent County. Carlile shale. T. 22 S., R. 53 W., 8.5 miles northwest of Las Animas. Lab. No. 15. (Butler, 1915, p. 342, 155, 157, 318, 319.) Shale and clay, gray to black, fine-grained, medium-hard; 35 ft exposed, overburden, 6 ft. Possible use: Brick, drain tile, sewer pipe, earthenware.

4. Boulder County. Dakota sandstone. T. 1 N., R. 71 W., in Polecat Canon near town of Boulder. Lab. No. 45. (Butler, 1915, p. 342, 158, 165, 318, 319.) Clay, gray, medium-grained, very hard, massive; 5 ft thick. Possible use: Brick.

5. Boulder County. Graneros shale. Sec. 19, T. 1 S., R. 70 W. Lab. No. 57. (Butler, 1915, p. 342, 158, 168, 320, 321.) Shale, gray with white streaks, very fine grained, soft; 20 ft exposed. Possible use: Brick, earthenware.

6. Boulder County. Upper Cretaceous, Niobrara limestone, argillaceous beds above base. NE¼ sec. 5, T. 2 N., R. 70 W. Analysts, Phillips, Brobst, and Bates. Lab. No. 158. (Martin, 1909, p. 324.) Clay shale, composite sample from outcrop. Possible use: Cement material.

7. Boulder County. Upper Cretaceous, Pierre shale. (T. 1 N., R. 70 W.), Boulder, Lee yard. Analyst, Stoddard. (Fenneman, 1905, p. 74.) Shale, selected sample. Use: Brick.

8-14. Boulder County. Pierre shale. Analyst, Tremaine. (Butler, 1915, p. 342, 158, 165-173, 320, 321.) Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

8. Boulder, yard of Austin Pressed Brick Co. Lab. No. 50. Shale, yellowish-green, medium-fine, gritty, medium-hard; contains numerous fossils, concretions, and much gypsum; 30 ft thick, overburden, 2 ft.

9. Boulder, Boulder Pressed Brick Co. pit. Lab. No. 49. Shale, yellowish-green, dark-gray and hard in lower part, medium-fine; bands and concretions of lime and iron carbonates; 50 ft thick, overburden, 3-10 ft.

10. Near Boulder, Adamant Brick Co. pit. Lab. No. 47. Shale, yellowish-green and gray, medium-grained, medium-hard to soft, thin beds; 40 ft thick, overburden, 1-3 ft.

11. W½ sec. 4, T. 2 N., R. 70 W., west of town of Longmont. Lab. No. 66. Shale, dark-gray, very fine grained, soft; some large concretions of lime and iron carbonates; 80 ft exposed.

12. Sec. 32, T. 3 N., R. 69 W., Longmont, brick company pit. Lab. No. 76. Clay, yellow-green, fine-grained, medium-hard, thick and thin beds; some grit; 15 ft exposed, overburden, 1 ft. Sample of 11 ft of clay. Possible use: Earthenware, drain tile.

13. NW¼ sec. 29, T. 1 S., R. 70 W. Lab. No. 55. Shale, yellowish-green, soft, somewhat gritty, coarsely granular on weathered surface; 15 ft exposed, overburden, 2-6 ft. Possible use: Earthenware.

14. Sec. 30, T. 1 S., R. 70 W. Lab. No. 56. Shale, blue-gray, fine-grained, medium-hard; 50 ft exposed, overburden, 3 ft.

15-18. Boulder County. Laramie formation. Analyst, Tremaine. (Butler, 1915, p. 342, 158-161, 318, 319.) Clay. Index map. Ceramic tests, physical properties, mineralogy.

15. T. 1 S., R. 69 W., 1 mile south of town of Louisville, Centennial mine. Lab. No. 28. Clay, gray, fine-grained, very hard, thick-bedded; 3 ft sampled, probably 10 ft available. Possible use: Brick.

16. Centennial mine. Lab. No. 30. Clay, gray, fine-grained, soft, soapy feel, thick-bedded; 4 ft sampled, probably 30 ft available. Possible use: Earthenware.

17. Near Louisville. Lab. No. 19. Clay, yellowish-green, fine-grained, somewhat gritty, medium-hard; thin beds contain thin coal layer; 30 ft exposed. Possible use: Brick.

18. T. 1 S., R. 70 W., town of Marshall, Old Rosser mine. Lab. No. 22. Clay, cream-colored, somewhat gritty, very hard; 5 ft thick. Possible use: Brick, vitrified and unvitrified floor tile.

19-20. Denver County. Pleistocene, probably equivalent to Peorian loess (G. R. Scott, written communication, 1956). (T. 3 S., R. 68 W.) town of Denver. Analyst, Eakins. (Emmons and others, 1896, p. 263, 262.) Loess. Mineralogy.

19. Contains grains of eruptive rock. Sampled at depth of 20 ft.

20. Typical of Denver loess. Sampled at depth of 8 ft.

21. Dolores County. (Pennsylvanian, Hermosa formation. Sec. 6, T. 40 N., R. 11 W.), Logan mine, Rico district. Analyst, Hillebrand. (Ransome, 1901, p. 287, 288.) Sandstone, near limonite layer. Mineralogy.

Colorado--Continued

22. Douglas County. Dakota sandstone, lower part. T. 6 S., R. 69 W., 0.75 mile east of railroad station at Platte Canon. Analyst, Tremaine. Lab. No. 120. (Butler, 1915, p. 342, 181, 186, 326, 327.) Clay, black to dark-gray, fine-grained, gritty, hard; 5 ft thick, 100 ft below top of formation. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, vitrified and unvitrified floor tile.

23-24. Douglas County. Analyst, Tremaine. (Butler, 1915, p. 342, 181, 187, 322, 323.) Index map. Ceramic tests, physical properties, mineralogy.

23. Carlile shale. Locality, 1 mile east of railroad station at Platte Canon. Lab. No. 122. Clay, yellow, medium fine-grained, medium-hard; 12 ft sampled, overburden, 3 ft. Contains 4 thin gypsum seams in sampled thickness. Possible use: Earthenware.

24. Laramie formation. T. 6 S., R. 68 W., 3 miles east of railroad station at Platte Canon. Lab. No. 123. Shale and clay, dark-gray, medium fine-grained, soft; 10 ft sampled, overburden 10 ft. Possible use: Brick.

25-28. El Paso County. T. 14 S., R. 67 W., Colorado City. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

25. Dakota sandstone. Lab. No. 156. (Butler, 1915, p. 343, 188, 196, 324, 325.) Shale, gray to black, fine-grained; soft to medium-hard; 10 ft thick, overburden 3 ft. Possible use: Refractories.

26. Graneros shale. Lab. No. 152. (Butler, 1915, p. 343, 188, 195, 324, 325.) Shale, dark-gray to black, medium fine-grained, medium-hard; 60 ft thick, overburden 1 ft. Possible use: Brick.

27. Pierre shale. Ben Brewer Brick Co. yard. Lab. No. 145. (Butler, 1915, p. 342, 188, 194, 324, 325.) Shale and clay, gray, black, and brown, fine-grained, sandy, hard; 20 ft sampled, exposure much thicker. Overburden, 6 in. - 10 ft. Possible use: Brick, earthenware.

28. Pierre shale. Lab. No. 149. Pressed Brick and Fire Brick Co. (Butler, 1915, p. 343, 188, 194, 324, 325.) Shale and clay, gray to black, medium fine-grained, medium-hard. Contains bacculites and impurities; 18 ft sampled, exposure much thicker. Possible use: Brick.

29. El Paso County. Upper Cretaceous and Eocene, Dawson arkose. T. 12 S., R. 62 W., near town of Calhan, Standard Fire Brick Co. Analyst, Tremaine. Lab. No. 148. (Butler, 1915, p. 342, 188, 194, 326, 327.) Clay. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

30. Fremont County. Lower Cretaceous, Purgatoire formation, Glencairn shale member. NE¼NW¼ sec. 20, T. 18 S., R. 69 W., Standard Fire Brick Co. mine. Lab. No. 91. (Waagé, 1953, p. 97, 3, 6, 30, 53, 80.) Plastic clay, dark blue-gray, from 5-8 ft bed near top of member. Index map, generalized columnar section. Use: Low-grade to semirefractories.

31. Fremont County. Purgatoire formation, or Dakota sandstone. T. 19 S., R. 70 W., 3 miles southwest of Canon City, Diamond Fire Brick Co. Analyst, Tremaine. Lab. No. 175. (Butler, 1915, p. 343, 201, 202, 324, 325.) Clay, dark-gray, medium coarse-grained, hard; 20-40 ft below top of formation. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

32-36. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

32. Garfield County. Pennsylvanian, probably Paradox formation (N. W. Bass, written communication, 1956). T. 7 S., R. 87 W., 18 miles south of town of Glenwood Springs. Lab. No. 205. (Butler, 1915, p. 343, 208, 209, 326, 327.) Clay, brown. Possible use: Brick, earthenware, unvitrified floor tile.

33. Garfield County. Probably Paradox formation (N. W. Bass, written communication, 1956). T. 7 S., R. 88 W., 7 miles south of Glenwood Springs, Glenwood Pressed Brick and Plaster Co. Lab. No. 206. (Butler, 1915, p. 343, 208, 209, 326, 327.) Shale, gray to brown, medium-fine, gritty; medium-hard; 15 ft thick. Use: None.

34. Garfield County. Eocene, Wasatch formation (N. W. Bass, written communication, 1956). T. 6 S., R. 93 W., 1 mile north of town of Rifle, Buckle's Brick yard. Lab. No. 211. (Butler, 1915, p. 343, 208, 211, 326, 327.) Shaly marl, purplish, medium coarse-grained, gritty, medium-soft; 15 ft sampled, overburden, 4 ft. Possible use: Brick.

35. Grand County. Upper Cretaceous, Mancos shale. T. 2 N., R. 78 W., 2 miles north of town of Hot Sulphur Springs. Lab. No. 218. (Butler, 1915, p. 343, 212, 213, 326, 327.) Shale, black, very fine-grained, medium-hard, sampled at intervals on several hundred foot exposure. Use: None.

36. Huerfano County. Purgatoire formation. T. 26 S., R. 64 W., about 6 miles northeast of Cuchara junction. Lab. No. 231. (Butler, 1915, p. 343, 216, 218, 328, 329.) Shale, dark-gray with white streaks, fine-grained, medium-hard; thin beds interbedded with thicker sandy layers; 8 ft thick. Possible use: Brick, earthenware, unvitrified floor tile.

TABLE 2.— Analyses of samples from Colorado containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Colorado												
	37	38	39	40	41	42	43	44	45	46	47	48	49
	5B28-2		5B28-3	5B28-4	5B28-5	5B30-2	5B30-3	5B30-4	5B30-5	5B30-6	5B30-7	5B30-8	5B30-9
SiO_2	76.96	71.27	60.91	61.69	66.42	63.29	60.66	63.05	65.17	66.50	60.79	53.17	64.86
Al_2O_3	20.77	19.24	18.77	19.55	21.19	20.93	19.84	13.83	16.73	19.52	16.88	17.36	20.00
Fe_2O_3	1.11	1.03	4.39	3.65	2.98	2.42	3.26	3.42	3.07	2.33	3.12	2.74	2.55
MgO	.32	.30	3.24	2.32	1.03	.97	1.00	1.00	.90	Tr.	1.00	3.65	2.30
CaO	.71	.66	1.36	1.25	2.35	1.05	2.15	3.83	4.64	.91	3.73	3.22	1.95
Na_2O	......	......	1.05	1.04	1.83	Tr.	.18	......	.27	.18	.54	.28	.24
K_2O	......	......	2.19	2.40	2.83	1.65	3.16	2.61	1.80	2.66	2.05	2.31	3.02
H_2O-	......	......	1.40	2.34	......	.76	.80	1.40	1.42	1.90	1.87	1.85	2.37
SO_3	......	......	......	......	......	Tr.	......	......	......	Tr.	......	......	......
Ignition loss	[1] (7.98)	7.39	7.16	9.50	5.15	8.76	8.80	11.60	6.52	6.79	10.50	13.39	5.01
Total	99.87	99.89	100.47	[2] 103.74	[3] 103.78	99.83	99.85	100.74	100.52	100.79	100.48	97.97	102.30
Class	......	36, 62, 2	23, 68, 3	23, 70, 7	26, 70, 0	24, 71, 4	22, 69, 6	35, 54, 9	32, 59, 3	29, 67, 2	27, 62, 9	19, 63, 13	27, 68, 0

	50	51	52	53	54	55	56	57	58	59	60	61	62
	5B30-10	5B30-11	5B30-12	5B30-13	5B30-14	5B30-15	5B30-16	5B30-17	5B30-18	5B30-19	5B30-20	5B30-21	5B30-22
SiO_2	65.77	73.23	66.53	63.61	69.05	73.61	63.69	68.02	71.69	69.48	71.30	64.66	66.03
Al_2O_3	12.69	13.98	17.18	17.43	14.78	13.56	16.20	13.90	10.89	12.44	13.56	18.96	16.50
Fe_2O_3	3.16	2.12	3.62	3.37	2.72	2.44	3.90	3.65	2.91	4.56	4.39	4.44	4.10
MgO	.95	.80	1.45	......	.72	.38	1.15	.90	1.03	.61	.82	1.26	.91
CaO	1.14	1.83	1.50	2.11	2.93	1.39	2.77	2.28	2.93	2.11	.98	1.22	1.30
Na_2O	2.19	.18	.15	.05	.18	.36	......	.28	.23	.30	.19	.27	.18
K_2O	2.79	1.07	2.16	.98	.42	1.09	2.73	1.52	1.78	1.36	1.24	.12	.40
H_2O-	3.39	1.75	1.65	3.17	2.14	1.90	3.04	.49	1.36	1.61	1.46	.65	1.85
SO_3	......	......	......	......	......	......	......	Tr.	......	......	......	......	......
Ignition loss	7.18	5.95	6.73	8.88	7.20	5.65	7.11	8.73	6.27	7.49	6.44	8.62	7.99
Total	99.26	100.91	100.97	99.60	100.14	100.38	100.59	99.77	[4] 99.09	99.96	100.38	100.20	99.26
Class	40, 50, 4	46, 49, 4	32, 62, 3	29, 66, 4	40, 53, 6	47, 49, 3	31, 61, 4	39, 53, 6	49, 41, 6	42, 51, 5	42, 53, 3	26, 69, 5	32, 62, 4

	63	64	65	66	67	68	69	70	71	72	73	74	75
	5B30-23	5B30-26	5B30-25	5B30-24	5B30-27	5B30-28	5B30-29	5B30-30	5B30-31	5B30-54	5B30-32	5B35-9	5B35-1
SiO_2	63.14	72.16	75.07	70.67	71.44	73.32	66.46	66.45	70.86	71.81	72.312	67.37	60.36
Al_2O_3	15.21	15.58	13.93	15.70	18.72	13.26	18.49	21.65	13.93	15.09	12.664	7.84	14.82
Fe_2O_3	3.39	1.37	1.37	3.65	1.38	3.54	3.26	1.65	5.92	[5] 1.75	4.669	1.30	1.38
MgO	2.61	1.01	1.56	.87	.56	.49	Tr.	.78	.91	.05	.944	4.40	1.29
CaO	3.20	1.06	1.13	.76	.41	.51	.41	.57	.65	.14	1.147	6.07	7.74
Na_2O	.78	.63	Tr.	Tr.	.037	.35	Tr.	1.13	.47	1.02	2.472	1.14	.20
K_2O	2.70	1.22	1.45	1.30	.11	.29	.28	.11	.44		3.748	2.38	.61
H_2O+	......	......	......	......	......	......	......	......	......	10.14	[6] 1.797	1.62	......
H_2O-	.84	1.67	1.39	1.09	.55	.72	.61	.61	.25				1.95
P_2O_5	......	......	......	......	......	......	......	......	......	......	.228	......	......
SO_3	......	Tr.	Tr.	Tr.	......	......	......	......	......	......	......	......	......
Ignition loss	7.32	5.20	5.84	5.91	6.15	6.54	9.00	7.63	7.08	......	......	[7] 9.00	11.24
Total	99.19	99.90	101.74	99.95	[8] 99.36	99.02	98.51	100.58	100.51	100.00	99.981	101.12	99.59
Class	32, 55, 6	43, 52, 2	49, 47, 4	39, 57, 2	37, 61, 2	46, 51, 2	30, 67, 1	26, 70, 3	40, 57, 3	45, 52, 0	45, 47, 0	52, 26, 19	33, 50, 16

	76	77	78	79	80	81	82	83	84	85	86	87
	5B35-2	5B35-3	5B35-4	5B35-5	5B35-8	5B35-6	5B35-7	5B36-2		5B36-3		5B39-1
SiO_2	74.90	61.49	74.25	59.36	63.48	58.77	60.01	85.25	81.34	85.98	81.83	63.44
Al_2O_3	12.07	15.51	11.48	18.40	13.16	18.33	14.45	11.45	10.92	13.67	13.01	16.28
Fe_2O_3	4.08	3.59	1.02	5.20	4.44	6.37	3.75	2.24	2.14	.41	.39	4.51
MgO	.65	2.35	.78	1.23	.53	.91	1.41	.21	.20	......	......	1.38
CaO	.73	3.74	5.05	.98	5.22	1.95	5.29	.26	.25	.21	.20	.82
Na_2O	Tr.	Tr.	Tr.	Tr.	.93	.46	Tr.	......	......	......	......	1.02
K_2O	2.46	2.87	1.97	2.03	1.63	3.13	3.15	......	......	......	......	2.12
H_2O-	.83	.86	.97	1.57	1.83	2.02	1.27	......	......	......	......	5.69
SO_3	......	......	......	Tr.	Tr.	Tr.	.43	......	......	......	......	......
Ignition loss	3.74	9.43	4.43	10.42	7.43	8.71	10.36	[1] (4.81)	4.59	[1] (5.07)	4.83	3.85
Total	99.46	99.84	99.95	99.19	98.65	100.65	100.12	99.41	99.44	100.27	100.26	[9] 99.11
Class	49, 47, 0	30, 56, 10	53, 38, 3	21, 72, 4	35, 52, 7	19, 73, 5	30, 54, 12	......	60, 39, 1	......	58, 41, 0	30, 64, 0

[1] Not included in total.
[2] 101.40 in text.
[3] 100.80 in text.
[4] 100.09 in text.
[5] Reported as FeO.
[6] Reported as H_2O (ignition).
[7] Reported as CO_2.
[8] 99.39 in text.
[9] 99.17 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

37. Huerfano County. Upper Cretaceous, Dakota sandstone. (T. 25 S., R. 64 W.), 3 miles southwest of Jones Spring, Turkey Ridge. Analyst, Stokes. (Stose, 1912, p. 11.) Clay, from transitional beds at top of formation. Geologic maps. Possible use: Refractories.

38. (Analysis of sample 37 calculated by compilers to include ignition loss.)

39. Huerfano County. Upper Cretaceous, Pierre shale. T. 28 S., R. 66 W., town of Walsenburg. Analyst, Tremaine. Lab. No. 226. (Butler, 1915, p. 343, 216, 217, 328, 329.) Clay. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware, drain tile.

40. Huerfano County. Pierre shale. Walsenburg. Analyst, Tremaine. Lab. No. 225. (Butler, 1915, p. 343, 216, 217, 326, 327.) Clay. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware.

41. Huerfano County. Recent. Walsenburg. Analyst, Tremaine. Lab. No. 224. (Butler, 1915, p. 343, 216, 326, 327.) (Clay) sandy, soft; 5 ft exposed in pit. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

42. Jefferson County. Upper Cretaceous, Graneros shale. T. 3 S., R. 70 W., north of town of Golden. Analyst, Tremaine. Lab. No. 272. (Butler, 1915, p. 343, 223, 229, 330, 331.) Shale, black, very fine grained, hard, 8 ft sampled. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware, vitrified and unvitrified floor tile.

43-63. Jefferson County. Pierre shale. T. 2 S., R. 70 W., north of Golden. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

- 43-44. (Butler, 1915, p. 343, 223, 229, 330, 331.)
  - 43. Lab. No. 273. Clay, drab, very fine-grained, medium-soft. Possible use: Brick, if grogged.
  - 44. Lab. No. 274. Clay, drab, coarse-grained, sandy, medium-soft. Possible use: Brick, earthenware.
- 45-63. (Butler, 1915, p. 344, 223, 229-232, 330, 331.)
  - 45. Lab. No. 276. Shale, light-drab, medium coarse-grained, sandy, medium-soft. Possible use: Brick, earthenware.
  - 46. Lab. No. 277. Shale and clay; cream-colored, fine-grained, soft. Possible use: Brick and earthenware, if grogged.
  - 47. Lab. No. 278. Shale, drab, fine-grained, sandy, medium-soft. Possible use: Brick.
  - 48. Lab. No. 279. Shale, drab, fine-grained, sandy, medium-soft. Use: None.
  - 49. Lab. No. 280. Clay, drab, medium fine-grained, hard. Use: None.
  - 50. Lab. No. 281. Clay, drab, fine-grained, hard. Possible use: Brick, earthenware.
  - 51. Lab. No. 282. Clay, drab, coarse-grained, medium-soft, sandy. Possible use: Brick, earthenware, if grogged.
  - 52. Lab. No. 283. Clay, yellowish-drab, medium coarse-grained, sandy, hard. Use: None.
  - 53. Lab. No. 284. Clay, drab, medium coarse-grained, sandy, hard. Possible use: Brick and earthenware, if grogged.
  - 54. Lab. No. 285. Clay, drab, medium fine-grained, sandy, medium-soft. Possible use: Brick, earthenware, if grogged.
  - 55. Lab. No. 286. Clay, drab, medium coarse-grained, sandy, medium-soft. Possible use: Brick.
  - 56. Lab. No. 287. Clay, yellowish-drab, medium fine-grained, sandy, hard. Possible use: Brick, if grogged.
  - 57. Lab. No. 288. Clay, drab, fine-grained, soft. Possible use: Brick, if grogged.
  - 58. Lab. No. 289. Clay, drab, coarse-grained, sandy, soft. Possible use: Brick.
  - 59. Lab. No. 290. Clay, drab, fine- to coarse-grained, sandy, hard. Possible use: Brick, if grogged.
  - 60. Lab. No. 291. Clay, brown, coarse-grained, sandy, hard. Possible use: Brick.
  - 61. Lab. No. 292. Clay, drab, fine-grained, soft. Use: None.
  - 62. Lab. No. 294. Clay, yellowish-drab, medium-grained, sandy, soft. Possible use: Brick, if grogged.
  - 63. Lab. No. 295. Shale, yellowish, medium coarse-grained, sandy, medium-hard. No ceramic tests or physical properties given. Possible use: Vitrified brick.

64-66. Jefferson County. Upper Cretaceous, Laramie formation. T. 5 S., R. 69 W., 3 miles east of town of Morrison. Analyst, Tremaine. (Butler, 1915, p. 343, 223, 225, 328, 329.) Index map. Ceramic tests, physical properties, mineralogy.

- 64. Lab. No. 258. Shale, gray, medium fine-grained, hard; 12 ft sampled, overburden 2 ft. Possible use: Brick, earthenware, vitrified and unvitrified floor tile.
- 65. Lab. No. 257. Shale, gray, medium fine-grained, soft; 15 ft sampled, overburden 1 ft. Possible use: Brick, earthenware, vitrified and unvitrified floor tile, stoneware.
- 66. Lab. No. 256. Clay and shale, gray, red, and yellow; medium fine-grained, soft; 10 ft thick, overburden 3 ft. Possible use: Brick, earthenware, vitrified and unvitrified floor tile.

67-71. Jefferson County. Laramie formation. T. 3 S., R. 70 W., west of Golden. Analyst, Tremaine. (Butler, 1915, p. 343, 223, 228, 328-331.) Clay. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

- 67. Lab. No. 267. Bed 50 ft thick, 50 ft from top of formation. Contains sandy layers. Possible use: Vitrified floor tile.
- 68. Lab. No. 268. Bed 25 ft thick, 100 ft from top of formation. Possible use: Earthenware.
- 69. Lab. No. 269. Bed 12 ft thick, 200 ft from top of formation. Possible use: Earthenware.
- 70. Lab. No. 270. Bed 15 ft thick, 250 ft from top of formation.
- 71. Lab. No. 271. Bed 10 ft thick, 250 ft from top of formation.

72. Jefferson County. Laramie formation, (K. M. Waagé, written communication, 1958). Golden. (Ries, 1895, p. 554-555.) Crucible clay.

73. Jefferson County. Pleistocene. Golden. Analyst, Hillebrand. (Emmons and others, 1896, p. 263.) Loess, surface sample.

74. Larimer County. (Triassic(?) or Permian(?), Lykins formation. Sec. 32, T. 5 N., R. 69 W.) near entrance to Big Thompson Canyon. Analyst, Brewster. Lab. No. 102. (Hague, 1877, p. 35; King, 1878, table 7A.) Sandstone, deep red, fine-grained, friable, laminated. Typical specimen.

75-78. Larimer County. Analyst, Tremaine. (Butler, 1915, p. 344, 234, 239, 241, 243, 332, 333.) Index map. Ceramic tests, physical properties, mineralogy.

- 75. Upper Jurassic, Morrison formation, near base. Sec. 17, T. 5 N., R. 69 W. Lab. No. 316. Shale, light-gray, medium-grained, marly, medium-hard; 20 ft thick, overburden, 1 or more ft. Possible use: Brick, unvitrified floor tile.
- 76. Morrison formation. Sec. 6, T. 5 N., R. 69 W. Lab. No. 323. Clay, gray, medium fine-grained, very hard; 8 ft thick. Possible use: Brick.
- 77. Dakota sandstone, lower part. Sec. 8, T. 6 N., R. 69 W. Lab. No. 330. Shale, black, fine-grained, hard; 6 ft thick. Possible use: Brick.
- 78. Dakota sandstone. Sec. 17, T. 5 N., R. 69 W., west of town of Loveland. Lab. No. 317. Clay, gray to light bluish-green, sandy, medium-hard, jointed. Two beds, 4 ft thick, between layers of hard sandstone. Possible use: Brick, earthenware, vitrified and unvitrified floor tile.

79-82. Larimer County. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

- 79. Graneros shale. Sec. 9, T. 6 N., R. 69 W. Lab. No. 334. (Butler, 1915, p. 344, 234, 244, 332, 333.) Shale, black, fine-grained, medium-hard; 100 ft thick. Possible use: Brick.
- 80. Pierre shale. Sec. 25, T. 5 N., R. 68 W., southeast of Loveland. Lab. No. 310. (Butler, 1915, p. 344, 234, 237, 330, 331.) Shale, yellowish-green, slightly gritty, soft; contains gypsum; 10 ft exposed, overburden, 1 ft. Possible use: Brick, earthenware, drain tile, vitrified floor and roofing tile.
- 81. Pierre shale, near base. Sec. 16, T. 5 N., R. 69 W., west of Loveland. Lab. No. 313. (Butler, 1915, p. 344, 234, 238, 330, 331.) Shale, black and brown, fine-grained, medium-hard; 20 ft exposed, overburden, 2 ft. Possible use: Brick, earthenware, vitrified and unvitrified floor tile.
- 82. Pierre shale. Sec. 4, T. 6 N., R. 69 W., Poudre Valley Pressed Brick Co. pit. Lab. No. 332. (Butler, 1915, p. 344, 234, 243, 332, 333.) Shale, yellowish-green, slightly gritty, fine-grained, soft; 60 ft thick, overburden, 1 ft. Possible use: Brick, earthenware.

83. Las Animas County. Dakota sandstone. (T. 26 S., R. 61 W.), 5 miles west of mouth of Apishapa Canyon. Analyst, Stokes. (Stose, 1912, p. 11.) Clay, transitional beds at top of formation. Geologic maps. Possible use: Refractories.

84. (Analysis of sample 83 calculated by compilers to include ignition loss.)

85. County, formation, analyst, reference, and use as in sample 83. (T. 27 S., R. 61 W.), 3 miles southeast of mouth of Apishapa Canyon. Clay, transitional beds at top of formation. Geologic maps. (Overlies sample 6, group A of this compilation.)

86. (Analysis of sample 85 calculated by compilers to include ignition loss.)

87. Mesa County. Upper Jurassic, Flaming Gorge group. (T. 1 S., R. 1 W.), 2 miles south of town of Grand Junction. Analyst, Tremaine. Lab. No. 396. (Butler, 1915, p. 345, 260, 261, 334, 335.) Shale, greenish-gray, very fine grained, medium-hard; 50 ft thick; contains layers of sand. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

TABLE 2.—Analyses of samples from Colorado containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Colorado										
	88	89	90	91	92	93	94	95	96	97	98
	5B39-2	5B40-2	5B43-1	5B43-2	5B44-1	5B45-1	5B47-2	5B50-1	5B51-1	5B51-2	5B51-3
SiO_2	65.02	64.46	61.76	65.48	65.34	63.67	56.5	74.49	68.08	78.4	80.0
Al_2O_3	20.25	12.95	10.62	8.41	14.56	17.20	6.5	16.37	19.50	10.4	7.7
Fe_2O_3	3.20	2.38	5.51	2.44	3.69	3.85	4.1	1.63	1.9	2.5	2.7
FeO	......	......	.97	.70	......	......	......	......	......	......	......
MgO	2.64	2.36	4.11	4.07	.59	Tr.	3.1	.21	.27	1.4	.8
CaO	1.15	3.17	2.38	2.58	2.87	.99	15.4	.66	.22	1.3	.9
Na_2O	.45	} 2.55	.09	.20	.53	.78	......	Tr.	......	......	......
K_2O	1.29		6.02	5.63	2.31	2.45	......	1.40	......	......	......
H_2O-	2.44	6.31	......	......	.89	2.08	......	.40	......	......	......
TiO_2	......	.21	.58	.59	......	......	......	......	......	......	......
V_2O_5	......	......	.07	.07	......	......	......	......	......	......	......
CO_2	......	......	1.38	2.20	......	......	12.0	......	......	......	......
SO_3	......	......	......	......	Tr.	Tr.	......	Tr.	......	......	......
Ignition loss	4.78	[1] 5.42	6.66	7.82	8.03	8.01	[2] Tr.	5.00	9.44	5.1	4.9
Total	101.22	99.81	100.15	100.19	98.81	99.03	97.6	100.16	99.4	99.1	97.0
Class	26,70,0	39,53,0	37,48,8	48,36,9	35,54,6	29,65,2	40,29,27	44,54,1	31,67,1	57,37,4	63,30,3

	99	100	101	102	103	104	105	106	107	108
	5B51-4	5B51-6	5B51-5	5B51-7		5B51-8		5B51-10	5B51-11	5B51-12
SiO_2	71.17	86.79	76.56	78.07	72.62	86.58	82.65	58.8	60.5	63.60
Al_2O_3	15.97	[5] 8.29	8.30	20.22	18.81	12.72	12.14	19.5	17.15	16.74
Fe_2O_3	1.53	.75	.38	.89	.83	.45	.43	3.9	4.4	4.63
MgO	.51	.13	.24	.26	.24	.11	.11	1.8	2.0	1.19
CaO	.07	.34	.12	......	......	.11	.11	1.4	2.2	.68
Na_2O	......	......	} Tr.	......	......	......	......	......	......	.29
K_2O	......	.25		......	......	......	......	......	......	2.92
H_2O+	......	} [5] 3.78	[4] 4.40	......	......	......	......	......	......	[4] 5.99
H_2O-	......		[4] 1.26	......	......	......	......	......	......	[4] 2.88
TiO_2	.89	......	.60	......	......	......	......	......	......	.66
P_2O_5	......	.05	.06	......	......	......	......	......	......	.16
Ignition loss	7.35	......	[2] 8.31	[6] (7.51)	6.99	[6] (4.75)	4.53	11.6	9.95	[2] .46
Total	97.49	100.38	100.23	99.44	99.49	99.97	99.97	97.0	96.2	100.20
Class	41,54,1	71,28,0	61,38,0	......	38,61,1	......	61,39,0	20,71,6	25,63,8	29,66,0

	109	110	111	112	*113	114	115	116	117	118
	5B51-9	5B51-67	5B51-13	5B51-14	5B51-16	5B51-15	5B54-1	5B57-1		5B62-1
SiO_2	50.35	60.60	63.15	60.80	58.85	58.83	68.40	77.51	65	62.00
Al_2O_3	16.47	16.42	21.48	15.63	15.56	18.77	13.93	} [3] 13.34	[3] 7	15.50
Fe_2O_3	2.68	4.95	2.12	4.62	3.20	3.48	2.62			4.30
MgO	Tr.	1.43	.31	2.73	3.00	2.14	.44	.25	......	.44
CaO	7.42	1.61	1.22	1.63	4.30	3.11	2.87	.12	......	2.18
Na_2O	.44	.92	.12	1.45	Tr.	.97	.94	.06	......	.62
K_2O	1.55	2.98	3.16	2.55	3.25	2.50	.89	2.41	......	2.81
H_2O+	......	[4] 5.72	......	[4] 4.16	......	......	......	[7] 1.31	.20	......
H_2O-	1.81	[4] 3.91	1.90	[4] 3.19	2.09	1.49	.36	[8] .58	[8] .04	2.00
TiO_2	......	.35	......	.47	......	......	......	.02	......	......
P_2O_5	......	.31	......	.10	......	......	......	None	......	......
SO_3	1.60	......	Tr.	......	2.82	Tr.	......	None	......	......
Cl	......	......	......	......	......	......	......	None	......	......
BaO	......	......	......	......	......	......	......	.37	......	......
UO_3	......	......	......	......	......	......	......	.05	......	......
PbO	......	......	......	......	......	......	......	.06	......	......
V_2O_3	......	......	......	......	......	......	......	3.50	......	......
V_2O_5	......	......	......	......	......	......	......	.05	......	......
Ignition loss	16.62	[2] .84	7.80	[2] 2.87	6.90	9.00	7.74	......	......	7.42
Total	98.94	100.04	101.26	100.20	[9] 99.97	[10] 100.29	98.19	[11,12] 99.93	[11,13] 72	97.27
Class	18,65,11	26,66,0	23,72,3	28,63,0	28,55,5	22,66,7	41,50,6	55,38,0	......	30,59,5

Semiquantitative spectrographic analyses

[C = 0.1-1.0 percent; D = 0.01-0.1 percent; E = 0.001-0.01 percent. The following elements looked for but, if present, in quantities below these limiting values: Rb, 10 percent; Cs, Tl, 1 percent; P, Sc, Ge, As, La, Ce, W, Re, Hg, Th, U, 0.1 percent; Cb, Cd, Nd, Ta, Pt, 0.01 percent; Be, Co, Zn, Y, Mo, Ag, Sb, Ir, Bi, 0.001 percent]

	90	91		90	91		90	91
B	E	E	Ni	D	E	Zr	C	C
Cr	D	D	Cu	D	D	Sn	......	D
Mn	D	D	Sr	C	C	Ba	D	D

[1] Reported as H_2O+.
[2] Reported as organic matter.
[3] Includes TiO_2.
[4] H_2O+ above 100°C; H_2O- at 100°C.
[5] Includes organic matter.
[6] Not included in total.
[7] H_2O+ from soluble portion, 0.14 percent at 105°-300°C; 0.97 percent above 300° C. H_2O+ from insoluble portion, 0.20 percent above 105° C.
[8] At 105° C.
[9] 99.70 in text.
[10] 100.35 in text.
[11] Zircon and other minerals not decomposed by HFl and H_2SO_4 equal about 0.3 percent.
[12] Li, Cu, Mo, and Bi, each reported as trace.
[13] Reported as about 65 percent SiO_2, 7 percent Al_2O_3 (Fe_2O_3, TiO_2). (To meet summation of sample 116, SiO_2 figured as 64.95 and Al_2O_3 (Fe_2O_3, TiO_2) as 6.99.)

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

88. Mesa County. Upper Jurassic, Flaming Gorge group. T. 1 S., R. 1 W., 2 miles south of town of Grand Junction. Analyst, Tremaine. Lab. No. 394. (Butler, 1915, p. 345, 260, 261, 334, 335.) Shale, red, very fine grained, medium-hard; 20 ft thick. Index map. Ceramic tests, physical properties, mineralogy. Use: Brick, earthenware.

89. Mineral County. Miocene, Creede formation (P. C. Patton, written communication, 1957). (T. 42 N., R. 1 W.) near town of Creede, Peerless Clay Co. (Nutting, 1943, p. 178, 141, 151.) Montmorillonite. Bleaching tests. Use: Bleach.

90-91. Montrose County. Upper Jurassic, Morrison formation, Salt Wash member. Sec. 1, T. 46 N., R. 17 W., Bitter Creek mine. Analyst, Sherwood; spectrographic analyst, Waring. (Weeks, 1951, p. 10, 8, 14; Waring and Annell, 1952, p. 25.) Mineralogy.
- 90. Red clay, underlying vanadium-bearing ore.
- 91. Gray clay, underlying vanadium-bearing ore.

92. Morgan County. Upper Cretaceous, Fox Hills sandstone. (T. 4 N., R. 58 W.) west of town of Fort Morgan. Analyst, Tremaine. Lab. No. 407. (Butler, 1915, p. 345, 264, 265, 336, 337.) Shale, yellowish-green, somewhat gritty, medium-hard; 20 ft sampled, overburden 3-4 ft. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

93. Otero County. Upper Cretaceous, Carlile shale, upper part. (T. 24 S., R. 55 W.) south of town of La Junta, near plant of La Junta Brick and Tile Manufacturing Co. Analyst, Tremaine. Lab. No. 421. (Butler, 1915, p. 345, 268, 269, 336, 337.) Shale and clay; gray, medium fine-grained, medium-hard; 45 ft sampled, overburden up to 3 ft. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Low-grade brick.

94. Park County. Pennsylvanian, Weber formation. SW¼ sec. 6, T. 13 S., R. 77 W., Salt Creek. Analyst, Hills. (Johnson, 1940, p. 593, 573, 576-578, 590.) Algal limestone. Description of organism which built colonies. Index map, detailed measured section. (For other analyses of algal limestone in Colorado, see sample 8 group A, samples 1 and 3 group C, samples 7 and 20 group F_1, and samples 16 and 70 group F_2; of this compilation.)

95. Prowers County. Upper Cretaceous, Dakota sandstone. (T. 23 S., R. 46 W.), 5.5 miles south of town of Lamar on Clay Creek. Analyst, Tremaine. Lab. No. 426. (Butler, 1915, p. 345, 270, 271, 336, 337.) Clay and shale; gray to brown, fine-grained, hard; 3 ft thick. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, vitrified and unvitrified floor and roofing tile, earthenware, stoneware.

96. Pueblo County. Lower Cretaceous, Purgatoire formation, Glencairn shale member. N½NW¼ sec. 6, T. 25 S., R. 65 W., Vulcan mine, Standard Fire Brick Co. Lab. No. 94. (Waagé, 1953, p. 97, 3, 6, 53, 88, pls. 1-3.) Plastic clay, dark-gray; 9-20 ft thick. Index map, generalized columnar sections. Possible use: Low grade to semirefractories.

97. County, formation, and reference as in sample 96. Sec. 36, T. 18 S., R. 67 W., Turkey Creek Canyon. Lab. No. 87. Plastic clay, sandy. Index map, outcrop map, geologic map; generalized columnar sections.

98. Information as in sample 97. Lab. No. 88.

99. Pueblo County. Dakota sandstone, Dry Creek Canyon member. NW corner NE¼ sec. 35, T. 22 S., R. 67 W., Rock Creek mine, Standard Fire Brick Co. Analyst, Davidson. Lab. No. 30. (Waagé, 1953, p. 95, 3, 6, 21, 44, 53, 74, pl. 5.) Sandstone with flint clay matrix, spot sample; about 42 inches below top of flint clay. Index map, outcrop map, geologic map; detailed measured section, generalized columnar sections. Use: Refractories. (For other analyses from same measured section see samples 35 and 36 group D, and sample 45 group Hk, of this compilation.)

100-101. Pueblo County. Dakota sandstone. Analyst, Steiger. (Gilbert, 1897, p. 7, 6.) Geologic maps. Possible use: Refractories.
- 100. (T. 18 S., R. 67 W.) near head of Pierce Gulch. Fire clay, light-gray.

Colorado--Continued

- 101. (T. 23 S., R. 67 W.) head of Rock Creek Canyon. Fire clay, nearly black, contains fossil leaves.

102-105. Pueblo County. Dakota sandstone. (T. 25 S., R. 63 W.), Jones Spring. Analyst, Stokes. (Stose, 1912, p. 11.) Clay. Geologic maps. Possible use: Refractories.
- 102. Clay; 13 ft below top of formation.
- 103. (Analysis of sample 102 calculated by compilers to include ignition loss.)
- 104. Clay; 12 ft below top of formation.
- 105. (Analysis of sample 104 calculated by compilers to include ignition loss.)

106. Pueblo County. Upper Cretaceous, Graneros shale. Sec. 22, T. 22 S., R. 67 W., Snake Creek. Lab. No. 1. (Waagé, 1953, p. 95, 3, 6, 53, pl. 5.) Clay shale, plastic; lower 20-30 ft of formation. Index map, geologic map; generalized columnar sections.

107. Information as in sample 106. Lab. No. 2.

108. Pueblo County. Graneros shale. (T. 23 S., R. 67 W.) head of Rock Creek Canyon. Analyst, Steiger. (Gilbert, 1897, p. 7; Clarke, 1915, p. 255.) Shale, 30 ft above base of formation. Geologic maps.

109. Pueblo County. Graneros shale, top of formation. (T. 24 S., R. 66 W.) north of Eagle Rock. Analyst, Tremaine. Lab. No. 445. (Butler, 1915, p. 345, 272, 277, 336, 337.) Shale, black, fine-grained, medium-hard; 40 ft exposed. One white bed 30 inches thick. Index map. Ceramic tests, physical properties, mineralogy. Use: None.

110. Pueblo County. Carlile shale. (T. 23 S., R. 66 W.), Salt Creek. Analyst and references as in sample 108. Shale, 70 ft below top of formation. Geologic maps.

111. Pueblo County. Carlile shale. (T. 19 S., R. 67 W.), 10 miles northeast of town of Florence. Analyst, Tremaine. Lab. No. 471. (Butler, 1915, p. 345, 272, 282, 338, 339.) Shale, black and brown, fine-grained, medium-hard; 15 ft thick, 40 ft below top of formation. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, unvitrified floor tile.

112. Pueblo County. Upper Cretaceous, Pierre shale, Tepee zone. (T. 19 S., R. 64 W.) near Nussbaum Spring. Analyst, Steiger. (Gilbert, 1897, p. 7; Clarke, 1915, p. 255.) Shale. Geologic maps.

*113. Pueblo County. Pierre shale. (T. 20 S., R. 65 W.) town of Pueblo, 0.5 mile west of Summit Pressed Brick and Tile Co. Analyst, Tremaine. Lab. No. 466. (Butler, 1915, p. 345, 272, 281, 338, 339.) (Analysis shows 3.3 percent alkalies; suggests 6.1 percent gypsum, 3.0 percent more CaO and MgO than required for carbonates.) Clay. Index map. Mineralogy. Possible use: Brick.

114. Pueblo County. Recent. (T. 20 S., R. 65 W.), Acme Brick works. Analyst, Tremaine. Lab. No. 469. (Butler, 1915, p. 345, 272, 282, 338, 339.) Clay. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware, unvitrified tile.

115. Routt County. Upper Cretaceous, Mancos shale. (T. 6 N., R. 86 W.), 12 miles west of town of Steamboat Springs. Analyst, Tremaine. Lab. No. 480. (Butler, 1915, p. 345, 284, 338, 339.) Clay, light-gray, fine-grained, some grit, medium-hard. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

116. San Miguel County. Upper Jurassic, La Plata formation, Placerville sandstone member. (T. 44 N., R. 11 W.) near town of Placerville. Analyst, Hillebrand; collector, Ransome. (Hillebrand and Ransome, 1900, p. 133, 144.) Sandstone, green, vanadiferous. Use: Source of vanadium.

117. Analysis of sample 116 insoluble in HNO_3; 72.48 percent of total rock.

118. Weld County. Pierre shale. Sec. 19, T. 4 N., R. 68 W., Berthoud Brick and Tile Co. Analyst, Tremaine. Lab. No. 504. (Butler, 1915, p. 345, 291, 293, 340, 341.) Shale, yellowish-green, gray in lower part; fine-grained, medium-hard, thick-bedded; 20 ft thick. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware, drain tile.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by county and stratigraphic position]

	Kansas												
	*1	2	3	4	5	6	7	*8	9	10	*11	12	*13
	15B1-2	15B1-1	15B1-3	15B3-1	15B4-4	15B4-5	15B4-6	15B4-7	15B5-2	15B5-3	15B6-1	15B7-1	15B7-2
SiO_2	53.99	56.0	54.18	[1] 70.97	83.29	75.98	73.02	61.47	76.52	72.56	53.41	57.32	54.51
Al_2O_3	16.21	} 22.1	19.17	15.98	[2] 8.19	[2] 7.92	[2] 7.15	[2] 14.10	13.57	17.44	11.65	15.89	15.19
Fe_2O_3	6.18		6.11	3.32	[3] .68	[3] 2.02	[3] 2.01	[3] 5.76	[4] 1.75	[4] 1.21	5.44	6.04	6.83
MgO	1.72	1.5	1.89	.42	.89	2.20	2.54	6.95	.21	.31	1.83	2.28	2.23
CaO	6.60	8.0	7.05	2.28	.72	3.16	4.85	.62	.41	.40	4.33	5.12	6.37
Na_2O	.80	......	......	......	1.90	1.54	1.38	1.38	......	......	......	1.04	1.89
K_2O	3.93	......	......	......	1.75	1.87	1.70	2.96	......	......	......	2.99	3.07
TiO_2	1.09	......	......	1.39	[5] .62	[5] .45	[5] 1.04	[5] .64	1.37	.84	1.96	1.20	1.26
P_2O_5	.18	......	......	......	.05	.07	.09	.14	......	Tr.	[6] 2.30	.20	.26
V_2O_5	......	......	......	......	......	......	......	......	[7] .05	[8] .04	......	......	......
SO_3	.22	......	......	......	Nil	Nil	Nil	.35	Tr.	Tr.	.12	Tr.	.10
S	......	......	......	......	Nil	Nil	Tr.	.06	......	......	......	......	......
Ignition loss	9.20	[9] 10.7	[9] 11.95	4.60	[10] 1.51	[10] 4.28	[10] 5.76	[10] 5.48	4.73	5.68	[10] 16.10	8.03	8.69
Total	[11] 100.12	98.3	100.35	98.96	99.60	99.49	99.54	[12] 99.91	98.61	98.48	97.14	100.11	[13] 100.40
Class	18,63,8	19,62,17	13,72,12	39,56,0	68,26,0	60,29,4	58,26,7	30,56,1	51,45,1	40,56,1	27,57,6	22,62,5	20,62,7

	14	15	16	17	18	19	20	21	*22	*23	*24	25	26
	15B10-2	15B10-1	15B10-3	15B11-1	15B12-2	15B12-1	15B12-3	15B12-4	15B13-5	15B13-4	15B13-6	15B13-1	15B13-2
SiO_2	65.52	64.42	67.75	85.19	69.99	67.62	70.62	68.25	52.08	50.50	60.86	75.61	73.34
Al_2O_3	15.09	15.98	12.83	} [14] 11.64	12.00	11.03	12.13	10.91	[2] 12.16	[2] 12.74	[2] 10.42	10.97	10.96
Fe_2O_3	4.09	4.22	2.66		2.84	2.86	3.07	2.49	[3] 4.42	[3] 3.84	[3] 3.35	3.27	1.86
MgO	.94	1.00	.52	[15] .07	1.62	1.55	1.42	1.27	18.14	19.54	12.88	1.03	.14
CaO	3.31	3.20	.90	[15] 1.55	4.21	5.57	3.36	6.41	1.34	.77	.81	.40	.87
Na_2O	.57	.48	} [16] 7.82	......	[16] 1.15	[16] .71	[16] .23	[16] .48	.43	.20	.24	.27	[17] 3.33
K_2O	2.32	2.50			2.86	3.47	3.19	2.97	2.41	2.13	3.57	1.76	[17] 4.80
H_2O^- [18]	......	......	......	......	(.19)	(.42)	(.49)	(.46)	......	......	......	......	......
TiO_2	1.18	1.11	1.78	......	.67	1.22	.99	1.01	[5] 1.01	[5] .94	[5] .97	.93	.68
P_2O_5	Tr.	.01	<.01	......	......	.24	.10	.26	.13	.06	.12	.17	Tr.
SO_3	Nil	Nil	.10	......	.09	.06	.06	.06	Nil	.17	Nil	.37	Tr.
S	Tr.	Tr.	......	......	......	......	......	......	......	.05	.02	......	......
Ignition loss	6.69	6.86	5.64	......	4.57	5.91	4.93	6.15	[10] 7.34	[10] 9.28	[10] 6.52	4.53	4.02
Total	99.71	99.78	<100.01	98.45	100.00	100.24	100.10	100.26	99.46	[19] 100.22	[20] 99.76	99.31	100.00
Class	34,55,4	31,58,4	42,46,3	66,33,0	46,43,2	45,40,5	46,44,2	46,39,6	26,47,6	24,48,10	39,39,6	53,41,2	52,38,2

Qualitative spectrographic analyses

[Carbon electrodes used. Higher numbers indicate greater abundance. Further explanation of table for samples 18-21 (Frye and others, 1949, p. 87); for sample 11 (Runnels, 1949, p. 45)]

	11	[21] 11	18	19	20	21		11	[21] 11	18	19	20	21
B	......	6	......	......	......	......	Cu	6	9	4	6	6	5
Na	6	......	......	......	......	......	Zn	6	4	4	6	5	6
K	8	......	......	......	......	......	Zr	8	......	7	7	6	7
V	9	9	4	6	6	6	Mo	......	5	......	......	......	......
Cr	9	9	3	4	4	4	Ag	4	5	ND	ND	ND	ND
Mn	8	10	6	9	8	8	Pb	......	7	......	......	......	......

[1] SiO_2, 70.98 percent (Plummer and Hladik, 1948, p. 74).
[2] Includes MnO_2.
[3] Total iron.
[4] Average of three or more determinations.
[5] Includes ZrO_2 and V_2O_5.
[6] Soluble in citric acid, 1.54 percent.
[7] Spectrographic determination, V_2O_5, 0.0473 percent. (Rounded by compilers.)
[8] Spectrographic determination, V_2O_5, 0.0415 percent. (Rounded by compilers.)
[9] Reported as water and CO_2.
[10] 140°-1,000° C.
[11] 100.00 in text.
[12] 99.85 in text.
[13] 100.35 in text.
[14] Reported as combined oxides.
[15] Calculated from reported $MgCO_3$ or $CaCO_3$.
[16] By difference.
[17] Na_2O+K_2O by difference; ratio by spectrographic determination.
[18] 105° - 140° C., (not included in total).
[19] 100.17 in text.
[20] 99.74 in text.
[21] High-purity graphite electrodes used.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

*1. Allen County. Pennsylvanian, Lane-Bonner Springs shale. NE¼SW¼ sec. 33, T. 25 S., R. 18 E., Humboldt Brick and Tile Co. pit. Analyst, under supervision of Runnels. Lab. No. AL-2. (Plummer and Hladik, 1951, p. 20, 24, 25, 31, 32, 52, 55.) (Analysis shows 4.7 percent alkalies, 1.1 percent TiO_2; suggests 4.1 percent more CaO and MgO than required for carbonates.) Shale, dark-gray, unoxidized, silty; 30.0 ft sampled; 50.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Low-density aggregate.

2. Allen County. (Probably Lane-Bonner Springs shale. T. 24 S., R. 18 E.) near town of Iola, Kansas Portland Cement Co. Lab. No. 5. (Burchard, 1913, p. 186.) Shale. Use: Cement material.

3. County, formation, locality, reference, and use as in sample 2. Iola Portland Cement Co. Lab. No. 3. Shale.

4. Atchison County. Pleistocene, Sanborn formation. Center north line, sec. 12, T. 7 S., R. 18 E. Analyst, Runnels. Lab. No. A-6. (Plummer and Hladik, 1948, p. 74, 62, 82, 83, 90, 96; Plummer and Hladik, 1951, p. 21, 28, 29, 31, 45, 72.) Loess, gray, oxidized; 32.0 ft sampled, 32.0 ft available, bed 50 ft thick. Index map, map of generalized thickness of loess deposit. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Firing and physical properties of ceramic slag. Possible use: Lightweight aggregate, railroad ballast.

5-7. Barber County. Permian, Cedar Hills sandstone. NW¼NW¼ sec. 9, T. 32 S., R. 10 W. Analyst, under supervision of Runnels. (Swineford, 1955, p. 122, 59, 60, 101, 113, 128.) Index and geologic map; generalized columnar and detailed measured sections. Mechanical analysis. Photomicrograph, electron micrograph of particles finer than 1 micron. Possible use: Brick.

   5. Basal part of Cedar Hills sandstone. Lab. No. 1147. Sandstone, white.
   6. Lab. No. 1146. Siltstone, red, sandy.
   7. Lab. No. 1128. Siltstone, red, sandy.

*8. Barber County. Permian, Flowerpot shale. SE¼SE¼ sec. 1, T. 32 S., R. 14 W. Analyst, under supervision of Runnels. Lab. No. 1138. (Swineford, 1955, p. 122, 10, 11, 64, 98, 113.) (Analysis suggests 7.1 percent more MgO than required for carbonate; shows 4.3 percent alkalies.) Shale, red, silty. Index and geologic map; generalized columnar and detailed measured sections. Mechanical analysis. Electron micrograph of particles finer than 1 micron.

9. Barton County. Upper Cretaceous, Dakota sandstone, Janssen clay member (R. T. Runnels, written communication, 1953). SW¼SW¼ sec. 21, T. 18 S., R. 13 W. Analyst, Runnels. Lab. No. BT-1-MR. (Reed, 1950, p. 27, 36.) Clay. Use: Brick.

10. Information as in sample 9. Lab. No. BT-3-3.

*11. Bourbon County. Pennsylvanian, Cherokee shale, above Mulky coal. NE¼NW¼ sec. 27, T. 26 S., R. 25 E. Spectrographic analyst, Reed. Lab. No. 48-298. (Runnels, 1949, p. 44, 42, 45.) (Analysis suggests 5.5 percent phosphate; shows 2.0 percent TiO_2.) Shale, composite sample of bed 2 ft thick. Size distribution of shales ground in pan mill. Dried at 140° C. Possible use: Fertilizer.

12-13. Brown County. Pennsylvanian, Willard shale. Analyst, under supervision of Runnels. (Plummer and Hladik, 1951, p. 20, 26, 27, 31, 32, 52, 62.) Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

   12. Lower part of shale. SW¼SW¼ sec. 4, T. 4 S., R. 18 E. Lab. No. BR-5. Shale, red and black, mostly oxidized; 12.0 ft sampled; 30.0 ft available.
   *13. Upper part of shale. NE¼SW¼ sec. 36, T. 4 S., R. 17 E. Lab. No. BR-6. (Analysis shows 5.0 percent alkalies, 1.3 percent TiO_2; suggests 4.9 percent more CaO and MgO than required for carbonates.) Shale, black, mostly unoxidized; 16.0 ft sampled; 30.0 ft available.

Kansas--Continued

14. Chautauqua County. Pennsylvanian, Howard limestone, Aarde shale member, Nodaway underclay. Sec. 15, T. 35 S., R. 9 E. (McMillan, 1956, p. 214, 194, 195, 248, pls. 1, 2.) Underclay, typically ash gray, plastic, thickness from thin film to 1.7 ft; selected sample; 7-15 inches blow coal; estimated amounts of clay constituents. Mineralogy. Index map, outcrop map; columnar section, correlated columnar sections; mechanical analysis.

15. Information as in sample 14. Underclay, 0-7 inches below coal.

16. Chautauqua County. Pleistocene, Meade formation, Pearlette ash bed. NW¼SE¼ sec. 9, T. 34 S., R. 12 E. Analysts, under supervision of Runnels. Lab. No. CQV-1. (Carey and others, 1952, p. 20, 4, 12, 15, 40.) Volcanic ash from bed 4.0 ft thick, underlies at least 10 acres. Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

17. Cherokee County. Mississippian, (Keokuk limestone or Warsaw(?) limestone. T. 34 S., R. 25 E.) town of Galena, Weilup mine. Analyst, Robertson. Lab. No. 379. (Haworth and others, 1904, p. 83.) Chert, soft, clayey; in fissures of primary chert.

18-21. Cheyenne County. Sanborn formation. SE¼SE¼ sec. 28, T. 3 S., R. 39 W. Spectrographic analyst, Reed. (Frye and others, 1949, p. 84, 52, 54, 56, 86-88, 98.) Silt. Index map, map showing thickness of loess; generalized columnar section. Plastic and dry properties, fired properties.

   18. Peoria silt member. Sample No. 7-A. Silt, 18 ft below top of section. Possible use: Ceramic slag.
   19. Peoria silt member. Sample No. 7-B. Silt, 10 ft below top of section. Possible use: Ceramic slag.
   20. Peoria silt member, Brady soil. Sample No. 7-C. Silt, plastic, 5.5 ft below top of section. Possible use: Ceramic material.
   21. Bignell silt member. Sample No. 7-D. Silt, 2.5 ft below top of section. Possible use: Ceramic aggregate, railroad ballast.

22-24. Clark County. Permian. (Swineford, 1955, p. 122, 10, 11, 80, 86.) (Analyses suggest more MgO than required for carbonate.) Shale. Index map and geologic map, generalized and detailed measured sections. Mineralogy of formation. X-ray diffraction data for some samples of Whitehorse sandstone and Taloga formation.

   *22. Whitehorse sandstone. NW¼ sec. 29, T. 32 S., R. 21 W., (R. T. Runnels, written communication, 1957). Lab. No. 1779. (Analysis suggests 16.5 percent unused MgO; shows 2.8 percent alkalies, 1.0 percent TiO_2.) Shale, dark red, silty.
   *23. Taloga formation, basal bed. Center sec. 14, T. 32 S., R. 23 W., (R. T. Runnels, written communication, 1957). Analyst, under supervision of Runnels. Lab. No. 1801. (Analysis suggests 15.6 percent unused MgO; shows 2.3 percent alkalies.) Shale, green.
   *24. Taloga formation. Center sec. 14, T. 32 S., R. 23 W., (R. T. Runnels, written communication, 1957). Analyst under supervision of Runnels. Lab. No. 1802. (Analysis suggests 10.8 percent unused MgO; shows 3.8 percent alkalies, 1.0 percent TiO_2.) Shale, red, silty.

25. Clark County. Lower Cretaceous, Kiowa shale. NW¼NW¼ sec. 18, T. 32 S., R. 22 W. Analyst, under supervision of Runnels. Lab. No. CL-6. (Plummer and Hladik, 1951, p. 21, 26, 27, 30, 37, 64, 65.) Shale, light-gray, unoxidized; 31.8 ft sampled; 50.0 ft available. Index and outcrop map. Physical properties of bloated aggregate, bloating results; screen analysis of lightweight aggregate. Possible use: Lightweight aggregate.

26. Clark County. Meade formation, Pearlette ash bed. SE¼SE¼ sec. 23, T. 30 S., R. 24 W. Analyst, under supervision of Runnels. Lab. No. CLV-1A. (Carey and others, 1952, p. 20, 4, 12, 15, 24, 40.) Volcanic ash, from lower 4.4 ft of bed 9 ft thick. Index map, generalized columnar section. Screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas												
	27	28	29	30	31	32	33	34	35	36	37	38	39
	15B13-3	15B14-2	15B14-3	15B14-5	15B14-4	15B14-1	15B14-7	15B14-6	15B15-1	15B15-4	15B15-2	15B15-5	15B15-3
SiO_2	73.73	77.32	77.64	78.62	77.95	76.69	75.86	74.75	65.20	72.01	68.56	72.18	68.61
Al_2O_3	11.67	10.83	10.38	10.24	10.18	10.80	10.79	10.96	18.79	[1] 19.50	[1] 17.39	[1] 19.58	16.16
Fe_2O_3	1.63	2.52	2.53	2.35	2.59	2.79	2.94	2.80	5.66	1.15	1.68	1.70	4.62
MgO	.09	.86	.74	.70	.70	.86	.89	1.19	.46	.24	.40	.51	1.03
CaO	.73	1.49	1.22	1.34	.86	.93	1.32	1.75	.48	.18	.30	.27	.72
Na_2O	[2] 2.71	[3] 1.12	[3] 1.32	[3] .56	[3] 1.38	[3] .50	[3] 1.77	[3] 1.75	2.25	2.32	1.56	2.11	
K_2O	[2] 4.95	2.87	3.23	3.23	3.02	3.68	3.18	3.27					......
H_2O - [4]	......	(.29)	(.25)	(.08)	(.18)	(.21)	(.23)	(.39)	......	......	......	......	......
TiO_2	.49	1.22	.88	.94	.72	.92	.83	1.17	......	......	......	......	2.66
P_2O_5	Tr.	.14	.14	.08	Tr.	Tr.	.11	.15	......	......	......	......	None
SO_3	Tr.	Tr.	.15	.20	Tr.	.07	Tr.	Tr.	......	......	......	......	.04
Ignition loss	4.00	1.77	1.83	1.74	2.60	2.76	2.31	2.36	6.49	5.01	10.91	5.29	6.34
Total	100.00	100.14	100.06	100.00	100.00	100.00	100.00	100.15	99.33	100.41	100.80	101.64	[5] 100.18
Class	51,39,1	55,37,0	56,36,0	58,35,0	57,36,0	54,39,0	53,38,0	52,39,0	26,70,1	36,61,0	36,62,1	36,63,0	35,62,2

	40	41	42	43	44	45	46	47	48	49	50	51	52
	15B15-28	15B15-29	15B15-23	15B15-22	15B15-24	15B15-10	15B15-11	15B15-26	15B15-27	15B15-25	15B15-17	15B15-16	15B15-13
SiO_2	76.04	76.58	66.66	67.58	70.04	80.85	73.29	64.30	65.14	68.26	84.15	77.81	83.92
Al_2O_3	14.76	13.12	15.83	16.45	12.15	7.95	10.76	17.99	18.30	13.55	7.15	12.25	5.61
Fe_2O_3	[6] 1.53	[6] 3.49	6.27	4.27	7.13	3.24	4.24	5.20	4.56	7.13	1.52	1.67	2.17
MgO	.34	.39	......	......	......	......	......	......	......	......	......	......	......
CaO	.42	.45	......	......	......	......	......	......	......	......	......	......	......
TiO_2	.89	.66	1.18	1.23	1.08	......	......	1.30	1.17	1.05	......	......	......
P_2O_5	Tr.	Tr.	......	......	......	......	......	......	......	......	......	......	......
SO_3	Tr.	Tr.	......	......	......	......	......	......	......	......	......	......	......
V_2O_5	[7] .0502	[7] .0816	......	......	......	......	......	......	......	......	......	......	......
Ignition loss	5.08	4.85	8.04	8.38	7.22	4.57	7.02	8.48	8.67	7.52	4.32	6.40	3.79
Total	99.11	99.62	97.98	97.91	97.62	96.61	95.31	97.27	97.84	97.51	97.14	98.13	95.49
Class	48,49,1	49,48,1	32,65,0	34,63,0	41,56,0	63,33,0	49,46,0	27,69,0	28,69,0	36,60,0	70,27,0	54,44,0	72,24,0

	53	54	55	56	57	58	59	60	61	62	63	64	*65
	15B15-20	15B15-21	15B15-6	15B15-18	15B15-7	15B15-9	15B15-12	15B15-8	15B15-19	15B15-14	15B15-15	15B17-3	15B17-4
SiO_2	68.00	65.88	80.14	72.68	66.28	74.20	68.38	66.16	64.04	75.04	64.59	73.00	71.68
Al_2O_3	17.56	18.72	7.69	14.19	21.32	13.09	14.02	17.82	14.84	11.54	15.65	[1] 12.59	12.00
Fe_2O_3	2.41	2.70	4.74	2.20	1.70	1.77	5.31	5.99	9.85	2.67	7.15	1.52	1.37
MgO	......	......	......	......	......	......	......	......	......	......	......	.14	.87
CaO	......	......	......	......	......	......	......	......	......	......	......	.59	.43
Na_2O	......	......	......	......	......	......	......	......	......	......	......	[2] 2.82	3.16
K_2O	......	......	......	......	......	......	......	......	......	......	......	[2] 5.59	6.76
TiO_2	1.03	1.18	......	1.43	1.18	1.48	......	1.09	1.19	......	......	......	.49
P_2O_5	......	......	......	......	......	......	......	......	......	......	......	Tr.	Tr.
SO_3	......	......	......	......	......	......	......	......	......	......	......	Nil	Nil
Ignition loss	8.82	9.01	4.23	7.47	6.12	7.15	7.95	7.30	7.75	6.12	8.94	3.75	4.02
Total	97.82	97.49	96.80	97.97	96.60	97.69	95.66	98.36	97.67	95.37	96.33	100.00	100.78
Class	34,63,0	30,67,0	61,36,0	45,51,0	27,69,0	49,47,0	38,58,0	28,69,0	27,70,0	52,44,0	29,67,0	49,42,0	49,39,1

Qualitative spectrographic analyses

[Carbon electrodes used. Higher numbers indicate greater abundance. Ag not detected. Further explanation of table (Frye and others, 1949, p. 87)]

	28	29	30	31	32	33	34		28	29	30	31	32	33	34
V	9	3	5	5	ND	5	5	Cu	6	5	6	6	5	6	6
Cr	7	3	4	5	ND	2	ND	Zn	5	3	4	4	2	4	4
Mn	7	5	6	6	4	6	5	Zr	7	3	ND	4	ND	3	ND

[1] Includes TiO_2.
[2] Na_2O+K_2O by difference; ratio by spectrographic determination.
[3] By difference.
[4] 105° -140° C. (not included in total).
[5] 99.98 in text.
[6] Average of three or more determinations.
[7] Analyzed spectrographically.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

27. Clark County. Pleistocene, Meade formation, Pearlette ash bed. SE¼SE¼ sec. 23, T. 30 S., R. 24 W. Analyst, under supervision of Runnels. Lab. No. CLV-1B. (Carey and others, 1952, p. 20, 4, 12, 15, 24, 40.) Volcanic ash, 1.6 ft below top of bed 9 ft thick. Index map, generalized columnar section. Screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate. (For another analysis from same measured section see sample 26, this group.)

28-34. Clay County. Pleistocene, Sanborn formation. NE¼NE¼ sec. 19, T. 8 S., R. 3 E. Spectrographic analyst, Reed. (Frye and others, 1949, p. 85, 52, 56, 87, 93, 112, 113.) Silt. Index map, generalized columnar section. Plastic and dry properties; fired properties.

28-32. Loveland silt member. Possible use: Brick, tile, lightweight ceramic aggregate.

28. Sample No. 32-A. Silt, 27.5 ft below top of section.
29. Sample No. 32-B. Silt, 22.5 ft below top of section.
30. Sample No. 32-C. Silt, 17.5 ft below top of section.
31. Sample No. 32-D. Silt, fairly plastic, 13.5 ft below top of section.
32. Sample No. 32-E. Silt, fairly plastic, 11 ft below top of section.

33-34. Peoria silt member. Possible use: Ceramic slag.

33. Sample No. 32-F. Silt, 8 ft below top of section.
34. Sample No. 32-G. Silt, 4 ft below top of section.

35-38. Cloud County. Upper Cretaceous, Dakota sandstone. Analysts, Thompson and Runnels. Clay. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

35. Terra Cotta clay member. S½ sec. 18, T. 8 S., R. 1 W. Lab. No. C-28-3. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 155, 163, 166, pl. 1.) Clay, 15.7 ft thick, sectioned from top to bottom as follows:

5.4 ft ... lavender and gray, red mottling, small amount of yellow, plastic.
1.9 ft ... light gray, red mottling, slightly silty.
7.2 ft ... gray, with lavender, red, brown mottling, plastic.
1.2 ft ... dark gray, silty, lignitic.

36. Terra Cotta clay member. NW¼ sec. 31, T. 8 S., R. 1 W. Lab. No. C-29-3. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 110, 122, 125, 126, pl. 1.) Clay, gray, slight yellow stain; rather silty; lignite fragments and fossil leaves; 5.5 ft thick. Possible use: Refractories.

37. Janssen clay member. SE¼ sec. 11, T. 8 S., R. 2 W. Lab. No. C-12-B. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 89, 99, 102, 103, pl. 1.) Clay, gray to light-gray, slight yellow stain, slightly silty to fairly plastic; lignite particles. Conchoidal fracture, vertical jointing; 17.2 ft thick. Possible use: Brick, tile.

38. Janssen clay member. NE¼NW¼ and NW¼NE¼ sec. 15, T. 8 S., R. 3 W. Lab. No. C-43-4. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 110, 122, 125, 126, pl. 1.) Siliceous fire clay; 5.6 ft thick. Upper 3.0 ft; gray to dark gray, some yellow stain, slightly silty. Lower 2.6 ft; light gray, some yellow stain, plastic; some limonite-filled root cavities. Possible use: Refractories.

39. Cloud County. Dakota sandstone, Janssen clay member. NW¼ sec. 12, T. 6 S., R. 3 W. Analyst, Runnels. Lab. No. C-51-7. (Plummer and Hladik, 1948, p. 74, 62, 80, 81, 90.) Clay, channel sample, 5.2 ft thick. Index map. Firing and physical properties of ceramic slag. Possible use: Ceramic slag.

40. Cloud County. Dakota sandstone, Janssen clay member (R. T. Runnels, written communication, 1953). NW¼NW¼ sec. 12, T. 6 S., R. 3 W. Analyst, Runnels. Lab. No. C-51-6. (Reed, 1950, p. 27, 24, 36.) Clay. Use: Brick.

41. Information as in sample 40. Lab. No. C-51-C.

Kansas--Continued

42-63. Cloud County. Dakota sandstone. Sec. 32, T. 8 S., R. 2 W. Clay. Index maps; generalized columnar section; logs of auger drill holes, open cuts, or pits. Possible use: Ceramic products.

42. NE¼NE¼ sec. 32. Hole A-43. (McMillan and Wilson, 1948, p. 11, figs. 1-4.) Clay, varicolored; 12.5-20 ft below surface.
43. Information as in sample 42. Clay, 6-12.5 ft below surface.
44. SW part, NE¼NE¼ sec. 32. Hole A-44. (McMillan and Wilson, 1948, p. 12, figs. 1-4.) Clay, varicolored; 10-14.5 ft below surface.
45. Center NE¼NE¼ sec. 32. Hole A-1. (McMillan and Wilson, 1948, p. 6, figs. 1-4.) Clay, gray, sandy; 6-9 ft below surface.
46. Center NW¼NE¼ sec. 32. Hole A-2. (McMillan and Wilson, 1948, p. 6, figs. 1-4.) Clay, blue-black; 25-30 ft below surface.
47. SW¼NE¼ sec. 32. Hole A-46. (McMillan and Wilson, 1948, p. 12, figs. 1-4.) Clay, varicolored; 8-13.5 ft below surface.
48. SW¼NE¼ sec. 32. Hole A-46. (McMillan and Wilson, 1948, p. 12, figs. 1-4.) Clay, gray, few yellow and brown streaks; 3-8 ft below surface.
49. NE part, SW¼NE¼ sec. 32. Hole A-45. (McMillan and Wilson, 1948, p. 12, figs. 1-4.) Clay, varicolored; 8-17 ft below surface.
50. NE part, NE¼NW¼ sec. 32. Hole A-17. (McMillan and Wilson, 1948, p. 9, figs. 1-4.) Clay, blue; 4-6 ft below surface.
51. Information as in sample 50. Clay, 0-4 ft below surface.
52. Center NE¼SW¼ sec. 32. Hole A-12. (McMillan and Wilson, 1948, p. 8, figs. 1-4.) Clay, gray, silty; 15-17 ft below surface. (For another analysis from same measured section see sample 20, group A of this compilation.)
53. SE¼SW¼ sec. 32. Hole A-34. (McMillan and Wilson, 1948, p. 10, figs. 1-4.) Clay, dark blue-gray; 28-33 ft below surface. (For another analysis from same measured section see sample 12, group D of this compilation.)
54. SE¼SW¼ sec. 32. Hole A-35. (McMillan and Wilson, 1948, p. 10, figs. 1-4.) Clay, dark blue-gray; 13-18 ft below surface.
55. NW part, SE¼SW¼ sec. 32. A-Cut-1. (McMillan and Wilson, 1948, p. 13, figs. 1-4.) Clay, red, brown; 0.5-2.7 ft below surface. (For analysis from same measured section see sample 13, group D of this compilation.)
56. SW part, SE¼SW¼ sec. 32. Hole A-31. (McMillan and Wilson, 1948, p. 9, figs. 1-4.) Clay, dark blue-gray, few yellow streaks, some silt; 0-6 ft below surface.
57. SW part, SE¼SW¼ sec. 32. A-Cut-2. (McMillan and Wilson, 1948, p. 13, figs. 1-4.) Clay, gray, weathered; 0.6-1.7 ft below surface. (For other analyses from same measured section see samples 6-8, group D of this compilation.)
58. SW part, SE¼SW¼ sec. 32. A-Pit-2. (McMillan and Wilson, 1948, p. 14, figs. 1-4.) Clay, dark blue-gray, few yellow streaks; 0-6 ft below surface.
59. Center NE¼SE¼ sec. 32. Hole A-11. (McMillan and Wilson, 1948, p. 7, figs. 1-4.) Clay, red, yellow, gray; 18-29 ft below surface.
60. Center NW¼SE¼ sec. 32. A-Cut-4. (McMillan and Wilson, 1948, p. 13, figs. 1-4.) Clay, gray; red and yellow streaks; some hematite; 7.5-12 ft below surface.
61. Center NW¼SE¼ sec. 32. Hole A-33. (McMillan and Wilson, 1948, p. 10, figs. 1-4.) Clay, gray, red; 7.5-12 ft below surface.
62. Center SW¼SE¼ sec. 32. Hole A-15. (McMillan and Wilson, 1948, p. 8, figs. 1-4.) Clay, gray, yellow; 20-23 ft below surface.
63. Center SE¼SE¼ sec. 32. Hole A-16. (McMillan and Wilson, 1948, p. 9, figs. 1-4.) Clay, gray, red; 22-26 ft below surface.

64-65. Comanche County. Meade formation, Pearlette ash bed. SE¼NE¼ sec. 12, T. 31 S., R. 18 W. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 15, 24, 41.) Estimated tonnage, index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

64. Lab. No. CMV-1A. Volcanic ash, from lower 5.5 ft of bed 13 ft thick.
*65. Lab. No. CMV-1B. (Analysis shows 9.9 percent alkalies.) Volcanic ash, fairly fresh; from upper 10.0 ft of 13 ft bed.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas											
	66	67	68	69	70	71	72	73	74	75	76	77
	15B19-2	15B19-3	15B19-4	15B19-5	15B22-4	15B22-8	15B22-5	15B22-1	15B22-2	15B22-3	15B22-7	15B22-9
SiO_2	67.46	67.56	64.79	73.43	75.63	76.80	76.58	71.21	71.62	73.33	76.79	77.38
Al_2O_3	17.10	19.90	16.17	12.43	11.95	12.05	12.05	10.11	11.61	12.00	10.85	11.82
Fe_2O_3	4.63	2.16	7.37	6.00	2.77	2.75	3.03	2.61	2.92	3.02	2.87	2.72
MgO	1.23	.52	.99	.62	1.27	.96	1.08	2.62	2.08	1.06	1.15	1.26
CaO	.27	.31	.38	.38	2.17	.98	1.17	3.70	3.55	2.67	1.10	.95
Na_2O	1.03	.18	.83	.23	[1] .59	[1] 1.39	[1] .82	[1] 1.62	[1] 1.54	[1] 1.48	[1] 2.39	[1] .77
K_2O	2.38	1.91	2.24	1.12	2.64	2.59	2.90	2.35	2.00	2.55	2.58	2.69
H_2O- [2]	......	......	......	......	(.39)	(.30)	(.26)	(.13)	(.56)	(.47)	(.36)	(.40)
TiO_2	1.01	1.15	1.65	1.26	......	......	......	......	......	......	......	......
P_2O_5	.17	.05	.05	.05	.14	.09	.17	.15	.16	.08	.13	.09
SO_3	Nil	Nil	Nil	Nil	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Ignition loss	4.72	6.02	5.69	4.59	2.98	2.48	2.37	5.78	4.68	3.89	2.27	2.41
Total	100.00	[3] 99.76	[4] 100.16	[5] 100.11	100.14	100.09	100.17	100.15	100.16	100.08	100.13	100.09
Class	32,62,0	30,65,1	28,66,0	45,52,0	51,42,0	52,42,0	52,42,0	50,37,5	48,42,2	49,43,0	54,38,0	53,41,0

	78	79	80	81	82	83	84	85	86	87	88	89
	15B22-6	15B22-15	15B22-12	15B22-14	15B22-13	15B22-10	15B22-11	15B25-1	15B26-1	15B26-2	15B27-64	15B27-63
SiO_2	76.78	76.99	68.02	69.11	68.83	65.39	66.58	62.50	60.43	72.96	83.76	82.83
Al_2O_3	10.47	11.14	10.82	10.80	11.09	10.15	11.06	16.95	18.68	12.62	4.06	9.89
Fe_2O_3	3.32	2.86	2.76	3.15	3.04	3.25	3.20	6.61	5.36	1.55	8.69	1.14
MgO	.97	1.01	3.22	2.51	2.41	2.97	2.50	2.24	1.35	.13	.94	Tr.
CaO	1.02	.98	4.87	4.22	4.16	6.15	5.60	.68	.81	.50	.00	.04
Na_2O	[1] 1.44	[1] 1.39	[1] 3.31	[1] 1.61	[1] 1.68	[1] 1.53	[1] .28	1.75	.46	2.51	......	} 1.77
K_2O	2.41	2.21	......	2.52	2.63	2.26	2.84	2.88	3.14	5.51	......	
H_2O- [2]	(.40)	(.60)	(.57)	(.45)	(.45)	(.08)	(.25)	......	......	......	......	......
TiO_2	1.30	.80	......	......	......	......	......	1.08	1.06	.21	.48	1.20
P_2O_5	.10	.08	Tr.	.17	.15	.15	.15	.19	.14	Tr.	......	......
SO_3	Tr.	.02	Tr.	.06	.06	.04	.20	.01	1.03	.31	.00	......
Ignition loss	2.29	2.60	7.00	6.02	6.10	8.26	7.74	4.56	8.19	4.01	2.04	3.07
Total	100.10	100.08	100.00	100.17	100.15	100.15	100.15	[6] 99.45	100.65	100.31	[7] 99.97	99.94
Class	55,38,0	54,40,0	46,39,8	46,40,5	46,41,5	44,38,10	43,41,9	25,66,0	21,69,4	49,42,1	67,32,0	64,33,0

	90	91	92	93	94	95	96	97	98	99
	15B27-56	15B27-17	15B27-16	15B27-19	15B27-25	15B27-21	15B27-26	15B27-3	15B27-33	15B27-37
SiO_2	75.31	67.00	66.80	67.14	68.70	67.59	68.98	62.99	70.34	72.46
Al_2O_3	17.04	21.11	[8] 20.94	22.15	[9] 21.05	21.13	19.35	22.30	16.63	16.58
Fe_2O_3	.97	3.20	[10] 1.40	1.28	1.23	1.15	1.61	1.74	.46	1.31
MgO	.25	.85	.65	.27	.37	.32	Tr.	.71	1.11	.73
CaO	.24	.38	.24	.55	.29	.66	.16	.73	.42	.49
Na_2O	} .67	1.15	.16	} 1.68	1.80	1.88	1.25	1.70	2.57	2.52
K_2O			1.98							
TiO_2	.17	.20	[11] 1.24	.56	......	.55	1.30	1.49	1.15	.45
P_2O_5	......	......	Tr.	......	......	......	......	......	......	......
SO_3	......	......	Tr.	......	......	......	......	......	......	......
S	......	......	[12] (.12)	......	......	......	......	......	......	......
Ignition loss	4.74	5.86	[13] 6.70	6.80	5.72	5.81	6.70	8.23	7.62	6.12
Total	99.39	99.75	100.11	[14] 100.43	99.16	99.09	99.35	99.89	100.30	100.66
Class	44,54,1	26,71,0	28,67,2	27,70,2	30,66,0	29,67,1	33,64,0	22,72,3	40,53,3	42,54,2

Qualitative spectrographic analyses

[Carbon electrodes used. Higher numbers indicate greater abundance. Zn not detected. Further explanation of table (Frye and others, 1949, p. 87)]

	71	74	75	76	77	78	79	83
V	4	5	7	6	5	6	3	8
Cr	4	5	5	7	ND	5	4	8
Mn	7	7	7	6	7	7	6	9
Cu	ND	ND	ND	ND	ND	ND	ND	1
Zr	6	8	6	6	6	6	5	9
Ag	ND	ND	ND	ND	ND	ND	ND	2

Spectrochemical analysis

[Standard graphite electrodes used. Co, Zn, Ge, Sr, Zr, Ag, Cd, Ba, and lanthanides not found. Further explanation of table (Plummer and others, 1954, p. 170)]

92			
V	0.0177	Ga	0.0034
Cr	.0105	Mo	.0027
Mn	.0072	Sn	Tr.
Ni	.0033	Pb	Tr.
Cu	[15] .00103		

[1] By difference.
[2] 105°-140° C. (not included in total).
[3] 99.71 in text.
[4] 100.11 in text.
[5] 100.06 in text.
[6] 99.63 in text.
[7] P_2O_5, nil; $BaSO_4$, nil (Frye and Swineford, 1947, p. 373); $BaSO_4$, 0.00 percent (Swineford, 1947, p. 74).
[8] Contains Ga_2O_3 and MnO_2 if present.
[9] Includes TiO_2.
[10] Total iron.
[11] Contains ZrO_2 and V_2O_5 if present.
[12] Sulfide sulfur, included in ignition loss for summation of constituents.
[13] 140° - 1,000° C.
[14] 100.51 in text.
[15] Not as accurate a determination as other elements (Plummer and others, 1954, p. 171).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

66-69. Crawford County. Analyst, under supervision of Runnels. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

66. Pennsylvanian, Cherokee shale, below Pilot coal underclay. NW¼SE¼ sec. 18, T. 30 S., R. 25 E. Lab. No. CR-7. (Plummer and Hladik, 1951, p. 20,24,25,30-32,52.) Shale, dark-gray, mostly unoxidized; 6.0 ft sampled; about 20.0 ft available. Geologic map.

67. Cherokee shale, below Pilot coal. NW¼SE¼ sec. 18, T. 30 S., R. 25 E. Lab. No. CR-6. (Plummer and Hladik, 1951, p. 20, 24, 25, 31, 32, 52.) Shale, gray, mostly oxidized; 12.0 ft sampled; 12.0 ft available. Geologic map.

68. Pleistocene, terrace deposit. NE¼ SE¼ sec. 16, T. 16 S., R. 25 E., (see Plummer and Hladik, 1951, p. 28; this township not in Crawford County.) Lab. No. CR-8. (Plummer and Hladik, 1951, p. 21, 28-32, 45, 72.) Loess, dark-gray, oxidized; 9.0 ft sampled; 9.0 ft available. Map of generalized thickness of loess deposits.

69. Terrace deposit. NW¼ SE¼ sec. 18, T. 30 S., R. 25 E. Lab. No. CR-5. (Plummer and Hladik, 1951, p. 21, 28-32, 45, 72.) Loess, red and gray, oxidized; 4.0 ft sampled, 4.0 ft available. Map of generalized thickness of loess deposits.

70-78. Doniphan County. Pleistocene, Sanborn formation. NE¼SE¼ sec. 6, T. 2 S., R. 20 E. Spectrographic analyst, Reed. (Frye and others, 1949, p. 85, 52, 56, 62, 87, 94, 95, 116, 117.) Silt. Index map, generalized columnar section. Plastic and dry properties, fired properties.

70-72. Loveland silt member. Possible use: Brick, tile, lightweight ceramic aggregate.

70. Sample No. 41-A. Silt, 71.3 ft below top of section.
71. Sample No. 41-B. Silt, 68.8 ft below top of section.
72. Sample No. 41-C. Silt, 66.3 ft below top of section.

73-77. Peoria silt member. Possible use: Ceramic slag.

73. Sample No. 41-D. Silt, 65 ft below top of section.
74. Sample No. 41-E. Silt, 60 ft below top of section.
75. Sample No. 41-F. Silt, 55 ft below top of section.
76. Sample No. 41-G. Silt, 50 ft below top of section.
77. Sample No. 41-H. Silt, 45 ft below top of section.

78. Peoria silt member, Brady soil. Sample No. 41-I. Silt, 40 ft below top of section. Possible use: Ceramic material.

79-84. Doniphan County. Sanborn formation, Bignell silt member. NE¼SE¼ sec. 6, T. 2 S., R. 20 E. (Frye and others, 1949, p. 85, 52, 56, 87, 94, 115, 116.) Silt. Index map, generalized columnar section. Plastic and dry properties, fired properties. Possible use: Ceramic aggregate, railroad ballast.

79. Spectrographic analyst, Reed. Sample No. 41-J. Silt, 36 ft below top of section.
80. Sample No. 41-K. Silt, 31 ft below top of section.
81. Sample No. 41-L. Silt, 27 ft below top of section.
82. Sample No. 41-N. Silt, 19 ft below top of section.
83. Spectrographic analyst, Reed. Sample No. 41-P. Silt, 13 ft below top of section.
84. Sample No. 41-R. Silt, 7 ft below top of section.

85. Elk Connty. Pennsylvanian, Severy shale. SW¼NW¼ sec. 2, T. 30 S., R. 10 E. Analyst, under supervision of Runnels. Lab. No. EK-5. (Plummer and Hladik, 1951, p. 20, 26, 27, 30, 33, 52.) Shale, gray, unoxidized; 22.0 ft sampled; 40.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

86. Ellis County. Upper Cretaceous, Carlile shale, Blue Hill shale member. NE¼SE¼ sec. 21, T. 13 S., R. 19 W. Analyst, under supervision of Runnels. Lab. No. ES-1. (Plummer and Hladik, 1951, p. 21, 28-30, 64, 65.) Shale, pink and gray, unoxidized; 13.0 ft sampled; 30.0 ft available. Index and geologic maps. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate. Possible use: Lightweight aggregate.

87. Ellis County. Pleistocene, Meade formation, Pearlette ash bed. SW¼NW¼ sec. 5, T. 13 S., R. 19 W. Analyst, nnder supervision of Runnels. Lab. No. ESV-3. (Carey and others, 1952, p. 20, 4, 12, 15, 24.) Volcanic ash, fairly fresh; 10.5 ft thick. Overburden, about 8 ft. Index map, generalized columnar section. Screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

88-91. Ellsworth County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay member.

88. SW¼ sec. 14, T. 15 S., R. 6 W. Analyst, Runnels. (Swineford, 1947, p. 74, 59, 75, 93; Frye and Swineford, 1947, p. 373, 376.) Sandstone, buff to gray, fine- to medium-grained; friable; dense, homogeneous, crossbedded. Soluble in HCl, 2.69 percent. Estimated tonnage. Outcrop map. Mineralogy. Use: Concrete aggregate, riprap, road metal.

Kansas--Continued

89-91. T. 15 S., R. 6 W. Analysts, Thompson and Runnels. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

89. W½SE¼ sec. 15, Lab. No. TC-2-1. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 136, 138, 141, 143, 148, 150, pl. 1.) Highly siliceous fire clay, light-gray, some yellow stain, silty to very silty; limonitic joint filling; spot sample; 7.0 ft thick. Absorption-temperature curves, porosity-temperature curves.

90. W½SE¼ sec. 15. Lab. No. TC-2-10. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 120, 122, 125, 129, 130, 148, pl. 1.) Siliceous fire clay, gray, some yellow stain on joints, few lignite fragments, slightly silty, massive; spot sample; 6.3 ft thick. Temperature-specific gravity and temperature-apparent specific gravity curves, absorption-temperature curves.

91. Center N½ sec. 16. Lab. No. El-32-A. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 156, 163, 166, pl. 1.) Clay, composite sample; 95 ft thick.

92. Ellsworth County. Dakota sandstone, Terra Cotta clay member. NW¼NW¼ sec. 30, T. 15 S., R. 6 W. Lab. No. El-69-2. (Plummer and others, 1954, p. 164, 161, 165, 170, 171, 173, 178, 181, 186, 206, pls. 1, 3.) Fire clay, gray to light-gray, some yellow stain; lignite particles; channel sample; 10 ft thick. Upper 0.5 ft, impure kaolin. Underlain by more than 10 ft of yellow sandstone, overlain by 6 ft of mottled clay. Additional chemical analyses of sized fractions of sample, spectrochemical analysis of clay fraction <2 microns. Petrographic and mineralogical data, ceramic properties, differential thermal analysis, mechanical analysis. Photomicrographs of thin sections, electron micrographs of clay particles; X-ray diffraction data; weighted composition of sized fractions, statistical data. Use: Brick, tile.

93-95. Ellsworth County. Dakota sandstone, Terra Cotta clay member. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 91, 93, 99, 102, 103, 107, 150, pl. 1.) Plastic fire clay. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile, refractories.

93. Sec. 25, T. 15 S., R. 7 W. Lab. No. El-14-01. Fire clay, gray to dark-gray, fine-grained, thin-bedded; minute amonnts of silt on bedding planes, some lignitic particles, small amount of pyrite; more than 6.9 ft thick. (For another analysis from same measured section see sample 54, group Hk of this compilation.)

94. NW¼NW¼ sec. 15, T. 16 S., R. 9 W. Lab. No. El-38-04. Fire clay, light-gray, slight amount of yellow stain, thin-bedded; 6.4 ft thick. Temperature-specific gravity and temperature-apparent specific gravity curves.

95. NW¼NW¼ sec. 15, T. 16 S., R. 9 W. Lab. No. E1-38-05. Fire clay, gray, some yellow and pinkish stain, thin-bedded; small amounts of sand; 5 ft thick. Porosity-temperature curve.

96-99. Ellsworth County. Dakota sandstone, Janssen clay member. Analysts, Thompson and Runnels. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

96. Center W½ sec. 23, T. 14 S., R. 7 W. Lab. No. El-29-4. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 92, 99, 102, 103, 107, pl. 1.) Fire clay, gray to nearly black; 12.8 ft thick; top 5 ft plastic, remainder silty. Temperature-specific gravity and temperature-apparent specific gravity curves. Possible use: Brick, tile, refractories.

97. NW¼ sec. 33, T. 14 S., R. 7 W. Lab. No. El-91-2. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 94, 99, 102, 104, pl. 1.) Fire clay, gray, slight yellow stain, slightly silty, plastic, conchoidal fracture, particles of lignitized wood and fossil leaves; 8.1 ft thick. Contains two layers of kaolin. Possible use: Brick, tile, refractories.

98. Sec. 2, T. 15 S., R. 7 W. Lab. No. El-85-3. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 115, 122, 125, 127, pl. 1.) Siliceous fire clay, gray to dark-gray, some yellow stain, silty, conchoidal fracture; small selenite crystals on joints, lignite fragments; 5.9 ft thick. Possible use: Refractories.

99. Sec. 2, T. 15 S., R. 7 W. Lab. No. El-85-4. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 115, 122, 125, 128, 148, pl. 1.) Siliceous fire clay, gray. Sectioned from top to bottom as follows:

1.6 ft ... some yellow stain, silty, lignitic.
1.5 ft ... some yellow stain, fairly plastic.
4.5 ft ... slight yellow stain, fairly silty, pronounced conchoidal fracture; lignite and some selenite crystals.

Absorption-temperature curve. Possible use: Refractories.

TABLE 3. — Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas												
	100	101	102	103	104	105	106	107	108	109	110	111	112
	15B27-35	15B27-36	15B27-45	15B27-57	15B27-55	15B27-11	15B27-2	15B27-28	15B27-20	15B27-39	15B27-91	15B27-7	15B27-47
SiO_2	71.80	72.38	73.26	76.40	75.18	66.02	62.25	69.32	67.31	72.68	78.49	65.16	73.52
Al_2O_3	19.12	18.55	[1]17.86	10.35	11.79	17.66	19.19	17.71	16.22	16.19	[2]14.57	19.25	11.97
Fe_2O_3	.88	.75	[3].65	1.40	1.26	3.19	3.40	1.92	4.32	1.35	.97	5.46	4.11
MgO	.16	.14	.15	.55	.35	......	......	......	......	......	.45	......	......
CaO	.18	.21	.14	.88	.11	......	......	......	......	......	.37	......	......
Na_2O	} .82	.78	.05	}	1.74	......	......	......	......	......	2.45	......	......
K_2O			.06										
TiO_2	1.30	1.33	[4]1.25	.91	1.89	1.13	1.32	1.26	1.24	1.30	......	1.21	1.12
P_2O_5	......	......	Tr.	......	......	......	......	......	......	......	......	......	......
SO_3	......	......	Tr.	......	......	......	......	......	......	......	......	......	......
S	......	......	[5](.02)	......	......	......	......	......	......	......	......	......	......
Ignition loss	[6]6.05	6.33	[6]6.48	7.76	7.46	10.21	11.56	7.70	9.04	7.66	3.67	5.92	6.04
Total	100.31	100.47	99.90	98.25	99.78	98.21	97.72	97.91	98.13	99.18	100.97	97.00	96.76
Class	37,61,1	39,59,1	41,57,1	57,38,3	53,42,1	31,66,0	24,72,0	36,61,0	34,63,0	43,55,0	52,46,0	25,71,0	48,48,0

	113	114	115	116	117	118	119	120	121	122	123	124	125
	15B27-51	15B27-31	15B27-43	15B27-41	15B27-44	15B27-40	15B27-38	15B27-13	15B27-4	15B27-30	15B27-9	15B27-14	15B27-48
SiO_2	74.46	70.00	73.18	73.16	73.22	72.79	72.50	66.19	63.89	69.61	65.44	66.20	73.64
Al_2O_3	13.24	14.88	12.80	9.61	10.46	16.96	16.53	16.68	17.01	14.26	15.33	18.79	11.12
Fe_2O_3	4.40	3.98	3.05	6.34	5.99	1.91	1.91	7.16	8.30	6.81	8.57	5.39	6.02
TiO_2	1.16	.94	1.04	1.47	1.48	1.11	1.12	1.20	1.28	1.29	1.34	1.21	.88
Ignition loss	5.27	8.66	7.71	7.33	7.03	5.77	5.81	6.79	6.92	6.50	6.98	7.97	4.83
Total	98.53	98.46	97.78	97.91	98.18	98.54	97.87	98.02	97.40	98.47	97.66	99.56	96.49
Class	46,51,0	39,58,0	47,50,0	49,47,0	48,49,0	41,57,0	41,56,0	29,68,0	24,72,0	37,60,0	29,68,0	27,71,0	47,48,0

	126	127	128	129	130	131	132	133	134	135	136	137	138
	15B27-50	15B27-6	15B27-32	15B27-18	15B27-23	15B27-10	15B27-22	15B27-5	15B27-12	15B27-34	15B27-15	15B27-46	15B27-53
SiO_2	74.34	64.60	70.28	67.05	68.02	65.94	67.75	64.40	66.08	71.64	66.24	73.31	75.06
Al_2O_3	13.31	18.84	12.62	19.33	16.06	17.88	16.66	18.62	[2]23.70	19.46	18.93	13.66	9.99
Fe_2O_3	3.47	4.06	6.70	2.84	4.46	5.44	4.61	5.89	.46	.36	4.33	4.04	5.53
MgO	......	......	......	......	......	......	......	......	......	.88	......	......	......
CaO	......	......	......	......	......	......	......	......	2.03	1.06	......	......	......
Na_2O+K_2O	......	......	......	......	......	......	......	......	......	1.93	......	......	......
TiO_2	1.15	1.05	1.19	1.03	.93	1.06	1.22	1.22	......	1.15	1.20	1.19	1.00
Ignition loss	4.41	9.17	7.37	7.90	7.20	7.38	6.37	7.13	[6]6.62	3.84	7.17	5.40	4.57
Total	96.68	97.72	98.16	98.15	96.67	97.70	96.61	97.26	98.89	100.32	97.87	97.60	96.15
Class	47,49,0	27,70,0	40,57,0	30,67,0	35,61,0	28,68,0	33,62,0	25,71,0	24,73,1	37,58,0	28,69,0	45,52,0	51,44,0

Spectrochemical analysis of sample 102

[Standard graphite electrodes used. Co, Zn, Ge, Sr, Zr, Ag, Cd, Ba, and lanthanides not found. Further explanation of table (Plummer and others, 1954, p. 170)]

V	0.0076	Ni	0.0029	Mo	0.0029
Cr	.0071	Cu	[7].00037	Sn	.002
Mn	.0073	Ga	.0036	Pb	Tr.

[1] Contains Ga_2O_3 and MnO_2 if present.
[2] Includes TiO_2.
[3] Total iron.
[4] Contains ZrO_3 and V_2O_5 if present.
[5] Sulfide sulfur, included in ignition loss for summation of constituents.
[6] 140°-1,000° C.
[7] Not as accurate a determination as other elements, (Plummer and others, 1954, p. 171).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

100-101. Ellsworth County. Upper Cretaceous, Dakota sandstone, Janssen clay member. SE¼ SW¼ sec. 19, T. 15 S., R. 9 W. Analysts, Thompson and Runnels. Index map, outcrop map; detail .d measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

100. Lab. No. El-60-6. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 112, 122, 125, 126, pl. 1; Kinney, 1952, p. 306, 303, 305, 308.) Siliceous fire clay, light-gray, yellow stain, very silty, pronounced conchoidal fracture; 4.1 ft thick. Trace of kaolin at top. Beneficiation tests. Sample dried at 140° C. Other analyses of sample when calcined and concentrated. Possible use: Refractories, source of alumina.

101. Lab. No. El-60-13. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 113, 122, 125, 127, 130, pl. 1.) Siliceous fire clay, gray, slight yellow stain, silty, pronounced conchoidal fracture; 4.3 ft thick. Temperature-specific gravity and temperature-apparent specific gravity curves. Possible use: Refractories.

102. Ellsworth County. Dakota sandstone, Janssen clay member. SE¼ SW¼ sec. 19, T. 15 S., R. 9 W. Analyst, Runnels. Lab. No. El-60-6. (Plummer and others, 1954, p. 164, 161, 165, 170, 173, 181, pls. 1, 3.) Clay, light-gray, gritty, silty, lignite particles; channel sample; 4.1 ft thick. Underlain by 0.8 ft of lignitic silt, overlain by 10 ft of refractory clay. Additional chemical analyses of sized fractions of sample, spectrochemical analysis of clay fraction <2 microns. Petrographic and mineralogical data, ceramic properties; differential thermal analysis, mechanical analysis. Photomicrographs of thin sections, electron micrographs of clay particles; X-ray diffraction data; weighted composition of sized fractions. Possible use: Brick.

103-104. Ellsworth County. Dakota sandstone, Janssen clay member. T. 14 S., R. 7 W. Analysts, Thompson and Runnels. Fire clay. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

103. SW¼ SE¼ sec. 19. Lab. No. El-73A. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 133, 134, 138, 141, 142, 148, 150, pl. 1.) Highly siliceous fire clay, some yellow stain, silty, some selenite. Composite sample; 32.2 ft thick; 7.2-9.7 ft, silt to fine-grained sandstone. Absorption-temperature curve, porosity-temperature curve. Possible use: Refractories, structural clay products.

104. SE¼ NE¼ sec. 30. Lab. No. El-78-3. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 114, 122, 125, 127, pl. 1.) Siliceous fire clay, gray to dark-gray, silty, lignitic; thin beds, limonite on joints. Spot sample, 19.2-25.6 ft thick. Lens of fine-grained sandstone to silt in lower part. Possible use: Brick.

105-109. Ellsworth County. Dakota sandstone. SW¼ NW¼ sec. 33, T. 14 S., R. 7 W. Clay. Index maps, generalized columnar section, logs of auger drill holes and open cut. Possible use: Ceramic products.

105-107. (McMillan and Wilson, 1948, p. 21, figs. 1-3, 5.)

105. Hole B-S-2. Clay, blue-black; 29.9-40 ft below surface.

106. Hole B-S-2. Clay, blue-black; 14.9-29.9 ft below surface.

107. Hole B-S-2. Clay, gray, few limonite streaks; 6.9-14.9 ft below surface.

108. Hole B-5. (McMillan and Wilson, 1948, p. 19, figs. 1-3, 5.) Clay, blue-black; 3.5-19 ft below surface.

109. B-Cut-1. (McMillan and Wilson, 1948, p. 23, figs. 1-3, 5.) Clay, blue-black; 2-8.5 ft below surface.

110. Ellsworth County. Dakota sandstone. S½ sec. 10, T. 15 S., R. 6 W. Analysts, Thompson and Runnels. Lab. No. El-2-04. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 122, 125, 126, 130, 150, pl. 1.) Fire clay, gray, siliceous. Index map, outcrop map; correlated columnar sections. Ceramic tests, physical properties, mineralogy. Temperature-specific gravity and temperature-apparent specific gravity curves, porosity-temperature curve. Possible use: Brick, refractories.

111-133. Ellsworth County. Dakota sandstone. T. 15 S., R. 6 W. Clay, index maps, generalized columnar sections, logs of open cuts and auger drill holes. Possible use: Ceramic products.

111. SW part NE¼ SW¼ sec. 15. Hole C-28. (McMillan and Wilson, 1948, p. 34, figs. 1-3, 6, 7.) Clay, varicolored; 0.5-10.5 ft below surface.

112. NW part SE¼ SW¼ sec. 15. C-Cut-10. (McMillan and Wilson, 1948, p. 36, figs. 1-3, 6, 7.) Clay, gray; red and yellow streaks; 2-7 ft below surface.

113. NW part SE¼ SW¼ sec. 15. Hole C-33. (McMillan and Wilson, 1948, p. 35, figs. 1-3, 6, 7.) Clay, gray; red and yellow streaks; 2-7 ft below surface.

114. NW part SE¼ SW¼ sec 15. C-Cut-8. (McMillan and Wilson, 1948, p. 36, figs. 1-3, 6, 7.) Clay, light-gray; yellow streaks; 1.5-7.5 ft below surface.

Kansas--Continued

115. NW part SE¼ SW¼ sec. 15. Hole C-31. (McMillan and Wilson, 1948, p. 36, figs. 1-3, 6, 7.) Clay, gray; yellow streaks; 1.5-7.5 ft below surface.

116. NW part SE¼ SW¼ sec. 15. Hole C-32. (McMillan and Wilson, 1948, p. 35, figs. 1-3, 6, 7.) Clay, varicolored; 1.5-6.5 ft below surface.

117. NW part SE¼ SW¼ sec. 15. C-Cnt-9. (McMillan and Wilson, 1948, p. 36, figs. 1-3, 6, 7.) Clay, gray-red; 1.5-5.9 ft below surface.

118. NW part SE¼ SW¼ sec. 15. Hole C-34. (McMillan and Wilson, 1948, p. 35, figs. 1-3, 6, 7.) Clay, dark blue-gray; yellow streaks; 1-6 ft below surface.

119. NW part SE¼ SW¼ sec. 15. C-Cut-11. (McMillan and Wilson, 1948, p. 36, figs. 1-3, 6, 7.) Clay, dark blue-gray; yellow streaks; 1-5.5 ft below surface.

120-124. (McMillan and Wilson, 1948, p. 34, figs. 1-3, 6, 7.)

120. SW part SE¼ SW¼ sec. 15. Hole C-27. Clay, gray-red; 10-20 ft below surface. (For another analysis from same measured section see sample 30, group D of this compilation.)

121. SW part SE¼SW¼ sec. 15. Hole C-25. Clay, gray, few red streaks; 6-16 ft below surface.

122. SW part SE¼ SW¼ sec. 15. Hole C-25. Clay, red-yellow; 1-6 ft below surface.

123. NW part SE¼ sec. 15. Hole C-26. Clay, gray-red; 6-26 ft below surface.

124. NW part SE¼ sec. 15. Hole C-26. Clay, varicolored; 1-6 ft below surface.

125. SW part NE¼ SE¼ sec. 19. Hole C-S-11. (McMillan and Wilson, 1948, p. 37, figs. 1-3, 6, 7.) Clay, dark-gray; red and yellow streaks; 8-17 ft below surface.

126. SW part NE¼ SE¼ sec. 19. C-Cut-6. (McMillan and Wilson, 1948, p. 38, figs. 1-3, 6, 7.) Clay, varicolored; 8-16.9 ft below surface.

127. SE part NW¼ SE¼ sec. 19. Hole C-9. (McMillan and Wilson, 1948, p. 37, figs. 1-3, 6, 7.) Clay, varicolored; 3-13 ft below surface. (For another analysis from same measured section see sample 31, group D of this compilation.)

128. NE part SW¼ SE¼ sec. 19. Hole C-10. (McMillan and Wilson, 1948, p. 37, figs. 1-3, 6, 7.) Clay, varicolored; 9.5-22 ft below surface.

129. NW corner sec. 29. Hole C-S-1. (McMillan and Wilson, 1948, p. 25, figs. 1-3, 8.) Clay, blue-black; 13-20 ft below surface.

130. Center NW¼ NE¼ sec. 29. Hole C-2. (McMillan and Wilson, 1948, p. 24, figs. 1-3, 8.) Clay, gray and red, mottled; 10-15 ft below surface.

131. Center SE¼ NE¼ sec. 29. Hole C-8. (McMillan and Wilson, 1948, p. 25, figs. 1-3, 8.) Clay, gray, few red streaks; 8-13 ft below surface.

132. Center NE¼ NW¼ sec. 29. Hole C-3. (McMillan and Wilson, 1948, p. 24, figs. 1-3, 8.) Clay, varicolored; 6-14 ft below surface.

133. NW part NW¼ NW¼ sec. 29. Hole C-S-5. (McMillan and Wilson, 1948, p. 26, figs. 1-3, 8.) Clay, light-gray; 1.5-9 ft below surface.

134. Ellsworth County. Dakota sandstone. W½ NW¼ sec. 30, T. 15 S., R. 6 W. Analyst, under supervision of Runnels. Lab. No. El-69-2. (Kinney, 1952, p. 306, 303, 305, 308.) Clay, kaolinitic. Beneficiation tests. Sample dried at 140° C. Other analyses of sample when calcined and concentrated. Possible use: Source of alumina, refractories.

135. Ellsworth County. Dakota sandstone, Terra Cotta clay member. Center S½ sec. 20, T. 15 S., R. 7 W. Analysts, Thompson and Runnels. Lab. No. El-21-9. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 111, 122, 125, 126, pl. 1.) Siliceous fire clay, gray to yellow, silty, lignitized fossil leaves; spot sample from bed 8.9 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories, brick.

136-138. Ellsworth County. Dakota sandstone. Sec. 25, T. 15 S., R. 7 W. (McMillan and Wilson, 1948, p. 29, figs. 1-3, 9.) Clay. Index maps, generalized columnar sections, logs of auger drill holes. Possible use: Ceramic products.

136. Center NE¼ NE¼ sec. 25. Hole C-50. Clay, varicolored; 12.5-26 ft below surface. (For another analysis from same measured section see sample 42, group D of this compilation.)

137. Center NW¼ NE¼ sec. 25. Hole C-51. Clay, gray, red, yellow; 15-28 ft below surface.

138. Center NW¼ NE¼ sec. 25. Hole C-51. Clay, gray, red, yellow; 10-15 ft below surface.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas											
	139	140	141	142	143	144	145	146	147	148	149	150
	15B27-52	15B27-49	15B27-59	15B27-60	15B27-61	15B27-54	15B27-29	15B27-24	15B27-8	15B27-42	15B27-27	15B27-58
SiO_2	74.70	73.66	78.92	79.42	79.95	75.17	69.40	68.52	65.23	73.18	69.28	76.52
Al_2O_2	13.89	14.07	10.24	10.31	10.10	13.17	11.77	14.81	17.65	15.79	13.97	12.89
Fe_2O_2	2.34	2.84	3.91	1.77	2.55	3.33	9.57	5.88	6.45	2.48	6.84	3.30
TiO_2	1.16	1.13	.79	1.28	1.03	1.24	.94	.96	.96	1.01	1.21	1.00
Ignition loss	5.17	5.60	5.37	5.10	4.39	4.44	6.16	5.23	7.43	4.39	7.54	4.07
Total	97.26	97.30	99.23	97.88	98.02	97.35	97.84	95.40	97.72	96.85	98.84	97.78
Class	48,49,0	46,51,0	56,42,0	59,37,0	59,38,0	48,48,0	38,59,0	36,59,0	27,70,0	42,53,0	37,61,0	50,47,0

	151	152	153	154	155	156	*157	158	159	160	161	162
	15B27-62	15B27-66	15B27-67	15B27-65	15B29-1	15B29-4	15B30-1	15B32-2	15B32-1	15B33-4	15B34-1	15B34-2
SiO_2	80.62	72.61	72.87	72.53	70.06	66.57	53.61	73.43	73.13	74.30	[1] 72.30	72.78
Al_2O_2	[2] 13.20	11.81	12.68	12.80	17.80	21.75	16.86	12.30	11.71	14.40	12.20	[2] 12.26
Fe_2O_2	.71	1.74	1.34	1.64	1.31	1.00	4.66	1.61	1.93	2.00	1.40	1.52
MgO	.47	.15	.05	.06	1.55	.61	2.41	.41	.12	1.00	.58	.07
CaO	.58	.72	.64	.77	.96	.63	3.32	.99	.65	.20	Tr.	.95
Na_2O	......	[3] 8.30 (Na₂O + K₂O)	[4] 2.64	[4] 2.45	1.48 (Na₂O + K₂O)	2.87 (Na₂O + K₂O)	......	2.45	[4] 2.56	......	6.52	3.10
K_2O	......		[4] 5.29	[4] 5.03			3.46	4.77	[4] 5.68	......	3.00	4.96
TiO_2	......	.36	.24	.30	1.00	1.01	1.12	.22	.29	......	......	......
P_2O_5	......	Nil	Tr.	Tr.	......	......	.86	Tr.	Tr.	......	......	Nil
SO_3	......	[5] Tr.	Tr.	Tr.	......	......	1.95	Tr.	Tr.	......	......	<.10
N	......	......	......	......	......	......	.10	......	......	......	......	......
Ignition loss	3.98	4.31	4.25	4.42	5.29	5.16	[6] 11.41	3.90	3.93	4.35	......	3.84
Total	99.56	100.00	100.00	100.00	99.45	99.60	99.76	100.08	100.00	[7] 96.25	[8] 96.00	<99.58
Class	56,42,1	50,40,2	49,42,1	48,43,2	37,57,1	27,67,0	19,65,7	50,41,1	50,40,1	47,48,0	49,40,1	49,41,1

	163	164	165	166	167	168	169	170	171	172	173	174
	15B37-4	15B37-2	15B37-3	15B39-1	15B39-2	15B39-3	15B42-1	15B45-9	15B45-2	15B45-3	15B45-4	15B45-54
SiO_2	63.70	54.29	61.60	63.35	77.54	65.02	59.47	76.01	60.60	63.00	63.40	65.31
Al_2O_2	16.68	15.32	18.10	[9] 8.63	[9] 7.69	[9] 11.03	19.90	12.35	18.65	20.40	19.70	17.25
Fe_2O_3	6.19	6.04	5.02	[10] 1.70	[10] 1.77	[10] 3.93	4.30	3.83	[11] 5.35	[11] 4.20	[11] 4.30	[11] 4.15
MgO	1.37	1.62	2.01	4.95	1.77	3.28	1.97	2.16	1.25	1.25	1.35	1.05
CaO	1.63	7.74	.61	6.46	2.61	4.40	.99	1.35	1.00	1.20	1.60	.95
Na_2O	1.25	.96	1.45	1.30	1.70	1.42	1.03 (Na₂O + K₂O)	......	3.10 (Na₂O + K₂O)	1.30 (Na₂O + K₂O)	1.40 (Na₂O + K₂O)	2.50 (Na₂O + K₂O)
K_2O	3.47	2.65	3.69	1.62	1.66	2.57						
TiO_2	1.30	.99	1.10	[12] 1.05	[12] .79	[12] 1.03	1.08	1.02	......	......	......	......
P_2O_5	.27	.15	.16	.11	.09	.12	......	.08	......	......	......	......
SO_3	Nil	Nil	.29	Tr.	Nil	Nil	......	.04	Tr.	.40	.45	.51
S	.02	Nil	.02	.03	Nil	.03	......	......	......	......	......	......
Ignition loss	5.13	9.80	5.89	[6] 10.56	[6] 3.67	[6] 6.87	10.62	[6] 2.57	9.70	8.10	7.60	[13] 8.27
Total	[14] 101.01	99.56	[15] 99.94	[16] 100.36	99.29	[17] 99.70	99.36	99.41	[18] 99.65	[19] 99.85	99.80	99.99
Class	27,64,0	20,61,10	24,67,0	46,30,17	62,27,3	41,43,7	19,72,6	50,45,0	22,71,4	22,72,4	24,70,3	30,65,0

	175	176	177	178	179	180
	15B45-55	15B45-7	15B45-1	15B45-5	15B45-6	15B45-8
SiO_2	65.81	64.18	60.12	63.90	64.04	66.78
Al_2O_2	17.51	19.31	18.81	19.09	19.67	18.36
Fe_2O_3, iron oxide	4.30	2.71	4.87	2.43	3.29	3.86
MgO	.99	1.65	1.25	1.01	1.30	1.65
CaO	.97	.50	.55	.50	.55	.70
Na_2O	2.60 (Na₂O + K₂O)	3.08	2.68	2.83	......	......
K_2O						
SO_2	.55	......	......	......	......	......
Ignition loss	[13] 7.16	8.98	10.97	9.50	9.40	7.53
Total	99.89	100.41	99.25	99.26	98.25	98.88
Class	30,65,0	27,66,4	21,72,4	21,66,3	26,69,4	30,65,4

Qualitative spectrographic analysis of sample 157

[Standard carbon electrodes used. Higher numbers indicate greater abundance. Further explanation of table, (Runnels, 1949, p. 45)]

B	5	Zn	2
Na	6	Zr	ND
V	6	Mo	ND
Cr	6	Ag	2
Mn	5	Pb	ND
Cu	7	Sr	ND

[1] 72.36, (Jewett and Schoewe, 1942, p. 171).
[2] Includes TiO_2.
[3] By difference.
[4] $Na_2O + K_2O$ by difference; ratio by spectrographic determination.
[5] Reported as slight trace.
[6] 140° - 1,000° C.
[7] Undetermined, 3.75 percent reported as probably potash and soda by Landes (1928, p. 15).
[8] 100.00 in text.
[9] Includes MnO_2.
[10] Total iron.
[11] Reported as iron oxide.
[12] Includes ZrO_2 and V_2O_5.
[13] Reported as water of constitution.
[14] 100.99 in text
[15] 99.92 in text.
[16] Includes 0.6 percent CuO, spectrographic determination; total, 100.33 in text.
[17] 99.67 in text.
[18] 99.85 in text.
[19] 99.95 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

139-150. Ellsworth County. Upper Cretaceous, Dakota sandstone. Sec. 25, T. 15 S., R. 7 W. Clay. Index maps, generalized columnar sections, logs of auger drill holes and opencut. Possible use: Ceramic products.

139-140. Center SW¼NE¼ sec. 25. Hole C-56. (McMillan and Wilson, 1948, p. 30, figs. 1-3, 9.)

139. Clay, dark-gray; 23-28 ft below surface.

140. Clay, gray; yellow streaks; 8.5-22.5 ft below surface.

141. SE part SW¼NE¼ sec. 25. Hole C-66. (McMillan and Wilson, 1948, p. 31, figs. 1-3, 9.) Clay, gray; red and yellow streaks; some sand and silt; 4.5-12.5 ft below surface.

142. SE part SW¼NE¼ sec. 25. C-Cut-4. (McMillan and Wilson, 1948, p. 33, 32, figs. 1-3, 9.) Clay, varicolored; 4.5-12.3 ft below surface.

143-144. Center SE¼NE¼ sec. 25. Hole C-57. (McMillan and Wilson, 1948, p. 30, figs. 1-3, 9.)

143. Clay, black; 11-21 ft below surface.

144. Clay, gray, yellow, mottled; 6-11 ft below surface.

145. Center SE¼NW¼ sec. 25. Hole C-55. (McMillan and Wilson, 1948, p. 30, figs. 1-3, 9.) Clay, red-yellow; 6-13 ft below surface.

146. Center NE¼SE¼ sec. 25. Hole C-58. (McMillan and Wilson, 1948, p. 31, figs. 1-3, 9.) Clay, gray; yellow streaks; 10-18 ft below surface.

147-148. NW¼SE¼ sec. 25. Hole C-S-50. (McMillan and Wilson, 1948, p. 32, figs. 1-3, 9.)

147. Clay, red, gray; 9-27 ft below surface.

148. Clay, gray; 2-6 ft below surface.

149. NW¼SE¼ sec. 25. Hole C-S-51. (McMillan and Wilson, 1948, p. 32, figs. 1-3, 9.) Clay, gray, yellow; 3-15 ft below surface.

150. Center SE¼SE¼ sec. 25. Hole C-65. (McMillan and Wilson, 1948, p. 31, figs. 1-3, 9.) Clay, gray-black; red and yellow streaks; 8-13 ft below surface.

151. Ellsworth County. Dakota sandstone, Terra Cotta clay member. SW¼ sec. 28, T. 15 S., R. 7 W. Analysts, Thompson and Runnels. Lab. No. El-20-EA. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 132, 138, 141, 142, 144, 148, 150, pl. 1.) Bed 13.1 ft thick, sectioned from top to bottom as follows:

2.9 ft ... clay, at top light-gray, plastic; at bottom gray, lignitic.
0.5 ft ... kaolin, white, banded with light-gray.
2.9 ft ... clay, dark-gray, slight yellow stain, slightly silty, lignitic.
5.0 ft ... silt, nearly white, some yellow stain, kaolinitic.
1.8 ft ... clay, gray, very silty, lignitic.

Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Temperature-specific gravity and temperature-apparent specific gravity curves, absorption-temperature curve, porosity-temperature curve. Possible use: Refractories.

152-154. Ellsworth County. Pleistocene, Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 15, 24, 43.) Volcanic ash. Index map, generalized columnar section, screen analyses. Possible use: Abrasive, cement material, ceramic glaze, lightweight aggregate.

152. Center north line SW¼ sec. 22, T. 15 S., R. 7 W. Lab. No. ELV-2A. From lower 3.0 ft of bed 9 ft thick, contains silt.

153-154. SE¼NW¼ sec. 28, T. 16 S., R. 7 W. Bed 13.5 ft thick; lower 9.5 ft, light-colored, clean ash; upper part, some streaks of silt and clay. Estimated tonnage.

153. Lab. No. ELV-24-A. From lower 7.5 ft of bed.

154. Lab. No. ELV-24-B. From upper 6.0 ft of bed.

155-156. Ford County. Dakota sandstone, Janssen clay member. Analysts, Thompson and Runnels. Index map, outcrop map; correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

155. SW¼SW¼ sec. 19, T. 25 S., R. 23 W. Lab. No. F-3-2. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 116, 122, 125, 128.) Siliceous fire clay, very light gray to white, smooth, hard; some limonite filling in root cavities; 5.4 ft thick. Detailed measured section.

156. NE part sec. 25, T. 25 S., R. 24 W. Lab. No. F-2-2. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 99, 102, 105, 212.) Fire clay, very light gray, plastic; conchoidal fracture.

*157. Franklin County. Pennsylvanian, Stanton limestone, Eudora shale member. SW¼SW¼ sec. 6, T. 17 S., R. 19 E., Ross quarry. Spectrographic analyst, Reed. Lab. No. 48-311. (Runnels, 1949, p. 44, 42, 45.) (Analysis suggests 4.2 percent gypsum, 2.0 percent phosphate; shows 3.5 percent alkalies, 1.1 percent TiO_2.) Phosphate-bearing shale, 8 ft thick, composite sample. Dried at 140° C. Possible use: Fertilizer.

158-159. Gove County. Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 15, 24, 43.) NE¼SW¼ sec. 21, T. 13 S., R. 26 W. Estimated tonnage. Screen analyses. Possible use: Abrasive, cement material, ceramic glaze, lightweight aggregate.

158. Lab. No. GV-1A. Volcanic ash, fresh, scattered concretions and yellowish streaks in lower 4-6 ft; from lower 6 ft of bed 17 ft thick.

159. Lab. No. GV-1B. Volcanic ash, fresh, scattered concretions; from upper 11 ft of bed 17 ft thick. Mechanical analysis.

160. Graham County. Meade formation, Pearlette ash bed, NE¼SW¼ sec. 11, T. 8 S., R. 25 W., (Carey and others, 1952, p. 45) town of Morland. (Landes, 1928, p. 15, 7, 22.) Volcanic ash, grayish-white. Screen analysis. Possible use: Abrasive.

161. Grant County. Meade formation, Pearlette ash bed. NW¼ sec. 24, T. 30 S., R. 35 W., Western Spar Products mine. Lab. No. GVT-3. (Landes, 1928, p. 15, 7, 22, 23.) Volcanic ash, gray, average thickness 9 ft; overburden 1-4 ft. Estimated tonnage. Index maps, generalized columnar section. Screen analyses. Possible use: Abrasive. (Formation, section, screen analysis, index map, generalized columnar section from Carey and others, 1952, p. 4, 12, 24, 45.)

162. Grant County. Meade formation, Pearlette ash bed. SE¼NE¼ sec. 1, T. 30 S., R. 36 W. Analyst, under supervision of Runnels. Lab. No. GTV-1. (Carey and others, 1952, p. 20, 4, 12, 15, 22-24, 45.) Volcanic ash, fresh, some fine sand; 19.5 ft thick in pit; maximum thickness, 23.5 ft. Index map, generalized columnar section; screen analysis, mechanical analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

163-165. Greenwood County. Pennsylvanian, Howard limestone, Aarde shale member. (McMillan, 1956, p. 214, 194, 195, 220, 221, 248, pl. 1.) Selected samples. Index map, outcrop map; columnar section; mechanical analyses; X-ray diffraction data. Estimated amounts of clay constituents.

163. Nodaway underclay. Sec. 33, T. 24 S., R. 11 E. Underclay, ash-gray, plastic; 0-5 inches below coal; from thin film to 1.7 ft thick.

164. Nonmarine shale. Sec. 33, T. 24 S., R. 11 E. Shale, yellowish-brown; 5-11 inches below coal; 0.1 inch-2 ft thick.

165. Nonmarine shale. Sec. 12, T. 28 S., R. 10 E. Shale, yellowish-brown; 0-6 inches below coal; 0.1 inch-2 ft thick. (For another analysis from same measured section see sample 23, group E of this compilation.)

166. Harper County. Permian, Ninnescah shale, Runnymede sandstone member. NE¼SE¼ sec. 10, T. 31 S., R. 6 W. Analyst, under supervision of Runnels. Lab. No. 1139. (Swineford, 1955, p. 122, 10, 11, 28, 29, 46, 47, 113.) Siltstone, gray, dolomitic. Index and geologic maps; detailed measured section, generalized columnar section; mechanical analysis. Possible use: Brick.

167. Harper County. Permian, Salt Plain shale. S½ sec. 3, T. 32 S., R. 9 W. Analyst, under supervision of Runnels. Lab. No. 1137. (Swineford, 1955, p. 122, 10, 11, 27, 28, 58, 113, 128.) Siltstone, red, sandy. Index and geologic maps; detailed measured section, generalized columnar section; mechanical analysis; photomicrograph.

168. Harper County. Salt Plain shale. S½ sec. 3, T. 32 S., R. 9 W. Analyst, under supervision of Runnels. Lab. No. 1156. (Swineford, 1955, p. 122, 10, 11, 27, 28, 58, 113, 128.) Siltstone, red, argillaceous. Index and geologic maps; detailed measured section, generalized columnar section; mechanical analysis; photomicrograph.

169. Hodgeman County. Upper Cretaceous, Graneros shale, and Dakota sandstone, Janssen clay member. Center SW¼ sec. 8, T. 23 S., R. 22 W. Analysts, Thompson and Runnels. Lab. No. H-3-4. (Plummer and Romary, 1947, p. 180, 10, 42, 43, 177, 179-182.) Composite sample: Graneros shale, clay shale, dark-gray, very fine grained, plastic, some pyrite, 3.8 ft thick; Dakota sandstone, clayey silt, gray, friable, 1.7 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, insulating and structural tiles and blocks, stoneware, earthenware.

170. Jewell County. Upper Cretaceous, Carlile shale, Codell sandstone member. Sec. 27, T. 4 S., R. 8 W. Lab. No. J-3-ss. (Runnels and Dubins, 1949, p. 23, 4, 6.) Sandstone, dirty-yellow to gray, friable. Index map.

171-180. Jewell County. Carlile shale. Sec. 5, T. 1 S., R. 7 W., Nebraska Portland Cement Co. quarry. Use: Cement material.

171. S½ sec. 5. Lab. No. N-59. (Barbour, 1913, p. 103.) Shale, light-gray, even-grained, soft. Physical tests on cement product.

172. S½ sec. 5. Lab. No. M-602. (Barbour, 1913, p. 101.) Shale.

173. S½ sec. 5. Lab. No. M-603. (Barbour, 1913, p. 101.) Shale.

174-175. S½ sec. 5. Analyst, Robinson. (Barbour, 1913, p. 97.) Clay.

176. SE¼SW¼ sec. 5. (Barbour, 1913, p. 106.) Shale.

177-180. NW¼SE¼ sec. 5. (Barbour, 1913, p. 106.) Shale.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas											
	181	182	183	184	185	186	187	188	189	190	191	*192
	15B45-15	15B45-12	15B45-11	15B45-13	15B45-10	15B45-14	15B46-2	15B46-3	15B46-4	15B46-5	15B46-1	15B50-1
SiO_2	73.32	73.11	72.84	73.26	72.24	73.36	73.90	74.50	77.03	77.04	68.64	47.79
Al_2O_3	10.76	12.45	12.12	10.94	11.52	12.32	12.38	11.24	8.85	11.36	16.28	14.44
Fe_2O_3	1.66	1.41	1.55	1.83	1.68	1.72	3.26	3.38	3.32	2.62	4.15	3.37
MgO	.23	.06	.02	.31	.21	.14	.99	1.60	1.57	1.25	1.58	1.64
CaO	.53	.54	.62	.66	.76	.07	.63	.64	.69	.46	2.17	3.03
Na_2O	2.27	[1] 2.93	} [2] 8.59	{ 2.66	} [2] 8.25	[2] 7.93	......	......	......	......	......	......
K_2O	5.30	[1] 5.45		5.18								
TiO_2	1.36	.14	.18	1.22	1.01	.54	1.34	1.60	1.46	1.11	1.21	1.00
P_2O_5	Tr.	Tr.	Tr.	Tr.	<.01	Nil	......	......	......	......	......	1.29
MnO	......	......	......	......	......	......	......	......	......	......	.98	......
SO_3	......	Nil	Tr.	......	[3] Tr.	[3] Tr.	......	......	......	......	......	.39
Ignition loss	3.93	3.91	4.08	3.95	4.33	3.92	6.42	5.16	4.62	5.02	5.66	[4] 21.42
Total	99.36	100.00	100.00	100.01	<100.01	100.00	[5] 98.92	[5] 98.12	[5] 97.54	[5] 98.86	[6] 100.67	94.37
Class	52,37,1	50,41,1	50,40,1	52,37,2	50,39,2	50,41,0	48,46,3	51,42,3	58,35,3	54,41,3	35,59,1	18,66,6

	*193	194	195	196	197	198	199	200	201	202	203	204
	15B50-2	15B50-3	15B52-1	15B53-5	15B53-6	15B53-7	15B53-8	15B53-9	15B53-4	15B53-1	15B53-3	15B53-2
SiO_2	52.96	55.97	55.25	68.97	70.00	71.03	71.60	80.50	68.40	65.91	67.04	66.75
Al_2O_3	12.43	15.72	17.92	19.96	16.77	19.22	18.15	10.79	20.60	22.91	22.43	22.26
Fe_2O_3	4.19	4.30	5.48	.59	1.58	.69	1.35	1.72	1.11	.73	.65	.79
MgO	1.55	1.74	2.08	1.04	1.26	.49	1.00	.68	.90	.85	1.06	.92
CaO	4.29	6.19	4.55	.72	.64	.55	.50	.29	.75	.93	.83	.87
Na_2O	......	......	.92	......	} 2.15	.18	1.10	1.00	1.50	.20	.76	.66
K_2O	2.07	......	3.01	......								
TiO_2	.85	1.18	.99	.48	1.71	.72	1.00	.86	.70	.35	.33	.45
P_2O_5	3.20	.09	.11	......	......	......	......	......	......	......	......	......
SO_3	.35	.96	.19	......	......	......	......	......	......	......	......	......
N	.20	......	......	......	......	......	......	......	......	......	......	......
Ignition loss	[4] 18.00	[4] 10.74	8.97	5.54	6.03	6.71	5.30	4.18	6.00	8.16	6.86	7.30
Total	100.09	96.89	[7] 99.47	97.30	100.14	99.59	100.00	100.02	99.96	100.04	[8] 99.96	100.00
Class	26,60,3	23,58,12	17,67,7	33,62,1	39,54,3	36,60,2	38,58,1	59,37,2	31,65,1	25,71,3	27,69,2	27,69,3

	*205	206	*207	208	*209	*210	*211	212	213	214	215
	15B53-12	15B53-10	15B55-6	15B55-1	15B55-7	15B55-9	15B55-8	15B55-2	15B55-3	15B55-4	15B55-5
SiO_2	72.51	72.28	52.16	72.73	72.31	67.19	65.37	65.37	69.88	67.78	68.66
Al_2O_3	11.55	12.60	13.46	11.55	12.14	13.61	11.61	12.00	14.03	12.55	12.27
Fe_2O_3	1.21	1.71	7.41	1.65	1.75	3.55	3.10	3.41	4.24	3.47	2.59
MgO	.07	.22	.90	.12	.14	1.99	1.79	1.89	1.67	1.64	1.54
CaO	.68	.69	4.36	.92	.84	3.76	5.85	5.88	1.42	4.35	4.57
Na_2O	[1] 2.77	2.90	.46	} [2] 8.35	{ 2.84	[2] 1.37	[2] 1.45	[2] 1.14	[2] .91	[2] 1.41	[2] 4.11
K_2O	[1] 6.86	5.45	2.60		6.37	2.94	2.89	2.78	2.88	2.78	......
H_2O- [9]	......	......	......	......	......	(.97)	(.86)	(.73)	(1.26)	(.90)	(.72)
TiO_2	.54	.27	1.58	.38	.26	.84	1.69	.83	.90	.58	.95
P_2O_5	Tr.	.008	.23	Nil	Nil	Tr.	.10	Tr.	Tr.	Tr.	Tr.
SO_2	Nil	Tr.	7.10	[3] Tr.	.10	Tr.	Tr.	.05	.05	.05	.05
Ignition loss	3.81	3.83	10.79	4.30	3.29	4.75	6.15	6.60	3.99	5.34	5.21
Total	100.00	99.96	[10] 101.05	100.00	100.04	100.00	100.00	99.95	99.97	99.95	99.95
Class	51,38,1	48,42,1	20,60,2	50,39,2	49,41,0	39,50,1	41,42,5	40,44,6	40,52,0	42,46,3	44,43,3

Qualitative spectrographic analyses

[SC = Standard carbon electrodes used. HP = High purity graphite electrodes used. Higher numbers indicate greater abundance. Further explanation of table, (Runnels, 1949, p. 45)]

	192		193	194		192		193	194
	SC	HP	SC	HP		SC	HP	SC	HP
B	ND	6	6	6	Zn	5	3	5	5
Na	5	...	...	...	Zr	5	2	4	5
K	8	...	...	...	Mo	ND	2	5	2
V	8	6	7	6	Ag	4	4	5	2
Cr	9	8	9	8	Pb	ND	5	4	4
Mn	5	6	8	10	Sr	ND	ND	ND	ND
Cu	6	7	8	7					

[Standard carbon electrodes used. Higher numbers indicate greater abundance. Further explanation of table, (Frye and others, 1949, p. 87)]

	210	211	212	213	214	215
V	5	4	3	6	4	4
Cr	3	4	ND	4	ND	ND
Mn	8	8	7	9	7	7
Cu	ND	ND	ND	4	ND	ND
Zn	6	ND	ND	ND	ND	ND
Zr	6	6	4	6	6	4
Ag	4	4	ND	5	2	2

[1] $Na_2O + K_2O$ by difference; ratio by spectrographic determination.
[2] By difference.
[3] Reported as slight trace.
[4] At 1,000° C.
[5] Difference between total and 100 percent is largely alkalies; sample 189, total, 97.57 in text.
[6] 100.72 in text.
[7] 99.77 in text.
[8] 99.13 in text.
[9] 105° - 140° C., (not included in total).
[10] 99.94 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

181-186. Jewell County. Pleistocene, Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 16, 22, 24, 47.) Estimated tonnage. Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

181. NW¼NE¼ sec. 16, T. 1 S., R. 6 W. Lab. No. JV-6. Volcanic ash, 17 ft exposed in open pit, basal 5 ft sampled by augering; overburden 1-14 ft. Screen analysis, mechanical analysis, cumulative size frequency curves.

182. NW¼SE¼ sec. 32, T. 1 S., R. 9 W. Lab. No. JV-3A. Volcanic ash, from lower 5.5 ft of bed 9 ft thick.

183. NW¼SE¼ sec. 32, T. 1 S., R. 9 W. Lab. No. JV-3B. Volcanic ash, from upper 3.5 ft of bed 9 ft thick; 4 ft overburden.

184. SW¼NE¼ sec. 7, T. 2 S., R. 9 W. Lab. No. JV-11A. Volcanic ash, from lower 4.0 ft of 8 ft exposure.

185. SE¼NE¼ sec. 6, T. 3 S., R. 8 W. Lab. No. JV-7. Volcanic ash, from bed 2.5 ft thick.

186. N½NE¼ sec. 29, T. 5 S., R. 9 W. Lab. No. JV-1. Volcanic ash, from bed 6.5 ft thick; overburden 3 ft. Screen analysis.

187-190. Johnson County. Pleistocene, Sanborn formation. SE¼ sec. 33, T. 11 S., R. 23 E. Analyst, Runnels. (Plummer and Hladik, 1948, p. 74, 62.) Silt. Index map. Possible use: Ceramic slag.

187. Lab. No. JN-AG-21A.

188. Lab. No. JN-AG-19A.

189. Lab. No. JN-AG-21B.

190. Lab. No. JN-AG-19B.

191. Johnson County. Sanborn formation. SE¼ sec. 34, T. 11 S., R. 23 E. Analyst, Runnels. Lab. No. JN-1-A. (Plummer and Hladik, 1948, p. 74, 62, 82, 83.) Clay, 30 ft thick. Channel sample. Index map. Firing and physical properties of ceramic slag. Possible use: Railroad ballast, concrete aggregate.

192-194. Labette County. Pennsylvanian. Spectrographic analyst, Reed. (Runnels, 1949, p. 44, 42, 43, 45.) Shale. Samples dried at 140° C. Possible use: Fertilizer.

*192. Pawnee limestone, Little Anna shale member (presumably same as Pawnee limestone, Anna shale member, Moore, 1949, p. 56). NE¼ sec. 16, T. 33 S., R. 21 E. Lab. No. 48-220. (Analysis suggests 3.1 percent phosphate; shows 1.0 percent TiO_2.) Shale, composite sample; from 2 ft bed.

*193. Pleasanton shale. SE¼ sec. 17, T. 32 S., R. 19 E. Lab. No. 48-224. (Analysis suggests 7.6 percent phosphate; shows 2.1 percent alkalies.) Shale, composite sample; 6 ft thick; 18 ft from top of 29-ft bed. Size distribution of shales ground in pan mill.

194. Pleasanton shale. SE¼ sec. 17, T. 32 S., R. 19 E. Lab. No. 48-219. Shale, spot sample; 15 ft from top of 29 ft bed.

195. Leavenworth County. Pennsylvanian, Vilas shale. NW¼NE¼ sec. 19, T. 9 S., R. 23 E. Analyst, under supervision of Runnels. Lab. No. LV-5. (Plummer and Hladik, 1951, p. 20, 24, 25, 31, 34, 52.) Shale, dark-gray, unoxidized; 20.0 ft sampled; 24.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate, bloating results. Possible use: Lightweight aggregate.

196-204. Lincoln County. Upper Cretaceous, Dakota sandstone. Analysts, Thompson and Runnels. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

196. Terra Cotta clay member. SE¼ sec. 1, T. 11 S., R. 6 W. Lab. No. L-6-11. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 98, 99, 102, 105, 107, 148, 150, pl. 1.) Plastic fire clay, 8.0 ft thick. Upper 3.5 ft; light-gray, slight yellow stain. Lower 4.5 ft; dark-gray, no stain, very tough. Lignitized fossil leaves abundant. Temperature-specific gravity and temperature-apparent specific gravity curves, absorption-temperature curve, porosity-temperature curve. Possible use: Face brick, structural tile, refractories.

197. Terra Cotta clay member. SE¼ sec. 1, T. 11 S., R. 6 W. Lab. No. L-6-6. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 117, 122, 125, 128, 130, 148, 150, pl. 1.) Siliceous fire clay, 8.2 ft thick sectioned from top to bottom as follows:

0.7 ft ... dark-gray, plastic.
0.7 ft ... light-gray, silty.
4.8 ft ... light-gray, some yellow in vertical joints, plastic.
2.0 ft ... gray to dark-gray, some yellow stain on joints, plastic; lignite fragments.

Temperature-specific gravity and temperature-apparent specific gravity curves, absorption-temperature curve, porosity-temperature curve. Possible use: Refractories, brick.

198. Terra Cotta clay member. SE¼ sec. 1, T. 11 S., R. 6 W. Lab. No. L-6-13. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 116, 122, 125, 128, 148, pl. 1.) Siliceous fire clay, gray, no stain, plastic; 3 ft thick. Small lenses of lignite. Absorption-temperature curve. Possible use: Refractories, brick.

199. Terra Cotta clay member. NW¼NW¼ sec. 10, T. 13 S., R. 7 W. Lab. No. L-10-01. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 118, 122, 125, 128, pl. 1.) Siliceous fire clay, gray to light-gray, silty; 12.4 ft thick. Lignite and some pyrite in lower 1.0 ft. Possible use: Refractories, brick.

200. Janssen clay member. SE¼ sec. 33, T. 13 S., R. 7 W. Lab. No. L-9-7. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 134, 138, 141, 142, 144, 148, 150, pl. 1.) Highly siliceous fire clay, gray, silty; 40 ft thick. Few lenses of yellow, fine-grained sandstone and silt 1-5 in. thick; lignite fragments. Temperature-specific gravity and temperature-apparent specific gravity curves, absorption-temperature curve; porosity-temperature curve. Possible use: Refractories, structural products.

201-204. Janssen clay member. SW¼NW¼ sec. 18, T. 13 S., R. 10 W. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 99, 102, 105, 106, 118, 122, 150, pl. 1.) Possible use: Refractories, brick.

201. Lab. No. L-39-1. Siliceous fire clay, bed 1; 3.6 ft thick. Upper 1.5 ft; pinkish-gray, yellow bands, silty, lignitic. Lower 2.1 ft; very light-gray, plastic, streaks of lignitic silt.

202. Lab. No. L-39-2. Fire clay, plastic; bed 2; 7.8 ft thick. Upper 5.3 ft; gray, very little stain. Lower 2.5 ft; dark-gray to nearly black, some lignite.

203. Lab. No. L-39-3. Siliceous fire clay, gray, slight yellow stain, silty to very silty; bed 3; 4.5 ft thick.

204. Lab. No. L-39-A. Siliceous fire clay. Composite sample; samples from successive beds 1, 2, and 3 combined in proportion to thickness of beds. Porosity-temperature curve.

205-206. Lincoln County. Meade formation, Pearlette ash bed. Sec. 27, T. 13 S., R. 10 W. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 16, 22-24, 49, 50.) Volcanic ash, clean, fairly fresh; overburden relatively thin. Index map, generalized columnar section, screen analyses. Use: Ceramics, sweeping compound. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

*205. SE¼SW¼ sec. 27. Lab. No. LV-1. (Analysis shows 9.6 percent alkalies.) Maximum thickness, 6.0 ft; exposed in pit. Mechanical analysis.

206. SW¼SE¼ sec. 27. Lab. No. LV-2. Maximum thickness, 6.5 ft; exposed in pit.

*207. Logan County. Upper Cretaceous, Pierre shale. Center S½ sec. 8, T. 12 S., R. 36 W. Analyst, under supervision of Runnels. Lab. No. LO-2. (Plummer and Hladik, 1951, p. 21, 28-30, 45, 64-66.) (Analysis suggests 13.4 percent gypsum; shows 3.1 percent alkalies, 1.6 percent TiO_2.) Shale, pink and gray, unoxidized; 25 ft sampled; 30 ft available. Index map, geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

208-209. Logan County. Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 16, 24, 25, 50, 51.) Index map, generalized columnar section, screen analyses. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

208. SE¼SW¼ sec. 35, T. 13 S., R. 33 W. Lab. No. LOV-5A. Volcanic ash, light-gray, few brown streaks; maximum thickness, 6 ft.

*209. SW¼NW¼ sec. 12, T. 13 S., R. 35 W. Lab. No. LOV-3. (Analysis shows 9.2 percent alkalies.) Volcanic ash, fresh, clean; maximum thickness 14.0 ft; overburden 10 ft.

210-215. Logan County. Sanborn formation. NE¼ sec. 32, T. 12 S., R. 37 W. Spectrographic analyst, Reed. (Frye and others, 1949, p. 84, 52, 56, 86-88, 97.) Silt. Index map, generalized columnar section. Plastic and dry properties, fired properties.

210-212. Peoria silt member. Possible use: Ceramic slag.

*210. Sample No. 3-A. Silt, 21 ft below top of section. (Analysis suggests 5.2 percent more CaO and MgO than required for carbonates; shows 4.3 percent alkalies.)

*211. Sample No. 3-B. Silt, 16 ft below top of section. Analysis suggests 4.8 percent more CaO and MgO than required for carbonates; shows 4.3 percent alkalies, 1.7 percent TiO_2.)

212. Sample No. 3-C. Silt, 12 ft below top of section.

213. Peoria silt member, Brady soil. Sample No. 3-D. Silt, 8 ft below top of section. Possible use: Ceramic material.

214-215. Bignell silt member. Possible use: Ceramic aggregate, railroad ballast.

214. Sample No. 3-E. Silt, 6 ft below top of section.

215. Sample No. 3-F. Silt, 3 ft below top of section.

TABLE 3. — Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas											
	*216	*217	218	219	220	221	222	223	224	225	226	227
	15B57-5	15B57-6	15B57-1	15B57-3	15B57-4	15B57-2	15B60-7	15B60-6	15B60-1	15B60-2	15B60-3	15B60-5
SiO_2	52.59	52.89	72.30	72.95	73.06	72.66	72.40	72.09	69.82	71.47	71.63	70.26
Al_2O_3	15.76	[1] 15.83	[2] 13.62	12.30	11.54	11.59	11.45	11.48	13.33	11.75	12.22	12.75
Fe_2O_3	1.96	[3] 5.87	2.33	1.73	1.31	1.68	1.70	2.07	1.80	1.63	1.50	1.84
MgO	6.31	6.39	} [2] .99	.16	.09	.16	.31	.65	.49	1.12	1.36	.41
CaO	5.63	3.97		.69	.63	1.00	.76	1.06	.72	.97	.83	.76
Na_2O	} 5.80	.72	4.00	[4] 2.90	} [5] 8.28	3.05	[4] 2.42	[4] 2.34	2.37	[4] 2.88	[4] 2.11	[4] 2.37
K_2O		3.23	2.00	[4] 5.04		4.80	[4] 5.75	[4] 5.49	5.95	[4] 5.18	[4] 5.34	[4] 5.54
TiO_2	.57	[6] 1.39	......	.30	.97	.51	.31	.53	.16	.50	.49	.70
P_2O_5	.32	.14	......	Tr.	<.02	Tr.	Nil	Tr.	Tr.	Tr.	Tr.	Tr.
SO_3	......	Tr.	......	Nil	[7] Tr.	......	Tr.	Tr.	.31	Nil	Nil	Tr.
Ignition loss	10.23	[8] 9.11	[2] 4.68	3.93	4.12	4.26	4.90	4.29	5.17	4.50	4.52	5.37
Total	99.17	99.54	99.92	100.00	<100.02	99.71	100.00	100.00	100.12	100.00	100.00	100.00
Class	23,52,12	18,62,7	46,47,2	49,41,1	51,38,1	50,39,2	50,39,2	49,40,2	44,45,2	49,39,2	48,40,2	46,44,2

	228	229	230	231	232	233	234	*235	236	237	238	239
	15B60-4	15B62-1	15B63-3	15B63-4	15B63-5	15B67-1	15B67-2	15B68-1	15B69-8	15B69-7	15B69-14	15B69-5
SiO_2	72.01	66.06	64.62	62.69	68.23	65.24	79.32	71.16	73.44	71.98	76.68	71.14
Al_2O_3	11.40	16.94	21.82	17.61	14.72	[9] 5.02	9.95	11.70	11.36	10.94	9.77	11.20
Fe_2O_3	1.49	4.01	......	6.62	5.89	[3] 3.48	2.35	1.47	2.01	1.93	1.44	1.89
MgO	.46	1.56	.43	1.49	1.33	1.08	.31	.38	.08	.15	.27	.41
CaO	.77	.51	2.50	.61	.46	12.49	.93	1.46	.61	2.14	1.45	1.81
Na_2O	[4] 2.68	.48	} 4.15	.67	.55	.59	1.81	} [5] 9.84	2.33	[4] 2.08	} [5] 6.86	[5] 7.81
K_2O	[4] 5.98	3.04		2.95	2.52	.39	1.43		5.23	[4] 5.94		
TiO_2	.88	.81	......	1.20	1.54	......	.99	.16	.39	.33	.51	.50
P_2O_5	Nil	.05	......	.14	.15	.06	.06	......	Tr.	Tr.	<.01	.03
SO_3	Tr.	.04	......	Nil	Nil	Nil	Nil	......	Nil	Nil	Tr.	Tr.
Ignition loss	4.33	6.40	[10] 5.01	5.62	4.81	[11] 11.65	[11] 2.70	3.86	3.93	4.51	3.02	5.21
Total	100.00	[12] 99.90	98.53	99.60	100.20	100.00	99.85	[13] 100.03	99.38	100.00	<100.01	100.00
Class	50,38,2	32,61,2	26,65,3	24,68,0	36,58,0	52,23,21	59,35,0	49,39,1	51,39,1	50,38,3	58,33,0	49,38,4

	240	241	242	243	244	245	246	247	248	249	250
	15B69-15	15B69-16	15B69-17	15B69-22	15B69-21	15B69-18	15B69-20	15B69-19	15B69-23	15B69-24	15B69-25
SiO_2	69.44	70.92	71.35	72.35	70.16	68.39	70.05	69.62	69.97	71.22	68.80
Al_2O_3	[14] 11.22	13.11	14.60	13.56	14.02	12.38	12.99	11.91	11.60	12.78	11.92
Fe_2O_3	2.67	3.97	3.53	3.46	2.70	3.56	3.91	3.60	3.27	3.25	4.29
MgO	1.20	1.74	.99	1.77	2.22	1.79	1.55	1.28	1.65	1.51	1.95
CaO	5.77	1.49	1.90	2.04	2.87	3.32	1.63	2.29	3.47	2.32	3.30
Na_2O, by difference	1.79	2.62	1.36	.24	.97	1.75	.98	1.89	.99	.42	......
K_2O	2.47	2.80	2.50	2.78	2.19	2.57	3.31	3.22	2.99	3.29	......
H_2O-[15]	(.35)	(.79)	(.94)	(.83)	(.67)	(.67)	(.68)	(.70)	(.49)	(.42)	......
TiO_2	......	......	......	......	......	.54	1.02	.79	.49	.73	1.45
P_2O_5	.09	.08	.08	.14	.15	.16	.14	.14	.17	.15	Tr.
SO_3	Tr.	Tr.	Tr.	Tr.	Tr.	.05	Tr.	Tr.	.05	.00	......
Ignition loss	5.35	3.27	3.69	3.66	4.12	5.54	4.42	5.26	5.40	4.48	4.58
Total	100.00	100.00	100.00	100.00	99.40	100.05	100.00	100.00	100.05	100.15	[16] 96.29
Class	47,40,4	43,48,0	42,52,0	44,49,0	42,49,0	42,46,3	43,49,0	45,45,3	46,43,4	45,46,1	43,46,1

Spectrochemical analysis

[Standard purity graphite electrodes used; Zn, Mo, Ag, and Ba not present in detectable amounts]

233			
B	0.01	Ni	0.001
Ti	.07	Cu	.00005
V	.025	Sr	.0014
Cr	.01	Pb	.01
Mn	.06	Sn	.002

Qualitative spectrographic analyses

[Carbon electrodes used. Higher numbers indicate greater abundance. Cu, Zn not detected. Further explanation of table (Frye and others, 1949, p. 87)]

	240	241	242	243	244	245	246	247	248	249
V	6	7	7	7	6	6	7	7	7	7
Cr	4	4	4	4	4	4	4	4	4	4
Mn	6	7	7	7	6	7	8	8	8	7
Zr	4	4	4	4	4	7	8	8	8	8
Ag	......	ND	ND	ND	......	......	ND	ND	ND	ND

[1] Includes MnO_3.
[2] Al_2O_3 reported as 16.62 percent; CaO reported as 0.99 percent; ignition loss not reported (Jewett and Schoewe, 1942, p. 171).
[3] Total iron.
[4] Na_2O+K_2O by difference; ratio by spectrographic determination.
[5] By difference.
[6] Includes ZrO_2 and V_2O_5.
[7] Reported as slight trace.
[8] 140°-1,000° C.
[9] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[10] Reported as H_2O.
[11] 105°-1,000° C.
[12] 99.81 in text.
[13] 100.00 in text.
[14] Includes TiO_2.
[15] 105°-140° C., not included in total.
[16] Difference between total and 100 percent is largely alkalies.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

*216. McPherson County. Permian, Wellington formation. SW¼ sec. 8, T. 18 S., R. 3 W. Analyst, Runnels. Lab. No. MP-7. (Plummer and Hladik, 1948, p. 74, 62, 80, 81.) (Analysis shows 5.8 percent alkalies; suggests 5.8 percent more CaO and MgO than required for carbonates.) Shale, 8 ft thick; channel sample. Index map. Firing and physical properties of ceramic slag. Possible use: Ceramic slag.

*217. McPherson County. Permian, Ninnescah shale. SE¼ SW¼ sec. 8, T. 18 S., R. 3 W., (R. T. Runnels, written communication, 1957). Lab. No. 48275. (Swineford, 1955, p. 122, 10, 11, 25, 28.) (Analysis suggests 6.6 percent more CaO and MgO than required for carbonates; shows 4.0 percent alkalies; 1.4 percent TiO_2.) Shale, red, blocky. Index map, generalized columnar section. Possible use: Lightweight ceramic aggregate, brick.

218. McPherson County. Pleistocene, Meade formation, Pearlette ash bed; NW¼ sec. 20, T. 18 S., R. 3 W., (R. T. Runnels, written communication, 1953). (Plummer, 1942, p. 8, 9; Jewett and Schoewe, 1942, p. 171, 170.) Volcanic ash. Estimated tonnage. Index map. Ceramic tests. Possible use: Abrasive, ceramic glaze.

219-221. McPherson County. Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 20, 4, 12, 16, 22, 52, 53.) Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

219. NW¼ SE¼ NW¼ sec. 20, T. 18 S., R. 3 W. Lab. No. MPV-1. Volcanic ash, light-colored, relatively clean, fairly fresh, exposed in pit; 8.5 ft bed, overburden 1-10 ft. Estimated tonnage, mechanical analysis.

220. SW¼ NW¼ sec. 22, T. 18 S., R. 4 W. Lab. No. MPV-6A. Volcanic ash, relatively clean, exposed in small pit; from lower 4.2 ft of bed 6.5 ft thick.

221. SW¼ NW¼ sec. 22, T. 18 S., R. 4 W. Lab. No. MPV-6B. Volcanic ash, relatively clean, exposed in small pit; from upper 2.3 ft of bed 6.5 ft thick.

222-228. Meade County. Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. Volcanic ash, underlain by clay. Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement material, lightweight aggregate.

222. SW¼ sec. 2, T. 31 S., R. 28 W., Cudahy Packing Co. mine. Lab. No. MEV-5A. (Carey and others, 1952, p. 21, 4, 12, 16, 19, 23, 25, 26, 28.) Volcanic ash, relatively fresh, exposed in pit; lower 13 ft of 20 ft bed. Mechanical analysis, screen analysis; cumulative size frequency curve; photomicrograph, electron micrograph.

223. SW¼ sec. 2, T. 31 S., R. 28 W., Cudahy Packing Co. mine. Lab. No. MEV-5B. (Carey and others, 1952, p. 21, 4, 12, 25, 26, 28.) Volcanic ash, relatively fresh; exposed in pit; upper 7 ft of 20 ft bed. Screen analysis; electron micrograph.

224. SE¼ SE¼ sec. 33, T. 31 S., R. 28 W. Lab. No. MEV-2. (Carey and others, 1952, p. 20, 4, 12.) Volcanic ash, maximum thickness 4.0 ft.

225. SW¼ sec. 34, T. 31 S., R. 28 W. Lab. No. MEV-1A. (Carey and others, 1952, p. 20, 4, 12, 25.) Volcanic ash, clean; lower 5 ft of 9.5 ft bed. Exposed in pit, pit inactive. Screen analysis.

226. SW¼ sec. 34, T. 31 S., R. 28 W. Lab. No. MEV-1B. (Carey and others, 1952, p. 20, 4, 12, 25.) Volcanic ash, few silty streaks, scattered calcareous concretions; upper 4.5 ft of 9.5 ft bed. Exposed in pit, pit inactive. Screen analysis.

227. NE¼ sec. 9, T. 32 S., R. 28 W. Lab. No. MEV-4A. (Carey and others, 1952, p. 21, 4, 12, 25.) Volcanic ash, dark specks and some yellow streaks; maximum thickness 8.0 ft; 23 ft below sample 228. Screen analysis.

228. NE¼ sec. 9, T. 32 S., R. 28 W. Lab. No. MEV-4B. (Carey and others, 1952, p. 20, 4, 12, 25.) Volcanic ash, relatively fresh, clean; upper 6.0 ft, separated by sandy silt from lower bed; pit inactive. Screen analysis.

229. Mitchell County. Upper Cretaceous, Carlile shale, Blue Hill shale member. NW¼ NW¼ sec. 26, T. 8 S., R. 10 W. Analyst, under supervision of Runnels. Lab. No. MT-1. (Plummer and Hladik, 1951, p. 21, 28-30, 43, 64, 65.) Shale, pink and gray, unoxidized; composite sample; 79.5 ft sampled; 90.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

230. Montgomery County. Pennsylvanian, lower part of Coffeyville formation, (R. T. Runnels, written communication, 1954). (T. 34 S., R. 16 E.), town of Coffeyville. (Haworth, 1903, p. 56.) Shale. Possible use: Cement material.

Kansas--Continued

231. Montgomery County. Pennsylvanian, Weston shale. North line SE¼ SW¼ sec. 1, T. 35 S., R. 13 E. Analyst, under supervision of Runnels. Lab. No. MG-1-2. (Plummer and Hladik, 1951, p. 20, 24, 25, 30, 31, 35, 52, 57.) Shale, dark-gray, unoxidized; 29.0 ft sampled; 45.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

232. Formation, locality, analyst, reference, tests, and use as in sample 231. Lab. No. MG-1-1. Shale, dark-gray, unoxidized; 27.0 ft sampled; 70.0 ft available. Geologic map.

233. Neosho County. Pennsylvanian, Iola limestone, Raytown limestone member. NW¼ sec. 2, T. 29 S., R. 17 E. Lab. No. 52356. (Runnels and Schleicher, 1956, table 22, pl. 3; p. 86, 97.) (Calcareous shale.) Chips from continuous surface; bed, 5.5 ft thick. Generalized index map, résumé of spectrographic results.

234. Neosho County. Pennsylvanian, Canville limestone. NE¼ NE¼ NE¼ sec. 29, T. 27 S., R. 19 E. Lab. No. O7. (Ives, 1955, p. 32, 37.) Sandstone, outcrop sample. Mineralogy.

*235. Ness County. Meade formation, Pearlette ash bed. SE¼ NW¼ sec. 30, T. 18 S., R. 23 W. Analyst, Schloesser. Lab. No. NSV-1 and 41. (Swineford and Frye, 1946, p. 22, 13, 18, 27, 28; Carey and others, 1952, p. 21.) (Analysis shows 9.8 percent alkalies; suggests 1.2 percent more CaO than required for carbonate.) Volcanic ash, from 6.0 ft bed. Index map. Size distribution; bulk density, 2.32; screen analysis. Ridgway color notation, dominant refractive index. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

236-239. Norton County. Pliocene, Ogallala formation, Ash Hollow member. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 21, 4, 6, 22, 25, 57, 58.) Volcanic ash. Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement material, lightweight aggregate.

236. Calvert ash bed. NW¼ SW¼ sec. 25, T. 2 S., R. 22 W., Wyandotte Chemicals Corp. mine. Lab. No. NNV-1A. Volcanic ash, gray, unaltered by weathering, free of silt and sand; from lower 7.5 ft of bed 17 ft thick; overburden, 2 ft. Screen analysis, mechanical analysis.

237. Calvert ash bed. NW¼ SW¼ sec. 25, T. 2 S., R. 22 W., Wyandotte Chemicals Corp. mine. Lab. No. NNV-1B. Volcanic ash, gray, unaltered by weathering, free of silt and sand; from upper 4.0 ft of bed 17 ft thick; overburden, 2 ft. Screen analysis.

238. Reager ash bed. Center SE¼ sec. 16, T. 1 S., R. 21 W. Lab. No. NNV-8. Volcanic ash, unaltered by weathering; contains coarse sand; 4.0 ft exposed; underlain by sand.

239. Reager(?) ash bed. Center south line, sec. 1, T. 3 S., R. 22 W. Lab. No. NNV-6. Volcanic ash, somewhat altered by weathering; 9.5 ft exposed. Overburden about 15 ft thick; underlain by sand. Screen analysis.

240-249. Norton County. Pleistocene, Sanborn formation. NW¼ NW¼ sec. 26, T. 2 S., R. 23 W. Spectrographic analyst, Reed. (Frye and others, 1949, p. 84, 52, 56, 86, 87, 89, 90, 102.) Silt. Plastic and dry properties, fired properties. Index map, generalized columnar section.

240-242. Loveland silt member. Possible use: Brick, tile, lightweight ceramic aggregate.

240. Sample No. 14-A. Silt, 32.5 ft below top of section.
241. Sample No. 14-B. Silt, 27.5 ft below top of section.
242. Sample No. 14-C. Silt, 25.5 ft below top of section.

243-245. Peoria silt member. Possible use: Ceramic slag.

243. Sample No. 14-D. Silt, 20.5 ft below top of section.
244. Sample No. 14-E. Silt, 15.5 ft below top of section.
245. Sample No. 14-F. Silt, 10.5 ft below top of section.

246-247. Peoria silt member, Brady soil. Possible use: Ceramic material.

246. Sample No. 14-G. Silt, 7 ft below top of section.
247. Sample No. 14-H. Silt, 4.5 ft below top of section.

248-249. Bignell silt member. Possible use: Ceramic aggregate, railroad ballast.

248. Sample No. 14-I. Silt, 4 ft below top of section.
249. Sample No. 14-J. Silt, 3 ft below top of section.

250. Norton County. Sanborn formation. Sec. 26, T. 2 S., R. 23 W. Analyst, Runnels. Lab. No. NN-5. (Plummer and Hladik, 1948, p. 74, 62, 82, 83, 90, 91.) (Silt), 19 ft thick. Index map. Firing and physical properties of ceramic slag. Data on compressive strength, Los Angeles abrasion loss tests, rotary kiln production. Possible use: Ceramic slag.

TABLE 3.—Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas											
	251	252	253	254	255	256	257	258	259	260	261	262
	15B69-26	15B70-4	15B70-2	15B70-3	15B71-1	15B71-2	15B71-3	15B72-2	15B72-13	15B72-8	15B72-12	15B72-7
SiO_2	70.56	70.36	68.57	69.63	60.61	72.70	50.54	64.78	73.97	69.32	72.37	69.24
Al_2O_3	13.12	14.02	15.46	16.39	19.03	12.56	[1] 7.66	22.24	11.73	15.26	14.12	15.48
Fe_2O_3	3.27	4.55	4.31	2.48	4.50	4.22	6.02	1.58	4.53	2.95	3.31	4.24
MgO	1.56	1.32	1.39	.83	2.07	2.23	.22	.66	......	......	......	......
CaO	2.85	.28	.23	.28	.41	1.87	18.13	.27	......	......	......	......
Na_2O	1.18	.34	1.46	1.34	.33	......	......	......	......	......	......	......
K_2O	2.68	3.27	1.98	2.69	3.29	......	......	......	......	......	......	......
TiO_2	.73	1.07	1.03	1.40	.84	1.55	......	1.32	......	......	......	......
P_2O_5	.09	.08	.05	Tr.	.05	.08	Tr.	Nil	......	......	......	......
SO_3	Tr.	.14	.17	Nil	.04	.04	......	.05	......	......	......	......
S	......	.42	.31	.01	......	......	Nil	......	......	......	......	......
Ignition loss	4.36	4.37	4.72	4.80	8.53	[2] 2.77	[2] 14.35	[2] 7.49	6.34	7.62	6.18	6.95
Total	100.40	[3] 100.22	[4] 99.68	[5] 99.85	99.70	98.02	96.92	98.39	96.57	95.15	95.98	95.91
Class	44,47,1	40,53,0	36,57,0	38,55,0	22,68,5	46,47,0	30,37,25	24,71,2	48,48,0	39,56,0	44,52,0	37,59,0

	263	264	265	266	267	268	269	270	271	272	273	274
	15B72-14	15B72-4	15B72-3	15B72-9	15B72-6	15B72-1	15B72-5		15B72-10	15B72-11	15B72-15	15B72-16
SiO_2	74.79	65.14	64.62	69.86	68.26	64.28	65.35	63.20	71.98	72.24	82.30	73.30
Al_2O_3	12.80	18.62	21.15	15.01	17.86	20.92	20.08	20.63	17.15	17.51	9.15	14.46
Fe_2O_3	2.67	3.51	1.98	5.13	2.84	2.63	2.38	3.17	1.55	1.56	1.23	1.54
MgO	......	......	......	......	......	......	......	......	.58	.73	.09	.21
CaO	......	......	......	......	......	......	......	......	.68	.96	.75	1.00
Na_2O+K_2O	......	......	......	......	......	......	......	......	......	......	2.06	5.64
TiO_2	......	......	1.52	1.12	1.13	1.28	......	1.20	.98	.53	.65	......
Ignition loss	5.60	7.98	8.33	7.30	8.11	8.59	7.65	6.84	5.44	5.50	4.22	[6] 4.60
Total	95.86	95.25	97.60	98.42	98.20	97.70	95.46	95.04	98.36	[7] 99.03	100.45	100.75
Class	49,47,0	28,67,0	25,71,0	38,60,0	33,64,0	24,72,0	27,68,0	....	40,55,2	40,57,2	65,31,2	46,47,1

	275	276	277	278	279	280	281	282	283	284	285
	15B74-4	15B74-7	15B74-5	15B74-6	15B74-8	15B74-10	15B74-12	15B74-9	15B74-13	15B74-15	15B74-14
SiO_2	57.25	66.44	59.34	61.35	61.52	72.82	73.00	72.46	73.03	72.90	72.71
Al_2O_3	15.34	17.26	16.45	17.47	21.47	[8] 11.50	[8] 11.31	[8] 11.40	11.79	12.05	12.28
Fe_2O_3	2.76	2.30	4.16	2.90	2.56	1.26	1.76	1.46	1.66	1.61	1.65
MgO	.10	.60	.05	.09	.06	.11	.24	.14	.09	.09	.08
CaO	4.67	2.34	2.59	1.87	3.46	.55	.97	.51	.64	.54	.58
Na_2O	.52	.35	......	1.54	.50	3.03	1.79	1.33	[9] 3.21	[9] 2.36	[9] 3.39
K_2O					1.11	6.02	6.00	6.24	[9] 4.77	[9] 6.39	[9] 5.06
H_2O-[10]	8.4	6.1	6.0	6.0	......	......	......	......	......	......	......
TiO_2	.03	.01	.03	.02	.03	.63	.49	.75	.31	.22	.31
P_2O_5	......	......	......	......	......	Tr.	Nil	Nil	Tr.	Tr.	Tr.
SO_3	.99	1.00	1.87	.93	......	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
Ignition loss	[11] 6.30	[11] 3.91	[11] 8.65	[11] 8.18	8.71	[12] 4.56	[12] 4.04	[12] 5.19	4.50	3.84	3.94
Total	96.4	100.3	99.1	100.4	99.42	100.48	99.60	99.48	100.00	100.00	100.00
Class	27,61,4	33,63,0	26,68,2	27,68,2	21,71,6	51,39,1	51,38,2	51,39,1	50,40,1	50,40,1	49,41,1

[1] Includes TiO_2.
[2] 140°-1,000° C.
[3] 99.88 in text.
[4] 99.36 in text.
[5] 99.84 in text.
[6] Includes moisture.
[7] 98.03 in text.
[8] Includes MnO_2 and Ga_2O_3 if present.
[9] Na_2O+K_2O by difference; ratio by spectrographic determination.
[10] At 105° C.
[11] At 900° C., (reported ignition loss less CO_2; calculated by compilers).
[12] At 1,000° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

251. Norton County. Pleistocene, Sanborn formation. NW¼ sec. 26, T. 2 S., R. 23 W. Analyst, under supervision of Runnels. Lab. No. NN-6. (Plummer and Hladik, 1951, p. 21, 28, 29, 31, 46, 72, 73.) Loess, gray, oxidized. Outcrop map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate, ceramic products.

252-254. Osage County. Pennsylvanian, Howard limestone, Aarde shale member. Sec. 34, T. 17 S., R. 14 E. (McMillan, 1956, p. 214, 194, 195, 222, 249, pl. 1.) Selected samples. Index map, outcrop map, columnar section. Mechanical analyses, X-ray pattern, estimated amounts of clay constituents.
- 252. Nonmarine shale, yellowish-brown; 0.1 inch - 2 ft thick; depth below coal, 15-23 inches.
- 253. Nonmarine shale, yellowish-brown; 0.1 inch - 2 ft thick; depth below coal, 7 - 15 inches.
- 254. Nodaway underclay, ash gray, plastic; thin film to 1.7 ft thick; depth below coal, 4 - 7 inches.

255. Osborne County. Upper Cretaceous, Carlile shale, Blue Hill shale member. Center SW¼ sec. 12, T. 7 S., R. 15 W. Analyst, under supervision of Runnels. Lab. No. OS-2. (Plummer and Hladik, 1951, p. 21, 28-30, 44, 64, 65.) Shale, red and gray, unoxidized; 59 ft sampled; 100 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

256. Osborne County. Carlile shale, Codell sandstone member. Sec. 31, T. 9 S., R. 12 W. Lab. No. Os-3-ss. (Runnels and Dubins, 1949, p. 23, 4, 6.) Sandstone, dirty yellow to gray; friable. Index map.

257. Osborne County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. Sec. 31, T. 9 S., R. 12 W. Lab. No. Ob-3-1a. (Runnels and Dubins, 1949, p. 22, 4, 12.) (Calcareous shale) composite sample from lower part of bed. Thin section description. Insoluble residue, 71.08 percent. Index map. (For another analysis from same measured section see sample 294, group F_2 of this compilation.)

258. Ottawa County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay member (Plummer and Romary, 1947, p. 71). NW¼NW¼ sec. 8, T. 9 S., R. 2 W. Analysts, Thompson and Runnels. Lab. No. O-38-4. (Kinney, 1952, p. 306, 303, 305, 308.) Clay, kaolinitic; dried at 140° C. Beneficiation tests. Possible use: Source of alumina.

259-270. Ottawa County. Dakota sandstone. Sec. 5, T. 9 S., R. 2 W. Clay. Index maps, generalized columnar sections; logs of auger drill holes and open cuts. Possible use: Ceramic products.
- 259-262. (McMillan and Wilson, 1948, p. 14, figs. 1-4.)
  - 259. NE part NE¼NW¼ sec. 5. Hole A-19. Clay, gray; 27-28 ft below surface.
  - 260. NE part NE¼NW¼ sec. 5. Hole A-19. Clay, gray; 22-27 ft below surface.
  - 261. Center NE¼NW¼ sec. 5. Hole A-21. Clay, gray, silty, 6.5-10.5 ft below surface.
  - 262. Center NE¼NW¼ sec. 5. Hole A-21. Clay, gray; 1.5-6.5 ft below surface.
- 263-264. (McMillan and Wilson, 1948, p. 16, figs. 1-4.)
  - 263. NE part SE¼NW¼ sec. 5. Hole A-30. Clay, gray; 13-16.5 ft below surface.
  - 264. NE part NE¼SW¼ sec. 5. Hole A-29. Clay, gray-red; 9-14 ft below surface.
- 265-267. (McMillan and Wilson, 1948, p. 17, figs. 1-4.)
  - 265. NE part NE¼SE¼ sec. 5. Hole A-56. Clay, gray, red streaks; 13-23 ft below surface.
  - 266. SE part NE¼SE¼ sec. 5. Hole A-53. Clay, gray, red streaks; 12-17 ft below surface.
  - 267. SE part NE¼SE¼ sec. 5. Hole A-53. Clay, dark-gray; 5-10 ft below surface.
- 268. SW part NW¼SE¼ sec. 5. Hole A-50. (McMillan and Wilson, 1948, p. 16, figs. 1-4.) Clay, dark blue-gray, few yellow streaks; 3-10 ft below surface. (For another analysis from same measured section see sample 71, group D of this compilation.)
- 269. SW part NW¼SE¼ sec. 5. AL-Cut-8. (McMillan and Wilson, 1948, p. 18, figs. 1-4.) Clay, dark blue-gray; 2.9 ft below surface.
- 270. (Possibly another analysis of sample 269.) AL-8. (McMillan and Wilson, 1948, p. 5, figs. 1-4.)

271. Ottawa County. Dakota sandstone. NE¼NW¼ sec. 14, T. 9 S., R. 5 W. Analysts, Thompson and Runnels. Lab. No. O-4-C. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 119, 122, 125, 129, 150, pl. 1.) Siliceous fire clay, composite sample, sectioned from top to bottom as follows:
- 5.4 ft ... (Sample 272 from this bed.)
- 6.7 ft ... clay, gray; almost no stain, fairly plastic to slightly silty; some lignite; conchoidal fracture.
- 4.9 ft ... clay, gray; some yellow stain, slightly silty; small flinty concretions.

Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Porosity-temperature curve. Possible use: Refractories, brick.

272. Ottawa County. Dakota sandstone. NE¼NW¼ sec. 14, T. 9 S., R. 5 W. Analysts, Thompson and Runnels. Lab. No. O-4-16. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 119, 122, 125, 129, pl. 1.) Siliceous fire clay, gray; some irregular yellow stain, slightly silty, conchoidal fracture; lignitized wood fragments; 5.4 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories, brick.

273. Ottawa County. Dakota sandstone. W½ sec. 4, T. 12 S., R. 1 W. Analysts, Thompson and Runnels. Lab. No. O-20-1. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 135, 138, 141, 143, pl. 1.) Highly siliceous fire clay, gray to light-gray, no stain, silty; small bits of lignitized wood with some pyrite; 8.5 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

274. Ottawa County. Pleistocene. NE¼NW¼ sec. 29, T. 10 S., R. 5 W. Analyst, Schloesser. Sample No. 56. (Swineford and Frye, 1946, p. 22, 13, 20, 28.) Volcanic ash, altered; 1 ft channel sample from middle bed; immediately above large molluscan faunal zone. Index map. Dominant refractive index, Ridgway color notation; particle size distribution.

275-278. Phillips County. Upper Cretaceous, presumably between Pierre shale and Niobrara formation. Analyst, Thompson. (Kinney, 1942, p. 358, 354, 356, 364-366, 370-373.) Immersion, gelation, and other physical tests. Index map.
- 275. Sec. 10, T. 1 S., R. 18 W. Lab. No. 3. Alkali-earth, subbentonite, green-gray. Lower 1.5 ft of bed. (For other analyses from same measured section see samples 73 and 74, group D of this compilation.)
- 276. SE¼ sec. 35, T. 1 S., R. 20 W. Lab. No. 6. Alkali-earth, bentonite, light-gray. Lower 1 ft of bed.
- 277. SE¼ sec. 35, T. 1 S., R. 20 W. Lab. No. 5. Clay, dark green-gray. Middle 2 ft of bed.
- 278. SE¼ sec. 35, T. 1 S., R. 20 W. Lab. No. 4. Alkali-earth, subbentonite, green-gray. Upper 1 ft of bed; overburden, 5 ft. Possible use: Clarifying dry cleaner fluids, deinking newsprint, bleaching agent for oil.

279. Phillips County. Pierre shale. SE¼NE¼ sec. 10, T. 1 S., R. 18 W. Analyst, under supervision of Runnels. Lab. No. PH-2. (Plummer and Hladik, 1951, p. 21, 28-30, 64, 65.) Shale, light-gray, unoxidized; 20 ft sampled; 20 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate. Possible use: Lightweight aggregate.

280-282. Phillips County. Pliocene, Ogallala formation, Ash Hollow member. Analyst, under supervision of Runnels. (Swineford and others, 1955, p. 252, 245, 246, 250, 254-256, 258, 259.) Volcanic ash. Picked samples of unaltered and relatively uncontaminated ash, screened; dried at 105° C. Index map, optical data; arithmetic mean, standard deviation, coefficient of variation.
- 280. NE¼NE¼ sec. 19, T. 2 S., R. 18 W. Locality 15. Channel sample; basal 4 inches of 2 ft bed.
- 281. Dellvale bed. NE¼NE¼ sec. 19, T. 2 S., R. 18 W. Locality 17. Channel sample; middle 1 ft of 2-ft bed. Photomicrograph of ash.
- 282. SW¼NE¼ sec. 3, T. 2 S., R. 19 W. Locality 13. Spot sample, 2 ft above base of 8.5 ft bed; ash interbedded with thin beds of silt and fine sand.

283. Phillips County. Ogallala formation. NE¼NE¼ sec. 19, T. 2 S., R. 18 W. Analyst, under supervision of Runnels. Lab. No. PHV-1. (Carey and others, 1952, p. 21, 4, 6, 17, 25, 60, 61.) Volcanic ash, fresh; from 9.0 ft bed. Small amount of sand. Deposit extends more than 0.25 mile. Index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

284. Phillips County. Pleistocene, Meade formation, Pearlette ash bed. NE¼NE¼ sec. 33, T. 5 S., R. 19 W. Analyst, under supervision of Runnels. Lab. No. PHV-3A. (Carey and others, 1952, p. 21, 4, 12, 17, 25, 60, 61.) Volcanic ash relatively unaltered, trace of sand; from lower 7.3 ft of bed 15 ft thick; overburden 2 ft. Index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

285. County, formation, locality, analyst, reference and use as in sample 284. Lab. No. PHV-3B. Volcanic ash, from upper 6.0 ft of bed 15 ft thick. Mined commercially. Index map, generalized columnar section, screen analysis.

TABLE 3.— Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas										
	286	287	288	289	290	291	292	293	294	*295	296
	15B75-1	15B76-1	15B76-2	15B77-1	15B77-3	15B77-2	15B77-4	15B77-5	15B77-9	15B78-3	15B78-1
SiO_2	54.72	72.51	72.89	67.48	72.12	60.64	72.77	73.88	73.51	58.39	72.83
Al_2O_3	15.99	11.96	11.11	10.73	11.49	9.32	12.06	[1] 12.08	12.10	9.67	11.06
Fe_2O_3	5.73	1.70	2.05	1.91	2.26	1.96	1.68	1.64	1.64	4.72	1.91
MgO	2.56	.18	.21	.30	.77	.55	.16	.14	.11	6.38	.40
CaO	6.70	.72	.89	5.10	1.10	10.37	.75	.63	.63	3.16	1.37
Na_2O	.87	[3] 8.33	[3] 7.65	[2] 1.71	[3] 7.03	[3] 5.06	2.71	[2] 2.09	[2] 2.67	4.55	3.16
K_2O	3.06			[2] 4.56			6.03	[2] 5.98	[2] 5.36		4.35
TiO_2	1.01	.36	.31	.54	.52	.58	.24	......	.30	6.35	1.27
P_2O_5	.21	Nil	Nil	<.10	.10	Nil	Nil	Tr.	Tr.	None	Tr.
SO_3	Tr.	Nil	[4] Tr.	Tr.	[4] Tr.	[4] Tr.	<.10	Tr.	Nil	......	......
Ignition loss	9.27	4.24	4.89	7.67	4.61	11.52	3.55	3.56	3.68	6.55	3.82
Total	100.12	100.00	100.00	<100.10	100.00	100.00	<100.05	100.00	100.00	[5] 99.77	100.17
Class	20,62,8	49,40,2	51,39,2	46,37,10	49,40,2	42,33,20	50,40,0	51,40,0	50,40,1	36,40,6	51,38,1

	*297	298	299	300	301	302	303	304	305	306
	15B78-4	15B78-2	15B79-1	15B79-2	15B79-4	15B79-3	15B79-6	15B79-5	15B80-2	15B80-6
SiO_2	74.12	73.14	72.80	71.01	73.30	71.45	71.01	68.36	59.66	78.95
Al_2O_3	11.20	12.13	11.97	12.39	12.01	11.59	12.70	12.22	19.44	9.23
Fe_2O_3	1.87	2.12	4.00	3.79	3.79	4.02	3.89	4.31	3.18	2.45
MgO	.31	.30	.43	1.68	1.69	1.12	1.81	2.63	3.02	.82
CaO	1.08	1.23	.48	2.27	.48	.93	1.52	1.64	1.35	1.03
Na_2O	[2] 2.77	2.37	4.05	[3] 1.30	[3] 1.03	[3] 1.74	[3] 2.28	[3] 2.51	4.25	[3] 4.49
K_2O	[2] 4.96	4.32		2.29	2.51	3.13	2.31	1.89		......
H_2O-[6]	......	......	......	(.29)	(.28)	(.25)	(.20)	(.22)	......	(.19)
TiO_2	.97	.67	2.26	.95	1.12	1.66	.54	1.13	1.97	1.16
P_2O_5	Nil	Nil	......	.10	.07	.08	.15	.15	......	.05
SO_3	Tr.	<.10	......	.14	.02	.02	.10	.14	......	.05
Ignition loss	2.72	3.67	4.36	4.18	3.55	4.34	3.84	5.17	7.58	1.77
Total	100.00	<100.05	100.35	100.10	99.57	100.08	100.15	100.15	[7] 100.45	100.00
Class	52,38,0	49,42,0	47,46,1	45,46,0	48,45,0	46,45,1	44,47,0	42,47,2	22,66,4	60,33,0

	307	308	309	310	311	312	313	314	315	316
	15B80-4	15B80-5	15B80-13	15B80-3	15B84-1	15B85-2	15B85-1	15B86-1	15B88-2	15B88-1
SiO_2	73.66	74.69	76.66	72.87	72.77	75.76	67.83	61.98	74.34	73.16
Al_2O_3	11.11	11.21	12.04	11.84	12.14	[1] 13.72	[1] 17.05	12.02	12.40	12.33
Fe_2O_3	2.68	3.65	3.36	3.20	1.57	2.88	3.25	3.44	2.07	1.67
MgO	1.03	1.07	1.01	1.11	.09	.38	.80	2.18	.65	.14
CaO	2.33	1.31	.91	.84	.59	.45	.71	9.05	.64	.69
Na_2O	[3] 3.51	[3] 4.11	[3] 1.36	[3] 4.24	[2] 2.79	......	......	......	5.59	[2] 2.84
K_2O	......	......	......	......	[2] 5.76	......	......	......		[2] 4.97
H_2O-[6]	(.41)	(.28)	(.28)	(.40)	......	......	......	......	......	......
TiO_2	1.36	.74	1.09	1.41	.23	......	......	.63	......	.36
P_2O_5	.05	Tr.	Tr.	Tr.	Tr.	......	......	......	......	Tr.
SO_3	.05	.05	.05	.00	Tr.	......	......	......	......	Nil
Ignition loss	4.22	3.12	3.47	4.49	4.06	5.23	6.84	7.93	4.24	3.84
Total	100.00	99.95	99.95	100.00	100.00	98.42	96.48	[8] 97.23	99.93	100.00
Class	51,40,2	51,42,0	52,44,0	48,43,1	50,40,1	48,49,2	34,60,3	37,44,9	50,42,1	49,41,1

Qualitative spectrographic analyses

[Carbon electrodes used. Higher numbers indicate greater abundance. Zn and Ag not detected. Further explanation of table (Frye and others, 1949, p.87)]

	300	301	302	303	304	306	307	308	309	310
V	6	5	6	5	6	6	6	5	5	7
Cr	4	4	4	4	4	4	5	6	2	5
Mn	6	6	7	6	7	6	6	7	4	6
Cu	ND	ND	ND	ND	ND	4	5	5	5	5
Zr	6	5	7	6	7	ND	ND	5	ND	ND

[1] Inclndes TiO_2.

[2] $Na_2O + K_2O$ by difference; ratio by spectrographic determination.

[3] By difference.

[4] Reported as slight trace.

[5] MnO reported as slight trace; difference between total and 100 percent is largely alkalies.

[6] 105°-140° C., (not included in total).

[7] 100.43 in text.

[8] 98.23 in text; difference between total and 100 percent is largely alkalies.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

286. Pottawatomie County. Pennsylvanian, Wabaunsee group, Harveyville shale. SW¼NE¼ sec. 13, T. 10 S., R. 9 E. Analyst, under supervision of Runnels. Lab. No. PT-1. (Plummer and Hladik, 1951, p. 20, 26, 27, 31, 36, 60, 64, 65.) Shale, black, partly oxidized; 15.0 ft sampled; 20.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

287. Pratt County. Pleistocene, Meade formation, Pearlette ash bed. S½SW¼ sec. 21, T. 27 S., R. 12 W. Analyst, under supervision of Runnels. Lab. No. PRV-1A. (Carey and others, 1952, p. 21, 4, 12, 17, 22, 23, 25, 61.) Volcanic ash, from lower 7.5 ft of bed 14 ft thick. Estimated tonnage, index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

288. County, formation, analyst, reference and use as in sample 287. NW¼SE¼ sec. 34, T. 27 S., R. 12 W. Lab. No. PRV-4. Volcanic ash, altered by weathering; 4.0 ft in pit; overlain by 6 ft of mixed ash, sand, and silt. Index map, generalized columnar section; screen analysis, mechanical analysis.

289-294. Rawlins County. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 21, 4, 6, 12, 17, 22, 23, 25, 62.) Index map, generalized columnar sections. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

- 289. Pliocene, Ogallala formation. NW¼NW¼ sec. 33, T. 3 S., R. 34 W. Lab. No. RWV-3. Volcanic ash; 6.0 ft thick. Extent, 0.3 mile. (Composed of two beds, analyzed separately, see samples 290 and 291.)
- 290. Formation and locality as in sample 289. Lab. No. RWV-3A. Volcanic ash, lower 3 ft of bed 6 ft thick. Screen analysis.
- 291. Formation and locality as in sample 289. Lab. No. RWV-3B. Volcanic ash, from upper 3 ft of 6 ft bed. Screen analysis, estimated tonnage.
- 292. Meade formation, Pearlette ash bed. NE¼NW¼ sec. 14, T. 3 S., R. 35 W. Lab. No. RWV-1. Volcanic ash, fresh, clean; from bed 14.0 ft thick; upper 6 ft exposed; lower 8 ft sampled by augering. Overburden, 10-16 ft. Mechanical analysis, screen analysis. Photomicrograph.
- 293. Formation and locality as in sample 292. Lab. No. RWV-1B. Volcanic ash, fresh, clean; from exposed upper 6 ft of bed 14 ft thick. (For analysis of entire bed see sample 292.)
- 294. Meade formation, Pearlette ash bed. NW¼SW¼ sec. 22, T. 3 S., R. 35 W. Lab. No. RWV-4. Volcanic ash, fresh, clean; from 14.0 ft exposure in pit; overburden 10-16 ft. Screen analysis.

*295. Reno County. Permian, Ninnescah shale. NW¼ sec. 8, T. 25 S., R. 5 W. Analyst, Runnels. Lab. No. RO-1-1. (Plummer and Hladik, 1948, p. 74, 62, 80, 81.) (*Analysis shows 6.4 percent TiO_2, 4.6 percent alkalies; suggests 6.6 percent more CaO and MgO than required for carbonates.*) Shale; 3 ft thick; channel sample. Index map, firing and physical properties of ceramic slag. Possible use: Ceramic slag.

296-298. Reno County. Meade formation, Pearlette ash bed. Analyst, under supervision of Runnels. (Carey and others, 1952, p. 21, 4, 12, 17, 25, 62, 63.) Index map, generalized columnar section. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

- 296. SE¼NE¼ sec. 1, T. 25 S., R. 7 W. Lab. No. ROV-2. Calcareous volcanic ash, somewhat altered by weathering, relatively free from sand. From 3.0 ft bed exposed in pit.
- *297. NW¼SE¼ sec. 14, T. 25 S., R. 8 W. Lab. No. ROV-1 (Analysis shows 7.7 percent alkalies, 1.0 percent TiO_2; suggests 1.4 percent more CaO and MgO than required for carbonates.) Volcanic ash, relatively clean, fresh; from 10 ft bed in pit face. Screen analysis. (For analysis of upper part of bed see sample 298.)
- 298. NW¼SE¼ sec. 14, T. 25 S., R. 8 W. Lab. No. ROV-1B (or ROV-1S). Volcanic ash, from upper 4.5 ft of bed 10 ft thick, exposed in pit. Screen analysis.

299. Republic County. Upper Cretaceous, Graneros shale. NE¼NW¼ sec. 34, T. 3 S., R. 1 W. Analysts, Thompson and Runnels. Lab. No. RP-7-3. (Plummer and Romary, 1947, p. 180, 10, 42, 43, 179, 181, 214, pl. 1.) Shale, 9.3 ft thick, sectioned from top to bottom as follows:

5.0 ft ... fine-grained sandstone, silt and clay, in thin beds; gray, yellow, buff.

4.3 ft ... clay-shale, light-gray, some yellow streaks; silt partings.

Index map, detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, insulating and structural tile.

Kansas--Continued

300-304. Republic County. Pleistocene, Sanborn formation. SW¼SE¼ sec. 35, T. 2 S., R. 3 W. Spectrographic analyst, Reed. (Frye and others, 1949, p. 85, 52, 56, 86, 87, 93, 111, 112.) Silt. Index map, generalized columnar section. Plastic and dry properties, fired properties.

- 300-302. Loveland silt member. Possible use: Brick, tile, lightweight ceramic aggregate.
  - 300. Sample No. 30-A. Silt, 11 ft below top of section.
  - 301. Sample No. 30-B. Silt, 8 ft below top of section.
  - 302. Sample No. 30-C. Silt, 5.5 ft below top of section.
- 303-304. Peoria silt member. Possible use: Ceramic slag.
  - 303. Sample No. 30-D. Silt, 3.5 ft below top of section.
  - 304. Sample No. 30-E. Silt, 0.5 ft below top of section.

305. Rice County. Lower Cretaceous, Kiowa shale. NW¼SE¼ sec. 3, T. 18 S., R. 6 W. Analysts, Thompson and Runnels. Lab. No. RE-2-1. (Plummer and Romary, 1947, p. 174, 10, 42, 43, 171, 172, 175, pl. 1.) Shale; 8.8 ft thick. Upper 6.8 ft: Clay to clay-shale, gray, some yellow stain, plastic; three thin bands of concretionary limonite and some gypsum crystals. Lower 2 ft: Clay-shale, dark-gray, plastic; large crystals of selenite and some pyrite. Index map, detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, insulating and structural tile.

306-310. Rice County. Sanborn formation. NW¼SW¼ sec. 7, T. 18 S., R. 7 W. Spectrographic analyst, Reed. (Frye and others, 1949, p. 84, 52, 56, 86, 87, 91, 105, 106.) Silt. Index map, generalized columnar section. Plastic and dry properties, fired properties.

- 306-308. Loveland silt member. Possible use: Brick, tile, lightweight ceramic aggregate.
  - 306. Sample No. 21-A. Silt, 14 ft below top of section.
  - 307. Sample No. 21-B. Silt, 10.5 ft below top of section.
  - 308. Sample No. 21-C. Silt, 8.5 ft below top of section.
- 309-310. Peoria silt member. Possible use: Ceramic slag.
  - 309. Sample No. 21-D. Silt, 7.5 ft below top of section.
  - 310. Sample No. 21-E. Silt, 5.5 ft below top of section.

311. Russell County. Meade formation, Pearlette ash bed. NE¼NW¼ sec. 2, T. 15 S., R. 11 W. Analyst, under supervision of Runnels. Lab. No. RV-2. (Carey and others, 1952, p. 21, 4, 12, 25, 63.) Volcanic ash, fresh, relatively clean; 7.0 ft exposed, overburden 4-11 ft. Index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

312-313. Saline County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay member. NW¼SE¼ sec. 18, T. 15 S., R. 5 W. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 160, 163, 166, 167, pl. 1.) Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

- 312. Lab. No. S-4-1. Clay, dark-gray, plastic, alternating in thin laminae with white silt and fine sand; 6.0 ft thick.
- 313. Lab. No. S-4-4. Clay, plastic; 28.5 ft thick, sectioned from top to bottom as follows:
  - 4.0 ft ... gray and yellow.
  - 2.0 ft ... yellow and red.
  - 7.0 ft ... gray, red mottling; slickensides on oblique joints.
  - 1.8 ft ... yellow, red mottling.
  - 3.6 ft ... gray, red mottling.
  - 3.8 ft ... red and yellow.
  - 1.0 ft ... silty, red and yellow.
  - 5.3 ft ... yellow, red, gray.

314. Scott County. Sanborn formation. Sec. 19, T. 18 S., R. 32 W. Analyst, Runnels. Lab. No. SC-1-A. (Plummer and Hladik, 1948, p. 74, 62, 82, 83, 90, 91.) Clay, 9 ft thick; auger sample. Index map, firing and physical properties of ceramic slag. Data on rotary kiln production, compressive strength, Los Angeles abrasion loss test. Possible use: Railroad ballast, concrete aggregate, ceramic slag.

315. Seward County. Meade formation, Pearlette ash bed. T. 33 S., R. 32 W. Analyst, Schloesser. Sample No. 31. (Swineford and Frye, 1946, p. 22, 13, 17, 27, 28.) Volcanic ash, groups of elongate vesicles common. Index map. Dominant refractive index, Ridgway color notation, particle size distribution.

316. Seward County. Meade formation, Pearlette ash bed. SW¼NE¼ sec. 13, T. 33 S., R. 32 W. Analyst, under supervision of Runnels. Lab. No. SDV-3. (Carey and others, 1952, p. 21, 4, 12, 17, 25, 64.) Volcanic ash, from 8.5 ft bed in face of old pit; overlain by 5 ft of silt and brown sandy volcanic ash. Index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

TABLE 3. — Analyses of samples from Kansas containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Kansas												
	317	318	*319	320	321	322	*323	*324	325	326	327	328	329
	15B89-5	15B89-1	15B89-2	15B90-2	15B90-1	15B90-3	15B100-1	15B100-8	15B100-2	15B100-3	15B100-4	15B100-7	15B101-2
SiO_2	69.55	61.84	59.30	73.75	72.73	72.83	44.91	54.90	51.06	60.94	62.57	63.33	66.95
Al_2O_3	13.67	18.31	16.73	13.20	11.82	14.38	16.07	13.63	17.09	18.79	19.31	12.92	21.57
Fe_2O_3	3.93	5.39	5.10	2.20	1.69	1.84	2.14	5.97	1.81	2.52	2.61	3.34	1.05
MgO	.79	1.03	2.63	.18	.03	......	1.77	3.43	2.51	.71	1.80	1.96	.19
CaO	.29	.37	3.56	1.30	.76	.56	11.26	7.06	6.15	1.39	.94	5.44	.36
Na_2O	1.55	1.11	1.98	......	[1] 2.51	......	2.95	.54	......	......	......	......	1.83
K_2O	2.44	3.39	3.51	......	[1] 6.18	......		4.10	......	......	......	......	
H_2O- [2]	......	......	......	......	......	......	5.4	......	6.7	5.5	4.1	......	......
TiO_2	1.39	.86	1.10	......	.21	......	.01	.64	Tr.	.06	.01	......	1.76
P_2O_5	.04	.02	.21	......	Tr.	......	......	.48	......	......	......	......	......
SO_3	1.15	.32	Tr.	......	Tr.	......	.26	.12	1.05	1.73	.49	......	......
S	.30	.05	......	......	......	......	......	......	......	......	......	......	......
Ignition loss	5.22	5.35	6.85	4.60	4.07	5.53	[3] 10.80	9.09	[3] 13.91	[3] 4.24	[3] 4.41	9.62	6.48
Total	[4] 100.32	[5] 98.04	[6] 100.97	[7] 95.23	100.00	95.14	95.6	99.96	100.3	95.9	96.2	96.61	100.19
Class	41,51,2	23,68,0	24,63,3	48,45,2	50,40,1	45,49,1	14,59,14	24,55,9	19,65,15	25,67,0	25,68,0	37,47,12	26,68,1

	330	331	332	333	334	335	336	337	338	339	340	*341	342
	15B101-1	15B101-3	15B101-25	15B101-7	15B101-8	15B101-4	15B101-6	15B101-5	15B101-9	15B103-6	15B103-7	15B105-2	15B105-1
SiO_2	65.44	67.20	79.95	71.53	80.03	68.17	70.36	68.32	59.02	66.84	61.80	61.21	48.78
Al_2O_3	21.05	18.70	13.33	17.58	12.44	17.10	13.91	17.46	17.97	[8] 8.89	22.7	18.91	14.54
Fe_2O_3	3.54	2.20	.78	1.69	.73	2.14	3.70	2.70	6.78	[9] 3.95		3.98	5.40
MgO	2.17	1.60	.51	1.00	.38	.64	......	......	1.64	.47	.216	2.19	2.65
CaO	.78	.70	.75	.71	.34	.35	......	......	.65	8.55	8.20	2.50	2.31
Na_2O	.60	1.00	......	......	2.02	3.71	......	......	.19	1.13	Tr.	......	......
K_2O									2.72	1.18		3.87	......
TiO_2	.40	1.40	......	.71	.36	2.35	1.44	1.31	1.51	......	......	.86	1.03
P_2O_5	......	......	......	......	......	......	......	......	.19	.05	......	1.65	.92
SO_3	......	......	......	......	......	......	......	......	.36	Nil	......	.13	.49
S	......	......	......	......	......	......	......	......	......	Nil	......	......	......
Ignition loss	6.08	7.10	4.18	5.68	3.79	5.65	8.31	8.20	8.97	[10] 8.55	[11] 7.50	[12] 5.46	[12] 20.12
Total	100.06	99.90	99.50	98.90	100.09	100.11	97.72	97.99	100.00	99.61	100.4	100.76	96.24
Class	24,72,0	32,62,4	56,42,1	39,57,2	57,39,1	36,57,2	42,55,0	34,62,0	20,71,5	47,36,12	24,68,2	23,66,0	17,68,8

Spectrochemical and qualitative spectrographic analyses

[Sample 339, spectrochemical analysis, standard purity graphite electrodes used; Sr present but not determined; Sn and Ba looked for but not detected. Samples 341 and 342, qualitative spectrographic analyses; sample 341, standard carbon electrodes used; sample 342, high purity graphite electrodes used. Higher numbers indicate greater abundance; further explanation of table see Runnels (1949, p. 45)]

	339	341	342		339	341	342
B	0.01	5	6	Cu	0.00007	6	7
Na	....	7	...	Zn	ND	6	6
Ti	.28	...	...	Zr	...	6	4
V	.05	10	9	Mo	.003	ND	5
Cr	.01	8	7	Ag	.00005	6	5
Mn	.04	4	9	Pb	.004	ND	7
Ni	.004	...	...	Sr	...	ND	ND

[1] Na_2O+K_2O by difference; ratio by spectrographic determination.
[2] At 105° C.
[3] At 900° C. (reported ignition loss less H_2O-, calculated by compilers).
[4] 100.02 in text.
[5] 99.79 in text.
[6] 100.54 in text.
[7] Undetermined, 4.77 percent, reported as probably potash and soda by Landes (1928, p. 15).
[8] Includes MnO, ZrO_2, and TiO_2, if present.
[9] Total iron.
[10] 105°-1,000° C.
[11] Reported as H_2O.
[12] At 1,000° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

317-318. Shawnee County. Pennsylvanian, Howard limestone, Aarde shale member. Sec. 27, T. 11 S., R. 15 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 195, 249, pls. 1, 2.) Selected samples. Estimated amounts of clay constituents. Index map, outcrop map; columnar section, correlated columnar sections; mechanical analyses. (For another analysis from same measured section see sample 87, group D of this compilation.)

317. Shale, yellowish-brown, 0.1 inch-2 ft thick; 10-14 inches below coal.

318. Underclay to shale, 5-10 inches below coal.

*319. Shawnee County. Pennsylvanian, Wabaunsee group, Harveyville shale. SW¼SW¼ sec. 30, T. 11 S., R. 14 E. Analyst, nnder supervision of Runnels. Lab. No. SH-3. (Plummer and Hladik, 1951, p. 20, 26, 31, 36, 52.) (Analysis shows 5.5 percent alkalies, 1.1 percent TiO_2; suggests 4.7 percent more CaO and MgO than required for carbonates.) Shale, black, partially oxidized; 12.0 ft sampled; 12.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate; bloating results. Possible use: Lightweight aggregate.

320. Sheridan County. (Pleistocene, Meade formation, Pearlette ash bed. T. 8 S., R. 27 W.) town of Tasco. (Landes, 1928, p. 15, 7, 13.) Volcanic ash. Screen analyses of deposits in this area. Index map, estimated tonnage. Possible use: Abrasive, cement.

321. Sheridan County. Meade formation, Pearlette ash bed. NE¼SW¼ sec. 11, T. 8 S., R. 28 W. Analyst, under supervision of Runnels. Lab. No. SNV-2. (Carey and others, 1952, p. 21, 4, 12, 17, 25, 65.) Volcanic ash, fresh, 6.0 ft exposed; contains about 2 percent sand and silt. Index map, generalized columnar section, screen analysis. Possible use: Abrasive, ceramic glaze, cement additive, lightweight aggregate.

322. Sheridan County. Pleistocene, Sanborn formation. NW¼ sec. 34, T. 8 S., R. 28 W. Analyst, Schloesser. Lab. No. 60. (Swineford and Frye, 1946, p. 22, 13, 20, 28.) Volcanic ash, groups of elongate vesicles abundant; crossbedded lens 3 ft from bottom. Dominant refractive index, Ridgway color notation, particle size distribution. Bulk density: Large grain size, 2.21; smaller grain size, 2.26. Index map.

*323. Wallace County. Pliocene, Ogallala formation. SW¼ sec. 19, T. 12 S., R. 41 W. Analyst, Thompson. Lab. No. 10a. (Kinney, 1942, p. 358, 354, 356, 357, 364, 366, 373.) (Analysis suggests 5.5 percent more CaO and MgO than required for carbonates; shows 3.0 percent alkalies.) Alkali bentonite, pale olive-green, light streaks; 10 ft sampled, overburden 0-20 ft. Index map; immersion, gelation, and other physical tests. Possible use: Drilling mud, core for earthfill dam.

*324. Wallace County. Ogallala formation. SW¼ sec. 19, T. 12 S., R. 41 W. Analyst, under supervision of Runnels. Lab. No. WC-1. (Plummer and Hladik, 1951, p. 21, 28, 31, 45, 71.) (Analysis suggests 5.4 percent more CaO and MgO than required for carbonates, 1.1 percent phosphate; shows 4.6 percent alkalies.) Clay, red, brown, unoxidized; 10.0 ft sampled, 14.0 ft available. Results of experimental production of lightweight aggregate, screen analysis of lightweight aggregate. Possible use: Lightweight aggregate.

325-327. County, formation, reference, analyst, and use as in sample 323. Index map; immersion, gelation, and other physical tests.

325. NW¼ sec. 29, T. 12 S., R. 41 W. Lab. No. 11. Clay, light-brown; 5 ft sampled, no overburden.

326. SE¼ sec. 2, T. 12 S., R. 42 W. Lab. No. 16. Clay, pale gray-green, sandy; 5 ft sampled.

327. NE¼ sec. 12, T. 12 S., R. 42 W. Lab. No. 13. Clay-shale, brownish-gray; 4 ft sampled, overburden 40 ft. Use: Bleaching agent for oil, deinking newsprint, clarifying dry cleaner fluids.

328. Wallace County. Sanborn formation. (T. 13 S., R. 40 W.) town of Sharon Springs. Analyst, Stadler. (Elias, 1931, p. 180.) Loess.

329-335. Washington County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay member. Analysts, Thompson and Runnels. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy.

329. Center S½SW¼ sec. 28, T. 1 S., R. 3 E. Lab. No. W-19-2. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 74, 82, 84, 99, pl. 1.) Plastic fire clay, gray, some yellow stain; lignite particles; 7.4 ft thick. Possible use: Refractories. (For another analysis from same measured section see sample 93, group D of this compilation.)

330. SE¼SE¼ sec. 27, T. 2 S., R. 2 E. Lab. No. W-16-1. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 161-163, 166, 167, pl. 1.) Clay, gray to light-gray, some lavender with red mottling, some yellow on slickenside joints; fairly plastic; 13.1-13.8 ft thick. Possible use: Refractories, face brick.

Kansas--Continued

331-333. SE¼SE¼ sec. 1, T. 3 S., R. 2 E. (Sample 333, composite of 3 samples from same measured section, samples 331, 332, this group and sample 95, group D of this compilation.)

331. Lab. No. W-1-1. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 98, 99, 102, 148, pl. 1.) Plastic fire clay, dark-gray, very little stain, slightly silty. Bed 1, 5.6 ft thick. Absorption-temperature curve. Use: Pottery. Possible use: Face brick.

332. Lab. No. W-1-4. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 122, 125, 129, pl. 1.) Siliceous fire clay, light-gray, small amount of yellow stain, slightly silty; lignite particles, conchoidal fracture. Bed 3, 7.7-10.7 ft thick. Possible use: Refractories.

333. Lab. No. W-1-B. (Plummer and Romary, 1947, p. 123, 10, 42, 43, 99, 122, 125, 129, pl. 1.) Siliceous fire clay. Composite sample.

334. NE¼NW¼ sec. 13, T. 5 S., R. 1 E. Lab. No. W-57-2. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 137, 138, 141, 143, pl. 1.) Highly siliceous fire clay, gray, some yellow in upper 1.9 ft; silty to very silty; lignite particles and selenite crystals. Spot sample, 4.7 ft thick. Possible use: Refractories. (For analysis of composite sample, see sample 335, below.)

335. NE¼NW¼ sec. 13, T. 5 S., R. 1 E. Lab. No. W-57-A. (Plummer and Romary, 1947, p. 139, 10, 42, 43, 99, 137, 138, 141, 143, pl. 1.) Plastic fire clay. Composite sample 23.7 ft thick, sectioned from top to bottom as follows:

- 2.5 ft ... clay, dark-gray, some yellow stain, slightly silty, lignitic.
- 2.2 ft ... silt, yellow and gray.
- 4.2 ft ... clay, gray; two yellow streaks, each 0.3 ft thick; fairly plastic; some concretionary limonite.
- 2.6 ft ... clay, gray, slight yellow stain, fairly plastic.
- 2.5 ft ... clay, gray, slightly silty, some lignite and selenite.
- 1.7 ft ... clay, light-gray, some yellow on slickenside joints, plastic, small amount of gypsum.
- 3.3 ft ... clay, gray, some yellow stain on joints, fairly plastic; some lignite and gypsum.
- 4.7 ft ... (sample 334 from this bed).

Possible use: Refractories.

336. Washington County. Dakota sandstone. SE¼NE¼ sec. 31, T. 2 S., R. 1 E. Cut C-W-59. (McMillan and Wilson, 1948, p. 29, 28, figs. 1-3.) Clay, gray and yellow, some limonite; 5.7-11.4 ft below surface. Index map, generalized columnar section, log of opencut. Possible use: Ceramic products. (For another analysis from same measured section see sample 102, group D of this compilation.)

337. County, formation and use as in sample 336. SW¼SE¼ sec. 6, T. 3 S., R. 2 E. Cut C-W-62. (McMillan and Wilson, 1948, p. 28, figs. 1-3.) Clay, gray and yellow; 4.2-7.9 ft below surface. Index map, generalized columnar section, log of opencut. (For another analysis from same measured section see sample 103, group D of this compilation.)

338. Washington County. Upper Cretaceous, Graneros shale. SW¼SW¼ sec. 1, T. 3 S., R. 1 E. Analyst, under supervision of Runnels. Lab. No. W-65. (Plummer and Hladik, 1951, p. 21, 28-30, 39, 64, 65.) Shale, gray, unoxidized; 7.0 ft sampled, 17.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis; bloating results. Possible use: Lightweight aggregate.

339. Wilson County. Pennsylvanian, Iola limestone, Paola shale member. SW¼ sec. 29, T. 29 S., R. 17 E. Lab. No. 52320. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) (Calcareous shale.) Chips from continuous surface; bed, 1.5 ft thick. Index map, résumé of spectrographic results.

340. Wilson County. (Pennsylvanian, Bonner Springs(?) shale. T. 30 S., R. 15 E.) town of Neodesha. (Haworth, 1903, p. 56; Haworth and Schrader, 1905, p. 509.) Shale. Possible use: Cement material.

*341. Wyandotte County. Pennsylvanian, Cherryvale shale, Quivira shale member. Sec. 12, T. 11 S., R. 24 E. Spectrographic analyst, Reed. Lab. No. 48-99. (Runnels, 1949, p. 44, 42, 43.) (Analysis shows 3.9 percent alkalies; suggests 3.9 percent phosphate, 2.2 percent more MgO than required for carbonate.) Shale, 3 ft thick; composite sample from lower half of bed; dried at 140° C. Size distribution of shales ground in pan mill. Possible use: Fertilizer.

342. Wyandotte County. Pennsylvanian, Iola limestone, Muncie Creek shale member. Sec. 12, T. 11 S., R. 24 E. Spectrographic analyst, Reed. Lab. No. 48-98. (Runnels, 1949, p. 44, 42, 43.) Shale, 3 ft thick; composite sample from upper part of member; dried at 140° C. Size distribution of shales ground in pan mill. Possible use: Fertilizer.

TABLE 4.—Analyses of samples from Montana and Nebraska containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position]

	Montana												
	1	*2	*3	4	*5	6	7	8	9	10	11	12	13
	25B1-3	25B1-4	25B1-6	25B1-5	25B15-1		25B16-1	25B16-2	25B16-4	25B16-5	25B16-3	25B34-1	25B41-1
Insoluble	63.2	51.2	70.0	[1] (66.1)	[1] (74.08)	......	......	......	......	......	......	......	......
SiO_2	......	......	......	60.60	68.37	......	60.98	61.82	68.68	71.01	65.56	65.76	68.49
Al_2O_3	10.9	7.2	4.3	7.9	7.02	5.96	21.69	19.86	12.69	15.17	[2] 18.24	17.18	21.35
Fe_2O_3	3.7	3.2	2.6	3.6	4.41	6.62			1.14				
FeO	......	......	......	......	3.99	......	......	......	1.17	......	......	......	......
MgO	......	......	......	2.34	4.41	3.64	1.33	.51	1.14	.34	.72	Tr.	.39
CaO	......	......	......	4.02	3.89	2.70	1.83	1.78	1.11	1.19	2.58	2.30	......
Na_2O	......	......	......	.17	.87	......	.80	2.38	1.23	2.77	2.08	2.22	3.49
K_2O	......	......	......	3.15	1.34	......	1.23	1.31	5.58	2.97	3.94	3.14	4.17
H_2O+	......	......	......	......	[3] 3.60	......	......	......	......	......	......	......	2.10
H_2O-	......	......	......	......	[4] .25	......	......	......	......	......	[5] 1.12	[5] 3.46	
TiO_2	......	......	......	.48	......	......	......	......	......	......	......	......	......
P_2O_5	1.4	14.5	5.1	[6] 2.81	......	......	......	......	......	......	......	......	......
MnO	......	......	......	.028	......	......	......	......	Tr.	......	......	......	......
Ignition loss	21.1	4.3	5.7	[7] 13.1	[8] 1.91	......	11.96	11.47	7.99	6.34	6.50	5.60	......
Subtotal	......	......	......	99.14	......	......	......	......	......	......	......	......	......
Less O	......	......	......	.13	......	......	......	......	......	......	......	......	......
Total	100.3	80.4	87.7	99.0	100.06	......	99.82	99.13	100.73	99.79	100.74	99.66	99.99
Class	(40,59) 0	(35,31) 0	(59,23) 0	44,40,6	51,33,4	......	25,67,6	29,63,4	45,43,4	46,46,3	35,54,4	-37,54,3	33,59,0

	Montana	Nebraska											
	14	15	16	17	18	19	20	21	*22	23	24	25	26
	25B41-2	26B7-2	26B7-1	26B7-3	26B10-1	26B11-1	26B16-1	26B16-2	26B23-1	26B28-1	26B28-3	26B28-2	26B28-4
SiO_2	68.54	74.82	72.41	73.01	71.93	66.93	70.81	71.91	59.14	72.53	79.50	76.49	85.35
Al_2O_3	21.27	[9] 10.16	[9] 11.53	[9] 10.73	13.35	16.34	[9] 13.31	[9] 11.46	[9] 16.14	12.05	11.61	17.73	8.14
Fe_2O_3		1.56	1.68	1.76	[10] 3.75	[10] 5.78	3.23	2.13	6.44	4.28	2.57	1.01	.56
MgO	.46	.21	.29	.25	1.29	1.13	.84	.03	1.80	1.20	.68	.89	.16
CaO	......	.73	.61	1.00	1.93	3.35	1.68	.42	4.69	1.03	......	2.33	.68
Na_2O	3.45	1.05	.93	1.06	4.10	.55	1.61	1.45	2.16	3.10	1.29	.33	.01
K_2O	4.15	5.56	6.50	6.08		1.24	3.24	6.85	3.08			.96	2.13
H_2O+	2.12	......	......	......	......	......	......	......	......	3.36	3.50	......	......
H_2O-										2.45	.85	......	......
TiO_2	......	.24	.23	.15	......	......	.51	.22	.77	......	......	......	......
P_2O_5	......	.03	Tr.	Tr.	......	......	.19	Tr.	.16	......	......	......	......
MnO	......	......	......	......	.09	......	......	......	......	......	......	......	......
SO_3	......	Tr.	Nil	Tr.	......	......	Tr.	Tr.	Tr.	......	......	......	......
Ignition loss	......	[11] 4.87	[11] 5.29	[11] 5.51	3.99	6.86	[11] 4.14	[11] 4.80	[11] 5.59	......	......	......	......
Total	99.99	[12] 99.23	99.47	99.55	100.43	102.18	99.56	99.27	99.97	100.00	100.00	99.74	97.03
Class	33,59,0	55,36,2	50,40,2	52,38,2	44,49,0	32,63,3	44,48,0	49,41,1	23,64,0	46,48,0	56,42,0	44,51,0	70,26,2

	Nebraska				
	27	28	29	30	31
	26B35-1	26B55-2	26B60-1	26B79-1	26B83-1
SiO_2	72.46	71.81	73.84	69.09	68.12
Al_2O_3	[9] 11.95	12.39	13.20	[9] 13.09	[9] 12.42
Fe_2O_3	2.04	4.36	3.50	1.82	1.79
MgO	.94	.93	1.33	1.98	2.09
CaO	1.32	1.32	1.33	1.76	1.66
Na_2O	1.94	[15] 2.68	1.93	2.30	1.38
K_2O	4.82		2.14	3.97	5.50

	27	28	29	30	31
H_2O	......	3.37	......	......	......
TiO_2	0.21	......	......	1.33	0.16
P_2O_5	.01	......	......	Tr.	.02
MnO	......	[13] Tr.	0.18	......	......
SO_3	Nil	......	......	Tr.	Tr.
Ignition loss	[11] 4.31	[14] 3.13	3.44	[11] 4.97	[11] 6.37
Total	100.00	99.99	100.89	100.31	99.51
Class	49,41,2	45,47,4	47,47,0	44,44,3	44,42,6

Semiquantitative spectrographic analyses

[A = more than 10 percent; C = 1-5 percent; D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Be, Ga, Ge, As, Cd, In, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, and Bi looked for but not detected]

	1	2	3		1	2	3		1	2	3
B	E	F	F	Cr	D	E	E	Sr	F	F	ND
Na	E	D	E	Mn	E	E	C	Zr	E	E	E
Mg	D	D	D	Ni	E	E	D	Cb	E	ND	ND
Ca	E	A	C	Co	ND	ND	E	Mo	E	F	E
Ti	D	E	E	Cu	G	G	G	Ag	F	F	G
V	D	E	D	Zn	E	E	D	Pb	ND	D	ND

Chemical analysis of minor elements and oxides of sample 4

4			
Ni	0.022	MoO_3	0.006
Cr_2O_3	.02	Ag	.0001
Co	.004	V_2O_5	[16] .56
Zn	.003	F	.31
Cu	.011	W	<.005
Pb	.006		

[1] Not included in total.
[2] Reported as mostly FeO.
[3] Above 110° C.
[4] At 110° C.
[5] At 105° C.
[6] P_2O_5 also reported as 1.5 percent.
[7] Includes organic matter, CO_2, and S; 6.66 percent.
[8] Reported as CO_2.
[9] Includes MnO_2 and Ga_2O_3 if present.
[10] Reported as iron oxide.
[11] At 1,000° C.
[13] 99.20 in text.
[13] Reported as MnO_2.
[14] Reported as organic and volatiles.
[15] By difference.
[16] V_2O_5 also reported as 0.47 percent.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Montana

1-3. Beaverhead County. Permian, Phosphoria formation. NW¼SW¼ sec. 23, T. 9 S., R. 9 W. Spectrographic analyst, Mortimer. Trench samples. Index and outcrop map, generalized columnar section. (For other analyses from same measured section see samples 47 and 48, group A, sample 1 group D, and samples 15-18 group P; of this compilation.)

1. Lab. No. LAT-24, bed D-25. (Swanson and others, 1953b, p. 17, 21, 2, pl. 1.) Mudstone, calcareous, 2.8 ft thick, 26.95 ft from top of member.

*2. Lab. No. RLP-63, bed B-5. (Swanson and others, 1953b, p. 18, 22, 2, pl. 1.) (Partial analysis suggests 34.4 percent phosphate.) Mudstone and phosphate rock; 1.45 ft thick; 2 ft from top of member.

*3. Lab. No. ERC-388, bed C-13. (Swanson and others, 1953b, p. 18, 21, 2, pl. 1.) (Partial analysis suggests 12.1 percent phosphate.) Mudstone nodules.

4. Beaverhead County. Phosphoria formation. SE¼SW¼ sec. 35, T. 13 S., R. 10 W. Lab. No. WRL-150-47. (Swanson and others, 1953b, p. 29, 31, 2, pl. 1.) Mudstone; 1.3 ft thick, sampled in hand trenches and natural exposures; 26.4 ft from top of member. Index and outcrop map, generalized columnar section.

*5. Flathead County. Precambrian, MacDonald formation. (About T. 37 N., R. 23 W.) top of Mount Hefty. Analyst, Dittrich. Lab. No. 1250. (Daly, 1912, p. 102, 101.) (Analysis suggests 6.3 percent more CaO and MgO than required for carbonates; shows 4.0 percent FeO, 2.2 percent alkalies.) Argillite, partially recrystallized. Bulk density, 2.687. General description of formation.

6. Soluble portion of sample 5. (Daly, 1912, p. 103.)

7-10. Gallatin County. (Tertiary, Bozeman "lake beds.") Gallatin Valley.

7. About sec. 19, T. 2 S., R. 7 E., (U. M. Sahinen, written communication, 1955) near Fort Ellis. Analyst, Clarke; collector, Peale. (Clarke, 1915, p. 93.) Volcanic dust or sand.

8. (T. 2 S., R. 5 E.) near town of Bozeman. Analyst, Clarke; collector, Peale. (Clarke, 1915, p. 93.) Volcanic dust or sand.

9. (Near Bozeman.) Analyst, Stokes. (Iddings, 1898, p. 147.) Volcanic dust. Petrographic analysis also given. General remarks: Beds 2-5 ft thick, separated by thin calcareous layers. Total thickness, 20 ft.

10. Near Bozeman. Analyst, Clarke; collector, Peale. (Clarke, 1915, p. 93.) Volcanic dust or sand.

11. Gallatin County. Tertiary sediments, T. 10 S., R. 4 E., (U. M. Sahinen, written communication, 1957). Little Sage Creek. Analyst, Whitfield. Lab. No. 35890a. (Merrill, 1886, p. 202, 199, 204.) Pumice dust, light-gray, fine-grained, rather friable, homogeneous, sharp and gritty; contains few particles of earthy matter. Possible use: Abrasive soap and powder.

12. Park County. Formation, analyst, reference, and use as in sample 11. T. 8(?) S., R. 8(?) E., (U. M. Sahinen, written communication, 1957) Devil's Pathway. Lab. No. 35893a. Pumice dust, light-ash color, fine-grained.

13-14. Ravalli County. Oligocene and Miocene, Tertiary lake beds (U. M. Sahinen, written communication, 1955). Parens mine, Bitter Root Valley. Analyst, Berry. (Rowe, 1903, p. 9, 25.) Volcanic ash, description of outcrops. Possible use: Abrasive.

Nebraska

15-17. Box Butte County. Miocene, Sheep Creek formation, Box Butte member. Sec. 26, T. 28 N., R. 52 W. Analyst, under supervision of Runnels. Locality 4. (Swineford and others, 1955, p. 252, 245, 248, 249, 256, 258, 259.) Volcanic ash, picked samples of unaltered and relatively uncontaminated ash, screened, dried at 105° C. Bed 2 ft thick. Index map, photomicrograph, optical data; arithmetic mean, standard deviation, coefficient of variation.

15. Channel sample, basal 6 in.

16. Channel sample, 6-10 in. above base.

17. Channel sample, 12-17 in. above base.

18. Buffalo County. (Recent. SE corner T. 9 N., R. 16 W. and NE corner T. 8 N., R. 16 W.) town of Kearney. Analyst, Borrowman. (Borrowman, 1942, p. 11.) Alluvium, brownish-yellow, soft; few sand, mica, and limestone particles; 0.5 percent does not pass 150-mesh. Pit covers 4 acres; 30 ft deep. Firing properties, physical tests. Use: Brick.

Nebraska--Continued

19. Burt County. Upper Cretaceous, Dakota sandstone. (T. 21 N., R. 11 E.) town of Tekamah, Farmers Clay Products Co. quarry. Analyst, Borrowman. (Borrowman, 1942, p. 7, 8.) Clay, yellow to reddish-yellow, gray and red, coarsely mottled, very hard; representative sample. Physical tests. Use: Brick, tile.

20-21. Cherry County. Pliocene, Ogallala formation. Analyst, under supervision of Runnels. (Swineford and others, 1955, p. 252, 244-246, 257-259.) Volcanic ash, picked samples of unaltered and relatively uncontaminated ash, screened, dried at 105° C. Index map, optical data, arithmetic mean, standard deviation, coefficient of variation.

20. Valentine member. NE¼ sec. 17, T. 33 N., R. 27 W. Locality 1. Volcanic ash; 2 in. thick, associated with bentonite beds in silty sands, about 75 ft above base of member. Spot sample, glass somewhat altered.

21. Ash Hollow member. Center E½ sec. 15, T. 32 N., R. 30 W. Locality 2. Spot sample, 0.8 ft above base of 10 ft bed.

*22. Dawes County. Sheep Creek formation, Sand Canyon member. Sec. 14, T. 29 N., R. 47 W. Analyst, under supervision of Runnels. Locality 3. (Swineford and others, 1955, p. 252, 245, 246, 248, 251, 258, 259.) (Analysis suggests 6.5 percent more CaO and MgO than required for carbonates; shows 5.2 percent alkalies.) Volcanic ash, dark-gray, crossbedded, cemented at top. Spot sample, 2.5 ft above base of 40 in. bed; unaltered, relatively uncontaminated, screened, dried at 105° C. Index map, photomicrograph, optical data, arithmetic mean, standard deviation, coefficient of variation.

23-24. Douglas County. (Pleistocene, glacial clays.) (T. 15 N., R. 13 E.) town of Omaha, probably Omaha Hydraulic Pressed Brick Co. (Ries, 1897, p. 1162.) Use: Brick.

23. Clay, red.

24. Clay, buff.

25-26. Douglas County. Recent. Analyst, Borrowman.

25. Missouri River sand. Omaha. (Condra, 1908b, p. 80, 36, 59, 142.) Sand, gray when dry, fine, grains subangular; much of sand passes 100-mesh. Dried at 100° C. Mechanical analysis, physical properties, mineralogy.

26. Platte River sand. (T. 16 N., R. 10 E.) town of Valley. (Condra, 1908b, p. 112, 36, 59, 143.) Sand, gray to mottled light-pink; natural gradation of particle size; dried at 100° C. Mechanical analysis, physical properties. Use: Commerical grade; used locally.

27. Garden County. Ogallala formation, Ash Hollow member. (T. 18 N., R. 46 W.) about 0.8 mile north of town of Lisco. Analyst, under supervision of Runnels. Locality 7. (Swineford and others, 1955, p. 252, 245, 246, 255-259.) Volcanic ash, partly cemented; channel sample of basal 16 in. of 4 ft lentil. Picked sample of unaltered and relatively uncontaminated ash, screened, dried at 105° C. Index map, optical data, arithmetic mean, standard deviation, coefficient of variation.

28. Lancaster County. (Dakota sandstone. Sec. 4, T. 9 N., R. 6 E.) southwest of Lincoln, pit of Yankee Hill brick plant. (Rymes, 1928, p. 49, 46, 53-56.) Clay, dirty-brown, contaminated. Screen analysis, physical properties. Use: Brick, tile.

29. Madison County. (Pleistocene, T. 21 N., R. 1 W.) town of Madison. Analyst, Borrowman. (Borrowman, 1942, p. 10.) Loess clay, brownish-yellow; 5 ft thick. Pit covers about 7 acres. Firing properties, physical tests. Use: Brick. Possible use: Tile.

30-31. Miocene. Analyst, under supervision of Runnels. (Swineford and others, 1955, p. 252, 244-246, 248, 257-259.) Picked samples of unaltered and relatively uncontaminated volcanic ash, screened, dried at 105° C. Index map, photomicrographs, optical data, arithmetic mean, standard deviation, coefficient of variation.

30. Scotts Bluff County. Gering formation, lower part. (T. 21 N., R. 56 W.) near Scotts Bluff National Monument. Locality 6. Volcanic ash; 1.5 in. bed.

31. Sioux County. Harrison formation. Sec. 30, T. 26 N., R. 55 W. Locality 5. Volcanic ash; partly indurated; 4 ft bed, about 10 ft below top of formation.

TABLE 5.—Analyses of samples from North Dakota containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by county and stratigraphic position. Minor discrepancies occur in naming of constituents, and in their amounts, when more than one version of the analysis is found in the literature (Babcock, 1901; Babcock and Clapp, 1906). For analysis 13, Hansen (1953): SiO_2, $Al_2O_3+Fe_2O_3$, and CaO given as whole numbers in text. Additional information on percentages of these constituents and of MgO, CO_2, and ignition loss were supplied by Miller Hansen (written communication, 1954)]

	North Dakota												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	33B4-1	33B4-2	33B8-1	33B10-1	33B10-2	33B10-3	33B10-4	33B13-1	33B13-2	33B13-3	33B18-2	33B21-2	33B21-3
SiO_2	68.38	66.22	58.73	61.52	67.55	67.51	60.17	65.98	75.65	70.27	51.27	76.24	50.26
Al_2O_3	18.48	20.51	14.98	18.65	12.40	} 20.08	{ 17.35	20.68	17.85	20.81	9.33	15.39	} 9.03
Fe_2O_3	4.46	3.49	5.63	4.90	5.86		4.91	3.82	.49	.33	3.52	.79	
MgO	......	.78	.74	1.32	Tr.	[1] 1.22	1.78	.41	.18	.26	2.31	.33	......
CaO	......	.23	2.10	.75	1.74	[1] 1.29	2.09	.29	.23	.23	11.15	.34	10.09
Na_2O	......	......	.988	......	......	......	......	......	Tr.	......	2.08	......	......
K_2O	......	......	.16	......	......	......	......	......	.88	......	.50	......	......
H_2O	......	......	......	8.80	10.45	......	......	......	......	......	......	......	[2] (15.78)
TiO_2	.50	......	......	......	......	......	......	......	......	......	......	......	......
SO_3	......	......	......	......	......	......	.41	......	......	......	......	......	......
Ignition loss	6.59	6.83	[3] 16.672	......	......	......	10.11	7.60	5.31	6.38	......	5.12	32.04
Total	98.41	98.06	100.00	95.94	98.00	90.10	96.82	98.78	100.59	98.28	80.16	98.21	101.42
Class	31,67,0	26,70,2	26,68,5	23,71,4	39,57,3	34,59,5	24,65,7	25,72,1	44,55,1	33,64,1	31,37,25	48,49,1	35,48,18

	14	15	*16	17	18	*19	20	21	22	23
	33B30-1	33B44-56	33B44-52	33B44-29	33B44-30	33B44-47	33B44-7	33B44-14	33B44-15	33B44-16
SiO_2	73.90	62.10	66.01	65.61	65.01	63.37	67.74	67.95	67.02	66.20
Al_2O_3	16.49	17.39	8.97	8.71	14.37	13.36	15.10	12.72	10.01	15.80
Fe_2O_3	1.25	6.08	4.39	4.50	4.87	4.60	5.58	4.39	4.62	5.35
MgO	.46	1.01	2.51	2.51	2.51	2.51	1.21	2.50	2.50	1.02
CaO	.29	.50	2.30	2.30	2.30	2.30	.87	2.47	2.47	1.22
Na_2O	.22	2.15	2.85	2.85	2.85	2.85	2.84	2.78	2.78	2.59
K_2O	1.20	......	2.29	2.29	2.29	2.29	1.76	1.38	1.38	1.50
H_2O-	......	......	......	......	......	......	......	......	[4] (29.47)	......
TiO_2	......	.86	.80	.30	.30	.80	.80	.18	1.24	1.18
Ignition loss	5.52	6.72	5.57	8.90	6.82	5.68	4.26	6.08	6.03	6.12
Total	99.33	96.81	95.69	97.97	101.32	97.76	100.16	100.45	98.05	100.98
Class	43,53,1	24,67,2	45,38,5	45,38,9	34,55,4	35,51,2	35,58,0	41,49,4	44,41,5	32,60,2

	24	25	26	27	28	29	30	31	32	33
	33B44-17	33B44-18	33B44-19	33B44-1	33B44-2	33B44-3	33B44-4	33B44-5	33B44-6	33B44-32
SiO_2	67.87	71.31	66.14	63.21	65.82	69.77	66.25	67.17	66.92	62.77
Al_2O_3	14.10	12.82	16.90	18.02	14.83	15.32	13.64	12.94	9.09	13.29
Fe_2O_3	5.80	3.72	6.03	5.12	5.88	4.85	5.92	4.85	4.73	4.86
MgO	1.02	.81	.81	......	1.09	1.09	1.17	1.17	3.73	......
CaO	1.22	.66	.66	......	.62	.62	.70	.70	1.42	......
Na_2O	2.59	2.05	2.05	......	2.51	2.51	3.50	3.50	2.23	......
K_2O	1.50	1.16	1.16	......	1.30	1.30	1.48	1.48	1.47	......
H_2O-	[4] (13.16)	......	......	......	......	......	......	......	......	......
TiO_2	1.12	1.08	1.16	.25	.88	.28	1.16	2.92	.16	.25
Ignition loss	5.38	5.32	6.20	9.19	4.24	5.70	5.10	6.34	6.50	18.81
Total	100.60	98.93	101.11	95.79	97.17	101.44	98.92	101.07	96.25	99.98
Class	36,56,1	44,48,2	29,65,1	26,70,0	33,58,0	37,58,1	35,55,0	39,51,4	46,39,6	34,66,0

	34	35	36	*37	38	39	40	*41	42	*43
	33B44-8	33B44-9	33B44-10	33B44-33	33B44-11	33B44-12	33B44-13	33B44-34	33B44-20	33B44-35
SiO_2	66.12	64.20	76.64	61.86	63.08	68.88	62.14	59.71	70.73	64.76
Al_2O_3	18.82	18.78	11.05	10.98	16.44	11.56	12.54	11.30	13.16	16.27
Fe_2O_3	6.48	5.67	4.05	5.19	4.86	4.96	3.12	4.85	5.35	4.39
MgO	......	......	......	3.31	.84	.84	3.31	3.31	1.04	.79
CaO	......	......	......	5.72	1.06	1.06	5.72	5.72	.74	2.16
Na_2O	......	......	......	2.74	1.30	1.30	2.74	2.74	2.97	3.05
K_2O	......	......	......	1.91	1.51	1.51	1.91	1.91	1.10	2.41
H_2O-	......	[4] (21.71)	......	......	......	......	......	......	......	......
TiO_2	.13	.25	.25	.72	1.34	.72	.56	.64	1.12	.86
Ignition loss	5.33	6.10	7.64	7.25	6.15	4.88	9.66	6.38	3.72	2.57
Total	96.88	95.00	99.63	99.68	96.58	95.71	101.70	96.56	99.93	[5] 97.26
Class	26,71,0	25,70,0	53,47,0	37,45,7	29,61,2	43,47,2	36,45,12	34,46,5	41,52,0	31,57,0

[1] Calculated from reported $MgCO_3$ or $CaCO_3$.
[2] Not included in total.
[3] By difference, reported as H_2O and volatile matter (Babcock, 1901, p.40).
[4] At 106° C., not included in total.
[5] 96.55 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota

1. Billings County. Eocene, Fort Union formation, Tongue River member. (T. 140 N., R. 100 W.), Belfield area, trench 102. Lab. No. 295. (Clarke, 1948, p. 21, 6, 23, figs. 1, 9.) Clay, uncombined silica present, alumina content of clay beds given. Index maps, generalized stratigraphic table.
2. Billings County. Eocene, Golden Valley formation (W. E. Benson, personal communication, 1954). T. 143 N., R. 99 W., divide between Knife and Little Missouri Rivers. Analyst, Babcock. Lab. No. 3702. (Babcock and Clapp, 1906, p. 191, 132, 167, 168, table 1, pl. 2.) Clay, light-gray to buff, sandy; 2 ft thick (5 ft from top of butte). Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Brick, dark-colored stoneware. (For another analysis from same measured section see sample 1, group D of this compilation.)
3. Burleigh County. Upper Cretaceous, Lance formation, Cannonball marine member (W. E. Benson, personal communication, 1954) reported as Laramie formation. (T. 139 N., R. 80 W.) near town of Bismarck. Analyst, Babcock. (Babcock, 1901, p. 40, 41; Babcock, 1906, p. 221, 224, pl. 2; Babcock and Clapp, 1906, p. 118, 117, table 1, pl. 2.) Clay, chocolate-colored, fine, plastic, uniform texture; about 6 ft thick. Geologic map, ceramic tests. Possible use: Brick, drain and sewer pipe, earthenware.
4. Cavalier County. Upper Cretaceous, Benton shale. Secs. 33, 34, T. 163 N., R. 57 W., Mayo Brick and Tile Co. Analyst, Berkey. Lab. No. 4. (Berkey, 1905, p. 151, 142, 149, 152, pl. 12.) Clay shale. General description: Black or greenish-gray, laminated, very plastic on weathered outcrops. Index map, geologic map, measured section. Use: Brick, tile. (For another analysis from same measured section see sample 2, group D of this compilation.)
5. Cavalier County. Formation, locality, analyst, and use as in sample 4. (Babcock and Clapp, 1906, p. 102, pl. 2) Clay, from top of formation. Geologic map.
6. Cavalier County. Upper Cretaceous, Niobrara formation. (Probably SE¼ sec. 13, T. 159 N., R. 57 W.), Park River outcrop. (Barry and Melsted, 1908, p. 171, 162, 163, pl. 28.) Shale. Geologic and outcrop map, detailed measured section.
7. Cavalier County. Upper Cretaceous, Pierre shale. NE¼ sec. 26, T. 159 N., R. 57 W., north of town of Union. (Barry and Melsted, 1908, p. 174, 173, pl. 28.) Shale, from exposure. Geologic and outcrop map. Possible use: Brick.
8. Dunn County. Golden Valley formation (W. E. Benson, personal communication, 1954). T. 147 N., R. 94 W., 5 miles east of Jim Creek. Analyst, Babcock. Lab. No. 3903. (Babcock and Clapp, 1906, p. 191, 159, 160, 168, table 1, pl. 2.) Clay, yellowish-white, compact. Contains fine sand, some mica, and segregations of iron; 2 ft thick (29 ft below top of exposure). Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Brick, stoneware. (For other analyses from same measured section see samples 4 and 5, group D of this compilation.)

9-10. Dunn County. Golden Valley formation (W. E. Benson, personal communication, 1954). Sec. 25, T. 141 N., R. 95 W., White Buttes. Analyst, Babcock. (Babcock, 1906, p. 216, 217, 241, pl. 2; Babcock and Clapp, 1906, p. 191, 132, 144-146, pl. 2.) Index and outcrop map, geologic map, detailed measured section. Ceramic tests, physical properties.
- 9. Lab. No. 2608. Clay, white, sandy; 25-30 ft thick (about 27.5 ft below top of exposure). Possible use: Refractories.
- 10. Lab. No. 2607. Clay, light-gray, sandy; 1.5 ft thick (26 ft below top of exposure). Possible use: Refractories, whiteware.

11. Grand Forks County. Pleistocene, Wisconsin drift. (T. 152 N., R. 50 W.) town of Grand Forks, Alsips brick works. Analyst, Babcock. (Babcock, 1901, p. 40; Babcock and Clapp, 1906, p. 185, pl. 2.) Clay, yellow; about 3 ft thick. Geologic map. Use: Brick.

12. Hettinger County. Golden Valley formation (W. E. Benson, personal communication, 1954). NE corner, T. 135 N., R. 95 W., Black Butte. Analyst, Babcock. Lab. No. 2103. (Babcock and Clapp, 1906, p. 191, 174, 175, pl. 2.) Clay, white, sandy; 5 ft thick (110 ft below top of butte). Contains very fine sand grains covered with kaolin. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Tile, semirefractories. (For another analysis from same measured section see sample 6, group D of this compilation.)

13. Hettinger County. Oligocene, White River formation. SW¼ sec. 6, T. 136 N., R. 94 W., School Butte. Analyst, under supervision of Burr. Lab. No. 20-2. (Hansen, 1953, fig. 11, p. 159, 172, fig. 14.) Clay, gray-green, calcareous; 1 ft thick. Overburden, estimated tonnage. Index maps, measured section, correlated (fence) diagram. Total insoluble, 65.26 percent; analysis on dry basis. Use: None.

North Dakota--Continued

14. Morton County. Golden Valley formation (W. E. Benson, personal communication, 1954). Sec. 11, T. 140 N., R. 90 W., Hebron Brick Co. pit. Analyst, Babcock. Lab. No. 2905. (Babcock and Clapp, 1906, p. 191, 135, 136, pl. 2.) Fire clay, light-gray, sandy; contains carbonaceous material, some iron stain; near top of 50 ft bed (about 30 ft below top of exposure). Index and outcrop map, geologic map, detailed measured section. Ceramic tests, physical properties. Use: Stoneware, white earthenware, brick.
15. Slope County. Upper Cretaceous, Hell Creek formation. Sec. 28 and 29, T. 133 N., R. 105 W., Marmarth area. Lab. No. 262. (Clarke, 1948, p. 20, 6, 23, 30, figs. 1, 8.) Clay, uncombined silica present, alumina content of clay beds given. Index maps, generalized stratigraphic table. Tests for water-softening properties.

16-43. Slope County. White River formation. Chalky Buttes area. Clay, trench samples. Uncombined silica present, alumina content of clay beds given. Index maps, generalized stratigraphic table. Tests of water-softening properties. Possible use: Water softener.
- 16-19. Sec. 30, T. 134 N., R. 100 W., Trench 28. (Clarke, 1948, p. 16, 6, 23, 30, figs. 1, 7.)
  - *16. Lab. No. 96. (Analysis shows 5.1 percent alkalies; suggests 2.5 percent more CaO and MgO than required for carbonates.)
  - 17. Lab. No. 97.
  - 18. Lab. No. 98.
  - *19. Lab. No. 99. (Analysis shows 5.1 percent alkalies; suggests 3.6 percent more CaO and MgO than required for carbonates.)
- 20-26. Sec. 14, T. 134 N., R. 101 W.
  - 20. Trench 5. Lab. No. 39. (Clarke, 1948, p. 14, 15, 6, 23, 30, figs. 1, 7.)
  - 21. Trench 10. Lab. No. 46. (Clarke, 1948, p. 15, 6, 23, 30, figs. 1, 7.)
  - 22. Trench 10. Lab. No. 47. (Clarke, 1948, p. 15, 6, 23, 30, figs. 1, 7.)
  - 23. Trench 11. Lab. No. 28. (Clarke, 1948, p. 14, 15, 6, 23, 30, figs. 1, 7.)
  - 24. Trench 11. Lab. No. 29. (Clarke, 1948, p. 14, 15, 6, 23, 30, figs. 1, 7.)
  - 25. Trench 12. Lab. No. 30. (Clarke, 1948, p. 14, 15, 6, 23, 30 figs. 1, 7.)
  - 26. Trench 12. Lab. No. 31. (Clarke, 1948, p. 14, 15, 6, 23, 30, figs. 1, 7.)
- 27-32. Sec. 15, T. 134 N., R. 101 W. Detailed measured sections.
  - 27. Trench 1. Lab. No. 6. (Clarke, 1948, p. 14, 6, 9, 23, 30, figs. 1, 7.)
  - 28. Trench 2. Lab. No. 43. (Clarke, 1948, p. 14, 15, 6, 9, 23, 30, figs. 1, 7.)
  - 29. Trench 2. Lab. No. 45. (Clarke, 1948, p. 15, 6, 9, 23, 30, figs. 1, 7.)
  - 30. Trench 3. Lab. No. 41. (Clarke, 1948, p. 14, 15, 6, 9, 23, 30, figs. 1, 7.)
  - 31. Trench 3. Lab. No. 42. (Clarke, 1948, p. 14, 15, 6, 9, 23, 30, figs. 1, 7.)
  - 32. Trench 4. Lab. No. 40. (Clarke, 1948, p. 14, 15, 6, 9, 23, 30, figs. 1, 7.)
- 33-42. Sec. 15, T. 134 N., R. 101 W. (Clarke, 1948, p. 14, 15, 6, 8, 23, 30, figs. 1, 7.) Detailed measured sections. (For another analysis from trench 7 see sample 10, group D of this compilation.)
  - 33. Trench 7. Lab. No. 7.
  - 34. Trench 7. Lab. No. 11.
  - 35. Trench 7. Lab. No. 11a.
  - 36. Trench 7. Lab. No. 12.
  - *37. Trench 8. Lab. No. 34. (Analysis suggests 5.5 percent more CaO and MgO than required for carbonates; shows 4.7 percent alkalies.)
  - 38. Trench 8. Lab. No. 35.
  - 39. Trench 8. Lab. No. 36.
  - 40. Trench 9. Lab. No. 32.
  - *41. Trench 9. Lab. No. 33. (Analysis suggests 6.4 percent more CaO and MgO than required for carbonates; shows 4.7 percent alkalies.)
  - 42. Trench 13. Lab. No. 25. (For another analysis from trench 13 see sample 11, group D of this compilation.)
- *43. Sec. 23, T. 134 N., R. 101 W. Trench 14. Lab. No. 48. (Clarke, 1948, p. 15, 6, 23, 30, figs. 1, 7.) (Analysis shows 5.5 percent alkalies; suggests 3.0 percent more CaO and MgO than required for carbonates.)

TABLE 5.—Analyses of samples from North Dakota containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	North Dakota												
	*44	*45	*46	*47	*48	49	50	*51	*52	53	*54	*55	56
	33B44-36	33B44-37	33B44-38	33B44-39	33B44-40	33B44-21	33B44-22	33B44-41	33B44-42	33B44-24	33B44-43	33B44-44	33B44-25
SiO_2	65.16	61.81	61.47	66.10	66.26	63.56	67.48	67.20	59.79	66.39	61.91	62.10	59.97
Al_2O_3	16.45	5.91	16.48	14.01	12.10	19.14	11.80	8.34	13.86	12.05	13.51	12.35	14.14
Fe_2O_3	4.96	4.60	5.08	6.03	6.48	5.53	5.55	3.93	7.61	4.52	4.29	4.03	4.17
MgO	1.27	3.07	1.15	1.01	1.01	1.01	1.01	2.30	1.54	1.54	1.54	2.01	2.36
CaO	2.64	5.26	.92	.85	.85	.85	.85	1.70	1.38	1.38	1.38	7.12	5.38
Na_2O	3.14	4.71	2.82	3.02	3.02	3.02	3.02	2.38	2.60	2.60	2.60	1.89	2.52
K_2O	2.21	2.25	1.63	1.73	1.73	1.73	1.73	1.56	1.91	1.91	1.91	1.42	2.25
H_2O-	......	......	......	......	......	......	......	......	......	......	[1] (18.73)	......	......
TiO_2	.96	.58	1.20	1.68	.98	1.10	1.20	1.38	1.08	1.60	2.14	.64	.80
Ignition loss	2.50	8.75	5.40	3.65	4.68	5.38	6.08	6.67	5.32	5.95	6.20	7.00	7.92
Total	[2] 99.29	96.94	96.15	98.08	97.11	101.32	98.72	95.46	95.09	97.94	95.48	98.56	99.51
Class	30,59,0	46,29,13	27,62,0	35,55,0	38,52,0	23,70,0	40,49,4	48,35,7	27,60,0	40,47,4	33,51,4	36,47,6	30,53,7

	*57	*58	*59	*60	61	62	*63	*64	65	66	67	68	69
	33B44-45	33B44-46	33B44-48	33B44-49	33B44-26	33B44-27	33B44-50	33B44-51	33B44-28	33B44-23	33B44-31	33B45-14	33B45-2
SiO_2	63.95	66.92	64.34	66.09	61.95	67.64	66.37	64.64	67.00	62.38	65.16	55.77	65.03
Al_2O_3	11.77	12.52	13.89	8.40	10.32	7.28	8.90	14.09	9.20	11.79	19.16	12.15	23.16
Fe_2O_3	4.96	3.39	4.86	4.16	4.39	3.93	4.05	4.63	4.50	4.37	3.32	4.27	1.00
MgO	2.36	2.36	2.42	2.42	2.42	2.42	2.85	2.85	2.85	3.15	1.75	1.90	.44
CaO	5.38	5.38	2.95	2.95	2.95	2.95	3.62	3.62	3.62	3.75	1.04	5.92	.29
Na_2O	2.52	2.52	2.00	2.00	2.00	2.00	1.93	1.93	1.93	2.48	......	.992	......
K_2O	2.25	2.25	1.68	1.68	1.68	1.68	2.01	2.01	2.01	1.52	......	.256	......
TiO_2	.84	.84	1.24	1.43	.40	.56	.94	2.14	1.06	.54	......	......	......
Ignition loss	6.34	5.34	3.90	7.05	9.97	7.18	6.40	5.40	7.70	9.00	4.83	[3] 18.742	7.21
Total	100.37	[4] 101.52	97.28	96.18	96.08	95.64	97.07	101.31	99.87	98.98	95.26	100.00	97.13
Class	38,47,5	41,46,3	34,53,0	47,35,8	39,43,10	50,31,9	46,37,7	34,53,2	46,38,9	37,46,10	28,65,0	29,55,15	23,73,1

	70	71	72	73	74	75	76	77	78	79	80	81	82
	33B45-4	33B45-13	33B45-7	33B45-11	33B45-12	33B45-9	33B45-6	33B45-3	33B45-97	33B45-98	33B45-99	33B45-100	33B45-101
SiO_2	65.70	75.27	66.55	72.66	73.20	67.60	66.48	65.46	65.39	65.52	63.44	63.46	63.36
Al_2O_3	22.07	17.29	23.22	17.33	18.56	16.32	19.55	20.97	15.95	15.79	16.67	17.00	15.41
Fe_2O_3	1.33	.83	1.16	1.05	.50	2.82	2.49	1.83	4.48	5.18	5.11	4.75	5.11
MgO	.36	.18	.61	......	.52	.51	1.16	1.14	.39	.39	.39	.39	.39
CaO	.23	.46	.29	.13	.29	3.45	.84	.23	1.20	1.20	1.20	1.20	1.20
Na_2O	......	Tr.	......	.38	.38	......	......	.72	[5] 1.12	[5] 1.12	[5] 1.12	[5] 1.12	[5] 1.12
K_2O	......	.32	......	.36	.36	......	......	1.38	......	......	......	......	......
TiO_2	......	......	......	......	......	......	......	......	.67	.74	.78	.80	.80
Ignition loss	6.90	5.75	7.09	9.35	5.93	7.07	7.45	6.79	9.21	6.56	6.58	6.82	7.92
Total	96.59	100.10	98.92	101.26	99.74	97.77	97.97	98.52	[6] 98.41	96.50	95.29	95.54	95.31
Class	25,70,1	44,55,1	24,73,2	41,59,0	40,58,2	36,56,5	29,65,4	26,68,2	32,62,3	32,60,3	28,62,2	28,63,3	30,60,3

	83	84	85	86	87	88	89	90	91	92	93	94	95
	33B45-102	33B45-103	33B45-104	33B45-105	33B45-106	33B45-107	33B45-108	33B45-109	33B45-110	33B45-111	33B45-112	33B45-113	33B45-114
SiO_2	62.38	62.79	62.90	67.47	65.54	66.04	62.71	63.24	62.12	62.38	63.80	62.72	67.52
Al_2O_3	17.57	18.94	16.33	16.58	15.34	17.90	17.98	16.66	19.05	17.40	18.21	18.09	15.32
Fe_2O_3	5.18	3.26	5.67	4.33	4.54	3.12	3.40	4.96	3.55	4.68	4.96	5.11	4.54
MgO	.39	.39	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	.87	.87	1.81
CaO	1.20	1.20	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	.45	.45	2.45
Na_2O [5]	1.12	1.12	.91	.91	.91	.91	.91	.91	.91	.91	3.00	3.00	1.14
TiO_2	.78	.78	.80	.86	.88	.70	.76	.80	.76	.78	.87	.86	.80
Ignition loss	6.87	6.82	7.40	6.49	7.22	6.68	7.01	7.51	7.17	7.52	6.10	7.67	7.72
Total	95.49	95.30	96.80	99.43	97.22	98.14	95.56	96.87	96.35	96.46	98.26	98.77	101.30
Class	25,65,3	26,65,3	28,63,4	33,60,3	33,57,5	31,61,3	27,62,3	28,62,4	24,66,3	26,64,4	26,67,1	25,67,3	35,57,6

[1] At 106° C., not included in total.
[2] 96.41 in text.
[3] By difference, reported as H_2O and volatile matter.
[4] 97.28 in text.
[5] (Not clear in text, Na_2O may include K_2O.)
[6] 98.39 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

44-66. Slope County. Oligocene, White River formation, Chalky Buttes area. Clay. Trench samples. Uncombined silica present. Alumina content of clay beds. Index maps, generalized stratigraphic table. Tests of water-softening properties. Possible use: Water softener.

44-50. Sec. 23, T. 134 N., R. 101 W. (Clarke, 1948, p. 15, 6, 23, 30, figs. 1, 7.)

*44. Trench 14. Lab. No. 49. (Analysis shows 5.4 percent alkalies, 1.0 percent TiO_2; suggests 3.9 percent more CaO and MgO than required for carbonates.)

*45. Trench 15. Lab. No. 51. (Analysis shows 7.0 percent alkalies, suggests 1.5 percent more CaO and MgO than required for carbonates.)

*46. Trench 16. Lab. No. 59. (Analysis shows 4.5 percent alkalies, 1.2 percent TiO_2; suggests 2.1 percent more CaO and MgO than required for carbonates.)

*47. Trench 17. Lab. No. 60. (Analysis shows 4.8 percent alkalies, 1.7 percent TiO_2; suggests 1.9 percent more CaO and MgO than required for carbonates.)

*48. Trench 17. Lab. No. 61. (Analysis shows 4.8 percent alkalies, 1.0 percent TiO_2; suggests 1.9 percent more CaO and MgO than required for carbonates.)

49. Trench 17. Lab. No. 62.

50. Trench 17. Lab. No. 63.

*51. Sec. 25, T. 134 N., R. 101 W. Trench 20. Lab. No. 78. (Clarke, 1948, p. 16, 6, 23, 30, figs. 1, 7.) (Analysis shows 3.9 percent alkalies, 1.4 percent TiO_2.)

*52. Sec. 25, T. 134 N., R. 101 W. Trench 21. Lab. No. 70. (Clarke, 1948, p. 15, 6, 10, 23, 30, figs. 1, 7.) (Analysis shows 4.5 percent alkalies, 1.1 percent TiO_2; suggests 2.9 percent more CaO and MgO than required for carbonates.) Detailed measured section.

53-65. Sec. 25, T. 134 N., R. 101 W. (Clarke, 1948, p. 16, 6, 10, 23, 30, figs. 1, 7.)

53. Trench 21. Lab. No. 72. Detailed measured section.

*54. Trench 21. Lab. No. 73. (Analysis shows 4.5 percent alkalies, 2.1 percent TiO_2; suggests 1.1 percent more CaO and MgO than required for carbonates.) Detailed measured section.

*55. Trench 22. Lab. No. 74. (Analysis suggests 5.7 percent more CaO and MgO than required for carbonates; shows 3.3 percent alkalies.) Detailed measured section.

56. Trench 24. Lab. No. 80.

*57. Trench 24. Lab. No. 81. (Analysis suggests 5.3 percent more CaO and MgO than required for carbonates; shows 4.8 percent alkalies.)

*58. Trench 24. Lab. No. 82. (Analysis suggests 6.2 percent more CaO and MgO than required for carbonates; shows 4.8 percent alkalies.)

*59. Trench 25. Lab. No. 83. (Analysis suggests 5.4 percent more CaO and MgO than required for carbonates; shows 3.7 percent alkalies.)

*60. Trench 25. Lab. No. 84. (Analysis shows 3.7 percent alkalies, 1.1 percent TiO_2; suggests 1.1 percent more CaO and MgO than required for carbonates.)

61. Trench 25. Lab. No. 85.

62. Trench 25. Lab. No. 86.

*63. Trench 26. Lab. No. 89. (Analysis shows 3.9 percent alkalies; suggests 3.0 percent more CaO and MgO than required for carbonates.)

*64. Trench 26. Lab. No. 90. (Analysis suggests 5.7 percent more CaO and MgO than required for carbonates; shows 3.9 percent alkalies, 2.1 percent TiO_2.)

65. Trench 26. Lab. No. 91.

66. Sec. 26, T. 134 N., R. 101 W. Trench 18. Lab. No. 112. (Clarke, 1948, p. 16, 6, 23, 30, figs. 1, 7.) Clay.

67. Slope County. White River formation (W. E. Benson, personal communication, 1954). T. 134 N., R. 101 W., butte about 4 miles north of Sandcreek Post Office. Analyst, Babcock. Lab. Nos. 406, 408. (Babcock, 1906, p. 210, pl. 2; Babcock and Clapp, 1906, p. 191, 179, 180, pl. 2.) Clay, grayish-white, calcareous; 7 ft thick (102 ft below top of butte). Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Use: Plaster. Possible use: Brick, red earthenware, tile.

68. Stark County. Eocene, Fort Union formation, Tongue River member (W. E. Benson, oral communication, 1954). (T. 139 N., R. 95 W.) east of town of Dickinson, Lehigh coal mine. Analyst, Babcock. (Babcock, 1901, p. 42.) Clay, gray; 5-10 ft thick, overlies coal bed. Bakes buff, tends to fuse at high temperatures. Possible use: Brick.

North Dakota--Continued

69-77. Stark County. Eocene, Golden Valley formation (W. E. Benson, oral communication, 1954). Analyst, Babcock. Clay. Index and outcrop map; geologic map; detailed measured sections. Ceramic tests, physical properties.

69-71. Locality, 6 miles east of Dickinson. (Babcock, 1906, p. 206, 207, 228, 239, 240, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 147, 148, pl. 2.)

69. Lab No. 2403. Clay, grayish-white to white; near bottom of 5-ft bed (8 ft from top of exposure). Possible use: Stoneware, brick, earthenware.

70. Lab. No. 2402. Clay, grayish-white to white, near top of 5-ft bed (3.5 ft from top of exposure). Possible use: Stoneware, brick, earthenware.

71. Lab. No. 2401. Clay, grayish-white, fine, sandy; some quartz, mica, iron stain; 2.5 ft thick (1 ft below top of exposure). Possible use: Refractories, pottery, earthenware.

72-73. Secs. 8, 9, 16, and 17, T. 139 N., R. 96 W., southwest of Dickinson. (For another analysis from same measured section see sample 13, group D of this compilation.)

72. Lab. No. 105. (Babcock, 1906, p. 205, 239, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 149, 150, 151, pl. 2.) Clay, blue-gray, compact, fine-grained, plastic; carbonaceous, fossil leaves. Near top of 5-ft bed (13.5 ft from top of bntte). Possible use: Stoneware.

73. Lab. No. 101. (Babcock, 1901, p. 45, 48, 51; Babcock, 1906, p. 214, pl. 2; Babcock and Clapp, 1906, p. 150, 133, 149, 151, pl. 2.) Clay, white, some sand; 4 ft thick; near top of butte. Possible use: Brick, refractories, earthenware.

74. Sec. 17, T. 139 N., R. 96 W., southwest of Dickinson. Lab. No. 111. (Babcock, 1906, p. 238, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 150, 151, pl. 2.) Fire clay, white, sandy; quartz sand coated with clay; 8 ft thick. Use: Brick. Possible use: Earthenware.

75. (T. 139 N., R. 96 W.), Antelope Creek, 10 miles south of Dickinson. Lab. No. 1103. (Babcock, 1906, p. 206, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 170, 171, pl. 2.) Clay, sandy; white quartz sand coated with kaolin. Contains ferruginous and calcareous concretions, 0.5 in.-15 ft in diameter; 10 ft below top of outcrop. Possible use: Refractories, brick.

76. (T. 139 N., R. 97 W.), 9 miles southwest of Dickinson. Lab. No. 803. (Babcock, 1906, p. 221, 224, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 154-156, pl. 2.) Clay, light bluish-gray; 1 ft thick (about 37 ft below top of butte). Possible use: Brick, tile, terra cotta.

77. T. 140 N., R. 93 W., butte 1.5 miles north of town of Taylor. Lab. No. 3304. (Babcock, 1906, p. 229, pl. 2; Babcock and Clapp, 1906, p. 191, 133, 141, 142, pl. 2.) Clay, white, sandy; 4 ft thick (26 ft below top of exposure). Possible use: Stoneware.

78-95. Stark County. White River formation. Sec. 6, T. 137 N., R. 97 W., town of South Heart, Little Badlands area. (Clarke, 1948, p. 19, 20, 6, 23, 25, 30, figs. 1, 6.) Clay. Trench samples. Uncombined silica present. Alumina content of clay beds. Index maps, generalized stratigraphic table. Tests of water-softening properties.

78. Trench 77. Lab. No. 213.

79. Trench 77. Lab. No. 215.

80. Trench 77. Lab. No. 216.

81. Trench 77. Lab. No. 217.

82. Trench 77. Lab. No. 218.

83. Trench 77. Lab. No. 219.

84. Trench 77. Lab. No. 221.

85. Trench 78. Lab. No. 222.

86. Trench 78. Lab. No. 223.

87. Trench 78. Lab. No. 224.

88. Trench 78. Lab. No. 225.

89. Trench 78. Lab. No. 226.

90. Trench 78. Lab. No. 227.

91. Trench 78. Lab. No. 228.

92. Trench 78. Lab. No. 229.

93. Trench 79. Lab. No. 231.

94. Trench 79. Lab. No. 232.

95. Trench 79. Lab. No. 234.

TABLE 5.—Analyses of samples from North Dakota containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	North Dakota												
	96	97	98	99	100	101	102	103	104	105	106	107	108
	33B45-115	33B45-116	33B45-117	33B45-118	33B45-119	33B45-120	33B45-121	33B45-122	33B45-123	33B45-124	33B45-125	33B45-126	33B45-127
SiO_2	64.10	65.83	61.78	60.08	59.36	66.94	65.48	64.32	66.24	67.83	67.40	65.64	64.94
Al_2O_3	14.86	17.22	16.86	17.58	16.89	16.71	17.42	17.81	17.55	17.64	15.88	15.94	17.26
Fe_2O_3	4.54	4.54	4.33	4.54	4.26	3.83	4.40	4.25	4.33	4.04	4.82	4.82	4.54
MgO	1.81	1.81	1.81	1.81	1.81	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
CaO	2.45	2.45	2.45	2.45	2.45	.69	.69	.69	.93	.93	.93	.93	.93
Na_2O	1.14	1.14	1.14	1.14	1.14	1.79	1.79	1.79	3.14	3.14	3.14	3.14	3.14
TiO_2	.90	.74	.68	.75	.88	.90	1.00	.82	.88	.79	.80	.88	.76
Ignition loss	7.64	7.52	7.69	8.16	8.81	5.84	5.74	6.08	6.27	6.32	7.20	6.78	7.46
Total	97.44	101.25	96.74	96.51	95.60	98.00	97.82	97.06	100.64	101.99	101.47	99.43	100.33
Class	33,56,6	30,63,4	27,61,5	24,64,6	25,61,7	33,60,1	30,63,1	28,64,1	30,63,2	32,63,2	34,59,4	32,60,3	29,63,4

	109	110	111	112	113	114	115	116	117	118	119	120	121
	33B45-128	33B45-129	33B45-130	33B45-131	33B45-132	33B45-133	33B45-134	33B45-135	33B45-136	33B45-137	33B45-138	33B45-86	33B45-82
SiO_2	63.80	64.96	64.44	65.53	63.44	66.08	65.43	65.47	65.24	67.08	64.24	66.30	71.32
Al_2O_3	17.21	17.56	16.50	15.98	16.93	16.82	16.90	16.91	16.97	15.75	17.97	14.82	13.79
Fe_2O_3	4.89	4.40	4.75	4.54	5.04	4.14	4.54	4.61	3.97	4.25	4.69	5.56	5.33
MgO	1.30	.98	.98	.98	.98	1.08	1.08	1.08	1.08	1.08	1.08	......	.90
CaO	.93	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	......	.32
Na_2O	3.14	1.52	1.52	1.52	1.52	1.52	1.35	1.35	1.35	1.35	1.35	......	1.40
K_2O	......	......	......	......	......	......	......	......	......	......	......	......	2.53
H_2O-, at 106°C	......	......	......	......	......	[1] (19.17)	......	......	......	......	......	......	2.28
TiO_2	.80	.74	.94	.85	.80	.75	.72	.58	.78	.94	.74	.70	.76
Ignition loss	7.34	6.20	8.71	7.63	7.82	6.05	7.59	7.18	6.81	5.64	5.83	8.12	3.52
Total	99.41	97.16	98.64	97.83	97.33	97.24	98.41	97.98	97.00	96.89	96.70	95.50	102.15
Class	28,64,4	29,63,1	30,63,3	32,60,3	28,64,3	32,61,2	30,62,4	30,62,4	31,61,3	34,58,1	27,65,0	34,61,0	41,55,0

	*122	123	124	125	126	127	128	129	130	131	132	133
	33B45-139	33B45-27	33B45-83	33B45-84	33B45-85	33B45-28	33B45-29	33B45-30	33B45-31	33B45-32	33B45-78	33B45-79
SiO_2	71.18	66.79	69.44	69.86	69.13	76.64	72.21	74.93	67.22	68.82	62.99	59.28
Al_2O_3	7.93	9.05	9.83	11.71	14.20	7.00	8.96	7.53	9.51	11.36	14.89	15.90
Fe_2O_3	4.27	3.23	4.63	4.17	5.33	4.61	3.21	3.93	3.17	4.38	4.05	4.86
MgO	2.37	2.37	.74	.74	.74	1.77	1.77	1.64	1.64	1.64	.91	.91
CaO	5.90	5.90	.60	.60	.60	.85	.85	3.50	3.50	3.50	.53	.53
Na_2O	1.67	1.67	1.85	1.85	1.85	2.82	2.82	1.52	1.52	1.52	1.84	1.84
K_2O	1.25	1.25	1.94	1.94	1.94	1.07	1.07	1.10	1.10	1.10	2.34	2.34
H_2O-, at 106°C	......	......	3.80	4.20	3.31	......	......	......	......	......	3.30	4.22
TiO_2	.46	.66	.48	1.52	.36	.52	.55	.46	.50	.60	.36	.24
Ignition loss	4.23	6.98	4.90	5.20	4.48	4.33	6.20	5.85	8.62	6.82	5.80	5.90
Total	99.26	97.90	98.21	101.79	101.94	99.61	97.64	100.46	96.78	99.74	97.01	96.02
Class	52,34,3	47,35,8	47,44,3	44,49,3	38,58,0	59,32,3	53,35,5	57,32,6	47,37,10	44,45,6	32,58,2	26,64,1

	134	135	136	137	138	139	140	141	142	143	144	*145
	33B45-80	33B45-81	33B45-15	33B45-16	33B45-49	33B45-50	33B45-51	33B45-52	33B45-53	33B45-54	33B45-55	33B45-143
SiO_2	68.06	69.41	63.24	63.10	69.56	67.23	67.89	68.09	66.61	68.74	71.53	67.05
Al_2O_3	14.15	12.98	17.49	18.18	13.30	14.25	13.75	13.67	12.92	15.81	10.74	11.78
Fe_2O_3	4.76	5.09	4.87	4.87	4.87	5.34	5.46	5.57	4.79	4.84	4.77	4.89
MgO	.91	.91	......	......	1.80	1.80	1.80	1.80	1.80	1.71	1.71	1.71
CaO	.53	.53	......	......	1.68	1.68	1.68	1.68	1.68	1.10	1.10	1.10
Na_2O	1.84	1.84	......	......	1.46	1.46	1.46	1.46	1.46	2.55	2.55	2.55
K_2O	2.34	2.34	......	......	1.18	1.18	1.18	1.18	1.18	1.01	1.01	1.01
H_2O-, at 106°C	2.99	2.99	......	......	......	......	......	......	......	......	......	......
TiO_2	.68	.92	.70	.75	.68	.63	.52	.55	.71	.75	.70	.66
Ignition loss	4.08	3.74	8.84	9.14	7.69	8.06	6.28	5.86	5.46	4.72	4.50	4.36
Total	100.34	100.75	95.14	96.04	102.22	101.63	100.02	99.86	96.61	101.23	98.61	95.11
Class	38,56,0	41,53,0	27,68,0	25,70,0	41,52,6	36,56,7	37,54,3	38,55,2	38,50,2	35,59,0	47,44,1	41,47,0

	146	147	148	149	150	151	152	153	154	155	156	157
	33B45-56	33B45-57	33B45-58	33B45-59	33B45-60	33B45-61	33B45-62	33B45-63	33B45-64	33B45-65	33B45-66	33B45-67
SiO_2	69.59	66.24	68.85	75.46	74.46	73.33	69.32	69.69	67.86	72.92	69.57	78.45
Al_2O_3	11.61	11.98	12.49	10.91	9.94	11.09	10.80	10.38	14.01	9.75	12.56	9.80
Fe_2O_3	4.63	4.76	5.56	4.53	4.41	4.40	4.83	4.40	5.23	5.34	5.20	3.71
MgO	1.71	1.71	1.71	1.66	1.66	1.66	1.66	1.66	1.66	1.10	1.10	1.10
CaO	1.10	1.10	1.10	1.22	1.22	1.22	1.22	1.22	1.22	.72	.72	.72
Na_2O	2.55	2.55	2.55	2.56	2.56	2.56	2.56	2.56	2.56	2.33	2.33	2.33
K_2O	1.01	1.01	1.01	1.37	1.37	1.37	1.37	1.37	1.37	1.38	1.38	1.38
TiO_2	.71	.63	.57	.58	.52	.47	.65	.73	.56	.74	.66	.51
Ignition loss	4.86	6.26	4.52	4.04	3.62	3.46	4.50	4.80	4.48	4.52	7.16	4.04
Total	97.77	96.24	98.36	102.33	99.76	99.56	96.91	96.81	98.95	98.80	100.68	102.04
Class	44,46,2	40,47,4	41,51,0	51,44,0	52,40,0	49,44,0	45,44,1	46,42,2	37,54,0	50,42,2	41,51,4	57,38,1

[1] Not inclnded in total.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

96-157. Stark County. Oligocene, White River formation. Town of South Heart, Little Badlands area. Clay. Trench samples. Uncombined silica present. Alumina content of clay beds given. Index maps. Generalized stratigraphic table.

96-112. Sec. 7, T. 137 N., R. 97 W. (Clarke, 1948, p. 19, 20, 6, 23, 30, figs. 1, 6.) Tests of water-softening properties.

96. Trench 80. Lab. No. 235.

97. Trench 80. Lab. No. 236.

98. Trench 80. Lab. No. 237.

99. Trench 80. Lab. No. 238.

100. Trench 80. Lab. No. 239.

101. Trench 81. Lab. No. 240.

102. Trench 81. Lab. No. 241.

103. Trench 81. Lab. No. 242.

104. Trench 82. Lab. No. 243.

105. Trench 82. Lab. No. 244.

106. Trench 82. Lab. No. 245.

107. Trench 82. Lab. No. 246.

108. Trench 82. Lab. No. 247.

109. Trench 82. Lab. No. 248.

110. Trench 83. Lab. No. 250.

111. Trench 83. Lab. No. 251.

112. Trench 83. Lab. No. 252.

113-119. Sec. 7, T. 137 N., R. 97 W. (Clarke, 1948, p. 20, 6, 23, 30, figs. 1, 6.) Tests of water-softening properties.

113. Trench 83. Lab. No. 253.

114. Trench 83. Lab. No. 253A.

115. Trench 84. Lab. No. 254.

116. Trench 84. Lab. No. 255.

117. Trench 84. Lab. No. 256.

118. Trench 84. Lab. No. 257.

119. Trench 84. Lab. No. 258.

120. Sec. 14, T. 138 N., R. 98 W. Trench 53. Lab. No. 13. (Clarke, 1948, p. 14, 6, 23, figs. 1, 6.) Clay.

121. Sec. 17, T. 138 N., R. 98 W. Trench 51. Lab. No. 141. (Clarke, 1948, p. 17, 6, 23, 26, 30, figs. 1, 6.) Clay. Tests for foundry sand binder, water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

122-126. Sec. 20, T. 138 N., R. 98 W. (Clarke, 1948, p. 17, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder, water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

*122. Trench 37. Lab. No. 130. (Analysis suggests 6.9 percent more CaO and MgO than required for carbonates; shows 2.9 percent alkalies.) (Probably bentonite) reported as clay.

123. Trench 37. Lab. No. 131.

124. Trench 52. Lab. No. 143.

125. Trench 52. Lab. No. 144.

126. Trench 52. Lab. No. 145.

North Dakota--Continued

127-135. Sec. 21, T. 138 N., R. 98 W. (Clarke, 1948, p. 17, 6, 10, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder, water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

127. Trench 38. Lab. No. 137. Detailed measured section.

128. Trench 38. Lab. No. 139. Detailed measured section.

129. Trench 39. Lab. No. 146.

130. Trench 39. Lab. No. 147.

131. Trench 39. Lab. No. 148.

132. Trench 50. Lab. No. 132.

133. Trench 50. Lab. No. 133.

134. Trench 50. Lab. No. 134.

135. Trench 50. Lab. No. 136.

136-137. Sec. 22, T. 138 N., R. 98 W. Trench 31. (Clarke, 1948, p. 14, 6, 23, figs. 1, 6.)

136. Lab. No. 19.

137. Lab. No. 21.

138-157. Sec. 22, T. 138 N., R. 98 W. (Clarke, 1948, p. 18, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder, water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

138. Trench 45. Lab. No. 178.

139. Trench 45. Lab. No. 179.

140. Trench 45. Lab. No. 180.

141. Trench 45. Lab. No. 182.

142. Trench 45. Lab. No. 183.

143. Trench 46. Lab. No. 184.

144. Trench 46. Lab. No. 185.

*145. Trench 46. Lab. No. 187. (Analysis shows 3.6 percent alkalies; suggests 3.0 percent more CaO and MgO than required for carbonates.) (Probably bentonite) reported as clay.

146. Trench 46. Lab. No. 188.

147. Trench 46. Lab. No. 189.

148. Trench 46. Lab. No. 190.

149. Trench 47. Lab. No. 191.

150. Trench 47. Lab. No. 192.

151. Trench 47. Lab. No. 193.

152. Trench 47. Lab. No. 195.

153. Trench 47. Lab. No. 196.

154. Trench 47. Lab. No. 197.

155. Trench 48. Lab. No. 200.

156. Trench 48. Lab. No. 201.

157. Trench 48. Lab. No. 202.

TABLE 5.—Analyses of samples from North Dakota containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	North Dakota										
	158	159	160	161	162	163	164	165	166	167	168
	33B45-68	33B45-69	33B45-70	33B45-71	33B45-72	33B45-73	33B45-74	33B45-75	33B45-76	33B45-77	33B45-144
SiO_2	73.13	71.75	73.43	66.41	70.41	72.16	68.43	70.92	68.33	73.69	63.70
Al_2O_3	6.69	6.75	12.60	14.51	11.02	9.45	10.40	11.82	10.16	6.84	11.82
Fe_2O_3	4.41	5.23	4.27	4.50	4.62	4.39	4.67	4.71	5.57	5.34	5.83
MgO	1.10	1.10	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	......
CaO	.72	.72	.66	.66	.66	.66	.66	.66	.66	.66	......
Na_2O	2.33	2.33	2.87	2.87	2.87	2.87	2.87	2.87	2.87	2.87	......
K_2O	1.38	1.38	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	......
TiO_2	.47	.52	.62	.69	.68	.62	.73	.70	.59	.49	.60
Ignition loss	7.84	6.80	4.60	4.88	4.80	5.24	6.14	4.68	7.24	6.26	18.00
Total	98.07	96.58	101.35	96.82	97.36	97.69	96.20	98.66	97.72	98.45	99.95
Class	56,34,4	54,35,4	46,48,1	36,54,0	46,44,2	51,39,4	45,43,4	45,47,1	44,45,4	56,35,4	36,63,0

	169	170	171	172	173	174	175	176	177	178
	33B45-88	33B45-89	33B45-87	33B45-33	33B45-34	33B45-35	33B45-36	33B45-37	33B45-38	33B45-39
SiO_2	71.01	68.60	68.70	67.60	64.73	71.16	70.50	71.81	69.80	67.40
Al_2O_3	14.41	14.15	15.50	10.62	12.34	9.77	12.35	8.34	10.70	11.56
Fe_2O_3	3.60	5.30	3.53	4.61	5.43	4.57	4.61	4.83	4.96	5.09
MgO	......	......	......	1.83	1.83	1.83	1.83	1.83	1.90	1.90
CaO	......	......	......	3.72	3.72	3.72	3.72	3.72	3.86	3.86
Na_2O	......	......	......	1.59	1.59	1.59	1.59	1.59	1.74	1.74
K_2O	......	......	......	1.23	1.23	1.23	1.23	1.23	1.28	1.28
TiO_2	.50	.65	.60	.71	.82	.54	.64	.52	.63	.76
Ignition loss	5.80	6.60	6.90	6.30	7.86	6.68	5.50	6.26	5.10	7.24
Total	95.32	95.30	95.23	98.21	99.55	101.09	101.97	100.13	99.97	100.83
Class	41,53,0	38,57,0	37,57,0	44,43,5	37,50,7	49,40,7	43,48,3	52,37,6	45,44,3	41,47,7

	179	*180	181	182	*183	184	185	*186	187	188
	33B45-40	33B45-140	33B45-41	33B45-42	33B45-141	33B45-43	33B45-44	33B45-142	33B45-45	33B45-46
SiO_2	70.02	66.01	68.31	68.82	65.59	69.12	67.18	66.76	68.61	66.51
Al_2O_3	10.91	12.36	11.20	10.89	13.04	12.80	9.84	13.69	13.56	12.47
Fe_2O_3	4.84	4.39	4.27	4.72	4.62	4.84	4.96	3.26	4.71	4.64
MgO	1.90	1.82	1.82	1.82	1.82	1.76	1.76	1.76	1.76	1.77
CaO	3.86	2.19	2.19	2.19	2.19	1.80	1.80	1.80	1.80	3.02
Na_2O	1.74	2.41	2.41	2.41	2.41	2.36	2.36	2.36	2.36	1.79
K_2O	1.28	1.26	1.26	1.26	1.26	1.12	1.12	1.12	1.12	1.24
TiO_2	.63	.54	.65	.67	.63	.62	.60	.67	.64	.78
Ignition loss	5.92	4.96	6.92	7.74	5.44	5.24	6.56	4.94	5.36	5.94
Total	101.10	95.94	99.03	100.52	97.00	99.66	[1] 96.18	96.36	99.92	98.16
Class	45,44,4	39,48,2	44,44,6	44,44,8	37,50,2	41,50,2	44,41,6	39,49,1	39,52,2	39,49,4

	189	190	191	192	193	194	195	196	197	198
	33B45-47	33B45-48	33B45-18	33B45-19	33B45-20	33B45-21	33B45-22	33B45-23	33B45-24	33B45-25
SiO_2	65.59	66.45	62.35	64.59	67.72	66.14	71.22	66.23	69.59	67.43
Al_2O_3	14.76	11.67	11.43	12.42	11.60	6.75	6.22	12.87	11.07	11.89
Fe_2O_3	4.74	5.11	5.32	4.61	4.73	4.04	5.46	5.20	4.57	4.84
MgO	1.77	1.77	2.28	2.01	2.01	2.01	1.97	1.97	2.18	2.18
CaO	3.02	3.02	4.89	1.65	1.65	1.65	1.41	1.41	1.63	1.63
Na_2O	1.79	1.79	1.43	1.96	1.96	1.96	1.67	1.67	1.31	1.31
K_2O	1.24	1.24	1.50	1.38	1.38	1.38	1.12	1.12	1.35	1.35
TiO_2	.60	.61	.63	.53	.67	.46	.62	.62	.67	.65
Ignition loss	5.78	6.16	9.22	7.96	7.04	14.27	8.10	7.02	7.20	6.40
Total	99.29	97.82	99.05	97.11	98.76	98.66	97.79	98.11	[2] 99.57	97.68
Class	34,56,2	40,47,4	36,47,11	37,49,7	42,46,6	50,38,7	54,34,7	38,51,5	45,44,7	41,47,5

	199	200	201	202	203	204	205	206	207	208
	33B45-26	33B45-17	33B45-90	33B45-91	33B45-92	33B45-93	33B45-94	33B45-95	33B45-96	33B50-1
SiO_2	69.14	69.99	66.60	70.55	66.53	66.89	69.13	69.20	65.98	75.37
Al_2O_3	10.47	8.22	16.83	16.42	18.35	18.12	17.78	16.00	17.15	11.25
Fe_2O_3	3.20	5.23	4.58	4.41	4.23	4.41	4.41	3.33	5.39	3.75
MgO	2.18	2.13	......	......	......	......	......	......	......	3.15
CaO	1.63	1.56	......	......	......	......	......	......	......	2.98
Na_2O	1.31	1.63	......	......	......	......	......	......	......	......
K_2O	1.35	1.12	......	......	......	......	......	......	......	......
TiO_2	.66	.52	.70	.65	.65	.65	.65	.60	.86	......
SO_3	......	......	......	......	......	......	......	......	......	.58
Ignition loss	5.88	6.84	6.71	6.65	5.44	5.84	5.20	6.20	5.68	......
Total	95.82	97.24	95.42	98.68	95.20	95.91	97.17	95.33	95.06	97.08
Class	47,39,5	50,37,7	32,63,0	37,61,0	29,65,0	30,65,0	33,64,0	37,58,0	30,65,0	51,42,0

[1] 96.81 in text.

[2] 98.57 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

158-199. Stark County. Oligocene, White River formation. Near town of South Heart, Little Badlands area. Clay. Trench samples. Uncombined silica present. Alumina content of clay beds. Index maps. Generalized stratigraphic table.

158-167. Sec. 22, T. 138 N., R. 98 W. (Clarke, 1948, p. 19, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

158. Trench 48. Lab. No. 203.

159. Trench 48. Lab. No. 204.

160. Trench 49. Lab. No. 205.

161. Trench 49. Lab. No. 206.

162. Trench 49. Lab. No. 207.

163. Trench 49. Lab. No. 208.

164. Trench 49. Lab. No. 209.

165. Trench 49. Lab. No. 210.

166. Trench 49. Lab. No. 211.

167. Trench 49. Lab. No. 212.

168-170. Sec. 22, T. 138 N., R. 98 W. (Clarke, 1948, p. 21, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Bleaching clay.

168. Trench 55. Lab. No. 316.

169. Trench 57. Lab. No. 326.

170. Trench 62. Lab. No. 343.

171. Sec. 23, T. 138 N., R. 98 W. Trench 54. Lab. No. 310. (Clarke, 1948, p. 21, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, water softener.

172-177. Sec. 28, T. 138 N., R. 98 W. (Clarke, 1948, p. 17, 6, 23, 28, 30, figs 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

172. Trench 40. Lab. No. 152.

173. Trench 40. Lab. No. 153.

174. Trench 40. Lab. No. 154.

175. Trench 40. Lab. No. 155.

176. Trench 40. Lab. No. 156.

177. Trench 41. Lab. No. 158.

178-190. Sec. 28, T. 138 N., R. 98 W. (Clarke, 1948, p. 18, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

178. Trench 41. Lab. No. 161.

179. Trench 41. Lab. No. 162.

*180. Trench 42. Lab. No. 164. (Analysis shows 3.7 percent alkalies; suggests 3.2 percent more CaO and MgO than required for carbonates.) (Probably bentonite) reported as clay.

181. Trench 42. Lab. No. 165.

182. Trench 42. Lab. No. 166.

North Dakota--Continued

*183. Trench 42. Lab. No. 167. (Analysis shows 3.7 percent alkalies; suggests 2.9 percent more CaO and MgO than required for carbonates.) (Probably bentonite) reported as clay.

184. Trench 42. Lab. No. 169.

185. Trench 43. Lab. No. 170.

*186. Trench 43. Lab. No. 171. (Analysis shows 3.5 percent alkalies; suggests 2.8 percent more CaO and MgO than required for carbonates.) (Probably bentonite) reported as clay.

187. Trench 43. Lab. No. 173.

188. Trench 44. Lab. No. 174.

189. Trench 44. Lab. No. 175.

190. Trench 44. Lab. No. 176.

191-199. Sec. 29, T. 138 N., R. 98 W. (Clarke, 1948, p. 17, 6, 23, 26, 30, figs. 1, 6.) Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

191. Trench 33. Lab. No. 116.

192. Trench 34. Lab. No. 120.

193. Trench 34. Lab. No. 121.

194. Trench 34. Lab. No. 122.

195. Trench 35. Lab. No. 124.

196. Trench 35. Lab. No. 125.

197. Trench 36. Lab. No. 127.

198. Trench 36. Lab. No. 128.

199. Trench 36. Lab. No. 129.

200. Stark County. White River formation. Sec. 30, T. 138 N., R. 98 W., near South Heart. Trench 32. Lab. No. 114. (Clarke, 1948, p. 17, 6, 11, 23, 26, 30, figs. 1, 6.) Clay. Trench sample. Uncombined silica present. Alumina content of clay beds. Index maps. Generalized stratigraphic table. Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, bleaching clay, water softener.

201-207. Stark County. White River formation. Sec. 32, T. 139 N., R. 97 W., near South Heart. (Clarke, 1948, p. 22, 6, 12, 23, 25-30, figs. 1, 6.) Clay. Trench samples. Uncombined silica present. Alumina content of clay beds. Index maps. Generalized stratigraphic table. Tests for foundry sand binder; water-softening properties. Possible use: Foundry sand binder, water-softener.

201. Trench 68. Lab. No. 367. Detailed measured section.

202. Trench 70. Lab. No. 376.

203. Trench 70. Lab. No. 377.

204. Trench 71. Lab. No. 379.

205. Trench 73. Lab. No. 386.

206. Trench 73. Lab. No. 387.

207. Trench 75. Lab. No. 365. Detailed measured section.

208. Walsh County. Upper Cretaceous, Pierre shale. (S½ sec. 2, T. 157 N., R. 57 W.) south branch of Park River. Analyst, Melsted. (Barry and Melsted, 1908, p. 180, 181.) Shale, weathered, stained yellow along seams. Small amount of sand. Detailed measured section. Possible use: Cement material.

TABLE 6.—Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position]

	South Dakota												
	1	*2	3	4	5	6	7	8	9	10	*11	12	13
	40B8-2	40B8-1	40B10-2	40B10-3	40B17-4	40B17-6	40B17-3	40B17-5	40B17-1	40B17-2	40B17-7	40B21-1	40B21-2
SiO_2	68.28	64.02	65.64	79.48	67.00	60.16	58.72	68.23	55.45	57.00	[1] 64.47	62.20	63.62
Al_2O_3	13.81	14.20	18.30	13.68	5.00	10.38	16.90	14.93	18.58	17.368	14.74	19.28	20.94
Fe_2O_3	......	......	5.46	.96	12.00	......	......	......	......	......	2.73	4.10	2.20
FeO	[2] 3.94	[2] 4.98	......	......	......	[3] 14.868	4.00	[3] 3.15	3.82	2.632	.78	......	......
MgO	1.82	2.14	.92	.30	......	1.714	2.56	.875	3.50	3.027	.29	2.34	1.76
CaO	1.38	1.54	.60	.30	......	4.96	4.06	2.93	3.40	3.00	4.00	1.26	.66
Na_2O	......	......	......	......	......	......	2.11	......	......	......	2.55	......	......
K_2O	......	......	......	......	......	......					3.31	......	......
H_2O+	......	......	......	......	15.00	......	......	......	[4] 5.35	[4] 5.85	4.78	......	......
H_2O-	......	......	1.39	.42			2.30	......			.93	2.20	1.22
TiO_3	......	......	......	......	......	......	......	......	......	......	.76	......	......
P_2O_5	......	......	......	......	......	......	......	......	......	......	.29	......	......
MnO	[2] .22	[2] 1.25	......	......	......	......	......	......	......	......	......	......	......
Mn_3O_4	......	......	.22	.18	......	......	......	......	......	......	......	.16	.24
SO_3	......	......	.17	.03	......	......	......	......	......	......	......	.02	.08
S	......	......	......	......	......	......	......	......	......	......	......	Tr.	......
BaO	......	......	......	......	......	......	......	......	......	......	.13	......	......
Ignition loss	5.60	6.73	5.85	4.38	......	7.20	8.10	6.20	8.80	9.50	......	5.99	6.85
Total	95.05	94.86	98.55	99.73	99.00	99.28	98.75	96.32	98.90	98.38	99.76	97.55	97.57
Class	44,42,4	39,43,7	27,70,0	54,44,0	45,54,0	25,67,2	29,53,8	38,53,4	23,57,13	26,54,12	35,52,1	23,70,0	24,70,2

	14	15	16	*17	18	19	*20	21	22	*23	24	25	*26
	40B24-2	40B24-3	40B32-1	40B41-1	40B41-2	40B43-1	40B43-2	40B43-4	40B43-5	40B43-3	40B43-8	40B43-7	40B43-12
SiO_3	54.01	54.75	62.04	67.23	58.32	58.9	61.30	63.10	63.66	62.22	66.36	64.62	45.62
Al_2O_3	19.20	20.74	15.94	16.10	8.59	15.2	16.91	15.14	15.93	15.26	15.18	16.40	10.30
Fe_2O_3	3.57	2.70	2.76	2.33	2.04	......	......	......	......	......	......	......	......
FeO	......	......	......	.36	.18	[2] 2.3	[2] 4.10	[2] 4.24	[2] 4.04	[2] 4.98	[2] 4.14	[2] 4.35	[2] 4.51
MgO	4.41	4.20	2.96	.74	3.65	2.2	2.57	2.19	2.40	2.30	2.08	2.12	1.94
CaO	1.91	1.00	2.56	.13	8.45	2.8	1.90	1.85	1.74	1.94	1.26	1.42	5.41
Na_2O	1.38	.76	1.36	.19	.72	......	......	......	......	......	......	......	......
K_2O	......	......	2.64	9.84	2.71	......	......	......	......	......	......	......	......
H_2O+	......	......	......	1.78	1.40	......	......	......	......	......	......	......	......
H_2O-	......	......	1.51	.56	.52	......	......	......	......	......	......	......	......
TiO_2	......	......	......	.60	.48	.60	......	......	......	......	......	......	......
P_2O_5	......	......	......	......	.05	[2] .34	......	......	......	......	......	......	......
MnO	......	......	[5] .24	......	.07	[2] 2.8	[2] .97	[2] 1.03	[2] .90	[2] 1.46	[2] .48	[2] .86	[2] 11.44
CO_2	......	......	......	......	12.08	......	......	......	......	......	......	......	......
SO_3	......	......	.12	......	.43	[6] .22	......	......	......	......	......	......	......
BaO	......	......	......	......	None	......	......	......	......	......	......	......	......
Cl	......	......	......	......	[7] Tr.	......	......	......	......	......	......	......	......
Ignition loss	16.91	16.48	7.76	......	......	11.5	7.33	7.87	7.23	7.68	6.94	6.38	16.32
Total	101.39	100.63	99.89	99.86	99.69	96.9	95.08	95.42	95.90	95.84	96.44	96.15	95.54
Class	16,71,13	15,74,11	31,56,6	36,52,0	41,30,24	32,49,10	31,51,6	36,46,8	36,48,7	35,46,8	40,46,6	36,50,5	27,38,14

	27	28	29	*30	31	32	33	34	35	36	37	38	39
	40B43-11	40B43-10	40B43-9	40B43-6	40B52-2	40B52-3	40B52-4	40B52-5	40B52-6	40B52-7	40B52-19	40B52-8	40B52-9
SiO_3	69.76	68.46	68.16	64.06	70.78	74.22	76.78	81.98	83.30	84.42	63.59	[3] 58.74	61.12
Al_2O_2	13.81	13.54	14.34	12.64	16.73	16.38	14.43	13.08	12.30	9.41	20.309	18.97	19.40
Fe_2O_3	......	......	......	......	2.78	1.95	.18	.21	.80	1.07	......	[3] 3.87	5.66
FeO	[2] 3.73	[2] 4.14	[2] 4.24	[2] 4.86	......	......	......	......	......	......	2.952	......	......
MgO	1.65	1.74	1.64	1.81	.90	Tr.	.95	.31	Tr.	.39	.612	1.62	1.93
CaO	1.13	1.26	1.34	2.55	.21	.40	2.18	1.46	1.30	Tr.	.52	.93	1.34
Na_2O	......	......	......	......	......	2.58	Tr.	Tr.	......	......	1.402	.58	......
K_2O	......	......	......	......	......							1.49	......
H_2O+	......	......	......	......	6.71	4.47	......	......	......	3.42	3.80	......	......
H_2O-	[9] (12.6)	[9] (13.1)	[9] (13.1)	......									
TiO_3	......	......	......	......	......	......	......	......	......	......	......	.71	......
P_2O_5	......	......	......	......	......	......	......	......	......	......	......	1.44	......
MnO	[2] .28	[2] .66	[2] .39	[2] 1.21	......	......	......	......	......	......	......	Tr.	......
SO_3	......	......	......	......	......	......	......	......	......	......	......	[6] .21	.44
Ignition loss	5.48	5.88	5.82	8.05	......	......	4.62	4.07	......	......	6.63	11.93	9.93
Total	95.84	95.68	95.93	95.18	98.11	100.00	99.14	[10] 101.11	[11] 97.70	98.71	99.82	[8] 100.49	99.82
Class	45,42,4	45,41,5	43,43,5	42,39,8	38,59,2	43,54,0	51,44,2	59,40,2	61,38,0	67,32,1	28,66,2	21,71,3	20,73,6

See following page for footnotes.

Spectrographic analysis of sample 20

CaO	0.01	TiO_2	0.02-0.2	V_2O_5	0.003-0.03	NiO	0.01

[1] SiO_2, 54.47 percent; total, 89.76 reported by Connolly and O'Harra (1929, p. 336).
[2] Calculated from reported Fe, Mn, or P.
[3] Reported as Fe_2O_2 by Vaughan (1902, p. 933). (Used as Fe_2O_3 in calculations and classification.)
[4] Reported as volatiles.
[5] Reported as Mn_3O_4.
[6] Reported as S.
[7] Reported as strong trace.
[8] SiO_2, 58.47 percent; Fe_2O_3, 3.89 percent; total, 100.24 reported by O'Harra and others (1908, p. 40).
[9] Not included in total.
[10] 100.86 in text.
[11] 99.40 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

South Dakota

1-2. Brule County. Upper Cretaceous, Pierre shale, Sully member, Agency-Oacoma zone. Sec. 19, T. 105 N., R. 70 W. (Pesonen and others, 1949, p. 49, 41, 42, 87, figs. 1, 2, 12, 15, 18.) Shale, from wall of DH-143. Estimated tonnage. Overburden. Index and outcrop maps; generalized stratigraphic table, correlated columnar sections. Calculated mineral analyses.
- 1. Lab. No. S23. Depth about 59 ft 11 in.
- *2. Lab. No. S21. (Analysis suggests 4.98 percent FeO, 1.25 percent MnO.) Depth about 59 ft 5 in.

3-4. Butte County. Lower Cretaceous, Fuson shale. (T. 8 N., R. 2 E.), 3 miles south of town of Belle Fourche. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 308, 307.) Use: Brick.
- 3. Clay, grab sample of ground clay at brick plant.
- 4. Clay, dark-gray; 2 ft bed.

5. Custer County. Lower Oligocene, Chadron formation (A. F. Agnew, written communication, 1957). (T. 4 S., R. 8 E.) town of Fairburn. Analyst, Bodenner. (Vaughan, 1902, p. 933.) Fuller's earth.

6. Custer County. (Chadron formation.) Fairburn. Analyst, Flinterman. (Ries, 1898, p. 335; Vaughan, 1902, p. 933.) Fuller's earth. Possible use: Clarifying oil.

7-10. Custer County. (Chadron formation.) (Ries, 1898, p. 335.) (Analyses reported in the following publications: Vaughan, 1902, p. 933; Great Britain, Imp. Min. Res. Bur., 1920, p. 11; O'Harra, 1920, p. 62; Connolly and O'Harra, 1929, p. 317. Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature.) Fuller's earth. Possible use: Clarifying oil.
- 7. Southeast of Fairburn. Analyst, Riederer.
- 8. Bodenner's pit, north of Fairburn. Analyst, Flinterman.
- 9. (T. 6 S., R. 4 E.) town of Argyle. Analyst, Flinterman.
- 10. Argyle. Analyst, Flinterman.

*11. Custer County. (Chadron formation. T. 6 S., R. 4 E.) 3 miles west of Argyle. Analyst, Steiger. Lab. No. 1875. (Darton, 1901, p. 544; Connolly and O'Harra, 1929, p. 336, 333, 335.) (Analysis shows 5.9 percent alkalies; suggests 4.0 percent more CaO than required for carbonate.) Volcanic ash, 3 ft thick; estimated tonnage. Possible use: Abrasive soaps, polishing and abrasive powders.

12. Dewey County. Upper Cretaceous, Hell Creek formation, T. 17 N., R. 22 E., (Searight, 1930, p. 26, 33) town of Isabel, Robbins mine. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 312.) Clay, associated with lignite beds.

13. Dewey County. Probably Hell Creek formation (E. P. Rothrock, written communication, 1955). (T. 17 N., R. 23 E.), Warner mine. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 312.) Clay, associated with lignite beds.

14-15. Fall River County. Pierre shale, Ardmore bed. SE¼ sec. 32, T. 9 S., R. 6 E. Analyst, Frary. (Spivey, 1940, p. 51, 31, 32, 52, pls. 1, 4, 5.) Base exchange capacity. Index maps, outcrop map; measured section, generalized columnar section, detailed columnar section; structural cross section.
- 14. Lab. No. 1. Bentonite, dark bluish-gray; pH 8.1.
- 15. Lab. No. 2. Bentonite, light-yellow; pH 4.2.

16. Harding County. Upper Cretaceous, Lance formation, Ludlow lignitic member. SE¼ sec. 22, T. 19 N., R. 8 E., (Searight, 1930, p. 29) Hodge mine. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 312.) Clay, associated with lignite beds.

*17. Lawrence County. Upper Cambrian, Deadwood formation. (T. 5 N., R. 2 E.) near town of Trojan, Mogul mine. Analyst, Ellestad. (Schwartz, 1935, p. 528.) (Analysis shows 10.0 percent alkalies.) Shale, light-gray; unaltered. Analysis of silicified shale also given. Bulk density, 2.553; porosity, 1.4 percent.

18. Lawrence County. Triassic(?), Spearfish formation. (T. 6 N., R. 2 E.) east of town of Spearfish. Analyst, Steiger. Lab. No. 55. (Richardson, 1903, p. 380, 367, 378.) Shale, red, sandy. Geologic map, measured section. Photomicrographs. Average mineral composition.

19. Lyman County. Pierre shale, Sully member, Oacoma zone. T. 104 N., R. 72 W., 8 miles west of town of Chamberlain. (Dupuy and others, 1946, p. 13, 4, 12, figs. 1-3.) Bentonitic shale with manganese nodules, very compact, fine-grained. Index and outcrop maps; generalized columnar section. Mineralogy. (For related analyses see samples 10-23, group Mn of this compilation.)

*20. Lyman County. Pierre shale, Sully member, Agency-Oacoma zone. Sec. 6, T. 104 N., R. 71 W. Lab. No. S70a. (Pesonen and others, 1949, p. 49, 41, 42, 50, 87, figs. 1, 2, 9, 15.) (Analysis suggests 4.10 percent FeO, 0.97 percent MnO.) Shale, DH-104; depth 71 ft 2 in. Analysis of shale envelope of concretion. Estimated tonnage. Overburden. Index and outcrop maps, generalized stratigraphic table. Calculated mineral analysis.

21-26. Lyman County. Pierre shale, Sully member, Agency-Oacoma zone. (Pesonen and others, 1949, p. 49, 41, 42, 87, figs. 1, 2, 11, 15, 18.) Shale. Estimated tonnage. Overburden. Index and outcrop maps, generalized stratigraphic table. Calculated mineral analyses.
- 21-24. Sec. 34, T. 104 N., R. 72 W. Shale, DH-167. Correlated columnar sections.
  - 21. Lab. No. S29. Depth about 64 ft 3 in., just under soft concretions.
  - 22. Lab. No. S30. Depth about 64 ft 3 in., same layer as soft concretions.
  - *23. Lab. No. S27. (Analysis suggests 4.98 percent FeO, 1.46 percent MnO.) Depth 64 ft 3 in., just above soft concretions.
  - 24. Lab. No. S31. Depth 63 ft 8 in., 7 inches above soft concretions.
- 25-26. Sec. 36, T. 104 N., R. 74 W. Shale, DH-190.
  - 25. Lab. No. S66a. Depth 64 ft 5 in. Analysis of shale envelope of soft concretion.
  - *26. Lab. No. S75a. (Analysis suggests 11.4 percent MnO, 4.51 percent FeO.) Depth 57 ft 10 in. to 60 ft 5 in. Analysis of shale envelope of white concretion.

27-29. Lyman County. Pierre shale, Sully member, Agency-Oacoma zone. Sec. 26, T. 104 N., R. 74 W. (Pesonen and others, 1949, p. 50, 41, 42, 87, figs. 1, 2, 11, 15.) Shale, light-gray, compact; DH-193. Estimated tonnage. Overburden. Index and outcrop maps, generalized stratigraphic table. Calculated mineral analyses.
- 27. Lab. No. S95. Depth 44.4-46.7 ft.
- 28. Lab. No. S94. Depth 36.8-38.8 ft.
- 29. Lab. No. S93. Depth 29.0-31.4 ft.

*30. Lyman County. Pierre shale, Sully member, Verendrye zone. Sec. 36, T. 104 N., R. 74 W. Lab. No. S64a. (Pesonen and others, 1949, p. 65, 41, 42, 87, figs. 1, 2, 11, 15.) (Analysis suggests 4.86 percent FeO, 1.21 percent MnO.) Shale, DH-191; depth 25-30 ft. Estimated tonnage. Overburden. Index and outcrop maps, generalized stratigraphic table. Calculated mineral analysis. (For another analysis from DH-191 see sample 25, group Mn of this compilation.)

31-32. Pennington County. Fuson shale (A. F. Agnew, written communication, 1957). (T. 1 N., R. 7 E.), Rapid City, Rapid City Steam Brick Works.
- 31. (Ries, 1895, p. 572, 573.) Shale clay. Use: Terra cotta.
- 32. (Ries, 1895, p. 568, 569.) Shale, soft. Use: Brick.

33-35. Pennington County. Fuson shale. Rapid City. Analyst, Slagle. (Todd, 1902, p. 104, 103.) Clay, light-gray, compact; conchoidal fracture. Possible use: Refractories.

36. Pennington County. Probably Fuson shale. Rapid City, Rapid City Steam Brick Works. (Ries, 1895, p. 558, 559.) Fire clay, hard. Use: Refractories.

37. Pennington County. Upper Cretaceous, Benton shale. Rapid City. Analyst, Smith. (Ries, 1897, p. 1164.) Clay.

38-39. Pennington County. Upper Cretaceous, Graneros shale. Near Rapid City.
- 38. Analyst, Coolbaugh. (O'Harra and others, 1908, p. 17.) Shale, black, fine, fissile; occasional layers of sandstone near lower part of bed. Use: Cement material.
- 39. Lab. No. 5. (O'Harra, 1924, p. 63, 64.) Shale. General remarks: Black, fine, fissile; 150-300 ft thick. Possible use: Portland cement material.

TABLE 6.— Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	South Dakota											
	40	41	42	43	44	45	46	47	48	49	50	51
	40B52-10	40B52-11	40B52-12	40B52-13	40B52-14	40B52-16	40B52-17	40B52-18	40B52-52	40B67-31	40B67-1	40B67-2
SiO_2	[1] 61.38	[1] 63.31	[1] 63.72	65.56	65.90	57.12	58.06	60.00	61.20	60.98	57.98	61.53
Al_2O_3	17.10	15.04	13.51	17.48	17.44	17.74	19.26	17.96	18.75	16.84	18.26	20.74
Fe_2O_3	......	......	......	4.48	4.20	7.36	5.10	5.24	4.39	3.20	4.57	4.01
FeO	4.95	4.88	2.96	......	......	......	......	......	.73	......	......	......
MgO	Tr.	Tr.	Tr.	1.35	1.40	2.56	2.53	1.70	1.06	1.69	1.83	1.72
CaO	.53	.24	Tr.	.29	.49	1.94	.94	1.74	.37	1.84	1.75	5.28
Na_2O	......	......	......	......	......	......	......	......	1.59	......	......	2.29
K_2O	......	......	......	......	......	......	......	......	3.83	......	......	
H_2O+	......	......	......	......	......	......	......	......	2.73	......	[2] 12.08	......
H_2O-	[3] 9.78	[3] 9.46	[3] 4.62	......	......	......	......	......		5.14	......	......
TiO_2	.25	.75	.33	......	......	......	......	......	.58	......	......	......
P_2O_5	Nil	Nil	Tr.	......	......	......	......	......	.09	......	......	......
MnO	......	......	......	......	......	[4] .86	......	......	.06	......	......	......
SO_3	Tr.	Nil	Tr.	.32	.43	.59	.99	2.40	......	None	1.28	......
S	......	......	......	......	[5] .02	......	......	......	......	......	......	1.26
Ignition loss	5.48	6.14	14.76	9.70	[6] 10.97	10.50	10.63	9.30	4.72	[7] 7.53	......	[8] 3.09
Total	99.47	99.82	[9] 99.90	99.18	100.85	98.67	97.51	98.34	100.10	97.22	97.75	[10] 99.92
Class	31, 62, 1	37, 57, 0	40, 53, 0	30, 66, 3	30, 66, 4	17, 71, 9	18, 72, 6	22, 67, 4	23, 64, 3	28, 64, 5	21, 72, 5	20, 66, 7

	Wyoming											
	52	53	*54	55	56	57	58	*59	60	*61	*62	*63
	49B1-3	49B1-22	49B7-2	49B11-2	49B11-3	49B12-12	49B12-1	49B12-18	49B12-2	49B12-49	49B12-19	49B12-50
Insoluble	......	......	......	......	......	72.2	[11] (80.3)	[11] (74.7)	[11] (73.5)	[11] (62.7)	[11] (44.0)	[11] (48.9)
SiO_2	59.78	67	67.98	63.60	67.10	......	69.28	61.56	61.56	55.29	39.08	44.45
Al_2O_3	15.10	16	15.01	14.66	10.26	9.72	10.1	9.8	9.7	4.2	5.6	3.0
Fe_2O_3	2.40		3.46	7.44	2.52	1.7	3.1	4.6	3.1	3.4	2.7	2.6
FeO	......	......	.26	......	.31	......	......	......	......	......	......	......
MgO	[12] 4.14	......	.59	.46	1.24	......	1.4	.87	3.0	.80	3.7	.64
CaO	.73	1	3.69	.78	5.88	......	2.60	.64	4.96	9.1	16.32	12.7
Na_2O	......	2.8	3.98	.37	1.42	......	.35	.24	.17	.59	.45	.30
K_2O	......	5	1.57	1.79	2.68	......	4.50	5.03	4.63	3.96	2.25	2.73
H_2O+	16.26	[15] 8.2	[13] 1.33	......	5.09	......	[14] 3.45	[14] 10.92	[14] 3.82	[14] 8.34	[14] 8.77	[14] 14.62
H_2O-			[13] 1.90	[16] 2.86		......	.75	1.58	.78	2.36	1.53	3.88
TiO_2	......	......	.50	......	......	......	.18	.11	.16	.45	.24	.40
P_2O_5	......	......	.00	......	.11	2.8	.67	.44	.3	5.0	7.5	8.1
CO_2	......	......	......	......	3.67	......	2.3	.3	6.1	.8	8.0	1.1
MnO	......	......	[17] .0	.20	......	......	......	......	......	......	......	......
SO_3	......	......	.06	.53	......	......	1.1	3.7	1.5	3.1	2.8	4.5
V_2O_5	......	......	[17] .0	......	......	......	.08	.19	.04	.36	.09	.35
F	......	......	......	......	......	......	.25	.29	.19	.77	.91	.83
Chem. U	......	......	......	......	......	......	.001	.001	.001	.003	.005	.006
Ignition loss	......	......	......	7.64	......	6.44	[11] (6.5)	[11] (12.8)	[11] (10.7)	[11] (11.5)	[11] (18.3)	[11] (19.6)
Subtotal	......	......	......	......	......	......	100.111	100.271	100.011	98.523	99.945	100.21
Less O[18]	......	......	......	......	......	......	.11	.12	.08	.32	.38	.35
Total	[19] 98.41	100	[20] 100.33	100.33	100.28	92.9	100.0	100.2	99.9	98.2	99.6	99.9
Class	30, 63, 0	40, 51, 0	38, 51, 0	29, 66, 2	46, 39, 8	(53, 37) 0	48, 39, 5	39, 49, 1	41, 38, 13	44, 28, 2	26, 31, 16	36, 31, 2

See following page for footnotes.

Semiquantitative spectrographic analyses

[A = more than 10 percent; B = 1-10 percent; D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Co, Ga, As, Cd, Sb, Ta, W, Pt, Au, Hg, and Bi looked for in all samples except 57, but not detected. Sc, Co, Ge, As, Rb, Y, Cd, In, Sb, Cs, La, Ce, Nd, Ta, W, Re, Pt, Hg, Tl, Bi, and Th looked for in sample 57 but not detected]

	57	58	59	60	61	62	63
Be	ND	ND	ND	ND	ND	ND	G
B	F	E	E	E	E	F	E
Na	D	......	......	......	......	......	......
Mg	D	......	......	......	......	......	......
Si	A	......	......	......	......	......	......
Ca	B	......	......	......	......	......	......
Ti	D	......	......	......	......	......	......
V	E	......	......	......	......	......	......
Cr	E	E	E	E	E	E	D
Mn	E	E	F	F	F	E	E
Ni	F	E	F	E	E	E	E

Semiquantitative spectrographic analyses--Continued

	57	58	59	60	61	62	63		57	58	59	60	61	62	63
Cu	F	G	G	G	G	G	F	Mo	ND	F	E	E	E	E	E
Zn	F	ND	ND	ND	E	E	E	Ag	G	G	G	G	G	G	F
Sr	D	E	E	E	E	F	E	Sn	F	ND	ND	ND	ND	ND	ND
Zr	E	E	E	E	E	E	E	Ba	F	E	E	E	E	E	E
Cb	ND	E	E	E	E	E	ND	Pb	E	ND	ND	ND	E	ND	E

[1] Reported as insoluble; insoluble mainly silica, but contains some iron, aluminum, and titanium oxides.
[2] Reported as water and organic.
[3] At 105° C.
[4] Reported as MnO_2.
[5] Not reported by O'Harra (1924, p. 63).
[6] Reported as 1.70 percent, 600° -1,000° C.; 9.27 percent, at 400° C.
[7] Reported as volatiles.
[8] Reported as carbonic acid.
[9] 99.80 in text.
[10] Organic and undetermined, 0.08 percent.
[11] Not inclnded in total.
[12] Reported as oxide of manganese by Knight (1893, p. 193).
[13] H_2O+ above 110° C.; H_2O- at 110° C.
[14] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[15] By difference.
[16] At 100° C.
[17] Reported as ppm, V_2O_5 reported as V.
[18] (Calculated by compilers from F.)
[19] 98.51 (Darton and Siebenthal, 1909, p. 59).
[20] Not included in total; Co, 10.0 ppm; Ni, 29.4 ppm; Se, 175.0 ppm.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

South Dakota--Continued

40-44. Pennington County. Upper Cretaceous, Graneros shale. (T. 1 N., R. 7 E.) near Rapid City.
- 40. Lab.No.12. (Waterman, 1927, p.168,166,169,170.) Shale, dark-gray to nearly black; weathers and erodes easily. Analysis an average of triplicate determinations, percentages on wet basis, chemical analysis on moisture-free basis also given. Results of distillation assays for oil. Kerogen present; also traces of zirconium, sodium, and potassium. Use: Not enough oil present to be economically important.
- 41. Information as in sample 40. Lab. No. 11.
- 42. Information as in sample 40. Lab. No. 2. Shale, 5 ft thick. Results of ignition also given.
- 43. Lab. No. 1. (O'Harra, 1924, p. 63, 64.) General remarks: Shale, black; 400-500 ft thick. Possible use: Portland cement.
- 44. Rex brick plant. Analyst, Bentley. Lab. No. 2. (O'Harra, 1924, p. 63, 62; Connolly and O'Harra, 1929, p. 310.) General remarks: Shale, black, fine, fissile; 150-300 ft thick. Use: Brick.

45-47. Pennington County. Upper Cretaceous, Pierre shale. (T. 1 N., R. 8 E.) about 3 miles east of Rapid City. (O'Harra, 1924, p. 63, 62.) General remarks: Shale, almost all black; weathers lighter. Lime and lime-iron concretions abundant at several horizons. Possible use: High-grade cement material.
- 45. Lab. No. 17.
- 46. Lab. No. 10.
- 47. Lab. No. 13.

48. Pennington County. Upper Cretaceous (Fox Hills sandstone) reported as Interior formation. (T. 3 S., R. 13 E.) 2 miles north of town of Scenic. Analyst, Phillips. (Wanless, 1923, p. 196, fig. 2.) Clay, blue and lavender; fossils, banded iron concretions, and calcareous cone-in-cone concretions. Generalized columnar sections.

49. Yankton County. Pierre shale, Sharon Springs member. NE¼NE¼ sec. 17, T. 93 N., R. 56 W., in quarry of abandoned cement plant. (Simpson, 1954, p. 64, 1-6, 61, 142.) Shale, medium dark-gray; 11 ft thick. Trench sample, representative of formation. In lower part, much disseminated bentonite, very few layers; in upper part, bentonite in beds, small amount of disseminated bentonite. Small siliceous concretions common in upper 2 ft locally. Index map, geologic map; detailed stratigraphic section.

50. Yankton County. Pierre shale. (T. 93 N., R. 55 W.) town of Yankton, Western Portland Cement Co. (Lewis, 1898, p. 97; Eckel, 1913, p. 329.) Clay. Use: Portland cement material.

51. Yankton County. Pierre shale. Yankton, Western Portland Cement Co. (Smith, 1893, p. 52; Eckel, 1905, p. 301; Lincoln, 1927b, p. 37.) Clay. Use: Portland cement material.

Wyoming

52. Albany County. Upper Cretaceous, Benton shale. NW¼ sec. 30, T. 22 N., R. 75 W., Taylor mine. (Knight, 1893, p. 193; Darton and Siebenthal, 1909, p. 59; Osterwald and Osterwald, 1952, p. 12, 11.) Bentonite or fire clay; 4-5 ft thick. Generally overlain by 20 ft of very dark shale containing concretions. Bulk density 2.18. Outcrop map. Use: Drilling mud, binder, filler for dams, paper manufacture, adulterant, retarder. Possible use: Medium-grade firebrick.

Wyoming--Continued

53. Albany County. Tertiary or Quaternary. NW¼ sec. 6, T. 13 N., R. 73 W., 1 mile northeast of Sportsman Lake. (Darton and Siebenthal, 1909, p. 65.) Volcanic ash, pure white, massive, fine-grained, soft. Measured section.

*54. Fremont County. Middle or Upper Eocene. Secs. 2, 3, 10, or 11, T. 39 N., R. 91 W., Lysite area. Analyst, Gilbert. (Beath and others, 1946, p. 12.) (Analysis shows 5.6 percent alkalies; 4.3 percent more CaO and MgO than required for carbonates.) Tuff, green, bed 3. Mineralogy. Glass partly devitrified.

55. Laramie County. Graneros shale. (Probably T. 19 N., R. 70 W.) near Bradley Station. Analyst, Phillips. (Ball, 1907, p. 242.) Shale, composite sample; middle 40 ft of 140 ft exposure. Lower 115 ft dark gray, slightly plastic; almost no grit. Possible use: Cement material.

56. Laramie County. Pleistocene. (T. 14 N., R. 66 W.) town of Cheyenne. Analyst, Eakins. (Emmons and others, 1896, p. 263.) Loess, surface sample.

57. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 13, T. 25 N., R. 118 W. Lab. No. RAH-47-47. (McKelvey and others, 1953, p. 24, 2, 27, pl. 1.) Mudstone, calcareous; trench sample. Bed P-67, 1.4 ft thick, 36.9 ft below top of member. Index and outcrop map, generalized columnar section.

58-63. Lincoln County. Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall; spectrographic analyst, Mortimer. Mudstone. Modal grain size, trench samples. Index map, outcrop map; generalized columnar section, detailed columnar section. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)
- 58-62. (McKelvey and others, 1953, p. 15, 19, 2, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, pl. 1.)
  - 58. Lab. No. VEM-2-47. Grayish-brown. Bed P-2, 1.4 ft thick, 142.15 ft from top of member.
  - *59. Lab. No. VEM-4-47. (Analysis shows 5.3 percent alkalies; suggests 2.8 percent SO_3 not used in gypsum, 1.3 percent gypsum, 1.1 percent phosphate.) Dusky-brown. Bed P-4, 0.6 ft thick, 141.05 ft from top of member.
  - 60. Lab. No. VEM-5-47. Grayish-brown. Bed P-5, 0.5 ft thick, 140.55 ft from top of member.
  - *61. Lab. No. 2064. (Analysis suggests 11.9 percent phosphate, 6.7 percent gypsum; shows 4.6 percent alkalies.) Brownish-black. Bed P-7, 0.5 ft thick, 137.45 ft from top of member.
  - *62. Lab. No. VEM-7-47. (Analysis suggests 17.8 percent phosphate, 6.0 percent gypsum; shows 2.7 percent alkalies.) Brownish-black, contains pellets. Bed P-10, 0.4 ft thick, 135.25 ft from top of member. (See samples 50 and 51, group P, for analyses of the adjoining bed and of the composite of the two beds.)
- *63. Lab. No. 2086. (McKelvey and others, 1953, p. 14, 18, 2, 22, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) (Analysis suggests 19.2 percent phosphate, 1.6 percent SO_3 not used in gypsum; shows 3.0 percent alkalies.) Mudstone and phosphate rock, brownish-black. Bed P-33, 0.8 ft thick, 109.95 ft from top of member.

TABLE 6.—Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Wyoming												
	*64	*65	*66	*67	*68	*69	*70	*71	*72	*73	*74	*75	*76
	49B12-16	49B12-17	49B12-20	49B12-21	49B12-22	49B12-23	49B12-24	49B12-25	49B12-26	49B12-27	49B12-28	49B12-29	49B12-30
Insoluble [1]	(47.2)	(48.2)	(35.23)	(42.4)	(65.1)	(73.0)	(57.9)	(46.66)	(65.75)	(56.38)	(59.32)	(54.7)	(56.8)
SiO_2	36.80	36.80	29.90	35.28	53.23	59.80	48.07	37.36	52.58	45.64	47.18	47.41	47.21
Al_2O_3	8.5	7.9	8.5	8.0	10.3	9.3	9.2	7.1	9.7	9.6	8.6	9.7	8.8
Fe_2O_3	2.5	2.5	2.6	2.6	3.4	2.8	3.6	3.3	4.4	4.0	3.4	3.0	2.5
MgO	1.5	1.9	.80	1.2	.48	2.4	.53	1.4	2.9	2.7	1.9	2.21	4.2
CaO	20.00	18.40	24.40	22.2	9.48	5.40	13.20	15.60	4.20	4.20	8.40	15.40	13.40
Na_2O	.87	1.44	1.02	1.20	1.20	1.50	1.30	1.27	1.30	.99	1.25	.62	.84
K_2O	3.27	2.62	1.95	2.14	2.62	2.30	2.38	2.11	2.85	2.78	2.12	2.45	2.43
H_2O+ [2]	6.50	6.34	9.18	6.88	8.20	5.31	8.45	10.63	10.68	16.98	11.19	5.14	3.58
H_2O-	.20	1.06	1.62	1.32	1.41	.99	1.33	.37	.32	.52	.51	.86	.62
TiO_3	.34	.28	.38	.38	.61	.42	.48	.28	.36	.23	.52	.10	.42
P_2O_5	12.33	10.75	12.38	9.97	6.02	.76	8.31	6.30	.05	.20	2.73	2.16	4.04
CO_2	3.5	4.3	5.1	6.1	.59	5.1	.52	6.4	5.6	5.1	5.0	10.5	10.0
SO_3	1.8	1.8	2.2	2.0	1.6	.90	1.6	9.4	8.4	10.6	8.6	1.0	.90
V_2O_5	.07	.05	.08	.03	.06	.08	.08	.14	.37	1.45	.52	.05	.05
F	1.1	1.1	1.3	1.1	.57	.09	.80	.67	.08	.23	.44	.31	.45
Se	......	......	......	......	......	......	......	.009	.010	.015	.015	......	......
Chem. U	.002	.002	.002	.002	.001	.0005	.002	.002	.0005	.001	.002	.000	.0001
Ignition loss [1]	(10.2)	(11.7)	(15.9)	(14.3)	(10.2)	(11.4)	(10.3)	(17.4)	(16.6)	(22.6)	(16.7)	(16.5)	(14.2)
Subtotal	99.28	97.24	101.41	100.40	99.77	97.1505	99.852	102.341	103.8005	105.236	102.377	100.910	99.4401
Less O [3]	.46	.46	.55	.46	.24	.04	.34	.28	.03	.10	.19	.13	.19
Total	98.8	96.8	100.9	99.9	99.5	97.1	99.5	102.1	103.8	105.1	102.2	100.8	99.3
Class	19,36,7	20,35,9	12,40,11	18,36,13	31,45,1	40,38,11	28,43,1	21,33,9	30;45,9	24,50,8	28,40,7	27,39,23	29,34,21

Semiquantitative spectrographic analyses

[D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Co, Ga, As, Sb, Ta, W, Pt, Au, Hg, and Bi looked for but not detected]

	64	65	66	67	68	69	70	71	72	73	74	75	76
Be	ND	ND	ND	ND	ND	ND	G	G	ND	G	G	ND	ND
B	F	F	E	E	E	E	E	E	E	D	E	F	F
Cr	E	E	D	D	E	E	D	D	E	D	E	E	E
Mn	F	F	E	E	E	E	E	E	E	E	E	E	E
Ni	E	E	E	E	E	E	E	E	E	D	E	E	E
Cu	G	G	G	G	G	G	F	F	G	F	F	G	G
Zn	E	E	E	E	ND	ND	F	E	E	E	E	ND	ND
Sr	ND	ND	E	E	ND	ND	E	F	ND	F	F	ND	ND
Zr	F	E	E	E	E	E	E	E	E	E	E	E	E
Cb	ND	ND	E	D	E	E	ND	ND	E	ND	ND	E	E
Mo	F	F	F	F	F	ND	F	E	E	D	E	F	F
Ag	G	G	G	G	ND	ND	G	G	G	G	G	ND	ND
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	ND	ND	E	E	E	E	E	E	E	E	E	E	E
Pb	ND	ND	ND	ND	ND	ND	E	E	ND	E	E	ND	ND

[1] Not included in total.

[2] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)

[3] (Calculated by compilers from F.)

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

64-76. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Modal grain size, trench samples. Index map, outcrop map; generalized columnar section, detailed columnar section. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

*64. Lab. No. LES-5-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) (Analysis suggests 29.2 percent phosphate, 3.9 percent gypsum; shows 4.1 percent alkalies.) Phosphatic mudstone, brownish-gray, contains pellets. Bed P-39, 0.6 ft thick; 105.05 ft from top of member.

*65. Lab. No. LES-7-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) (Analysis suggests 25.5 percent phosphate, 3.9 percent gypsum; shows 4.1 percent alkalies.) Phosphatic mudstone, brownish-gray. Bed P-41, 3.8 ft thick, 98.25 ft from top of member.

*66. Lab. No. VEM-32-47. (McKelvey and others, 1953, p. 13, 17, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 29.3 percent phosphate, 4.7 percent gypsum; shows 3.0 percent alkalies.) Phosphatic mudstone, brownish-gray, contains incipient pellets. Bed P-63, 2.0 ft thick, 65.85 ft from top of member.

*67. Lab. No. VEM-34-47. (McKelvey and others, 1953, p. 13, 17, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 23.6 percent phosphate, 4.3 percent gypsum; shows 3.3 percent alkalies.) Phosphatic mudstone and calcareous phosphatic mudstone; brownish-gray, contains incipient pellets. Bed P-65, 3.0 ft thick, 62.15 ft from top of member.

*68. Lab. No. VEM-36-47. (McKelvey and others, 1953, p. 13, 17, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 14.3 percent phosphate, 3.4 percent gypsum; shows 3.8 percent alkalies.) Mudstone, brownish-gray. Bed P-67, 0.5 ft thick, 59.35 ft from top of member.

*69. Lab. No. VEM-37-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis shows 3.8 percent alkalies; suggests 1.9 percent gypsum, 1.8 percent phosphate.) Mudstone, brownish-gray. Bed P-68, 1.4 ft thick, 57.95 ft from top of member.

*70. Lab. No. VEM-38-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis suggests 19.7 percent phosphate, 3.4 percent gypsum; shows 3.7 percent alkalies.) Phosphatic mudstone, brownish-gray, contains incipient pellets. Bed P-69, 1.5 ft thick, 56.45 ft from top of member.

*71. Lab. No. VEM-40-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis suggests 20.2 percent gypsum, 14.9 percent phosphate; shows 3.4 percent alkalies.) Mudstone, grayish-black. Bed P-71, 1.05 ft thick, 54.30 ft from top of member.

*72. Lab. No. VEM-41-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis suggests 12.7 percent gypsum, 2.5 percent more SO_3 than required for gypsum; shows 4.2 percent alkalies.) Mudstone, grayish-black. Contains pyrite. Bed P-72, 0.9 ft thick, 53.40 ft from top of member.

*73. Lab. No. VEM-42-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis suggests 10.7 percent gypsum; shows 3.8 percent alkalies, 1.5 percent V_2O_5.) Mudstone, grayish-black. Bed P-73, 0.65 ft thick, 52.75 ft from top of member.

*74. Lab. No. VEM-44-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 26, 27, pl. 1.) (Analysis suggests 14.8 percent gypsum, 6.5 percent phosphate, 1.7 percent more SO_3 than required for gypsum; shows 3.4 percent alkalies.) Mudstone, grayish-black, fossiliferous. Bed P-75, 0.75 ft thick, 51.6 ft from top of member.

*75. Lab. No. VEM-48-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 5.1 percent phosphate, 2.2 percent gypsum; shows 3.1 percent alkalies.) Calcareous mudstone, brownish-gray, fossiliferous. Bed P-79, 0.8 ft thick, 46.7 ft from top of member.

*76. Lab. No. VEM-50-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 9.6 percent phosphate, 1.9 percent gypsum; shows 3.3 percent alkalies.) Calcareous mudstone and phosphate rock, brownish-gray. Bed P-81, 2.0 ft thick, 43.7 ft from top of member.

TABLE 6.— Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Wyoming												
	*77	*78	*79	80	*81	*82	*83	*84	*85	*86	*87	*88	*89
	49B12-31	49B12-32	49B12-51	49B12-13	49B12-52	49B12-53	49B12-54	49B12-42	49B12-41	49B12-14	49B12-15	49B12-33	49B12-34
Insoluble	[1] (40.4)	[1] (58.5)	[1] (69.3)	[1] (66.9)	[1] (73.3)	[1] (68.8)	[1] (75.6)	40.3	40.2	......	......	[1] (73.2)	[1] (82.5)
SiO_2	34.24	47.36	57.11	55.26	61.14	57.58	61.52	......	......	43.8	44.00	67.60	71.02
Al_2O_3	5.3	7.8	10.2	9.3	12.1	10.9	13.3	5.4	4.5	12.7	10.9	5.1	7.5
Fe_2O_3	1.9	2.6	3.3	3.0	3.4	3.1	4.0	5.58	4.45	4.0	3.6	3.5	3.2
MgO	.43	3.8	.90	4.2	.63	.67	.82	......	......	......	......	.55	.73
CaO	25.41	12.80	10.40	9.00	6.60	9.00	5.60	......	......	9.9	7.8	8.40	4.40
Na_2O	1.09	.96	1.02	.84	.40	.59	.35	......	......	......	......	.40	.52
K_2O	1.60	2.30	1.67	2.53	3.57	3.30	3.90	......	......	......	......	1.83	2.60
H_2O+	[2] 6.42	[2] 3.87	[2] 3.57	[2] 2.87	[2] 4.66	[2] 4.48	[2] 4.21	......	......	......	} [3] 15.60	[2] 2.22	[2] 2.66
H_2O-	1.08	.83	.93	.43	1.04	1.02	.79	......	......	......	}	.38	.54
TiO_2	.40	.42	.43	.54	.45	.47	.01	......	......	.7	......	.33	.34
P_2O_5	16.52	3.80	4.51	.65	4.35	6.15	3.25	9.3	.3	2.6	1.4	4.1	.75
CO_2	2.0	8.8	3.2	10.4	.6	.8	.9	......	......	6.5	4.7	1.8	2.0
SO_3	2.4	1.1	.77	.31	.76	.91	.60	......	......	[4] 4.1	[4] 4.0	.24	.21
V_2O_5	.05	.09	.04	.02	.04	.06	.07	......	......	.52	.74	.04	.05
MoO_3	......	......	......	......	......	......	......	......	......	.02	.02	......	......
F	1.6	.51	.52	.15	.48	.59	.37	......	......	......	......	.51	.22
Chem. U	.012	.002	.001	.001	.001	.002	.002	......	......	......	......	......	......
Organic C	......	......	......	......	......	......	......	......	......	10.7	4.7	......	......
Ignition loss	[1] (9.5)	[1] (13.5)	[1] (7.7)	[1] (13.7)	[1] (6.3)	[1] (6.3)	[1] (5.9)	15.4	16.8	......	[1] (20.3)	[1] (4.4)	[1] (5.2)
Subtotal	100.452	97.042	98.571	99.501	100.221	99.622	99.692	......	......	......	......	97.00	96.74
Less O[5]	.67	.21	.22	.06	.20	.25	.16	......	......	......	......	.21	.09
Total	99.8	96.8	98.4	99.4	100.0	99.4	99.5	76.0	66.2	95.5	97.5	96.8	96.7
Class	23,25,4	21,32,19	35,40,7	35,35,22	36,46,1	35,42,2	34,50,2	(24,42) 0	(27,39) 0	17,59,13	21,57,11	55,24,4	54,31,4

Semiquantitative spectrographic analyses

[B=1-10 percent; D=0.1-1 percent; E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. Li, Co, Ga, As, Sb, Ta, W, Pt, Au, Hg, and Bi looked for in samples 77-83 but not detected. Sc, Co, Ge, As, Rb, In, Sb, Cs, Ce, Nd, Ta, W, Re, Pt, Hg, Tl, Bi, and Th looked for in samples 84 and 85 but not detected]

	77	78	79	80	81	82	83	84	85
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND
B	F	F	E	E	E	E	F	F	F
Na	......	......	......	......	......	......	......	D	E
Mg	......	......	......	......	......	......	......	......	B
Ca	......	......	......	......	......	......	......	B	B
Ti	......	......	......	......	......	......	......	D	D
V	......	......	......	......	......	......	......	E	E
Cr	E	E	E	F	E	E	E	D	E
Mn	F	E	E	E	F	F	F	E	E
Ni	E	E	E	E	E	E	E	E	E
Cu	G	G	G	G	G	G	G	F	F
Zn	ND	E	ND	ND	ND	ND	ND	E	E
Sr	E	ND	ND	ND	ND	ND	ND	D	D
Y	......	......	......	......	......	......	......	E	F
Zr	E	E	E	E	E	E	E	ND	E
Cb	E	E	ND	ND	ND	ND	ND	ND	ND
Mo	F	F	F	F	F	F	F	F	F
Ag	G	G	ND	ND	ND	ND	ND	G	G
Cd	ND	ND	ND	ND	ND	ND	ND	F	F
Sn	ND	ND	ND	ND	ND	ND	ND	F	F
Ba	E	E	ND	ND	ND	ND	ND	F	F
La	......	......	......	......	......	......	......	E	ND
Pb	ND	ND	ND	ND	ND	ND	ND	E	F

[1] Not included in total.

[2] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)

[3] (Calculated by compilers, difference between CO_2 and ignition loss.)

[4] Reported as S.

[5] (Calculated by compilers from F.)

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

77-83. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Modal grain size, trench samples. Index map, outcrop map; generalized columnar section, detailed columnar section. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

*77. Lab. No. VEM-53-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 39.2 percent phosphate, 5.2 percent gypsum; shows 2.7 percent alkalies.) Phosphate rock and phosphatic mudstone; brownish-gray, fossiliferous, contains pellets. Bed P-84, 1.8 ft thick, 39.2 ft from top of member.

*78. Lab. No. VEM-60-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 9.0 percent phosphate, 2.4 percent gypsum; shows 3.3 percent alkalies.) Dolomitic mudstone, grayish-brown. Bed P-91, 0.4 ft thick, 33.3 ft from top of member.

*79. Lab. No. DML-3-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 10.7 percent phosphate, 1.7 percent gypsum; shows 2.7 percent alkalies.) Mudstone, grayish-brown. Bed P-101, 1.2 ft thick, 23.6 ft from top of member.

80. Lab. No. DML-4-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) Dolomitic mudstone, light brownish-gray. Bed P-102, 3.2 ft thick, 20.4 ft from top of member.

*81. Lab. No. DML-5-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 10.3 percent phosphate, 1.6 percent gypsum; shows 4.0 percent alkalies.) Mudstone, grayish-brown. Bed P-103, 0.5 ft thick, 19.9 ft from top of member.

*82. Lab. No. DML-6-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 14.6 percent phosphate, 2.0 percent gypsum; shows 3.9 percent alkalies.) Mudstone, grayish-brown. Bed P-104, 0.5 ft thick, 19.4 ft from top of member.

*83. Lab. No. DML-7-47. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 7.7 percent phosphate, 1.3 percent gypsum; shows 4.3 percent alkalies.) Mudstone, grayish-brown. Bed P-105, 0.4 ft thick, 19.04 ft from top of member.

Wyoming--Continued

84-85. Lincoln County. Phosphoria formation, Meade Peak member. Secs. 19 and 30, T. 27 N., R. 119 W. Spectrographic analyst, Mortimer. (McKelvey and others, 1953, p. 6, 2, 9, pl. 1.) Index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

*84. Lab. No. RAH-166-47. (Analysis suggests 22.0 percent phosphate.) Calcareous mudstone and phosphate rock. Trench sample. Bed P-87, 1 ft thick, 32.55 ft from top of member.

*85. Lab. No. RAH-160-47. (Partial analysis.) Mudstone. Trench sample. Bed P-93, 2.2 ft thick, 22.45 ft from top of member.

86-87. Lincoln County. (Phosphoria formation, Meade Peak member. Sec. 19, T. 27 N., R. 119 W., and sec. 6, T. 26 N., R. 119 W.), Sublette Ridge area. (Ravitz and others, 1947, p. 2, 13, 14.) Carbonaceous shale, black, fairly soft, fine-grained; beds composed of layers alternately rich and lean in vanadium; high vanadium layers richer in organic matter. Possible use: Source of vanadium, fertilizer.

*86. Lab. No. 1-3. (Analysis suggests 6.2 percent phosphate; shows 4.1 percent S.)

*87. Lab. No. 6-5. (Analysis shows 4.0 percent S; suggests 3.3 percent phosphate.)

88-89. Lincoln County. Phosphoria formation. (McKelvey and others, 1953, p. 11, 16, 2, pl. 1.) Sec. 7, T. 26 N., R. 119 W. Trench samples. Index map, outcrop map; generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

*88. Lab. No. VEM-74-47. (Analysis suggests 9.7 percent phosphate, 1.4 percent more CaO and MgO than required for carbonates; shows 2.2 percent alkalies.) Mudstone. Bed U-5, 1.4 ft thick, 53.50 ft from top of member.

*89. Lab. No. VEM-76-47. (Analysis shows 3.1 percent alkalies; suggests 1.8 percent phosphate, and 1.8 percent more CaO and MgO than required for carbonates.) Mudstone. Bed U-7, 3.1 ft thick, 48.1 ft from top of member.

TABLE 6.—Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Wyoming												
	90	91	92	*93	94	*95	96	97	98	99	100	*101	*102
	49B12-3	49B12-4	49B12-55	49B12-35	49B12-5	49B12-36	49B12-6	49B12-7	49B12-8	49B12-9	49B12-10	49B12-37	49B12-38
Insoluble[1]	(85.2)	(79.5)	(64.4)	(73.4)	(75.00)	(76.8)	(80.3)	(68.0)	(68.5)	(69.2)	(72.1)	(73.0)	(70.3)
SiO_2	72.94	70.14	57.51	61.70	65.02	66.84	70.84	62.36	62.30	61.52	65.32	63.04	59.54
Al_2O_3	10.4	9.8	6.4	10.3	10.4	8.1	8.7	4.5	7.3	7.8	7.3	11.7	10.7
Fe_2O_3	3.9	4.7	2.9	4.0	3.5	3.2	2.8	2.3	2.5	2.6	2.5	4.3	4.5
MgO	.79	.86	4.4	2.0	2.2	1.9	1.3	3.0	3.1	3.7	2.6	1.2	1.1
CaO	1.42	2.00	10.80	5.40	5.30	4.20	4.90	10.20	8.20	8.20	8.36	5.80	7.32
Na_2O	3.20	.40	.28	.25	3.10	.60	2.40	.44	.50	.40	2.20	.50	3.10
K_2O	.50	3.10	1.79	3.20	.30	2.77	.49	1.85	2.13	2.40	.57	3.50	.69
H_2O+[2]	3.92	4.58	2.75	3.84	3.58	3.36	3.63	2.59	3.04	2.80	3.03	5.49	5.11
H_2O-	.78	.92	.55	.86	.82	.64	.77	.41	.46	.50	.57	1.31	1.89
TiO_2	.52	.55	.37	.44	.44	.44	.46	.37	.43	.52	.35	.53	.49
P_2O_5	1.00	.91	1.60	.60	.85	1.21	.25	1.01	1.39	.30	2.00	4.00	4.60
CO_2	.2	.3	10.8	3.9	4.2	3.1	3.1	8.8	7.1	8.4	5.9	.4	.5
SO_3	.17	.31	.28	.20	.13	.20	.20	.21	.17	Nil	.11	.26	.39
V_2O_5	.05	.05	.08	.04	.08	.05	.08	.04	.05	.06	.10	.10	.06
F	.22	.17	.17	.26	.26	.24	.19	.16	.18	.21	.31	.47	.58
Ignition loss[1]	(4.9)	(5.8)	(14.1)	(8.6)	(8.6)	(7.1)	(7.5)	(11.8)	(10.6)	(11.7)	(9.5)	(7.2)	(7.5)
Subtotal	100.01	98.79	100.68	96.99	100.18	96.85	100.11	98.24	98.85	99.41	101.22	102.60	100.57
Less O[3]	.09	.07	.07	.11	.11	.10	.08	.07	.08	.09	.13	.20	.24
Total	99.9	98.7	100.6	96.9	100.1	96.8	100.0	98.2	98.8	99.3	101.1	102.4	100.3
Class	50,42,0	48,43,1	43,27,23	39,42,8	43,41,9	49,33,6	52,34,7	52,20,19	47,29,15	45,30,18	50,29,13	38,48,1	36,46,1

	*103	104	105	*106	*107	*108	109	110	111	112	113	*114	115
	49B12-39	49B12-11	49B12-106	49B12-40	49B12-43	49B12-46	49B12-47	49B12-48	49B13-1	49B15-1	49B19-2	49B21-1	49B23-11
Insoluble[1]	(77.1)	(85.9)	(81.3)	(42.10)	......	......	......	(57.8)	......	......	......	......	......
SiO_2	65.22	78.46	74.62	37.30	52.0	42.2	49.0	43.6	65.24	65.63	62.431	66.17	60.96
Al_2O_3	11.2	5.4	5.3	9.1	12.3	11.6	12.63	12.55	15.88	13.40	14.566	14.95	18.27
Fe_2O_3	4.9	3.8	3.2	4.2	[3] 5.08	[3] 3.43	[3] 1.57	[3] 4.43	3.12	} 2.55	......	2.76	2.83
FeO	......	......	......	......	......	......	......	......	......			1.95	.14
MgO	.88	.51	.84	1.4	.55	2.3	2.3	1.85	} 5.34	2.17	1.409	1.88	2.96
CaO	4.00	3.60	4.70	22.60	5.5	10.4	5.2	9.30		.85	1.859	3.87	.10
Na_2O	......	.62	.97	......	......	......	......	......	......	.69	} 4.900	2.84	1.44
K_2O	......	1.50	1.20	......	......	......	......	......	......	.27		3.77	.31
H_2O+	[2] 4.67	[2] 1.50	[2] 1.10	[2] 3.52	......	......	......	......	} 9.17	14.33	[4] 14.836	2.61	6.56
H_2O-	1.23	.30	.30	.88	......	......	......	......					6.78
TiO_2	.52	.34	.34	......	......	......	......	......	......	......	......	......	.08
P_2O_5	2.93	1.65	.70	15.14	[3] 2.11	[3] 2.12	[3] .76	[3] 1.90	......	......	......	......	......
CO_2	.2	.7	2.9	2.3	......	......	......	6.80	......	......	......	......	......
S	......	......	......	......	.78	3.40	4.00	3.85	......	......	......	......	......
SO_3	.32	.22	<.1	.75	......	......	......	[5] .05	......	......	......	Tr.	......
V_2O_5	.09	.04	.04	......	.81	.525	.920	.605	......	......	......	......	......
F	.34	.18	.13	1.3	......	......	......	......	......	......	......	......	......
Cu	......	......	......	......	......	......	......	.025	......	......	......	......	......
Ag	......	......	......	......	......	......	......	.26	......	......	......	......	......
Au	......	......	......	......	......	......	......	.00	......	......	......	......	......
Pb	......	......	......	......	......	......	......	.05	......	......	......	......	......
Organic matter[3]	......	......	......	......	7.85	15.66	14.45	16.83	......	......	......	......	......
Ignition loss[1]	(6.1)	(2.5)	(4.3)	(6.7)	......	......	......	(15.4)	......	......	......	......	......
Subtotal	96.50	98.82	<96.4	98.49	......	......	......	......	......	......	......	......	......
Less O[3]	.14	.08	.05	.55	......	......	......	......	......	......	......	......	......
Total	96.4	98.7	<96.4	97.9	86.98	91.64	90.8	102.1	98.75	99.89	100.001	[6] 100.80	100.43
Class	40,47,0	65,25,2	52,23,6	16,39,5	25,57,6	18,59,10	25,56,10	16,61,18	34,60,3	39,57,0	37,55,0	37,50,0	25,70,0

Spectrographic data for sample 115

[P = Phillips Research Lab. determinations; S = Shell Oil Co. determinations; Pres. = Present]

	P	S		P	S		P	S
Li	Pres.	<0.09	Co	....	<0.001	Zr	0.03	0.01
Be	....	<.0005	Cu	0.001	.0007	Mo	....	<.003
B	0.003	.01	Zn	....	<.03	Ag	.001	.006
Sc	....	([7])	Ga	.01	.01	Cs	....	([7])
V	....	<.002	Rb	....	<.01	Ba	.04	[8] <.04
Cr	....	<.0007	Sr	.07	[8] <.03	Tl	....	<.00003
Mn	.005	.006	Y	....	<.005	Pb	.07	.02
Ni	....	<.001						

[1] Not included in total.
[2] (Calculated by compilers, ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[3] (Calculated from reported Fe, P, or C. Less O calculated by compilers from F.)
[4] Includes organic matter.
[5] Reported as SO_4.
[6] Manganese and lithia reported as trace.
[7] Presence not detected; limit of detectability by procedure employed is as yet uncertain.
[8] Element detected; present in too small concentration for spectrochemical determination by procedures employed.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

90-106. Lincoln County. Permian, Phosphoria formation. (McKelvey and others, 1953, p. 11, 16, 2, pl. 1.) Sec. 7, T. 26 N., R. 119 W. Trench samples. Index map, outcrop map; generalized columnar section.

90. Lab. No. VEM-77-47. Mudstone. Bed U-8, 2.7 ft thick, 45.4 ft from top of member.

91. Lab. No. VEM-78-47. Mudstone. Bed U-9, 0.7 ft thick, 44.7 ft from top of member.

92. Lab. No. VEM-79-47. Dolomitic mudstone. Bed U-10, 1.0 ft thick, 43.7 ft below top of member.

*93. Lab. No. VEM-80-47. (Analysis suggests 2.2 percent more CaO and MgO than required for carbonates, 1.4 percent phosphate; shows 3.5 percent alkalies.) Mudstone. Bed U-11, 1.4 ft thick, 42.3 ft from top of member.

94. Lab. No. VEM-81-47. Mudstone. Bed U-12, 4.3 ft thick, 38 ft below top of member.

*95. Lab. No. VEM-82-47. (Analysis shows 3.4 percent alkalies; suggests 2.9 percent phosphate, 1.1 percent more CaO and MgO than required for carbonates.) Mudstone. Bed U-13, 3.6 ft thick, 34.4 ft from top of member.

96. Lab. No. VEM-83-47. Mudstone. Bed U-14, 3.7 ft thick, 30.7 ft from top of member.

97. Lab. No. VEM-84-47. Mudstone. Bed U-15, 3.9 ft thick, 26.8 ft from top of member.

98. Lab. No. VEM-85-47. Mudstone. Bed U-16, 3.5 ft thick, 23.3 ft from top of member.

99. Lab. No. VEM-87-47. Calcareous mudstone. Bed U-18, 2.6 ft thick, 19.1 ft from top of member.

100. Lab. No. VEM-88-47. Mudstone. Bed U-19, 2.6 ft thick, 16.5 ft from top of member.

*101. Lab. No. VEM-89-47. (Analysis suggests 9.5 percent phosphate, 1.3 percent more CaO and MgO than required for carbonates; shows 4.0 percent alkalies.) Mudstone. Bed U-20, 3.0 ft thick, 13.50 ft from top of member.

*102. Lab. No. VEM-90-47. (Analysis suggests 10.9 percent phosphate, 1.8 percent more CaO and MgO than required for carbonates; shows 3.8 percent alkalies.) Mudstone. Bed U-21, 3.2 ft thick, 10.3 ft from top of member.

*103. Lab. No. VEM-91-47. (Analysis suggests 6.9 percent phosphate.) Mudstone. Bed U-22, 1.6 ft thick, 8.7 ft from top of member.

104. Lab. No. VEM-92-47. Mudstone, cherty. Bed U-23, 1.6 ft thick, 7.1 ft from top of member.

Wyoming--Continued

105. Lab. No. VEM-93-47. Mudstone and chert. Bed U-24, 4.0 ft thick, 3.1 ft from top of member.

*106. Lab. No. VEM-95-47. (Analysis suggests 35.9 percent phosphate, 1.6 percent gypsum.) Phosphate rock and chert. Bed U-26, 0-6 ft thick, 1.7 ft from top of member.

107-110. Lincoln County. Phosphoria formation. Tps. 26 and 27 N., R. 119 W. Carbonaceous shale. General description of deposit, geologic and topographic map, geologic profile.

*107. Lab. No. Wy-1.1 altered. (Allsman and others, 1949, p. 7, 3-5, figs. 1, 2.) (Analysis suggests 5.0 percent phosphate.)

*108. Lab. No. Wy-1.9 Met. D. (Allsman and others, 1949, p. 7, 3-5, figs. 1, 2.) (Analysis suggests 5.0 percent phosphate; shows 3.4 percent S.)

109. Lab. No. Wy-1.10 Met. F. (Allsman and others, 1949, p. 7, 3-5, figs. 1, 2.)

110. Lab. No. Wy-6.1. Wyodak composite. (Allsman and others, 1949, p. 5, 7, 3, 4, figs. 1, 2.) Physical tests.

111. Natrona County. Upper Cretaceous, Thermopolis shale or Mowry shale. (T. 33 N., R. 79 W.) near town of Casper. Analyst, Knight. (Fisher, 1905, p. 560.) Bentonite. Geologic map. Use: *Soap, adulterant.*

112. Park County. Upper Cretaceous, Frontier formation. (Probably sec. 31, T. 53 N., R. 101 W.), Shoshone River. Collector, Hewett. (Hewett, 1926, p. 56, 49, 57, pl. 6.) Bentonite, from bed 8 ft thick, top bed of formation. Detailed columnar sections, correlated columnar sections. Mineralogy.

113. (Sweetwater County.) Eocene, Green River formation. (T. 13 N., R. 100 W.), Brown's Park. Analyst, Brewster. Lab. No. 94. (Emmons, 1877, p. 223; King, 1878, table 7A.) Silt, white, very fine, siliceous.

*114. (Uinta County.) Eocene, Bridger formation. (T. 13 N., R. 113 W.), Grizzly Buttes. Analyst, Woodward. Lab. No. 124. (Emmons, 1877, p. 246; King, 1878, table 7B.) (Analysis shows 6.6 percent alkalies, 2.0 percent FeO; suggests 5.9 percent more CaO and MgO than required for carbonates.) Sandstone, light bluish-green, fresh. Mineralogy.

115. Weston County. Mowry shale. (Probably T. 47 N., R. 64 W.), 4.8 miles south of town of Upton, Baroid Co. pit. Lab. No. 26. (Kerr and others, 1950, p. 53, 61, 80, 81, 96, 107, 154; for additional information see: Kerr and Kulp, 1949, p. 54, 56, 57; Kerr and others, 1949, figs. 11, 14, 16; Main, 1950, p. 38, 50, 53; Adler and others, 1950, p. 102, 138, pls. 5, 14.) Montmorillonite, from layer 2 ft thick; sample of about 80 pounds, pH 8.22. Index maps. Summary of base-exchange capacity; exchange isotherms graph; thermal curves; infrared absorption measurements. Staining tests, mineralogy.

TABLE 6.—Analyses of samples from South Dakota and Wyoming containing uncombined silica and clay each less than 75 percent; uncombined silica and clay each greater than carbonates (Group B) common and mixed rock categories--Continued

	Wyoming									
	116	117	*118	119	120	121	*122	123	124	125
	49B23-12	49B23-3	49B23-10	49B23-7	49B23-8	49B23-1	49B23-9	49B23-6	49B23-2	49B23-38
SiO_2	64.32	70.98	56.20	58.82	68.30	67.55	63.25	56.93	69.54	66.90
Al_2O_3	20.74	[1] 11.47	11.50	16.43	14.65	17.58	12.63	14.75	10.63	15.26
Fe_2O_3	3.03	2.48	3.64	4.47	.37	.47	3.70	2.08	.53	2.80
FeO	.46	([2])	.65	......	......	......	......	......	......	.12
MgO	2.30	1.38	4.23	1.68	1.03	.74	3.97	1.86	.22	2.26
CaO	.52	.26	5.83	.54	1.18	.36	4.12	6.35	3.27	.46
Na_2O	2.59	1.69	.98	.33	.30	.21	......	2.28	1.87	2.12
K_2O	.39	.75	3.74	2.18	.39	.79	3.55	.93	.80	.42
H_2O+	5.15	} 11.32	[3] 2.84	......	......	......	......	} 10.61	12.76	[4] 3.67
H_2O-	......		[3] 1.61	[3] 6.39	[3] 6.82	......	[5] 7.19			[4,6] 5.83
TiO_2	.14	.10	.77	......	......	......	......	......	......	.11
P_2O_5	......	......	.12	......	......	......	......	......	......	[6] .03
CO_2	......	None	5.72	......	......	......	......	4.61	None	.05
MnO	......	......	.10	.24	.33	.18	......	......	......	......
SO_3	......	......	2.26	1.32	.09	.50	[6] 1.30	......	......	[7] .07
[illegible]O	......	......	None	......	......	......	......	......	......	......
[illegible]	......	......	Tr.	......	......	......	......	......	......	......
Ignition loss	......	......	......	7.93	6.56	11.68	......	......	......	[8] .05
Total	99.64	100.43	100.19	100.33	100.02	[9] 100.06	99.71	100.40	99.62	100.15
Class	24, 69, 1	48, 48, 0	32, 43, 12	25, 67, 4	42, 53, 4	36, 60, 2	37, 50, 1	29, 56, 10	50, 43, 1	37, 58, 0

	126	127	128	129	130	*131	132	*133	*134	*135
	49B23-5	49B24-63	49B24-64	49B24-65	49B24-61	49B24-68	49B24-58	49B24-69	49B24-70	49B24-71
SiO_2	60.66	79.60	80.74	84.90	75.75	48.08	71.54	55.66	71.73	68.34
Al_2O_3	22.13	[10] 11.42	[10] 10.00	[10] 8.48	[10] 16.18	[10] 8.54	[10] 19.88	[10] 11.90	[10] 11.91	[10] 12.52
Fe_2O_3	1.21	......	......	......	......	......	......	......	......	......
MgO	1.54	......	.20	......	......	Tr.	None	.06	None	.02
CaO	1.59	.30	.44	.32	.26	.34	.36	.34	.44	.50
Na_2O	.53	1.52	1.26	1.76	.62	1.69	.24	.46	1.80	.66
K_2O	2.16	3.53	2.36	2.98	1.52	2.83	.60	.76	3.74	1.74
H_2O	......	3.44	5.54	1.62	6.22	1.73	8.10	5.60	2.01	6.02
MnO	.44	......	......	......	......	......	......	......	......	......
S	......	......	None	None	......	37.19	......	26.00	8.50	10.10
SO_3	.43	......	......	......	......	......	......	......	......	......
Ignition loss	9.28	......	......	......	......	......	......	......	......	......
Total	99.97	99.81	100.54	100.06	100.55	100.40	100.72	100.78	100.13	99.90
Class	20, 70, 6	59, 35, 0	63, 33, 0	70, 25, 0	47, 51, 0	33, 25, 0	36, 63, 0	35, 39, 0	51, 35, 0	46, 41, 0

	*136	*137	138	139	140	141	142	143	144	145
	49B24-72	49B24-73	49B24-59	49B24-62	49B24-25	49B24-28	49B24-27	49B24-29	49B24-83	49B24-60
SiO_2	63.92	66.31	73.34	75.88	82.80	76.80	72.25	81.95	73.00	74.68
Al_2O_3	[10] 6.34	[10] 2.04	[10] 14.16	[10] 16.66	5.64	9.46	10.96	6.49	} 13.50	11.71
Fe_2O_3	......	......	......	......	1.49	Tr.	.76	Tr.		
FeO	......	......	......	......	......	......	.31	......	......	......
MgO	.09	.02	.10	None	Tr.	Tr.	.10	.15	......	1.32
CaO	.28	.18	.28	.26	2.13	1.80	.74	.56	......	1.30
Na_2O	.46	.12	.80	.26	[11] Tr.	[11] Tr.	3.55	2.56	......	2.04
K_2O	.54	.04	2.54	.36	[11] Tr.	......	1.66	.65	......	2.29
H_2O+	} 5.98	.51	8.70	6.72	......	......	} [12] 9.02	7.50	11.00	6.72
H_2O-					[13] 2.66	[13] 5.00				
MnO	......	......	......	......	[11] Tr.	......	......	......	......	......
S	22.24	30.70	......	......	......	......	......	......	......	......
SO_3	......	......	......	......	......	......	[14] .45	.16	......	......
Cl	......	......	......	......	......	......	.36	Tr.	......	......
Organic matter	......	......	......	......	......	......	[15] .34	......	......	......
Ignition loss	......	......	......	......	6.33	8.00	......	......	......	......
Total	99.85	99.92	[16] 99.92	100.14	101.05	101.06	100.50	100.02	97.50	100.06
Class	53, 24, 0	63, 6, 0	48, 48, 0	46, 53, 0	71, 26, 4	60, 38, 3	52, 42, 0	70, 25, 0	50, 47, 0	55, 38, 0

[1] Includes P_2O_5.
[2] Probably absent.
[3] H_2O+, above 100° C.; H_2O-, at 100° C.
[4] H_2O+, above 105° C.; H_2O-, at 105° C.
[5] H_2O-, 6.91 percent; 0.28 percent calculated from reported H_2SO_4.
[6] Calculated from H_2SO_4 and/or H_3PO_4, calculated H_2O, 0.03 percent.
[7] Calculated from H_2SO_4; includes 0.01 percent S.
[8] Calculated from reported C, 0.03 percent.
[9] 100.26 in text.
[10] Reported as Al_2O_2, etc.
[11] Determined spectroscopically.
[12] Includes H of organic matter.
[13] At 110° C.
[14] May be either S or SO_3.
[15] Calculated from reported C.
[16] 100.12 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

116. Weston County. Upper Cretaceous, probably Mowry shale, (H. D. Thomas, written communication, 1956). Town of Upton, American Colloid Co. Lab. No. 5D. (Grim and Rowland, 1942, p. 756, 755.) Montmorillonite. Differential thermal curve.

117. Weston County. Mowry shale, top of formation. Sec. 30, T. 47 N., R. 63 W., Clay Spur siding. Analyst, Fairchild; collector, Rubey. (Rubey, 1929, p. 157-159.) Bentonite, from quarry. Mineralogy.

*118. Weston County. Triassic(?), Spearfish formation. (T. 45 N., R. 61 W.) east of town of Newcastle. Analyst, Steiger. Lab. No. 54. (Richardson, 1903, p. 380, 367, 378.) (Analysis suggests 4.9 percent gypsum, 2.4 percent more CaO and MgO than required for carbonates; shows 4.7 percent alkalies.) Shale, red, sandy. Geologic map. Photomicrographs of Spearfish formation red beds; average mineral composition.

119-121. Weston County. Upper Cretaceous, Graneros shale. (T. 45 N., R. 61 W.) near Newcastle. (Ball, 1907, p. 237.) Shale.

119. Analyst, Bates. Shale, black, fissile; numerous gypsum crystals. Possible use: Portland cement material.

120. Analyst, Bates. Shale, gray; no sand or gypsum. Use: Too little iron and too much silica for Portland cement material.

121. Analysts, Phillips and Bates. Shale, dark gray, fissile; no gypsum. Use: Too little iron for Portland cement material.

*122. Weston County. Graneros shale. (T. 46 N., R. 63 W.) near town of Osage. Analyst, Knight. (Darton, 1904, p. 9; Darton, 1905b, p. 12; Fisher, 1905, p. 560.) (Analysis suggests 6.9 percent more CaO and MgO than required for carbonates, 2.8 percent gypsum; shows 3.6 percent K_2O.) Bentonite, light-gray, fine-textured, soft, massive; 4 ft thick. Locally occurs as light powdered substance between thin layers of reddish-brown concretionary material. Bulk density, 2.132. Geologic maps. Use: Filler, soap, adulterant.

123-124. Weston County. Upper Cretaceous, Pierre shale. SE¼ sec. 6, T. 45 N., R. 62 W., (from U. S. Geol. Survey files). Analyst, Fairchild; collector, Rubey. Lab. No. C-941. (Wells, 1937, p. 65, 64.) (Some of the following information from U. S. Geol. Survey files.)

123. From mine near Pedro siding; bentonite, from thick bed at base of formation.

124. Pedro bentonite bed. Near Pedro bentonite quarry; tuff, white, hard, essentially unaltered; top of bed.

125. Weston County. Pierre shale. (T. 45 N., R. 62 W.) probably Newcastle district. (Spence, 1924, p. 14.) Bentonite.

126. Weston County. Pierre shale. Southeast of Newcastle. Analysts, Phillips and Bates. (Ball, 1907, p. 238; O'Harra and others, 1908, p. 25.) Shale, greenish-gray, fine-grained, soft. Use: Iron content too low for Portland cement material.

Wyoming--Continued

127-139. Yellowstone National Park. (Recent.) Norris Geyser Basin. Microscopic examinations by H. E. Merwin. (Allen and Day, 1935, p. 484, 232, 483, 485.) Spring sediments. Index map. Mineralogy.

127. Large mud spring, eastern edge south section. Lab. No. 1.

128. Small clear spring, center south section. Lab. No. 2.

129. Large, hot, muddy pool; east side of Porcelain Basin. Lab. No. 8.

130. Very acid, muddy spring, east of new museum. Lab. No. 20.

*131. Between Congress Pool and museum, east side of road. Lab. No. 22. (Analysis shows 37.2 percent S, 4.5 percent alkalies.)

132. Irregular sinter-lined crater, eastern edge, south section. Lab. No. 27.

*133. Large deep pool, eastern edge south of Coral Spring. Lab. No. 30. (Analysis shows 26.0 percent S, 1.3 percent alkalies.)

*134. Large shallow pool, extreme southeast corner of basin. Lab. No. 31. (Analysis shows 8.3 percent S, 5.5 percent alkalies.)

*135. Gable Spring, north of Gray Lakes. Lab. No. 32. (Analysis shows 10.1 percent S, 2.4 percent alkalies.)

*136. Deep spring northwest of Verma Spring. Lab. No. 59. (Analysis shows 22.2 percent S, 1.0 percent alkalies.) Spring sediment, black.

*137. Largest spring not far east of highway, northeast of Opal Spring. Lab. No. 62. (Analysis shows 30.7 percent S.)

138. Crystal Spring. Lab. No. 67.

139. Mud pot some distance west of Sieve Lake. Lab. No. 73.

140-145. Yellowstone National Park. (Recent.)

140. From ravine near Great Fountain. Lower Geyser Basin, Fire Hole River. Analyst, Peale. (Peale, 1873, p. 158, 145.) Spring deposit, black, contains organic matter.

141. Shoshone Lake Geyser Basin. Analyst, Peale. (Peale, 1873, p. 158, 157.) Geyserite, bluish-gray, amorphous, laminated, dull luster; hardness, 5.

142. Spring 8, Giant Group, Upper Basin. Analyst, Whitfield; collector, Weed. (Clarke, 1915, p. 223.) Geyserite incrustation.

143. Near Splendid Geyser, Upper Geyser Basin. Analyst, Whitfield. (Weed, 1889a, p. 670, 671.) Sinter. Interior greenish-gray; exterior light-gray, fiberous.

144. Gibbon Geyser Basin, Echinus Geyser, No. 45. Analyst, Leffmann. (Peale, 1883, p. 411, 409.) Geyserite, reddish thin coating, uneven fracture; hardness, 5.

145. Heart Lake Basin, Rustic Group of springs at foot of Mount Sheridan. (Allen and Day, 1935, p. 323, 232, 320-322.) Loose sediment partially covering siliceous sinter lining of spring. Index map.

TABLE 7.—Analyses of samples from Colorado, Kansas, Montana, North Dakota, and Wyoming containing uncombined silica and carbonates each less than 75 percent; uncombined silica and carbonates each greater than clay (Group C) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado				Kansas								
	1	2	3	4	5	6	7	8	9	10	11	12	13
	5C8-1	5C17-1	5C47-3	5C59-1	15C6-2	15C7-3	15C11-2	15C25-2	15C27-68	15C27-69	15C31-1	15C52-2	15C53-16
SiO_2	25.1	23.51	30.7	56.33	32.07	21.44	47.95	61.21	62.42	65.12	33.78	43.65	60.95
Al_2O_3	Tr.	1.56	3.2	.77	3.99	[1] 3.02	} .62	{ [1] 2.28	1.12	1.34	[1] 1.33	[1] 4.11	.76
Fe_2O_3	3.8	.30	4.0	.97	3.40	[2] 1.25	}	{ [2] 2.07	.16	1.34	[2] .60	[2] 1.99	.25
FeO	......	[3] .56	......	......	......	......	......	......	......	......	......	......	......
MgO	2.2	2.29	2.4	7.30	[4] 2.28	.41	[4] .22	1.02	.60	1.05	1.14	3.01	6.31
CaO	35.6	39.15	32.9	14.01	[4] 30.70	40.05	[4] 28.54	17.62	19.18	17.06	34.23	23.72	13.74
Na_2O	......	......	......	......	......	......	......	.11	......	......	.10	......	......
K_2O	......	......	......	......	......	......	......	.29	......	......	.22	......	......
H_2O+	......	[5] .66	......	......	......	......	......	......	......	......	......	......	......
H_2O-	[6] Tr.	[7] .51	[6] Tr.	......	......	......	......	......	......	......	......	......	......
TiO_2	......	.06	......	......	......	......	......	......	......	......	......	......	.82
P_2O_5	......	Tr.	......	......	......	.22	......	.04	......	......	.07	Tr.	Nil
MnO	......	[8] .54	......	......	......	......	......	......	......	......	......	......	......
S	......	......	......	......	......	[9] (.01)	......	[9] (.08)	......	......	Nil	......	......
SO_3	......	......	......	......	......	.12	......	Nil	......	.07	Tr.	.28	Nil
Ignition loss	[10] 30.8	[11] (30.86)	[10] 22.9	......	......	[12] 31.90	......	[12] 15.30	16.20	12.65	[12] 28.00	[12] 22.42	16.73
Total	97.5	[13] 69.14	96.1	79.38	72.44	98.41	77.33	99.94	99.68	98.63	99.47	99.18	[14] 99.56
Class	21, 9, 68	20, 6, 69	21, 19, 55	54, 5, 40	21, 20, 58	15, 12, 70	47, 2, 51	55, 12, 32	60, 4, 36	61, 7, 27	31, 5, 62	34, 17, 46	59, 3, 35
CaO/MgO	magnesian calcite	magnesian calcite	magnesian calcite	calcareous dolomite	magnesian calcite	calcite	calcite	......	calcite	......	calcite	magnesian calcite	calcareous dolomite

	Kansas												
	14	15	16	17	18	19	20	21	22	23	24	25	26
	15C53-14	15C53-17	15C53-19	15C53-23	15C53-18	15C53-20	15C53-26	15C53-24	15C53-13	15C53-15	15C53-21	15C53-22	15C53-25
SiO_2	60.62	61.10	62.70	63.50	62.26	63.11	64.42	64.02	58.02	60.86	63.30	63.32	64.38
Al_2O_3	.03	1.32	1.84	1.86	.95	1.75	.08	1.07	1.49	2.40	1.08	.98	1.98
Fe_2O_3	1.48	.50	.42	.64	.21	.00	.92	.83	.08	1.62	1.52	2.66	.18
MgO	.00	.87	.37	.37	.55	.37	.00	.38	.44	5.07	5.61	3.68	5.64
CaO	21.24	19.92	18.22	18.08	20.60	19.82	18.46	19.12	21.05	12.93	12.22	14.14	11.58
Na_2O+K_2O	......	......	......	......	......	0.37	......	[15] .03	......	.10	.12	......	......
H_2O-	.04	......	......	......	......	......	.04	......	......	......	......	......	......
TiO_2	......	......	......	......	......	......	......	......	.59	......	......	......	......
P_2O_5	......	......	......	......	......	......	......	......	Nil	......	......	......	......
SO_3	.00	.09	.00	.00	.00	.00	.00	.00	.03	.00	.00	.01	.00
$BaSO_4$	......	......	......	......	......	......	......	......	.00	......	......	......	......
Ignition loss	16.31	15.68	16.00	15.20	15.24	14.95	15.74	14.55	16.60	16.92	15.70	15.04	16.16
Total	99.72	99.48	99.55	99.65	99.81	100.37	99.66	100.00	98.30	99.90	99.55	99.83	99.92
Class	59, 4, 36	58, 5, 34	59, 7, 33	59, 7, 33	60, 3, 34	60, 5, 33	63, 3, 33	61, 5, 32	55, 5, 37	55, 11, 34	60, 7, 32	59, 9, 31	61, 7, 32
CaO/MgO	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	......	calcite	calcareous dolomite	......	......	......

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not determined. Zn and Ag looked for in all samples but not detected]

	6	8	11		6	8	11
B	0.0001	–	0.01	Cu	0.0002	0.0005	0.002
Ti	.04	0.005	.001	Mo	–	–	.0002
V	.0015	.04	.0005	Sn	–	.003	.02
Cr	.0003	.015	.005	Ba	–	.002	–
Mn	.036	.03	.025	Pb	Tr.	.0005	.005
Ni	.00005	.001	.01				

[1] Includes MnO, ZrO_2, V_2O_5 and TiO_2 if present.
[2] Total iron.
[3] Carbonate, 0.16 percent.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Above 110° C.
[6] Reported as organic matter.
[7] At 110° C.
[8] As carbonate.
[9] Not included in total, included in ignition loss.
[10] Reported as CO_2.
[11] Reported as CO_2. By difference, not included in total.
[12] 105° - 1,000° C.
[13] BaO, ZnO, and CuO reported as faint trace; SrO and ZrO_2 reported as none.
[14] Reported $BaSO_4$ as nil.
[15] Average of two tests.

DESCRIPTIVE NOTES

[First page number in reference indicates source or analysis]

Colorado

1. Chaffee County. Pennsylvanian, Weber formation, upper part. Secs. 21 and 22, T. 13 S., R. 77 W., Trout Creek Pass. Analyst, Hills. Lab. No. 3. (Johnson, 1940, p. 593, 573-575, 589, 590.) Algal limestone, large quantity of included foreign material. Description of organism which built colonies. Index map, detailed measured section. (For other analyses of algal limestone in Colorado, see sample 3 this group, and sample 8 group A, sample 94 group B, samples 7 and 20 group F_1, and samples 16 and 70 group F_2 of this compilation.)
2. Dolores County. Pennsylvanian, Hermosa formation, lower part. (T. 40 N., R. 11 W.), Forest-Payroll mine, Rico District. Analyst, Hillebrand. (Ransome, 1901, p. 283, 239, 282, 346, pl. 41.) Limestone, light-buff, siliceous, fine-grained, laminated; in blanket 5-6 ft thick; partially altered to sooty material. Index map, geologic map. An analysis of the alteration product or residue of the limestone is also given.
3. Park County. Weber formation, upper part. NE¼ sec. 22, T. 11 S., R. 78 W., Sherman's ranch. Analyst, Hills. Lab. No. 4. (Johnson, 1940, p. 593, 573, 582, 583.) Algal limestone, dark-gray; irregular bed 6-8 cm thick in black shales. Description of organism which built colonies. Index map. (For other analyses of algal limestone in Colorado, see sample 1 this group, and sample 8 group A, sample 94 group B, samples 7 and 20 group F_1, and samples 16 and 70 group F_2 of this compilation.)
4. Summit County. Pennsylvanian, Minturn formation (A. H. Koschmann, written communication, 1956). (T. 7 S., R. 79 W.), Robinson mine (1.5 miles southwest of town of Kokomo). Analyst, Eakins. (Clarke, 1915, p. 220.) Sandstone.

Kansas

5. Bourbon County. Pennsylvanian, Fort Scott limestone, lower part. (T. 25 S., R. 25 E.) cement works north of town of Fort Scott. Analyst, Bartow. (Haworth, 1898, p. 67.) Limestone, about 4 ft thick. Use: Cement material. (For another analysis from same measured section see sample 30, group F_1 of this compilation.)
6. Brown County. Pennsylvanian, Wabaunsee group, Auburn shale member. SW¼ sec. 29, T. 1 S., R. 18 E. Lab. No. 51273. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 7 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.
7. Cherokee County. Mississippian, Warsaw limestone, or Keokuk(?) limestone. (T. 34 S., R. 25 E.) town of Galena. Analyst, Robertson. Lab. No. 355. (Winslow, 1894, p. 731; Haworth and others, 1904, p. 79.) Limestone, cherty.
8. Elk County. Pennsylvanian, Topeka limestone, Hartford limestone member. SW¼ sec. 12, T. 30 S., R. 10 E. Lab. No. 5381. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) (Calcareous shale), 4.1 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.
9. Ellsworth County. Lower Cretaceous, Kiowa shale. SE¼ sec. 19, T. 16 S., R. 6 W. Lab. No. 8973. (Swineford, 1947, p. 91, 59, 90, 93.) Calcareous sandstone. Soluble in HCl, 37.00 percent. Bulk density, 2.65. Estimated tonnage, outcrop map, physical tests. Use: Dam construction. Possible use: Concrete aggregate.
10. County, formation, locality, and reference as in sample 9. Lab. No. 12709. Calcareous sandstone; rock dust from crusher. Soluble in HCl, 32.00 percent. Bulk density, 2.66. Estimated tonnage, outcrop map, physical tests.
11. Geary County. Permian, Barneston formation, Florence limestone member. NW¼ sec. 10, T. 12 S., R. 5 E. Lab. No. 53158. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 24 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.
12. Leavenworth County. Pennsylvanian, Wyandotte limestone, Argentine limestone member. SW¼ sec. 13, T. 12 S., R. 22 E. Lab. No. 49275. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone, 8 ft thick. Chips from continuous surface. Index map, resume of spectrographic results.

Kansas--Continued

13. Lincoln County. Upper Cretaceous, Dakota sandstone or upper part of Kiowa shale. NW¼ sec. 7, T. 12 S., R. 10 W. Analyst, Runnels. (Frye and Swineford, 1947, p. 373.) Quartz sandstone, buff to gray, fine- to medium-grained; dense to homogeneous; crossbedded. Generally occurs in lenticular masses in loose sand partly cemented with iron oxide. Soluble in HCl, 37.13 percent. Cross profile, particle size distribution; photographs of solution features. (See also: Swineford, 1947, p. 74, 59, 72, 93. Calcareous sandstone, outcrop map. Possible use: Concrete aggregate.)

14-26. Lincoln County. Dakota sandstone. (Swineford, 1947, p. 91, 59, 90, 98.) Calcareous sandstone. Outcrop map. Possible use: Concrete aggregate.

14-17. Sec. 6, T. 12 S., R. 7 W. Physical tests.

14. Lab. No. 24711. Apparent bulk density, 2.65. Soluble in HCl, 40.50 percent.
15. Lab. No. 6128. Bulk density, 2.64. Soluble in HCl, 34.78 percent.
16. Lab. No. 9820. Bulk density, 2.61. Soluble in HCl, 37.28 percent.
17. Lab. No. 9819. Bulk density, 2.62. Soluble in HCl, 36.08 percent.

18. NE¼ sec. 12, T. 12 S., R. 8 W. Lab. No. 23934. Sample from material lost in Los Angeles abrasion test. Soluble in HCl, 35.00 percent.
19. NE¼ sec. 12, T. 12 S., R. 8 W. Lab. No. 23934. Bulk density, 2.63. Soluble in HCl, 34.91 percent. Physical tests.
20. NE¼ sec. 12, T. 12 S., R. 8 W. Lab. No. 247717. Apparent bulk density, 2.65. Soluble in HCl, 37.54 percent. Physical tests.
21. NE¼ sec. 12, T. 12 S., R. 8 W. Lab. No. 9819. Occurs in lentils in sec. 12, 13, 14, 23, and 24, T. 12 S., R. 8 W. Soluble in HCl, 35.27 percent.
22. Sec. 13, T. 12 S., R. 8 W. Analyst, Runnels. (Swineford, 1947, p. 74, 59.) Soluble in HCl, 39.74 percent. Outcrop map. (See also Frye and Swineford, 1947, p. 373, 367, 368. Dakota sandstone or Kiowa shale, upper part. Analyst, Runnels. Lab. No. 2. Quartz sandstone, buff to gray, fine- to medium-grained, dense, homogeneous, crossbedded. Generally occurs in lenticular masses in loose sand or sandstone partly cemented with iron oxide. Particle size distribution.)

23-26. NE¼ sec. 7, T. 12 S., R. 10 W.

23. Quartzite Stone Co. quarry. Lab. No. 23997. Area contains large lentils of hard sandstone 0.5 mile in diameter and up to 50 ft thick. Bulk density, 2.60. Soluble in HCl, 37.97 percent. Estimated tonnage. Physical tests.
24. Soluble in HCl, 35.01 percent.
25. Lab. No. 27423. Bulk density, 2.56. Soluble in HCl, 34.04 percent. Insoluble residue 65.96 percent. Physical tests.
26. Lab. No. 11562. Bulk density, 2.61. Soluble in HCl, 35.22 percent. Physical tests.

TABLE 7.—Analyses of samples from Colorado, Kansas, Montana, North Dakota, and Wyoming containing uncombined silica and carbonates each less than 75 percent; uncombined silica and carbonates each greater than clay (Group C) common and mixed rock categories--Continued

	Kansas											
	27	28	29	30	31	32	33	34	35	36	37	38
	15C56-1	15C57-8	15C57-9	15C57-7	15C58-1	15C66-1	15C77-10	15C80-7	15C81-1	15C81-2	15C82-2	
SiO_2	36.62	60.29	61.61	55.88	28.25	24.02	55.08	62.57	60.71	24.93	46.36	90.40
Al_2O_3	[1] 5.67	[2] 2.07	1.31	[2] 2.37	[3] .76	[3] 2.03	1.07	1.06	[3] .70	[3] .46	4.80	2.38
Fe_2O_3	1.86	.19	.52	.50	[4] .42	[4] .62	.11	.90	[4] .52	[4] .42	[2] 3.17	1.98
MgO	.92	1.42	5.75	6.92	.60	1.11	.80	.20	.46	1.14	.45	.29
CaO	29.39	17.82	16.07	13.51	38.71	39.55	22.50	20.39	19.91	40.24	23.45	.42
Na_2O	......	......	......	......	......	......	......	......	......	......	......	[5] Nil
K_2O	......	......	......	......	......	......	......	......	......	......	......	3.05
TiO_2	......	......	.18	......	......	......	......	.21	......	......	......	.87
P_2O_5	.13	[6] Nil	[6] Nil	......	.06	.07	......	......	.04	.14	.56	......
S	......	......	......	......	[7] (.02)	Nil	......	......	......	......	Nil	......
SO_3	Nil	[8] 1.37	.00	.07	Tr.	.11	.00	.00	.56	.20	......	......
BaO	......	[9] 1.94	[10] .00	[10] .00	......	......	......	[10] .00	......	......	......	......
Ignition loss	23.84	13.61	16.48	18.35	[11] 30.92	[11] 31.38	20.32	13.99	[11] 16.20	[11] 32.29	[12] 19.03	[12] .61
Total	98.43	98.71	101.92	97.60	99.72	[13] 98.89	99.88	99.32	99.10	99.82	97.82	100.00
Class	25,22,50	56,7,29	59,5,35	51,8,37	26,3,69	20,8,69	53,5,42	60,5,31	59,3,36	24,2,73	34,22,39	......
CaO/MgO	calcite	......	calcareous dolomite	calcareous dolomite	calcite	calcite	calcite	......	calcite	calcite	calcite	......

	Kansas				Montana				North Dakota			
	39	40	41	42	43	44	45	46	47	48	49	50
	15C92-2		15C101-16	15C104-1	25C12-2	25C15-2	25C16-6	25C16-23	33C21-8	33C21-4	33C21-6	33C21-9
Insoluble	......	......	......	......	......	......	[14] 23.50	[14] 25.24	[15] (34.27)	[15] (25.81)	[15] (29.98)	[5] (61.42)
SiO_2	47.95	90.20	62.56	57.55	44.80	35.58	......	......	31.57	20.71	26.27	60.45
Al_2O_3	6.53	3.76	[2] 2.12	[3] 3.14	8.96	3.40	} 2.50	5.30	2.70	3.53	3.94	5.13
Fe_2O_3	[2] 2.60	1.87	1.49	7.03	......	1.56						
FeO	......	......	......	......	[4] 2.85	.87	......	......	......	......	......	......
MgO	.62	.40	.72	.90	5.90	10.09	[16] 2.95	[16] 12.07	......	......	......	......
CaO	22.73	.45	16.71	15.82	16.42	19.72	[16] 38.01	[16] 22.53	33.77	42.66	37.02	14.08
Na_2O	......	[5] .58	......	.46	.43	.51	......	......	......	......	......	......
K_2O	......	1.91	......	.68	2.14	1.21	......	......	......	......	......	......
H_2O+	......	......	......	......	} [18] 3.33	[17] 2.93	......	......	......	......	......	......
H_2O-	......	......	......	......		[19] .17	......	......	[15] (15.79)	[15] (18.95)	[15] (2.28)	[15] (13.30)
TiO_2	......	.67	......	......	.37	......	......	......	......	......	......	......
P_2O_5	Nil	......	......	.09	......	......	......	......	......	......	......	......
CO_2	......	......	......	......	[20] 15.42	23.80	......	......	......	......	......	......
SO_3	[21] Nil	......	.00	Nil	......	......	......	......	......	......	......	......
BaO	......	......	.00	......	......	......	......	......	......	......	......	......
Ignition loss	[12] 16.87	[12] .46	14.17	[11] 14.33	......	[22] .03	......	......	[23] 28.08	[23] 32.78	[23] 29.60	[23] 18.99
Total	97.30	100.30	97.77	100.00	100.62	99.87	66.96	65.14	96.12	99.68	96.83	98.65
Class	33,26,33	......	57,10,30	44,26,27	29,28,33	28,16,51	(19,7)73	(16,16)65	27,9,60	15,10,73	20,12,65	52,22,25
MgO/CaO	calcite	......	......	......	calcareous dolomite	calcareous dolomite	magnesian calcite	calcareous dolomite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (—) indicates element not present in detectable amount, except Sr present in each sample but not determined. Zn, Mo, Sn, and Ba looked for in each sample but not detected]

	31	32	36	42		31	32	36	42
B	0.003	—	0.002	0.02	Ni	0.0003	0.0005	0.0003	0.002
Ti	.01	Tr.	.001	.08	Cu	.00003	.002	.0005	.000025
V	Tr.	—	Tr.	.05	Ag	—	—	—	.00001
Cr	.0005	0.001	.0005	.01	Pb	—	—	—	.02
Mn	.008	.20	.03	.25					

[1] Includes MnO and TiO_2.
[2] Includes TiO_2.
[3] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[4] Total iron.
[5] By difference.
[6] Reported by Frye and Swineford (1947, p. 373).
[7] Not included in total, included in ignition loss.
[8] Includes 1.01 percent SO_3 calculated from reported $BaSO_4$.
[9] Calcnlated from reported $BaSO_4$.
[16] Reported as $BaSO_4$.
[11] 105° - 1,000° C.
[12] 140° - 1,000° C.
[13] 99.34 in text.
[14] Reported as insoluble (Silica), (Peale, 1893, p. 40).
[15] Not included in total.
[16] Calculated from reported $MgCO_3$ or $CaCO_3$.
[17] Above 110° C.
[18] Determined by loss on ignition, corrected for CO_2 and oxidation of ferrous iron.
[19] At 110° C.
[20] Presence of small amount of carbonaceous matter determined qualitatively.
[21] Reported as S.
[22] Reported as C.
[23] Ignition loss on dry basis.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

27. Lyon County. Pennsylvanian, Dover limestone. NW¼SW¼ sec. 25, T. 16 S., R. 12 E. (O'Connor and others, 1953, p. 25, 32, 33, pls. 1, 2.) Limestone, outcrop sample, composite of entire bed, 1.5 ft thick. Geologic and economic maps, geologic cross section.

28-30. McPherson County. Lower Cretaceous, Kiowa shale. Analyst, Runnels. (Swineford, 1947, p. 74, 59, 100, pl. 5.) Outcrop map.

28. Sec. 25, T. 17 S., R. 1 W. Sandstone, calcite-barite cement. Soluble in HCl, 35.45 percent. (Similar sample in Frye and Swineford, 1947, p. 373, 367, 368. Kiowa shale, upper part or Upper Cretaceous, Dakota sandstone. NE¼ sec. 25, T. 17 S., R. 2 W.) Lab. No. 4. Quartz sandstone, buff to gray, fine- to medium-grained, dense, homogeneous, crossbedded. Generally occurs in lenticular masses in loose sand or sandstone partly cemented with iron oxide.

29. Sec. 19, T. 17 S., R. 2 W. Sandstone, dolomitic cement. Isolated outcrop. Soluble in HCl, 36.08 percent. Photomicrograph. (See also Frye and Swineford, 1947, p. 373, 367, 368. Remarks as in sample 28. Lab. No. 3. Particle size distribution.)

30. Sec. 1, T. 18 S., R. 2 W. Sandstone, dolomitic cement. Soluble in HCl, 41.34 percent. Possible use: Concrete aggregate.

31. Marion County. Permian, Barneston formation, Florence limestone member. SE¼ sec. 6, T. 21 S., R. 5 E. Lab. No. 53194. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 22.1 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

32. Nemaha County. Permian, Cottonwood limestone. NE¼ sec. 24, T. 3 S., R. 14 E. Lab. No. 51323. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 4 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

33. Rawlins County. Pliocene, Ogallala formation. Sec. 10, T. 4 S., R. 36 W. (Frye and Swineford, 1946, p. 63, 62, 71.) Chert, gray to white to cream-colored; mottled on exposed surface. Maximum thickness 12 ft. Physical tests. Bulk density, 2.21. Possible use: Railroad ballast, riprap, road metal.

34. Rice County. Kiowa shale. Sec. 26, T. 20 S., R. 10 W., near town of Raymond. Analyst, Runnels. (Swineford, 1947, p. 74, 59, 93, 100, 101.) Sandstone, calcite cement, 5 ft thick. Outcrop sample. Soluble in HCl, 34.58 percent. Outcrop map. Possible use: Concrete aggregate.

35-36. Riley County. Permian. Chips from continuous surface. Index map, résumé of spectrographic results.

35. Beattie limestone, Morrill limestone member. Sec. 10, T. 8 S., R. 7 E. Lab. No. 48176. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86.) (Calcareous shale), 3 ft thick.

36. Wreford limestone, Threemile limestone member. Sec. 2, T. 8 S., R. 6 E. Lab. No. 49405. (Runnels and Schleicher, 1956, table 6, pl. 1, p. 86, 97.) Limestone, 10 ft thick.

37-38. Rooks County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. SW¼ sec. 34, T. 7 S., R. 19 W. Index map. (For another analysis from same measured section see sample 309, group F_2 of this compilation.)

37. Lab. No. Ro-4-A1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 24.) Chalk; lower part of basal bed. Insoluble residue, 51.46 percent.

38. Lab. No. Ro-4-A1aI. (Runnels and Dubins, 1949, p. 23.) Analysis of coarser portion of insoluble residue of sample 37.

39-40. Smith County. Niobrara formation, Fort Hays limestone member. NE¼ sec. 32, T. 5 S., R. 13 W. Index map, columnar section. (For other analyses from same measured section see samples 333 - 338, group F_2 of this compilation.)

39. Lab. No. Sm-1-1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 24.) Chalk. Composite sample from first foot of basal bed. Insoluble residue, 61.16 percent.

Kansas--Continued

40. Lab. No. Sm-1-1aI. (Runnels and Dubins, 1949, p. 23.) Analysis of coarser portion of insoluble residue of sample 39.

41. Washington County. Dakota sandstone. Sec. 11, T. 3 S., R. 4 E. Analyst, Runnels. (Swineford, 1947, p. 74, 59, 93.) Sandstone, calcite cement. Soluble in HCl, 34.28 percent. Outcrop map. Possible use: Concrete aggregate.

42. Woodson County. Pennsylvanian, Stranger formation, Westphalia limestone member. NW¼ sec. 1, T. 25 S., R. 15 E. Lab. No. 52322. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Remarks as in samples 35-36. Calcareous shale, 3.5 ft thick.

Montana

43. Deer Lodge County. Precambrian, Newland limestone. Sec. 6, T. 5 N., R. 13 W., gorge below Georgetown Lake. Analyst, Schaller. (Emmons and Calkins, 1913, p. 45, 19, 44, pls. 1, 2.) Limestone, impure, dark, fine-grained; stained with yellowish-brown ocher on weathered surface. Index maps, geologic map. Petrographic data given.

44. Flathead County. Precambrian, Siyeh formation. (T. 37 N., R. 20 W.) cliffs of Sawtooth ridge, 1.5 miles east of Lower Kintla Lake. Analyst, Dittrich. Lab. No. 1306. (Daly, 1912, p. 75, 71-76.) Limestone, impure. Sample represents average composition. Bulk density, 2.741. Calculated mineral composition, molecular percentage. General description of formation, measured section.

45. Gallatin County. Precambrian, Belt series. (T. 2 N., Rs. 1 and 2 E.) north of East Gallatin River, near town of Three Forks. Analyst, Catlett; collector, Peale. (Peale, 1893, p. 16, 17, pls. 1, 4; Clarke, 1915, p. 238.) Limestone, siliceous. General description: Occurs in bands, 5 to 20 ft thick, many beds blue-black on fresh fractures with light yellowish-brown on weathered surface; finely laminated; in series with sandstones, conglomerates and slates. Geologic map, columnar section.

46. Gallatin County. Upper Mississippian and Pennsylvanian, Quadrant formation. North of Gallatin River. Analyst, Catlett; collector, Peale. (Peale, 1893, p. 40; Clarke, 1915, p. 238.) Limestone, red, argillaceous. Geologic map.

North Dakota

47-50. Hettinger County. Oligocene, White River formation. Sec. 17, T. 136 N., R. 93 W., Colgrove Butte. Analyst, under supervision of Burr. Correlation (fence) diagram. Overburden, estimated tonnage. Index maps, geologic maps, detailed measured sections or logs of drill holes. Use: Not useful for cement material due to chert content, low calcium carbonate content, or thin beds.

47. NE¼NE¼ sec. 17. Lab. No. 48-11. (Hansen, 1953, fig. 7B, p. 44, 134, 137, 145, figs. 6, 14.) Limestone, contains chert, about 1 ft thick.

48. NE¼NE¼ sec. 17. Lab. No. 48-5. (Hansen, 1953, fig. 7B, p. 44, 134, 137, 145, figs. 6, 14.) Calcareous clay, about 1 ft thick.

49. SW¼NW¼ sec. 17. Lab. No. 34-2. (Hansen, 1953, fig. 7B, p. 44, 134, 137, 154, figs. 6, 14.) Limestone, gray, dense; brown chert in upper 18 in. of bed 2 ft thick.

50. NE¼SE¼ sec. 17. Lab. No. 11-2. (Hansen, 1953, fig. 7A, p. 44, 134, 137, 154, figs. 6, 14.) Clay, gray-green, calcareous, soft, blocky; 16.5 ft thick. (For another analysis from same measured section see sample 26, group F_1 of this compilation.)

TABLE 7.—Analyses of samples from Colorado, Kansas, Montana, North Dakota, and Wyoming containing uncombined silica and carbonates each less than 75 percent; uncombined silica and carbonates each greater than clay (Group C) common and mixed rock categories--Continued

	North Dakota				Wyoming						
	51	52	53	*54	55	56	*57	*58	*59	*60	*61
	33C21-5	33C21-7	33C45-172	33C45-173	49C1-4	49C12-58	49C12-70	49C12-71	49C12-72	49C12-73	49C12-74
Insoluble[1]	(29.41)	(48.77)	(43.68)	(35.19)	22.87	(64.7)	(16.2)	(22.7)	(23.8)	(27.3)	(28.0)
SiO_2	21.33	30.01	40.39	27.54		53.36	16.02	21.25	21.20	25.91	25.87
Al_2O_3	3.54	4.14	4.98	1.51	1.81	7.5	1.2	1.7	2.0	2.7	2.8
Fe_2O_3	.40			.99		2.5	1.5	1.1	1.2	1.3	1.4
MgO	2.48	......	......	3.38	Tr.	5.8	6.7	5.9	9.0	3.3	5.0
CaO	35.36	38.37	29.84	33.02	39.83	10.00	35.00	30.9	26.7	29.4	27.8
Na_2O	......	......	......	......	......	.40	.77	.42	.30	.63	.60
K_2O	......	......	......	......	......	4.10	.83	1.65	2.29	2.26	1.53
H_2O+	......	......	......	......	......	[2] 1.27	[2] 1.95	[2] 2.29	[2] 2.30	[2] 4.02	[2] 3.30
H_2O-	[1] (6.21)	[1] (9.68)	[1] (2.13)	[1] (2.38)	......	.33	.55	.71	.70	1.38	1.30
TiO_2	......	......	......	......	......	.18	.17	.31	.11	.21	.21
P_2O_5	......	......	......	......	......	.26	15.69	13.3	6.9	15.5	12.8
CO_2	30.80	......	......	23.87	31.00	13.3	17.7	16.0	23.5	8.6	12.5
SO_3	......	......	......	......	......	.39	1.2	1.5	1.1	2.3	2.1
V_2O_5	......	......	......	......	......	.09	.05	.05	.06	.06	.08
F	......	......	......	......	......	.12	1.6	1.6	.82	1.7	1.4
Ag	......	......	......	......	......	......	[3] .0003	......	......	......	......
Chem. U	......	......	......	......	......	.002	.002	.004	.002	.006	.004
Ignition loss	[4] 1.39	25.94	23.84	4.81	......	[1] (14.9)	[1] (20.2)	[1] (19.0)	[1] (26.5)	[1] (14.0)	[1] (17.1)
Subtotal	......	......	......	......	......	99.602	100.9323	98.684	98.182	99.276	98.694
Less O [5]	......	......	......	......	......	.05	.67	.67	.35	.72	.59
Total	95.30	98.46	99.05	95.12	95.51	99.6	100.3	98.0	97.8	98.6	98.1
Class	15,12,69	23,12,57	32,15,51	24,11,53	(21,4)70	37,28,28	12,9,38	17,10,34	16,11,49	20,15,18	19,15,27
CaO/MgO	magnesian calcite	calcite	calcite	magnesian calcite	calcite	.....	calcareous dolomite	calcareous dolomite	calcareous dolomite	......	......

	Wyoming										
	*62	*63	*64	*65	*66	67	*68	69	70	71	72
	49C12-75	49C12-76	49C12-77	49C12-78	49C12-79	49C12-57	49C12-80	49C12-59	49C12-60	49C12-61	49C12-56
Insoluble[1]	(24.4)	(25.5)	(40.2)	(28.8)	(29.2)	(28.7)	(47.4)	(27.6)	(41.2)	(38.6)	(35.6)
SiO_2	22.77	22.93	36.28	25.76	26.12	25.56	38.32	22.98	35.27	32.32	30.02
Al_2O_3	2.2	1.3	2.4	2.4	2.3	2.2	4.6	2.6	5.8	3.4	4.3
Fe_2O_3	1.3	1.2	1.9	.8	.8	.9	2.1	1.2	2.1	2.0	1.5
MgO	3.7	9.5	4.8	9.1	10.3	12.4	8.4	1.8	2.1	4.9	10.0
CaO	30.4	26.7	21.5	24.53	24.20	23.2	16.2	36.40	26.80	25.60	22.20
Na_2O	.70	1.02	1.10	1.00	.80	.45	1.19	1.10	.74	.90	1.00
K_2O	1.88	1.30	2.03	.97	1.05	.85	2.17	.70	1.45	1.47	1.22
H_2O+[2]	3.51	2.05	3.81	1.50	2.66	2.49	2.41	1.11	.96	1.48	1.39
H_2O-	1.39	.75	1.19	.60	.54	.41	.59	.29	.34	.32	.31
TiO_2	.21	.23	.36	.13	.26	.06	.06	.06	.19	.01	.31
P_2O_5	16.4	6.4	6.0	7.08	4.75	1.90	1.55	.80	2.11	.20	.81
CO_2	9.8	22.9	11.6	22.6	24.4	28.6	19.5	29.3	20.8	24.8	26.6
SO_3	2.7	1.3	3.1	1.2	1.0	.71	.63	.60	.90	.85	.48
V_2O_5	.09	.18	.23	.05	.05	.04	.05	.06	.06	.08	.06
F	1.8	.71	.88	.75	.50	.21	.19	.10	.24	.12	.15
Chem. U	.010	.002	.007	.001	.000	.007	.001	.0005	.0005	.001	.001
Ignition loss[1]	(14.7)	(25.7)	(16.6)	(24.7)	(27.6)	(31.5)	(22.5)	(30.7)	(22.1)	(26.6)	(28.3)
Subtotal	98.860	98.472	97.187	98.471	99.730	99.987	97.961	99.1005	99.8605	98.451	100.351
Less O [5]	.76	.30	.37	.32	.21	.09	.08	.04	.10	.05	.06
Total	98.1	98.2	96.8	98.2	99.5	99.9	97.9	99.1	99.8	98.4	100.3
Class	17,13,20	19,9,49	30,14,25	21,10,46	21,11,52	21,11,60	28,20,41	17,11,66	23,22,46	24,15,54	21,17,57
CaO/MgO	......	calcareous dolomite	......	dolomite	dolomite	dolomite	dolomite	magnesian calcite	magnesian calcite	magnesian calcite	calcareous dolomite

See following page for footnotes.

Semiquantitative spectrographic analyses

[E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. Li, Be, Co, Ga, As, Cd, Sn, Sb, Ta, W, Pt, Au, Hg, Pb, and Bi looked for in all samples but not detected]

	56	57	58	59	60	61	62	63	64	65	66	67	68
B	F	F	F	F	F	F	F	F	F	F	F	F	F
Cr	F	E	E	E	E	E	E	F	E	E	E	E	E
Mn	E	F	F	F	F	F	F	F	F	F	F	F	F
Ni	F	F	E	E	E	E	E	F	E	F	F	F	F
Cu	G	G	G	G	G	G	G	G	G	G	G	G	G
Zn	ND	ND	E	E	E	E	E	E	E	ND	ND	ND	ND
Sr	F	E	E	ND	E	E	E	ND	ND	ND	ND	ND	ND
Zr	E	F	F	F	F	F	F	F	E	F	F	F	E
Cb	E	ND	ND	ND	F	F	E	F	E	ND	ND	ND	ND
Mo	F	ND	F	F	F	F	F	F	F	F	F	F	F
Ag	G	G	G	G	G	G	G	G	G	G	G	G	G
Ba	E	E	ND	ND	ND	ND	ND	ND	E	ND	ND	ND	ND

Semiquantitative spectrographic analyses--Continued

	69	70	71	72		69	70	71	72
B	F	F	F	F	Sr	ND	ND	ND	ND
Cr	E	E	E	F	Zr	E	E	F	E
Mn	E	E	F	E	Cb	E	E	ND	ND
Ni	F	F	F	F	Mo	ND	F	ND	F
Cu	G	G	G	G	Ag	ND	ND	ND	ND
Zn	ND	ND	ND	ND	Ba	E	E	ND	ND

[1] Not included in total (except 55).
[2] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[3] Composite of four consecutive samples.
[4] (Loss on ignition less CO_2.)
[5] (Calculated from F by compilers.)

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

51-54. Oligocene, White River formation. Analyst, under supervision of Burr. Overburden, estimated tonnage. Index maps, geologic maps, detailed measured sections or logs of drill holes.

51-52. Hettinger County. NE¼NE¼ sec. 7, T. 136 N., R. 94 W., School Butte. (Hansen, 1953, fig. 11, p. 44, 134, 138, 159, figs. 10, 14.) Limestone. Correlation (fence) diagram. Use: Not useful for cement material due to low calcium carbonate content, thin beds, and large amount of overburden.

51. Lab. No. 19-5. Limestone, gray, 11 in. thick.

52. Lab. No. 18-1. Limestone, gray-white, clay inclusions; 1 ft 8 in. thick.

53. Stark County. SW¼NW¼ sec. 30, T. 137 N., R. 94 W., Long Butte. Lab. No. 14-5. (Hansen, 1953, fig. 9A, p. 44, 134, 138, 156, figs. 8, 14.) Limestone, gray, weathered; about 50 percent chert, 1 ft 2 in. thick. Correlation (fence) diagram. Possible use: Cement material. (For other analyses from same measured section see sample 66, group E and sample 37, group F_1 of this compilation.)

*54. Stark County. SW¼ sec. 36, T. 137 N., R. 94 W., Straight Butte. Lab. No. 29-1. (Hansen, 1953, fig. 13A, p. 44, 134, 138, 161, figs. 12, 14.) (Analysis suggests 7.1 percent more CaO and MgO than required for carbonates.) Limestone, chert, and clay inclusions; 6 in. thick. Use: Not useful for cement material due to thin beds.

Wyoming

55. Albany County. Upper Cretaceous, Niobrara formation. (T. 16 N., R. 73 W.), west of town of Laramie. Analyst, Wells. (Clarke, 1915, p. 237.) Limestone.

56-72. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall; spectrographic analyst, Mortimer. Trench samples. Modal grain size given. Index map, outcrop map; generalized columnar section, detailed columnar section. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in other groups of this compilation.)

56-58. (McKelvey and others, 1953, p. 15, 19, 2, 20, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, pl. 1.)

56. Lab. No. VEM-6-47. Mudstone, dolomitic, grayish-brown. Bed P-6, 2.6 ft thick, 137.95 ft from top of member.

*57. Lab. No. VEM-10-47. (Analysis suggests 37.2 percent phosphate, 2.6 percent gypsum; shows 1.6 percent alkalies.) Phosphate rock, dolomitic, brownish-gray. Contains pellets. Bed P-13, 0.9 ft thick, 133.15 ft from top of member.

*58. Lab. No. 2070. (Analysis suggests 31.5 percent phosphate, 3.2 percent gypsum; shows 2.1 percent alkalies.) Dolomite, phosphatic, argillaceous, brownish-gray. Fossiliferous, contains incipient pellets. Bed P-17, 0.4 ft thick, 128.65 ft from top of member.

59-61. (McKelvey and others, 1953, p. 15, 19, 2, 20, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.)

*59. Lab. No. 2071. (Analysis suggests 16.4 percent phosphate, 2.4 percent gypsum; shows 2.6 percent alkalies.) Dolomite, argillaceous, brownish-gray. Bed P-18, 0.7 ft thick, 127.95 ft from top of member.

*60. Lab. No. 2072. (Analysis suggests 36.7 percent phosphate, 5.0 percent gypsum; shows 2.9 percent alkalies.) Phosphate rock, argillaceous, dolomitic, brownish-black. Fossiliferous. Bed P-19, 1.1 ft thick, 126.85 ft from top of member.

*61. Lab. No. 2073. (Analysis suggests 30.3 percent phosphate, 4.5 percent gypsum; shows 2.1 percent alkalies.) Phosphate rock, argillaceous, brown. Bed P-20, 1.2 ft thick, 125.65 ft from top of member.

62-68. (McKelvey and others, 1953, p. 14, 18, 2, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.)

*62. Lab. No. 2074. (Analysis suggests 38.9 percent phosphate, 5.8 percent gypsum; shows 2.6 percent alkalies.) Phosphate rock, argillaceous, dolomitic; brownish-gray. Fossiliferous, contains pellets. Bed P-21, 0.9 ft thick, 124.75 ft from top of member.

*63. Lab. No. 2081. (Analysis suggests 15.2 percent phosphate, 2.8 percent gypsum; shows 2.3 percent alkalies.) Dolomite, argillaceous, light brownish-gray. Contains pellets. Bed P-28, 1.7 ft thick, 115.25 ft from top of member.

*64. Lab. No. 2082. (Analysis suggests 14.2 percent phosphate, 6.7 percent gypsum, 3.0 percent more CaO and MgO than can be present as carbonates; shows 3.1 percent alkalies.) Mudstone, dolomitic, brownish-black. Contains pellets. Bed P-29, 0.8 ft thick, 114.45 ft from top of member.

*65. Lab. No. LES-2-47. (Analysis suggests 16.8 percent phosphate, 2.6 percent gypsum; shows 2.0 percent alkalies.) Dolomite, argillaceous, dusky-brown. Contains pellets. Bed P-36, 0.9 ft thick, 108.05 ft from top of member.

*66. Lab. No. LES-3-47. (Analysis suggests 11.3 percent phosphate, 2.2 percent gypsum; shows 1.9 percent alkalies.) Dolomite, argillaceous, grayish-brown. Contains pellets. Bed P-37, 0.6 ft thick, 107.45 from top of member.

67. Lab. No. LES-4-47. Dolomite, argillaceous, brownish-gray. Fossiliferous. Bed P-38, 1.8 ft thick, 105.65 ft from top of member.

*68. Lab. No. LES-6-47. (Analysis suggests 3.7 percent phosphate, 1.4 percent gypsum; shows 3.4 percent alkalies.) Mudstone, dolomitic, light brownish-gray. Fossiliferous. Bed P-40, 3.0 ft thick, 102.05 ft from top of member.

69. Lab. No. VEM-39-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 81, pl. 1.) Limestone, argillaceous, light brownish-gray. Bed P-70, 1.1 ft thick, 55.35 ft from top of member. Photomicrograph.

70. Lab. No. VEM-51-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) Limestone, argillaceous, light brownish-gray. Bed P-82, 1.7 ft thick, 42 ft from top of member.

71-72. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, 86, pl. 1.)

71. Lab. No. VEM-59-47. Limestone, argillaceous, dolomitic; light brownish-gray. Fossiliferous. Bed P-90, 1.9 ft thick, 33.7 ft from top of member.

72. Lab. No. DML-1-47. Dolomite, argillaceous, light brownish-gray. Bed P-99, 1.4 ft thick, 25.2 ft from top of member. Photomicrograph.

TABLE 7.— Analyses of samples from Colorado, Kansas, Montana, North Dakota, and Wyoming containing uncombined silica and carbonates each less than 75 percent; uncombined silica and carbonates each greater than clay (Group C) common and mixed rock categories--Continued

	Wyoming										
	73	74	75	76	77	78	79	*80	81	*82	83
	49C12-62	49C12-63	49C12-64	49C12-65	49C12-66	49C12-67	49C12-68	49C12-82	49C12-69	49C12-81	49C15-2
Insoluble[1]	(63.8)	(68.5)	(72.3)	(66.7)	(73.8)	(73.0)	(61.5)	(69.6)	(77.6)	(46.8)	24.8
SiO_2	63.28	66.91	73.72	66.49	72.48	73.49	61.05	69.00	74.34	43.60	......
Al_2O_3	.4	.7	.3	.5	.4	.2	.7	1.5	2.4	3.8	......
Fe_2O_3	1.9	2.3	2.2	2.1	1.9	2.5	1.8	3.2	2.6	2.2	[2] 1.2
MgO	.62	.48	.41	.41	.64	.78	1.00	.39	.40	5.4	.9
CaO	18.00	14.00	11.50	16.40	12.00	11.80	19.00	13.20	9.00	19.80	39.0
Na_2O	......	......	.89	......	......	......	......	.32	.60	.72	......
K_2O	......	......	2.72	......	......	......	......	.42	.60	1.22	......
H_2O+[3]	.23	.32	......	.34	.85	......	.51	.57	.84	1.50	......
H_2O-	.07	.08	.15	.06	.05	.12	.09	.13	.16	.30	......
TiO_2	......	......	......	......	......	......	......	.10	.09	.27	......
P_2O_5	.25	.20	.23	.20	.22	.11	.65	4.71	.49	6.25	......
CO_2	14.1	11.2	9.5	12.7	9.3	9.6	14.7	5.3	6.6	13.5	......
SO_3	Nil	<.1	<.1	Nil	<.1	Nil	<.1	.21	.10	.43	......
V_2O_5	......	......	......	......	......	......	......	.03	.04	.05	......
F	.05	.04	.04	.04	.03	.05	.08	.54	.10	.68	......
Ignition loss[1]	(14.4)	(11.6)	(9.6)	(13.1)	(10.2)	(9.6)	(15.3)	(6.0)	(7.6)	(15.3)	......
Subtotal	98.90	96.33	101.76	99.24	97.97	98.65	99.68	99.62	98.36	99.72	......
Less O[4]	.02	.02	.02	.02	.01	.02	.03	.23	.04	.29	......
Total	99.9	< 96.3	< 101.7	99.2	< 98.0	98.6	< 99.7	99.4	98.3	99.4	65.9
Class	60,5,32	63,7,25	71,6,21	63,6,29	70,6,21	70,7,22	58,6,33	67,12,12	67,13,15	34,17,29	(25,0)72
CaO/MgO	......	......	......	......	......	......	magnesian calcite	......	......	......	calcite

	84	85	86	87
	49C15-3	49C19-3	49C19-18	49C24-31
Insoluble	24.1	......	......	......
SiO_2	......	31.45	31.28	42.2
Al_2O_3	......	1.58	1.83	......
Fe_2O_3	1.2	.21	.22	......
MgO	1.3	.08	.11	[5] 16.0
CaO	38.0	34.18	34.20	[5] 10.0
Na_2O	......	.28	.18	6.6 (Na_2O + K_2O)
K_2O	......	.33	.33	
H_2O	......	4.64	4.64	......
CO_2	......	26.82	26.79	......
Total	64.6	99.57	99.58	74.8
Class	(24,0)71	28,9,61	28,10,61	42,0,51
CaO/MgO	calcite	calcite	calcite	dolomitic magnesite

[1] Not included in total.
[2] Calculated as FeO from reported Fe.
[3] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[4] (Calculated from F by compilers.)
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

73-82. Lincoln County. Permian, Phosphoria formation. Sec. 7, T. 26 N., R. 119 W. Trench samples. Index map and outcrop map. Generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in other groups of this compilation.)

73-79. Rex chert member. (McKelvey and others, 1953, p. 12, 16, 2, pl. 1.) Chert and limestone.

73. Lab. No. VEM-62-47. Bed R-1; 9.6 ft thick, 57.2 ft from top of member.

74. Lab. No. VEM-64-47. Bed R-3; 10.4 ft thick, 37 ft from top of member.

75. Lab. No. VEM-65-47. Bed R-4; 9.0 ft thick, 28 ft from top of member.

76. Lab. No. VEM-66-47. Bed R-5; 10.5 ft thick, 17.5 ft from top of member.

77. Lab. No. VEM-67-47. Bed R-6; 9.0 ft thick, 8.5 ft from top of member.

78. Lab. No. VEM-68-47. Bed R-7; 8.5 ft thick, top of member.

79. Lab. No. VEM-69-47. Bed R-7. Top 1.4 ft of sample 78.

80-82. Upper shale member. (McKelvey and others, 1953, p. 11, 16, 2, pl. 1.)

*80. Lab. No. VEM-72-47. (Analysis suggests 11.2 percent phosphate.) Chert. Bed U-3; 1.1 ft thick; 55.5 ft from top of member.

Wyoming--Continued

81. Lab. No. VEM-74-47. Mudstone. Bed U-4; 0.6 ft thick, 54.9 ft from top of member.

*82. Lab. No. VEM-94-47. (Analysis suggests 14.8 percent phosphate; shows 1.9 percent alkalies.) Chert, dolomitic. Bed U-25; 0.8 ft thick; 2.3 ft from top of member.

83. Park County. Middle Cambrian, Park shale. Sec. 1, T. 58 N., R. 108 W., along Index Creek. Analyst, Bartzen. Lab. No. I-1D10. (Hanson, 1952, p. 42, pls. 7, 9.) Limestone. Isopach map, correlated columnar sections.

84. Park County. Upper Cambrian, Snowy Range formation. T. 58 N., R. 107 W., (U. M. Sahinen, written communication, 1957) along Fox Creek about 0.5 mile southeast of Index Creek. Analyst, Bartzen. Lab. No. I-2F12. (Hanson, 1952, p. 43, 39-40, pls. 8, 9.) Shale and limestone; mostly greenish-gray shale containing lenses of lithographic limestone; 11 ft thick, 134 ft below top of formation. Isopach map, detailed measured section, correlated columnar sections. (For other analyses from same measured section see analyses of Park County in groups F_1 and F_2 of this compilation.)

85-86. (Sweetwater County.) Eocene, Bridger formation. (T. 12 N., R. 111 W.) face of Turtle Bluffs. Analyst, Brewster. (Emmons, 1877, p. 247; King, 1878, table 6A.) Marl, green, fossiliferous.

87. Yellowstone National Park. (Recent. West Thumb), Yellowstone Lake. Analyst, Steitz. (Hayden, 1872, p. 130; Langford, 1905, p. 93, 94.) Sediment, white; from mud-springs.

TABLE 8.—Analyses of samples from Colorado containing more than 75 percent clay (Group D) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by connty and stratigraphic position]

	Colorado											
	1	2	3	4	5	6	7	8	9	10	11	12
	5D7-16	5D7-17	5D14-4	5D14-3	5D18-7	5D18-8	5D21-6	5D21-7	5D21-9	5D21-10	5D21-11	5D21-12
SiO_2	58.97	57.73	62.06	61.75	63.00	58.86	56.92	62.14	56.50	56.91	59.02	59.50
Al_2O_3	19.27	21.24	22.31	22.80	21.76	24.64	24.16	24.30	29.10	29.04	24.59	25.41
Fe_2O_3	5.58	4.01	2.03	2.08	2.29	4.11	4.34	1.15	3.29	3.92	5.76	2.29
MgO	1.10	1.21	None	None	.81	.74	1.92	1.45	Tr.	2.64	......	1.65
CaO	.57	.81	None	None	.16	.24	.49	1.32	.60	1.90	.39	.65
Na_2O	.21	.31	......	......	Tr.	Tr.	2.10	Tr.	Tr.	.23	Tr.	Tr.
K_2O	1.01	1.87	......	......	1.51	3.03	3.48	1.11	.25	.62	.67	3.13
H_2O -	2.08	2.74	......	......	1.57	.45	.57	2.80	.70	.70	.70	1.57
TiO_2	......	......	.76	.68	......	......	......	......	......	......	......	......
SO_3	......	Tr.	......	......	Tr.	......	......	Tr.	Tr.	......	......	......
Ignition loss	11.16	10.45	10.05	9.50	9.57	8.50	5.39	6.39	9.81	4.20	9.37	6.43
Total	99.95	100.37	97.21	96.81	100.67	100.57	99.37	100.66	100.25	100.16	100.50	100.63
Class	19,77,3	16,79,4	20,76,0	19,77,0	22,75,2	11,85,2	9,82,0	18,79,0	1,98,1	1,94,0	9,90,1	12,83,0

	13	14	15
	5D21-14	5D22-5	5D22-4
SiO_2	56.16	61.7	58.34
Al_2O_3	26.65	21.8	26.29
Fe_2O_3	3.22	1.2	2.69
MgO	.04	1.0	.67
CaO	.60	Tr.	Tr.
Na_2O	.48	......	......
K_2O	0.35	......	......
H_2O-	[1] 1.91	......	......
TiO_2	1.12	......	......
Ignition loss	9.51	13.4	12.40
Total	100.04	99.1	[2] 100.39
Class	5,92,1	22,75,2	9,90,1

[1] At 100° C.

[2] 100.32 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1-2. Boulder County. Analyst, Tremaine. (Butler, 1915, p. 342, 158, 163, 165, 303, 318-321.) Index map. Ceramic tests, physical properties, mineralogy.

1. Upper Jurassic, Morrison formation. T. 1 N., R. 71 W., Polecat Canon, near town of Boulder, Adamant Brick Co. Lab. No. 46. Shale, black, medium-grained, hard; yellow streaks on weathered surface; 20 ft thick, overburden 2 ft. Possible use: Brick.

2. Upper Cretaceous, Laramie formation. T. 1 S., R. 69 W., about 1 mile northeast of town of Louisville, Summit mine. Lab. No. 39. Clay, dark-gray, fine-grained, very hard, massive, contains thin streaks of sand; 10 ft thick; 2 ft exposed. Possible use: Brick, earthenware.

3-4. Custer County. Upper Cretaceous, Dakota sandstone, Dry Creek Canyon member. SE¼SE¼ sec. 11, T. 22 S., R. 69 W., north bank of South Hardscrabble Creek. Analyst, Cress. (Waage, 1953, p. 97, 3, 6, 21, 86, 87.) General description: Plastic clay, light-gray, blue-gray to black, massive to blocky; compact, tough splintery to rough blocky fracture. Index map, outcrop map; generalized columnar section. Use: Not valuable for refractories.

3. Lower bed of sandy, plastic clay; 3 ft thick.

4. Upper bed of sandy plastic clay; 3.5 ft thick.

5-6. Douglas County. Analyst, Tremaine. (Butler, 1915, p. 342, 181, 184, 185, 305, 322, 323.) Index map. Ceramic tests, physical properties, mineralogy.

5. Laramie formation. T. 7 S., R. 67 W., 4 miles west of town of Sedalia. Lab. No. 115. Shale, dark-brown, fine-grained, soft; 4 ft thick, overburden 3 ft. Possible use: Brick, vitrified and unvitrified floor tile.

6. Upper Cretaceous and Eocene, Dawson arkose. T. 9 S., R. 67 W., 2.5 miles north of town of Larkspur. Lab. No. 109. Clay, red and gray, medium coarse-grained, sandy, medium-hard; 7 ft lens-shaped bed, overburden 11 ft, 600 ft below top of formation. Possible use: Brick.

7-12. El Paso County. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

7. Pennsylvanian, Fountain formation. (T. 14 S., R. 67 W.), 0.25 mile west of Balanced Rock, Garden of the Gods. Lab. No. 158. (Butler, 1915, p. 343, 188, 197, 306, 324, 325.) Shale, red and green, medium fine-grained, medium soft; 2 ft thick, overburden 3-8 ft. Possible use: Brick. Former use: Pottery.

Colorado--Continued

8. Dakota sandstone. T. 16 S., R. 67 W., 8.75 miles west of town of Fountain. Lab. No. 135. (Butler, 1915, p. 342, 188, 191, 305, 322, 323.) Clay, black, very fine-grained, hard; 7 ft thick, overburden 5 ft. Possible use: Brick, earthenware.

9. Dawson arkose. T. 12 S., R. 62 W., 1 mile southeast of town of Calhan. Lab. No. 171. (Butler, 1915, p. 343, 188, 200, 306, 324, 325.) Clay, grayish-red, fine-grained, hard; contains a little sand; 9 ft sampled, overburden 10-25 ft. Possible use: Brick, earthenware, refractories, drain tile, wall tile, vitrified floor tile.

10. Dawson arkose. Near Calhan. Lab. No. 147. (Butler, 1915, p. 342, 188, 194, 305, 324, 325.) Fire clay. Possible use: Refractories, brick.

11. Dawson arkose. Locality, 0.75 mile southwest of Calhan. Lab. No. 169. (Butler, 1915, p. 343, 188, 199, 306, 324, 325.) Clay, light-brown, fine-grained, sandy, hard; 5 ft sampled, overburden 10 ft. Possible use: Brick, earthenware, refractories, stoneware.

12. Dawson arkose. (T. 12 S., R. 67 W.), 0.25 mile north of town of Edgerton. Lab. No. 165. (Butler, 1915, p. 343, 188, 198, 306, 324, 325.) Clay, gray and red, medium coarse-grained, sandy, hard; 5 ft sampled. Possible use: Brick, earthenware, vitrified and unvitrified floor tile, stoneware.

13. El Paso County. (Dawson arkose. T. 12 S., R. 61 W.) southeast of Calhan. (Richardson, 1911, p. 295, 293.) Clay, light buff, fine-textured. Ceramic tests. Possible use: Face brick.

14-15. Fremont County. Lower Cretaceous, Purgatoire formation, Glencairn shale member. (Waage, 1953, p. 97, 3, 6, 31, 53, 79, 80.) Index map, outcrop maps; generalized columnar sections. Possible use: Low-grade to semi-refractories, terra cotta, conduits.

14. NE¼NW¼ sec. 20, T. 18 S., R. 69 W., Standard Fire Brick Co. mine. Lab. No. 90. Clay, dark blue-gray, plastic; 5-8 ft thick; from upper 15 ft of member.

15. Sec. 14, T. 19 S., R. 71 W., Diamond Fire Brick Co. mine. Lab. No. 89. Clay, blue-gray, plastic; at top of member. Deposit largely mined out.

TABLE 8.—Analyses of samples from Colorado containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	Colorado												
	16	17	*18	19	*20	21	22	23	24	25	26	27	28
	5D22-12	5D22-13	5D23-5	5D23-6	5D23-7	5D28-9	5D28-10	5D28-11	5D28-12	5D28-8	5D30-38	5D36-4	5D38-1
SiO_2	64.89	63.14	52.57	52.63	22.89	57.16	63.01	63.16	63.00	61.39	56.41	59.47	59.97
Al_2O_3	32.89	23.46	17.80	23.15	4.77	26.78	24.40	22.75	24.00	25.97	26.37	21.26	21.52
Fe_2O_3	1.20	.69	6.85	1.60	[1] 2.97	1.55	1.26	1.57	1.74	1.33	......	3.59	4.38
MgO	.17	.12	3.95	2.75	1.94	.57	.60	1.06	.75	......	.20	Tr.	Tr.
CaO	.52	.49	4.77	3.62	6.29	.38	.19	.44	.20	1.35	.29	1.65	4.13
Na_2O	......	.23	.15	Tr.	2.05	......	......	......	......	.46	} 1.55	Tr.	.58
K_2O	......	.38	5.22	4.13	1.52	......	......	......	......	.46	}	2.00	2.22
H_2O+	......	......	......	......	} .22	......	......	......	......	......	} 14.66	......	......
H_2O-	......	.74	.95	4.41	}					.46	}	2.87	.85
TiO_2	......	......	......	......	.20	......	......	......	......	......	......	......	......
P_2O_5	......	......	......	......	.48	......	......	......	......	......	......	......	......
CO_2	......	......	......	......	4.38	......	......	......	......	......	......	......	......
S	......	......	......	......	2.66	......	......	......	......	......	......	......	......
SO_3	......	Tr.	Tr.	......	Tr.?	......	......	......	......	......	......	......	Tr.
Organic S	......	......	......	......	[2] (1.5)	......	......	......	......	......	......	......	......
Organic matter	......	......	......	......	[3] (46.1)	......	......	......	......	......	......	......	......
Ignition loss	......	11.13	8.59	8.82	[4] 49.52	12.47	10.55	10.60	10.20	9.77	......	9.45	9.21
Total	99.67	100.38	100.85	[5] 101.11	99.89	98.91	100.01	[6] 99.58	99.89	[7] 101.19	99.48	100.29	[8] 102.86
Class	5,94,0	21,78,1	13,71,5	10,78,6	11,70,9	8,89,2	18,80,2	21,75,3	19,79,2	14,84,2	10,88,1	18,78,3	17,76,6

	29	30	31	32	33	34	35	36	37	38	39	40	41
	5D51-17	5D51-18	5D51-19	5D51-20	5D51-31	5D51-37	5D51-40	5D51-38	5D51-39	5D51-47	5D51-50	5D51-48	5D62-2
SiO_2	60.27	61.30	62.14	62.48	50.27	53.77	60.62	58.84	60.62	51.69	63.22	56.05	59.08
Al_2O_3	23.19	23.65	23.88	22.31	27.61	28.30	24.35	25.94	21.83	16.50	24.72	28.84	20.53
Fe_2O_3	2.5	2.2	1.7	2.18	1.36	1.83	2.44	1.94	3.03	7.90	.43	1.91	3.62
MgO	.32	.18	.30	.30	.70	.70	.73	.01	.53	2.10	.13	1.00	......
CaO	.32	.18	.30	.64	.71	.50	.11	.48	.28	4.41	.30	......	.66
Na_2O	......	......	......	......	......	......	......	......	......	2.07	} Tr.	.08	.23
K_2O	......	......	......	......	......	......	......	......	......	2.68	}	3.73	1.51
H_2O+	......	......	......	......	......	......	......	......	......	[9] 6.00	8.63	......	......
H_2O-	......	......	......	......	......	......	......	......	......	[10] 3.02	1.36	.99	2.08
TiO_2	......	......	......	......	.95	.80	.90	1.28	.70	.66	.68	......	......
P_2O_5	......	......	......	......	......	......	......	......	......	.22	......	......	......
CO_2	......	......	......	......	......	......	......	......	......	3.19	......	......	......
SO_3	......	......	......	......	......	......	......	......	......	......	......	......	Tr.
Organic matter	......	......	......	......	......	......	......	......	......	.53	.40	......	......
Ignition loss	11.26	11.64	10.80	10.43	17.87	13.33	10.59	11.19	11.01	......	[2] (10.39)	7.96	11.39
Total	97.9	99.2	99.1	98.34	99.47	99.23	99.74	99.68	98.00	100.97	99.87	[11] 100.56	99.10
Class	16,80,1	17,81,1	18,80,1	21,76,2	0,96,3	2,94,2	15,82,2	11,87,1	19,77,2	14,72,7	19,80,0	3,93,1	19,77,1

[1] From total Fe (Bradley, 1931, p. 32).
[2] Not included in total.
[3] Not included in total; determined from ignition loss, less H_2O in hydrous minerals, less CO_2.
[4] Loss on ignition less CO_2, includes H_2O of hydrous minerals.
[5] 100.91 in text.
[6] 99.04 in text.
[7] 100.73 in text.
[8] 100.86 in text.
[9] Above 100° C.
[10] At 100° C.
[11] 100.66 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

16. Fremont County. Upper Cretaceous, Dakota sandstone, Dry Creek Canyon member. E½SE¼ sec. 4, W½SW¼ sec. 3, T. 18 S., R. 70 W., Deer Hill mine. Lab. No. 67. (Waagé, 1953, p. 96, 32, 38, 39, 81, 82.) Flint clay. General remarks: Light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture. Index map, outcrop map, detailed measured section, generalized columnar section. Mineralogy. Possible use: High-grade refractories.

17-19. Analyst, Tremaine. Index map. Ceramic tests, physical properties, mineralogy.

17. Fremont County. Dakota sandstone. T. 18 S., R. 69 W., about 5 miles north of town of Florence. Lab. No. 192. (Butler, 1915, p. 343, 201, 206, 306, 326, 327.) Clay, black, fine-grained, hard; 3 ft thick; sandstone overburden, 27 ft. Possible use: Brick, vitrified and unvitrified floor tile.

*18. Garfield County. Pennsylvanian, Paradox formation (N. W. Bass, written communication, 1956). T. 7 S., R. 88 W., 7 miles south of town of Glenwood Springs. Lab. No. 209. (Butler, 1915, p. 343, 208, 210, 307, 326, 327.) (Analysis suggests 6.1 percent more CaO and MgO than required for carbonates; shows 5.4 percent alkalies.) Shale, bright-red, fine-grained, medium-hard; 15 ft thick. Possible use: Brick.

19. Garfield County. Upper Cretaceous, Mancos shale. T. 5 S., R. 90 W., town of New Castle. Lab. No. 213. (Butler, 1915, p. 343, 208, 211, 307, 326, 327.) Clay, buff, very fine grained, soft; 3 ft thick, overburden, 6 in. Possible use: Brick.

*20. Garfield County. Eocene, Green River formation. Sec. 10, T. 5 S., R. 95 W., near head of East Middle Fork of Parachute Creek. Analyst, Fairchild. Lab. No. 111. (Bradley, 1931, p. 32, 31.) (Analysis shows 3.6 percent alkalies 2.7 percent S; suggests 1.1 percent phosphate, 3.2 percent more CaO and MgO than required for carbonates.) Oil shale. Estimated oil yield, outcrop map, geologic map, correlated columnar sections, mineralogy. (For other analyses of oil shale see sample 6 group E and samples 22-24 group M of this compilation.)

21-24. Huerfano County. Dakota sandstone, upper sandstone unit. SW corner sec. 3, T. 25 S., R. 65 W., Shamblin mine, Standard Fire Brick Co. (Waagé, 1953, p. 95, 3, 6, 53, 88.) Bed 3-4 ft below surface; 4.5-6 ft thick. Index map, generalized columnar sections. Possible use: Refractories.

21. Lab. No. 7. Clay, blue-black, plastic.
22. Lab. No. 6. Clay shale, gray, plastic.
23. Lab. No. 5. Clay, plastic; run of mine sample.
24. Lab. No. 4. Clay, dark-blue, plastic, gritty. Lower half of clay bed (for an analysis of upper half see sample 16, group Hk of this compilation).

25. Huerfano County. Dakota sandstone. T. 26 S., R. 68 W., 5 miles northwest of St. Mary. Analyst, Tremaine. Lab. No. 241. (Butler, 1915, p. 343, 216, 220, 307, 328, 329.) Clay and shale, light-gray, fine-grained, very hard; 2 ft thick. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

26. Jefferson County. Upper Cretaceous, Laramie formation (K. M. Waagé, written communication, 1958). (T. 3 S., R. 70 W.) town of Golden. (Ries, 1895, p. 560, 561.) Kaolin.

27. Las Animas County. Dakota(?) sandstone. (T. 29 S., R. 61 W.) Analyst, Tremaine. Lab. No. 387. (Butler, 1915, p. 345, 254, 257, 258, 310, 334, 335.) Clay, gray to black, sandy, medium fine-grained, hard; 6 ft thick, underlying 15-20 ft of sandstone. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

Colorado--Continued

28. Logan County. Laramie(?) formation. SE¼ sec. 6, T. 7 N., R. 52 W., 5 miles southeast of town of Sterling. Analyst, Tremaine. Lab. No. 390. (Butler, 1915, p. 345, 258, 259, 334, 335.) Shale, yellow and gray, fine- to coarse-grained, medium-hard, sandy; 15 ft thick, 2 ft overburden. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware.

29-32. Pueblo County. Lower Cretaceous, Purgatoire formation, Glencairn shale member. Center N½NW¼ sec. 6, T. 25 S., R. 65 W., Vulcan mine. (Waagé, 1953, p. 97, 31, 36, 53, 88.) Semiplastic clay, dark-gray; 9-20 ft thick. Index map, generalized columnar sections. Possible use: Low-grade to semirefractories, terra cotta, conduits.

29. Lab. No. 95.
30. Lab. No. 96.
31. Lab. No. 97.
32. Lab. No. 93.

33-37. Pueblo County. Dakota sandstone, Dry Creek Canyon member. (Waagé, 1953, p. 95, 3, 5, 6, 31-44, 53, 73, 74, pls. 1-3, 5.) Index maps, outcrop map; correlated columnar sections, generalized columnar sections.

33-34. SW¼SE¼ sec. 26, T. 18 S., R. 67 W., Dry Creek Canyon mine, Pueblo Clay Products Co. Analyst, Brannock. Clay. Estimated tonnage, fired properties.

33. Lab. No. 9. Clay, black, semiplastic; in lenticular beds between flint and plastic clay.
34. Lab. No. 8. Plastic clay. General remarks: Light-gray or blue-gray to black, massive to blocky, splintery to rough blocky fracture. Possible use: Semirefractories.

35. NW corner NE¼ sec. 35, T. 22 S., R. 67 W., Rock Creek mines of Standard Fire Brick Co. Analyst, Davidson. Lab. No. 29. Flint clay, sandy, spot sample; 1 ft thick. Use: Refractories. (For other analyses from same measured section see sample 36 this group, sample 99 group B, and sample 45 group Hk of this compilation.)

36. NW corner NE¼ sec. 35, T. 22 S., R. 67 W., Rock Creek mines of Standard Fire Brick Co. Analyst, Davidson. Lab. No. 28. Flint clay, sandy, spot sample; 1 ft thick. Use: Refractories.

37. SE¼SW¼ sec. 26, T. 22 S., R. 67 W., Rock Creek mines of Standard Fire Brick Co. Analyst, Davidson. Lab. No. 25. Plastic clay, channel sample; 4 ft thick. Fired properties. Use: Refractories.

38. Pueblo County. Upper Cretaceous, Pierre shale, rusty zone. (NW¼ T. 20 S., R. 64 W.) near Nussbaum Spring. Analyst, Steiger. Lab. No. 5. (Gilbert, 1897, p. 7.) Shale. Geologic maps.

39. Pueblo County. Pierre shale (K. M. Waagé, written communication, 1958). (T. 20 S., R. 64 W.) town of Pueblo. Analyst, Steiger. (Ries, 1895, p. 554, 555.) Fire clay.

40. Pueblo County. Pierre shale. T. 20 S., R. 65 W., 5 miles north of Pueblo, Colorado Brick and Tile Co. plant. Analyst, Tremaine. Lab. No. 470. (Butler, 1915, p. 345, 272, 282, 312, 338, 339.) (Clay.) Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

41. Weld County. Laramie formation. T. 1 N., R. 68 W., south of town of Erie, Lehigh mine. Analyst, Tremaine. Lab. No. 494. (Butler, 1915, p. 345, 291, 292, 312, 338, 339.) Clay, gray, fine-grained, medium-hard, 3-5 ft thick. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Earthenware, if grogged; brick, stoneware.

TABLE 9.— Analyses of samples from Kansas containing more than 75 percent clay (Group D) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by county and stratigraphic position]

	Kansas										
	1	2	*3	4	5	6	7	8	9	10	11
	15D3-3	15D3-2	15D6-3	15D7-4	15D7-5	15D15-30	15D15-31	15D15-33	15D15-35	15D15-32	15D15-36
SiO_2	62.17	59.01	51.03	55.33	56.22	56.72	57.32	58.88	59.60	57.94	59.94
Al_2O_3	19.72	22.50	21.63	20.69	20.61	27.89	29.56	26.86	[1] 26.71	27.35	29.38
Fe_2O_3	4.43	4.43	7.61	7.58	8.26	2.17	1.20	1.70	1.44	1.79	1.20
MgO	1.00	1.20	2.25	2.55	2.67	......	......	......	.64	.47	......
CaO	.53	.60	2.44	.86	.55	......	......	......	.22	.62	1.10
Na_2O	.92	.62	......	.49	.56	......	......	......	} 3.88	.87	......
K_2O	3.73	4.11	......	3.03	3.45	......	......	......			
TiO_2	1.66	.93	1.20	1.22	.59	1.18	1.12	1.22	......	.13	......
P_2O_5	.08	.03	Tr.	.23	.18	......	......	......	......	......	......
SO_3	.22	.11	.84	.53	.17	......	......	......	......	......	......
S	Nil	.01	......	......	......	......	......	......	......	......	......
Ignition loss	5.73	6.14	[2] 8.45	6.75	6.20	8.30	8.38	7.76	7.80	9.71	[3] 8.60
Total	100.19	99.69	95.45	99.26	99.46	96.26	97.58	96.42	100.29	[4] 98.88	[5] 100.22
Class	22,70,0	14,78,0	4,83,2	10,80,0	10,81,0	5,90,0	4,93,0	9,86,0	11,84,2	8,88,2	7,92,2

	12	13	14	*15	16	*17	18	19	20	21
	15D15-38	15D15-37	15D15-34	15D19-1	15D19-7	15D19-6	15D22-16	15D23-1	15D23-2	15D23-3
SiO_2	63.75	62.43	59.60	45.58	60.92	44.13	60.38	58.96	54.46	58.38
Al_2O_3	20.95	22.17	25.44	14.10	18.48	13.79	18.60	18.44	25.05	19.96
Fe_2O_3	3.13	1.74	1.58	4.30	6.82	4.29	6.94	6.15	6.78	6.95
MgO	......	......	.64	.99	1.76	1.87	2.05	1.64	.39	1.75
CaO	......	......	.22	5.46	.49	5.06	.84	3.02	.25	1.24
Na_2O	......	......	.73	......	1.20	......	.85	.69	} [6] 4.51	{ .74
K_2O	......	......	1.78	......	3.47	......	2.63	2.83		3.17
TiO_2	1.28	......	1.32	.29	1.68	.29	1.31	1.27	.98	1.15
P_2O_5	......	......	......	4.24	.22	2.08	.19	.20	......	.23
SO_3	......	......	......	Tr.	Nil	1.24	Tr.	Tr.	.04	Tr.
Ignition loss	9.00	8.70	7.80	[2] 21.77	5.39	[2] 20.22	5.99	7.13	7.31	6.10
Total	98.11	95.04	99.11	96.73	100.43	92.97	99.78	100.33	[7] 99.77	99.67
Class	23,74,0	21,74,0	13,81,2	16,69,2	21,71,0	15,64,7	20,72,0	19,70,2	3,91,0	15,76,0

	22	23	24	25	26	27	28	29	30
	15D25-3	15D27-70	15D27-71	15D27-86	15D27-82	15D27-79	15D27-94	15D27-85	15D27-80
SiO_2	54.20	57.25	59.38	61.40	60.26	56.40	62.58	60.96	57.99
Al_2O_3	19.87	22.98	25.50	[1] 26.74	28.69	31.00	22.02	20.77	23.03
Fe_2O_3	6.37	3.30	1.49	1.67	.49	1.08	2.18	6.17	5.03
MgO	2.04	2.35	1.15	.27	......	......	.44	......	......
CaO	3.30	.48	.73	.36	.21	.18	.61	......	......
Na_2O	.49	} 3.87	3.95	.64	......	......	1.38	......	......
K_2O	3.12								
TiO_2	.98	1.15	1.64	......	......	......	.29	1.12	1.10
P_2O_5	.18	......	......	......	......	......	......	......	......
SO_3	.14	......	......	......	......	......	......	......	......
Ignition loss	8.32	8.21	6.58	9.41	9.81	11.15	10.88	7.30	10.08
Total	[8] 99.01	99.59	[9] 100.42	100.49	99.46	99.81	100.38	96.32	97.23
Class	12,75,4	13,77,3	13,80,0	12,86,1	9,90,0	0,99,0	21,76,2	17,78,0	12,85,0

Qualitative spectrographic analyses

[s=standard graphite electrodes used. h=high purity graphite electrodes used. Higher numbers indicate greater abundance. A dash (–) =not seen; further explanation of table (Runnels, 1949, p. 45)]

	3s	3h	15s	15h	17s	17h		3s	3h	15s	15h	17s	17h
B	–	6	–	6	–	6	Zn	3	–	4	4	5	4
Na	6	......	6	......	7	......	Sr	–	–	–	–	–	–
K	7	......	6	......	6	......	Zr	4	–	4	–	3	1
V	6	6	7	7	7	9	Mo	–	–	–	6	–	7
Cr	5	3	7	9	7	9	Ag	–	–	3	4	4	5
Mn	8	10	5	6	6	9	Pb	–	3	–	5	–	6
Cu	5	7	6	8	6	9							

[1] Includes TiO_2.
[2] At 1,000° C.
[3] 8.40 percent (Plummer and Romary, 1942, p. 335).
[4] 98.75 in text.
[5] 100.32 in text.
[6] By difference.
[7] 100.00 in text.
[8] 99.19 in text.
[9] 100.45 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

1-2. Atchison County. Pennsylvanian, Howard limestone, Aarde shale member. Sec. 21, T. 5 S., R. 19 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 195, 249, pl. 1.) Channel samples. Index map, outcrop map; columnar section, correlated columnar sections; mechanical analyses, estimated amounts of clay constituents and relationship to structure.
 1. Nonmarine shale, 12-18 in. below coal.
 2. Nodaway underclay, 0-6 in. below coal.

*3. Bourbon County. Pennsylvanian, Cherokee shale, above Bevier coal. SW¼SE¼ sec. 18, T. 27 S., R. 25 E. Spectrographic analyst, Reed. Lab. No. 48-297. (Runnels, 1949, p. 44, 42, 45.) (Analysis shows 1.2 percent TiO; suggests 1.8 percent gypsum, 2.9 percent more CaO and MgO than reqnired for carbonates.) Shale, composite sample, dried at 140° C.; 6 ft thick. Possible use: Fertilizer.

4-5. Brown County. Pennsylvanian, Wabaunsee group, Caneyville-Pony Creek shale. SE¼SE¼ sec. 31, T. 1 S., R. 17 E. Analyst, under supervision of Runnels. (Plummer and Hladik, 1951, p. 20, 26, 27, 30, 31, 52.) Geologic map. Results of experimental production of lightweight aggregate; bloating results, screen analysis. Possible use: Lightweight aggregate.
 4. Lab. No. BR-3-1. Shale, red and gray, unoxidized; 8.5 ft sampled, 8.5 ft available.
 5. Lab. No. BR-3-2. Shale, pink and gray, unoxidized; 4.5 ft sampled, 4.5 ft available.

6-8. Clond County. Upper Cretaceous, Dakota sandstone. SW part SE¼SW¼ sec. 32, T. 8 S., R. 2 W. A-Cut-2. (McMillan and Wilson, 1948, p. 13, figs. 1-4.) Index map, generalized columnar section, log of cut. Possible use: Ceramic products. (For analysis of top 1.1 ft of this section see sample 57, group B of this compilation.)
 6. Clay, gray, yellow streak; 5.7-10.3 ft below surface.
 7. Clay, tan, gray; 4.1-5.7 ft below surface.
 8. Clay, gray; 1.7-4.1 ft below surface.

9-10. Cloud County. Dakota sandstone, Terra Cotta clay member. T. 8 S., R. 2 W. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 67, 75, 82, 83, pl. 1.) Ball clay. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Use: Refractories.
 9. SE¼ sec. 13. Lab. No. C-27-5. Ball clay, gray and light-gray, slight yellow stain on joints in lower portion; fossil leaves, some lignite, slight amount of gypsum; conchoidal fracture; 7.5 ft thick.
 10. SW¼ sec. 32. Lab. No. C-27-13a. Ball clay, gray, slight yellow stain, plastic, massive; conchoidal fracture on fresh exposure; tends to weather platy; 10.8 ft thick.

11. Cloud County. Dakota sandstone, Terra Cotta clay member. Cen. S½ sec. 32, T. 8 S., R. 2 W. Analyst, Thompson. Lab. No. C-27. (Jewett and Schoewe, 1942, p. 102, 99; Plummer and Romary, 1942, p. 335, 316, 329-331, 336.) Alumina clay, partly thin bedded, contains fossil leaves. Overlain by light-gray and red mottled clay that grades upward into highly hematitic clay; underlain by gray, silty, lignitic clay. Bulk density, 2.40. Estimated tonnage. Index map, outcrop map, generalized measured section, correlated columnar sections. Ceramic tests, mineralogy. Possible use: Source of alumina.

12-13. Cloud County. Dakota sandstone. T. 8 S., R. 2 W. Clay. Index maps, generalized columnar section, logs of auger drill hole and open-cut. Possible use: Ceramic products.
 12. SE¼SW¼ sec. 23. Hole A-34. (McMillan and Wilson, 1948, p. 10, figs. 1-4.) Clay, dark blue-gray; 20.5-28 ft below surface. (For analysis of sample immediately below, see sample 53, group B of this compilation.)
 13. NW part SE¼SW¼ sec. 32. A-Cut-1. (McMillan and Wilson, 1948, p. 13, figs. 1-4.) Clay, gray; 2.7-10 ft below surface. (For analysis from same measured section, see sample 55, group B of this compilation.)

14. Cloud County. Dakota sandstone. NE¼NW¼ sec. 32, T. 8 S., R. 2 W. Analyst, under supervision of Runnels. Lab. No. C-27. (Plummer and Hladik, 1951, p. 21, 26, 27, 31, 64, 65.) Clay, unoxidized; 12.0 ft sampled, 12.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, screen analysis. Possible use: Lightweight aggregate.

*15. Crawford County. Cherokee shale, above Croweburg coal. SW¼SW¼ sec. 34, T. 38 S., R. 25 E. (as reported, this township not in Crawford County). Spectrographic analyst, Reed. Lab. No. 48-296. (Runnels, 1949, p. 44, 42, 45.) (Analysis suggests 9.4 percent phosphate.) Shale, composite sample 4 ft thick, dried at 140° C. Possible use: Fertilizer.

16. Crawford County. Cherokee shale. NE¼SE¼ sec. 16, T. 16 S., R. 25 E. (as reported, this township not in Crawford County). Analyst, under supervision of Runnels. Lab. No. CR-9. (Plummer and Hladik, 1951, p. 20, 24-27, 30, 31, 33, 52.) Shale, mostly oxidized; 10.0 ft sampled, 20.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

Kansas--Continued

*17. Crawford County. Pennsylvanian, Fort Scott limestone, Little Osage shale member. SE¼ sec. 12, T. 30 S., R. 22 E., Stark quarry. Spectrographic analyst, Reed. Lab. No. 48-295. (Runnels, 1949, p. 44, 42, 45.) (Analysis suggests 4.9 percent phosphate, 2.7 percent gypsum.) Shale, composite sample, dried at 140° C. Possible use: Fertilizer.

18. Doniphan County. Pennsylvanian, Lawrence shale. Cen. W½SW¼ sec. 33, T. 3 S., R. 22 E. Analyst, reference, tests, map, and use as in sample 16. Lab. No. DN-4. Shale, partially oxidized; 25.0 ft sampled, 25.0 ft available.

19. Douglas County. Pennsylvanian, Stranger formation, Vinland shale member. Cen. S½SW¼ sec. 15, T. 14 S., R. 20 E. Analyst, reference, tests, map, and use as in sample 16. Lab. No. DG-15. Shale, oxidized; 20.0 ft sampled, 30.0 ft available.

20. Douglas County. Stranger formation. SW¼ sec. 11, T. 14 S., R. 20 E. Analyst, Runnels. Lab. No. DH-12-A. (Plummer and Hladik, 1948, p. 74, 62, 78, 79.) Shale; channel sample, 12 ft thick. Firing and physical properties of ceramic slag. Index and geologic map.

21. Douglas County. Lawrence shale. SW¼NW¼ sec. 27, T. 14 S., R. 20 E. Analyst, reference, tests, map, and use as in sample 16. Lab. No. DG-14. Shale, oxidized; 20.0 ft sampled, 25.0 ft available.

22. Elk County. Stranger formation, Robbins shale member. W½SW¼ sec. 22, T. 31 S., R. 13 E. Analyst, reference, tests, map, and use as in sample 16. Lab. No. EK-1. Shale, unoxidized; 22.0 ft sampled, 22.0 ft available.

23-24. Ellsworth County. Lower Cretaceous, Kiowa shale. Analysts, Thompson and Runnels. (Plnmmer and Romary, 1947, p. 174, 42, 43, 170-172, 175, pl. 1.) Index map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, structural tile, stoneware, earthenware.

 23. Cen. S½ sec. 1, T. 16 S., R. 7 W. Lab. No. El-22-6. Clay-shale, gray to dark-gray, some brown and yellow stain, plastic; selenite crystals, clay-ironstone bands; cone-in-cone gypsiferous limestone; 21.1 ft thick.

 24. NE¼NE¼ sec. 34, T. 17 S., R. 6 W. Lab. No. El-100-3. Clay-shale, gray, yellow stain, plastic; 10 ft thick; upper part shows weathering; bottom half contains clay-ironstone concretions.

25-27. Ellsworth County. Dakota sandstone, Terra Cotta clay member.

 25. NW¼ sec. 29, T. 15 S., R. 6 W. Analysts, Thompson and Runnels. Lab. No. El-12-4. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 67, 68, 75, 82, 83, 87.) Ball clay; 6.6 ft thick, sectioned from top to bottom as follows:
  3.0 ft ...... gray, plastic with fossil leaves.
  1.0 ft ...... light-gray, slightly silty.
  2.6 ft ...... dark-gray, fairly plastic; considerable lignite, some fossil leaves.

 Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic texts, physical properties, temperature-specific gravity and temperature-apparent specific gravity curves, mineralogy. Possible use: Refractories.

 26. (Probably Dakota sandstone, Terra Cotta clay member; NW¼ sec. 29, T. 15 S., R. 6 W. Plummer and Romary, 1947, p. 68.) Analyst, Thompson. Lab. No. El-12-4. (Jewett and Schoewe, 1942, p. 102.) High-alumina clay. Estimated tonnage. Possible use: Source of alumina.

 27. (Probably Dakota sandstone, Terra Cotta clay member; NW¼ sec. 19, T. 16 S., R. 7 W. Plummer and Romary, 1947, p. 69.) Analyst, Thompson. Lab. No. El-52-3. (Jewett and Schoewe, 1942, p. 102.) High-alumina clay. Estimated tonnage. Possible use: Source of alumina.

28. Ellsworth County. Dakota sandstone, Janssen clay member. NW¼ sec. 33, T. 14 S., R. 7 W. Analysts, Thompson and Runnels. Lab. No. El-91-1. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 94, 102, 104, pl. 1.) Plastic fire clay, dark-gray, some yellow-orange stain on joints; slightly silty; some selenite crystals, lignitized wood and fossil leaves; conchoidal fracture; massive, weathers platy; more than 16 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile, refractories.

29-30. Ellsworth County. Dakota sandstone. SW part SE¼SW¼ sec. 15, T. 15 S., R. 6 W. Clay. Index maps, generalized colnmnar section; logs of auger drill holes. Possible use: Ceramic products.
 29. Hole C-29. (McMillan and Wilson, 1948, p. 35, figs. 1-3, 6.) Clay, dark-gray, 3-16.5 ft below surface.
 30. Hole C-27. (McMillan and Wilson, 1948, p. 34, figs. 1-3, 6.) Clay, gray; 1.5-10 ft below surface. (For analysis from same measured section, see sample 120, group B of this compilation.)

TABLE 9.—Analyses of samples from Kansas containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	Kansas											
	31	32	33	34	35	36	37	38	39	40	41	42
	15D27-87	15D27-90	15D27-93	15D27-74	15D27-73	15D27-72	15D27-81	15D27-84	15D27-78	15D27-92	15D27-88	15D27-83
SiO_2	61.86	64.48	59.73	52.90	52.24	51.88	59.60	60.56	56.26	55.06	63.42	60.54
Al_2O_3	18.25	20.70	21.56	21.23	21.28	22.88	23.55	22.06	22.38	21.49	16.71	24.07
Fe_2O_3	6.34	7.16	6.52	9.63	10.85	9.08	5.15	4.70	5.34	7.20	9.41	2.98
TiO_2	1.28	1.07	1.04	1.04	1.11	1.06	1.32	1.14	1.08	1.04	1.11	1.24
Ignition loss	10.37	7.40	7.58	12.90	12.63	10.58	9.36	9.52	12.79	12.95	6.96	8.15
Total	98.10	100.81	96.43	97.70	98.11	95.48	98.98	97.98	97.85	97.74	97.61	96.98
Class	22,74,0	20,80,0	14,81,0	5,92,0	2,95,0	1,93,0	12,86,0	16,81,0	11,86,0	9,88,0	23,73,0	15,81,0

	43	44	45	46	47	48	*49	50	51	52	53
	15D27-89	15D27-76	15D29-2	15D29-3	15D30-2	15D30-3	15D42-3	15D42-2	15D44-2	15D44-1	15D44-3
SiO_2	63.91	55.63	57.48	62.16	51.56	54.28	59.13	63.07	57.68	55.59	58.66
Al_2O_3	19.36	25.84	27.03	22.71	22.50	21.90	15.30	23.91	22.45	23.08	22.50
Fe_2O_3	5.25	3.77	1.70	1.64	8.21	8.28	9.48	1.61	6.24	6.98	4.86
MgO	......	1.27	1.02	1.80	2.27	1.96	.91	.30	1.18	1.34	1.29
CaO	......	.85	.79	.64	1.09	.65	.48	.39	.41	.42	.34
Na_2O	......	2.76	2.71	2.20	.59	.67	3.54	1.62	.60	.64	.60
K_2O	......				3.54	3.69			4.04	3.87	4.28
TiO_2	1.10	1.01	.30	1.10	1.27	1.01	4.66	2.46	.67	.67	.78
P_2O_5	......	......	......	......	.22	.13	......	......	.09	.11	Tr.
SO_3	......	......	......	......	.23	Tr.	......	......	.21	.18	Nil
S	......	......	......	......	......	......	......	......	Nil	.01	.02
Ignition loss	7.30	8.36	7.61	7.09	7.77	6.79	5.92	7.75	6.19	6.89	6.01
Total	96.92	99.49	[1] 98.64	99.34	[2] 99.25	[3] 99.36	99.42	101.11	99.76	99.78	99.34
Class	24,72,0	6,87,2	8,86,1	20,72,2	3,87,0	6,85,0	21,68,0	19,77,1	11,82,0	7,86,0	13,79,0

	54	55	56	57	58	59	60	61	62	63	*64
	15D45-42	15D46-6	15D51-1	15D52-3	15D53-28	15D53-27	15D56-2	15D56-3	15D63-7	15D63-6	15D70-5
SiO_2	60.78	55.14	60.26	61.54	62.96	59.64	55.74	58.81	57.09	54.73	48.60
Al_2O_3	17.95	21.05	18.35	18.52	25.25	17.98	21.00	29.39	20.31	17.90	21.85
Fe_2O_3	5.61	7.59	5.45	6.54	.96	8.14	7.49		7.47	8.05	[4] 16.70
MgO	.10	2.12	3.40	1.75	.48	2.09	2.57	2.11	1.86	2.56	[5] .35
CaO	1.20	1.32	1.07	.41	.44	.94	.70	.94	.69	3.55	[5] 2.80
Na_2O	2.01	1.08	.63	.79	1.71	.29	1.54	([6])	.87	1.42	......
K_2O		3.56	2.98	2.97		1.93	3.77		2.44	3.07	......
H_2O	[7] 11.34	......	......	......	......	......	......	......	......	......	[8] 3.00
TiO_2	......	1.47	1.42	1.36	.57	2.36	1.02	......	1.55	.87	......
P_2O_5	......	.22	.17	.18	......	.04	.17	Tr.	......	.28	......
SO_3	.92	.22	Tr.	Tr.	......	.21	Nil	......	.10	Tr.	[5] 4.70
S	......	......	......	......	......	......	Nil	......	......	......	......
Ignition loss	......	6.90	6.27	5.89	6.79	6.69	5.97	5.17	6.83	8.33	[9] 2.00
Total	99.91	[10] 100.67	100.00	99.95	99.16	100.31	[11] 99.97	96.42	[12] 99.21	100.76	100.00
Class	23,73,0	9,81,0	22,68,1	21,71,0	17,78,1	19,74,0	10,80,0	10,84,0	13,79,0	14,73,4	10,64,0

[1] 99.41 in text.
[2] 99.47 in text.
[3] 99.49 in text.
[4] Reported as protoxide.
[5] Calculated from reported $MgSO_4$ and (or) $CaSO_4$.
[6] Difference between 100 percent and total is largely alkalies.
[7] Reported as water of constitution.
[8] At 100° C., reported as H_2O-.
[9] Reported as organic matter.
[10] 100.60 in text.
[11] 100.14 in text.
[12] 99.31 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

31. Ellsworth County. Upper Cretaceous, Dakota sandstone. SE part NW¼SE¼ sec. 19, T. 15 S., R. 6 W. Hole C-9. (McMillan and Wilson, 1948, p. 37, figs. 1-3, 7.) Clay, varicolored, 13-27 ft below surface. Index maps, generalized columnar section; log of auger drill hole. Possible use: Ceramic products. (For analysis from same measured section see sample 127, group B of this compilation.)

32-43. Ellsworth County. Dakota sandstone. Clay. Index maps, generalized columnar section; logs of auger drill holes and open cuts. Possible use: Ceramic products.

32. NW part SE¼SE¼ sec. 19, T. 15 S., R. 6 W. C-Cut-7. (McMillan and Wilson, 1948, p. 38, figs. 1-3, 7.) Clay, gray-brown; 7-14.3 ft below surface.

33. NW part SE¼SE¼ sec. 19, T. 15 S., R. 6 W. Hole C-S-12. (McMillan and Wilson, 1948, p. 38, figs. 1-3, 8.) Clay, gray-brown; few yellow streaks; 7-14 ft below surface.

34. NW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-9. (McMillan and Wilson, 1948, p. 27, 26, figs. 1-3, 8.) Clay, gray; red and yellow streaks; 2-10.5 ft below surface.

35. NW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. C-Cut-2. (McMillan and Wilson, 1948, p. 27, 26, figs. 1-3, 8.) Clay, varicolored; 2-9.9 ft below surface.

36. SW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-2. (McMillan and Wilson, 1948, p. 25, figs. 1-3, 8.) Clay, varicolored; 12-22 ft below surface.

37. SW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-2. (McMillan and Wilson, 1948, p. 25, Figs. 1-3, 8.) Clay, red, gray; 7-12 ft below surface.

38. SW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-2. (McMillan and Wilson, 1948, p. 25, figs. 1-3, 8.) Clay, red, gray; 2-7 ft below surface.

39. SW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-10. (McMillan and Wilson, 1948, p. 27, figs. 1-3, 8.) Clay, gray; red and yellow streaks; 1.5-8 ft below surface.

40. SW part NW¼NW¼ sec. 29, T. 15 S., R. 6 W. C-Cut-3. (McMillan and Wilson, 1948, p. 27, figs. 1-3, 8.) Clay, varicolored; 1.5-7.2 ft below surface; some lignite.

41. NW part NW¼SE¼ sec. 29, T. 15 S., R. 6 W. Hole C-S-3. (McMillan and Wilson, 1948, p. 26, 25, figs. 1-3, 8.) Clay, gray, red; 9-15.5 ft below surface.

42. Cen. NE¼NE¼ sec. 25, T. 15 S., R. 7 W. Hole C-50. (McMillan and Wilson, 1948, p. 29, figs. 1-3, 9.) Clay, gray; brown streaks; 3-12.5 ft below surface. (For another analysis from same measured section, see sample 136, group B of this compilation.)

43. Cen. NE¼NW¼ sec. 25, T. 15 S., R. 7 W. Hole C-52. (McMillan and Wilson, 1948, p. 29, figs. 1-3, 9.) Clay, varicolored, 5-18 ft below surface.

44. Ellsworth County. Upper Cretaceous, Graneros shale. NW¼NW¼ sec. 25, T. 15 S., R. 10 W. Analysts, Thompson and Runnels. Lab. No. El-43-19. (Plummer and Romary, 1947, p. 180, 42, 43, 176, 179, 181, pl. 1.) Clay shale, yellowish-gray, very plastic; 2 ft thick; concretionary limonite at top and bottom. Index map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, insulating and structural tiles; stoneware, earthenware.

45-46. Ford County. Dakota sandstone, Janssen clay member. NW¼SW¼ sec. 30, T. 25 S., R. 23 W. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 75, 96, 99, 102, 104, 105, pl. 1.) Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile, refractories.

45. Lab. No. F-1-13. Ball clay, smooth, hard; 2.5 ft thick. Upper 1.6 ft nearly white, almost no stain; lower 0.9 ft dark gray.

46. Lab. No. F-1-14. Fire clay, nearly white, smooth, fine-grained, hard; few limonite-filled root cavities; 2.8 ft thick.

47-48. Franklin County. Pennsylvanian, Weston shale. Cen. SW¼ sec. 29, T. 15 S., R. 21 E. Analyst, under supervision of Runnels. (Plummer and Hladik, 1951, p. 20, 24, 25, 30, 52, 58.) Shale, red and gray, mostly unoxidized; 48.5 ft sampled, 60.0 ft available. Results of experimental production of lightweight aggregate; screen analysis. Geologic map. Electron micrograph. Possible use: Lightweight aggregate.

47. Lab. No. FR-6-AB.

48. Lab. No. FR-6-C.

*49. Hodgeman County. Dakota sandstone, Terra Cotta clay member. SE¼ sec. 24, T. 22 S., R. 22 W. Analyst, Runnels. Lab. No. H-1-0. (Plummer and Hladik, 1948, p. 74, 62, 82, 83, 95.) (Analysis shows 4.7 percent TiO_2, 3.5 percent alkalies; suggests 1.4 percent more CaO and MgO than required for carbonates.) Clay, 5.3 ft thick; channel sample. Firing and physical properties of ceramic slag. Index map. Possible use: Ballast, concrete aggregate.

Kansas--Continued

50. Hodgeman County. Dakota sandstone, Janssen clay member. SE¼SW¼ sec. 24, T. 22 S., R. 22 W. Analysts, Thompson and Runnels. Lab. No. H-1-6. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 97, 99, 102, 105, pl. 1.) Fire clay, gray to black, fairly plastic; 5.4 ft thick; some lignite in lower 2.5 ft. Index map, outcrop map, detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile, refractories.

51-53. Jefferson County. Pennsylvanian, Howard limestone, Aarde shale member. Sec. 22, T. 9 S., R. 17 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 195, pls. 1, 2.) Selected samples. Index map, outcrop map, columnar section, correlated columnar sections; mechanical analyses; estimated amounts of clay constituents and relationship to structure.

51. Nonmarine shale, 14-20 in. below coal.

52. Nodaway underclay, 7-14 in. below coal.

53. Nodaway underclay, 0-7 in. below coal.

54. Jewell County. Upper Cretaceous, Niobrara formation, S½ sec. 5, T. 1 S., R. 7 W., Kern farm, near town of Superior, Nebraska. Analyst, Robinson. Lab. No. 10. (Barbour, 1913, p. 98, 105.) Clay. Use: Cement material.

55. Johnson County. Pennsylvanian, Cherryvale shale, Fontana-Wea shale member. North line NE¼NE¼ sec. 21, T. 13 S., R. 25 E. Analyst, under supervision of Runnels. Lab. No. JN-7. (Plummer and Hladik, 1951, p. 20, 24, 25, 31, 34, 52.) Shale, red and black, mostly unoxidized; 37.0 ft sampled, 37.0 ft available. Geologic map. Results of experimental production of lightweight aggregate; bloating results, screen analysis. Possible use: Lightweight aggregate.

56. Lane County. Pliocene, Ogallala formation. SW¼NW¼ sec. 23, T. 16 S., R. 27 W. Analyst, under supervision of Runnels. Lab. No. LE-1. (Plummer and Hladik, 1951, p. 21, 50, 71.) Shale 8 ft thick. Possible use: Lightweight aggregate.

57. Leavenworth County. Pennsylvanian, Weston shale. Cen. east line sec. 35, T. 9 S., R. 22 E. Analyst, under supervision of Runnels. Lab. No. LV-4. (Plummer and Hladik, 1951, p. 20, 24, 25, 31, 34, 52.) Shale, mostly unoxidized; 30.0 ft sampled, 30.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

58. Lincoln County. Dakota sandstone, Terra Cotta clay member. NE¼ sec. 19, T. 12 S., R. 10 W. Analysts, Thompson and Runnels. Lab. No. L-38-5. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 70, 75, 82, 83, pl. 1.) Ball clay, light-gray, slight amount of sulfur yellow on joints; plastic, lignite particles and lignitized fossil leaves; 7.2 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories, structural units.

59. Lincoln County. Dakota sandstone. SW¼NW¼ sec. 36, T. 11 S., R. 7 W. Analyst, under supervision of Runnels. Lab. No. L-4-C. (Plummer and Hladik, 1951, p. 21, 28, 29, 31, 64, 65.) Clay, dark-gray, unoxidized; 14.2 ft sampled, about 20.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

60. Lyon County. Pennsylvanian, Wabaunsee group, Langdon shale. NE¼SW¼ sec. 35, T. 17 S., R. 12 E. Analyst, under supervision of Runnels. Lab. No. LY-4. (Plummer and Hladik, 1951, p. 20, 26, 27, 30, 35, 52.) Shale, red and gray, unoxidized; 11.0 ft sampled, 11.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

61. Lyon County. Langdon shale. SE¼ sec. 35, T. 17 S., R. 12 E. Analyst, Runnels. Lab. No. LY-22. (Plummer and Hladik, 1948, p. 74, 62, 78, 79.) Shale, 5 ft thick, channel sample. Firing and physical properties of ceramic slag. Index map. Possible use: Ceramic slag.

62. Montgomery County. Pennsylvanian, Coffeyville formation. W½ sec. 2, T. 35 S., R. 16 E. Analyst, under supervision of Runnels. Lab. No. MG-3. (Plummer and Hladik, 1951, p. 20, 24, 25, 30, 35, 52, 56.) Shale, red and gray, unoxidized; 25.0 ft sampled, 60.0 ft available. Geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Electron micrograph. Possible use: Lightweight aggregate.

63. Montgomery County. Pennsylvanian, Bonner Springs shale. NE¼SW¼ sec. 7, T. 31 S., R. 16 E. Lab. No. MG-2. Analyst, reference, map, tests and use as in sample 62. Shale, dark-gray, unoxidized; 15.0 ft sampled, about 50.0 ft available.

*64. Osage County. Howard limestone, Aarde shale member, Nodaway underclay, (R. T. Runnels, written communication, 1954). T. 14 S., R. 15 E., town of Carbondale. (Saunders, 1875, p. 8.) (Analysis shows 16.7 percent FeO; suggests 8.6 percent gypsum.) Fire clay; beneath coal bed.

TABLE 9.—Analyses of samples from Kansas containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	Kansas										
	65	66	67	68	69	70	71	72	73	74	75
	15D70-1	15D72-17	15D72-18	15D72-24	15D72-20	15D72-23	15D72-21	15D72-22	15D74-16	15D74-17	15D74-18
SiO_2	59.77	60.41	61.62	64.23	62.14	63.54	62.90	63.17	51.60	51.92	52.36
Al_2O_3	21.95	[1] 26.93	[1] 26.46	[2] 22.84	[2] 24.27	20.88	20.85	23.07	20.46	20.52	18.82
Fe_2O_3	4.85	1.41	1.12	[3] 1.51	[3] 2.16	2.55	2.55	1.55	1.86	2.10	3.16
MgO	1.01	.76	.50	.63	.54	......	......	......	.04	.02	.45
CaO	.36	.31	.35	.28	.54	......	......	......	2.25	2.17	1.98
Na_2O	.73	2.25	2.90	.20	.15	......	......	......	.19	.62	......
K_2O	3.71			1.59	.72	......	......	......			
H_2O-	......	......	......	......	......	......	......	......	[4] 13.6	[4] 12.2	[4] 12.9
TiO_2	.97	......	......	[5] 1.29	[5] 1.09	1.31	1.32	1.39	.02	.02	.02
P_2O_5	Tr.	......	......	Tr.	Nil	......	......	......	......	......	......
SO_3	Nil	......	......	Tr.	Tr.	......	......	......	1.10	.84	.90
S	.01	......	......	Nil	Nil	......	......	......	......	......	......
Ignition loss	6.38	7.65	7.28	[6] 7.33	[6] 8.41	9.28	9.77	8.83	[7] 9.35	[7] 10.47	[7] 9.58
Total	99.74	99.72	[8] 100.23	99.90	100.02	97.56	97.39	98.01	100.5	100.9	100.2
Class	15,77,0	11,85,1	14,83,1	22,73,2	17,79,2	24,73,0	23,73,0	21,76,0	13,82,3	13,83,3	16,80,3

	76	*77	*78	79	80	81	82	83	*84	85	86
	15D74-19	15D78-5	15D78-6	15D79-7	15D79-8	15D84-2	15D84-3	15D84-4	15D84-5	15D85-3	15D89-3
SiO_2	53.39	52.00	52.36	62.00	59.83	58.65	61.81	61.94	55.30	60.56	57.45
Al_2O_2	18.15	17.04	15.81	20.19	21.02	21.22	[1] 26.45	[1] 25.48	16.02	18.96	20.75
Fe_2O_3	4.05	6.23	7.03	5.46	6.07	4.27	1.28	2.86	8.31	5.86	6.48
MgO	.13	6.83	9.14	.55	.38	.53	.64	.26	.79	1.84	2.07
CaO	5.15	2.40	3.10	.41	1.82	.98	.37	.53	2.06	1.37	.82
Na_2O	1.80	3.69	.65	2.41	1.57	2.40	1.98	2.03	2.18	.11	1.08
K_2O			3.28							2.32	3.54
H_2O-	[4] 9.0	......	......	......	......	......	......	......	......	......	......
TiO_2	.03	5.59	.91	2.86	1.16	3.91	......	......	.59	1.09	1.37
P_2O_5	......	None	Nil	......	......	......	......	......	.24	.12	.23
SO_3	.34	......	......	......	......	......	......	......	4.70	1.19	Tr.
Ignition loss	[7] 7.02	6.66	7.72	6.50	7.83	7.55	8.97	7.68	10.70	6.53	6.67
Total	99.1	[9] 100.44	100.00	[10] 100.38	[11] 99.68	99.51	[12] 101.50	[13] 100.78	100.89	[14] 99.95	100.46
Class	17,73,3	15,66,2	16,64,4	20,74,0	16,78,2	16,74,3	14,84,2	14,84,1	18,69,2	20,71,1	13,78,0

Quantitative spectrochemical analyses

[Standard graphite electrodes used. Co, Zn, Ge, Sr, Zr, Ag, Cd, Ba, and lanthanides not found. Further explanation of table (Plummer and others, 1954, p.169,170)]

	68	69		68	69
V	0.0131	0.0125	Ga	0.0038	0.0049
Cr	.0105	.0102	Mo	.00	.0033
Mn	.0070	.0069	Sn	Tr.	Tr.
Ni	.0038	.0050	Pb	Tr.	Tr.
Cu	[15] .0018	[15] .00135			

[1] Includes TiO_2.
[2] Includes Ga_2O_3 and MnO_2 if present.
[3] Total iron.
[4] At 105° C.
[5] Contains ZrO_2 and V_2O_5 if present.
[6] 140° - 1,000° C.
[7] At 900° C. (Ignition loss reported in text includes H_2O-.)
[8] 100.20 in text.
[9] 100.40 in text. MnO reported as slight trace.
[10] 100.47 in text.
[11] 100.12 in text.
[12] 101.40 in text.
[13] 100.68 in text.
[14] 100.07 in text.
[15] Not as accurate a determination as other elements (Plummer and others, 1954, p. 171).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

65. Osage County. Pennsylvanian, Howard limestone, Aarde shale member, Nodaway underclay. Sec. 34, T. 17 S., R. 14 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 195, 222, pls. 1, 2.) Underclay, 0-4 in. below coal. Index map, outcrop map; columnar section; mechanical analysis; X-ray patterns; estimated amounts of clay constituents and relationship to structure.

66-67. Ottawa County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay members. T. 9 S., R. 2 W. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 70, 71, 75, 81-83, 87, 148, 150, pl. 1.) Index map, outcrop map, detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

66. SW¼SE¼ sec. 5. Lab. No. O-6-3. Ball clay, light-gray, very little stain, plastic; conchoidal fracture; 5.3 ft thick.

67. NW¼NE¼ sec. 8. Lab. No. O-38-4. Ball clay, light-gray, almost no stain, plastic; slickensides on small joints; some lignite particles; 6.2 ft thick. Correlation of temperature-porosity and temperature-absorption curves. Temperature-specific gravity and temperature-apparent specific gravity curves. Absorption-temperature curve, porosity-temperature curve.

68-69. Ottawa County. Dakota sandstone. Analyst, Runnels. (Plummer and others, 1954, p. 164, 160-162, 166, 170, 171, 173, 178, 181, 186, 206, pls. 2, 3.) Additional chemical analyses of sized fractions of sample; spectrochemical analyses of clay fraction <2 microns. Statistical data. Petrographic and mineralogical data, ceramic tests, differential thermal curves, mechanical analyses. Photomicrographs of thin sections, electron micrographs of clay particles. X-ray diffraction data. Weighted composition of sized fractions.

68. Terra Cotta clay member. NW¼NE¼ sec. 8, T. 9 S., R. 2 W. Lab. No. O-38-4. Ball clay, light-gray, moderately fine-grained, smooth, plastic, some lignite particles and small amount of limonite stain; bed 6.3 ft thick; overlain by mottled clay, underlain by silty and gritty clay. Use: Pottery.

69. Janssen clay member. SW¼NE¼ sec. 18, T. 11 S., R. 4 W. Lab. No. O-5-6. Clay, dark-gray to black, plastic, fine-grained, slick appearance, conchoidal fracture, hard; contains numerous small slickensides; 2.8-5.7 ft thick; channel sample from 3 pits. Possible use: Brick.

70-72. Ottawa County. Dakota sandstone. T. 9 S., R. 2 W. Index maps, generalized columnar section, logs of open-cut and drill holes. Possible use: Ceramic products.

70. SW part SW¼NE¼ sec. 5. Hole A-54. (McMillan and Wilson, 1948, p. 17, figs. 1-4.) Clay, gray, few yellow streaks; 7-18 ft below surface.

71. SW part NW¼SE¼ sec. 5. Hole A-50. (McMillan and Wilson, 1948, p. 16, figs. 1-4.) Clay, dark-gray, some silt; 10-16 ft below surface. (For another analysis from same measured section see sample 268, group B of this compilation.)

72. SW part NW¼SE¼ sec. 5. A-Cut-5. (McMillan and Wilson, 1948, p. 18, figs. 1-4.) Clay, dark, blue-gray, few yellow streaks; 2-9 ft below surface.

73-76. Phillips County. Upper Cretaceous, between Pierre shale and Niobrara formation. Analyst, Thompson. (Kinney, 1942, p. 358, 354, 364-366, 373, 375.) Immersion, gelation, and other physical tests. Index map.

73. Sec. 10, T. 1 S., R. 18 W. Lab. No. 2. Alkali-bentonite, very light-gray; middle of deposit, 1 ft thick. Possible use: Refractories; filler, cosmetics. (For other analyses from same measured section see sample 74, following sample, and sample 275, group B of this compilation.)

74. Location as in sample 73. Lab. No. 1. Alkali-earth subbentonite, blue-gray; upper part of deposit; 1.5 ft thick; overburden 15 ft.

75. SE¼ sec. 35, T. 1 S., R. 20 W. Lab. No. 7. Alkali subbentonite, traces of volcanic ash, very light yellow-gray; bottom of deposit, 0.66 ft thick. Possible use: Soap.

76. Location as in sample 75. Lab. No. 8. Alkali-bentonite, light greenish gray; upper part of deposit, 3.5 ft thick, overburden 5 ft. Possible use: Bond for foundry sand, ceramic products, cement mixtures.

Kansas--Continued

*77. Reno County. Permian, Ninnescah shale (R. T. Runnels, written communication, 1954.) NW¼ sec. 8, T. 25 S., R. 5 W. Analyst, Runnels. Lab. No. RO-1-2. (Plummer and Hladik, 1948, p. 74, 62.) (Analysis shows 5.6 percent TiO_2, 3.7 percent alkalies; suggests 8.4 percent more CaO and MgO than required for carbonates.) (Shale.) Index map. Use: Ceramic slag.

*78. Reno County. Ninnescah shale. Sec. 21, T. 25 S., R. 6 W. Analyst, under supervision of Runnels. Lab. No. RO-2. (Plummer and Hladik, 1951, p. 21, 26, 27, 31, 64, 65.) (Analysis shows 3.9 percent alkalies; suggests 10.3 percent more CaO and MgO than required for carbonates.) Shale, oxidized; 11.3 ft sampled, about 30.0 ft available. Index and geologic map. Resnlts of experimental production of lightweight aggregate, screen analysis. Possible use: Lightweight aggregate.

79. Republic County. Dakota sandstone, Terra Cotta clay member. Cen. W½ sec. 11, T. 4 S., R. 1 W. Analyst, Thompson and Runnels. Lab. No. RP-8-2. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 159, 163, 166, 167, pl. 1.) Clay, 21.9 ft sectioned from top to bottom as follows:

2.4 ft ...... clay, buff and gray, silty.
6.8 ft ...... clay, yellow-gray and brownish-red to mottled red, slightly silty.
12.7 ft ...... clay, light-gray with pinkish-red, yellow and some lavender mottling, slightly silty.

Index map, outcrop map, detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

80. Republic County. Upper Cretaceous, Graneros shale. NE¼NW¼ sec. 34, T. 3 S., R. 1 W. Analysts, Thompson and Runnels. Lab. No. RP-7-2. (Plummer and Romary, 1947, p. 180, 42, 43, 179, 181, pl. 1.) Clay-shale, gray to dark-gray, some silty partings, yellow limonitic sand streaks; 12.5 ft thick. Index map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Lightweight aggregate, insulated structural tile; stoneware, earthenware.

81-83. Russell County. Dakota sandstone, Janssen clay member. NE¼NW¼ sec. 25, T. 12 S., R. 11 W. Analysts, Thompson and Runnels. Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

81. Lab. No. R-6-5. (Plummer and Romary, 1947, p. 165, 10, 42, 43, 158, 163, 166, 167, pl. 1.) Clay, gray, some fine red mottling, small selenite crystals; some yellow mottling in upper 7 ft; plastic; 11.2 ft thick.

82. Lab. No. R-6-9. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 72, 75, 82, 83, pl. 1.) Ball clay, gray to black, some sulfur yellow stain; some lignite and selenite in upper 4.2 ft; plastic; 7.8 ft thick.

83. Lab. No. R-6-11. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 72, 75, 82, 83, pl. 1.) Ball clay, gray to dark-gray, lignite particles, plastic; 5.7 ft thick.

*84. Russell County. Graneros shale. NW¼NW¼ sec. 35, T. 12 S., R. 14 W. Analyst, under supervision of Runnels. Lab. No. R-15. (Plummer and Hladik, 1951, p. 21, 28, 30, 39, 64, 65.) (Analysis shows 2.2 percent alkalies; suggests 6.3 percent gypsum, 1.8 percent SO_3 not used in gypsum.) Shale, red and gray, unoxidized; 14.0 ft sampled, 14.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

85. Saline County. Lower Cretaceous, Kiowa shale. NE¼NE¼ sec. 8, T. 15 S., R. 4 W. Analyst, under supervision of Runnels. Lab. No. S-18. (Plummer and Hladik, 1951, p. 21, 26, 27, 30, 39, 64, 65.) Shale, pink and gray, unoxidized; 27.0 ft sampled, 27.0 ft available. Index and geologic map. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Possible use: Lightweight aggregate.

86. Shawnee County. Pennsylvanian, Calhoun shale. Cen. N½SW¼ sec. 15, T. 11 S., R. 16 E. Analyst, under supervision of Runnels. Lab. No. SH-2. (Plummer and Hladik, 1951, p. 20, 26, 27, 30, 36, 52.) Shale, red and gray, unoxidized; 15.0 ft sampled, 15.0 ft available. Results of experimental production of lightweight aggregate, bloating results, screen analysis. Geologic map. Possible use: Lightweight aggregate.

TABLE 9.—Analyses of samples from Kansas containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	Kansas									
	*87	88	89	90	91	92	93	94	95	96
	15D89-4	15D100-10	15D100-11	15D101-17	15D101-23	15D101-16	15D101-11	15D101-18	15D101-20	15D101-24
SiO_2	56.39	52.28	55.71	59.88	62.02	59.76	56.74	60.70	60.95	62.26
Al_2O_3	20.06	20.20	21.55	30.90	[1] 26.54	26.15	25.24	28.44	24.09	22.68
Fe_2O_3	6.64	3.20	3.31	1.69	1.52	2.18	2.06	2.88	2.54	2.48
MgO	.95	.49	.16	......	.65	1.35	1.37	......	1.17	......
CaO	.40	2.04	1.32	.24	.39	1.27	.54	.27	.65	......
Na_2O	.78	} .27	......	......	3.19	2.70	3.42	......	1.76	......
K_2O	3.70									
H_2O- at 105° C	......	6.4	9.0	......	......	......	......	......	......	......
TiO_2	1.61	.01	.02	......	......	1.06	2.27	......	.33	1.33
P_2O_5	.03	......	......	......	......	......	......	......	......	......
SO_3	.32	1.57	2.13	......	......	......	......	......	......	......
S	.03	......	......	......	......	......	......	......	......	......
Ignition loss	6.55	[2] 13.66	[2] 2.78	7.26	7.45	7.20	7.50	7.33	8.44	9.20
Total	[3] 97.46	100.1	96.0	99.97	101.76	[4] 101.67	99.14	99.62	99.93	97.95
Class	13,76,0	13,82,3	14,78,0	3,96,0	13,84,1	11,84,0	10,81,1	7,92,0	15,79,4	19,77,0

	97	98	99	100	101	102	103	104	105
	15D101-22	15D101-12	15D101-19	15D101-13	15D101-21	15D101-14	15D101-15	15D103-8	15D103-9
SiO_2	61.94	56.75	60.88	57.40	61.10	58.96	59.02	55.94	60.04
Al_2O_3	22.28	19.43	21.58	22.67	19.89	23.47	22.22	22.42	19.13
Fe_2O_3	3.05	11.49	3.13	6.06	7.27	2.98	2.63	7.47	6.94
MgO	......	......	......	......	......	......	......	1.93	1.86
CaO	......	......	......	......	......	......	......	.49	.42
Na_2O	......	......	......	......	......	......	......	.67	1.31
K_2O	......	......	......	......	......	......	......	3.14	3.04
TiO_2	1.29	1.11	1.28	1.38	1.43	1.21	1.18	1.76	1.60
P_2O_5	......	......	......	......	......	......	......	.20	.18
SO_2	......	......	......	......	......	......	......	Tr.	Tr.
Ignition loss	9.52	8.65	10.92	10.43	8.91	11.75	12.53	7.40	5.94
Total	98.08	97.43	97.79	97.94	98.60	98.37	97.58	[5] 101.42	100.46
Class	19,78,0	9,87,0	19,77,0	10,86,0	18,79,0	14,83,0	17,80,0	8,85,0	18,74,0

[1] Includes TiO_2.
[2] At 900° C. (Ignition loss reported in text includes H_2O-.)
[3] 99.75 in text.
[4] 99.67 in text.
[5] 100.60 in text.

TABLE 10.—Analyses of samples from Montana containing more than 75 percent clay (Group D) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by county and stratigraphic position]

	Montana					
	*1	2	3	*4	*5	*6
	25D1-7	25D7-2	25D7-1	25D12-4	25D12-3	25D47-1
Insoluble	23.7	[1] 55.38	[1] 53.70	[1] 53.29	24.7	39.9
Al_2O_3	6.0	30.86	27.20	22.38	7.30	10.4
Fe_2O_3	2.0	[2] .86	5.00	[3] 6.57	2.80	10.0
MgO	......	1.03	Tr.	2.10	......	......
CaO	......	.40	Tr.	.53	......	......
Na_2O	......	.26	} 2.90	1.11	......	......
K_2O	......	1.04		7.43	......	......
H_2O+	......	......	......	} [6] 4.12	......	......
H_2O-	......	[7] .84	......			

	1	2	3	4	5	6
TiO_2	......	......	......	0.91	......	......
P_2O_5	18.8	......	......	......	19.2	4.4
SO_3	......	0.16	0.30	......	......	......
F	......	......	......	......	......	2.40
Fe_2S_3	......	2.23	......	......	......	......
Ignition loss	25.5	6.86	10.85	[4] .58	16.52	6.2
Total	76.0	99.92	99.95	99.02	70.5	[5] 72.3
Class	(11,46)0	1,93,0	0,97,0	14,66,1	(9,43)0	(10,56)0

Semiquantitative spectrographic analyses

[A=more than 10.0 percent; D=0.1-1.0 percent; E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. Li, Be, Co, Ga, Ge, As, Cb, Cd, In, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, Pb, and Bi looked for in both samples but not detected]

	1	6		1	6		1	6
B	F	F	V	D	D	Zn	E	E
Na	E	E	Cr	E	D	Sr	ND	F
Mg	D	A	Mn	F	E	Zr	E	E
Ca	A	A	Ni	E	D	Mo	E	E
Ti	E	D	Cu	G	G	Ag	G	G

[1] Reported as SiO_2.
[2] Reported as FeO.
[3] Total iron reported as FeO.
[4] Reported as CO_2.
[5] (O calculated from F, by compilers, 1.01 percent. Subtotal, 73.30; total, 72.3.)
[6] Determined by loss on ignition, corrected for CO_2 and oxidation of ferrous iron.
[7] At 100° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

*87. Shawnee County. Pennsylvanian, Howard limestone, Aarde shale member, Nodaway underclay. Sec. 27, T. 11 S., R. 15 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 195, pls. 1, 2.) (Analysis shows 4.5 percent alkalies, 1.6 percent TiO_2; suggests 1.4 percent more CaO and MgO than required for carbonates.) Underclay, 0-5 in. below coal. Index map, outcrop map; columnar section, correlated columnar sections; mechanical analysis; estimated amounts of clay constituents and relationship to structure. (For analyses from same measured section see samples 317 and 318, group B of this compilation.)

88-89. Wallace County. Pliocene, Ogallala formation. Analyst, Thompson. (Kinney, 1942, p. 358, 354, 356, 364-366, 373, 375.) Index map. Immersion, gelation, and other physical tests.

88. SW¼ sec. 19, T. 12 S., R. 41 W. Lab. No. 9. Alkali-bentonite, pale olive-green; 10 ft sampled; overburden 0-20 ft. Possible use: Bleaching and clarifying agent, drilling mud, core for earth-fill dams. (For analysis of lower bed see sample 38, group E of this compilation.)

89. SE¼ sec. 2, T. 12 S., R. 42 W. Lab. No. 15. Alkali subbentonite, pale gray-green; 5 ft sampled; overburden 20 ft. Possible use: Cement mixture, refractories, bond for foundry sand.

90. Washington County. Upper Cretaceous, Dakota sandstone, Terra Cotta clay member. SE¼ sec. 14, T. 1 S., R. 3 E. Analysts, Kinney and Thompson. Lab. No. W-5. (Plummer and Romary, 1942, p. 335, 316, 329-331.) Clay, partly thin bedded, contains fossil leaves. Index map; generalized measured section, correlated columnar sections. Ceramic tests. (For similar analysis see Jewett and Schoewe, 1942, p. 102.)

91-93. Washington County. Dakota sandstone, Terra Cotta clay member. T. 1 S., R. 3 E. Analysts, Thompson and Runnels. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 73, 74, 81, 82, 84, 87, 148, 150, pl. 1.) Index map, outcrop map; detailed measured sections, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Possible use: Refractories.

91. NW¼ SE¼ sec. 14. Lab. No. W-5-5. Ball clay, light-gray, some yellow stain; some lignite; small amount of selenite; plastic, thin-bedded, 4 ft thick. Correlation of temperature-porosity and temperature-absorption curves. Temperature-specific gravity and temperature-apparent specific gravity curves. Absorption-temperature curve, porosity-temperature curve. (For analysis of composite sample from beds including this bed see sample 92.)

92. NW¼ SE¼ sec. 14. Lab. No. W-5-A. Ball clay, 16.6 ft thick, sectioned from top to bottom as follows:

4.0........clay, light-gray, some yellow stain, some lignite, small amount of selenite; plastic thin-bedded. (For analysis of this bed see sample 91.)
9.2 ft......clay, plastic; upper 6.4 ft light gray, very light brown mottling; lower 2.8 ft dark gray, some yellow joint stain; light-brown mottling.
3.4 ft......clay, dark-gray, very little stain; lignite particles, flinty concretions toward bottom; very plastic; thin bedded.

Porosity-temperature curve.

93. Center S½ SW¼ sec. 28. Lab. No. W-19-3. Ball clay, smooth, fine-grained, plastic; 11.2 ft thick, sectioned from top to bottom as follows:

2.4 ft......gray, slight yellow stain, lignite particles.
1.8 ft......light-gray, much yellow stain.
7.0 ft......gray, yellow stain.

(For another analysis from same measured section see sample 329, group B of this compilation.)

94. Washington County. (Probably Dakota sandstone, Terra Cotta clay member. SW¼ sec. 28, T. 1 S., R. 3 E., Plummer and Romary, 1947, p. 74.) Analyst, Thompson. Lab. No. W-19-A. (Jewett and Schoewe, 1942, p. 102.) High alumina clay. Estimated tonnage, mineralogy. Possible use: Source of alumina.

95. County, formation, and member as in sample 94. SE¼ SE¼ sec. 1, T. 3 S., R. 2 E. Analysts, Thompson and Runnels. Lab. No. W-1-2. (Plummer and Romary, 1947, p. 101, 10, 42, 43, 99, 102, 103, 148, pl. 1.) Plastic fire clay, gray, slight yellow stain; lignite particles, conchoidal fracture; 4.7-5.5 ft thick. Index map, outcrop map; detailed measured section, correlated columnar sections. Ceramic tests, physical properties, mineralogy. Absorption-temperature curve. Use: Pottery. Possible use: Face brick. (For analysis of composite sample from beds, including this bed, see sample 333, group B of this compilation.)

Kansas--Continued

96-103. Washington County. Dakota sandstone. (McMillan and Wilson, 1948, p. 28, figs. 1-3.) Index maps, generalized columnar section; logs of open cuts. Possible use: Ceramic products.

96. NW¼ SE¼ sec. 14, T. 1 S., R. 3 E. Opencut No. C-W-5. Clay, dark blue-gray; 10.3-16 ft below surface.

97. NW¼ SE¼ sec. 14, T. 1 S., R. 3 E. Opencut No. C-W-5. Clay, dark blue-gray; few red streaks; 6.6-10.3 ft below surface.

98. NW¼ SE¼ sec. 14, T. 1 S., R. 3 E. Opencut No. C-W-5. Clay, gray and red; some hematite; 2-6.6 ft below surface.

99. Center S½ SW¼ sec. 28, T. 1 S., R. 3 E. Opencut No. C-W-19. Clay, dark blue-gray; 10.9-17.5 ft below surface.

100. Center S½ SW¼ sec. 28, T. 1 S., R. 3 E. Opencut No. C-W-19. Clay, gray and yellow; 5.7-10.9 ft below surface.

101. Center S½ SW¼ sec. 28, T. 1 S., R. 3 E. Opencut No. C-W-19. Clay, gray and yellow, showing limonite; 1.5-7 ft below surface.

102. SE¼ NE¼ sec. 31, T. 2 S., R. 1 E. Opencut No. C-W-59. (McMillan and Wilson, 1948, p. 29, figs. 1-3.) Clay, dark blue-gray; 11.4-16.4 ft below surface. (For another analysis from same measured section see sample 336, group B of this compilation.)

103. SW¼ SE¼ sec. 6, T. 3 S., R. 2 E. Opencut No. C-W-62. Clay, dark blue-gray, few yellow streaks; 7.9-14.4 ft below surface. (For another analysis from same measured section see sample 337, group B of this compilation.)

104. Wilson County. Pennsylvanian, Weston shale. NW¼ SW¼ sec. 11, T. 29 S., R. 14 E. Analyst, under supervision of Runnels. Lab. No. WL-1. (Plummer and Hladik, 1951, p. 20, 26, 30, 36, 52; Kinney, 1952, p. 312, 315.) Shale, red, mostly unoxidized; 32.0 ft sampled, about 100.0 ft available. Geologic map. Results of experimental production of lightweight aggregate; bloating results, screen analysis, results of lime-sinter process. Possible use: Production of alumina, lightweight aggregate.

105. Wilson County. Pennsylvanian, Lawrence shale. NW¼ SW¼ sec. 12, T. 27 S., R. 15 E. Analyst, under supervision of Runnels. Lab. No. WL-2. (Plummer and Hladik, 1951, p. 20, 26, 27, 30, 36, 52.) Shale, red, gray, mostly unoxidized; 25.0 ft sampled. Geologic map. Results of experimental production of lightweight aggregate; bloating results, screen analysis. Possible use: Lightweight aggregate.

Montana

*1. Beaverhead County. Permian, Phosphoria formation. NW¼ SW¼ sec. 23, T. 9 S., R. 9 W. Spectrographic analyst, Mortimer. Lab. No. ERC-37. (Swanson and others, 1953b, p. 17, 21, 2, pl. 1.) (Partial analysis suggests 44.6 percent phosphate.) Phosphate rock and mudstone; 1.7 ft thick, 43.09 ft from top of member. Trench sample. Bed D-12. Index, outcrop map; generalized columnar section. (For other analyses from same measured section see samples 47, 48 group A, samples 1-3 gronp B, and samples 15-18 group P; of this compilation.)

2-3. Cascade County. Lower Cretaceous, Kootenai formation. Sec. 31, T. 19 N., R. 7 E., town of Armington, Anaconda Copper Mining Co. Clay, light-gray to slate-colored, fine-grained, homogeneous, subconchoidal fracture; 4.5 ft thick. Index maps, detailed measured section, generalized measured section. Use: Refractories.

2. (Fisher, 1908, p. 420, 418, pl. 5.)

3. Average sample. (Fisher, 1908, p. 421, 418, pl. 5.)

*4. Deer Lodge County. Cambrian, Silver Hill formation. Sec. 4, T. 5 N., R. 13 W., (U. M. Sahinen, written communication, 1955) southwest slope of Cable Mountain. Analyst, Schaller. (Emmons and Calkins, 1913, p. 57.) (Analysis shows 8.5 percent alkalies, 6.6 percent FeO; suggests 2.1 percent more CaO and MgO than required for carbonates.) Shale, olive-green, slightly altered, fine-grained, fissile. Index map, geologic map, detailed measured section, generalized columnar section, mineralogy.

*5. Deer Lodge County. Phosphoria formation. Sec. 23, T. 5 N., R. 12 W., north side of Warm Spring Creek. Lab. No. 5895-RWS. (Swanson and others, 1953a, p. 7, 2, 3.) (Partial analysis suggests 45.5 percent phosphate.) Phosphate rock, argillaceous; 0.5 ft thick. Sampled in outcrop and hand trench in bluff. Index, outcrop map, generalized columnar section.

*6. Silver Bow County. Phosphoria formation. NW¼ sec. 5, T. 2 S., R. 9 W., Melrose property of Anderson Phosphate Mines, Inc. Spectrographic analyst, Mortimer. Lab. No. MRK-288. (Klepper and others, 1953, p. 11, 12.) (Partial analysis suggests 10.4 percent phosphate.) Mndstone, calcareous; bed D-5; 0.4 ft thick. (For other analyses from same measured section see samples 26-28, group P of this compilation.)

TABLE 11.—Analyses of samples from North Dakota, South Dakota, and Wyoming containing more than 75 percent clay (Group D) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position. Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature]

	North Dakota									
	1	2	3	4	5	6	7	8	9	10
	33D4-3	33D10-5	33D10-6	33D13-4	33D13-5	33D21-12	33D21-13	33D29-1	33D29-2	33D44-53
SiO_2	62.65	61.03	50.45	53.32	63.19	60.98	63.64	62.90	63.90	57.03
Al_2O_3	20.76	22.70	17.57	23.76	23.35	26.24	24.17	22.68	25.79	21.23
Fe_2O_3	4.98	6.53	2.80	9.30	1.49	1.34	.95	4.98	1.49	5.22
MgO	.77	.51	1.79	1.26	.98	.94	.98	.72	.25	1.04
CaO	.26	.97	.25	.25	.29	.34	.45	.32	.25	.74
Na_2O	......	......	.86	.10	......	1.22	......	......	......	2.97
K_2O	......	......	.07	2.10	......	1.26	......	......	......	1.10
TiO_2	......	......	......	......	......	......	......	......	......	1.14
Ignition loss	[1] 6.55	[2] 7.92	[3] 22.55	8.50	7.82	[1] 7.85	[1] 7.60	[1] 7.46	[1] 7.28	8.28
Total	95.97	99.66	96.34	98.59	97.12	100.17	97.79	99.06	98.96	98.75
Class	20,74,0	14,85,1	16,75,4	1,94,0	20,74,3	13,82,2	20,75,3	17,80,1	17,81,1	14,76,3

	North Dakota								
	11	12	13	14	15	16	17	18	19
	33D44-55	33D44-54	33D45-146	33D45-147	33D45-152	33D45-151	33D45-149	33D45-148	33D45-150
SiO_2	64.17	63.34	64.84	65.64	63.80	63.58	56.85	63.30	60.78
Al_2O_3	19.55	19.01	24.31	22.74	20.21	19.73	23.91	21.06	15.66
Fe_2O_3	5.40	5.79	1.60	1.66	5.11	5.11	3.98	5.56	10.78
MgO	......	1.15	.24	.61	.98	.87	......	......	......
CaO	......	.92	.11	.29	.80	.45	......	......	......
Na_2O	......	2.82	.32	1.76	1.52	3.00	......	......	......
K_2O	......	1.63	Tr.	1.46	......	......	......	......	......
TiO_2	.25	1.02	......	......	.70	.73	.50	.70	.84
Ignition loss	6.01	5.22	[4] 8.58	[1] 6.15	6.90	5.68	13.08	6.70	7.24
Total	95.38	100.90	100.00	100.31	100.02	99.15	98.32	97.32	95.30
Class	24,72,0	23,70,0	20,79,1	24,73,0	22,73,1	23,71,0	10,88,0	20,77,0	21,74,0

	North Dakota		South Dakota						
	20	21	22	23	24	25	26	27	28
	33D51-1	33D51-2	40D10-1	40D10-4	40D10-6	40D10-5	40D10-7	40D17-8	40D24-4
SiO_2	53.72	56.86	63.22	60.64	58.53	59.66	59.34	56.18	53.77
Al_2O_3	17.78	25.03	19.14	23.26	19.61	21.04	22.70	23.23	22.70
Fe_2O_3	3.85	6.11	6.20	3.92	3.10	2.66	3.92	1.26	4.05
FeO	......	......	......	......	.13	......	......	......	......
MgO	.50	.76	1.08	2.19	2.65	3.56	2.57	3.29	3.25
CaO	.81	.71	.50	.59	.25	.96	1.27	5.88	1.23
Na_2O	1.72	.016	......	4.33	1.68	1.94	......	......	2.46
K_2O	.28	.50	......	.37	.31	.10	......	......	......
H_2O+	......	......	......	2.83	6.21	......	3.84	11.45	......
H_2O-	......	......	.88		7.89	[5] 3.51			
TiO_2	......	......	......	.12	.12	......	......	......	......
Mn_2O_4	......	......	.26	......	......	.22	......	......	......
SO_3	......	......	.03	......	......	.32	.39	......	......
Ignition loss	[3] 21.82	[4] 10.014	6.22	......	......	6.19	5.75	......	12.17
Total	100.48	100.00	97.53	98.25	100.48	100.16	99.78	101.29	99.63
Class	18,78,3	6,91,3	22,73,0	15,76,3	20,75,0	19,73,1	15,75,8	14,78,0	9,79,9

Spectrographic data for sample 24

[P = Phillips Research Lab. determination; S = Shell Oil Co. determination; Pres. = Element present]

	P	S		P	S		P	S
Li	Pres.	<0.09	Co	......	<0.001	Zr	0.03	0.05
Be	......	<.0005	Cu	0.001	.003	Mo	......	<.003
B	0.004	.01	Zn	......	<.03	Ag	.003	.002
Sc	......	([6])	Ga	.02	.009	Cs	......	([6])
V	......	<.002	Rb	......	<.01	Ba	.08	[7] <.04
Cr	......	<.0007	Sr	.09	[7] .03	Tl	......	<.00003
Mn	.01	.01	Y	......	<.005	Pb	.06	.04
Ni	......	<.001						

[1] Reported as volatile matter.
[2] Reported as H_2O.
[3] Reported as H_2O and volatile matter.
[4] By difference.
[5] At 110° C.
[6] Presence not detected; limit of detectability by procedure employed is as yet uncertain.
[7] Element detected; present in too small concentration for spectrochemical determination by procedure employed.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota

1. Billings County. Eocene, Golden Valley formation (W. E. Benson, personal communication, 1954). NW corner T. 143 N., R. 99 W., divide between Knife and Little Missouri Rivers. Analyst, Babcock. Lab. No. 3703. (Babcock and Clapp, 1906, p. 168, 133, 167, pl. 2.) Clay, yellow and white; 2 ft thick. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Brick, stoneware. (For analysis from same measured section see sample 2, group B of this compilation.)

2. Cavalier County. Upper Cretaceous, Benton shale. Secs. 33, 34, T. 163 N., R. 57 W., Mayo Brick and Tile Co. Analyst, Berkey. Lab. No. 0. (Berkey, 1905, p. 151, 146, 149, pl. 12; Babcock and Clapp, 1906, p. 102, 149.) Clay shale. General description: Black or greenish-gray, laminated, very plastic on weathered outcrops. Index map, geologic map; measured section. Use: Brick, tile. (For analysis from same measured section see sample 4, group B of this compilation.)

3. Cavalier County. Upper Cretaceous, probably Pierre shale. (T. 161 N., R. 57 W.) near town of Olga. Analyst, Babcock. (Babcock and Clapp, 1906, p. 105, 106, pl. 2.) Clay, white, fine, 2-3 ft thick, overlain and underlain by black carbonaceous clay shale. Geologic map. Firing tests. Possible use: Stoneware and low-grade refractories.

4-5. Dunn County. Golden Valley formation (W. E. Benson, personal communication, 1954). SW corner T. 147 N., R. 94 W., 5 miles east of Jim Creek. Analyst, Babcock. (Babcock and Clapp, 1906, p. 191, 133, 159, 160, pl. 2.) Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. (For another analysis from same measured section see sample 8, group B of this compilation.)

4. Lab. No. 3904. Clay, cream-colored streaked with iron stain, smooth, some sand in upper part; 6 ft thick. Underlies yellowish-white clay. Possible use: Brick, terra cotta, building block. (For analyses from same measured section see sample 5, group D and sample 8, group B of this compilation.)

5. Lab. No. 3906. Clay, white, very fine, compact, very little grit; 4 ft thick. Possible use: Brick, stoneware.

6. Hettinger County. Golden Valley formation (W. E. Benson, personal communication, 1954). NE corner T. 135 N., R. 95 W., Black Butte. Analyst, Babcock. Lab. No. 2104. (Babcock and Clapp, 1906, p. 174, 133, 175, pl. 2.) Clay, white, compact, fine-grained, almost no grit, no iron stain; 2 ft thick. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Earthenware, terra cotta; low-grade fire clay. (For analysis from same measured section see sample 12, group B of this compilation.)

7. Hettinger County. Golden Valley formation (W. E. Benson, personal communication, 1954). North part T. 136 N., R. 96 W., Yellow Buttes. Analyst, Babcock. Lab. No. 1201. (Babcock and Clapp, 1906, p. 172, 133, 171, pl. 2.) Clay, light bluish-gray, shaly, compact, fine-textured; 7 ft thick. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties. Possible use: Stoneware, earthenware.

8-9. Mercer County. Golden Valley formation (W. E. Benson, personal communication, 1954). T. 145 N., R. 90 W. Analyst, Babcock. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties.

8. Lab. No. 4004. (Babcock and Clapp, 1906, p. 162, 133, 161, pl. 2.) Clay, grayish-white, iron-stained, sandy, compact; from bed 10 ft thick. Possible use: Brick, tile.

9. Lab. No. 4008. (Babcock and Clapp, 1906, p. 163, 133, 161, pl. 2.) Clay, grayish-white, sandy; 2 ft thick. Possible use: Brick, stoneware.

)-11. Slope County. Oligocene, White River formation. Sec. 15, T. 134 N., R. 101 W., Chalky Buttes area. (Clarke, 1948, p. 14, 15, 6, 8, 23, 26, 30, figs. 1, 7.) Clay, uncombined silica present, alumina content of clay beds given. Index maps, generalized and detailed measured sections. Tests for foundry sand binder, water-softening properties. Possible use: Water softener.

10. Lab. No. 26. Trench 13. (For analysis from same trench see sample 42, group B of this compilation.)

11. Lab. No. 10. Trench 7. (For analyses from same trench see samples 33-36, group B of this compilation.)

12. Slope County. White River formation. Sec. 23, T. 134 N., R. 101 W., Chalky Buttes area. Lab. No. 58. (Clarke, 1948, p. 15, 6, 23, figs. 1, 7.) Clay, trench 16. Uncombined silica present. Alumina content of clay beds given. Index maps, generalized measured section. Tests for foundry sand binder, water-softening properties. Possible use: Water softener.

13-14. Stark County. Golden Valley formation (W. E. Benson, personal communication, 1954). T. 139 N., R. 96 W. Analyst, Babcock. Index and outcrop map, geologic map; detailed measured section. Ceramic tests, physical properties.

North Dakota--Continued

13. Location, one mile southwest of town of Dickinson. Lab. No. 104. (Babcock, 1901, p. 46; Babcock and Clapp, 1906, p. 150, 133, 149, 151, pl. 2.) Clay, light-gray or blue, very fine grained, almost no grit, 2 ft thick; underlies white sandy clay. Use: Fire brick, earthenware, stoneware. (For analyses from same measured section see samples 72, 73, group B of this compilation.)

14. Two miles north of town of Gladstone. Lab. No. 3502. (Babcock and Clapp, 1906, p. 143, 133, pl. 2.) Clay, white; somewhat sandy; 3 ft thick. Possible use: Brick, stoneware.

15-19. Stark County. White River formation. Town of South Heart, Little Badlands area. Clay. Trench samples. Uncombined silica present. Alumina content of clay beds. Index map, generalized measured section. Tests for foundry sand binder, water-softening properties.

15. Sec. 7, T. 137 N., R. 97 W. Lab. No. 249. Trench 83. (Clarke, 1948, p. 19, 20, 6, 12, 23, 26, 30, figs. 1, 6.)

16. Sec. 6, T. 138 N., R. 97 W. Lab. No. 233. Trench 79. (Clarke, 1948, p. 19, 20, 6, 23, 26, 30, figs. 1, 6.)

17. Sec. 13, T. 139 N., R. 98 W. Lab. No. 354. Trench 65. (Clarke, 1948, p. 22, 6, 23, 26, 30, figs. 1, 6.) Detailed measured section. Possible use: Foundry sand binder, water softener.

18. Sec. 22, T. 139 N., R. 98 W. Lab. No. 17. Trench 31. (Clarke, 1948, p. 14, 6, 23, figs. 1, 6.) No tests.

19. Sec. 31, T. 139 N., R. 98 W. Lab. No. 373. Trench 76. (Clarke, 1948, p. 22, 6, 23, 26, 30, figs. 1, 6.) Possible use: Foundry sand binder, water softener.

20-21. Ward County. Eocene, Fort Union formation, Tongue River member (W. E. Benson, personal communication, 1954). T. 155 N., R. 83 W.

20. Town of Minot. (Babcock, 1901, p. 55.) Clay, black; underlies coal.

21. Northwest of Minot, Colton mine. Analyst, Babcock. (Babcock, 1901, p. 40; 1906, p. 209, pl. 2.) Clay, blue or slaty-gray, very plastic, smooth greasy texture; above coal bed. Geologic map. Possible use: Brick, ornamental stone.

South Dakota

22. Butte County. Lower Cretaceous, Fuson shale. (T. 8 N., R. 2 E.), 3 miles south of town of Belle Fourche. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 308, 307.) Clay, purple and brown, 20-30 ft thick, overburden of sandstone up to 25-30 ft thick. Represents nearly all of middle and lower part of bed. Possible use: Brick, tile.

23. Butte County. Upper Cretaceous, Graneros shale, Mowry shale member. (Tps. 8-10 N., Rs. 1 and 2 E.), Belle Fourche bentonite district. Analyst, Selvig. Lab. No. 1. (Ladoo, 1921, p. 5; Ladoo, 1925, p. 96.) Bentonite, yellow; colloidal. Near surface in beds from few inches to 4 ft thick. Estimated tonnage, physical properties. Possible use: Filler, water softener.

24. Butte County. Graneros shale, Mowry shale member. Northwest of Belle Fourche, American Colloid Co. pit. Lab. No. 27. (Kerr and others, 1950, p. 54, 80, 81, 96, 108, 154; Kerr and Kulp, 1949, p. 54, 55; Kerr and others, 1949, figs. 15, 16; Main, 1950, p. 38, 50, 53; Adler and others, 1950, p. 138, pls. 5, 14.) Montmorillonite, 2-4 ft thick; sample of 80 lbs. Index maps. Summary of base-exchange capacity; exchange isotherms graph; thermal curves; infrared absorption measuremenrs. Staining tests, mineralogy.

25. Butte County. Graneros shale. Locality, 3-4 miles northwest of Belle Fourche, Belle Fourche Bentonite Products Co. mine. Analyst, Bentley. Lab. No. 3. (O'Harra, 1929, p. 48, 45.) Bentonite, about 8 ft above Mowry shale member; probably averages 3-3.5 ft in thickness. Forms jellylike mass in water. Moisture as received, 34.8 percent at 110° C.

26. Butte County. Graneros shale, near Belle Fourche. Analyst, Bentley. Lab. No. 6. (Lincoln, 1927a, p. 54.) Bentonite, yellow, in 3-ft bed about 8 ft above Mowry shale member. Forms jellylike mass in water.

27. Custer County. Oligocene, (Chadron formation. T. 4 S., R. 8 E.) town of Fairburn. Analyst, Flinterman. Lab. No. 3. (Ries, 1898, p. 335, 333, 334; Vaughan, 1902, p. 933.) Fuller's earth. General description and remarks: Yellowish, gritty clay; somewhat nodular structure; detailed measured sections. Possible use: Clarifying oil.

28. Fall River County. Graneros shale, oligonite zone. NW¼ sec. 2, T. 9 S., R. 2 E., 1 mile west of town of Edgemont. Lab. No. 6. (Spivey, 1940, p. 51, 43, 44, 52, pls. 1, 3, 7.) Bentonite. Base exchange capacity; pH 9.3. Index maps, outcrop map; detailed measured section, generalized columnar section, structural cross section.

TABLE 11.—Analyses of samples from North Dakota, South Dakota, and Wyoming containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	South Dakota												
	29	30	31	32	33	34	35	36	37	38	39	40	41
	40D24-5	40D24-11	40D24-8	40D24-9	40D24-7	40D24-6	40D52-21	40D52-22	40D52-20	40D52-24	40D52-23	40D52-25	40D52-29
SiO_2	55.52	48.80	55.18	56.42	51.64	[1] 51.1	62.32	60.60	[2] 60.90	[2] 49.80	[2] 49.63	[2] 53.45	[2] 55.53
Al_2O_3	21.95	21.08	21.28	23.62	18.25	15.4	20.22	20.24	22.80	22.71	17.51	20.50	24.50
Fe_2O_3	1.91	.92	2.36	1.64	1.24	} [3] 4.5	{ 5.24	5.80	......	......	......	......	......
FeO	......	......	.62	.18	1.40		{	......	[4] 2.03	[4] 4.58	[4] 6.00	[4] 4.79	[4] 5.17
MgO	3.43	4.84	4.26	4.24	3.41	3.8	1.34	2.10	Tr.	Tr.	Tr.	Tr.	Tr.
CaO	.55	1.36	2.16	.62	2.18	5.2	.84	1.09	Tr.	1.28	1.83	1.17	1.26
Na_2O	3.32	......	2.38	.07	2.09	} 1.5							
K_2O	......	......	.14	.01	.12		......	......	......	......	......	......	......
H_2O+	......	} 20.92	{	......	6.33	4.0	......	......	......	......	......	......	......
H_2O-	......		[5] 6.03	[5] 6.13	13.22	13.1	......	......	[6] 4.28	[6] 15.77	[6] 16.15	[6] 12.29	[6] 9.08
TiO_2	......	......	......	......	[7] Tr.	......	......	......	.61	.35	.55	.25	.42
P_2O_5	......	......	......	......	......	......	......	......	Tr.	Nil	Tr.	Nil	Nil
Mn_3O_4	......	......	.06	.04	......	......	......	......	......	......	......	......	......
CO_2	......	......	......	......	[7] Tr.	1.4	......	......	......	......	......	......	......
SO_3	......	......	Tr.	Tr.	......	......	.94	.04	Tr.	Tr.	Tr.	Tr.	Tr.
Ignition loss	13.28	......	5.90	7.18	......	......	9.30	10.17	9.32	5.95	7.82	7.21	4.86
Total	99.96	97.92	100.37	100.15	99.88	100.0	100.20	100.04	[8] 99.94	100.44	99.49	99.66	100.82
Class	15,74,8	10,81,4	15,76,0	13,81,2	18,73,0	19,69,3	21,75,3	18,75,6	21,77,0	10,84,1	19,71,3	17,75,2	12,82,0

	South Dakota												
	42	43	44	45	46	47	48	49	50	51	52	53	54
	40D52-34	40D52-26	40D52-30	40D52-36	40D52-15	40D52-27	40D52-28	40D52-31	40D52-33	40D52-35	40D52-37	40D52-32	40D52-48
SiO_2	[2] 56.87	[2] 53.64	[2] 55.69	[2] 57.48	56.82	54.24	55.32	56.10	56.78	57.10	58.12	56.22	56.32
Al_2O_3	21.49	23.52	19.61	22.11	17.98	18.44	19.82	20.18	18.86	19.80	19.32	19.63	18.84
Fe_2O_3	......	......	......	......	6.94	7.36	6.52	7.98	6.94	7.26	7.36	6.84	7.11
FeO[4]	4.42	4.22	4.54	4.81	......	......	......	......	......	......	......	......	......
MgO	Tr.	Tr.	Tr.	Tr.	2.68	2.84	2.96	1.88	2.10	2.66	3.04	1.90	2.70
CaO	1.58	.94	1.03	2.20	1.19	2.88	2.04	1.59	2.44	1.60	1.14	2.57	2.09
H_2O- [6]	8.45	9.66	9.49	4.82	......	......	......	......	......	......	......	......	......
TiO_2	.33	.63	.35	.65	......	......	......	......	......	......	......	......	......
P_2O_5	Tr.	Tr.	Tr.	Tr.	......	......	......	......	......	......	......	......	......
MnO_2	......	......	......	......	......	1.10	1.20	......	.46	......	.68	......	.86
SO_3	Tr.	Tr.	1.62	1.87	1.77	2.70	1.03	1.79	.69	.57	.70	1.78	1.14
Ignition loss	6.59	7.49	7.74	6.03	10.58	10.30	10.11	10.92	10.24	8.50	9.81	9.60	10.19
Total	99.73	100.10	100.07	99.97	97.96	99.86	99.00	100.44	98.51	97.49	100.17	98.54	99.25
Class	19,73,3	12,82,2	21,72,0	18,72,1	17,72,6	13,72,8	13,75,7	11,81,5	16,73,8	14,77,4	16,76,6	14,76,6	15,74,7

	Wyoming										
	55	56	57	58	59	60	61	62	63	64	*65
	49D1-9	49D1-10	49D1-11	49D1-5	49D1-7	49D1-8	49D1-6	49D4-1	49D4-2	49D4-8	49D7-6
SiO_2	64.0	64.0	66.5	58.25	60.18	60.18	58.74	57.98	49.20	53.90	58.86
Al_2O_3	22.9	24.0	23.9	24.70	} 26.11	26.58	{ 22.83	22.46	17.60	18.00	18.69
Fe_2O_3	3.1	3.2	3.1	2.61			1.83	3.80	1.60	3.21	4.38
FeO	....,.	......	......	......	......	......	......	......	......	.18	.08
MgO	2.0	1.5	1.0	1.30	} 2.54	{ 1.01	1.17	3.24	5.08	3.61	1.24
CaO	1.0	.6	.5	1.61		.23	.75	1.92	1.52	1.00	4.83
Na_2O	......	......	......	......	} .80	1.23	{ 3.11	} 1.35	......	{ 2.72	4.31
K_2O	......	......	......	......			......			.21	1.44
H_2O+	} 7.0	6.7	5.0	11.00	10.26	[10] 10.26	11.57	......	25.52	{ [9] 3.24	[5] 2.08
H_2O-										[11] 11.99	[12] 4.25
TiO_2	......	......	......	......	......	......	......	......	......	.65	.69
P_2O_5	......	......	......	......	......	......	......	......	......	[13] .06	.30
V_2O_5	......	......	......	......	......	......	......	......	......	......	[14] (100.0)
MnO	......	......	......	......	......	......	......	......	......	......	[14] (50.0)
SO_3	......	......	......	......	......	......	......	.75	......	[13] .15	.08
S	......	......	......	......	......	......	......	......	......	Nil	......
Co	......	......	......	......	......	......	......	......	......	......	[14] (5.0)
Ni	......	......	......	......	......	......	......	......	......	......	[14] (6.3)
Se	......	......	......	......	......	......	......	......	......	......	[14] (187.0)
Organic matter	......	......	......	......	......	......	......	......	......	[13] .90	......
Ignition loss	......	......	......	......	......	......	......	7.93	......	[15] .21	......
Total	100.0	100.0	100.0	[16] 99.47	99.89	99.49	100.00	99.43	100.52	100.03	101.23
Class	20,77,0	18,80,0	21,78,0	12,85,1	17,80,0	16,81,1	16,79,0	14,77,3	16,78,0	18,72,0	21,67,0

[1] Includes TiO_2.
[2] Reported as insoluble (Sil); mainly silica but contains a little iron, aluminum and titanium oxides.
[3] Includes MnO.
[4] Ferric oxide recalculated as ferrous oxide (Waterman, 1927, p. 170).
[5] H_2O+, above 110° C.; H_2O-, at 110° C.
[6] At 105° C.
[7] Reported as present.
[8] 99.96 in text.
[9] Above 105° C.
[10] Reported as H_2O at 105° C. (Kinney, 1942, p.359).
[11] At 105° C., includes 0.08 percent H_2O calculated from H_2SO_4 and H_3PO_4.
[12] Below 110° C.
[13] Calculated from reported C, H_3PO_4, or H_2SO_4.
[14] Not included in total, reported as ppm; V_2O_5 reported as V.
[15] Reported as CO_2.
[16] 97.47 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

South Dakota--Continued

29. Fall River County. Upper Cretaceous, Graneros shale, upper part. SE¼ sec. 18, T. 9 S., R. 5 E., about 14 miles south of town of Hot Springs. Lab. No. 5. (Spivey, 1940, p. 51, 18, 39, 52, pls. 1, 4.) Bentonite, 45 inches thick. Base exchange capacity; pH 4.3. Estimated tonnage. Index maps, detailed measured section, generalized columnar section.

30-33. Fall River County. Upper Cretaceous. (T. 12 S., R. 4 E.) near town of Ardmore.

30. (Base of Pierre shale.) Analyst, Shannon. (Ross and Shannon, 1926, p. 88.) Bentonite, purified by washing.
31. Pierre shale, lower part. Refinite Co. property. Analyst, Bentley. Lab. No. 2. (O'Harra, 1929, p. 48, 44, 45.) Bentonite, dark bluish-gray, unoxidized. In several layers, main bed averages 2.5-3 ft in thickness, overburden of main bed, few inches to 20 ft or more. Moisture as received, 25.97 percent at 110° C. Use: Water softener.
32. Pierre shale, lower part. Refinite Co. property. Analyst, Bentley. Lab. No. 1. (O'Harra, 1929, p. 48, 44.) Bentonite, light-colored, oxidized. Moisture as received, 33.19 percent at 110° C. Use: Water softener.
33. (Probably Pierre shale, Ardmore bed.) Analyst, Schaller. Lab. No. C-207. (Wells, 1937, p. 69.) Bentonite, natural clay; swells slightly in water.

34. Fall River County. Pierre shale. (T. 7 S., R. 9 E.), 8 miles south of Buffalo Gap. (Wherry, 1917, p. 580, 577-579.) (Bentonite) reported as clay, altered volcanic ash. General description and remarks: Deep gray when fresh, yellowish when weathered; extremely fine grained, forms dense compact masses; conchoidal fracture. Columnar sections, absorption tests, mineralogy.

35-36. Pennington County. Graneros shale, lower part. (T. 1 N., R. 7 E.), near Rapid City. (O'Harra, 1924, p. 63, 64.) Shale, black, fine, fissile; 150-300 ft thick. Use: Portland cement.

37-45. Pennington County. Upper Cretaceous. Analyst, Lykken. (Waterman, 1927, p. 168, 166-171.) Shale, generally dark gray to nearly black; weathers and erodes easily. Each analysis average of three determinations, percentages on wet basis; analyses on moisture free basis, and distillation assays also given. Samples contain kerogen, small amount of ammonia, traces of zirconium and phosphorus. Use: Not useful as source of oil.

37. Graneros shale. (T. 1 N., R. 7 E.) near Rapid City. Lab. No. 1. Underlain and overlain by Dakota sandstone; 5 ft thick. (For analysis from same locality see sample 42, group B, of this compilation.)

38. Pierre shale, extreme lower part. East of Rapid City, State cement plant quarry. Lab. No. 3. Constituents of ignition loss also given.

39. Pierre shale. (T. 1 N., R. 14 E.), 0.5 mile north of town of Wasta. Lab. No. 10. From stratum of Pierre shale well below sample, Lab. No. 9, below.

40-42. Pierre shale, probably top of formation. Sec. 29, T. 2 N., R. 15 E., about 5 miles northeast of Wasta. Overlain by coarse sandstone and conglomerate. Samples collected at about 200-ft intervals down face of outcrop.

40. Lab. No. 9.
41. Lab. No. 8.
42. Lab. No. 7.

43-45. Pierre shale. About 5.5 miles southeast of town of Wasta. Samples collected at about 200-ft intervals in outcrop.

43. Lab. No. 6.
44. Lab. No. 5.
45. Lab. No. 4. Constituents of ignition loss also given.

South Dakota--Continued

46-52. Pennington County. Pierre shale. (T. 2 N., R. 8 E.) about 3 miles east of Rapid City. (O'Harra, 1924, p. 62, 63.) Shale. General remarks: Almost wholly black, weathers lighter; lime and lime-iron concretions abundant at several horizons; about 1,200 ft thick. Use: Cement.

46. Lab. No. 7.
47. Lab. No. 16.
48. Lab. No. 14.
49. Lab. No. 4.
50. Lab. No. 18.
51. Lab. No. 1.
52. Lab. No. 15.

53. Pennington County. Pierre shale. About 5 miles east of Rapid City. Analyst, Ernst. (Connolly and O'Harra, 1929, p. 275, 274.) Shale. General description: Grayish, dull, thin-bedded, easily broken, little overburden. Use: Cement material.

54. Pennington County. Pierre shale. Near Rapid City. Lab. No. 5. (Lincoln, 1925, p. 366; Lincoln, 1927b, p. 37.) Shale, average of 30 ft. General description: Dark bluish-gray, weathers dark brown; 1,200 ft thick. Use: Portland cement.

Wyoming

55-60. Albany County. Upper Cretaceous, Benton shale, corresponds to Graneros shale, but above Mowry shale. (Siebenthal, 1906b, p. 446; Darton and Siebenthal, 1909, p. 59.) Bentonite, 4-5 ft thick; generally overlain by 20 ft of dark shale containing concretions. Use: Filler.

55. NW¼ sec. 12, T. 21 N., R. 75 W. Analyst, Ogden.
56. NW¼ sec. 12, T. 21 N., R. 75 W. Analyst, Ogden. (Osterwald and Osterwald, 1952, p. 11, 10.) Outcrop map.
57. SE¼NE¼ sec. 14, T. 22 N., R. 76 W., or NW¼ sec. 17, T. 21 N., R. 75 W. Analyst, Ogden. (Osterwald and Osterwald, 1952, p. 11, 10.) Outcrop map.
58. NW¼SE¼ sec. 30, T. 22 N., R. 75 W., Taylor mine. Analyst, Hodges. (Osterwald and Osterwald, 1952, p. 12, 10, 11.) Exposed over several acres. Outcrop map.
59. N½ sec. 10, T. 22 N., R. 76 W., Cassa Mining Co. Analyst, Read. (Osterwald and Osterwald, 1952, p. 12, 10.) Outcrop map.
60. N½ sec. 10, T. 22 N., R. 76 W., Cassa Mining Co. Analyst, Read. (Kinney, 1942, p. 359.)

61. Albany County. Associated with Benton shale. T. 22 N., R. 75 W. (?), (H. D. Thomas, written communication, 1957), Rock Creek. (Ries, 1897, p. 1146.) Clay, "mineral soap." Shrinks and cracks in burning; lacks plasticity. Use: Manufacture of paper. Possible use: Hydraulic lime.

62. Carbon County. In lower part of Benton shale. (T. 21 N., R. 78 W.) town of Medicine Bow. Analyst, von Eman. (Ladoo, 1921, p. 5; Spence, 1924, p. 14.) Bentonite, yellow, colloidal. Near surface, few inches to more than 5 ft thick. Possible use: Filler, binder, water softener, plaster.

63. Carbon County. Upper Cretaceous, Mesaverde(?) formation (H. D. Thomas written communication, 1957). (T. 21 N., R. 85 W.) town of Fort Steele. Analyst, Shannon. (Ross and Shannon, 1926, p. 89.) Bentonite, pale-yellow. Purified by washing (washing loss less than 10 percent of sample; C. S. Ross, personal communication).

64. Carbon County. Pierre shale. (T. 21 N., R. 78 W.) town of Medicine Bow, Owyhee Chemical Products Co. Analyst, Sadler. (Spence, 1924, p. 14, 10, 13.) Bentonite, greenish-yellow when wet, creamy white when dry. Main bed about 5 ft thick. Air-dried sample.

*65. Fremont County. Middle or Upper Eocene. Secs. 2, 3, 10, or 11, T. 39 N., R. 91 W., near town of Lysite. Analyst, Gilbert. (Beath and others, 1946, p. 12, 10, 11.) (Analysis suggests 6.1 percent more CaO and MgO than required for carbonates; shows 5.8 percent alkalies.) Tuff, buff-colored; composite sample. Glass partly altered and devitrified. Mineralogy.

TABLE 11.—Analyses of samples from North Dakota, South Dakota, and Wyoming containing more than 75 percent clay (Group D) common and mixed rock categories--Continued

	Wyoming									
	66	*67	*68	*69	*70	71	72	73	74	75
	49D11-4	49D12-108	49D12-44	49D12-45	49D17-1	49D23-22	49D23-13	49D23-15	49D23-20	49D23-14
Acid insoluble	......	[1](38.27)	......	......	......	......	......	......	......	......
SiO_2	62.34	32.60	43.8	46.5	49.23	45.78	55.44	60.26	57.49	59.57
Al_2O_3	21.98	10.5	12.7	12.15	7.11	12.92	20.14	21.50	20.27	19.67
Fe_2O_3	7.92	3.1	[2] 4.00	[2] 4.22	20.89	3.96	3.67	3.76	2.92	2.91
FeO	......	......	......	......	3.06	......	.30	......	.19	......
MgO	.73	.63	2.0	2.5	3.44	.73	2.49	2.50	3.18	2.46
CaO	1.28	20.07	9.9	6.5	Tr.	.56	.50	.00	.23	.66
Na_2O	.19	.75	......	......	.11	.64	2.75	2.67	1.32	2.09
K_2O	1.71	2.60	......	......	8.51	.50	.60	.43	.28	.29
H_2O+	......	[3] 12.48	......	......	[4] 4.88	......	} 14.70	{	6.85	4.73
H_2O-	[4] 1.83	1.86	......	......	[4] 1.83	[4] 8.26		{ [5] 3.53	7.63	7.49
TiO_2	......	.38	......	......	......	......	.10	.22	.12	Tr.
P_2O_5	......	13.63	[2] 2.63	[2] .94	......	......	......	......	......	......
V_2O_5	......	.05	.52	.77	......	......	......	......	......	......
MnO	.26	......	......	......	Tr.	.33	......	......	......	......
CO_2	......	.86	......	......	......	......	......	......	......	......
F	......	1.5	......	......	......	......	......	......	......	......
SO_3	.36	2.5	[6] 4.1	[6] 4.05	......	[7] .42	......	......	......	......
Chem. U	......	.002	......	......	......	......	......	......	......	......
Ignition loss	1.77	[1](15.2)	[8] 18.17	[8] 18.53	......	26.32	......	5.34	......	......
Total	[9] 100.37	[10] 102.9	97.8	96.2	99.06	100.42	100.69	100.21	100.48	99.87
Class	15,81,0	11,49,2	17,62,0	20,65,0	13,71,2	18,78,3	16,78,0	18,76,0	18,77,0	22,73,0

	76	77	78	79	80	81	82	83	84
	49D23-16	49D23-17	49D23-18	49D23-21	49D23-19	49D23-27	49D24-51	49D24-52	49D24-57
SiO_2	61.78	60.80	61.00	53.50	54.31	51.26	54.36	70.00	61.99
Al_2O_3	21.56	22.40	20.98	[11] 21.57	20.22	27.10	5.90	29.54	25.22
Fe_2O_3	3.10	.97	3.04	3.28	1.88	......	25.48	......	2.64
FeO	.28	.41	.34	([12])	.19	......	......	......	......
MgO	2.62	2.34	2.68	1.89	.98	2.15	.17	Tr.	.04
CaO	.68	.76	.44	1.25	.94	1.14	1.86	.13	.44
Na_2O	2.22	2.69	2.36	1.94	2.35	8.74	1.30	......	.14
K_2O	.31	.32	.35	1.04	.21	......	1.21	......	.19
H_2O+	......	......	......	} 15.20	{ 13.18	......	} 9.60	......	9.44
H_2O-	[5] 2.98	[5] 3.82	[5] 3.10		{ 5.46	......			
TiO_2	......	......	......	.11	......	......	......	......	......
MnO	.08	.12	.10	......	......	......	.33	......	......
CO_2	......	......	......	None	......	......	......	......	......
SO_3	Tr.	.18	.36	......	......	......	......	......	......
Li_2O	......	......	......	......	......	......	None	......	......
As_2O_5	......	......	......	......	......	......	.28	......	......
Ignition loss	4.73	5.08	5.09	......	......	......	......	......	......
Total	100.34	99.89	99.84	99.78	99.72	90.39	100.49	99.67	100.10
Class	20,74,0	20,73,0	20,73,0	12,82,0	16,79,1	3,82,6	15,80,0	18,82,0	14,85,0

See following page for footnotes.

Semiquantitative spectrographic analysis of sample 67

[E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent. Li, Be, Co, Ga, As, Cb, Cd, Sn, Sb, Ta, W, Pt, Au, Hg, Pb, and Bi looked for but not detected]

B	E	Cu	G	Mo	F
Cr	E	Zn	E	Ag	G
Mn	F	Sr	E	Ba	E
Ni	E	Zr	F		

Spectrographic analysis of sample 74

[P = Phillips Research Laboratory determination; S = Shell Oil Company determination; Pres. = Present; a = Element detected; present in too small concentration for spectrochemical determination by procedure employed; b = Presence uncertain by reason of interference at only characteristic spectral lines exhibited; c = Presence not detected; limit of detectability by procedure employed is as yet uncertain]

	P	S		P	S
Li	Pres.	(b)	Cr	......	<0.0007
Be	......	<0.0005	Mn	0.01	.01
B	0.004	.009	Ni	......	.004
Sc	......	(c)	Co	......	<.001
V	......	<.002	Cu	.002	.003

Spectrographic analysis of sample 74--Continued

	P	S		P	S
Zn	......	<0.03	Mo	......	<0.003
Ga	0.02	.02	Ag	0.002	.001
Rb	......	<.01	Ba	.03	[a]<.04
Sr	.1	[a]<.03	Ce	......	(c)
Y	......	<.005	Tl	......	<.00003
Zr	.02	.04	Pb	.08	.03

[1] Not included in total.
[2] Calculated from reported Fe or P.
[3] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[4] H_2O+, above 100° C.; H_2O-, at 100° C.
[5] At 110° C.
[6] Reported as S.
[7] Reported as 0.48 percent by O'Harra and others (1908, p. 23).
[8] Organic matter calculated from reported C.
[9] 100.27 in text.
[10] (O calculated from F, by compilers, 0.63 percent. Subtotal, 103.51; total, 102.9.)
[11] Includes any P_2O_5.
[12] Probably absent.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

66. Laramie County. Upper Cretaceous. Pierre shale. T. 19 N., R. 70 W. (?), (H. D. Thomas, written communication, 1956), 0.75 mile northwest of Bradley station. Analyst, Phillips. (Ball, 1907, p. 243.) Shale, dark-gray, soft, fissile; contains some selenite. Composite sample from 100-ft exposure. Possible use: Cement material.

*67. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Lab. No. VEM-26-47. (McKelvey and others, 1953, p. 13, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 32.3 percent phosphate, 5.4 percent gypsum; shows 3.4 percent alkalies.) Mudstone, phosphatic; brownish black, fossiliferous, contains incipient pellets. Bed P-57; 1.6 ft thick. Trench sample, 79.05 ft from top of member. Index map, outcrop map; generalized columnar section, detailed columnar section. Modal grain size. Mineralogy. (For other analyses from same measured section see samples in Lincoln County in other groups of this compilation.)

68-69. Lincoln County. Phosphoria formation. T. 27 N., R. 119 W. (Allsman and others, 1949, p. 7, 3, 4, figs. 1, 2.) Carbonaceous shale, black. General description of deposit. Geologic and topographic map, geologic profile. Possible use: Source of vanadium.

*68. Lab. No. Wy-1.3 Met. A. (Analysis suggests 6.2 percent phosphate, 8.4 percent more CaO and MgO than required for carbonates; shows 4.1 percent S.)

*69. Lab. No. Wy-1.4 Met. B. (Analysis shows 4.1 percent S; suggests 2.2 percent phosphate, 7.8 percent more CaO and MgO than required for carbonates.)

*70. Sheridan County. Upper Jurassic, Sundance(?) formation, T. 55 N., R. 86 W., (H. D. Thomas, written communication, 1957), Big Goose Canyon, 15 miles southwest of town of Sheridan. Analyst, Steiger. (Clarke, 1910, p. 296.) (Analysis shows 8.6 percent alkalies, 3.1 percent FeO; suggests 2.6 percent more MgO than required for carbonate.) Glauconite. Bulk density, 2.73.

71. Weston County. Upper Jurassic, Morrison formation. T. 45 N., R. 61 W., near town of Newcastle. Analyst, Bates. (Ball, 1907, p. 236; O'Harra and others, 1908, p. 23.) Shale, average sample. Carbonaceous, slightly plastic, few iron pyrite nodules, from 20 ft outcrop; outcrop map. Possible use: Cement material.

72. Weston County. Upper Cretaceous, Mowry(?) shale (H. D. Thomas, written communication, 1957). (T. 48 N., R. 65 W.) town of Upton. Analyst, Fairchild. Collector, Ross. Lab. No. C-993. (Wells, 1937, p. 71.) Bentonite.

73. Weston County. Mowry(?) shale (H. D. Thomas, written communication, 1957). Upton. Analyst, Shell. Lab. No. 6. (Speil, 1944, p. 13.) Montmorillonite.

74. Weston County. (Mowry shale.) Upton. Microscopic examination by Main. (Kerr and others, 1950, p. 53, 80, 81, 96, 106, 131, 154. For additioual information see Kerr and Kulp, 1949, fig. 18; Kerr and others, 1949, figs. 11, 14, 16; Main, 1950, p. 37, 38, 50, 53; Davis and others, 1950, pl. 22; Adler and others, 1950, pls. 5, 14.) Montmorillonite, light-gray; small amount of gypsum. Index map, stratigraphic section. Staining tests; thermal curves; exchange isotherms graph, summary of base-exchange capacity; size composition; electron micrograph; infrared absorption measurements. Mineralogy.

75. Weston County. Mowry(?) shale (H. D. Thomas, written communication, 1957). (T. 48 N., R. 66 W.) town of Thornton, American Colloid Co. mine. (Nutting, 1943, p. 178, 153, 179, 184.) Clay, montmorillonite, also reported as swelling bentonite. Physical tests. Possible use: Binder in drilling muds, molding sands, filler.

76. Weston County. Upper Cretaceous, Graneros shale, above Mowry shale. (T. 48 N., R. 65 W.) about 2 miles northwest of Upton, American Colloid Co. Analyst, Bentley. (O'Harra, 1929, p. 48.) Bentonite, creamy- to greenish-yellow; about 3.5 ft thick; little overburden. Moisture as received, 25.71 percent at 110° C.

77. Weston County. Graneros shale, above Mowry shale. (T. 46 N., R. 63 W.), 4 miles west of town of Osage, Wyoming Bentonite Co. Analyst, Bentley. (O'Harra, 1929, p. 48, 47.) Bentonite, mostly greenish-gray, about 3 ft thick; little overburden. Moisture as received, 23.45 percent at 110° C. Use: Molding sand.

78. Weston County. Graneros shale, above Mowry shale. (T. 47 N., R. 64 W.), about 1.5 miles from Jerome Siding, Federal Foundries Co. Analyst, Bentley. (O'Harra, 1929, p. 48.) Bentonite, yellowish tinge; about 3.5 ft thick; little overburden. Moisture as received, 31.03 percent at 110° C. Use: In foundries.

79. Weston County. Graneros shale, lower part of Belle Fourche shale member. (T. 46 N., R. 63 W.), Osage. Analyst, Fairchild. Collector, Rubey. Lab. Nos. C-870, C-941. (Wells, 1937, p. 71.) Bentonite.

80. Weston County. Graneros shale. Sec. 30, T. 47 N., R. 63 W. Collector, Mondell. (Hewett, 1926, p. 56.) Bentonite.

81. Weston County. Upper Cretaceous, associated with Benton shale. (Sec. 6, T. 42 N., R. 60 W.) town of Clifton. (Ries, 1897, p. 1146.) Clay, "mineral soap." Shrinks and cracks in burning; lacks plasticity. Use: Manufacture of paper. Possible use: Hydraulic lime.

82. Yellowstone National Park. (Recent.) Norris Basin, spring 75. Analyst, Whitfield. (Clarke, 1924, p. 209, 208.) Spring deposit. Dried at 104° C.

83. Yellowstone National Park. (Recent.) Bank of Pelican Creek near Yellowstone Lake. Analyst, Heizmann. (Peale, 1883, p. 411.) Geyserite, red and white.

84. Yellowstone National Park. (Recent.) Artist's Paint Pots, spring at foot of terrace. (Allen and Day, 1935, p. 455, 232.) Clay, red, tinted with hematite. Index map.

TABLE 12.—Analyses of samples from Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing clay and carbonates each less than 75 percent; clay and carbonates each greater than uncombined silica (Group E) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position. For analyses from North Dakota: (Hansen, 1953) SiO_2, $Al_2O_3+Fe_2O_3$, and CaO given as whole numbers in text. Additional information on percentages of these constituents and of MgO, CO_2, and ignition loss were supplied by Miller Hansen (written communication, 1954)]

	Colorado												
	1	2	3	4	5	6	7	*8	9	10	11	12	13
	5E7-18	5E7-19	5E8-2	5E19-1	5E19-2	5E23-8	5E34-1	5E35-10	5E35-11	5E35-12	5E35-13	5E51-60	5E51-61
SiO_2	48.09	25.54	18.16	23.32	36.77	26.51	48.87	34.92	24.85	17.40	18.59	45.89	38.30
Al_2O_3	14.23	8.72	15.34	9.68	9.93	5.19	12.26	9.73	8.41	6.17	6.03	13.24	13.90
Fe_2O_3	3.88	.54	3.81			[1] 2.56	4.44	4.21	.79	.54	.31	3.88	2.66
FeO	......	.80	......	......	......	......	......	......	......	.56	.89	......	......
MgO	1.97	.56	3.94	2.31	Tr.	6.77	3.82	15.10	1.06	.67	.70	2.12	2.46
CaO	12.23	33.70	25.88	[2] 34.61	[2] 28.80	13.50	10.06	10.00	32.68	39.38	38.55	12.09	17.36
Na_2O	.10	.12	......	......	......	2.36	.55	.62	Tr.	.18	.24	.47	.24
K_2O	2.10	.47	......	......	......	1.55	1.76	1.22	1.22	.62	.98	2.31	2.05
H_2O+	......	[3] 2.38	8.28	......	......	.22	......	......	......	[3] 1.98	[3] 2.13	[3] 4.16	......
H_2O-	1.00	[3] .66					[3] 1.27	2.52	.55	[3] .86	[3] .67	[3] 1.38	.75
TiO_2	......	......	......	......	......	.20	......	......	......	......	......	.52	......
P_2O_5	......	......	......	......	......	.02	......	......	......	......	......	.17	......
MnO	......	......	......	......	......	......	.07	......	......	......	......	......	......
CO_2	......	25.43	24.62	......	......	18.27	......	......	......	30.75	29.14	10.38	......
S	......	......	......	......	......	.86	......	......	......	......	......	......	......
SO_3	Tr.	.14	......	......	......	Tr.	.45	......	Tr.	.52	.10	......	2.27
Organic matter	......	1.19	......	......	.87	[4] (21.6)	......	......	......	.36	1.78	3.47	......
Ignition loss	14.93	......	......	......	......	[5] 22.17	16.39	19.82	30.04	......	......	......	21.95
Total	98.53	100.25	100.03	69.92	76.37	[6] 100.18	[7] 99.94	[8] 98.14	99.60	99.99	100.11	100.08	101.94
Class	19,53,23	10,30,58	0,38,54	7,28,62	20,30,48	14,42,39	22,49,26	13,42,33	9,29,61	6,21,70	8,22,66	18,54,23	11,51,33
CaO/MgO	......	calcite	magnesian calcite	magnesian calcite	calcite	calcareous dolomite	......	magnesian dolomite	calcite	calcite	calcite	......	magnesian calcite

	Colorado		Kansas									
	14	15	16	17	18	19	20	21	22	23	24	25
	5E51-62	5E54-2	15E6-4	15E6-5	15E13-7	15E25-4	15E25-5	15E26-3	15E31-2	15E37-5	15E38-1	
SiO_2	50.36	35.10	24.25	18.45	27.71	22.38	41.52	18.76	22.08	45.91	20.18	85.92
Al_2O_3	19.38	11.48	2.28	8.47	[9] 7.28	[10] 4.26	[10] 8.03	[11] 5.32	[10] 7.47	12.44	[11] 6.57	5.09
Fe_2O_3	2.17	1.87	5.04	2.17	[12] 3.30	[12] 2.77	[12] 2.93	4.18	[12] 1.34	5.16	2.05	.62
MgO	1.50	.68	[2] 7.59	[2] 2.12	14.04	1.98	.84	.29	2.29	1.96	1.16	.32
CaO	7.95	21.61	[2] 28.64	[2] 36.76	16.38	36.38	24.34	39.02	35.04	14.91	38.93	.30
Na_2O	.15	.42	......	......	.66	.13	.98	......	.08	.90	......	[13] 3.79
K_2O	2.88	1.72	......	......	1.61	.36	.97	......	1.48	1.87	......	.93
H_2O	[14] .60	[14] .27	.63	.44	......	......	......	......	......	......	......	......
TiO_2	......	......	......	......	[15] .42	......	......	......	......	.82	......	2.79
P_2O_5	......	......	......	......	.09	.03	.10	Nil	.04	.11	Nil	......
S	......	......	......	......	.10	Nil	Nil	Nil	[16] (.12)	.19	Nil	......
SO_3	......	.32	......	......	Nil	Nil	Nil	......	Tr.	Tr.	......	......
Ignition loss	14.32	25.18	......	......	[17] 27.94	[18] 31.25	[18] 20.25	[17] 30.95	[18] 29.21	15.05	[17] 31.85	[17] .72
Total	[19] 99.31	98.65	68.43	68.41	[20] 99.53	99.54	[21] 99.96	98.52	99.03	[22] 99.32	100.74	100.48
Class	14,65,17	13,44,40	15,18,67	1,29,70	11,30,53	12,19,66	24,31,40	5,26,65	7,26,61	18,50,24	6,25,67	......
CaO/MgO	......	calcite	calcareous dolomite	magnesian calcite	dolomite	magnesian calcite	calcite	calcite	magnesian calcite	......	calcite	......

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not determined. Zn and Mo looked for in all samples but not detected]

	19	20	22		19	20	22		19	20	22
B	0.003	–	0.0035	Mn	0.25	0.055	0.015	Sn	–	0.001	–
Ti	.008	0.02	.007	Ni	.005	.002	.002	Ba	–	.03	–
V	.001	.02	Tr.	Cu	.0001	.001	.0003	Pb	–	.001	–
Cr	.001	.01	.003	Ag	.0001	–	–				

Spectrographic analysis of sample 25

[Li, Sr, Zr, and Ba may be present but not shown on spectrograph]

P .... small but positive trace	Mn .... very faint trace

[1] From total Fe (Bradley, 1931, p. 32).
[2] Calculated from reported $MgCO_3$ or $CaCO_3$.
[3] H_2O+, above 100° C.; H_2O-, at 100° C.
[4] Not included in total.
[5] Loss on ignition, less CO_2, includes H_2O of hydrous minerals.
[6] V_2O_5, 0.00 percent; Cr_2O_3, 0.00 percent; ZrO_2, faint trace(?).
[7] 98.94 in text.
[8] 99.50 in text.
[9] Includes MnO.
[10] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[11] Includes TiO_2.
[12] Total iron.
[13] By difference.
[14] Reported as H_2O-.
[15] Includes ZrO_2 and V_2O_5.
[16] Not included in total, included in ignition loss.
[17] 140° -1,000° C.
[18] 105° -1,000° C.
[19] 97.81 in text.
[20] 99.43 in text.
[21] 100.06 in text.
[22] 99.13 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1. Boulder County. Upper Cretaceous, Graneros shale, near base. T. 1 N., R. 71 W., Polecat Canon, near town of Boulder, Adamant Brick Co. Analyst, Tremaine. Lab. No. 43. (Butler, 1915, p. 342, 158, 164, 165, 318, 319.) Clay, gray, fine-grained, medium-hard, massive; 20 ft thick, overburden, 3-4 ft. Index map. Ceramic tests, physical properties, mineralogy. Use: None. Plasticity too low; cohesion and absorption too high.

2. Boulder County. Upper Cretaceous, Niobrara limestone, argillaceous bed above base. Sec. 28, T. 3 N., R. 70 W., northwest of town of Longmont. Analysts, Phillips, Brobst, and Bates. Lab. No. 159. (Martin, 1909, p. 324, 315, 322.) Limestone, black, shaly; 20 ft available. Composite sample from outcrop. Index and outcrop map. Possible use: Cement material.

3. Chaffee County. Upper Devonian, Ouray limestone. Tps. 49 and 50 N., R. 6 E., Monarch Hill. Analyst, Butters. (Crawford, 1913, p. 63, 21, 62, 236.) Limestone, dark-gray, argillaceous; 12 ft thick. Index map, detailed measured section.

4-5. Eagle County. Lower Mississippian, probably Leadville limestone, T. 5 S., R. 86 W., or farther west (Ogden Tweto, written communication, 1956), near town of Eagle. (Burchard, 1912, p. 661.) Limestone.

6. Garfield County. Eocene, Green River formation. Sec. 32, T. 6 S., R. 97 W., Monarch Shale Oil Co. mine. Analyst, Fairchild. Lab. No. 17. (Bradley, 1931, p. 32, 31, pls. 1-3.) Oil shale; estimated oil yield. Outcrop map, geologic map, correlated columnar sections, mineralogy. Organic matter from calculated mineral composition, reported as organic matter minus combined water. (For other analyses of oil shale see sample 20 group D and samples 22-24 group M, of this compilation.)

7. La Plata County. Upper Cretaceous, Mancos shale. (T. 35 N., R. 9 W.), near town of Durango, Durango Pressed Brick Co. quarry. Analyst, Bates. (Shaler and Gardner, 1907, p. 297.) Shale, black or dark-gray, hard. Contains a little lime, usually in concretions. Use: Brick.

*8. Larimer County. Triassic(?) and probably Permian, Lykins formation. Sec. 7, T. 5 N., R. 69 W., northwest of town of Loveland. Analyst, Tremaine. Lab. No. 314. (Butler, 1915, p. 344, 234, 238, 239, 330, 331.) (Analysis suggests 8.4 percent more CaO and MgO than required for carbonates; shows 1.8 percent alkalies.) Shale, red, fine-grained, soft; 8-10 ft exposed. Index map. Ceramic tests, physical properties, mineralogy. Possible use: None.

9. Larimer County. Niobrara formation. Sec. 7, T. 5 N., R. 69 W., northwest of Loveland. Analyst, Tremaine. Lab. No. 320. (Butler, 1915, p. 344, 234, 240, 332, 333.) Shale, yellow to brownish, calcareous, medium-hard, quite sandy; 50-75 ft exposed; overburden 2 ft. Index map. Ceramic tests, physical properties, mineralogy. Possible use: None.

10-11. Larimer County. Niobrara limestone, argillaceous bed above base. Analysts, Phillips, Brobst, and Bates. (Martin, 1909, p. 324, 315, 320, 321.) Index and outcrop map. Possible use: Cement material.

- 10. NE¼ sec. 29, T. 8 N., R. 69 W. Lab. No. 165. Limestone, shaly, thin-bedded; 18 ft thick; composite sample from outcrop.
- 11. Sec. 35, T. 4 N., R. 70 W. Lab. No. 164. Limestone, shaly. Composite sample from outcrop. Detailed measured section.

12. Pueblo County. Niobrara formation, Smoky Hill chalk member (K. M. Waagé, written communication, 1958). (Probably T. 20 S., R. 67 W., near Rush Creek.) Analyst, Steiger. (Gilbert, 1897, p. 7, 6.) Shale; 150 ft above base of formation. Index map, geologic maps. Possible use: Portland cement material.

Colorado--Continued

13-14. Pueblo County. Upper Cretaceous, Pierre shale. (T. 20 S., R. 65 W.), town of Pueblo, Summit Brick and Tile Co. Analyst, Tremaine. (Butler, 1915, p. 345, 272, 282, 338, 339.) Index map. Ceramic tests, physical properties, mineralogy.

- 13. Clay. Lab. No. 468. Possible use: Brick.
- 14. Clay. Lab. No. 467. Use: Brick.

15. Routt County. Mancos shale. (T. 6 N., R. 84 W.), 1.25 miles northwest of town of Steamboat Springs. Analyst, Tremaine. Lab. No. 482. (Butler, 1915, p. 345, 285, 286, 338, 339.) Shale, gray, fine-grained, hard; contains streaks of sandstone. From lower part of 100-ft exposure. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

Kansas

16-17. Bourbon County. Pennsylvanian, Fort Scott limestone. (T. 25 S., R. 25 E.) Analyst, Bartow. (Haworth, 1898, p. 67, 66.) Use: Cement material.

- 16. Northeast of town of Fort Scott. Lab. No. 2, c. Limestone, from bottom of stratum.
- 17. Cement works, north of Fort Scott. Lab. No. 3, a. Limestone, about 4 ft thick, top of stratum.

18. Clark County. Permian, Whitehorse sandstone, upper shale. NE¼ sec. 27, T. 31 S., R. 22 W., (R. T. Runnels, written communication, 1957). Analyst, under supervision of Runnels. Lab. No. 1794. (Swineford, 1955, p. 122.) Dolomite-shale, red.

19. Elk County. Pennsylvanian, Lecompton limestone, Beil limestone member. Sec. 21, T. 30 S., R. 11 E. Lab. No. 5382. (Runnels and Schleicher, 1956, table 15, pl. 2. p. 86, 97.) Limestone, 9.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

20. Elk County. Pennsylvanian, Howard limestone, Bachelor Creek limestone member. SE¼ sec. 11, T. 30 S., R. 10 E. Lab. No. 5379. (Runnels and Schleicher, 1956, table 12, pl. 1., p. 86, 97.) Limestone, 4 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

21. Ellis County. Niobrara formation, Fort Hays limestone member. Sec. 27, T. 11 S., R. 18 W. Lab. No. El-3-1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 10.) Chalk, from lower part of basal bed. Insoluble residue, 32.1 percent. Index map. Thin section description.

22. Geary County. Permian, Fort Riley limestone. NW¼ sec. 10, T. 12 S., R. 5 E. Lab. No. 53159. (Runnels and Schleicher, 1956, table 4, pl. 1., p. 86, 97.) Limestone, 7.6 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

23. Greenwood County. Howard limestone, Aarde shale member, nonmarine shale. Sec. 12, T. 28 S., R. 10 E. Analyst, Runnels. (McMillan, 1956, p. 214, 194, 220, 248, pls. 1, 2.) Shale, yellowish-brown; 6-11 inches below coal. Selected sample, estimated amounts of clay constituents. Outcrop map; columnar sections, correlation of columnar sections; mechanical analysis, X-ray pattern. (For another analysis from same measured section see sample 165, group B of this compilation.)

24. Hamilton County. Niobrara formation, Fort Hays limestone member. Sec. 25, T. 22 S., R. 43 W. Lab. No. Ha-1-1a. (Runnels and Dnbins, 1949, p. 22, 4, 9, 10.) Chalk, from lower part of basal bed. Insoluble residue, 28.31 percent. Index map. Thin section description.

25. Analysis of coarser portion of insolnble residue of sample 24. Lab. No. Ha-1-1aI. (Runnels and Dubins, 1949, p. 23, 17, 26.)

TABLE 12.—Analyses of samples from Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing clay and carbonates each less than 75 percent; clay and carbonates each greater than uncombined silica (Group E) common and mixed rock categories--Continued

	Kansas												
	26	27	28	29	30	31	32	33	*34	35	36	*37	38
	15E45-16		15E45-17	15E45-43	15E45-44	15E45-45	15E45-46	15E54-1	15E58-2	15E82-3	15E96-1		15E100-12
Insoluble	[1] (29.33)	......	[1] (38.03)	......	......	......	......	......	......	[1] (25.37)	......	......	......
SiO_2	18.84	87.68	25.04	16.50	18.15	20.44	27.00	17.18	44.33	16.71	34.84	34.84	11.68
Al_2O_3	} [2] 6.48	{ 4.06	[2] 6.48	8.65	9.70	7.06	10.91	[3] 1.90	13.68	[2] 4.64	9.92	9.92	4.17
Fe_2O_3		1.16	2.05	3.85	3.60	3.50	4.82	[4] 4.16	5.05	1.60	4.09	[4] 4.09	.99
MgO	......	.39	1.40	.35	.21	.40	.19	1.24	9.66	([5])	14.46	13.64	.83
CaO	40.61	.30	38.00	38.90	37.66	35.12	27.54	41.53	7.86	41.84	12.05	11.90	38.12
Na_2O	......	[6] 2.06	......	} .75	.81	2.53	2.10	......	{ .67	......	.36	.36	......
K_2O	......	2.73	......						2.51	......	1.68	1.68	......
H_2O	......	......	......	......	......	3.01	5.36	......	......	......	......	......	[7] .85
TiO_2	......	1.02	......	......	......	......	......	......	1.10	......	.94	[8] .94	.02
P_2O_5	Nil	[9] Tr.	Nil	......	......	......	......	Tr.	.18	.10	.18	.18	......
CO_2	......	......	......	30.86	29.79	27.89	21.74	......	......	......	......	......	......
SO_3	......	......	......	.05	.02	.09	Tr.	Nil	Tr.	......	Tr.	Tr.	2.60
S	.01	......	Nil	......	......	......	......	Nil	......	Nil	......	ND	......
Ignition loss	[10] 31.92	[10] .60	[10] 28.53	......	......	......	......	[11] 33.84	14.09	[10] 32.95	21.56	[10] 21.56	[12] 36.84
Total	97.86	[13] 100.00	101.50	99.91	99.94	100.04	99.66	99.85	99.13	97.84	100.08	99.11	96.10
Class	8,19,69	......	11,24,60	0,27,70	0,30,68	4,30,63	2,46,49	9,16,73	14,53,19	7,18,71	......	13,39,37	3,21,67
CaO/MgO	calcite	......	calcite	calcite	calcite	calcite	calcite	calcite	......	calcite	magnesian dolomite	magnesian dolomite	calcite

	Kansas			Montana				Nebraska	North Dakota				
	39	40	41	42	43	44	45	46	47	48	49	50	51
	15E103-10	15E103-11		25E6-1	25E6-2	25E15-3		26E91-1	33E2-1	33E2-2	33E10-7	33E10-8	33E10-9
Insoluble	......	......	......	[1] (54.48)	[14] 4.90	[1] (30.80)	......	......	......	......	......	......	......
SiO_2	19.36	50.80	50.80	[15] 40.98	24.00	26.07	......	14.7	29.27	30.70	13.72	14.37	17.4
Al_2O_3	[3] 3.63	} 21.58	{ 16.75	[15] 8.04	} 4.00	{ 3.92	2.17	7.1	10.74	} 15.20	{ 5.38	6.87	7.0
Fe_2O_3	[4] 3.02		4.83	[15] 1.10		2.08	4.25	1.7	3.82		2.41	2.36	3.5
FeO	......	......	......	......	......	2.68	......	......	......	......	......	......	......
MgO	1.42	2.19	2.19	1.47	1.26	12.99	12.69	1.0	1.53	[16] 1.43	.73	Tr.	.5
CaO	38.70	8.87	8.83	22.06	35.79	19.58	19.38	37.3	26.68	[17] 25.21	[16] 35.97	[16] 34.45	33.9
Na_2O	.29	......	......	......	......	1.04	......	......	......	......	......	......	......
K_2O	.73	......	......	......	......	1.40	......	......	......	......	......	......	......
H_2O+	......	} 5.37	......	......	......	{ [18] 1.52	......	......	......	......	......	......	......
H_2O-	......					[18] .04	......	......	......	......	......	......	......
P_2O_5	.24	......	......	......	......	......	......	......	......	......	......	......	......
CO_2	......	......	......	18.24	......	29.14	......	29.3	......	......	......	......	25.6
S	[19] (.06)	......	......	......	......	......	......	.6	......	......	......	......	1.7
SO_3	.11	......	None	[15] .11	......	......	......	.2	......	......	.75	.75	......
Organic matter	......	......	......	......	......	......	......	6.3	......	......	[20] 8.00	[21] 8.00	......
Ignition loss	[11] 32.26	......	12.24	......	30.02	......	......	......	23.59	......	......	......	[22] 5.5
Total	99.76	88.81	95.64	92.00	99.97	100.46	......	98.2	95.63	72.54	66.96	66.80	95.1
Class	10,18,69	......	16,62,20	26,33,41	9,26,63	17,17,61	......	0,31,66	6,42,45	5,44,48	1,30,66	0,34,61	1,32,58
CaO/MgO	calcite	......	......	magnesian calcite	calcite	dolomite	......	calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (—) indicates element not present in detectable amount, except Sr present in both samples but not determined. V, Zn, Sn, and Ba looked for in both samples but not detected]

	33	39		33	39		33	39
B	0.003	0.003	Mn	0.40	0.25	Mo	—	0.0002
Ti	.002	.007	Ni	.0002	.003	Ag	0.00005	.00005
Cr	—	.0001	Cu	.000025	.00004	Pb	—	.002

[1] Not included in total.
[2] Includes TiO_2.
[3] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[4] Total iron.
[5] Lost.
[6] By difference.
[7] Reported as H_2O- at 105° C.
[8] Includes ZrO_2 and V_2O_5.
[9] Reported as P, by spectrographic determination, small but positive.
[10] 140°-1,000° C.
[11] 105°-1,000° C.
[12] At 900° C., (loss on ignition less H_2O-, calculated by compilers).
[13] Mn by spectrographic determination, very faint; Sr, Li, Zr, and Ba may be present, but not shown on spectrograph.
[14] Reported as insoluble, 28.90 percent; SiO_2, 24.00 percent by Bauer (1925, p. 249); reported as SiO_2 and insoluble, 28.90 percent by Wells (1937, p. 54).
[15] Information from U. S. Geol. Survey files.
[16] Calculated from reported $MgCO_3$ or $CaCO_3$.
[17] $CaCO_3$ reported as 75.00 percent, corrected to 45.00 percent (Leonard, 1906, p. 70). Calculated from corrected $CaCO_3$.
[18] H_2O+, above 110° C; H_2O-, at 110° C.
[19] Not included in total, included in ignition loss.
[20] Reported as carbonaceous matter.
[21] Reported as bituminous matter.
[22] Loss on ignition less CO_2 (calculated by compilers); loss on ignition on dry basis.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

26. Jewell County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. NW¼ sec. 9, T. 2 S., R. 7 W. Lab. No. Jw-2-1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 24, 26.) Chalk. From lower part of basal bed. Index map, columnar section. Thin section description.

27. Analysis of coarser portion of insoluble residue of sample 26. Lab. No. Jw-2-1al. (Runnels and Dubins, 1949, p. 23, 17, 26.)

28. Jewell County. Niobrara formation, Fort Hays limestone member. Sec. 27, T. 4 S., R. 8 W. Lab. No. Jw-3-1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 10.) Chalk. Index map, thin section description.

29-32. Jewell County. Niobrara formation. S½ sec. 5, T. 1 S., R. 7 W., Kern farm, near town of Superior, Nebraska. Analyst, Robinson. Chalk. Outcrop map, geologic map. Possible use: Cement material.

29. Lab. No. 4. (Barbour, 1913, p. 97, 95, 105, pl. 19.)

30. Lab. No. 9. (Barbour, 1913, p. 98, 95, 105, pl. 19.) Average chalk.

31. Lab. No. 3. (Barbour, 1913, p. 97, 95, 105, pl. 19.) Average chalk.

32. Lab. No. 8. (Barbour, 1913, p. 98, 95, 105, pl. 19.)

33. Linn County. Pennsylvanian, Hertha formation, Critzer limestone member. NE¼ sec. 23, T. 22 S., R. 23 E. Lab. No. 52275. (Runnels and Schleicher, 1956, table 27, pl. 3, p. 86, 97.) Limestone, 11 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

*34. Marion County. Permian, Wellington formation. SW¼SE¼ sec. 34, T. 21 S., R. 1 E. Analyst, under supervision of Runnels. Lab. No. M-5. (Plummer and Hladik, 1951, p. 21, 37, 47, 64, 65.) (Analysis suggests 7.7 percent more CaO and MgO than required for carbonates; shows 3.2 percent alkalies, 1.1 percent TiO_2.) Shale, 14 ft thick. Bloating results. Index and geologic map. Possible use: Lightweight aggregate.

35. Rooks County. Niobrara formation, Fort Hays limestone member. Sec. 26, T. 10 S., R. 17 W. Lab. No. Ro-3-1a. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 25.) Chalk, lowest part of section. Index map, columnar section, thin section description. (For analyses from same measured section see samples 310-314, group F_2 of this compilation.)

36. Sumner County. Wellington formation. SW¼NW¼ sec. 26, T. 32 S., R. 1 W. Analyst, under supervision of Runnels. Lab. No. SU-2. (Plummer and Hladik, 1951, p. 21, 37, 47, 64, 65.) Shale, 11 ft thick. Bloating results. Index and geologic map.

*37. Presumably same sample as 36. Lab. No. 49417. (Swineford, 1955, p. 122.) (Analysis suggests 12.7 percent more CaO and MgO than required for carbonates; shows 2.0 percent alkalies.) Shale, gray and yellow. Possible use: Brick, lightweight ceramic aggregate.

38. Wallace County. Pliocene, Ogallala formation. SW¼ sec. 19, T. 12 S., R. 41 W. Analyst, Thompson. Lab. No. 10b. (Kinney, 1942, p. 358, 357, 364, 365.) Calcareous clay, pale greenish-white, 0.5 ft thick. Immersion, gelation, and other physical tests. (For analysis from upper part of bed see sample 88, group D of this compilation.)

39. Wilson County. Pennsylvanian, Drum formation, Dewey limestone member. SW¼ sec. 14, T. 30 S., R. 16 E. Lab. No. 52318. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.) Limestone, 2.3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

40. Wilson County. Pennsylvanian, (Lane-Bonner Springs shale) reported as Concreto shale. (T. 30 S., R. 15 E.) town of Neodesha. (Haworth, 1903, p. 56.) Shale. Possible use: Cement material.

Kansas--Continued

41. Presumably same sample as 40. Analysts, Lathbury and Sparkman. Lab. No. 1257. (Haworth, 1903, p. 50, 51; Schrader and Haworth, 1906, p. 56, 57.) Shale. Screen and physical tests, fired properties of cement mixture.

Montana

42. Carter County. Upper Cretaceous, Pierre shale, Monument Hill bentonitic member. Sec. 12, T. 9 S., R. 55 E., about 4 miles north of town of Ridge (from U. S. Geol. Survey files; analysis incorrectly reported as being from Wyoming). Analyst, Fairchild; collector, Rubey. Lab. Nos. C-941-a and C-941-b. (Wells, 1937, p. 65, 64.) Carbonate concretions in bentonite.

43. Carter County, reported as Fallon County. Oligocene, White River formation. (Sec. 16), T. 3 S., R. 62 E., Capitol Rock. Analyst, Wheeler. Lab. No. 3006. (Bauer, 1925, p. 249; Wells, 1937, p. 54.) Siliceous limestone. Use: Silica content too high for use as cement material.

44. Flathead County. Precambrian, Altyn formation. (About T. 37 N., R. 24 W.) canyon six miles west of Hefty Ridge. Analyst, Dittrich. Lab. No. 1270. (Daly, 1912, p. 99, 98.) Dolomite, impure. Type specimen, general description of formation given. Bulk density, 2.816. Molecular percentage, calculated mineral composition.

45. Soluble portion of sample 44.

Nebraska

46. Webster County. Niobrara formation. (T. 1 N., R. 11 W.), 2 miles southeast of town of Red Cloud. (Darton, 1910, p. 385.) Limestone, contains clay. Outcrop map, geologic cross-section. Possible use: Cement material.

North Dakota

47. Barnes County. Niobrara formation. T. 140 N., R. 58 W., near Valley City. Analyst, Babcock. Lab. No. 5503. (Babcock and Clapp, 1906, p. 104, 103, pl. 2.) Clay, medium-gray, weathers to light-cream; fine-grained, contains very fine sand. Geologic map. Ceramic tests, physical properties. Use: None. (Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature.)

48. Barnes County. Niobrara formation. Near Valley City. (Leonard, 1904, p. 152.) Calcareous clay. Cream-colored layer in light-gray, clay-shale.

49-51. Cavalier County. Niobrara formation. Possible use: Cement material.

49. SE¼ sec. 13, T. 159 N., R. 57 W. Analyst, Babcock. (Barry and Melsted, 1908, p. 163, 162.) Calcareous shale; strong odor of petroleum, conchoidal fracture; from 6-ft exposure, overlain by 15 ft of carbonaceous shale. Detailed measured section.

50. Secs. 25, 26, T. 161 N., R. 57 W., (Miller Hansen, written communication,1954). (Melsted, 1908, p. 218, 219-222.) (Shale.) Tests for cement.

51. NE¼ sec. 24, T. 161 N., R. 57 W., near town of Concrete. Analysts, McMillian and Hoeppner. (Hansen, 1953, fig. 15, p. 44.) (Shale) 2 ft thick. DH-2, depth of sample 225-227 ft. Index map.

TABLE 12.—Analyses of samples from Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing clay and carbonates each less than 75 percent; clay and carbonates each greater than uncombined silica (Group E) common and mixed rock categories--Continued

	North Dakota										
	*52	53	54	55	*56	*57	58	*59	60	61	62
	33E10-11	33E10-10	33E21-16	33E21-21	33E21-19	33E21-25	33E21-23	33E21-26	33E21-17	33E21-18	33E21-20
Insoluble[1]	......	......	(18.79)	(35.76)	......	......	(47.74)	(45.47)	(23.28)	(36.88)	(32.79)
SiO_2	14.00	19.06	17.33	29.67	27.26	32.69	35.57	25.59	18.05	27.01	27.71
Al_2O_3	} 18.00	7.32	} 4.63	6.76	4.22	8.55	} 16.87	8.89	4.67	9.16	9.96
Fe_2O_3		[2] 2.68			1.64	1.96					
MgO	......	.67	.00	......	6.10	4.76	......	......	......	......	......
CaO	[3] 33.61	36.92	39.17	30.48	30.31	23.47	21.06	37.06	39.48	30.35	28.90
H_2O-	8.00	......	[4] (4.92)	[4] (4.40)	[4] (36.89)	[4] (32.70)	[4] (6.03)	[4] (17.00)	[4] (9.52)	[4] (18.70)	[4] (7.24)
CO_2	......	......	......	......	18.92	18.26	......	......	......	......	......
Ignition loss	......	......	[5] 34.49	[5] 28.90	[6] 8.48	[6] 4.50	[5] 23.83	[5] 24.46	[5] 33.16	[5] 27.80	[5] 28.80
Total	73.61	66.65	95.62	95.81	96.93	94.19	97.33	96.00	95.36	94.32	95.37
Class	0,39,50	3,28,67	10,16,70	18,23,54	18,24,42	15,32,40	7,52,38	11,26,51	10,15,70	12,30,54	11,33,52
CaO/MgO	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite

	North Dakota							South Dakota			
	63	64	65	66	67	68	69	*70	71	72	73
	33E21-15	33E21-22	33E45-157	33E45-154	33E45-153	33E45-155	33E45-156	40E18-8	40E18-1	40E18-6	40E18-7
Insoluble	(26.73)	(57.15)	(42.88)	(27.66)	(22.61)	(33.91)	(30.85)	......	......	......	......
SiO_2	16.70	32.94	28.85	22.26	16.26	25.74	26.63	12.04	13.12	24.40	25.34
Al_2O_3	3.84	} 7.06	8.30	5.79	9.26	8.09	5.42	5.94	5.81	7.15	5.40
Fe_2O_3	.61							5.02	5.03	3.77	3.46
MgO	4.84	......	......	......	......	......	......	.59	.33	.50	1.57
CaO	38.45	18.36	33.25	35.35	40.88	30.91	33.45	36.65	41.53	30.84	34.70
H_2O-[4]	(2.73)	(11.11)	(6.58)	(3.56)	(2.40)	(11.29)	(4.62)	......	......	......	......
CO_2	28.46	......	......	......	......	......	......	......	......	......	......
SO_3	......	......	......	......	......	......	......	.82	1.72	.53	1.13
S in FeS_2	......	......	......	......	......	......	......	4.03	1.97	1.48	3.60
Ignition loss	[6] 4.84	37.57	28.14	31.91	34.23	30.04	[5] 29.77	31.48	31.82	26.96	29.74
Total	97.74	95.93	98.54	95.31	100.63	94.78	95.27	96.57	101.33	95.63	104.94
Class	9,20,63	21,42,33	15,24,59	13,20,63	1,27,73	12,28,55	18,18,60	0,23,66	0,24,67	8,31,55	12,25,62
CaO/MgO	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite

	South Dakota										
	74	75	76	77	78	79	80	81	82	83	84
	40E18-3	40E18-4	40E18-2	40E18-5	40E31-3	40E31-1	40E31-2	40E47-1	40E52-39	40E67-30	40E67-29
SiO_2	23.16	24.00	22.94	24.12	19.98	17.94	19.12	15.51	22.47	33.36	26.66
Al_2O_3	9.76	6.70	9.50	5.73	9.16	8.76	9.38	} 5.80	9.80	7.54	8.12
Fe_2O_3	3.46	3.14	1.40	2.83	2.66	3.06	2.80			3.20	6.00
MgO	.52	1.34	.64	1.89	.71	1.37	1.27	1.08	1.54	3.71	1.66
CaO	30.02	30.95	30.56	32.49	36.44	37.08	35.27	38.85	25.01	25.31	28.85
$Na_2O + K_2O$	......	......	......	......	......	......	......	1.50	.75	......	......
H_2O-	......	......	......	......	......	......	......	......	......	3.22	3.71
SO_3	.85	1.39	1.60	1.21	.10	.10	.04	[7] Tr.	[7] 1.84	None	None
S in FeS_2	.55	3.26	3.33	3.35	.13	.13	.07	......	......	......	......
Ignition loss	31.56	30.10	31.60	28.44	31.77	31.93	31.44	36.67	38.25	23.43	23.78
Total	99.88	100.88	101.57	100.06	100.95	100.37	99.39	99.41	99.66	99.77	98.78
Class	2,42,54	9,30,56	5,37,54	11,24,59	1,34,65	0,32,66	0,34,64	6,20,72	6,43,48	16,34,46	6,42,46
CaO/MgO	calcite	magnesian calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	magnesian calcite

[1] Not included in total.
[2] Reported as iron.
[3] Calculated from reported $MgCO_3$ or $CaCO_3$.
[4] Reported as mechanical moisture; not included in total.
[5] Ignition loss on dry basis.
[6] Loss on ignition less CO_2 (calculated by compilers). Loss on ignition on dry basis.
[7] Reported as S.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

52-53. Cavalier County. Upper Cretaceous, Niobrara formation. Possible use: Cement material.

*52. (T. 163 N., R. 57 W.), Pembina area. (Berkey, 1905, p. 151, 142, 149, 150.) (Analysis suggests 9.6 percent excess Al_2O_3 and Fe_2O_3; 2.7 percent more CaO than required for carbonate.) Marl, yellowish and bluish, massive; 150 ft thick. Index map, detailed measured section, generalized geologic cross section.

53. T. 163 N., R. 58 W., junction of Pembina and Little North Rivers. Lab. No. 3. (Barry and Melsted, 1908, p. 198, pl. 28.) Calcareous shale; 8 ft thick. Index and geologic map.

54-62. Hettinger County. Oligocene, White River formation. T. 136 N., R. 93 W., Colgrove Butte. Analyst, under supervision of Burr. Overburden and estimated tonnage. Index map, geologic map; detailed measured sections or logs of auger drill hole. Correlation (fence) diagram. Use: None, contains chert, beds too thin.

54. SW¼ sec. 16. Lab. No. 2-2. (Hansen, 1953, fig. 7A, p. 44, 134, 152, 172, figs. 6, 14.) Limestone, light-gray, some chert; dense; 1 ft 4 in thick.

55. NE¼ sec. 16. Lab. No. 5-1. (Hansen, 1953, fig. 7A, p. 44, 134, 153, 172, figs. 6, 14.) Limestone, gray, some chert, soft; 11 ft 3 in thick; from top of bed. (For another analysis from same measured section see sample 23, group F_1 of this compilation.)

*56. Center east line SE¼NE¼NE¼ sec. 17. Lab. No. 44-16. (Hansen, 1953, fig. 7B, p. 44, 134, 143, 172, figs. 6, 14.) (Analysis suggests 13.8 percent more CaO and MgO than required for carbonates.) Limestone, some chert (1 ft thick).

*57. Center east line SE¼NE¼NE¼ sec. 17. Lab. No. 44-6. (Hansen, 1953, fig. 7B, p. 44, 134, 143, 172, figs. 6, 14.) (Analysis suggests 6.4 percent more CaO and MgO than required for carbonates.) Clay (1 ft thick).

58. NW¼NE¼ sec. 17. Lab. No. 8-1. (Hansen, 1953, fig. 7B, p. 44, 134, 154, 172, figs. 6, 14.) Limestone, gray-white, clayey, some chert. Composite sample, noncalcareous, green clay inclusions.

*59. Center south line NW¼SE¼NE¼ sec. 17. Lab. No. 47-10. (Hansen, 1953, fig. 7B, p. 44, 134, 154, 172, figs. 6, 14.) (Analysis suggests 11.0 percent more CaO than required for carbonate.) Clay (1 ft thick). (For another analysis from same measured section see sample 129, group F_2 of this compilation.)

60-61. Center east line SE¼NE¼ sec. 17. (Hansen, 1953, fig. 7B, p. 44, 134, 144, 172, figs. 6, 14.) Limestone, some chert. (For other analyses from same measured section see samples 27 and 28, group F_1 of this compilation.)

60. Lab. No. 46-15.

61. Lab. No. 46-14.

62. SW¼ sec. 17. Lab. No. 10-1. (Hansen, 1953, fig. 7A, p. 44, 134, 154, 172, figs. 6, 14.) Limestone, cherty, fossiliferous, sandy; more than 4 ft thick.

63-64. Hettinger County. White River formation. Analyst, under supervision of Burr. Overburden and estimated tonnage. Index map, geologic map; detailed measured sections. Correlation (fence) diagram. Use: None, contains chert, beds too thin.

63. Sec. 18, T. 136 N., R. 93 W., Bull Butte. Lab. No. 31-1. (Hansen, 1953, fig. 5, p. 44, 134, 150, 172, figs. 4, 14.) Limestone, gray, soft; clay inclusions; two thin zones of limestone nodules; 15 ft thick.

64. NW¼ sec. 7, T. 136 N., R. 94 W., School Butte. Lab. No. 22-4. (Hansen, 1953, fig. 11, p. 44, 134, 160, 172, figs. 4, 14.) Clay, gray-green, calcareous; 4 ft 2 in. thick.

65-69. Stark County. White River formation. Overburden and estimated tonnage. Index map, detailed measured sections. Correlation (fence) diagram.

65. NW¼NE¼ sec. 30, T. 137 N., R. 94 W., Long Butte. Lab. No. 41-2. (Hansen, 1953, fig. 9, p. 44, 134, 158, 172, figs. 8, 14.) Clay, white, calcareous, limestone nodules; 1 ft 4 in. thick. Possible use: Cement material.

66. SW¼NW¼ sec. 30, T. 137 N., R. 94 W., Long Butte. Lab. No. 14-2. (Hansen, 1953, fig. 9A, p. 44, 134, 156, 172, figs. 8, 14.) Limestone, gray, soft; 2 ft thick. Possible use: Cement material. (For other analyses from same measured section see sample 53, group C, and sample 37, group F_1 of this compilation.)

North Dakota--Continued

67. SE¼ sec. 36, T. 137 N., R. 94 W., Straight Butte. Lab. No. 67-2. (Hansen, 1953, fig. 13A, p. 44, 134, 162, 172, figs. 12, 14.) Limestone, hard, clay inclusions; 1 ft thick. Use: Not desirable as cement material; beds too thin.

68. SE¼ sec. 24, T. 137 N., R. 95 W., Long Butte. Lab. No. 16-4. (Hansen, 1953, fig. 9A, p. 44, 134, 156, 172, figs. 8, 14.) Clay, gray-white, calcareous; 3 ft thick. Possible use: Cement material. (For other analyses from same measured section, see samples 44 and 45, group F_1 of this compilation.)

69. Secs. 11 and 12, T. 139 N., R. 91 W., Young Man's Butte. Lab. No. 43-4. (Hansen, 1953, fig. 3, p. 44, 134, 163, 172, figs. 2, 14.) Limestone, gray, harder at top and at base; 6 ft 3 in thick. Use: None; small tonnage. (For another analysis from same measured section, see sample 46, group F_1 of this compilation.)

South Dakota

70-77. Davison County. Niobrara formation. Analyst, under direction of Frary; collector, Kirby. Index and outcrop maps.

*70. NW¼ sec. 27, T. 102 N., R. 61 W., Enemy Creek area. (Rothrock, 1931, p. 34.) (Analysis shows 4.0 percent S in FeS_2; suggests 1.8 percent gypsum; 1.5 percent excess Al_2O_3, 1.3 percent excess Fe_2O_3.) Chalk, blue, unweathered, unleached. Analysis of 10 ft at depth of 40-50 ft. (For other analyses from same measured section see samples 54 and 55, group F_1 of this compilation.)

71. Secs. 28, 33, T. 102 N., R. 61 W., Enemy Creek area. (Rothrock, 1931, p. 33.) Chalk, blue, unleached; average of 22 ft, at depth of 27-49 ft.

72. NW¼ sec. 34, T. 102 N., R. 61 W., Enemy Creek area. (Rothrock, 1931, p. 34.) Chalk, blue, unleached; average of 21 ft, at depth of 29-50 ft.

73. Secs. 31, 32, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 32.) Chalk, blue; analysis of 27 ft at depth of 13-40 ft.

74. Secs. 31, 32, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 31.) Chalk, blue; analysis of 25 ft at depth of 15-40 ft.

75. Sec. 33, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 31.) Chalk, blue; analysis of 14 ft at depth of 20-34 ft.

76. Sec. 33, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 30.) Chalk, blue; analysis of 14 ft at depth of 19-33 ft.

77. Sec. 33, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 31.) Chalk, blue; analysis of 8 ft at depth of 33-41 ft.

78-80. Hanson County. Niobrara formation. T. 101 N., R. 59 W., Twelvemile Creek area. Analyst, under direction of Frary; collector, Kirby. Index and outcrop maps. Possible use: Cement material.

78. SE¼ sec. 18. (Rothrock, 1931, p. 37.) Chalk, white; average sample; analysis of 12 ft at depth of 4-16 ft.

79. NE¼ sec. 19. (Rothrock, 1931, p. 36.) Chalk, blue; analysis of 16 ft at depth of 19-35 ft.

80. Sec. 19. (Rothrock, 1931, p. 36.) Chalk, blue; analysis of 15 ft at depth of 20-35 ft.

81-82. Niobrara formation. Limestone. Outcrop map. Possible use: Cement material.

81. Meade County. (T. 4 N., R. 6 E.) 10 miles east of town of Tilford, near Antelope Creek. Analyst, Coolbaugh. (O'Harra and others, 1908, p. 20.)

82. Pennington County. (T. 1 N., R. 7 E.) near Rapid City. (O'Harra and others, 1908, p. 21.)

83-84. Yankton County. Upper Cretaceous, Pierre shale. NE¼NE¼ sec. 17, T. 93 N., R. 56 W., abandoned cement plant quarry. Marl. Detailed description of deposit. Index map, geologic map, detailed measured section, summary of stratigraphic units.

83. Gregory member, lower part. (Simpson, 1954, p. 67, 2, 30, 66, app. 5.) Marl, 5.5 ft sampled.

84. Crow Creek member and 3 ft of Gregory member. (Simpson, 1954, p. 71, 2, 30, 70, app. 5.) Marl, channel sample.

TABLE 12.— Analyses of samples from Colorado, Kansas, Montana, Nebraska, North Dakota, Sonth Dakota, and Wyoming containing clay and carbonates each less than 75 percent; clay and carbonates each greater than uncombined silica (Group E) common and mixed rock categories--Continued

	Wyoming								
	85	86	87	*88	*89	*90	*91	*92	93
	49E1-67	49E8-1	49E8-2	49E12-93	49E12-87	49E12-88	49E12-89	49E12-90	49E12-83
Insoluble[1]	......	......	......	(20.0)	(23.8)	(18.02)	(15.28)	(26.53)	(23.4)
SiO_2	17.50	47.94	49.32	17.98	19.38	14.50	13.10	22.60	18.63
Al_2O_3	6.00	} 14.52	14.21	{ 2.4	3.7	3.0	4.3	7.1	3.6
Fe_2O_3	1.00			1.4	1.7	1.1	1.4	2.3	1.3
MgO	.50	[2] 1.55	[2] 1.50	9.5	9.9	8.0	6.1	3.4	12.3
CaO	40.50	[2] 19.18	[2] 18.64	26.8	24.96	27.20	32.05	26.40	25.8
Na_2O	......	......	......	.42	.89	.78	.79	.89	1.26
K_2O	......	......	......	1.31	1.59	1.12	1.22	1.70	.97
H_2O+[3]	......	......	......	2.35	4.95	5.13	6.77	8.54	2.86
H_2O-	......	......	......	1.35	1.15	1.07	1.23	1.76	.54
TiO_2	......	......	......	.14	.22	.04	.18	.29	.10
P_2O_5	......	[4] .02	[4] .025	9.7	4.85	4.42	14.85	14.29	2.22
CO_2	......	......	......	21.9	24.4	28.6	14.4	7.9	30.3
SO_3	.30	......	......	2.1	1.6	1.7	2.5	2.5	.80
V_2O_5	......	......	......	.09	.08	.06	.21	.08	.05
F	......	......	......	.93	.56	.47	1.5	1.3	.22
Chem. U	......	......	......	.001	.001	.001	.002	.004	.002
Ignition loss	31.50	......	......	[1] (25.6)	[1] (30.5)	[1] (34.8)	[1] (22.4)	[1] (18.2)	[1] (33.7)
Subtotal	......	......	......	98.371	99.931	97.191	100.602	101.054	100.952
Less O [5]	......	......	......	.39	.24	.20	.63	.55	.09
Total	97.30	[6] 83.21	[6] 83.70	98.0	99.7	97.0	100.0	100.5	100.9
Class	6,20,67	24,42,29	26,42,28	12,13,44	11,20,52	8,17,57	4,22,30	7,34,17	11,16,64
CaO/MgO	calcite	......	......	dolomite	calcareous dolomite	calcareous dolomite	......	......	calcareous dolomite

	94	95	96	*97	*98	99	100	101	102
	49E12-84	49E12-85	49E12-86	49E12-91	49E12-92	49E19-4	49E19-5	49E23-23	49E24-34
Insoluble[1]	(15.00)	(39.9)	(41.4)	(25.2)	(37.0)	[7] (29.19)	(29.22)	......	......
SiO_2	19.60	32.75	33.46	21.10	31.21	23.47	23.49	18.10	50.70
Al_2O_3	4.3	5.9	5.7	6.2	6.7	6.27	6.17	6.26	20.27
Fe_2O_3	1.4	1.9	1.9	2.6	2.3	2.20	2.16	.80	3.25
MgO	5.3	8.6	5.4	1.70	.90	.74	.62	.76	11.55
CaO	32.40	20.20	23.20	30.80	26.4	33.83	33.79	37.57	Tr.
Na_2O	.95	1.44	1.20	1.00	.45	} .38	.38	{ 2.14	......
K_2O	.95	1.25	1.30	1.49	1.89			.92	......
H_2O+	[3] 2.55	[3] 2.01	[3] 2.44	[3] 6.63	[3] 5.85	6.20	6.27	......	......
H_2O-	.45	.39	.46	1.37	1.35	......	......	[8] 1.25	......
TiO_2	.13	.27	.24	.26	.32	......	......	......	......
P_2O_5	.69	1.51	.66	9.92	9.90	......	......	......	......
CO_2	30.1	23.3	23.0	14.0	9.6	27.03	27.08	......	......
MnO	......	......	......	......	......	......	......	.50	......
SO_3	.56	.55	.62	2.2	2.1	......	......	.27	......
V_2O_5	.05	.05	.05	.07	.09	......	......	......	......
F	.09	.18	.08	1.1	1.1	......	......	......	......
Chem. U	.000	.001	.0005	.003	.003	......	......	......	......
Ignition loss	[1] (33.1)	[1] (25.7)	[1] (25.9)	[1] (22.0)	[1] (16.8)	......	......	31.58	15.15
Subtotal	99.520	100.301	99.7105	100.443	100.163	......	......	......	......
Less O [5]	.04	.08	.03	.46	.46	......	......	......	......
Total	99.5	100.2	99.7	100.0	99.7	100.12	99.96	100.15	[9] 100.92
Class	10,18,66	20,23,50	21,23,50	7,31,31	17,31,22	10,28,61	10,28,61	6,22,68	11,69,18
CaO/MgO	magnesian calcite	calcareous dolomite	magnesian calcite	......	......	calcite	calcite	calcite	......

See following page for footnotes.

Semiquantitative spectrographic analyses

[C = 1-5 percent; D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Co, Ga, As, Cd, Sn, Sb, Ta, W, Pt, Au, Hg, and Bi looked for in all samples but not detected]

	88	89	90	91	92	93	94	95	96	97	98
Be	ND	G	ND	ND	G	ND	ND	ND	ND	ND	ND
B	F	E	F	F	E	F	F	F	F	E	F
Cr	E	E	E	E	C	E	E	E	E	E	D
Mn	F	E	F	F	E	F	E	E	E	E	E
Ni	E	E	E	E	D	E	F	F	F	E	E
Cu	G	F	G	G	F	G	G	G	G	G	G
Zn	E	E	ND	E	F	ND	ND	ND	ND	ND	E

Semiquantitative spectrographic analyses--Continued

	88	89	90	91	92	93	94	95	96	97	98
Sr	ND	E	E	E	E	ND	ND	ND	ND	E	E
Zr	F	E	F	F	E	E	E	E	E	F	E
Cb	ND	ND	ND	ND	ND	ND	D	ND	E	E	E
Mo	F	F	F	F	E	F	F	ND	ND	ND	F
Ag	G	G	G	G	G	G	ND	ND	ND	G	G
Ba	ND	E	E	E	E	E	E	E	E	E	E
Pb	ND	E	ND	ND	E	ND	ND	ND	ND	ND	ND

[1] Not included in total.
[2] Calculated from reported $MgCO_3$ or $CaCO_3$.
[3] (Calculated by compilers; ignition loss, less CO_2, and less H_2O-; probably contains some F and S.)
[4] Calculated from reported P.
[5] (Calculated from F by compilers.)
[6] Sample probably contains some Mn.
[7] Insoluble residue broken down (Emmons, 1877, p. 243) and constituents added in to complete analysis.
[8] At 100° C.
[9] Includes H_2SO_4, trace; and Cl, trace.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming

85. Albany County. Upper Cretaceous, Niobrara formation. T. 16 N., R. 73 W, town of Laramie. (Rock Products, 1929, p. 35, 36.) Limestone. Use: Portland cement.

86-87. Goshen County. Miocene, Arikaree sandstone. Goshen Hole. Analyst, Warner. (Ziegler, 1914, p. 127.) Sand cemented by calcite. Grades from individual crystals to irregular masses of solid rock.

86. Sand concretion. Sand, 62.54 percent. Soluble matter, 37.46 percent. (Barbour and Fisher, 1902, p. 453.)

87. Sand crystal. Sand, 63.63 percent. Soluble matter, 36.37 percent. (Barbour and Fisher, 1902, p. 454.)

88-98. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Trench samples. Index map, outcrop map; generalized columnar section, detailed columnar section. Modal grain size. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in other groups.)

*88. Lab. No. 2066. (McKelvey and others, 1953, p. 15, 19, 2, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, pl. 1.) (Analysis suggests 23.0 percent phosphate, 4.5 percent gypsum; shows 1.7 percent alkalies.) Dolomite, phosphatic, argillaceous, dusky-brown. Bed P-9; 1.4 ft thick; 135.65 ft from top of member.

*89. Lab. No. VEM-15-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) (Analysis suggests 11.5 percent phosphate, 3.4 percent gypsum; shows 2.5 percent alkalies.) Dolomite, argillaceous, brownish-black. Bed P-46; 1.1 ft thick; 92.35 ft from top of member.

*90. Lab. No. VEM-19-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 10.5 percent phosphate, 3.7 percent gypsum; shows 1.9 percent alkalies.) Dolomite, brownish-black; contains pellets. Bed P-50; 1.3 ft thick; 88.25 ft from top of member.

*91. Lab. No. VEM-24-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 35.2 percent phosphate, 5.4 percent gypsum; shows 2.0 percent alkalies.) Phosphate rock, dolomitic, brownish-black; contains pellets. Bed P-55; 1.6 ft thick; 81.85 ft from top of member.

*92. Lab. No. VEM-28-47. (McKelvey and others, 1953, p. 13, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 33.9 percent phosphate, 5.4 percent gypsum; shows 2.6 percent alkalies.) Phosphate rock, dolomitic, argillaceous, brownish-gray; contains incipient pellets. Dolomite lens included in sample. Bed P-59; 3.0 ft thick; 74.45 ft from top of member.

Wyoming--Continued

93. Lab. No. VEM-29-47. (McKelvey and others, 1953, p. 13, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) Dolomite, argillaceous, brownish-gray. Bed P-60; 1.1 ft thick; 73.35 ft from top of member.

94. Lab. No. VEM-30-47. (McKelvey and others, 1953, p. 13, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) Limestone, dolomitic, brownish-gray. Bed P-61; 3.5 ft thick; 69.85 ft from top of member.

95. Lab. No. VEM-33-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) Dolomite, argillaceous, light brownish-gray. Bed P-64; 0.7 ft thick; 65.15 ft from top of member.

96. Lab. No. VEM-35-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) Mudstone, calcareous, dolomitic, light brownish-gray; fossiliferous. Bed P-66; 2.3 ft thick; 59.85 ft from top of member.

*97. Lab. No. VEM-46-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 23.5 percent phosphate, 4.7 percent gypsum; shows 2.5 percent alkalies.) Phosphate rock, calcareous mudstone, and argillaceous limestone; brownish-gray; contains pellets. Bed P-77; 2.1 ft thick; 47.9 ft from top of member.

*98. Lab. No. VEM-49-47. (McKelvey and others, 1953, p. 13, 17, 2, 21, 22, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) (Analysis suggests 23.5 percent phosphate, 4.5 percent gypsum; shows 2.3 percent alkalies.) Phosphate rock, mudstone, and argillaceous limestone; brownish-gray, fossiliferous, contains pellets. Bed P-80; 1 ft thick; 45.7 ft from top of member.

99-100. Sweetwater County. Eocene, Green River formation. (T. 18 N., R. 107 W.), town of Green River. Analyst, Brewster. (Emmons, 1877, p. 243, 242; Eckel, 1913, p. 375.) Limestone. Possible use: Cement material.

101. Weston County. Upper Cretaceous, Graneros shale. (T. 45 N., R. 61 W.), 2.25 miles southeast of town of Newcastle. Analysts, Phillips and Bates. (Ball, 1907, p. 234, 233.) Shale, calcareous, light-gray, fissile; 40 ft exposed. Geologic map. Possible use: Cement material.

102. Yellowstone National Park. Recent. Mud spring, Upper Basin, near Castle geyser. Analyst, Endlich. (Peale, 1873, p. 151.) Clay, blue.

TABLE 13.—Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category

[Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado										
	1	2	3	4	5	6	7	8	9	10	11
	$5F_17$-21	$5F_17$-20	$5F_116$-3	$5F_119$-3	$5F_119$-4	$5F_119$-5	$5F_119$-6	$5F_130$-42	$5F_130$-43	$5F_130$-46	$5F_130$-45
SiO_2	15.34	9.60	[1]12.01	7.30	8.00	[1]10.09	10.3	[1]10.80	[1]12.80	[1]18.00	[1]16.70
Al_2O_3	5.34	2.41	.54	} 3.26	3.48	......	{ 1.7	......	......	......	......
Fe_2O_3	.54	.18	.11	}		......	{ 1.10	......	......	......	......
FeO	1.13	.81	......	......	......	[2]1.19	......	......	......	......	......
MgO	.80	.81	18.03	1.22	1.18	18.33	.88	1.00	17.00	16.80	15.80
CaO	40.81	45.87	27.49	[3]49.30	[3]48.85	28.01	47.6	47.80	28.50	25.60	27.60
Na_2O	.29	.19	......	......	......	......	......	......	......	......	......
K_2O	.93	.69	......	......	......	......	......	......	......	......	......
H_2O+	[4]1.61	[4]1.43	} .61	......	......	......	......	......	......	......	......
H_2O-	[4].48	[4].41	}								
P_2O_5	......	......	.03	......	......	......	.5	......	......	......	......
MnO	......	......	.20	......	......	......	......	......	......	......	......
CO_3	32.15	36.00	41.40	......	......	......	37.02	......	......	......	......
SO_3	.12	.32	......	......	......	......	......	......	......	......	......
Organic matter	.67	1.48	......	......	......	......	.3	......	......	......	......
Total	100.21	100.20	100.42	61.08	61.51	57.62	99.4	59.60	58.30	60.40	60.10
Class	5,19,73	5,10,82	(11,2)87	2,10,86	2,10,85	(10,0)89	6,7,84	(11,0)87	(13,0)86	(18,0)81	(17,0)82
CaO/MgO	calcite	calcite	dolomite	calcite	calcite	dolomite	calcite	calcite	dolomite	dolomite	calcareous dolomite

	Colorado										
	12	13	14	15	16	17	18	19	20	21	22
	$5F_130$-44	$5F_130$-47	$5F_133$-1	$5F_133$-2	$5F_133$-3	$5F_135$-14	$5F_135$-16	$5F_135$-15	$5F_147$-6	$5F_149$-1	$5F_149$-2
SiO_2	[1]13.10	[1]21.4	11.84	22.71	1.14	7.14	11.13	11.10	14.6	[5]13.63	12.12
Al_2O_3	......	......	1.66	} 1.18	{ 2.62	1.63	4.58	3.51	2.8	......	3.97
Fe_2O_3	......	......	1.51	}	{	.14	.40	.18	2.6	1.88	2.06
FeO	......	......	.83	......	.41	.48	.56	.81	......	.64	......
MgO	17.65	1.9	17.41	15.48	[3]16.81	1.04	1.05	.99	6.6	8.25	15.97
CaO	26.60	39.1	26.60	24.26	[3]28.03	49.11	43.60	43.86	35.7	35.98	25.63
Na_2O	......	......	.029	......	......	.17	.20	.11	......	......	......
K_2O	......	......	.017	......	......	.45	.78	.61	......	......	......
H_2O+	......	......	} .48	......	{	[4].19	[4]1.21	[4]2.01	......	......	......
H_2O-	......	......	}		{ 10.64	[4].33	[4].57	[4].60	......	......	......
P_2O_5	......	......	Tr.	.10	......	......	......	......	......	......	......
CO_3	......	......	40.01	36.26	......	39.00	34.38	34.58	34.2	......	......
SO_3	......	......	......	.07	......	Tr.	Tr.	.07	......	......	......
Cl	......	......	.05	......	......	......	......	......	......	......	......
Organic matter	......	......	......	Tr.	......	.52	1.72	1.64	Tr.	......	......
Total	57.35	62.4	100.44	100.06	59.65	100.20	100.18	100.07	96.5	60.38	59.75
Class	(13,0)84	(21,0)74	7,8,84	21,3,76	0,12,84	4,6,88	3,17,78	5,14,78	7,14,75	12,4,81	3,17,79
CaO/MgO	dolomite	magnesian calcite	dolomite	dolomite	dolomite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	dolomite

	Kansas										
	23	24	25	26	27	28	29	30	31	32	33
	$15F_13$-4	$15F_16$-6	$15F_16$-9	$15F_16$-10	$15F_16$-8	$15F_16$-13	$15F_16$-14	$15F_16$-12	$15F_16$-7	$15F_16$-11	$15F_16$-15
SiO_2	10.96	11.08	13.84	[6]15.21	13.34	16.64	18.75	16.27	11.75	15.48	11.91
Al_2O_3	[7]1.27	1.77	2.47	4.56	1.51	3.09	2.15	2.91	2.06	2.71	[7].65
Fe_2O_3	[8]1.28	1.69	1.68	......	6.57	4.43	2.32	3.87	4.59	2.98	[8].68
MgO	1.74	[3]1.59	[3]1.56	[3]5.09	[3]10.00	[3]5.84	[3]1.08	[3]5.26	[3]12.72	[3]8.27	1.54
CaO	46.27	[3]45.57	[3]43.64	[3]36.53	[3]31.04	[3]35.32	[3]41.43	[3]36.38	[3]29.78	[3]33.73	46.42
H_2O	......	......	......	......	.29	.26	.37	......	.33	.31	......
P_2O_5	.08	......	......	......	......	......	......	......	......	......	.06
SO_3	.51	......	......	......	......	......	......	......	......	......	Tr.
S	[9](.22)	......	......	......	......	......	......	......	......	......	......
Ignition loss	[10]38.14	......	......	......	......	......	......	......	......	......	[10]38.14
Total	100.25	61.70	63.19	61.39	62.75	65.58	66.10	64.69	61.23	63.48	99.40
Class	7,7,85	6,9,84	8,11,81	7,14,76	3,18,76	6,18,75	12,11,76	7,18,74	3,16,80	7,14,78	10,4,85
CaO/MgO	calcite	calcite	calcite	magnesian calcite	calcareous dolomite	magnesian calcite	calcite	magnesian calcite	calcareous dolomite	calcareous dolomite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in both samples but not determined. Zn, Ag, Sn, and Ba looked for in both samples but not detected]

	23	33		23	33		23	33
B	0.0002	–	Cr	Tr.	–	Cu	0.00004	0.00004
Ti	.01	0.001	Mn	0.017	0.025	Mo	.00007	–
V	.0016	–	Ni	.0003	.001	Pb	.002	.0005

[1] Reported as insoluble.
[2] Includes MnO. Manganese and iron present as carbonates but Fe_2O_3 and Al_2O_3 were not separated from them.
[3] Calculated from reported $CaCO_3$ or $MgCO_3$.
[4] H_2O+, above 100° C.; H_2O-, at 100° C.
[5] Reported as insoluble (Clarke, 1900, p. 272).
[6] Includes insoluble residne.
[7] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[8] Total iron.
[9] Not included in total, included in ignition loss.
[10] 105° -1,000° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1-2. Boulder County. Upper Cretaceons, Niobrara limestone, argillaceous bed above base. Analysts, Phillips, Brobst, and Bates. (Martin, 1909, p. 324, 315, 321, 322, 326.) Limestone, composite sample from outcrop. Index and outcrop map. Possible use: Cement material.
1. NE¼ sec. 5, T. 2 N., R. 70 W., 8 miles west of town of Longmont. Lab. No. 157. Limestone, shaly; 30 ft thick.
2. NE¼ sec. 28, T. 3 N., R. 70 W., northwest of Longmont. Lab. No. 161. Limestone, black, shaly; 30 ft thick.

3. Denver County. Niobrara limestone. (T. 4 S., R. 68 W.) west of town of Denver. Analyst, Eakins. (Darton, 1905a, p. 399, pls. 2, 12, 43, 44, 58, 59, 70.) Limestone, typical specimen of formation. General description of formation west of Denver: Dark gray when fresh, weathers to bright yellow; about 400 ft thick. Index map, geologic maps, correlated columnar sections.

4-5. Eagle County. Lower Mississippian, probably Leadville limestone, T. 5 S., R. 86 W. or farther west (Ogden Tweto, written communication, 1956), town of Eagle. (Burchard, 1912, p. 661.) Limestone.

6. (Eagle County) reported in Summit County. Pennsylvanian, Minturn formation, Resolution dolomite member (Ogden Tweto, written communication, 1956). (T. 7 S., R. 79 W.) Pearl Hill, Tenmile district. Analyst, Hillebrand. (Clarke, 1900, p. 274.) (Limestone, dolomitic.)

7. Eagle County. Pennsylvanian, Weber formation. Sec. 8, T. 8 S., R. 83 W., Lime Creek. Analyst, Schroder. Lab. No. 7. (Johnson, 1940, p. 593, 573, 579, 589.) Algal limestone in black shale; about 50 ft thick. Description of organism which built colony. Index map, detailed measured section. (For other analyses of algal limestone in Colorado, see sample 20 this group, sample 8 group A, sample 94 group B, samples 1 and 3 group C, and samples 16 and 70 group F_2 of this compilation.)

8-13. Jefferson County. Triassic(?) and probably Permian, Lykins formation, Glennon limestone member. T. 5 S., R. 70 W. Index map, detailed measured sections, generalized and correlated columnar sections. Use: Lower part extensively quarried. (Use not stated.) Samples contain minor amounts of Fe_2O_3, Al_2O_3 and Mn_2O_3; percentages range from 0.33 to 2.90. Iron and aluminum oxides generally in slight excess of the manganese oxide.
8. Cen. sec. 12. Analyst, Aller. Lab. No. LW-7. (LeRoy, 1946, p. 39, 12, 14, 17, 36, 37.) Limestone, pink to gray, interlaminated, hard, brittle, massive, finely crystalline; 2 ft thick, 12 ft from top of member.
9. Cen. sec. 12. Analyst, Aller. Lab. No. LW-5. (LeRoy, 1946, p. 39, 12, 14, 17, 36, 37.) Limestone, gray to white, laminated, finely crystalline; contains vugs, chert concretions, quartz crystals, quartz-grain aggregates; 1 ft 4 in. thick, 10 ft 8 in. from top of member.
10. Cen. sec. 12. Analyst, Aller. Lab. No. LW-1. (LeRoy, 1946, p. 39, 12, 14, 17, 36, 37.) Limestone, pink to gray, irregularly laminated; 2 ft thick, 8 ft 8 in. from top of member.
11. Cen. sec. 12. Analyst, Aller. Lab. No. LW-8. (LeRoy, 1946, p. 39, 12, 14, 17, 36, 37.) Limestone, pink and gray, laminated; 4 ft thick, 2 ft 8 in. from top of member.
12. NW¼ sec. 12. Lab. No. LR-13. (LeRoy, 1946, p. 40, 12, 14, 17, 36, 41.) Limestone, pink and gray, silty, laminated; 10 ft thick, 5 ft 10 in. from top of member.
13. NW¼ sec. 12. Lab. No. LR-11. (LeRoy, 1946, p. 40, 12, 14, 17, 36, 41.) Limestone, gray and pink, laminated; 3 ft thick, at top of member.

14. Lake County. Lower Ordovician (Manitou limestone) reported as White limestone. (T. 9 S., R. 80 W.) southeast of town of Leadville, Carbonate Hill quarry. Analyst, Hillebrand. (Emmons, 1886, p. 65, 60, 61.) Dolomite, white. From upper part of formation. General description of deposit: White, thin-bedded, compact, conchoidal fracture, texture nearly lithographic, some beds contain concretions of white semitransparent chert; average thickness, 120-160 ft.

15. Lake County. (Manitou limestone) reported as White limestone. Sec. 24, T. 9 S., R. 80 W., Leadville district, Carbonate Hill, Morning Star or Evening Star mine. (Emmons and others, 1927, p. 28, 23, 29, pls. 2, 8, 33, 34, 38.) (Dolomite.) Index map, geologic maps, generalized columnar section, correlated columnar sections.

Colorado--Continued

16. Lake County. (Leadville limestone) reported as Blue limestone, southeast of Leadville, Glass-Pendery mine. Analyst, Hardman. (Emmons, 1886, p. 645, 65.) Dolomite. Use: Flux.

17-19. Larimer County. Niobrara limestone. Analysts, Phillips, Brobst, and Bates. (Martin, 1909, p. 324, 315, 320, 321, 326.) Limestone. Composite sample from outcrop. Index and outcrop map. Possible use: Cement material.
17. Basal bed. NE¼ sec. 13, T. 4 N., R. 70 W., 5 miles west of Berthoud. Lab. No. 169. Limestone, white, massive; 19.4 ft thick.
18. Argillaceous bed above base of Niobrara limestone. SW¼ sec. 9, T. 5 N., R. 69 W., 3 miles west of town of Loveland. Lab. No. 168. Limestone, shaly, thin-bedded; 43 ft thick.
19. Argillaceous bed above base of Niobrara limestone. Sec. 20, T. 7 N., R. 69 W., southwest of town of Fort Collins. Lab. No. 167. Limestone, shaly, thin-bedded; 49 ft thick.

20. Park County. Weber formation. Sec. 10, T. 11 S., R. 78 W., Wood's Cabin. Analyst, Hills. (Johnson, 1940, p. 593, 573, 578-583.) Algal limestone. Occurs in black shales near top of formation. Associated with oolites, pisolitic algal growths and fish scales. Description of organism which built colony. Index map. Detailed measured section. (For other analyses of algal limestone in Colorado, see sample 7 this group, sample 8 group A, sample 94 group B, samples 1 and 3 group C, and samples 16 and 70 group F_2 of this compilation.)

21. Pitkin County. Leadville limestone. (T. 10 S., R. 84 W.) top of Aspen Mtn. Analyst, Steiger. Lab. No. 1559. (Spurr, 1898, p. 210, 208; Clarke, 1900, p. 272.) Dolomite, from main fault zone. Microscopic description.

22. Pitkin County. Minturn formation (Ogden Tweto, written communication, 1956) reported as Weber formation. T. 9 S., R. 84 W., (Ogden Tweto, written communication, 1956), Clark tunnel. (Spurr, 1898, p. 242, 241.) Dolomite, fresh. Alters to clay when softened and bleached.

Kansas

23. Atchison County. Pennsylvanian, Oread limestone, Plattsmouth limestone member. SW¼ sec. 7, T. 6 S., R. 21 E. Lab. No. 51120. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 12 ft thick, chips from continuous surface. Index map; résumé of spectrographic results.

24-32. Bourbon County. Pennsylvanian, (probably Fort Scott limestone) reported as Swallow limestone or lower member of Oswego limestone. (T. 25 S., R. 25 E.) Analyst, Bartow. (Haworth, 1898, p. 67, 66.) Limestone. Use: Hydraulic cement.
24. Town of Fort Scott. Lab. No. 5. Use: Contains too much lime (for a natural cement rock).
25. Fort Scott. Lab. No. 4. Use: Best rock in area for cement.
26. Fort Scott. (See also Smith, 1893, p. 49.) Use: Natural cement rock.
27. Quarries in southeastern part of Fort Scott. Lab. No. 1c. From bottom of stratum.
28. Quarries in southeastern part of Fort Scott. Lab. No. 1b. From middle of stratum.
29. Quarries in southeastern part of Fort Scott. Lab. No. 1a. From top of stratum.
30. Cement works north of Fort Scott. Lab. No. 3b. From middle of stratum; 4 ft thick. (For sample from same measured section see sample 5, group C of this compilation.)
31. Northeast of Fort Scott. Lab. No. 2b. From middle of stratum. (For sample from same measured section see sample 16, group E of this compilation.)
32. Northeast of Fort Scott. Lab. No. 2a. From top of stratum.

33. Bourbon County. Pennsylvanian, Dennis limestone, Winterset limestone member. NW¼ sec. 7, T. 25 S., R. 22 E. Lab. No. 52302. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 13.5 ft thick, chips from continuous surface. Index map; résumé of spectrographic results.

TABLE 13.— Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category--Continued

	Kansas												
	34	35	36	37	38	39	40	41	42	43	44	45	46
	$15F_18$-3	$15F_18$-1	$15F_18$-2	$15F_18$-4	$15F_18$-5	$15F_18$-6	$15F_18$-7	$15F_19$-2	$15F_19$-4	$15F_19$-3	$15F_19$-5	$15F_19$-6	$15F_19$-8
SiO_2	10.52	7.45	10.31	8.32	8.97	9.14	13.45	13.69	11.10	[1] 8.57	8.03	10.95	10.26
Al_2O_3	[2] 2.95	[2 3] 1.94	[2] 3.61	[2] 1.17	[2] 2.69	[2] 1.45	[2] 2.64	[2] 1.53	[2] 3.78	} 3.62	{ 1.59	[2] 1.21	[2] 2.48
Fe_2O_3	[5] 1.03	[5] .84	[5] .99	[5] .67	[5] .25	[5] .80	[5] 1.15	[5] .83	[5] .90		{ 1.14	[5] .62	[5] 1.32
MgO	1.15	2.08	1.83	.82	18.40	17.95	14.95	4.22	.72	[6] .84	.11	.51	18.69
CaO	46.17	47.41	45.26	49.01	27.32	28.06	28.35	41.66	45.56	[6] 47.46	50.14	47.80	26.64
Na_2O	......	......	.14	......	.29	......	.14	......	......	......	......	......	......
K_2O	......	......	.45	......	.34	......	.47	......	......	......	......	......	......
H_2O-	......	......	......	......	......	......	......	......	......	......	[7] .35	......	......
P_2O_5	Tr.	.05	.02	.07	.04	.04	.03	.06	.28	......	......	.17	.09
SO_3	.08	......	.24	.38	Nil	.07	Tr.	.05	.26	.90	......	Tr.	Tr.
S [8]	(.01)	[9] (.37)	(.28)	(.05)	(.04)	(.02)	(.03)	(.52)	......	......	......	......	......
Ignition loss	[10] 37.23	[10] 38.84	[10] 36.89	[10] 39.28	[10] 41.46	[10] 41.70	[10] 39.38	[10] 37.20	[10] 36.96	......	[11] 38.62	[10] 38.06	[10] 40.43
Total	99.13	98.61	99.74	99.72	99.76	99.21	[12] 100.56	[13] 99.24	99.56	61.39	99.98	[14] 99.32	99.91
Class	4, 11, 82	3, 8, 86	3, 13, 81	5, 5, 88	4, 9, 86	6, 6, 87	7, 11, 82	11, 6, 82	3, 14, 81	(3, 11) 85	4, 8, 86	8, 5, 85	4, 11, 83
CaO/MgO	calcite	magnesian calcite	magnesian calcite	calcite	dolomite	dolomite	calcareous dolomite	magnesian calcite	calcite	calcite	calcite	calcite	dolomite

	47	48	49	50	51	52	53	54	55	56	57	58	59
	$15F_19$-9	$15F_19$-10	$15F_19$-11	$15F_114$-8	$15F_114$-9	$15F_116$-2	$15F_116$-1	$15F_118$-2	$15F_118$-3	$15F_118$-4	$15F_119$-8	$15F_121$-2	$15F_121$-3
SiO_2	10.27	13.32	13.35	9.31	[1] 9.50	6.83	6.48	8.08	[1] 13.60	15.73	6.84	10.91	12.21
Al_2O_3	1.62	[2] 2.43	1.71	[2] 2.54	} 6.40	{ [2] 1.36	[2] 1.41	[2] 2.54	} 2.55	{ [2] 4.15	[2] .70	[2] 2.63	[2] 2.38
Fe_2O_3	1.32	[5] 1.37	1.37	[5] .89		{ [5] 3.62	[5] 2.77	[5] .69		{ [5] 1.36	[5] 2.19	[5] .64	[5] .56
MgO	18.72	18.79	18.83	1.12	[6] 11.82	1.22	1.64	2.02	[6] 3.65	1.47	2.90	1.36	1.78
CaO	26.68	25.45	25.50	47.61	[6] 33.64	48.36	47.85	45.91	[6] 42.67	41.43	46.92	46.54	45.81
Na_2O	......	......	......	.09	......	......	......	.15	......	.16	......	......	......
K_2O	......	......	......	.55	......	......	......	.27	......	.62	......	......	......
TiO_2	.77	......	.55	......	......	......	......	......	......	......	......	......	......
P_2O_5	.09	.17	.17	.05	......	Tr.	.07	.02	......	.02	.03	.04	.04
SO_3	Tr.	Tr.	Tr.	Nil	......	Nil	Nil	.12	......	Tr.	Tr.	.09	.07
S	......	......	......	Nil	......	Tr.	Nil	Nil	......	[8] (.06)	[8] (.03)	......	......
Ignition loss	40.49	[10] 38.72	38.93	[10] 37.61	......	[10] 38.72	[10] 39.67	[10] 39.30	......	[10] 34.61	[10] 40.27	[10] 37.46	[10] 36.84
Total	99.96	100.25	100.41	99.77	61.36	100.11	99.89	99.10	62.47	99.55	99.85	[15] 99.67	99.69
Class	6, 8, 83	7, 11, 79	9, 8, 80	4, 10, 83	(0, 17) 80	0, 13, 85	1, 11, 87	3, 10, 86	(9, 7) 82	7, 16, 75	3, 7, 89	6, 9, 83	7, 9, 81
CaO/MgO	dolomite	dolomite	dolomite	calcite	calcareous dolomite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	magnesian calcite	calcite	magnesian calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	34	36	37	38	39	40	41	42	45	46	48	50	52
B	0.002	0.001	–	–	0.0005	–	0.002	0.0005	0.0005	0.003	0.002	–	0.001
Ti	.06	.01	0.05	0.001	.01	0.02	.004	.009	Tr.	.002	.0015	0.0015	.005
V	.01	.001	.0011	Tr.	.0011	.001	.002	.0025	.0016	.0012	.0016	–	–
Cr	.001	.001	–	–	–	.0005	Tr.	–	–	–	–	–	–
Mn	.02	.01	.005	.01	.004	.03	.03	.008	.008	.01	.007	.01	.04
Ni	.001	.001	.0005	.001	.0002	.003	.0003	.0003	.0003	Tr.	.0005	–	.0005
Cu	.0001	.0005	.00003	.0005	.000013	.0005	.00005	.00006	.000015	.000025	.000075	.0003	.00003
Zn	–	–	.0025	–	.005	–	.007	.003	.003	.005	.005	–	–
Sr	–	–	–	–	–	–	>.20	.022	–	–	–	–	–
Mo	–	–	–	–	.00008	.0002	–	–	–	–	.00005	–	–
Ag	–	–	–	–	–	.0001	.00007	.000025	.000025	.000025	–	–	–
Sn	–	–	–	–	–	–	–	–	–	–	–	–	–
Ba	–	–	–	–	–	–	.10	–	–	–	–	–	–
Pb	–	–	.0005	–	.003	.001	.004	.005	.0005	.0002	.002	–	.001

	53	54	56	57		53	54	56	57
B	–	0.002	0.003	–	Zn	–	–	–	–
Ti	0.005	.08	.1	0.01	Sr	–	–	–	0.072
V	.0025	.003	.0005	.0025	Mo	–	–	–	.0001
Cr	–	.001	.002	–	Ag	–	–	–	.0001
Mn	.03	.015	.03	.05	Sn	–	–	0.0002	–
Ni	.0005	.0004	.002	.001	Ba	–	–	–	.03
Cu	.000018	.0001	.0005	.000025	Pb	–	–	–	–

[1] Reported as insoluble residue.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Includes MnO and TiO_2 (Swineford, 1955, p. 123).
[4] Not corrected for TiO_2 and P_2O_5.
[5] Total iron.
[6] Calculated from reported $MgCO_3$ or $CaCO_3$.
[7] At 140° C.
[8] Not included in total, included in ignition loss.
[9] No footnote for S, (Swineford, 1955, p. 123).
[10] 105° - 1,000° C.
[11] At 1,000° C.
[12] 99.56 in text.
[13] 99.54 in text.
[14] 99.60 in text.
[15] 99.69 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

34-40. Butler County. Permian. Chips from continuous surface. Index map, résumé of spectrographic results.

34. Fort Riley limestone. SW¼ sec. 2, T. 24 S., R. 6 E. Lab. No. 53171. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 8.5 ft thick.

35. Fort Riley limestone. NE¼ sec. 5, T. 26 S., R. 6 E. Lab. No. 5128. (Swineford, 1955, p. 123; Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 45 ft thick.

36. Fort Riley limestone. NE¼ sec. 9, T. 28 S., R. 4 E. Lab. No. 5353. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 10 ft thick.

37. Winfield limestone, Cresswell limestone member. SE¼ sec. 13, T. 27 S., R. 3 E. Lab. No. 5195. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Limestone, 10 ft thick.

38. Herington limestone. NW¼ sec. 8, T. 25 S., R. 4 E. Lab. No. 53156. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) (Impure dolomite) 8 ft thick.

39. Herington limestone. NE¼ sec. 10, T. 27 S., R. 3 E. Lab. No. 5194. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) (Impure dolomite) 10 ft thick.

40. Herington limestone. NE¼ sec. 15, T. 29 S., R. 3 E. Lab. No. 53205. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) (Impure dolomite) 11.5 ft thick.

41-42. Chase County. Permian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

41. Foraker limestone, Long Creek limestone member. SE¼ sec. 24, T. 21 S., R. 9 E. Lab. No. C-18. (Runnels and Schleicher, 1956, table 11, pl. 1, p. 86, 97.) Limestone, 10 ft thick. (See also: O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2. Dolomitic limestone. Outcrop sample. Geologic map, economic map, geologic cross section in county. Possible use: Agricultural limestone, riprap. Fe_2O_3, reported as 0.38 percent; TiO_2, 0.23 percent; S and SO_4, 0.12 percent; FeS_2, 0.97 percent. No footnotes on Al_2O_3 and Fe_2O_3 or ignition loss.)

42. Neva limestone. NW¼ sec. 23, T. 19 S., R. 8 E. Lab. No. C-1. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.)

43. Chase County. Permian, Cottonwood limestone (R. T. Runnels, written communication, 1953). (T. 19 S., R. 8 E.) town of Cottonwood Falls, Bettiger Bros. quarry. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 78, 74, 75.) General description: Fossiliferous limestone, white or light-cream, fine and non-crystalline, even-textured, average thickness, 5-8 ft. Physical properties. Bulk density, 2.59. Use: Building stone, construction.

44. Chase County. Permian, Funston limestone. Sec. 16, T. 19 S., R. 8 E., (R. T. Runnels, written communication, 1957). Analyst, Runnels. (Garrels and others, 1949, p. 1812, 1814.) Limestone. Physical tests.

45. Chase County. Fort Riley limestone. Sec. 36, T. 22 S., R. 7 E. Lab. No. C-12. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

46. Chase County. Permian, Nolans limestone, Krider limestone member. Sec. 3, T. 22 S., R. 6 E. Lab. No. C-8. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) (Impure dolomite), 0.8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

Kansas--Continued

47. Chase County. Nolans limestone, Krider limestone member. NW¼NE¼ Sec. 3, T. 22 S., R. 6 E. (O'Connor and others, 1951, p. 17, 18, 24, 25, pls. 1, 2.) (Dolomite) reported as limestone. Spot sample of 0.8 ft thick bed in upper part of member. Geologic map, economic map, geologic cross section in county.

48. Chase County. Herington limestone. NE¼ sec. 3, T. 22 S., R. 6 E. Lab. No. C-14. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) (Impure dolomite) 14 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

49. Chase County. Herington limestone. NW¼NE¼ sec. 3, T. 22 S., R. 6 E. (O'Connor and others, 1951, p. 17, 19, 24, 25, pls. 1, 2.) Dolomitic limestone. Composite of 4 spot samples. Geologic map, economic map, geologic cross section in county. Possible use: Agricultural limestone, crushed stone, riprap.

50. Clay County. Fort Riley limestone. NW¼ sec. 15, T. 9 S., R. 4 E. Lab. No. 53304. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 9 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

51. Clay County. Herington limestone (R. T. Runnels, written communication, 1956). (T. 8 S., R. 3 E.) town of Clay Center. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) (Calcareous dolomite) reported as limestone. Fossiliferous. Average from 3 blocks. Physical properties. Bulk density, 2.73. Use: Building stone.

52. Coffey County. Pennsylvanian, Stranger formation, Westphalia limestone member. NW¼ sec. 31, T. 21 S., R. 16 E. Lab. No. 52355. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 10 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

53. Coffey County. Pennsylvanian, Oread limestone, Plattsmouth limestone member. SE¼ sec. 2, T. 22 S., R. 15 E. Lab. No. 52316. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 12 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

54. Cowley County. Fort Riley limestone. NE¼ sec. 26, T. 32 S., R. 4 E. Lab. No. 53173. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 10 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

55. Cowley County. Fort Riley limestone (R. T. Runnels, written communication, 1953). (T. 34 S., R. 4 E.), Arkansas City. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone, fine-grained, homogeneous, fossiliferous. Physical properties. Bulk density, 2.65. Use: Building stone.

56. Cowley County. Winfield limestone, Cresswell limestone member. NE¼ sec. 1, T. 31 S., R. 3 E. Lab. No. 53196. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Limestone, 11.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

57. Crawford County. Pennsylvanian, Fort Scott limestone, Higginsville limestone member. SE¼ sec. 12, T. 30 S., R. 22 E. Lab. No. 52272. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone, 17 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

58-59. Dickinson County. Herington limestone. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86.) Limestone. Chips from continuous surface. Index map.

58. SE¼ sec. 20, T. 14 S., R. 4 E. Lab. No. 54374. Limestone, 6.5 ft thick.

59. NW¼ sec. 12, T. 16 S., R. 4 E. Lab. No. 54373. Limestone, 10.4 ft thick.

TABLE 13.—Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category--Continued

	Kansas												
	60	61	62	63	64	65	66	67	68	69	70	71	72
	15F$_1$21-1	15F$_1$22-17	15F$_1$22-18	15F$_1$22-19	15F$_1$22-21	15F$_1$22-20	15F$_1$23-4	15F$_1$23-8	15F$_1$23-5	15F$_1$23-6	15F$_1$23-7	15F$_1$23-9	15F$_1$25-6
SiO_2	9.64	8.10	11.01	5.16	9.12	8.54	8.26	13.94	7.59	7.62	[1] 8.02	6.29	6.18
Al_2O_3	[2] 2.16	[2] 1.14	[2] 1.11	[2] 1.45	[2] 1.72	[2] 2.23	[2] 1.32	[2] .92	[2] 1.04	[2] .93	} 2.05	{ [2] 1.55	[2] 1.67
Fe_2O_3	[3] .59	[3] 1.14	[3] .86	[3] 1.73	[3] 2.82	[3] 4.24	[3] 3.97	[3] 1.83	[3] 1.01	[3] 1.01		[3] 4.22	[3] 2.48
MgO	3.04	1.65	.63	1.66	3.01	6.96	3.36	.73	.50	.76	[4] .62	5.93	1.79
CaO	45.32	47.58	47.85	47.55	44.43	39.79	44.19	45.69	49.58	49.39	[4] 49.60	41.63	48.28
Na_2O	......	......	......	......	......	......	......	......	......	......	......	......	.04
K_2O	......	......	......	......	......	......	......	......	......	......	......	......	.08
P_2O_5	.04	.04	.07	.04	.08	.06	.04	Tr.	.04	.10	......	.08	Tr.
S	......	[5] (.04)	[5] (.02)	[5] (.08)	[5] (.08)	......	Nil	......	Nil	[5] (.08)	......	[5] (.01)	Nil
SO_3	.09	Nil	Nil	.05	.10	.07	Nil	Tr.	Nil	.06	......	.10	Nil
Ignition loss [6]	38.60	39.65	38.12	42.27	38.89	38.76	38.65	37.38	39.61	39.83	......	40.00	39.46
Total	99.48	99.30	99.65	99.91	100.17	100.65	99.79	100.49	99.37	99.70	60.29	99.80	99.98
Class	5,8,85	5,6,88	8,5,85	1,11,88	3,12,85	0,16,82	1,13,84	10,7,83	5,6,89	5,5,89	(5,6)89	0,12,86	0,11,87
CaO/MgO	magnesian calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite

	73	74	75	76	77	78	79	80	81	82	83	84	85
	15F$_1$25-7	15F$_1$25-8	15F$_1$26-5	15F$_1$26-6	15F$_1$26-4	15F$_1$30-4	15F$_1$31-4	15F$_1$31-3	15F$_1$38-2	15F$_1$38-3	15F$_1$43-4	15F$_1$43-1	15F$_1$43-3
Insoluble	......	......	[7] (15.3)	[7] (17.40)	[7] (10.21)	......	......	......	18.56	[7] (11.56)	......	......	......
SiO_2	6.24	11.58	7.52	9.02	6.59	6.70	7.83	10.01	......	6.47	8.49	8.99	11.98
Al_2O_3	[2] 1.22	[2] 2.65	2.79	2.78	1.14	[2] 2.08	[2] 2.77	3.74	......	[8] 2.31	[2] 2.44	[2] 2.65	[2] 1.57
Fe_2O_3	[3] 2.07	[3] 3.08	[8] 2.42	2.82	1.77	[3] 1.27	[3] 1.03	Tr.	......	.78	[3] 2.40	[3] 1.01	[3] .72
MgO	1.04	1.37	.38	.97	.52	1.95	7.68	[9] 1.04	.39	.95	4.27	1.44	.95
CaO	49.53	44.58	48.53	47.30	49.84	47.73	40.19	[9] 46.80	42.75	50.81	43.42	47.28	47.17
Na_2O	.04	.06	......	......	......	......	.11	......	......	......	......	......	......
K_2O	.07	.23	......	......	......	......	.53	......	......	......	......	......	......
P_2O_5	.09	.06	.10	Tr.	Tr.	.03	.03	......	......	Nil	.04	.05	.09
CO_2	......	......	......	......	......	......	......	[9] 36.66	......	......	......	......	......
S	Nil	Nil	Nil	Tr.	Tr.	[5] (.11)	[5] (.09)	......	......	Nil	[5] (.06)	[5] (.19)	......
SO_3	Nil	Nil	......	......	......	Tr.	Tr.	......	......	......	.02	.16	.11
Ignition loss	[6] 39.58	[6] 36.16	[10] 38.07	[10] 36.82	[10] 39.78	[6] 39.45	[6] 39.84	......	35.18	[10] 39.13	[6] 38.61	[6] 37.98	[6] 37.32
Total	[11] 99.88	99.77	99.81	99.71	99.64	[12] 99.21	100.01	98.25	96.88	100.45	99.69	99.56	99.91
Class	2,9,88	3,15,78	0,14,84	1,15,80	3,8,89	2,9,87	2,11,86	3,11,83	(19,1)77	2,9,87	1,13,83	3,10,84	8,6,83
CaO/MgO	calcite	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite

See following page for footnotes.

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. For samples 61-69, Zn and Sn not present in detectable amounts]

	61	62	63	64	65	66	67	68	69
B	–	–	–	0.0025	–	0.001	0.0005	–	–
Ti	0.02	0.02	0.002	.05	0.001	.009	.05	0.01	0.005
V	.0013	.0014	.003	.0012	–	.01	.0011	.0025	.003
Cr	Tr.	.0002	–	–	–	–	.0003	–	.0005
Mn	.041	.021	.20	.085	.60	.15	.01	.05	.10
Ni	.0005	.0004	.001	.0005	–	.001	.0007	.001	.0005
Cu	.00002	.00004	.0002	.00004	.001	.00002	.00009	.000013	.0001
Sr	–	.037	–	.064	.023	–	.029	–	–
Mo	–	–	–	.00005	–	–	–	–	–
Ag	–	–	.00005	–	–	–	.00005	–	.00003
Ba	–	–	–	–	–	–	.005	–	–
Pb	–	.0003	.0005	.001	.0005	–	.001	–	–

	71	72	73	74	78	79	83	84	85
B	–	–	–	0.001	–	0.002	0.002	0.001	0.001
Ti	0.10	0.006	0.005	.03	0.01	.03	.042	.05	.03
V	.002	.001	.0015	Tr.	.0005	.002	.005	.003	.0025
Cr	–	.0003	–	.0003	.001	.0003	–	.001	.001
Mn	.10	.15	.20	.20	.007	.003	.023	.015	.015
Ni	.0005	.0001	.0001	.0005	.005	.006	.001	.0005	.0005
Cu	.001	.0005	.000025	.0001	.0015	.0015	.03	.05	.03

Spectrochemical analyses--Continued

	71	72	73	74	78	79	83	84	85
Zn	–	–	–	–	–	–	–	–	–
Sr	–	–	0.058	0.056	0.0048	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
Ag	0.0001	–	–	.00005	–	–	0.00005	0.0001	0.0001
Sn	.0005	–	–	–	.005	0.005	.001	.001	.001
Ba	–	–	–	–	.02	.003	–	–	–
Pb	.0005	–	–	–	.002	.0005	.0025	.001	.001

[1] Reported as insoluble residue.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Total iron.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Not included in total, included in ignition loss.
[6] 105° - 1,000° C.
[7] Not included in total.
[8] Includes TiO_2.
[9] Calculated from $MgCO_3$, 2.17 percent and $CaCO_3$, 83.53 percent (Prosser, 1895, p. 782).
[10] 140° - 1,000° C.
[11] 99.78 in text.
[12] 99.18 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

60-65. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
60. Dickinson County. Permian, Herington limestone. SW¼ sec. 13, T. 16 S., R. 4 E. Lab. No. 54375. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86, 97.) Limestone, 5.4 ft thick.
61. Doniphan County. Pennsylvanian, Oread limestone, Plattsmouth limestone member. NW¼ sec. 24, T. 2 S., R. 21 E. Lab. No. 51314. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 20 ft thick.
62. Doniphan County. Oread limestone, Plattsmouth limestone member. SE¼ sec. 26, T. 4 S., R. 21 E. Lab. No. 51315. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 16.5 ft thick.
63. Doniphan County. Pennsylvanian, Deer Creek limestone, Ervine Creek limestone member. NE¼ sec. 3, T. 3 S., R. 20 E. Lab. No. 51118. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, 14 ft thick.
64. Doniphan County. Pennsylvanian, Topeka limestone, Hartford limestone member. SE¼ sec. 36, T. 1 S., R. 19 E. Lab. No. 51313. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 5 ft thick.
65. Doniphan County. Topeka limestone, Curzon limestone member. SE¼ sec. 36, T. 1 S., R. 19 E. Lab. No. 51311. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 5 ft thick.

66-69. Douglas County. Oread limestone. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
66. Toronto limestone member. SW¼ sec. 25, T. 12 S., R. 19 E. Lab. No. 52358. Limestone, 8 ft thick.
67. Plattsmouth limestone member. NE¼ sec. 1, T. 12 S., R. 19 E. Lab. No. 51438. Limestone, 14 ft thick.
68. Plattsmouth limestone member. SW¼ sec. 25, T. 12 S., R. 19 E. Lab. No. 52367. Limestone, 8 ft thick.
69. Plattsmouth limestone member. SW¼ sec. 4, T. 13 S., R. 19 E. Lab. No. 53212. Limestone, 11 ft thick.

70. Douglas County. Oread limestone, probably upper part of Plattsmouth limestone member (R. T. Runnels, written communication, 1953). (T. 12 S., R. 20 E.) town of Lawrence. Analyst, under supervision of Bailey; collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone, fossiliferous. Physical properties. Bulk density, 2.67. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

71. Douglas County. Pennsylvanian, Lecompton limestone, Spring Branch limestone member. NW¼ sec. 36, T. 11 S., R. 17 E. Lab. No. 53216. (Runnels and Schleicher, 1956, table 15, pl. 2, p. 86, 97.) Limestone, 6.8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

72-74. Elk County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
72. Topeka limestone, Coal Creek limestone member. NE¼ sec. 23, T. 30 S., R. 10 E. Lab. No. 5380. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 6 ft thick.
73. Burlingame limestone. NE¼ sec. 6, T. 31 S., R. 10 E. Lab. No. 5378. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 5 ft thick.

Kansas--Continued

74. Wabaunsee group, Wakarusa limestone. NE¼ sec. 6, T. 31 S., R. 10 E. Lab. No. 5376. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 5 ft thick.

75-77. Ellis County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 12, 14, 25, 32.) Index map. Thin section description. Possible use: Whiting.
75. Sec. 13, T. 11 S., R. 19 W. Lab. No. El-2-1a. Chalk, from lower part of basal bed. (For another analysis from same measured section see sample 118, group F_2 of this compilation.)
76. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-1a. Chalk; basal bed. Petrographic analysis, columnar section. (For analyses from same measured section see sample 77, following sample, and samples 126-129, group F_2 of this compilation.)
77. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-1b. Chalk; upper part of basal bed. Petrographic analysis, columnar section.

78. Franklin County. Pennsylvanian, Plattsburg limestone, Spring Hill limestone member. NW¼ sec. 12, T. 17 S., R. 19 E. Lab. No. 53191. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 17.2 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also Ives, 1955, p. 32, 39. Lab. No. O20. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3 or Fe_2O_3; sulfide sulfur as S, 0.11 percent; ignition loss at 1,000° C., sample dried at 105° C.)

79. Geary County. Permian, Fort Riley limestone. NW¼ sec. 10, T. 12 S., R. 5 E. Lab. No. 53157. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 22.2 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

80. Geary County. Fort Riley limestone. (T. 11 S., R. 6 E.) near town of Fort Riley. Analyst, Finney. (Prosser, 1895, p. 782.) Limestone, buff, massive.

81. Hamilton County. Upper Cretaceous, Greenhorn limestone. Southern part T. 26 S., Rs. 39 and 40 W. and NW cor. T. 27 S., R. 39 W., ledges southeast of town of Syracuse. Analyst, Wheeler. (Darton, 1920, p. 8, 3, 7; Wells, 1937, p. 53.) Limestone. Geologic maps, geologic cross section, generalized columnar section. Possible use: Cement material.

82. Hamilton County. Niobrara formation, Fort Hays limestone member. Sec. 25, T. 22 S., R. 43 W. Lab. No. Ha-1-1b. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 12, 14, 32.) Chalk, from upper part of basal bed. Index map. Petrographic analysis. Thin section description. Possible use: Whiting. (For another analysis from same measured section see sample 24, group E of this compilation.)

83-85. Jackson County. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
83. Burlingame limestone. NE¼ sec. 27, T. 8 S., R. 16 E. Lab. No. 51236. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 5 ft thick.
84. Permian, Neva limestone. SE¼ sec. 1, T. 6 S., R. 12 E. Lab. No. 51238. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone, 6.5 ft thick.
85. Permian, Cottonwood limestone. SE¼ sec. 1, T. 6 S., R. 12 E. Lab. No. 51237. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 5 ft thick.

TABLE 13.—Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category--Continued

	Kansas												
	86	87	88	89	90	91	92	93	94	95	96	97	98
	15$F_1$44-4	15$F_1$44-5	15$F_1$45-15	15$F_1$45-16	15$F_1$45-47	15$F_1$45-48	15$F_1$45-49	15$F_1$45-50	15$F_1$46-7	15$F_1$50-4	15$F_1$52-4	15$F_1$52-8	15$F_1$52-9
SiO_2	8.23	6.42	5.14	5.82	6.40	10.40	12.33	14.38	14.80	9.44	11.56	10.89	13.59
Al_2O_3	[1] 1.07	[1] 3.79	2.14	} 3.18	{ 2.80	5.29	6.53	8.76	[1] .90	[1] .54	[1] .74	[1] 2.71	[1] 3.05
Fe_2O_3	[2] 1.57	......	[3] 2.72	}	{ 1.95	3.51	2.00	2.74	[2] .78	[2] .78	[2] .50	[2] 3.28	[2] 1.44
MgO	2.60	3.48	.32	[4] .24	.65	.50	.25	.15	1.07	1.29	.69	14.46	.73
CaO	46.08	46.28	49.36	[4] 50.25	48.75	44.00	43.26	40.76	45.33	48.18	48.68	28.18	45.25
$Na_2O + K_2O$	......	......	......	......	.91	1.05	1.23	.75	......	......	......	......	......
H_2O-	......	......	......	[5] .45	......	......	......	......	......	......	......	......	......
P_2O_5	.08	.06	Tr.	......	......	......	......	......	.05	.02	.03	.10	.10
CO_2	......	......	......	......	38.30	34.95	33.99	32.23	......	......	......	......	......
SO_3	.49	.12	......	......	.08	.15	.10	Tr.	.10	Tr.	.20	.61	.14
S	......	[6] (.16)	.22	......	......	......	......	......	[6] (.04)	[6] (.06)	......	......	......
Ignition loss	[7] 39.40	[7] 39.90	[8] 38.65	......	......	......	......	......	[7] 36.55	[7] 39.37	[7] 37.94	[7] 39.17	[7] 36.35
Total	99.52	100.05	98.55	59.94	99.84	99.85	[9] 99.69	99.77	99.58	99.62	100.34	[10] 99.40	100.65
Class	5,7,87	0,11,87	0,10,86	1,10,89	0,11,87	0,17,79	0,20,77	0,24,73	12,5,82	8,3,88	10,3,85	2,16,80	7,13,80
CaO/MgO	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcareous dolomite	calcite

	99	100	101	102	103	104	105	106	107	108	109	110	111
	15$F_1$52-16	15$F_1$52-5	15$F_1$52-6	15$F_1$52-7	15$F_1$52-10	15$F_1$54-4	15$F_1$54-3	15$F_1$54-2	15$F_1$56-4	15$F_1$56-5	15$F_1$56-6	15$F_1$56-7	15$F_1$56-8
SiO_2	[11] 6.20	6.08	6.62	7.96	[11] 12.97	6.65	8.93	8.27	6.06	5.32	6.53	9.56	6.19
Al_2O_3	} 3.31	{ [1] .89	[1] 2.19	[1] 1.03	} 3.06	{ [1] 1.96	[1] .82	[1] .78	[1] 1.54	[1] 1.60	[1] 1.43	[1] 2.93	[12] 1.38
Fe_2O_3	}	{ [2] 4.71	[2] 1.53	[2] .84	}	{ [2] 2.40	[2] .54	[2] .86	[2] 2.79	[2] 3.24	[2] 1.38	[2] 3.08	1.83
MgO	[4] .90	5.03	2.17	.29	[4] .55	.76	.63	1.54	2.02	3.94	.93	2.04	2.09
CaO	[4] 49.39	42.72	47.64	50.00	[4] 43.95	48.84	49.51	47.92	47.76	45.26	49.45	44.36	47.65
H_2O-	.04	......	......	......	......	......	......	......	......	......	......	......	......
P_2O_5	......	.05	.09	.05	......	Tr.	.04	.04	.19	.08	.09	.01	.29
SO_3	.28	.06	.02	.12	2.32	Nil	Nil	Tr.	.20	.16	.47	.01	.69
S	......	......	[6] (.12)	......	......	Nil	Nil	[6] (.10)	......	......	......	[6] (.01)	......
Ignition loss	......	[7] 40.21	[7] 40.15	[7] 39.63	......	[7] 39.20	[7] 39.44	[7] 39.74	[7] 39.56	[7] 40.22	[7] 39.48	[7] 37.41	39.19
Total	60.12	99.75	100.41	99.92	62.85	99.81	99.91	99.15	100.12	99.82	99.76	[13] 99.40	99.31
Class	(1,10)88	0,12,87	1,10,88	5,5,89	8,8,77	0,12,86	7,4,89	6,4,89	0,11,87	0,10,88	2,8,88	1,16,81	2,9,87
CaO/MgO	calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	magnesian calcite	magnesian calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined; Zn not present in detectable amounts]

	86	87	94	95	96	101	102	104	105	106	108
B	0.0025	–	–	–	–	–	–	0.0003	–	0.0005	0.001
Ti	.02	0.006	0.03	0.005	0.0025	0.0015	0.004	.06	0.0015	.001	.015
V	.0014	.01	.0011	.0025	.001	–	.002	.001	.0005	.0005	.005
Cr	–	–	–	–	.001	–	.001	.0003	–	–	.0005
Mn	.026	.03	.007	.02	.015	.05	.04	.25	.007	.04	.15
Ni	.0007	–	.0003	.0005	.0005	.0007	.001	.0015	.0005	.001	.0005
Cu	.00004	.0003	.000025	.00003	.0003	.00005	.0002	.00002	.00002	.00004	.00005
Sr	–	–	.029	–	–	–	–	–	–	–	–
Mo	.0003	–	–	–	–	–	–	–	–	–	–
Ag	.00025	–	–	–	–	.0003	.00005	.00005	–	.00005	–
Sn	–	–	–	–	–	–	–	–	–	.0007	–
Ba	–	–	–	–	–	–	–	–	–	–	.03
Pb	.0025	–	Tr.	–	–	.0005	.0005	.0005	–	.0008	.0005

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[2] Total iron.
[3] Includes TiO_2.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Reported as moisture and organic matter.
[6] Not included in total, included in ignition loss.
[7] 105° - 1,000° C.
[8] 140° - 1,000° C.
[9] 99.71 in text.
[10] 99.80 in text.
[11] Reported as insoluble residue.
[12] Includes MnO and TiO_2.
[13] 99.54 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

86-87. Jefferson County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

86. Oread limestone, Plattsmouth limestone member. Sec. 21, T. 11 S., R. 17 E. Lab. No. 51132. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 18 ft thick.

87. Deer Creek limestone, Ervine Creek-Rock Bluff limestone members. SE¼ sec. 32, T. 7 S., R. 20 E. Lab. No. 51134. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, 18 ft thick.

88. Jewell County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. NW¼SE¼ sec. 10, T. 2 S., R. 8 W. Lab. No. Jw-1-1. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 24, 32.) Chalk, 33 ft in quarry face. Thin section description. Index map. Possible use: Whiting. (For analyses from same measured section see samples 179-182, group F_2 of this compilation.)

89-93. Jewell County. Niobrara formation. T. 1 S., R. 7 W. Estimated tonnage. Index map, topographic and outcrop map, generalized measured section.

89. Sec. 5, Nebraska Portland Cement Co. quarry. (Barbour, 1913, p. 107, 93, 95, 105, 109, pl. 12.) Limestone, average sample from pit 6 ft deep. Use: Cement material.

90-93. S½ sec. 5. Analyst, Robinson. (Barbour, 1913, p. 97, 93, 95, 105, 109, pl. 12.) Chalk. Possible use: Cement material.

94. Johnson County. Pennsylvanian, Wyandotte limestone, Argentine limestone member. NE¼ sec. 16, T. 13 S., R. 22 E. Lab. No. 51137. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone, 34 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

95. Labette County. Pennsylvanian, Fort Scott limestone, Higginsville limestone member. SW¼ sec. 21, T. 34 S., R. 20 E. Lab. No. 52273. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone, 10 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

96-98. Leavenworth County. Pennsylvanian. SW¼ sec. 13, T. 12 S., R. 22 E. Chips from continuous surface. Index map.

96. Wyandotte limestone, Argentine limestone member. Lab. No. 49183. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone, 20 ft thick. Résumé of spectrographic results.

97. Plattsburg limestone, Merriam limestone member. Lab. No. 49277. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86.) (Dolomite), 4.5 ft thick.

98. Plattsburg limestone, Spring Hill limestone member. Lab. No. 49280. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86.) Limestone, 6 ft thick.

99. Leavenworth County. Pennsylvanian, Stanton limestone (R. T. Runnels, written communication, 1955). (T. 9 S., R. 23 E.) town of Lansing. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone. Physical properties. Bulk density, 2.71. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

100-102. Leavenworth County. Oread limestone. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map.

100. Toronto limestone member. Sec. 7, T. 11 S., R. 21 E. Lab. No. 5110. Limestone, 8 ft thick.

101. Plattsmouth limestone member. NW¼ sec. 6, T. 11 S., R. 21 E. Lab. No. 51276. Limestone, 13 ft thick. Résumé of spectrographic results.

102. Plattsmouth limestone member. SE¼ sec. 14, T. 9 S., R. 21 E. Lab. No. 51131. Limestone, 15 ft thick. Résumé of spectrographic results.

Kansas--Continued

103. Leavenworth County. Oread limestone (R. T. Runnels, written communication, 1953). (T. 9 S., R. 23 E.), Lansing. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone. Physical properties. Bulk density, 2.73. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

104. Linn County. Pennsylvanian, Hertha formation, Critzer limestone member. NE¼SE¼ sec. 24, T. 21 S., R. 23 E. Lab. No. 52366. (Runnels and Schleicher, 1956, table 27, pl. 3, p. 86, 97.) Limestone, 5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also Ives, 1955, p. 32, 27, 37. Lab. No. O11. Limestone, fossiliferous; outcrop sample. Mineralogy. Bulk density, average of 4 determinations, 2.54. No footnote for Al_2O_3 or Fe_2O_3; ignition loss at 1,000° C., sample dried at 105° C.)

105. Linn County. Pennsylvanian, Dennis limestone, Winterset limestone member. NE¼ sec. 27, T. 19 S., R. 23 E. Lab. No. 52319. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 16 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

106. Linn County. Dennis limestone, Winterset limestone member. SE¼ sec. 28, T. 20 S., R. 22 E. Lab. No. 52370. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 17 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

107. Lyon County. Pennsylvanian, Wabaunsee group, White Cloud shale. NE¼NE¼ sec. 30, T. 19 S., R. 13 E. Lab. No. 49389. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86.) Limestone, 30 ft thick. Chips from continuous surface. Index map. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Silver Lake(?) shale. Limestone conglomerate, filling channel cut down into White Cloud shale; about 20 ft thick. Outcrop sample. Geologic and economic maps; geologic cross section. Possible use: Agricultural limestone, road metal. Al_2O_3 includes MnO and TiO_2. No footnote for Fe_2O_3 or ignition loss.)

108. Lyon County. Wabaunsee group, Wakarusa limestone. SW¼SE¼ sec. 9, T. 19 S., R. 12 E. Lab. No. 49390. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 4.3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Composite of 3 ledges. Outcrop sample. Geologic and economic maps; geologic cross section. Use: Concrete aggregate, road metal. Possible use: Agricultural limestone. Al_2O_3 includes MnO and TiO_2. No footnote for Fe_2O_3 or ignition loss.)

109. Lyon County. Wabaunsee group, Reading limestone. SE¼SE¼ sec. 12, T. 17 S. R. 12 E. Lab. No. 49395. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86.) Limestone, 2.8 ft thick. Chips from continuous surface. Index map. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, road metal. Possible use: Agricultural limestone. Al_2O_3 includes MnO and TiO_2. No footnote for Fe_2O_3 or ignition loss.)

110. Lyon County. Wabaunsee group, Grandhaven limestone. SW¼SW¼ sec. 15, T. 17 S., R. 12 E. Lab. No. 51280. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86.) Limestone, composite of entire lower bed 2.6 ft thick. Chips from continuous surface. Index map. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Concrete aggregate, road metal. Possible use: Agricultural limestone. Al_2O_3 includes MnO and TiO_2; P_2O_5 reported as 0.15 percent; no footnote for Fe_2O_3 or ignition loss; S not reported.)

111. Lyon County. Wabaunsee group, Brownville limestone. NW¼NW¼ sec. 21, T. 16 S., R. 12 E. (O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2.) Limestone, composite of bed 3.0 ft thick. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, road metal.

TABLE 13.— Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category--Continued

	Kansas												
	112	113	114	115	116	117	118	119	120	121	122	123	124
	$15F_156$-9	$15F_156$-10	$15F_156$-11	$15F_158$-3	$15F_158$-5	$15F_159$-2	$15F_159$-1	$15F_159$-3	$15F_159$-4	$15F_159$-6	$15F_159$-5	$15F_159$-7	$15F_159$-8
SiO_2	9.70	14.09	7.90	8.97	[1] 6.85	11.78	10.99	8.25	19.71	11.01	[1] 8.75	[1] 13.89	[1] 14.01
Al_2O_3	[2] .97	[2] 2.76	[2] 1.49	[2] 1.39	1.91	[2] 1.71	[2] 1.42	[2] 1.52	[2] 1.20	[2] 2.71	2.37	4.29	1.34
Fe_2O_3	[3] .51	[3] 1.03	[3] .70	[3] .55		[3] .64	[3] .59	[3] .73	[3] .76	[3] 1.23			
MgO	.73	1.01	......	1.15	[4] 14.38	1.28	1.04	1.22	16.20	8.39	[4] 1.34	[4] .48	[4] 1.85
CaO	48.30	43.71	49.11	48.12	[4] 33.17	46.66	47.32	48.33	24.08	37.52	[4] 47.51	[4] 44.87	[4] 44.99
Na_2O	......	......	......	.07	......	......	......	.05	.10	.13	......	......	......
K_2O	......	......	......	.13	......	......	......	.15	.28	.47	......	......	......
H_2O-	......	......	......	......	.90	......	......	......	......	......	.25	......	......
P_2O_5	.12	.05	.04	.04	......	.04	.05	.04	.08	.02	......	......	......
SO_3	.39	.06	.15	.08	.95	.13	.11	.24	Tr.	.36	.78	.39	......
S	......	[5] (.02)	[5] (.02)	......	......	[5] (.02)	Nil	[5] (.05)	[5] (.03)	[5] (.06)	......	......	......
Ignition loss [6]	38.70	36.47	39.24	38.69	......	37.53	37.82	38.94	36.91	37.76	......	......	......
Total	99.42	99.18	98.63	99.19	58.16	99.77	99.34	99.47	99.32	99.60	61.00	63.92	62.19
Class	7,4,87	8,11,80	4,6,88	6,6,86	(4,6)88	8,7,84	8,6,84	5,6,87	17,5,77	5,11,80	(5,7)87	(7,13)79	(12,4)84
CaO/MgO	calcite	calcite	calcite	calcite	calcareous dolomite	calcite	calcite	calcite	dolomite	magnesian calcite	calcite	calcite	magnesian calcite

	125	126	127	128	129	130	131	132	133	134	135	136	137
	$15F_161$-1	$15F_161$-3	$15F_161$-2	$15F_161$-4	$15F_164$-2	$15F_164$-4	$15F_164$-3	$15F_164$-7	$15F_166$-2	$15F_166$-3	$15F_166$-4	$15F_167$-3	$15F_170$-7
SiO_2	9.41	8.65	6.69	7.06	12.83	6.90	6.32	7.95	11.58	5.18	[1] 11.97	7.54	5.34
Al_2O_3	[2] .94	[2] 2.03	[2] 1.68	[2] 2.35	[2] 1.26	[2] 2.15	[2] 1.99	[2] 1.79	[2] 3.01	[2] 2.42	3.59	[2] 1.53	[2] 1.64
Fe_2O_3	[3] 1.65	[3] 1.81	[3] 1.67	[3] 2.51	[3] .45	[3] .94	[3] .91	[3] .89	[3] 3.86	[3] 6.03		[3] .96	[3] 2.24
MgO	1.88	2.92	3.05	.89	1.48	1.05	.80	.81	2.53	3.94	[4] .57	.77	.95
CaO	47.37	45.55	47.23	47.40	46.40	50.18	49.46	48.30	42.53	43.56	[4] 45.93	48.70	49.32
Na_2O	......	.13	......	.10	......	......	......	.08	......	......	......	.11	......
K_2O	......	.35	......	.37	......	......	......	.28	......	......	......	.25	......
H_2O-	......	......	......	......	......	......	......	......	......	......	.29	......	......
P_2O_5	Tr.	Tr.	.04	.07	.09	.01	.01	.02	.13	.02	......	.07	.07
SO_3	Nil	Tr.	......	Nil	.15	.10	.08	.18	.06	Nil	.55	Nil	Tr.
S	[5] (.11)	[5] (.30)	......	Nil	Nil	......	Nil	Tr.	......	......	......	......	......
Ignition loss [6]	38.52	38.42	39.72	38.29	37.11	39.49	39.83	39.00	36.23	38.43	......	39.16	39.85
Total	99.77	99.86	100.08	99.04	99.77	100.82	99.40	99.30	99.93	99.58	62.90	99.09	99.41
Class	6,7,85	3,10,84	2,9,87	0,13,84	10,5,83	2,9,88	2,13,85	4,8,87	2,18,78	0,10,84	(6,11)82	4,7,87	0,10,88
CaO/MgO	magnesian calcite	magnesian calciate	magnesian calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Mo and Ba looked for in all samples but not detected; Zn looked for in samples 112-115, 117-121, 125, and 126 but not detected]

	112	113	114	115	117	118	119	120	121	125	126
B	–	0.002	–	–	0.0015	0.0015	0.002	0.0025	0.001	0.001	0.0005
Ti	0.0015	.032	0.0015	0.002	.035	.043	.04	Tr.	.005	.03	.001
V	.001	.001	.003	.0005	.001	Tr.	.02	Tr.	.001	–	–
Cr	.0005	.001	–	–	.001	.001	.001	.0005	–	–	–
Mn	.025	.023	.10	.004	.025	.04	.025	.04	.01	.03	.05
Ni	.0005	.001	.001	.0005	.002	.001	.002	.0015	.0005	.0005	.001
Cu	.0002	.001	.00005	.00003	.0003	.00007	.00007	.000025	.0005	.00004	.00004
Sr	–	–	.030	.04	.0065	–	–	–	.0086	–	–
Ag	–	.0001	–	–	–	–	.00005	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–	–	.0007
Pb	–	.002	–	.0005	–	–	.0005	.001	–	.0005	.0005

	127	128	129	130	131	132	133	134	136	137
B	0.001	0.0015	–	0.0005	–	–	0.002	–	–	–
Ti	.025	.09	0.006	.035	0.03	0.032	.02	0.003	0.007	0.009
V	.007	.0025	–	.005	.001	.005	.001	.003	–	.01
Cr	–	.0003	–	.0003	–	.0005	–	–	.0005	.001
Mn	.04	.04	.02	.02	.003	.01	.20	.05	.04	.25
Ni	.004	.0005	.001	.0005	.0005	.0003	.005	–	.001	.001
Cu	.000025	.00004	.00004	.0002	.00005	.000025	.001	.0005	.00003	.0003
Zn	.0007	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	.016	–	–	–
Ag	–	–	–	–	–	–	.0005	.00005	–	–
Sn	–	–	–	–	–	–	.005	.0005	–	.001
Pb	–	–	–	–	.0005	–	.001	.0005	–	.005

[1] Reported as insoluble residue.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Total iron.
[4] Calculated from reported $MgCO_3$ or $CaCO_2$.
[5] Not included in total, included in ignition loss.
[6] 105° -1,000° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

112-115. Permian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

112. Lyon County. Cottonwood limestone. SE¼NW¼ sec. 17, T. 16 S., R. 11 E. Lab. No. 49397. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 5.3 ft thick. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, concrete aggregate, road metal. Possible use: Agricultural limestone. No footnote for Al_2O_3, Fe_2O_3, or ignition loss.)

113. Lyon County. Garrison shale, Crouse limestone member. NE¼NW¼ sec. 15, T. 16 S., R. 10 E. Lab. No. 51260. (Runnels and Schleicher, 1956, table 8, pl. 1, p. 86, 97.) Limestone, 5.6 ft thick. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, road metal. Possible use: Agricultural limestone. No footnote for Al_2O_3, Fe_2O_3 or ignition loss; S not reported.)

114. Lyon County. Funston limestone. NW¼NE¼ sec. 18, T. 16 S., R. 10 E. Lab. No. 51271. (Runnels and Schleicher, 1956, table 7, pl. 1, p. 86, 97.) Limestone, 5.6 ft thick. (See also O'Connor and others, 1953, p. 25-27, 32, 33, pls. 1, 2. Limestone, composite of lower 5.6 ft of upper bed. Outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, road metal. Possible use: Agricultural limestone. No footnote for Al_2O_3, Fe_2O_3, or ignition loss.)

115. Marion County. Winfield limestone, Cresswell limestone member. NW¼ sec. 7, T. 20 S., R. 4 E. Lab. No. 53185. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Limestone, 10.3 ft thick.

116. Marion County. Permian, Herington limestone (R. T. Runnels, written communication, 1954). (T. 19 S., R. 4 E.) town of Marion. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone. Physical properties. Bulk density, 2.72. Use: Building stone.

117-121. Marshall County. Permian. Chips from continuous surface. Index map, résumé of spectrographic results.

117. Cottonwood limestone. SW¼ sec. 20, T. 2 S., R. 9 E. Lab. No. 53204. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 4.9 ft thick.

118. Cottonwood limestone. SE¼ sec. 10, T. 5 S., R. 9 E. Lab. No. 53201. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 5.4 ft thick.

119. Beattie limestone, Morrill limestone member. SW¼ sec. 20, T. 2 S., R. 9 E. Lab. No. 53176. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 2.4 ft thick.

120. Barneston formation, Florence limestone member. NE¼ sec. 25, T. 3 S., R. 6 E. Lab. No. 53180. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) (Dolomite), 14.6 ft thick.

121. Winfield limestone, Cresswell limestone member. NW¼ sec. 32, T. 2 S., R. 7 E. Lab. No. 53195. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Limestone, 19 ft thick.

122-124. Marshall County. Probably Winfield limestone (R. T. Runnels, written communication, 1953). (T. 2 S., R. 9 E.) town of Beattie. Analyst, under supervision of Bailey. Limestone. Physical properties. Use: Building stone.

122. (Day, 1895, p. 504; Haworth, 1898, p. 78, 76.) Average from 5 blocks. Bulk density, 2.61.

123. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Average from 5 blocks. Bulk density, 2.54.

124. (Day, 1895, p. 504; Haworth, 1898, p. 78, 76.) Average from 4 blocks. Bulk density, 2.62.

Kansas--Continued

125-132. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

125. Miami County. Pennsylvanian, Cherryvale shale, Block limestone member. SW¼SE¼ sec. 28, T. 18 S., R. 25 E. Lab. No. 52276. (Runnels and Schleicher, 1956, table 24, pl. 3, p. 86, 97.) Limestone, 12 ft thick. (See also Ives, 1955, p. 32, 37. Lab. No. O6. Limestone, fossiliferous; outcrop sample, mineralogy. No footnote for Al_2O_3, Fe_2O_3, or S; ignition loss at 1,000° C., sample dried at 105° C.)

126. Miami County. Pennsylvanian, Iola limestone, Raytown limestone member. SE¼SE¼ sec. 7, T. 17 S., R. 22 E. Lab. No. 52280. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) Limestone, 11 ft thick. (See also Ives, 1955, p. 32, 27, 38. Lab. No. O16. Limestone, fossiliferous; outcrop sample. Bulk density, average of 4 determinations, 2.58. Mineralogy. No footnote for Al_2O_3, or Fe_2O_3; S reported as 0.31 percent; ignition loss at 1,000°C., sample dried at 105° C.)

127. Miami Connty. Iola limestone, Raytown limestone member. NE¼ sec. 7, T. 17 S., R. 23 E. Lab. No. 5152. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) Limestone, 13 ft thick.

128. Miami County. Pennsylvanian, Lane shale, unnamed limestone member. SE¼NE¼ sec. 7, T. 17 S., R. 22 E. Lab. No. 52299. (Runnels and Schleicher, 1956, table 21, pl. 3, p. 86, 97.) Limestone, 6 ft thick. (See also Ives, 1955, p. 32, 38. Lab. No. O15. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3, Fe_2O_3, or S; ignition loss at 1,000°C., sample dried at 105° C.)

129. Morris County. Permian, Wreford limestone, Threemile limestone member. SW¼ sec. 23, T. 15 S., R. 8 E. Lab. No. 52308. (Runnels and Schleicher, 1956, table 6, pl. 1, p. 86, 97.) Limestone, 12 ft thick.

130. Morris County. Permian, Fort Riley limestone. NW¼ sec. 32, T. 14 S., R. 7 E. Lab. No. 53192. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 17.5 ft thick.

131. Morris County. Fort Riley limestone. SE¼ sec. 29, T. 16 S., R. 7 E. Lab. No. 53203. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 16.5 ft thick.

132. Morris County. Fort Riley limestone. NW¼ sec. 20, T. 17 S., R. 6 E. Lab. No. 53206. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 7.7 ft thick.

133-134. Nemaha County. Pennsylvanian, Wabaunsee group. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results.

133. Reading limestone. SW¼ sec. 29, T. 1 S., R. 12 E. Lab. No. 51321. Limestone, 2 ft thick.

134. Tarkio limestone member. NE¼ sec. 29, T. 5 S., R. 11 E. Lab. No. 51322. Limestone, 4.5 ft thick.

135. Nemaha County. Cottonwood limestone (R. T. Runnels, written communication, 1953). (T. 2 S., R. 14 E.) town of Sabetha. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone. Physical properties. Bulk density, 2.59. Use: Building stone.

136. Neosho County. Pennsylvanian, Hertha limestone, Critzer limestone member. NE¼ sec. 20, T. 29 S., R. 20 E. Lab. No. 52301. (Runnels and Schleicher, 1956, table 27, pl. 3, p. 86, 97.) Limestone, 6.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

137. Osage County. Wabaunsee group, Tarkio limestone member. Sec. 12, T. 15 S., R. 13 E. Lab. No. 49380. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 2.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

TABLE 13.— Analyses of samples from Colorado and Kansas containing 75 to 90 percent carbonates (Group F_1) common rock category--Continued

	Kansas											
	138	139	140	141	142	143	144	145	146	147	148	149
	$15F_1$71-5	$15F_1$74-20	$15F_1$81-4	$15F_1$81-5	$15F_1$81-7	$15F_1$89-6	$15F_1$89-7	$15F_1$89-8	$15F_1$98-2	$15F_1$99-1	$15F_1$99-8	$15F_1$99-3
SiO_2	6.55	14.27	5.54	7.83	9.28	5.40	9.04	10.12	14.06	[1] 9.12	7.47	16.94
Al_2O_3	2.29	[2] 3.48	[3] 1.36	[3] 2.24	[3] 2.50	[3] 1.51	[3] .87	[3] 2.06	......	} .70	{ [3] 1.40	[3] .29
Fe_2O_3	[2] 2.94	2.37	[4] 2.12	[4] .61	[4] 1.00	[4] 5.53	[4] 1.93	[4] 2.64	5.10	}	{ [4] .60	[4] .34
MgO	.12	.26	.62	1.95	.83	2.19	1.59	3.50	.50	[5] .60	1.56	.78
CaO	48.13	43.97	49.95	47.46	47.45	47.05	47.91	43.03	43.05	[5] 49.61	48.97	45.47
Na_2O	......	......	.04	.08	......	......	......	.12	......	......	......	......
K_2O	......	......	.12	.35	......	......	......	.25	......	......	......	......
H_2O	......	......	......	......	......	......	......	......	1.77	......	......	......
P_2O_5	Nil	Nil	.06	.02	.04	.08	.14	.10	......	......	.04	.07
CO_2	......	......	......	......	......	......	......	......	35.03	......	......	......
S	Nil	Nil	Nil	......	Nil	......	......	[6] (.07)	......	......	Nil	[6] (.02)
SO_3	......	......	.05	.11	.10	.14	Nil	.11	......	......	.17	.10
Ignition loss	[7] 37.63	[7] 35.15	[8] 39.84	[8] 38.85	[8] 38.05	[8] 38.99	[8] 39.08	[8] 37.78	......	......	[8] 39.29	[8] 36.12
Total	97.66	99.50	99.70	99.50	99.25	100.89	100.56	99.71	99.51	60.03	99.50	100.11
Class	0,12,83	5,16,77	1,9,85	3,8,86	4,10,84	0,11,85	5,7,87	4,13,82	8,13,77	(8,2)90	4,6,88	16,2,81
CaO/MgO	calcite	calcite	calcite	magnesian calcite	calcite	magnesian calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite

	150	151	152	153	154	155	156	157	158	159	160
	$15F_1$99-4	$15F_1$103-12	$15F_1$103-13	$15F_1$103-17	$15F_1$103-16	$15F_1$103-15	$15F_1$103-14	$15F_1$104-2	$15F_1$104-3	$15F_1$104-4	$15F_1$104-5
SiO_2	22.31	11.57	6.33	8.22	8.13	7.50	6.90	6.94	7.84	[1] 6.80	5.99
Al_2O_3	[3] .61	[3] 3.90	[3] 2.61	[3] 2.00	[3] 1.88	[3] 1.63	[3] 1.94	[3] .73	[3] 2.76	} 2.60	{ [3] 1.24
Fe_2O_3	[4] .39	[4] 2.66	[4] 1.05	[4] 3.67	[4] 3.90	[4] 5.26	[4] 1.96	[4] 1.99	[4] 2.39	}	{ [4] 2.18
MgO	.24	1.63	2.14	1.78	4.78	5.48	1.10	.77	.83	[5] .98	.93
CaO	42.29	43.01	47.89	45.50	42.00	40.32	48.71	49.37	47.04	[5] 49.32	49.13
Na_2O	.02	.17	......	.10	......	.11	......	......	.07	......	......
K_2O	.05	.62	......	.28	......	.17	......	......	.03	......	......
P_2O_5	.07	.08	.08	Tr.	.06	.01	.06	.03	.07	......	.06
S	......	[6] (.13)	[6] (.14)	[6] (.10)	[6] (.01)	Nil	Nil	Nil	Nil	......	[6] (.23)
SO_3	.06	.16	.04	Nil	.05	Nil	.04	Nil	.10	.21	Nil
Ignition loss [8]	33.57	36.30	39.44	38.20	39.05	39.43	39.12	40.18	38.47	......	40.05
Total	99.61	100.10	99.58	[9] 99.75	99.85	99.91	99.83	100.01	99.60	59.91	99.58
Class	21,3,76	2,18,78	1,10,87	1,15,83	0,15,84	0,15,83	1,11,86	3,7,90	0,14,84	(2,8)89	1,9,89
CaO/MgO	calcite	magnesian calcite	magnesian calcite	magnesian calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. For samples 140-145, 148-155; Mo not present in detectable amounts. For samples 157, 158, and 160; Zn and Ba not present in detectable amounts]

	140	141	142	143	144	145	148	149	150	151	152	153	155
B	–	–	0.002	–	–	–	–	0.001	–	0.002	0.001	–	–
Ti	0.01	0.01	.14	0.002	0.002	0.007	0.02	.003	Tr.	.11	.006	0.009	0.04
V	.01	.0005	.002	.003	.0025	Tr.	.0025	.0025	–	.0005	.0067	–	.001
Cr	.0003	–	.001	–	–	–	–	.0005	–	.0003	–	–	–
Mn	.20	.005	.03	.30	.04	.05	.01	.02	0.025	.04	.015	.25	.30
Ni	.003	.006	.001	.001	.0001	.0005	.001	.001	.0008	.003	.0001	.001	.0005
Cu	.00003	.000025	.00005	.0005	.00003	.0001	.00007	.00004	.00004	.00007	.000015	.00002	.000015
Zn	–	–	–	–	–	–	–	–	–	–	.007	–	–
Sr	–	–	.02	–	–	–	.0019	.023	–	–	–	–	–
Ag	.0002	–	–	.00005	–	–	–	–	–	.00005	–	–	.00005
Sn	.0005	.005	–	–	–	–	.003	.0007	–	.0007	–	–	–
Ba	–	–	–	–	–	–	–	–	–	–	–	–	.02
Pb	.001	–	–	.015	–	–	–	.0005	.002	.0025	.002	–	.0005

	157	158	160
B	0.00005	–	–
Ti	.015	0.07	0.02
V	.001	.0025	.0025
Cr	–	.0005	–
Mn	.005	.20	.20
Ni	.00007	.001	.001

	157	158	160
Cu	0.00004	0.00006	0.00003
Mo	–	.0003	–
Ag	–	.00005	–
Sn	–	.003	–
Pb	.0008	.002	–

[1] Reported as insoluble residue.
[2] Includes TiO_2.
[3] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] Not included in total, included in ignition loss.
[7] 140° -1,000° C.
[8] 105° -1,000° C.
[9] 99.77 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

138. Osborne County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. Secs. 19, 20, 29, and 30, T. 10 S., R. 15 W. Lab. No. Ob-2-1a. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 32.) Chalk, from lower part of basal bed. Insoluble residue, 14.76 percent. Index map, thin section description. Possible use: Whiting. (For another analysis from same measured section see sample 295, group F_2 of this compilation.)

139. Phillips County. Formation and reference as in sample 138. SE¼SW¼ sec. 36, T. 4 S., R. 18 W. Lab. No. Ph-1-1a. Chalk, from lower part of basal bed. Insoluble residue, 22.9 percent. Index map, thin section description. Use: Development improbable; small outcrops, poor location. (For another analysis from same measured section see sample 296, group F_2 of this compilation.)

140-145. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

140. Riley County. Pennsylvanian, Wabaunsee group, Tarkio limestone member. SE¼ sec. 29, T. 10 S., R. 9 E. Lab. No. 53202. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 7.6 ft thick.

141. Riley County. Permian, Neva limestone. NE¼ sec. 26, T. 10 S., R. 7 E. Lab. No. 53177. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone, 5.7 ft thick.

142. Riley County. Permian, Doyle shale, Towanda limestone member. NW¼ sec. 18, T. 7 S., R. 6 E. Lab. No. 53169. (Runnels and Schleicher, 1956, table 3, pl. 1, p. 86, 97.) Limestone, 7.1 ft thick.

143. Shawnee County. Pennsylvanian, Topeka limestone, Hartford limestone member. Sec. 16, T. 11 S., R. 16 E. Lab. No. 49445. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 3 ft thick.

144. Shawnee County. Topeka limestone, Curzon limestone member. Sec. 16, T. 11 S., R. 16 E. Lab. No. 49454. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 4 ft thick.

145. Shawnee County. Topeka limestone, Hartford-Curzon limestone members. SW¼ sec. 4, T. 13 S., R. 16 E. Lab. No. 53211. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 13 ft thick.

146. Trego County. Niobrara formation, probably Smoky Hill chalk member (R. T. Runnels, written communication, 1953). (T. 12 S., R. 23 W.) near town of Wakeeney. Analyst, Clarke. Lab. No. 212. (Clarke, 1900, p. 263.) Supposed marl, weathered; large surface deposit.

147. Wabaunsee County. Permian, Cottonwood limestone (R. T. Runnels, written communication, 1953). (T. 12 S., R. 10 E.) town of Alma, Zechser quarry. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 78, 76.) Limestone. Physical properties. Bulk density, 2.58. Use: Building stone.

148-150. Wabaunsee County. Permian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

148. Cottonwood limestone. NW¼ sec. 23, T. 13 S., R. 10 E. Lab. No. 52296. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 6 ft thick.

Kansas--Continued

149. Wreford limestone, Threemile limestone member. NW¼ sec. 10, T. 15 S., R. 10 E. Lab. No. 52344. (Runnels and Schleicher, 1956, table 6, pl. 1, p. 86, 97.) Limestone, 15.5 ft thick.

150. Barneston formation, Florence limestone member. SW¼ sec. 25, T. 14 S., R. 9 E. Lab. No. 52269. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 11 ft thick.

151-156. Wilson County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

151. Plattsburg limestone, Merriam limestone member. SW¼SW¼ sec. 18, T. 29 S., R. 16 E. Lab. No. 52345. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 1.5 ft thick. (See also Ives, 1955, p. 32, 38. Lab. No. O14. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3, Fe_2O_3, or S; ignition loss, 36.31 percent, at 1,000° C., sample dried at 105° C.)

152. Stanton limestone, Stoner limestone member. NW¼ sec. 19, T. 29 S., R. 15 E. Lab. No. 5191. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 40 ft thick.

153. Stranger formation, Westphalia limestone member. NW¼ sec. 17, T. 27 S., R. 14 E. Lab. No. 52335. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 3 ft thick.

154. Stranger formation, Westphalia limestone member. Sec. 19, T. 28 S., R. 14 E. Lab. No. 51293. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 5 ft thick.

155. Stranger formation, Westphalia limestone member. SW¼ sec. 19, T. 28 S., R. 14 E. Lab. No. 52300. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 5 ft thick.

156. Stranger formation, Haskell limestone member. Sec. 19, T. 28 S., R. 14 E. Lab. No. 51291. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 4 ft thick.

157. Woodson County. Stanton limestone, Stoner limestone member. SE¼ sec. 32, T. 26 S., R. 16 E. Lab. No. 52336. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 4 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

158. Woodson County. Stanton limestone, South Bend limestone member. NE¼NE¼ sec. 32, T. 25 S., R. 17 E. Lab. No. 52317. Limestone, 6 ft thick. Reference and remarks as in sample 157. (See also Ives, 1955, p. 32, 38, 39. Lab. No. O17. Limestone, banded; outcrop sample. Mineralogy. No footnote for Al_2O_3, or Fe_2O_3; ignition loss at 1,000° C., sample dried at 105° C.)

159. Woodson County. Pennsylvanian, Oread limestone, Toronto limestone member or Stanton limestone, Stoner limestone member (R. T. Runnels, written communication, 1953). (T. 25 S., R. 15 E.) town of Yates Center. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone. Physical properties. Bulk density, 2.69. Use: Building stone.

160. Woodson County. Oread limestone, Toronto limestone member. NW¼ sec. 35, T. 25 S., R. 13 E. Lab. No. 52328. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 7.2 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

237-368 O—67——8

TABLE 14.— Analyses of samples from Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing 75 to 90 percent carbonates (Group F_1) common and mixed rock categories

[Samples of mixed rock category indicated by an asterisk (*). Chemical analyses arranged by State, county, and stratigraphic position. For analyses from North Dakota: (Hansen, 1953) SiO_2, $Al_2O_3+Fe_2O_3$, and CaO given as whole numbers in text. Additional information on percentages of these constituents and of MgO, CO_2, and ignition loss were supplied by Miller Hansen (written communication, 1954)]

	Montana									
	*1	2	3	4	5	6	7	8	9	10
	$25F_11$-8	$25F_112$-5	$25F_116$-8	$25F_116$-10	$25F_116$-9	$25F_116$-11	$25F_120$-4	$25F_120$-5	$25F_120$-2	$25F_120$-1
Insoluble	8.5	[1] 7.4	10.2	[2] 9.98	[1] 8.00	[1] 16.54	17.4	21.8	18.4	14.7
Al_2O_3	} 2.3	.6	......	} .38	{ 3.30	5.37	......	......	......	......
Fe_2O_3		}[3] 1.3	{		......	......	......	......	......	......
FeO	......		[4] .9	......	1.16	1.31	[4] .4	[4] .4	[4] 1.4	[4] .5
MgO	2.9	2.0	1.5	[4] .45	1.38	1.46	18.8	15.5	1.7	1.2
CaO	45.5	50.2	46.2	[4] 49.58	46.98	40.59	25.9	24.8	42.7	44.8
P_2O_5	13.7	......	......	......	......	......	......	......	......	......
CO_2	22.6	......	......	......	......	......	......	......	......	......
Ignition loss	......	......	......	......	38.69	33.42	......	......	......	......
Total	95.5	61.5	58.8	60.39	99.51	98.69	62.5	62.5	64.2	61.2
Class	(5,7) 50	5,5,86	(10,0) 86	(9,1) 89	2,10,86	7,16,72	(17,0) 79	(22,0) 77	(18,0) 80	(15,0) 82
CaO/MgO	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	dolomite	dolomite	magnesian calcite	calcite

	Montana							Nebraska	
	11	12	13	14	15	16	17	18	19
	$25F_120$-3	$25F_122$-1	$25F_122$-2	$25F_129$-2	$25F_129$-3	$25F_129$-30	$25F_130$-1	$26F_131$-1	$26F_154$-1
Insoluble	24.0	14.9	[5] 16.23	11.6	14.3	19.5	17.4	[1] 6.9	[1] 4.52
Al_2O_3	......	......	[5] 1.55	......	......	......	......	3.3	} 1.87
Fe_2O_3	......	......	......	......	......	......	......	1.0	
FeO	[4] 1.0	[4] 2.3	......	[4] .9	[4] 1.3	[4] .8	[4] 1.3	......	......
MgO	2.1	8.6	......	.7	3.0	15.5	.4	.8	Tr.
CaO	39.1	34.8	[6] 46.19	46.0	45.7	23.9	43.0	45.3	49.66
H_2O-	......	......	......	......	......	......	......	......	.70
CO_2	......	......	......	......	......	......	......	35.2	37.80
MnO_2	......	......	.34	......	......	......	......	......	......
S	......	......	......	......	......	......	......	.5	......
SO_3	......	......	......	......	......	......	......	1.6	2.14
Organic matter	......	......	......	......	......	......	......	4.1	3.14
Total	66.2	60.6	[5] 64.31	59.2	64.3	59.7	62.1	98.7	[7] 99.83
Class	(24,0) 74	(15,0) 80	13,5,81	(12,0) 84	(14,0) 80	(20,0) 75	(17,0) 78	0,16,80	1,9,86
CaO/MgO	magnesian calcite	calcareous dolomite	calcite	calcite	magnesian calcite	dolomite	calcite	calcite	calcite

	Nebraska		North Dakota						
	20	21	22	23	24	25	26	27	28
	$26F_154$-2	$26F_191$-2	$33F_121$-27	$33F_121$-28	$33F_121$-29	$33F_121$-30	$33F_121$-31	$33F_121$-34	$33F_121$-35
Insoluble [8]	......	......	(11.74)	(15.09)	(11.87)	(11.25)	(13.45)	(19.23)	(18.07)
SiO_2	6.02	9.7	11.58	13.95	11.13	10.23	11.55	13.77	14.95
Al_2O_3	} 5.92	{ 5.0	} 1.59	1.80	1.06	1.33	{ 1.94	3.26	2.24
Fe_2O_3		1.7					.53	.71	.78
MgO	Tr.	.6	......	......	......	......	3.15	......	......
CaO	47.98	43.3	46.61	46.28	47.77	48.07	43.00	42.96	42.56
H_2O-	1.11	......	[8] (.95)	[8] (.07)	.00	[8] (5.41)	[8] (3.49)	[8] (2.92)	[8] (13.27)
CO_2	37.11	33.9	......	......	......	......	33.65	31.73	32.08
S	......	.5	......	......	......	......	......	......	......
SO_3	.85	.04	......	......	......	......	......	......	......
Organic matter	1.03	4.2	......	......	......	......	......	......	......
Ignition loss [9]	......	......	38.22	37.37	38.67	39.29	1.29	4.14	3.58
Total	100.02	98.9	98.00	99.40	98.63	98.92	95.11	96.57	96.19
Class	0,12,84	0,21,77	9,6,83	11,6,83	9,4,85	8,5,86	8,8,75	7,16,72	10,12,73
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite

[1] Reported as SiO_2.
[2] Reported as insoluble (silica).
[3] Reported as iron oxide.
[4] (Calculated by compilers from reported Fe, $MgCO_3$ or $CaCO_3$.)
[5] (Figures include amounts calculated by compilers from analysis of insoluble material.) Insoluble in HCl, 18.50 percent: Analyzed as SiO_2, 87.7 percent; Al_2O_3, 8.4 percent; and CaO, 3.9 percent.
[6] (Calculated by compilers from reported $CaCO_3$, includes 0.72 percent CaO from insoluble.)
[7] 99.86 in text.
[8] Not included in total.
[9] On dry basis. (If CO_2 reported, it is subtracted from ignition loss; calculation by compilers.)

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Montana

*1. Beaverhead County. Permian, Phosphoria formation. Sec. 4, T. 15 S., R. 9 W., South Fork of Little Sheep Creek. Analysts, Erickson, Wells, and Salkover. Lab No. 411. (Condit, 1920, p. 36, 20, 24, 26, 35, pl. 3.) (Analysis suggests 32.5 percent phosphate, 2.6 percent more CaO and MgO than required for carbonates.) Phosphate rock, gray, oolitic, weathered; 1.5 ft thick. Index map, generalized measured section, columnar section. Possible use: Fertilizer.

2. Deer Lodge County. Lower Mississippian, Madison limestone. Sec. 23, T. 5 N., R. 12 W., (U. M. Sahinen, written communication, 1955) near town of Anaconda, Browns quarry, Anaconda Copper Mining Co. (Perry, 1949, p. 37, 29, 34, pl. 6.) Limestone. General description: Dark-gray, finely crystalline, jointed. Composite sample. Index map, outcrop map, generalized stratigraphic table. Use: Lime.

3. Gallatin County. Middle Cambrian, Meagher limestone. T. 2 N., R. 3 E., (U. M. Sahinen, written communication, 1957) near town of Logan. Analyst, Bartzen. Lab. No. L-1C4. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.) Limestone. General description of 336 ft of formation: Dark-gray to brown, mottled, thin-bedded, some beds in lower 10 ft medium- to thick-bedded; fossiliferous. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see samples 28-35, group F_2 of this compilation.)

4. Gallatin County. Madison limestone. (T. 2 N., Rs. 1, 2 E.) Bridger Range, near town of Three Forks. Analyst, Catlett. (Peale, 1893, p. 33.) Limestone, dark, fine-grained, compact, laminated, some fossils.

5-6. Gallatin County. Madison limestone. (T. 2 N., R. 2 E.) town of Trident. Three Forks Portland Cement Co. quarry. (Burchard, 1912, p. 675; Perry, 1949, p. 41.) Limestone. Use: Cement material, lime.

7-8. Granite County. Upper Cambrian, Hasmark formation. SW¼ sec. 14, SE¼ sec. 15, T. 8 N., R. 13 W., near town of Princeton. Analyst, Bartzen. (Hanson, 1952, p. 42, 25, pls. 4, 5A, 5B, 9.) Index map, isopach map, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see samples 9-11 below, and samples 39-45, group F_2 of this compilation.)

- 7. Lab. No. P-3C9. Dolomite; pinkish-gray, saccharoidal in lower part; gray and tannish-gray in upper part; upper 10 ft silty and weathers brown; 47 ft thick.
- 8. Lab No. P-3C11. Dolomite, light-gray and pinkish-gray, siliceous. Medium-bedded; a few thin beds of light buff-gray, brown-weathering sandstone in lower part; pink sandy dolomite at top. Top 20 ft of formation.

9-11. Granite County. Upper Cambrian, Red Lion formation. SW¼ sec. 14, SE¼ sec. 15, T. 8 N., R. 13 W., near town of Princeton. Analyst, Bartzen. (Hanson, 1952, p. 43, 25, pls. 4, 5A, 5B, 8B, 9.) Index map, isopach maps; detailed measured section, correlated columnar sections, correlation chart.

- 9. Lab. No. P-3D3. Limestone. Silty limestone and limestone interlaminated, some intraformational conglomerate, fossil zones; 33 ft thick.
- 10. Lab No. P-3D5. Limestone, medium-gray, thin-bedded, irregular silty laminations, fossil zones; 95 ft thick.
- 11. Lab. No. P-3D6. Limestone, medium-gray, medium to coarsely crystalline; thin-bedded with irregular silty laminations, fossil zones; 42 ft thick.

12. Jefferson County. Meagher limestone. T. 2 N., R. 4 W., (U. M. Sahinen, written communication, 1957) Whitetail Deer Creek. Analyst, Bartzen. Lab. No. J-A-2. (Hanson, 1952, p. 42, pls. 4, 5A, 5B, 7A, 9.) Limestone, tan; from segregated portion of mottled rock. Index map, isopach maps, correlated columnar sections, correlation chart. (For another analysis from same measured section see sample 47, group F_2 of this compilation.)

13. Jefferson County. Recent. Sec. 9, T. 5 N., R. 4 W., (U. M. Sahinen, written communication, 1955), 3 miles from town of Boulder. (Weed, 1900, p. 243, 235, 240, pl. 33.) Hot spring deposit. Calcite, gray; netted with silica films. Index maps.

14. Madison County. Middle Cambrian, Flathead quartzite, and Wolsey shale. W½ sec. 23, T. 9 S., R. 2 E., Taylor Peak area. Analyst, Bartzen. Lab. No. X-1A7. (Hanson, 1952, p. 42, 38, pls. 4, 5A, 5B, 6A, 6B, 9.) Limestone, brownish-gray, mottled; dark greenish-gray shale at top. Very thin-bedded; 22 ft thick. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see samples 89-93, group F_2 of this compilation.)

15. Madison County. Meagher limestone. Secs. 22, 23, T. 5 S., R. 1 E., about 8 miles northeast of town of Ennis. Analyst, Bartzen. Lab. No. E-1C1. (Hanson, 1952, p. 42, 37, 38, pls. 4, 5A, 5B, 7A, 9.) Limestone, medium to light brownish-gray, finely crystalline, thin-bedded, with intercalated micaceous shale in lower part; upper part, thick-bedded in part and mottled with tan stringers; 109 ft thick. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see samples 84 and 85, group F_2 of this compilation.)

Montana--Continued

16. Madison County. Upper Cambrian, Pilgrim limestone. T. 6 S., R. 5 W., (U. M. Sahinen, written communication, 1957), 18 miles northeast of town of Dillon. Lab. No. R-1E7. (Hanson, 1952, p. 43, 29, pls. 4, 5A, 5B, 8, 9.) Dolomite, light-gray, sandy. Contains an intraformational pebble bed. Thickness, 13 ft. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For another analysis from same measured section see sample 95, group F_2 of this compilation.)

17. Meagher County. Meagher limestone. Sec. 32, T. 8 N., R. 7 E., 10 miles south of town of White Sulphur Springs. Analyst, Bartzen. Lab. No. W No. 1. (Hanson, 1952, p. 42, 35, pls. 4, 5A, 5B, 7A, 9.) Limestone, tan, from segregated portion of mottled rock. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section, see samples 102-104, group F_2 of this compilation.)

Nebraska

18. Franklin County. Upper Cretaceous, Niobrara formation. (T. 1 N., R. 13 W.), town of Riverton. (Darton, 1910, p. 385, 383, 384.) Limestone, contains clay; 30 ft of massive limestone exposed at this locality. General description: Limestone, lead-gray or bluish-gray when fresh, light-yellow when weathered; interbedded deposits of soft limestone or chalk and calcareous clay from 5-30 ft thick; flint in upper beds. Outcrop map. Possible use: Cement material.

19-20. Knox County. Niobrara formation. Bazile Creek, 1 mile south of Bazile Point. Analyst, Crouch. (Condra, 1908a, p. 15, 14, pls. 1-3.) Index map, geologic map, geologic cross section, detailed measured section.

- 19. Chalk, blne, fossiliferous, unweathered; 8 ft thick.
- 20. Chalk, yellowish with light-colored streaks, fossiliferous, weathered; 7 ft thick.

21. Webster County. Niobrara formation. (T. 1 N., R. 9 W.) south of town of Guide Rock. (Darton, 1910, p. 385, 383, 384.) Limestone, contains clay. General description as in sample 18. Possible use: Cement material.

North Dakota

22-28. Hettinger County. Oligocene, White River formation. T. 136 N., R. 93 W., Colgrove Butte. Analyst, under supervision of Burr. Limestone. Overburden, estimated tonnage. Index maps, geologic maps. Measured sections or logs of drill holes. Correlation (fence) diagram. Use: None, contains chert.

- 22. NE¼ sec. 16. Lab. No. 4-2. (Hansen, 1953, fig. 7A, p. 44, 134, 152-154, 172, figs. 6, 14.) Limestone, tan-gray; calcite crystals; 1 ft thick. (For another analysis from same measured section, see sample 128, group F_2 of this compilation.)
- 23. NE¼ sec. 16. Lab No. 5-2. Reference as in sample 22. Limestone, tan-gray; contains brown chert, calcite crystals, fossils; 2 ft 9 in. thick. (For another analysis from same measured section see sample 55, group E of this compilation.)
- 24. NE¼ sec. 16. Lab. No. 6-2. (Hansen, 1953, fig. 7B, p. 44, 134, 153, 172, figs. 6, 14.) Limestone, tan-gray; contains 4-inch cherty layer, calcite crystals, fossils; 3 ft thick. (For another analysis from same measured section, see sample 25, this group.)
- 25. NE¼ sec. 16. Lab. No. 6-4. Reference as in sample 24. Limestone, tan-gray; weathered; 10 in. thick.
- 26. NE¼ SE¼ sec. 17. Lab. No. 11-1. (Hansen, 1953, fig. 7A, p. 44, 134, 152-154, 172, figs. 6, 14.) Limestone, gray-white; calcite crystals; 1 ft 2 in. thick. (For another sample from same measured section, see sample 50, group C of this compilation.)
- 27. Center east line, SE¼ NE¼ sec. 17. Lab. No. 46-1. (Hansen, 1953, fig. 7C, p. 44, 134, 144, 145, 172, figs. 6, 14.) (For other analyses from same measured section, see sample 28, this group, and samples 60 and 61, group E of this compilation.)
- 28. Center east line, SE¼ NE¼ sec. 17. Lab. No. 46-16. Reference as in sample 27.

TABLE 14.—Analyses of samples from Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing 75 to 90 percent carbonates (Group F_1) common and mixed rock categories--Continued

	North Dakota												
	29	30	31	32	33	34	35	36	37	38	39	40	41
	$33F_121$-36	$33F_121$-37	$33F_121$-38	$33F_121$-39	$33F_121$-40	$33F_145$-165	$33F_145$-169	$33F_145$-168	$33F_145$-161	$33F_145$-170	$33F_145$-167	$33F_145$-159	$33F_145$-160
Insoluble[1]	(11.27)	(14.27)	(16.24)	(19.58)	(12.96)	(18.96)	(21.99)	(15.71)	(14.70)	(18.37)	(12.88)	(17.34)	(19.95)
SiO_2	8.47	11.84	13.74	15.95	7.66	18.19	16.30	10.78	11.88	13.50	10.02	14.47	11.97
Al_2O_3 }	1.36	1.22	1.24	1.37	1.22	1.51	2.97	2.21	2.80	3.34	1.06	2.42	2.17
Fe_2O_3 }					.63	.31	.98	.70	.29			.28	
MgO	......	......	......	......	2.10	4.50	......	1.85	3.62	......	......	5.22	......
CaO	45.96	45.73	44.79	43.31	46.21	42.17	40.95	42.72	46.32	43.26	47.45	42.35	43.95
H_2O-[1]	(13.37)	(15.69)	(11.83)	(9.66)	(2.06)	(2.31)	(7.42)	(1.94)	(2.03)	(.86)	(2.11)	(3.05)	(2.75)
CO_2	......	......	......	......	36.06	33.39	31.96	34.64	32.24	......	......	31.66	......
Ignition loss[2]	38.94	37.01	35.90	34.72	[3] 2.29	[3] 1.60	[3] 1.98	[3] 2.34	[3] 4.93	35.39	37.94	[3] 3.88	36.86
Total	94.73	95.80	95.67	95.35	96.17	101.67	95.14	95.24	102.08	95.49	96.47	100.28	94.95
Class	6, 6, 81	10, 4, 82	12, 4, 80	14, 4, 77	5, 7, 81	15, 6, 74	10, 13, 73	6, 11, 78	7, 13, 72	8, 10, 77	8, 4, 85	10, 11, 70	8, 8, 78
CaO/MgO	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	magnesian calcite	magnesian calcite	calcite	calcite	magnesian calcite	calcite

	North Dakota						South Dakota						
	42	43	44	45	46	47	48	49	50	51	52	53	*54
	$33F_145$-158	$33F_145$-162	$33F_145$-163	$33F_145$-164	$33F_145$-171	$33F_145$-166	$40F_15$-2	$40F_15$-1	$40F_15$-3	$40F_18$-4	$40F_18$-3	$40F_117$-9	$40F_118$-12
Insoluble	[1] (15.30)	[1] (17.32)	[1] (15.32)	[1] (14.05)	[1] (15.25)	[1] (15.14)	5.43	4.69	12.55	15.94	15.46	......	......
SiO_2	8.95	10.87	13.30	12.32	12.11	11.02	......	......	......	......	......	7.42	17.34
Al_2O_3	8.28	3.06	2.67	3.93	1.69	1.06	.60	.80	.57	2.13	1.44	1.84	.12
Fe_2O_3	1.12	.30					......	......	......	......	......	[4] 1.60	3.92
FeO	......	......	......	......	......	......	2.30	1.37	.76	2.13	1.37		......
MgO	2.14	3.83	......	......	......	......	......	......	......	......	......	.44	1.06
CaO	42.68	46.76	42.28	42.97	43.96	47.66	[5] 45.11	[5] 47.90	[5] 45.18	[5] 42.36	[5] 41.53	48.64	40.66
H_2O-	[1] (3.08)	[1] (2.71)	[1] (4.13)	[1] (4.36)	[1] (10.72)	[1] (.95)	[6] 7.28	[6] 6.74	[6] 2.54	[6] 2.34	[6] 5.06	......	......
CO_2	31.67	33.55	......	......	......	......	......	......	......	......	......	......	......
Mn_3O_4	......	......	......	......	......	......	......	......	......	......	......	.16	......
S in FeS_2	......	......	......	......	......	......	......	......	......	......	......	......	.12
SO_3	......	......	......	......	......	......	......	......	......	......	......	......	4.01
Ignition loss	[3] 4.55	[3] 3.40	36.65	36.78	36.88	37.27	......	......	......	......	......	39.52	31.07
Total	99.39	101.77	94.90	96.00	94.64	97.01	60.72	61.50	61.60	64.90	64.86	99.62	98.30
Class	0, 19, 71	5, 13, 75	9, 11, 75	6, 14, 77	9, 7, 78	9, 3, 84	(4, 10) 81	(3, 9) 86	(12, 4) 81	(12, 8) 76	(13, 9) 74	2, 9, 88	13, 10, 64
CaO/MgO	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	South Dakota											
	55	56	57	58	59	60	61	*62	63	64	65	66
	$40F_118$-10	$40F_118$-11	$40F_118$-9	$40F_134$-1	$40F_147$-2	$40F_167$-5	$40F_167$-8	$40F_167$-9	$40F_167$-3	$40F_167$-7	$40F_167$-4	$40F_167$-6
Insoluble	......	......	......	12.98	......	7.51	12.74	5.11	6.66	9.45	7.30	......
SiO_2	7.92	13.10	6.38	......	6.81	......	......	......	......	......	......	8.20
Al_2O_3	2.24	1.70	3.56	3.70	3.23	......	.44	1.16	.81	2.57	.35	7.07
Fe_2O_3	3.36	3.30	1.40	......			......	......	......	......	......	
FeO	......	......	......	1.62	......	1.26	1.73	2.17	1.55	1.29	1.73	......
MgO	.53	.52	.31	......	.93	......	......	......	......	......	......	......
CaO	43.33	40.59	46.93	[5] 45.11	46.75	[5] 46.65	[5] 43.34	44.40	[5] 47.24	[5] 47.51	[5] 48.72	[5] 46.83
$Na_2O + K_2O$	......	......	......	......	1.43	......	......	......	......	......	......	......
H_2O-[6]	......	......	......	2.51	......	6.08	5.02	11.68	5.10	1.74	2.29	......
CO_2	......	......	......	......	......	......	......	31.16	......	......	......	......
S in FeS_2	1.90	2.64	.48	......	Tr.	......	......	......	......	......	......	......
SO_3	.36	1.10	.46	......	......	......	......	......	......	......	......	......
Ignition loss	36.78	37.64	40.03	......	39.56	......	......	......	......	......	......	......
Total	96.42	100.59	99.55	65.92	[7] 98.71	61.50	63.27	95.68	61.36	62.56	60.39	62.10
Class	0, 16, 78	6, 18, 72	0, 13, 84	(6, 13) 77	1, 10, 85	(8, 6) 83	(12, 6) 77	(3, 15) 71	(5, 7) 84	(5, 9) 85	(7, 3) 87	0, 14, 83
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

[1] Not included in total.
[2] On dry basis.
[3] (Ignition loss less CO_2 calculated by compilers.)
[4] Reported as iron oxide.
[5] Calculated from reported $CaCO_3$.
[6] Reported as volatile matter.
[7] 99.71 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota--Continued

29-47. Oligocene, White River formation. Analyst, under supervision of Burr. Limestone. Overburden, estimated tonnage. Index maps, geologic maps. Measured sections or logs of drill holes.

29-32. Hettinger County. NE¼NE¼ sec. 17, T. 136 N., R. 93 W., Colgrove Butte. (Hansen, 1953, fig. 7 C, p. 44, 134, 144, 145, 172, figs. 6, 14.) Correlation (fence) diagram. Use: None, contains chert. (For other analyses from same measured section, see samples 47 and 48, group C of this compilation.)

29. Lab. No. 48-3.

30. Lab. No. 48-4.

31. Lab. No. 48-6.

32. Lab. No. 48-9.

33. Hettinger County. NE¼NW¼ sec. 3, T. 136 N., R. 94 W., Straight Butte. Lab. No. 70-2. (Hansen, 1953, fig. 13A, p. 44, 134, 138, 162, 172, figs. 12, 14.) Limestone, gray; 6 in. thick. Use: None, thin beds.

34-45. Stark County. Long Butte. Overburden, 3-5 ft; 7 ft of usable material. Correlation (fence) diagram. Possible use: Cement material.

34. SW¼ sec. 19, T. 137 N., R. 94 W. Lab. No. 17-1. (Hansen, 1953, fig. 9B, p. 44, 134, 137, 138, 148, 157, 172, figs. 8, 14.) Limestone, tan-gray, calcite crystals; 1 ft thick.

35. NE¼NW¼ sec. 30, T. 137 N., R. 94 W. Lab. No. 62-6. Reference as in sample 34. Clay, calcareous.

36. NW¼NW¼ sec. 30, T. 137 N., R. 94 W. Lab. No. 40-5. (Hansen, 1953, fig. 9A, p. 44, 134, 137, 138, 155, 156, 158, 172, figs. 8, 14.) Limestone, gray, calcite crystals; 1 ft 2 in. thick.

37. SW¼NW¼ sec. 30, T. 137 N., R. 94 W. Lab. No. 14-3. Reference as in sample 36. Limestone, gray, calcite crystals and stringers; 6 in. thick. (For other analyses from same measured section, see sample 53, group C and sample 66, group E of this compilation.)

38. SE¼NW¼ sec. 30, T. 137 N., R. 94 W. Lab. No. 64-8. (Hansen, 1953, fig. 9B, p. 44, 134, 137, 138, 148, 157, 172, figs. 8, 14.) Limestone.

39. NE¼SW¼ sec. 30, T. 137 N., R. 94 W. Lab. No. 38-1. Reference as in sample 38. Limestone, tan-gray, fossiliferous; upper 10 inches cherty; 4 ft thick.

40. SW¼ sec. 12, T. 137 N., R. 95 W. Lab. No. 13-3. (Hansen, 1953, fig. 9, p. 44, 134, 137, 138, 155, 172, figs. 8, 14.) Limestone, tan-gray, calcite crystals; 1 ft 10 in. thick.

41. Location and reference as in sample 40. Lab. No. 13-5. Limestone, tan-gray, weathered, 6 in. thick.

42. NE¼ sec. 24, T. 137 N., R. 95 W. Lab. No. 12-4. (Description of sample given here is that of Lab. No. 12-5.) Reference as in sample 40. Limestone, tan-gray, dense; with calcite crystals; 1 ft thick.

43. SE¼ sec. 24, T. 137 N., R. 95 W. Lab. No. 16-1. (Hansen, 1953, fig. 9A, p. 44, 134, 137, 138, 155, 156, 158, 172, figs. 8, 14.) Limestone, gray; 1 ft 6 in. thick. (For other analyses from same measured section, see samples 44 and 45, this group and sample 68, group E of this compilation.)

44. SE¼ sec. 24, T. 137 N., R. 95 W. Lab. No. 16-3. Reference as in sample 43. Limestone, gray, calcite crystals, small green, clay inclusions; 1 ft thick.

45. SE¼ sec. 24, T. 137 N., R. 95 W. Lab. No. 16-5. Reference as in sample 43. Limestone, gray, weathered; 6 in. thick.

46-47. Stark County. T. 139 N., R. 91 W. (Hansen, 1953, fig. 3, p. 44, 134, 135, 149, 163, 172, figs. 1, 2, 8.) Correlation (fence) diagram. Use: None, deposit small.

46. Secs. 11, 12, Young Man's Butte. Lab. No. 43-2. Limestone, gray, calcite crystals; 3 ft 10 in. thick. (For another analysis from same measured section, see sample 69, group E of this compilation.)

47. Sec. 16, Antelope Butte. Lab. No. 36-2. Limestone, tan-gray, calcite crystals, minor amount of chert; thick to thin bedded; 1 ft 6 in. thick.

South Dakota

48-52. Upper Cretaceous, Niobrara formation. Analyst, under supervision of Frary; collector, Kirby. Index and outcrop maps, measured sections. Possible use: Whiting.

48. Bon Homme County. About NW cor. sec. 22, T. 92 N., R. 61 W. Lab. No. 23. (Rothrock, 1931, p. 23, 8, 25.) Chalk, black, weathers dark buff; 50 ft thick in cliff.

49. Bon Homme County. SW¼ sec. 27, T. 93 N., R. 60 W. Lab. No. 22. (Rothrock, 1931, p. 22, 23, 8, 24.) Chalk.

50. Bon Homme County. (T. 96 N., R. 58 W.) east of town of Scotland. Lab. No. 15. (Rothrock, 1931, p. 38, 8.) Chalk, white or light-gray, weathers white, 16 ft thick; overburden.

51. Brule-Lyman County line. SW¼ sec. 17, T. 104 N., R. 71 W. Lab. No. 29. (Rothrock, 1931, p. 42, 8, 41.) Chalk, gray, weathers white, beds 2-6 in. thick, total thickness 10 ft.

52. Brule County. Secs. 35 and 36, T. 105 N., R. 71 W. Lab. No. 27. (Rothrock, 1931, p. 42, 8, 40.) Chalk, light-gray, thin-bedded, shaly. Weathers gray and on longer exposure, bright-buff. From upper half of 85 ft outcrop.

53. Custer County. Niobrara formation. (T. 6 S., R. 7 E.) near town of Buffalo Gap. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 288, 58.) Chalk. General description: Bluish gray when fresh, weathers creamy yellow; thin bedded.

54-58. Niobrara formation. Analyst, under supervision of Frary; collector, Kirby. Index and outcrop maps, measured sections. Possible use: Whiting.

*54. Davison County. NW¼ sec. 27, T. 102 N., R. 61 W. (Rothrock, 1931, p. 34, 8.) (Analysis suggests 8.6 percent gypsum, 3.3 percent more CaO and MgO than required for carbonates.) Chalk, white, leached; 4.5 ft sampled at depth of 13-17.5 ft. (For other analyses from same measured section see following sample and sample 70, group E of this compilation.)

55. Davison County. NW¼ sec. 27, T. 102 N., R. 61 W. (Rothrock, 1931, p. 34, 8.) Chalk, unweathered, unleached, average of 22 ft, sampled at depth of 18-40 ft.

56. Davison County. NW¼ sec. 33, T. 104 N., R. 61 W. (Rothrock, 1931, p. 30, 8.) Chalk, blue. Sampled at depth of 30-45 ft.

57. Davison County. NW cor. sec. 34, T. 104 N., R. 61 W. (Rothrock, 1931, p. 29, 8.) Chalk, unweathered, unleached; lower part of exposure. (For another analysis from same measured section see sample 17, group F_2 of this compilation.)

58. Hutchinson County. SW cor. sec. 20, T. 98 N., R. 57 W., northwest of town of Menno. (Rothrock, 1931, p. 39, 8.) Chalk, white, weathers white, lower 6 ft slightly buff, 45 ft exposure. Use: Agricultural rock.

59. Meade County. Niobrara formation. (Probably T. 6 N., R. 8 E.), Bear Butte. (O'Harra and others, 1908, p. 21.) Limestone. Outcrop map. Possible use: Cement material.

60-65. Yankton County. Niobrara formation. Analyst, under supervision of Frary; collector, Kirby. Index and outcrop maps, measured sections. Possible use: Whiting.

60. NE¼ sec. 14, T. 93 N., R. 56 W., 1 mile west of town of Yankton. Lab. No. 12. (Rothrock, 1931, p. 17, 8, 18.) Chalk, dark-gray to black, weathers lighter, beds 1-3 ft thick; total thickness 28 ft.

61. Information as in sample 60. Lab. No. 13. (Rothrock, 1931, p. 18, 8, 17.)

*62. NE¼ sec. 17, T. 93 N., R. 56 W., old cement quarry 4 miles west of town of Yankton. Lab. No. 10. (Rothrock, 1931, p. 4, 8, 17, 19.) (Analysis suggests 4.7 percent more CaO than required for carbonate, shows 2.2 percent FeO.) Chalk, black, fossiliferous; 7.5 ft thick. (For another analysis from same measured section, see sample 35, group F_2, of this compilation.)

63. (T. 93 N., Rs. 56 and 57 W.) (Rothrock, 1931, p. 17, 8.) Chalk, average analysis of white and black Yankton chalks.

64. NE¼ sec. 12, T. 94 N., R. 54 W. Lab. No. 1. (Rothrock, 1931, p. 10, 8, 13.) Chalk, outcrop 33 ft thick; overburden.

65. SE¼ sec. 35, T. 95 N., R. 54 W. Lab. No. 4. (Rothrock, 1931, p. 11, 8, 14.) Chalk, gray; from lower part of exposure; 16 ft thick. (For another analysis from same measured section see sample 42, group F_2 of this compilation.)

66. Yankton County. (Niobrara formation.) Yankton. (Lewis, 1898, p. 97.) Chalk. Use: Portland cement.

TABLE 14.—Analyses of samples from Montana, Nebraska, North Dakota, South Dakota, and Wyoming containing 75 to 90 percent carbonates (Group F_1) common and mixed rock categories--Continued

	Wyoming												
	67	68	69	70	*71	72	73	74	75	76	*77	*78	*79
	$49F_1$1-68	$49F_1$7-15	$49F_1$7-16	$49F_1$7-20	$49F_1$7-26	$49F_1$9-1	$49F_1$9-2	$49F_1$9-3	$49F_1$11-5	$49F_1$11-6	$49F_1$12-98	$49F_1$12-99	$49F_1$12-104
Insoluble	......	10.7	15.0	9.2	[1] (6.4)	......	......	......	......	......	[1] (12.2)	[1] (16.5)	[1] (16.1)
SiO_2	10.50	......	......	......	5.0	5.8	10.4	20.0	10.52	6.44	13.00	15.20	16.21
Al_2O_3	4.20	[2] .2	[2] .4	[2] .8	1.1	4.35	3.5	2.5	.46	1.46	.9	.5	1.2
Fe_2O_3	.60				[3] 1.00	[4] .58	[4] .77	[4] .13	1.55	2.32	.7	.8	.5
MgO	.50	18.0	16.9	.7	9.55	11.8	15.7	14.8	3.53	2.65	10.1	12.3	12.2
CaO	46.00	26.3	25.9	48.7	38.7	35.7	29.0	24.7	43.30	45.90	32.15	30.60	28.2
Na_2O	......	......	......	......	......	......	......	......	.05	......	.62	.40	.33
K_2O	......	......	......	......	......	......	......	......	.70	.66	.69	.78	.79
H_2O+	......	......	......	......	......	......	......	......	......	.33	[5] .54	[5] 1.33	......
H_2O-	......	......	......	......	......	......	......	......	[6] .50	[6] .55	1.46	.57	.59
TiO_2	......	......	......	......	......	......	......	......	......	......	.12	.08	.09
P_2O_5	......	......	......	......	17.1	......	......	......	......	......	11.5	6.4	5.2
CO_2	......	......	......	......	......	40.7	39.5	35.4	......	......	25.3	29.8	33.2
MnO	......	......	......	......	......	......	......	......	.14	.11	......	......	......
SO_3	Tr.	......	......	......	[7] .90	......	......	......	.06	.07	2.3	1.1	1.0
V_2O_5	......	......	......	......	.01	......	......	......	......	......	.05	.05	.05
F	......	......	......	......	1.76	......	......	......	......	......	1.3	.74	.55
Chem. U	......	......	......	......	......	......	......	......	......	......	.003	.001	.002
Ignition loss	36.00	41.9	39.8	39.0	......	......	......	......	39.22	39.71	[1] (27.3)	[1] (31.7)	[1] (32.6)
Subtotal	......	......	......	......	75.12	......	......	......	......	......	100.733	100.651	100.112
Less O [8]	......	......	......	......	.74	......	......	......	......	......	.55	.31	.23
Total	97.80	97.1	98.0	98.4	74.4	98.9	98.9	97.5	100.03	[9] 100.20	[10] 100.2	[10] 100.3	99.9
Class	2, 14, 79	(10, 2)85	(14, 2)82	(8, 2)88	2, 6, 49	0, 10, 88	4, 11, 84	16, 8, 75	8, 6, 85	1, 10, 87	11, 5, 51	13, 5, 63	14, 5, 66
CaO/MgO	calcite	dolomite	dolomite	calcite	dolomite	calcareous dolomite	calcareous dolomite	dolomite	magnesian calcite	magnesian calcite	dolomite	calcareous dolomite	dolomite

	*80	*81	*82	*83	*84	85	86	87	88	89	90	91	92
	$49F_1$12-97	$49F_1$12-100	$49F_1$12-101	$49F_1$12-102	$49F_1$12-103	$49F_1$12-94	$49F_1$12-95	$49F_1$12-96	$49F_1$13-2	$49F_1$13-3	$49F_1$13-4	$49F_1$13-5	$49F_1$15-4
Insoluble	[1] (17.8)	[1] (12.92)	[1] (13.63)	[1] (4.93)	[1] (10.8)	[1] (25.48)	[1] (10.47)	[1] (20.0)	......	......	......	......	10.2
SiO_2	14.42	10.47	11.19	5.20	8.69	7.82	8.27	17.58	8.2	7.6	8.6	11.4	......
Al_2O_3	2.0	1.7	1.7	.1	1.3	2.2	2.2	2.5	2.0	1.85	2.15	2.6	......
Fe_2O_3	.8	.9	1.0	.5	.9	.7	.7	.9	[4] .26	[4] .45	[4] .45	[4] .51	[4] .51
MgO	12.8	13.9	13.2	13.0	10.9	15.0	15.1	11.1	5.8	.94	1.08	.87	.8
CaO	28.40	27.36	26.60	36.00	31.80	29.72	29.60	29.80	42.9	49.0	47.9	46.3	50.5
Na_2O	.70	.84	.58	.60	.50	.60	.80	.54	......	......	......	......	......
K_2O	.85	.69	.82	.40	.66	.71	.50	.63	......	......	......	......	......
H_2O+ [5]	2.66	4.80	4.80	2.39	3.02	2.87	3.73	1.64	......	......	......	......	......
H_2O-	.44	1.10	1.00	.41	.58	.43	.77	.26	......	......	......	......	......
TiO_2	.11	.06	.07	.13	.11	.10	.06	.14	......	......	......	......	......
P_2O_5	4.41	3.05	4.04	8.11	5.38	2.24	2.10	.76	......	......	......	......	......
CO_2	30.6	32.8	31.2	33.00	32.3	36.7	36.2	33.8	39.8	39.2	38.5	37.0	......
SO_3	.96	1.6	1.7	1.0	1.1	.60	1.0	.51	......	......	......	......	......
V_2O_5	.05	.09	.07	.07	.04	.05	.07	.04	......	......	......	......	......
F	.44	.35	.44	.78	.56	.27	.22	.13	......	......	......	......	......
Chem. U	.001	.000	.001	.001	.001	.001	.001	.001	......	......	......	......	......
Ignition loss [1]	(33.7)	(38.7)	(37.0)	(35.8)	(35.9)	(40.0)	(40.7)	(35.7)	......	......	......	......	......
Subtotal	99.641	99.71	98.411	101.691	97.841	100.011	101.321	100.331	......	......	......	......	......
Less O	.19	.15	.15	.33	.24	.11	.09	.05	......	......	......	......	......
Total	99.5	99.6	98.3	101.4	97.6	99.9	101.2	100.3	99.0	99.0	98.7	98.7	62.0
Class	10, 10, 65	6, 13, 69	7, 13, 64	4, 4, 70	5, 9, 67	3, 11, 78	4, 12, 77	12, 11, 73	5, 6, 88	4, 6, 89	5, 6, 87	7, 8, 84	(10, 0)86
CaO/MgO	calcareous dolomite	dolomite	dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	magnesian calcite	calcite	calcite	calcite	calcite

	93	94	95	96	97	98	*99
	$49F_1$15-6	$49F_1$15-5	$49F_1$15-7	$49F_1$15-10	$49F_1$15-8	$49F_1$15-9	$49F_1$24-35
Insoluble	19.7	14.0	23.2	9.8	14.2	14.2	[11] 3.32
Al_2O_3	......	......	......	......	......	......	3.31
FeO	.90	1.03	.64	.51	.77	.90	[12] 3.62
MgO	.7	.1	.7	.4	.7	1.1	Tr.
CaO	42.3	45.8	42.5	47.8	44.6	44.6	57.70
H_2O- at 110° C	......	......	......	......	......	......	1.75
Ignition loss	......	......	......	......	......	......	30.35
Total	63.6	60.9	67.0	58.5	60.3	60.8	[13] 100.05
Class	(20, 0)77	(14, 0)82	(23, 0)75	(10, 0)86	(14, 0)81	(14, 0)82	0, 8, 68
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrographic analyses

[E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. Li, Be, Co, Ga, As, Cd, Sn, Sb, Ta, W, Pt, Au, Hg, and Bi looked for in all samples but not detected]

	77	78	79	80	81
B	F	F	F	F	F
Cr	E	E	E	E	E
Mn	E	F	E	F	F
Ni	F	F	E	E	E
Cu	G	G	G	G	G
Zn	ND	ND	ND	E	ND
Sr	F	E	ND	ND	E
Zr	E	F	F	F	F
Cb	E	ND	ND	ND	ND
Mo	F	ND	F	F	F
Ag	G	G	G	G	G
Ba	E	E	ND	ND	E
Pb	ND	ND	E	ND	ND

See following page for footnotes.

Spectrographic analyses--Continued

	82	83	84	85	86	87		82	83	84	85	86	87
B	F	F	F	F	F	F	Zr	F	F	F	F	F	F
Cr	E	E	E	E	E	F	Cb	ND	ND	ND	ND	ND	ND
Mn	F	F	F	F	F	E	Mo	F	ND	ND	ND	F	F
Ni	E	F	F	F	E	F	Ag	G	G	G	ND	ND	ND
Cu	G	G	G	G	G	G	Ba	E	E	E	E	E	ND
Zn	ND	ND	ND	ND	ND	ND							
Sr	E	E	E	E	ND	ND	Pb	ND	ND	ND	ND	ND	E

[1] Not included in total.
[2] Reported as R_2O_3.
[3] Calculated from reported Fe.
[4] FeO calculated from reported Fe.
[5] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[6] At 100° C.
[7] Reported as S.
[8] (Calculated by compilers from F.)
[9] 100.10 in text.
[10] Ag, 0.0003 percent, composite of samples VEM-9-47 through VEM-12-47.
[11] Reported as SiO_2.
[12] Reported as Fe_2O_3.
[13] Na_2O reported as trace, by spectroscopic examination.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming

67. Albany County. Upper Cretaceous, Niobrara formation. (T. 16 N., R. 73 W.) town of Laramie. (Rock Products, 1929, p. 36.) Limestone. Use: Cement.

68-70. Fremont County. Lower Mississippian, Madison limestone. (T. 32 N., R. 101 W.), 10 miles southwest of town of Lander. (Deiss, 1949.)
- 68. Lab. No. 4239. Dolomite.
- 69. Lab. No. 4240. Dolomite.
- 70. Lab. No. 4244. Limestone.

*71. Fremont County. Permian, Phosphoria formation. Sec. 11, T. 30 N., R. 99 W., Twin Creek area. (King and Schumacher, 1949, p. 9, 3, 11, figs. 1, 3, 4.) (Analysis suggests 40.5 percent phosphate.) Phosphate, interbedded with shaly limestone, core sample from depth of 85.1-86 ft. DH-1. Index and geologic maps. (For other analyses from same measured section see samples 29-32, group P of this compilation.)

72-74. Hot Springs County. (Phosphoria formation) reported as Embar formation. (T. 42 N., R. 95 W.), 6 miles south of town of Thermopolis. (Osterwald and Osterwald, 1952, p. 52, 3, 51.) Dolomite, no overburden; generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.
- 72. Bottom 12 ft of formation.
- 73. Middle part of formation, 12-24 ft from base.
- 74. Upper part of formation, 24-36 ft from base.

75. Laramie County. Permian(?), Minnekahta limestone. T. 19 N., R. 70 W.(?), (H. D. Thomas, written communication, 1956) about 0.5 mile west of Bradley station. Analyst, Phillips. (Ball, 1907, p. 242, 241.) Limestone, 50 ft sampled. General description: Gray, purplish, or white, fine-grained, jointed. Possible use: Cement.

76. County, analyst, and use as in sample 75. Niobrara limestone. T. 19 N., R. 70 W.(?), (H. D. Thomas, written communication, 1956) east of Bradley spur. (Ball, 1907, p. 241.) Limestone, white; thin-bedded, shaly; 60 ft sampled.

77-87. Lincoln County. Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall; spectrographic analyst, Mortimer. Trench samples. Index map, outcrop map; generalized columnar section, detailed columnar section. Modal grain size. Mineralogy. (For other analyses from same measured section see analyses in Lincoln County in other groups of this compilation.)
- *77. Lab. No. VEM-9-47. (McKelvey and others, 1953, p. 15, 19, 2, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, 106, pl. 1.) (Analysis suggests 27.3 percent phosphate, 4.9 percent gypsum; shows 1.3 percent alkalies.) Dolomite, phosphatic, brownish-gray; contains pellets. Bed P-12, 0.5 ft thick, 134.05 ft from top of member.
- *78. Lab. No. VEM-11-47. References as in sample 77. (Analysis suggests 15.2 percent phosphate, 2.4 percent gypsum; shows 1.2 percent alkalies.) Dolomite, brownish-gray; contains pellets. Bed P-14, 0.5 ft thick, 132.65 ft from top of member.
- *79. Lab. No. 2069. References as in sample 77. (Analysis suggests 12.3 percent phosphate, 2.2 percent gypsum; shows 1.1 percent alkalies.) Dolomite, brownish-gray, interbedded chert. Bed P-16, 2.3 ft thick, 129.05 ft from top of member. Photomicrograph.
- *80. Lab. No. LES-8-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 13, 5, 100, pl. 1.) (Analysis suggests 10.5 percent phosphate, 2.1 percent gypsum, shows 1.6 percent alkalies.) Dolomite, brownish-gray. Bed P-42, 2 ft thick, 96.25 ft from top of member. Photomicrograph.
- *81. Lab. No. VEM-16-47. References as in sample 80. (Analysis suggests 7.2 percent phosphate, 3.4 percent gypsum; shows 1.5 percent alkalies.) Dolomite, brownish-black. Bed P-47, 1.1 ft thick, 91.25 ft from top of member.

Wyoming--Continued

- *82. Lab. No. VEM-17-47. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) (Analysis suggests 9.6 percent phosphate, 3.7 percent gypsum; shows 1.4 percent alkalies.) Dolomite, phosphatic, brownish-black; contains pellets. Beds P-48, 1.1 ft thick, 90.15 ft from top of member.
- *83. Lab. No. VEM-21-47. References as in sample 82. (Analysis suggests 19.2 percent phosphate, 2.2 percent gypsum; shows 1.0 percent alkalies.) Dolomite, phosphatic, brownish-gray; fossiliferous, contains pellets. Bed P-52. 0.7 ft thick, 87.25 ft from top of member.
- *84. Lab. No. VEM-23-47. References as in sample 82. (Analysis suggests 12.8 percent phosphate, 2.4 percent gypsum; shows 1.2 percent alkalies.) Dolomite, brownish-gray. Bed P-54, 1.3 ft thick, 83.45 ft from top of member.
- 85. Lab. No. VEM-25-47. (McKelvey and others, 1953, p. 13, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, 101, pl. 1.) Dolomite, argillaceous. Interbedded chert. Bed P-56, 1.2 ft thick, 80.65 ft from top of member. Photomicrograph.
- 86. Lab. No. VEM-27-47. References as in sample 85. Dolomite, brownish-black; contains pellets. Bed P-58, 1.6 ft thick, 77.45 ft from top of member.
- 87. Lab. No. DML-9-47. (McKelvey and others, 1953, p. 12, 16, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, 82, 83, 98, pl. 1.) Dolomite, calcareous, argillaceous, light brownish-gray; fossiliferous. Bed P-107, 5.7 ft thick, 13.0 ft from top of member. Photomicrographs.

88-91. Natrona County. (T. 32 N., R. 80 W.), 10 miles southwest of town of Casper. (Osterwald and Osterwald, 1952, p. 53, 3, 51.) Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.
- 88. Minnekahta limestone. Dolomite, base to 11 ft of formation.
- 89-91. Triassic(?), Chugwater formation, Alcova limestone member.
  - 89. Dolomite, from north end of exposure.
  - 90. Dolomite, from south end of exposure.
  - 91. Dolomite, from middle of exposure.

92-98. Park County. Analyst, Bartzen. Isopach maps, correlated columnar sections, correlation chart.
- 92-93. Middle Cambrian. Sec. 31, T. 58 N., R. 105 W., Beartooth Butte. (Hanson, 1952, p. 42, 41, pls. 4, 5, 7, 9.) Limestone, brownish-gray, thin-bedded.
  - 92. Meagher limestone. Lab. No. B-2C2. Thickness, 15 ft.
  - 93. Park shale. Lab. No. B-2D2. Fossiliferous, 6 ft thick.
- 94-95. Park shale. S½ sec. 25, T. 58 N., R. 106 W., Beartooth Butte. (Hanson, 1952, p. 42, pls. 4, 5, 7, 9.) (Limestone.)
  - 94. Lab. No. B-1D2.
  - 95. Lab. No. B-1D1.
- 96-98. Upper Cambrian, Snowy Range formation. T. 58 N., R. 107 W., (U. M. Sahinen, written communication, 1957), Fox Creek. (Hanson, 1952, p. 43, 40, pls. 4, 5, 8, 9.) (For another analysis from same measured section see sample 84, group C of this compilation.)
  - 96. Lab. No. I-2F2. (Limestone) 3.5 ft thick.
  - 97. Lab. No. I-2F5. Limestone, greenish-to brownish-gray, lithographic; in beds 0.5 inch to 1 ft thick, total thickness 3 ft.
  - 98. Lab. No. I-2F10. Shale, greenish-gray, interbedded with limestone; total thickness 14 ft.

*99. Yellowstone National Park. (Recent. Between Gardiner's River and Mammoth Hot Springs.) Analyst, Endlich. (Peale, 1873, p. 125.) (Analysis suggests 2.2 percent excess Al_2O_3, 2.4 percent excess Fe_2O_3.) Spring deposit, from group of springs on fourteen terraces.

TABLE 15.—Analyses of samples from Colorado containing more than 90 percent carbonates (Group F_2) common rock category

[Chemical analyses arranged by county and stratigraphic position. Minor discrepancies may occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature]

	Colorado												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	$5F_27$-22	$5F_27$-24	$5F_27$-23	$5F_28$-3	$5F_28$-4	$5F_28$-5	$5F_28$-8	$5F_28$-6	$5F_28$-9	$5F_28$-7	$5F_28$-10	$5F_28$-11	$5F_28$-12
Insoluble	......	......	......	......	......	......	......	0.18	0.54	0.24	1.45	3.60	6.67
SiO_2	4.79	5.35	5.10	3.24	3.68	0.12	0.34	......	......	......	......	......	......
Al_2O_3	.99	1.45	1.80	2.72	3.20	} .20	.16	.22	.25	.70	.83	.63	1.00
Fe_2O_3	.14	.45	.03	1.80	.64								
FeO	.48	.56	.56	......	......	......	......	......	......	......	......	......	......
MgO	.56	.57	1.01	1.88	14.07	13.55	20.07	[1].38	[1].71	[1]1.41	[1]20.04	[1]19.41	[1]16.60
CaO	50.54	51.29	50.27	48.80	34.33	38.56	32.12	[1]55.20	[1]55.08	[1]54.16	[1]31.65	[1]31.26	[1]30.91
Na_2O	.14	.03	.07	......	......	......	......	......	......	......	......	......	......
K_2O	.37	.13	.26	......	......	......	......	......	......	......	......	......	......
H_2O+	[2].29	[2].24	[2].49	} 1.14	1.27	2.30	.00	......	......	......	......	......	......
H_2O-	[2].17	[2].08	[2].17										
CO_2	40.38	40.07	40.11	40.50	42.54	45.32	47.37	......	......	......	......	......	......
SO_3	.10	.09	.12	......	......	......	......	......	......	......	......	......	......
Organic matter	1.09	.27	.16	......	......	......	......	......	......	......	......	......	......
Total	100.04	100.58	100.15	100.08	99.73	100.05	100.06	55.98	56.58	56.51	53.97	54.90	55.18
Class	3,5,91	2,6,91	2,6,91	0,7,91	0,7,91	0,2,97	0,0,100	(0,0)99	(0,1)98	(0,1)98	(0,2)97	(3,2)95	(5,3)90
CaO/MgO	calcite	calcite	calcite	magnesian calcite	calcareous dolomite	calcareous dolomite	dolomite	calcite	calcite	calcite	dolomite	dolomite	calcareous dolomite

	14	15	16	17	18	19	20	21	22	23	24	25	26
	$5F_28$-13	$5F_28$-14	$5F_28$-15	$5F_214$-6	$5F_214$-7	$5F_214$-8	$5F_215$-1	$5F_217$-2	$5F_219$-9	$5F_219$-7	$5F_219$-8	$5F_219$-10	$5F_221$-15
Insoluble	......	......	......	} 0.08	0.10	0.17	{	......	7.47	0.24	0.30	......	......
SiO_2	1.00	1.90	3.2				[3]0.51	0.80	......	......	......	......	0.14
Al_2O_3	......	......	1.7	Tr.	Tr.	......	} .20	{ .04	......	......	......	......	.29
Fe_2O_3	......	.30	Tr.	.20	1.08	1.82		.07	......	......	......	......	......
FeO	......	......	......	......	......	......	......	[4].10	.60	.55	.63	......	.04
MgO	......	......	.80	1.50	1.39	1.01	1.37	[4].25	19.48	21.95	21.37	[5]Tr.	5.71
CaO	53.00	51.90	52.0	53.11	52.60	52.59	48.84	[6]55.10	28.23	29.71	29.50	[1]54.40	48.72
Na_2O	......	......	......	.17	.16	.09	Tr.	......	......	......	......	......	......
K_2O	......	......	......	.03	.03	.04	......	......	......	......	......	......	......
H_2O+	......	......	......	[7].88	[7].72	[7].87	......	......	......	......	......	......	......
H_2O-	......	......	......	[7].33	[7].51	[7].53	......	......	......	......	......	......	.04
TiO_2	......	......	......	......	......	......	......	Tr.	......	......	......	......	Tr.
P_2O_5	......	......	.12	Tr.	Tr.	Tr.	......	[8]Tr.	......	......	......	......	.07
CO_2	[9](46.00)	[9](45.90)	42.8	42.98	42.57	42.03	39.39	[9](43.39)	43.21	46.84	46.15	......	44.68
MnO	......	......	......	[10].026	[10].03	......	.62	[4].13	......	......	......	......	.01
SO_3	......	......	......	.29	.50	.58	[1]1.86	[11]Tr.	......	......	......	......	.05
Li_2O	......	......	......	Tr.	Tr.	Tr.	Tr.	......	......	......	......	......	......
CuO	......	......	......	......	......	......	......	[4].03	......	......	......	......	......
ZnO	......	......	......	......	......	......	......	[4].09	......	......	......	......	......
SrO	......	......	......	.17	.26	.22	1.16	None	......	......	......	......	.22
BaO	......	......	......	......	......	......	[1]3.56	None	......	......	......	......	......
Cl	......	......	......	[12]Tr.	[12]Tr.	[12]Tr.	Tr.	......	......	......	......	......	.02
Organic matter	......	......	Tr.	......	......	......	2.29	......	......	......	......	......	.36
Total	54.00	54.10	100.6	99.77	99.95	99.95	99.80	56.61	98.99	99.29	97.95	54.40	100.35
Class	1,0,95	2,1,93	0,5,94	0,1,97	0,1,96	0,2,95	0,3,88	1,0,97	(7,0)91	(0,0)98	(0,0)97	0,0,97	0,1,99
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	dolomite	dolomite	calcite	magnesian calcite

	27	28	29	30	31	32	33	34	35	36	37	38	39
	$5F_221$-16	$5F_221$-17	$5F_222$-16	$5F_222$-17	$5F_222$-18	$5F_223$-9	$5F_223$-12	$5F_223$-10	$5F_223$-11	$5F_223$-13	$5F_226$-4	$5F_226$-6	$5F_226$-5
SiO_2	0.30	1.50	2.49	2.53	3.10	0.06	0.23	0.11	0.22	2.27	0.05	0.27	0.24
Al_2O_3	} .50	......	1.05	.47	} 1.50	{	......	......	......	......	.03	.05	......
Fe_2O_3						.00	} .9	{ .03	.10	} .14	{ Tr.	.28	......
FeO	......	......	......	......		.00		.07	.10		[1].02	[1].01	......
MgO	[1].72	.58	1.56	[1].29	[1]3.01	Tr.	.24	Tr.	.24	.46	[1].09	[1].12	......
CaO	[1]54.17	[1]51.68	53.07	[1]53.85	[1]49.80	55.81	55.49	55.68	55.45	53.79	[1]55.78	[1]55.41	[1]55.89
H_2O-	......	[13]4.61	......	......	......	......	......	......	......	......	......	......	......
CO_2	......	......	[14]41.77	......	......	......	......	......	......	......	......	......	......
MnO	......	......	......	......	......	......	......	......	......	......	[15].02	[16].08	......
P	......	......	.0042	......	......	......	......	......	......	......	......	......	......
SO_3	[1].34	[17].23	[18].030	[18]Tr.	......	......	......	......	......	......	[1].05	[1].06	......
BaO	[1].66	......	......	......	......	......	......	......	......	......	......	......	......
Organic matter	......	.20	......	......	......	......	......	......	......	......	......	......	......
Total	56.69	58.80	99.97	57.14	57.41	55.87	56.9	55.89	56.11	56.66	56.04	56.28	56.13
Class	0,1,98	2,5,93	1,3,94	2,1,97	1,4,95	0,0,100	0,1,98	0,0,99	0,0,99	2,0,97	0,0,100	0,1,99	0,0,100
CaO/MgO	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

See following page for footnotes.

DESCRIPTIVE NOTES

[*First page number in reference indicates source of analysis*]

Colorado

1-3. Boulder County. Upper Cretaceous, Niobrara limestone, basal bed. Analysts, Phillips, Brobst, and Bates. (Martin, 1909, p. 324, 315, 321, 322, 326.) Limestone, massive; composite samples from outcrop. Index and outcrop map. Possible use: Cement material.
- 1. $NE\frac{1}{4}$ sec. 5, T. 2 N., R. 70 W., 8 miles west of town of Longmont. Lab. No. 156. Limestone, 15 ft thick.
- 2. $NE\frac{1}{4}$ sec. 21, T. 3 N., R. 70 W. Lab. No. 162. Limestone, white, 15.5 ft thick.
- 3. $NW\frac{1}{4}$ sec. 28, T. 3 N., R. 70 W., northwest of Longmont. Lab. No. 160. Limestone, white, 10 ft thick.

4-5. Chaffee County. Ordovician, Tomichi limestone. Tps. 49, 50 N., R. 6 E., Monarch district. Analyst, Butters. (Crawford, 1913, p. 58, 21, 56, 74, pls. 2, 4, 5.) Magnesian limestone. General description: Bluish-gray, very fine texture, thick-bedded. Index maps, geologic maps, columnar section.
- 4. Limestone, 5 ft above base of formation.
- 5. Limestone, 210 ft above base of formation.

6-7. Chaffee County. Upper Devonian, Ouray limestone. Tps. 49, 50 N., R. 6 E. Analyst, Butters. (Crawford, 1913, p. 63, 21, 62, 74, pls. 2, 4, 5.) Index maps, geologic maps, columnar section.
- 6. Magnesian limestone; 240 ft above base of formation.
- 7. Dolomite, black, coarsely crystalline; about 40 ft thick, about 150 ft below top of formation. Detailed measured section.

8-13. Chaffee County. Ouray limestone. (Reported as Lower Mississippian, Leadville limestone, Argall, 1949, p. 258.) T. 50 N., R. 6 E., Garfield quarry, town of Garfield. (Crawford, 1913, p. 63, 21, 62, 74, pls. 2, 4, 5.) Index maps, geologic maps, columnar section.
- 8. Limestone, average of 12 samples taken across quarry face.
- 9. Limestone, mostly blue, crystalline; from bed 100 ft thick, near center of quarry face. Use: Flux.
- 10. Limestone, west of quarry.
- 11. Dolomite, west of quarry.
- 12. Dolomite, west of quarry.
- 13. Dolomitic limestone, west of quarry.

14-15. Chaffee County. Leadville limestone (T. 50 N., R. 6 E.), 0.25 mile west of town of Garfield (M. G. Dings, written communication, 1956, no quarry reported in town). Ohio and Colorado Smelting and Refining Company quarry. (Burchard, 1912, p. 661.) Limestone. Use: Flux.

16. Chaffee County. Pennsylvanian, Weber formation. Secs. 22 and 23, T. 13 S., R. 77 W., Trout Creek Pass. Analyst, Hills. (Johnson, 1940, p. 593, 573-575, 590.) Algal limestone. Occurs with pisolites and oolites in some beds. Description of organism which built colony. Index map. Detailed measured section. (For other analyses of algal limestone in Colorado, see sample 70 this group, sample 8 group A, sample 94 group B, samples 1 and 3 group C, and samples 7 and 20 group F_1; of this compilation.)

17-19. Custer County. (Recent. T. 22 S., R. 72 W.), Geyser mine, Silver Cliff district. Analyst, Hillebrand. (Emmons, 1896, p. 459, 460, 453.) Calcareous sinter, sampled at 2,000 ft level of mine. Cross section of Geyser mine.
- 17. Calcareous sinter, white, slight iron stain.
- 18. Calcareous sinter, white and brown.
- 19. Calcareous sinter, brown, iron stain, pisolitic texture.

20. Delta County. (Recent. T. 14 S., R. 93 W.), Doughty Springs, about 4.5 miles from town of Hotchkiss. (Headden, 1905, p. 307.) Sinter; from bed 400 ft long by 147 ft wide, exposed thickness about 20 ft.

Colorado--Continued

21. Dolores County. Pennsylvanian, Hermosa(?) formation. (Sec. 6, T. 40 N., R. 11 W.), Logan mine, Rico district. Analyst, Hillebrand. (Ransome, 1901, p. 286, 239, 285, 392, pl. 41.) Limestone, gray, compact; sampled close to gypsum crust separating limestone from limonite blanket. Index map, geologic map, geologic cross section.

22-24. Eagle County. Leadville limestone. (T. 7 S., R. 80 W.), Eagle Bird Gulch, near town of Gilman, Red Cliff mining district. Analyst, Dean. (Crawford and Gibson, 1925, p. 60, 1, 33, 37, pl. 1.) Dolomite, from outcrop. Index map, geologic map, detailed measured section.
- 22. Lab. No. 1. Dolomite, dense; about 30 ft above bottom of formation.
- 23. Lab. No. 2. Dolomite, fine-grained, crystalline; 35 ft below top of formation.
- 24. Lab. No. 3. Dolomite, medium-grained, crystalline; about 30 ft below top of formation.

25. Eagle County. Pennsylvanian(?), Minturn formation (Q. D. Singewald, written communication, 1956) reported as Robinson limestone, upper bed. T. 7 S., R. 79 W., (Q. D. Singewald, written communication, 1956). Robinson mine, town of Robinson, Tenmile district. Analyst, Hillebrand. Lab. No. 20. (Emmons, 1886, p. 598, 69, 279, 646.) Limestone. Similar in appearance to lithographic limestone. General description of upper bed: Light, fine-grained, compact; conchoidal fracture.

26. El Paso County. Lower Ordovician, Manitou(?) limestone (A. H. Koschmann, written communication, 1956). (T. 14 S., R. 67 W.), Quarry Canyon near town of Manitou. Analyst, Erickson; collector, Heald. Lab. No. C-304. (Wells, 1937, p. 51.) Limestone.

27. El Paso County. Manitou(?) limestone (G. R. Scott, written communication, 1956). Town of Manitou, U. S. Lime Company quarry. (Burchard, 1912, p. 661.) Limestone. Use: Flux, lime.

28. El Paso County. (Recent. T. 14 S., R. 67 W.), Soda Springs, 3 miles above Colorado City. (Hayden, 1873, p. 146.) Spring deposit.

29-30. Fremont County. Probably Leadville limestone (M. G. Dings, written communication, 1956). Colorado Fuel and Iron Company quarry. (Burchard, 1912, p. 661.) Limestone. Use: Flux.
- 29. (T. 48 N., R. 10 E.) town of Calcite.
- 30. (T. 49 N., R. 10 E.) town of Howard.

31. Fremont County. Probably Niobrara formation, Timpas limestone member (Ogden Tweto, written communication, 1956). (T. 18 S., R. 70 W.), Canon City. Analyst, Iles. Lab. No. 20. (Emmons, 1886, p. 646.) Limestone. Possible use: Flux.

32-36. Garfield County. Leadville limestone. (T. 6 S., R. 88 W.) town of Glenwood Springs. Limestone.
- 32. Near Yampa Spring. Lab. No. 1. (Spurr, 1898, p. 214.) Blue, fresh; apparently unaltered.
- 33. Near Yampa Spring. Lab. No. 2. (Spurr, 1898, p. 214.)
- 34. Near Cloud Cave. Lab. No. 2. (Spurr, 1898, p. 214.)
- 35. In Cloud Cave. Lab. No. 1. (Spurr, 1898, p. 214.) Blue, altered.
- 36. Lab. No. 2. (Spurr, 1898, p. 215.) Blue, hard, unaltered, close-jointed.

37-39. Gunnison County. Leadville limestone, Yule marble. (T. 12 S., R. 87 W.), 4 miles southeast of town of Marble. Use: Building stone.
- 37. (Argall, 1949, p. 281, 282.) Limestone, white, crystalline. Bulk density, 2.711. Physical tests.
- 38. (Argall, 1949, p. 281, 282.) Limestone, white, streaked, crystalline. Bulk density, 2.711. Physical tests.
- 39. Colorado Yule Marble Company quarry. (Burchard, 1912, p. 661; Vanderwilt and others, 1947, p. 246, 247, pl. 5.) Limestone, predominantly white, gray and yellow banding, medium-grained; 240 ft thick, chert bands limit production to 40 ft. Index map.

Footnotes of analyses on preceding page:

1 Calculated from reported $FeCO_3$, $MgCO_3$, $CaCO_3$, $CaSO_4$, or $BaSO_4$.
2 H_2O+, above 100° C.; H_2O-, at 100° C.
3 Includes sand.
4 Reported as the carbonate.
5 Includes $FeCO_3$ and $MnCO_3$.
6 Includes 0.03 percent not carbonate.
7 H_2O+, above 110° C.; H_2O-, below 110° C.
8 Reported as a little.
9 By difference, not included in total.
10 Reported as "Mn_2O_3 (Mn_3O_4?)." Manganese estimated on 34 grams. Sample also showed minute traces of Pb, Cu, Ni, Co, Zn, and a doubtful trace of Sb.
11 Reported as S, pyrite.
12 Reported as faint trace.
13 Includes ignition loss.
14 Includes H_2O.
15 Reported as $MnCO_3$. MnO_2 reported as 0.00 percent.
16 Calculated from reported $MnCO_3$, includes 0.06 percent MnO_2.
17 Reported as sulfate of lime, chloride of calcium, and chloride of magnesia (probably determined by difference).
18 Reported as S.

TABLE 15.—Analyses of samples from Colorado containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Colorado										
	40	41	42	43	44	45	46	47	48	49	50
	$5F_226$-7	$5F_230$-50	$5F_230$-52	$5F_230$-49	$5F_230$-51	$5F_230$-53	$5F_233$-6	$5F_233$-10	$5F_233$-14	$5F_233$-15	$5F_233$-16
SiO_2	1.44	[1] 4.50	[1] 8.10	[1] 5.00	[1] 6.80	[1] 5.32	......	0.76	2.50	2.80	4.22
Al_2O_3	[2] .13	([3])	([3])	([3])	([3])	.53	......	1.65	6.13	2.50	3.53
Fe_2O_3	}					.38	......	}			
FeO	......	......	......	......	......	......	......	[4] None	[4] None	[4] None	[5] 3.86
MgO	Tr.	.90	15.30	1.20	17.50	2.95	[5] 20.65	[5] 18.95	[5] 19.01	[5] 18.81	[5] 17.72
CaO	[5] 55.00	52.40	32.50	50.80	31.50	48.73	[5] 30.64	[5] 32.47	[5] 28.91	[5] 31.01	[5] 27.77
P_2O_5	......	......	......	......	......	.032	......	......	......	......	......
CO_2	......	......	......	......	......	41.71	......	......	......	......	......
MnO	......	([3])	([3])	([3])	([3])	.49	......	......	......	......	......
Organic matter	......	......	......	......	......	[6] .11	......	None	None	None	None
Total	56.57	57.80	55.90	57.00	55.80	100.25	51.29	53.83	56.55	55.12	57.10
Class	1,0,98	(5,0)95	(8,0)90	(5,0)93	(7,0)93	(4,2)93	0,0,98	0,1,97	0,4,91	0,5,94	0,7,87
CaO/MgO	calcite	calcite	calcareous dolomite	calcite	calcareous dolomite	magnesian calcite	dolomite	calcareous dolomite	dolomite	dolomite	dolomite

	51	52	53	54	55	56	57	58	59	60
	$5F_233$-17	$5F_233$-11	$5F_233$-12	$5F_233$-13	$5F_233$-8		$5F_233$-9	$5F_233$-18		$5F_234$-2
SiO_2	7.76	0.21	0.27	0.70	0.04	0.19	0.34	1.78	60.00	0.24
Al_2O_3	.11	.27	.04	.17	.06	.15	.22	......	16.	.13
Fe_2O_3	.10	.21	.22	.11	.00	......	.09	......	4.	.08
FeO	.57	.24	.13	.38	.27	......	.71	1.84	......	......
MgO	20.05	21.14	21.52	20.78	21.23	......	21.32	19.85	......	.19
CaO	27.26	30.79	29.97	30.43	30.64	......	29.84	29.83	None	55.87
Na_2O	.037	.062	.016	.094	......	.11	.59	.08	......	......
K_2O	.017	.03	.013	.046	......	}	Tr.	......	3.	.08
H_2O+	.05	.22	.07	.04	.18	......	.32	......	8.	......
H_2O-	}				.00	......	.15	.09	}	[7] .07
TiO_2	......	......	......	......	......	.00	.00	......	None	......
P_2O_5	.07	Tr.	.03	.12	Tr.	......	Tr.	.06	......	......
CO_2	43.79	46.84	47.39	46.93	46.88	......	45.18	46.18	......	[8] 43.47
MnO	.06	Tr.	.20	.05	Tr.	......	.19	.28	......	.05
SO_3	Tr.	Tr.	......	......	.03	......	......	......	......	.10
FeS_2	Tr.	Tr.	......	Tr.	......	.00	.35	......	2.	......
SrO	......	......	......	......	......	......	......	None	......	......
BaO	......	......	......	......	......	......	......	None	......	......
Cl	.062	.10	.041	.143	.08	......	Tr.	.09	......	......
Organic matter	.07	.03	.015	.025	......	.26	[9] .17	......	5.	......
Total	100.01	100.14	99.93	100.02	[10] 100.12	......	99.47	[11] 100.06	......	100.28
Class	7,1,91	0,1,98	0,1,99	0,1,98	0,0,98	......	0,1,95	2,0,96	......	0,1,99
CaO/MgO	dolomite	dolomite	dolomite	dolomite	dolomite	......	dolomite	dolomite	......	calcite

	61	62	63	64	65	66	67	68	69	70
	$5F_235$-17	$5F_235$-18	$5F_247$-7	$5F_247$-8	$5F_247$-9	$5F_247$-13	$5F_247$-14	$5F_247$-10	$5F_247$-11	$5F_247$-12
SiO_2	5.33	5.97	[1] 0.51	[1] 1.98	[1] 2.37	......	......	......	......	0.68
Al_2O_3	1.54	1.74	......	......	......	......	......	......	......	.52
Fe_2O_3	.23	.18	......	......	......	......	......	......	......	.43
FeO	.48	.64	[12] .10	[12] .46	[12] .19	......	......	......	......	......
MgO	.56	.75	.17	20.47	.73	[13] 20.02	[13] 21.19	[13] 20.90	[13] 20.95	.72
CaO	50.69	49.82	55.50	30.19	53.64	[5] 31.82	[5] 30.42	[5] 30.20	[5] 30.44	54.4
Na_2O	.05	.16	......	......	......	......	......	......	......	......
K_2O	.21	.34	......	......	......	......	......	......	......	......
H_2O+	[7] .51	[7] .07	......	......	.51	......	......	......	......	......
H_2O-	[7] .12	[7] .17	......	......	}					
CO_2	39.90	39.84	......	......	......	......	......	......	......	42.90
SO_3	......	Tr.	......	......	......	......	......	......	......	......
Cl	......	......	......	......	......	Tr.	Tr.	......	Tr.	......
Organic matter	.44	.43	......	......	......	......	......	......	......	.40
Total	100.06	100.11	56.28	53.10	57.44	51.84	51.61	51.10	51.39	100.0
Class	2,6,91	3,6,90	(1,0)99	(2,0)97	(2,1)96	0,0,99	0,0,99	0,0,98	0,0,98	0,1,97
CaO/MgO	calcite	calcite	calcite	dolomite	calcite	dolomite	dolomite	dolomite	dolomite	calcite

[1] Reported as insoluble.
[2] Reported as oxide of iron and alumina.
[3] Minor amounts of Fe_2O_3, Al_2O_3, and Mn_2O_3; percentages range from 0.33-2.90. Iron and aluminum oxides generally in slight excess of manganese oxide.
[4] Reported as $FeCO_3$.
[5] Calculated from reported $FeCO_3$, $MgCO_3$, or $CaCO_3$.
[6] Reported as H_2O.
[7] H_2O+, above 100° C.; H_2O-, at 100° C.
[8] Reported as ignition loss, includes CO_2.
[9] Approximate figure.
[10] Includes 0.71 percent insoluble in HCl, see sample 56 for analysis of the insoluble.
[11] Total 100.08, less O=Cl, 0.02 percent.
[12] Reported as FeO and MnO.
[13] Calculated from reported $MgCO_3$; $MgCO_3$ includes $FeCO_3$ and $MnCO_3$.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

40. Gunnison County. Lower Mississippian, probably Leadville limestone, T. 14 S., R. 85 W.,(J. C. Olson, written communication, 1956), 1.5 miles from Denver and Rio Grande railroad. Analyst, Chauvenet. (Chauvenet, 1888, p. 21.) Limestone. Possible use: Flux.

41-43. Jefferson County. Triassic(?) and probably Permian, Lykins formation, Glennon limestone member. Center sec. 12, T. 5 S., R. 70 W. Analyst, Aller. (LeRoy, 1946, p. 39, 12, 14, 17, 36, 37.) Index map; detailed measured sections, generalized and correlated columnar sections. Use: Lower part extensively quarried.

41. Lab. No. LW-6. Limestone, pink to gray, interlaminated, hard, brittle, massive, finely crystalline; 2 ft thick, 12 ft from top of member.

42. Lab. No. LW-3. Limestone, pink to gray, regularly laminated; 2 ft thick, 8 in. from top of member.

43. Lab. No. LW-4. Limestone, gray to pink, coarsely crystalline, vuggy, irregularly laminated; 8 in. thick; at top of member.

44. Jefferson County. Lykins formation, Glennon limestone member. NW¼ sec. 12, T. 5 S., R. 70 W. Lab. No. LR-14. (LeRoy, 1946, p. 40, 12, 14, 17, 35, 36, 41.) Limestone, gray, some brown chert inclusions. Massive to finely laminated, medium to finely crystalline; many small vugs lined with quartz crystals; about 4 ft thick, 16 ft from top of formation. Index map; detailed measured section, generalized and correlated columnar sections. Use: Lower part extensively quarried.

45. Jefferson County. (Lykins formation) reported as Wyoming formation, upper division. (T. 5 S., R. 70 W.) town of Morrison. Analyst, Eakins. (Emmons and others, 1896, p. 55, 52, 54, pls. 1-3.) Limestone, from bed 5 ft thick. Geologic maps, detailed measured section.

46. Lake County. (Leadville limestone) reported as Blue limestone. (About T. 9 S., R. 80 W.) (Emmons, 1886, p. 64.) Dolomite, average of six analyses, from different localities.

47-50. Lake County. (Leadville limestone) reported as Blue limestone. (T. 9 S., R. 80 W.), Carbonate Hill. Analyst, Iles. (Emmons, 1886, p. 646.) Dolomite. Use: Flux.

47. Carbonate mine. Lab. No. 17.

48. Glass-Pendery mine. Lab. No. 18.

49. Glass-Pendery mine. Lab. No. 19.

50. Glass mine. Lab. No. 16.

51-54. Lake County. (Leadville limestone) reported as Blue limestone. (T. 9 S., R. 80 W.), Leadville district. (Emmons, 1886, p. 65, 450, 596, 598, 643.)

51. Near base of formation Montgomery quarry, Iron Hill. Analyst, Guyard. Dolomite, composite sample. Use: Flux.

52. Upper part of formation. Silver Wave mine, Iron Hill. Analyst, Hillebrand. Lab. No. 8. (Dolomite) dolomitic limestone.

53. Upper part of formation. Glass-Pendery mine, Carbonate Hill. Analyst, Guyard. Dolomite, composite sample. Use: Flux.

54. Upper part of formation. Dugan quarry, near Mount Zion, Arkansas Valley. Analyst, Guyard. Dolomite. Use: Flux.

55. Lake County. Leadville limestone. (T. 9 S., R. 80 W.) quarry in south end of Iron Hill. Analyst, Fairchild. (Emmons and others, 1927, p. 35, pls. 2, 8, 33, 34, 38.) (Dolomite) unweathered, unaltered. Mineralogy. Analysis of material soluble in 1:3 HCl. Index map, geologic maps, generalized columnar section, correlated columnar sections.

56. Analysis of material insoluble in 1:3 HCl. (For analysis of soluble material see sample 55 above.)

Colorado--Continued

57. Lake County. Probably Leadville limestone, possibly Upper Devonian, Chaffee formation, Dyer dolomite member (Ogden Tweto, written communication, 1956). (Sec. 30, T. 9 S., R. 79 W.) from dump of Stephens mine. Analyst, Fairchild. (Emmons and others, 1927, p. 35, pls. 2, 8, 33, 34, 38.) Dolomite. Bulk density, hand specimen, 2.774; powder, 2.865. Calculated porosity by volume, 0.0319 percent. Mineralogy. Index map, geologic maps; generalized columnar section, correlated columnar sections.

58. Lake County. Pennsylvanian, Minturn formation (Ogden Tweto, written communication, 1956) reported as Weber(?) formation. (T. 9 S., R. 80 W., east of town of Leadville) west of gap between Little Ellen Hill and West Dyer Mtn. Analyst, Fairchild. Collector, Behre. Lab. No. D-163. (Wells, 1937, p. 51; Behre, 1953, p. 39, 5, 6, 26, 30, pls. 1, 2, 4, 10.) Dolomite, blue-gray, granular. Insoluble, claylike. Index maps, geologic maps; generalized columnar section, correlated columnar sections; geologic cross sections.

59. Analysis of insoluble of sample 58. Approximate percentages. (Behre, 1953, p. 39.)

60. La Plata County. Probably Leadville limestone, SW¼ sec. 12, T. 37 N., R. 9 W., (N. W. Bass, written communication, 1956). Rockwood quarry, town of Rockwood. Analyst, Bates. (Shaler and Gardner, 1907, p. 298.) Limestone. Possible use: Portland cement.

61-62. Larimer County. Upper Cretaceous, Niobrara limestone, basal bed. (Martin, 1909, p. 324, 315, 320, 321, 324, 326.) Composite sample from outcrop. Index and outcrop map. Possible use: Cement material.

61. SW¼ sec. 35, T. 4 N., R. 70 W., northwest of town of Longmont. Analysts, Brobst and Bates. Lab. No. 163. Limestone, white, massive; 14 ft thick.

62. SE¼ sec. 20, T. 7 N., R. 69 W., southwest of town of Fort Collins. Analysts, Phillips, Brobst, and Bates. Lab. No. 166. Limestone; contains thin shale beds; about 16 ft thick.

63-65. Park County. (Leadville limestone.) Analyst, Hillebrand.

63. (T. 8 S., R. 77 W.), Mount Silverheels, near town of Fairplay. (Clarke, 1900, p. 272; Eckel, 1913, p. 127.) Limestone. Possible use: Cement material.

64. (T. 8 S., R. 77 W.), Mount Silverheels, near Fairplay. (Clarke, 1900, p. 272.) (Dolomite.)

65. (Secs. 33 and 34, T. 9 S., R. 77 W.), Fairplay. (Clarke, 1900, p. 272; Eckel, 1913, p. 127.) Limestone. Possible use: Cement material.

66-67. Park County. (Leadville limestone) reported as Blue limestone. (T. 9 S., R. 79 W.) Analyst, Hillebrand. (Emmons, 1886, p. 598, 530.) (Dolomite.)

66. Ridge south of Sacramento mine. Lab. No. 12.

67. Sacramento mine, Spring Valley. Lab. No. 13.

68-69. Park County. (Minturn formation) reported as Weber grits. Analyst, Hillebrand. (Emmons, 1886, p. 598.) (Dolomite.)

68. Beaver Creek, west base of Mount Silverheels. Lab. No. 18.

69. Ridge west of Mount Silverheels. Lab. No. 16.

70. Park County. Oligocene, Antero formation. Tps. 10, 11 S., Rs. 74, 75 W., and Tps. 12-16 S., Rs. 75, 76 W., South Park. Analyst, Schroder. (Johnson, 1937, p. 1229, 1228, 1234, 1235.) Algal limestone, pale yellowish-white to rich brown; weathers gray to white; fragment of algal colony. Description of organism which built colonies. (For other analyses of algal limestone in Colorado, see sample 16 of this group, sample 8 group A, sample 94 group B, samples 1 and 3 group C, and samples 7 and 20 group F_1 of this compilation.)

TABLE 15.—Analyses of samples from Colorado containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Colorado										
	71	72	73	74	75	76	77	78	79	80	81
	$5F_249$-3	$5F_249$-4	$5F_249$-5	$5F_249$-6	$5F_249$-7	$5F_249$-8	$5F_249$-18	$5F_249$-19	$5F_249$-17	$5F_249$-15	$5F_249$-20
SiO_2	......	......	......	......	......	......	1.21	1.29	1.02	0.75	[1] 4.13
Al_2O_3	......	......	......	......	......	......	......	......	......	} 1.00	......
Fe_2O_3	......	......	......	......	......	......	......	......	2.10		} Tr.
FeO	......	......	......	......	......	......	1.46	None	.06	......	
MgO	16.21	17.72	20.80	20.40	20.60	19.20	18.42	.05	16.76	[2] .45	[2] .59
CaO	35.2	32.5	30.2	30.9	31.	31.3	32.08	54.45	33.74	[2] 53.42	[2] 53.02
CO_2	......	......	......	......	......	......	46.32	42.99	......	......	......
MnO	......	......	......	......	......	......	.21	.29	......	......	......
Total	51.4	50.2	51.0	51.3	52.	50.5	99.70	99.07	53.68	55.62	57.74
Class	0, 0, 97	0, 0, 95	0, 0, 97	0, 0, 98	0, 0, 98	0, 0, 96	1, 0, 96	1, 0, 97	0, 2, 95	0, 1, 96	(4, 0)96
CaO/MgO	calcareous dolomite	calcareous dolomite	dolomite	dolomite	dolomite	dolomite	calcareous dolomite	calcite	calcareous dolomite	calcite	calcite

	82	83	84	85	86	87	88	89	90	91	92
	$5F_249$-13	$5F_249$-14	$5F_249$-16	$5F_249$-9	$5F_249$-10	$5F_249$-11	$5F_249$-12	$5F_250$-2	$5F_251$-65	$5F_251$-64	$5F_251$-66
Insoluble	0.33	0.52	0.84	0.16	0.80	1.42	7.78	[3] 4.36	[3] 4.08	3.64	[3] 5.56
Al_2O_3	......	......	......	......	......	......	......	} 1.88	2.44	1.40	{ ......
Fe_2O_3	Tr.	.88	1.31	.22	1.63	3.34	.88				.89
FeO	......	......	......	.09	.23	.42	.22	......	......	......	......
MgO	.16	20.64	20.90	20.94	19.69	18.06	9.97	.34	.57	Tr.	......
CaO	55.81	31.16	30.46	30.66	31.19	31.61	38.85	51.71	51.60	[2] 52.62	[2] 51.11
P_2O_5	......	......	......	......	......	......	......	Tr.	[2] .80	......	......
CO_2	......	......	......	......	......	......	......	41.40	[4] 41.00	......	......
S	......	......	......	......	......	......	......	......	.056	......	......
Total	56.30	53.20	53.51	52.07	53.54	54.85	57.70	99.69	100.55	57.66	57.56
Class	(0, 0)99	(0, 1)98	(0, 2)97	(0, 0)99	(0, 2)97	(0, 3)94	(7, 2)90	1, 5, 93	0, 7, 93	(1, 4)94	5, 2, 91
CaO/MgO	calcite	dolomite	dolomite	dolomite	dolomite	calcareous dolomite	calcareous dolomite	calcite	calcite	calcite	calcite

	93	94	95	96	97	98	99	100	101	102
	$5F_259$-5	$5F_259$-12	$5F_259$-6	$5F_259$-8	$5F_259$-10	$5F_259$-13	$5F_259$-7	$5F_259$-11	$5F_259$-14	$5F_259$-9
Insoluble	......	2.69	0.36	0.82	2.04	4.42	0.78	2.68	6.75	1.37
FeO+MnO	......	.21	.17	.07	.15	.10	1.50	1.52	3.08	.20
MgO	[2] [5] .17	.21	.37	.22	.25	.40	20.15	18.27	18.15	.28
CaO	[2] 54.64	54.23	55.58	55.47	54.62	52.97	30.55	31.60	28.05	55.17
Total	54.81	57.34	56.48	56.58	57.06	57.89	52.98	54.07	56.03	57.02
Class	0, 0, 98	(3, 0)97	(0, 0)99	(1, 0)99	(2, 0)98	(4, 0)95	(1, 0)97	(3, 0)95	(7, 0)88	(1, 0)98
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	calcareous dolomite	dolomite	calcite

[1] Reported as insoluble residue of organic matter by Lakes (1887, p. 67).
[2] Calculated from reported $MgCO_3$, $CaCO_3$, or P.
[3] Reported as SiO_2.
[4] Includes H_2O.
[5] Includes $FeCO_3$ and $MnCO_3$.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

71-76. Pitkin County. Upper Devonian, Chaffee formation, Dyer dolomite member; probably T. 10 S., R. 85 W., (Ogden Tweto, written communication, 1956), Aspen district. (Spurr, 1898, p. 25.) Dolomite.

77-78. Pitkin County. Upper Devonian or Lower Mississippian, probably Leadville limestone, possibly Chaffee formation, Dyer dolomite member (P. C. Patton, written communication, 1957). (T. 10 S., R. 84 W.) town of Aspen. Analyst, Fairchild. Collector, Hewett. (Wells, 1937, p. 51.)
- 77. Lab. No. C-1038. (Dolomite) reported as limestone, altered.
- 78. Limestone.

79. Pitkin County. Lower Mississippian, Leadville limestone. Top of Aspen Mountain. Lab. No. 2. (Spurr, 1898, p. 210, 208.) Dolomite, from main fault zone. Microscopic description.

80-81. Pitkin County. (Leadville limestone) reported as Blue limestone. Aspen Mountain. (Lakes, 1887, p. 67, 60, 66; Eckel, 1913, p. 127.) Limestone. General description of bed: Bluish-gray, compact, heavy bedded; contains concretions; 60-120 ft thick. Detailed measured section, generalized geologic cross section.
- 80. Analyst, Bardwell.
- 81. Analysts, Reese and Richards.

Colorado--Continued

82-84. Pitkin County. (Leadville limestone. T. 10 S., R. 84 W.) near town of Aspen. Analyst, Eakins. (Clarke, 1900, p. 273.)
- 82. (Eckel, 1913, p. 127.) Limestone. Possible use: Cement material.
- 83. Limestone, blue.
- 84. (Spurr, 1898, p. 25.) Dolomite.

85-87. Pitkin County. (Leadville limestone. T. 10 S., R. 84 W.) near town of Aspen. Analyst, Steiger. Lab. No. 1559. (Clarke, 1900, p. 272.) Dolomite.

88. Pitkin County. (Leadville limestone. T. 10 S., R. 84 W.) near town of Aspen. Analyst, Steiger. Lab. No. 1559. (Spurr, 1898, p. 210; Clarke, 1900, p. 272.) Dolomite from top of Aspen Mountain; partially altered. Microscopic description.

89. Prowers County. Upper Cretaceous, Timpas limestone. (T. 23 S., R. 44 W.), town of Granada. Analyst, Wheeler. Lab. No. 2974. (Wells, 1937, p. 51.) Limestone.

90-91. Pueblo County. Timpas limestone (K. M. Waagé, written communication, 1956). (Burchard, 1912, p. 661.) Limestone. Use: Lime, flux.
- 90. (T. 20 S., R. 65 W.) town of Lime, Colorado Fuel and Iron Co. quarry.
- 91. (T. 21 S., R. 66 W.) town of Livesey, Pueblo Lime and Quarrying Co.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

92. Pueblo County. Upper Cretaceous, probably limestone in Apishapa shale, (K. M. Waagé, written communication, 1956). (T. 21 S., R. 65 W.), town of Pueblo, Pueblo Lime and Quarrying Company. (Burchard, 1912, p. 661.) Limestone. Use: Lime, flux.

93. Summit County. Pennsylvanian, Minturn formation or Permian, Jacque Mountain(?) limestone member (Q. D. Singewald, written communication, 1956). (T. 7 S., R. 79 W.), Jacque Mountain, near summit. Analyst, Hillebrand. Lab. No. 23. (Emmons, 1886, p. 598) Limestone, conchoidal fracture.

94-98. Summit County. Minturn formation (A. H. Koschmann, written communication, 1956). Tenmile district. Analyst, Hillebrand. (Clarke, 1900, p.274; Eckel, 1913, p. 127.) Limestone. Manganese and iron present as carbonates but Fe_2O_3 and Al_2O_3 were not separated from them (Clarke, 1900, p.274). Possible use: Cement material.

94. T. 7 S., R. 78 W., (A. H. Koschmann, written communication, 1956), Fletcher shaft, Copper Mountain.

Colorado--Continued

95. (T. 7 S., R. 79 W.) quarry on southeast side of Searls Gulch.
96. (T. 7 S., R. 79 W.) below Sabbath Rest tunnel, Elk Mountain.
97. (T. 7 S., R. 79 W.) Jacque Mountain.
98. Robinson limestone member (Ogden Tweto, written communication, 1956). (T. 7 S., R. 79 W.) hill north of Sugar Loaf.

99-102. Summit County. Minturn formation (A. H. Koschmann, written communication, 1956). Tenmile district. Analyst, Hillebrand. (Clarke, 1900, p. 274.) Manganese and iron present as carbonates but Fe_2O_3 and Al_2O_3 were not separated from them.

99. (T. 7 S., R. 79 W.), Sheep Mountain. Dolomite.

100. (T. 7 S., R. 79 W.), Blackbird tunnel, Tucker Mountain. Dolomite.

101. Summit City, Summit King shaft. (Dolomitic limestone.)

102. Elk Ridge limestone member, T. 6 S., R. 79 W., (Ogden Tweto, written commnnication, 1956). Limestone, oolitic.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category

[Chemical analyses arranged by county and stratigraphic position]

	Kansas										
	1	2	3	4	5		1	2	3	4	5
	$15F_21$-4	$15F_21$-6	$15F_21$-5	$15F_21$-7	$15F_21$-10						
SiO_2	3.59	5.03	2.95	7.10	2.59	P_2O_5	0.04	0.04	Tr.	0.03	0.10
Al_2O_3[1]	.74	.28	.31	.46	.54	SO_3	Tr.	Tr.	Tr.	Tr.	Nil
Fe_2O_3[2]	.40	.51	.79	.44	1.04	S	Tr.	......	......	......	[3] (.19)
MgO	.48	.34	.81	.64	.55	Ignition loss[4]	41.79	41.20	42.06	40.32	42.13
CaO	52.78	52.16	52.44	50.51	52.68	Total	99.94	99.56	99.36	99.50	99.63
Na_2O	.05	......	......	......	......	Class	2,3,94	4,2,93	2,3,95	6,2,91	0,4,95
K_2O	.07	......	......	......	......	CaO/MgO	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. For all samples, Zn, Mo, Sn, and Ba not present in detectable amounts]

	1	2	3	4	5		1	2	3	4	5
B	–	–	–	0.0015	–	Ni	0.0005	0.0005	0.001	0.0005	0.0005
Ti	0.01	0.001	0.009	.04	0.02	Cu	.000025	.00003	.000025	.000025	.000025
V	.0025	.0025	.001	–	.001	Sr	–	–	.035	–	–
Cr	–	–	.0003	–	.001	Ag	–	–	.0001	.00001	.0001
Mn	.007	.04	.03	.025	.035	Pb	–	.0005	.0005	.001	.0005

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[2] Total iron.
[3] Not included in total, included in ignition loss.
[4] 105° - 1,000° C.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

1-5. Allen County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

1. Swope limestone, Bethany Falls limestone member. SE¼ sec. 15, T. 26 S., R. 21 E. Lab. No. 52313. (Runnels and Schleicher, 1956, pl. 3, table 26, p. 86, 97.) Limestone, 8 ft thick.
2. Dennis limestone, Winterset limestone member. SE¼SE¼ sec. 21, T. 23 S., R. 21 E. Lab. No. 52359. (Runnels and Schleicher, 1956, pl. 3, table 25, p. 86, 97.) Limestone, 9.5 ft thick. (See also Ives, 1955, p. 32, 39. Lab. No. O23. Limestone, fossiliferous. Outcrop sample; mineralogy. No footnote given for Al_2O_3 or Fe_2O_3, ignition loss at 1,000° C., sample dried at 105° C.)

Kansas--Continued

3. Dennis limestone, Winterset limestone member. SW¼ sec. 33, T. 25 S., R. 21 E. Lab. No. 52353. (Runnels and Schleicher, 1956, pl. 3, table 25, p. 86, 97.) Limestone, 13 ft thick.

4. Dennis limestone, Winterset limestone member. SE¼ sec. 9, T. 26 S., R. 20 E. Lab. No. 52310. (Runnels and Schleicher, 1956, pl. 3, table 25, p. 86, 97.) Limestone, 22 ft thick.

5. Drum limestone, Corbin City limestone member. SE¼ sec. 33, T. 26 S., R. 18 E. Lab. No. 52349. (Runnels and Schleicher, 1956, pl. 3, table 23, p. 86, 97.) Limestone, 3 ft thick.

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	6	7	8	9	10	11	12	13	14	15	16	17	18
	$15F_21$-8	$15F_21$-9	$15F_21$-18	$15F_21$-11	$15F_21$-19	$15F_21$-15	$15F_21$-21	$15F_21$-22	$15F_21$-17	$15F_21$-16	$15F_21$-12	$15F_21$-13	$15F_21$-14
SiO_2	1.12	2.09	2.08	0.70	2.24	1.22	[1] 2.75	[1] 3.79	[1] 1.99	[1] 1.53	[2] 0.86	1.1	1.19
Al_2O_3	[3] .33	[3] .30	[3] .56	[3] .25	[3] .55	[3] .74	5.91	1.07	1.21	1.75	......	1.8	.95
Fe_2O_3	[4] 1.34	[4] .78	[4] 1.17	[4] .94	[4] 1.24	[4] 1.42					.29		1.28
MgO	1.75	.40	1.58	1.40	1.79	2.00	......	[5] .48	[5] .53	[5] 1.30	[5] .51	2.0	1.36
CaO	52.90	53.72	52.02	52.97	51.77	51.96	[5] 50.99	[5] 52.21	[5] 53.33	[5] 52.73	[5] 54.87	51.7	53.13
H_2O	......	......	......	......	......	......	......	......	......	......	.04	......	......
P_2O_5	Tr.	.01	.01	.02	Nil	.02	......	......	......	......	......	......	......
CO_2	......	......	......	......	......	......	......	......	......	......	[6] (42.76)	[7] 43.3	[7] 42.66
S	Tr.	Nil	[8] (.07)	[8] (.15)	[8] (.06)	[8] (.03)	......	......	......	......	......	......	......
SO_3	Tr.	Nil	Tr.	.11	.04	.07	.14	.20	......	......	......	......	......
Ignition loss [9]	42.69	42.61	42.32	42.96	42.33	42.51	......	......	......	......	......	......	......
Total	100.13	99.91	99.74	99.35	99.96	99.94	59.79	57.75	57.06	57.31	56.57	99.9	100.57
Class	0,2,96	1,3,96	0,4,95	0,1,97	0,4,95	0,2,95	(0,5)91	(2,3)91	(0,3)96	(0,3)96	(1,1)99	0,2,97	0,2,96
CaO/MgO	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite

	19	20	21	22	23	24	25	26	27	28	29	30	31
	$15F_21$-24	$15F_21$-25	$15F_22$-1	$15F_22$-4	$15F_22$-3	$15F_22$-2	$15F_22$-8	$15F_22$-10	$15F_22$-6	$15F_22$-5	$15F_22$-9	$15F_23$-5	$15F_23$-6
SiO_2	1.06	4.95	3.89	1.26	0.99	0.68	2.23	5.43	[10] 1.18	[10] 0.61	[10] 4.30	3.69	3.52
Al_2O_3	[3] .30	[3] 1.42	[3] .88	[3] .67	[3] .58	[3] .64	[3] .53	[3] 1.47	3.09	[11] 1.51	.81	[3] 2.03	[3] .92
Fe_2O_3	[4] 1.37	[4] .89	[4] .85	[4] .94	[4] .71	[4] .49	[4] 1.06	[4] 1.21				[4] 5.50	[4] 1.78
MgO	.51	1.21	.26	.24	1.19	.43	.96	2.08	[5] 1.26	[5] .15	[5] .45	3.03	.70
CaO	52.98	50.27	52.35	53.20	53.37	55.06	53.04	49.06	[5] 51.94	[5] 54.52	[5] 51.97	45.96	51.24
Na_2O	......	......	.05	......	......	......	......	......	......	......	......	......	......
K_2O	......	......	.08	......	......	......	......	......	......	......	......	......	......
H_2O-	......	......	......	......	......	......	......	......	......	......	.43	......	......
P_2O_5	Tr.	.03	Tr.	......	.04	Tr.	Tr.	.05	......	......	......	Tr.	.05
S	Nil	[8] (.08)	Tr.	......	[8] (.05)	......	Nil	[8] (.18)	......	......	......	......	......
SO_3	Nil	Tr.	Tr.	......	.01	Nil	Nil	Tr.	......	.43	.23	Nil	Tr.
Ignition loss [9]	42.89	40.58	41.11	42.73	43.24	43.00	42.32	40.46	......	......	......	39.59	41.61
Total	99.11	[12] 99.35	[13] 99.47	99.04	100.13	100.30	100.14	[14] 99.76	57.47	[15] 57.22	58.19	99.80	99.82
Class	0,3,96	1,6,91	1,5,92	0,3,95	0,2,97	0,1,97	0,4,95	1,7,90	(0,2)95	(0,1)97	(3,3)94	0,7,87	0,7,93
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	magnesian calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Sn looked for in all samples but not detected]

	6	7	8	9	10	11	19	20	21	23	24	25	26	31
B	–	–	–	–	–	–	–	–	0.0005	–	–	–	–	0.00005
Ti	0.02	0.001	Tr.	0.025	0.015	Tr.	0.01	0.02	.06	0.01	0.002	0.007	0.04	.025
V	.01	.01	0.01	.002	.015	0.004	.025	.005	.0025	.005	.0044	.0025	.002	.0036
Cr	–	–	–	.008	.0005	–	.002	.0005	.0003	.0003	.0003	–	–	.0003
Mn	.05	.03	.05	.054	.12	.05	.20	.015	.05	.01	.067	.05	.07	.12
Ni	.0005	.0005	.001	.003	.001	.002	.0005	.0015	.001	.0005	.003	.0005	.001	.005
Cu	.000025	.000025	.00003	.00002	.00004	.00002	.000025	.00004	.000015	.000025	.00002	.000013	.00004	.000025
Zn	–	–	–	–	–	–	–	–	–	–	.02	–	–	.0005
Sr	–	–	–	–	–	–	.048	.056	–	–	–	–	–	.06
Mo	–	–	–	–	–	–	–	–	–	–	.00002	–	–	.0005
Ag	–	–	–	.00005	.00005	–	–	–	–	–	.00005	–	–	.00004
Ba	.02	–	–	–	–	–	–	.02	–	.01	–	–	–	.015
Pb	.003	.001	–	–	–	–	–	–	.0005	–	.0004	.001	–	.0003

[1] Reported as insoluble residue.
[2] Sand and clay (Clarke, 1891, p. 124; Hay, 1893, p. 145); $SiO_2+Al_2O_3$ (Burchard, 1913, p. 186).
[3] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] Not included in total; CO_2 reported by Burchard (1913, p. 186).
[7] Includes water.
[8] Not included in total; included in ignition loss.
[9] 105°-1,000° C.
[10] Insoluble residue, also reported as SiO_2, (Haworth and Schrader, 1905, p. 509; Schrader and Haworth, 1906, p. 57).
[11] In ferrous state (Haworth, 1898, p. 79).
[12] 99.32 in text.
[13] 99.45 in text.
[14] 99.96 in text.
[15] Alumina, 0.51 percent (Haworth and Schrader, 1905, p. 509).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

6-11. Allen County. Pennsylvanian. Chips from continuous surface. Index map, résumé of spectrographic results.

6-7. Drum limestone. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.)

6. Dewey limestone member. NE¼NE¼ sec. 18, T. 26 S., R. 19 E. Lab. No. 52327. Limestone, 4.5 ft thick. (See also Ives, 1955, p. 32, 37, 38. Lab. No. O12. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3 or Fe_2O_3; sulfide sulfur as S, trace; ignition loss at 1,000° C., sample dried at 105° C.)

7. SW¼ sec. 30, T. 26 S., R. 20 E. Lab. No. 52352. Limestone, 7 ft thick.

8-11. Iola limestone, Raytown limestone member. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.)

8. NW¼SW¼ sec. 2, T. 24 S., R. 20 E. Lab. No. 52307. Limestone, 18 ft thick. (See also Ives, 1955, p. 32, 37. Stanton limestone, Captain Creek limestone member. Lab. No. O10. Outcrop sample. Mineralogy. No footnote for Al_2O_3 or Fe_2O_3; sulfide sulfur as S, 0.07 percent; ignition loss at 1,000° C., sample dried at 105° C.)

9. Sec. 2, T. 25 S., R. 18 E. Lab. No. 5197. Limestone, 40 ft thick.

10. NE¼ sec. 2, T. 25 S., R. 19 E. Lab. No. 52342. Limestone, 21 ft thick.

11. Sec. 9, T. 26 S., R. 18 E. Lab. No. 5196. Limestone, 50 ft thick.

12-15. Allen County. Iola limestone (R. T. Runnels, written communication, 1953). Analyst, under supervision of Bailey. Collector, Williston. Limestone, fossiliferous. Physical properties. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

12. Raytown limestone member (R. T. Runnels, written communication, 1953). (T. 24 S., R. 18 E.) town of Iola, Iola Marble Co. (Day, 1895, p. 505; Haworth, 1898, p. 78, 76.) Bnlk density, 2.68.

13. Raytown limestone member (R. T. Runnels, written communication, 1953). (T. 26 S., R. 18 E.) town of Humboldt. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Bulk density, 2.66.

14. Raytown limestone member (R. T. Runnels, written communication, 1953). Humboldt. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Bulk density, 2.70.

15. Humboldt. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.)

16-18. Allen County. Iola limestone. Near town of Iola. (Burchard, 1913, p. 186, pl. 7.) Limestone. Geologic map of principle limestone deposits. Use: Cement material.

16. Analyst, Stokes. (See also Clarke, 1891, p. 124. Marble, light-brown, fossiliferous.) (See also Hay, 1893, p. 145. Marble, light-colored, in massive bed 30 ft thick, no cracks or flaws. Crushing strain tests. Use: Building stone.)

17. Kansas Portland Cement Co.

18. Iola Portland Cement Co.

19-26. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

19. Allen County. Stanton limestone, Captain Creek limestone member. NW¼NW¼ sec. 20, T. 24 S., R. 18 E. Lab. No. 52305. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 6 ft thick. (See also Ives, 1955, p. 32, 37. Lab. No. O8. Limestone, outcrop sample. Mineralogy. Bulk density, average of four determinations, 2.44. No footnote for Al_2O_3 or Fe_2O_3; sulfide sulfur as S, nil; ignition loss at 1,000° C., sample dried at 105° C.)

Kansas--Continued

20. Allen County. Stanton limestone, Captain Creek limestone member. SW¼ sec. 4, T. 24 S., R. 19 E. Lab. No. 52351. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 16 ft thick.

21. Anderson County. Iola limestone, Raytown limestone member. SW¼ sec. 29, T. 21 S., R. 21 E. Lab. No. 52282. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) Limestone, 9 ft thick.

22. Anderson County. Plattsburg limestone, Merriam limestone member. SW¼ sec. 29, T. 20 S., R. 21 E. Lab. No. 48164. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86.) Limestone, 3 ft thick.

23. Anderson County. Plattsburg limestone, Spring Hill limestone member. SW¼ sec. 12, T. 20 S., R. 19 E. Lab. No. 5113. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 16 ft thick. (See also Runnels, 1951, p. 87, 85, 91, 101. Garnett Rock Co. Locality No. 1. Chemical analysis of calcined base also given. Possible use: Lime, metallurgical limestone, glass manufacture. No footnote for Fe_2O_3; Al_2O_3 contains MnO and TiO_2 if present; P_2O_5, 0.035 percent; P, 0.015 percent; total sulfur as S, 0.05 percent; sulfate sulfur as S, trace; sulfide sulfur as S, 0.05 percent; ignition loss at 1,000° C., sample dried at 105° C.)

24. Anderson Connty. Plattsburg limestone, Spring Hill limestone member. SW¼ sec. 29, T. 20 S., R. 21 E. Lab. No. 49379. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 19.3 ft thick. (See also Runnels, 1951, p. 87, 85, 91, 101. Locality No. 2. Chemical analysis of calcined base also given. Possible use: Lime, metallurgical limestone. No footnote for Fe_2O_3; Al_2O_3 contains MnO and TiO_2 if present; P_2O_5, 0.025 percent; P, 0.011 percent; total sulfur as S, 0.04 percent; sulfide sulfur as S, 0.012 percent; sulfate sulfur as S, 0.028 percent; ignition loss at 1,000° C., sample dried at 105° C.)

25. Anderson County. Stanton limestone, Stoner limestone member. SW¼ sec. 31, T. 19 S., R. 19 E. Lab. No. 52369. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 9 ft thick.

26. Anderson County. Stanton limestone, Stoner limestone member. SE¼ sec. 34, T. 20 S., R. 19 E. Lab. No. 52364. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 23 ft thick.

27-29. Anderson County. (Stanton limestone) reported as Piqua limestone, (Haworth and Schrader, 1905, p. 509). Analyst, under supervision of Bailey. Collector, Williston. Limestone, fossiliferous. Physical properties. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

27. (T. 19 S., R. 21 E.) town of Greeley. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Bulk density, 2.59.

28. (T. 20 S., R. 20 E.) town of Garnett. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Bulk density, 2.47.

29. Garnett. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Bnlk density, 2.69.

30-31. Atchison County. Pennsylvanian, Oread limestone. NW¼ sec. 13, T. 5 S., R. 21 E. (Runnels and Schleicher, 1956, table 16, pl. 2., p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results.

30. Toronto limestone member. Lab. No. 51318. Limestone, 2.8 ft thick.

31. Plattsmouth limestone member. Lab. No. 51319. Limestone, 12 ft thick.

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	32	33	34	35	36	37	38	39	40	41	42	43	44
	15$F_2$3-7	15$F_2$6-17	15$F_2$6-16	15$F_2$6-18	15$F_2$6-23	15$F_2$6-26	15$F_2$6-25	15$F_2$6-28	15$F_2$6-27	15$F_2$6-21	15$F_2$6-24	15$F_2$6-22	15$F_2$6-20
SiO_2	4.17	3.42	2.33	1.07	3.51	7.71	4.76	1.32	1.19	1.82	4.44	3.09	5.03
Al_2O_3 [1]	1.09	.41	.26	.17	.94	.29	.77	.69	.18	.44	1.12	.53	.96
Fe_2O_3 [2]	2.76	.55	.38	.39	1.45	.50	1.40	.24	.48	.42	1.08	.69	1.10
MgO	4.42	.43	.41	1.18	2.00	1.42	1.80	.74	.53	.68	1.90	.66	1.15
CaO	45.53	53.35	54.11	53.51	50.28	49.78	49.93	53.97	54.66	53.85	49.96	52.83	50.55
Na_2O	......	.04	.02	......	......	......	......	......	......	......	......	......	......
K_2O	......	.05	.03	......	......	......	......	......	......	......	......	......	......
P_2O_5	.03	.02	.04	.02	.02	.01	.01	.04	.03	.06	.03	.03	.05
S	[3] (.16)	Tr.	Tr.	......	[3] (.10)	Nil	Nil	[3] (.10)	[3] (.21)	[3] (.18)	Nil	......	[3] (.08)
SO_3	.10	Tr.	Tr.	Tr.	.06	Nil	Nil	Tr.	Tr.	Tr.	Nil	Nil	Nil
Ignition loss [4]	41.83	41.96	42.57	43.17	41.52	40.38	41.06	42.94	43.10	42.78	41.06	41.79	40.93
Total	99.93	100.23	100.15	99.51	99.78	100.09	99.73	99.94	100.17	100.05	99.59	99.62	99.77
Class	0, 9, 91	2, 3, 95	1, 2, 96	0, 1, 97	0, 6, 92	7, 2, 91	2, 6, 91	0, 2, 97	0, 2, 97	1, 2, 97	1, 6, 91	1, 3, 94	2, 6, 91
CaO/MgO	magnesian calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite

	45	46	47	48	49	50	51	52	53	54	55	56	57
	15$F_2$6-19	15$F_2$8-9	15$F_2$8-8	15$F_2$8-11	15$F_2$8-12	15$F_2$8-10	15$F_2$9-21	15$F_2$9-20	15$F_2$9-23	15$F_2$9-24	15$F_2$9-25	15$F_2$9-26	15$F_2$9-27
SiO_2	4.06	[5] 5.04	4.48	7.49	6.68	6.21	6.85	[5] 6.64	4.40	4.94	1.72	5.69	2.84
Al_2O_3	[1] .74	.96	[1] .95	[1] .70	[1] 1.45	[1] 1.30	[6] 1.18	.84	[1] 1.24	[1] 1.31	.30	[1] 1.65	[1] 1.28
Fe_2O_3	[2] .41		[2] .56	[2] .46	[2] .93	[2] .79	.59		[2] .58	[2] 1.49	.32	[2] .65	[2] .27
MgO	.43	[7] .51	.88	.70	.85	18.04	1.78	[7] .65	.74	.28	.48	.66	.65
CaO	52.26	[7] 52.28	51.54	50.05	49.98	30.52	49.53	[7] 50.70	51.44	50.79	54.56	50.14	52.59
TiO_2	......	......	......	......	......	......	......	......	......	......	Tr.	......	......
P_2O_5	Tr.	......	.01	.04	.03	.04	.20	......	Tr.	Tr.	Tr.	Tr.	.03
S	......	......	Nil	[3] (.16)	[3] (.05)	[3] (.07)	......	......	......	......	......	......	......
SO_3	Tr.	......	.09	......	Tr.	......	Tr.	......	Tr.	Tr.	Nil	Tr.	Tr.
Ignition loss	[4] 41.40	......	[4] 41.42	[4] 40.03	[4] 39.91	[4] 43.40	40.24	......	[4] 41.17	[4] 40.43	42.92	[4] 40.41	[4] 41.88
Total	99.30	58.79	99.93	99.47	99.83	100.30	100.37	58.83	99.57	99.24	100.30	[8] 99.20	99.54
Class	2, 3, 93	(3, 3) 93	2, 4, 93	6, 3, 90	3, 7, 89	3, 6, 91	4, 5, 90	(5, 2) 92	2, 4, 93	2, 6, 90	1, 2, 97	2, 7, 90	0, 5, 94
CaO/MgO	calcite	calcite	calcite	calcite	calcite	dolomite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (—) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	32	33	34	35	36	37	38	39	40	41
B	—	—	—	—	0.0005	—	—	—	—	—
Ti	0.03	0.01	0.001	—	.01	Tr.	0.006	0.003	0.01	0.007
V	.001	.05	.01	0.01	.0011	0.0025	.01	.005	.0025	.002
Cr	—	—	—	—	—	—	.0003	—	—	—
Mn	.13	.10	.035	.015	.007	.01	.25	.025	.10	.07
Ni	—	.001	.0005	—	.00005	.0005	.001	.0003	.0008	.0006
Cu	.000025	.00004	.00002	.00002	.00002	.000025	.00004	.00002	.00001	.000025
Zn	—	—	—	—	—	—	—	—	—	—
Sr	—	—	—	.056	—	—	.046	—	—	—
Mo	—	—	—	—	—	—	.0001	—	—	—
Ag	—	.0003	—	—	—	—	—	—	.0003	.00001
Sn	—	—	—	—	—	—	—	—	—	—
Ba	—	—	—	—	—	—	—	—	—	—
Pb	—	.001	—	—	—	.0025	—	.0015	.001	.0005

	42	43	44	45	47	49	53	54	56	57
B	—	—	—	—	—	0.0005	—	0.0005	0.002	—
Ti	0.01	0.01	0.01	0.009	0.08	.01	0.01	.10	.015	0.004
V	—	.002	.0025	.003	.0025	.0005	.002	.002	.0011	.01
Cr	—	.0003	.0002	—	.0005	.005	—	—	Tr.	.0002
Mn	.04	.40	.03	.009	.01	.01	.01	.008	.005	.007
Ni	.001	.0015	.0005	.0005	.0005	.001	Tr.	Tr.	.003	.0004
Cu	.00003	.00002	.00003	.00002	.0002	.000025	.00004	.0004	.000013	.00002
Zn	—	—	—	—	—	—	—	—	—	—
Sr	—	.045	—	—	—	—	—	—	.021	—
Mo	—	.0005	—	—	—	—	—	.0003	.0001	—
Ag	.00005	.00001	—	—	—	—	—	.000025	—	—
Sn	—	—	.0007	—	—	—	—	—	—	—
Ba	—	.20	—	—	—	—	Tr.	—	.004	—
Pb	.001	—	.002	—	—	Tr.	Tr.	Tr.	.001	—

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[2] Total iron.
[3] Not included in total, included in ignition loss.
[4] 105° -1,000° C.
[5] Insoluble.
[6] Includes TiO_2.
[7] Calculated from $MgCO_3$ or $CaCO_3$.
[8] 99.43 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

32-35. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

32. Atchison County. Deer Creek limestone, Ervine Creek limestone member. $SW\frac{1}{4}$ sec. 11, T. 5 S., R. 19 E. Lab. No. 51316. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, 14.5 ft thick.

33. Bourbon County. Swope limestone, Bethany Falls limestone member. $NE\frac{1}{4}$ sec. 21, T. 24 S., R. 23 E. Lab. No. 52363. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone, 6.5 ft thick.

34. Bourbon County. Swope limestone, Bethany Falls limestone member. $NE\frac{1}{4}$ sec. 11, T. 27 S., R. 21 E. Lab. No. 52321. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone, 5 ft thick.

35. Bourbon County. Dennis limestone, Winterset limestone member. $NE\frac{1}{4}$ sec. 7, T. 25 S., R. 22 E. Lab. No. 52323. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 27 ft thick.

36-43. Bourbon County. Pennsylvanian. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

36. Fort Scott limestone, Higginsville limestone member. $NE\frac{1}{4}$ sec. 19, T. 25 S., R. 25 E. Lab. No. 5189. Limestone, 13 ft thick.

37-42. Pawnee limestone, Laberdie limestone member.

37. $NE\frac{1}{4}$ sec. 33, T. 23 S., R. 25 E. Lab. No. 52312. Limestone, 17 ft thick.

38. $SW\frac{1}{4}$ sec. 17, T. 25 S., R. 25 E. Lab. No. 52340. Limestone, 14 ft thick.

39. $SE\frac{1}{4}$ sec. 34, T. 25 S., R. 25 E. Lab. No. 52365. Limestone, 14 ft thick.

40. $SW\frac{1}{4}$ sec. 1, T. 26 S., R. 23 E. Lab. No. 52362. Limestone, 8.5 ft thick.

41. $SE\frac{1}{4}$ sec. 10, T. 26 S., R. 24 E. Lab. No. 52350. Limestone, 8.5 ft thick.

42. $SW\frac{1}{4}$ sec. 16, T. 26 S., R. 24 E. Lab. No. 52341. Limestone, 20.5 ft thick.

43. Altamont limestone, Worland limestone member. $NW\frac{1}{4}$ sec. 25, T. 23 S., R. 23 E. Lab. No. 52368. Limestone, 5 ft thick.

44-45. Bourbon County. Pennsylvanian, Dennis limestone, Winterset limestone member. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

44. $NE\frac{1}{4}$ sec. 4, T. 25 S., R. 22 E. Lab. No. 52339. Limestone, 17 ft thick.

45. $SW\frac{1}{4}$ sec. 19, T. 26 S., R. 22 E. Lab. No. 52354. Limestone, 10 ft thick.

46. Butler County. Permian, Fort Riley limestone (R. T. Runnels, written communication, 1953). (T. 26 S., R. 5 E.) town of El Dorado. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone, fossiliferous. Physical properties; bulk density, 2.61. Use: Building stone.

47-50. Butler County. Permian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

47. Fort Riley limestone. $SW\frac{1}{4}$ sec. 26, T. 27 S., R. 4 E. Lab. No. 53207. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 10 ft thick.

48. Fort Riley limestone. $NE\frac{1}{4}$ sec. 9, T. 28 S., R. 4 E. Lab. No. 5125. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86.) Limestone, 10 ft thick.

Kansas--Continued

49. Winfield limestone, Cresswell limestone member. Sec. 18, T. 29 S., R. 4 E. Lab. No. 53197. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Limestone, 10 ft thick.

50. Herington limestone. $SW\frac{1}{4}$ sec. 19, T. 24 S., R. 4 E. Lab. No. 5124. (Runnels and Schleicher, 1956, table 1, pl. 1, p. 86.) Impure dolomite, 7 ft thick. (See also Swineford, 1955, p. 123, 10, 11, 29. Index and geologic map, generalized columnar section. No footnote for S, Fe_2O_3, or ignition loss; Al_2O_3 contains TiO_2 and MnO_2.)

51. Chase County. Permian, Cottonwood limestone. $NW\frac{1}{4}SW\frac{1}{4}$ sec. 3, T. 22 S., R. 9 E. (O'Connor and others, 1951, p. 17, 18, 24, 25, pls. 1, 2.) Limestone, outcrop sample, composite of bed 3.2 ft thick. Geologic map, economic map, geologic cross section. Use: Agricultural limestone, road metal. Possible use: Building stone, riprap.

52. Chase County. Permian, Beattie limestone (R. T. Runnels, written communication, 1957). (T. 19 S., R. 8 E.) town of Cottonwood Falls. (Burchard, 1912, p. 668.) Limestone.

53-54. Chase County. Permian, Crouse limestone. $NW\frac{1}{4}NW\frac{1}{4}$ sec. 4, T. 18 S., R. 9 E. (Runnels and Schleicher, 1956, table 8, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2. Limestone, outcrop samples. Geologic map, geologic cross section, economic map. Use: Building stone. Possible use: Agricultural limestone, crushed rock, riprap.) (Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature.)

53. Lab. No. C-11.

54. Lab. No. C-10. Limestone, massive, composite of lower 2.75 ft of bed.

55. Chase County. Permian, Wreford limestone, Threemile limestone member. $NW\frac{1}{4}NE\frac{1}{4}$ sec. 18, T. 19 S., R. 8 E. (O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2.) Limestone, no chert, composite of upper 13.3 ft; outcrop sample. Geologic map, geologic cross section, economic map. Use: Building stone. Possible use: Agricultural limestone, crushed rock, riprap.

56. Chase County. Fort Riley limestone. $NW\frac{1}{4}NE\frac{1}{4}$ sec. 6, T. 22 S., R. 6 E. Lab. No. C-13. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2. Limestone, composite of lower 8.85 ft of member, outcrop sample. Geologic map, geologic cross section, economic map. Use: Building stone. Possible use: Agricultural limestone, crushed rock, riprap.) (Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature.)

57. Chase County. Permian, Doyle shale, Towanda limestone member. $SW\frac{1}{4}SW\frac{1}{4}$ sec. 24, T. 21 S., R. 6 E. Lab. No. C-20. (Runnels and Schleicher, 1956, table 3, pl. 1, p. 86, 97.) Limestone, 10.3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2. Composite of 10 spot samples. Geologic map, geologic cross section, economic map. Use: Building stone. Possible use: Agricultural limestone, crushed rock, riprap. Al_2O_3, 1.11 percent; TiO_2, 0.17 percent.) (See also Runnels, 1951, p. 88, 83, 85, 91. Lab. No. 4. Analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3, 1.11 percent; total sulfur as S, 0.08 percent; sulfide sulfur as S, 0.02 percent; sulfate sulfur as S, 0.060 percent; P_2O_5, 0.030 percent; P, 0.013 percent; Al_2O_3 contains MnO and TiO_2 if present; ignition loss at 1,000° C., sample dried at 105° C.)

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	58	59	60	61	62	63	64	65	66	67	68	69	70
	$15F_29$-7	$15F_29$-28	$15F_29$-14	$15F_29$-13	$15F_29$-15	$15F_29$-12	$15F_29$-16	$15F_29$-18	$15F_29$-17	$15F_29$-22	$15F_29$-19	$15F_210$-4	$15F_211$-4
SiO_2	6.34	5.30	2.85	6.05	5.09	1.62	5.50	5.47	4.75	[1] 7.30	6.57	1.15	0.19
Al_2O_3	[2] 1.06	[2] 2.28	[2] .90	[2] 2.29	[2] 1.03	[2] 1.30	[2] 2.58	[2] 1.15	[3] .98	} 1.05	{ [2] 1.38	[2] .39	[2] .27
Fe_2O_3	[4] .76	[4] .14	[4] .32	[4] .21	[4] .42	[4] .36	[4] .49	[4] .28	.28	}	{ [4] .59	[4] 1.55	[4] .10
MgO	1.89	.68	1.05	.75	.56	.57	.65	1.35	1.35	[5] .76	1.78	1.54	.42
CaO	50.04	50.06	52.86	50.00	50.97	52.78	50.05	50.50	50.55	[5] 50.42	49.48	52.33	54.83
P_2O_5	.14	.20	.14	.09	.11	.12	.15	.17	.17	......	.20	Tr.	Tr.
S	......	......	......	......	......	......	......	......	......	......	......	Nil	......
SO_3	......	.26	Tr.	.22	.21	.12	.32	Tr.	Tr.	.03	Tr.	Nil	Nil
Ignition loss	[6] 40.01	[6] 41.01	[6] 42.05	[6] 40.34	[6] 41.38	[6] 42.96	[6] 40.68	[6] 41.09	41.13	......	[6] 40.20	[6] 42.97	[6] 43.41
Total	100.24	99.93	100.17	99.95	99.77	99.83	100.42	100.01	99.21	59.56	100.20	99.93	[7] 99.22
Class	4,5,89	2,6,91	1,3,95	2,7,90	3,5,92	0,4,95	2,7,91	3,4,92	3,4,92	(6,3)91	3,6,90	0,2,97	0,0,98
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	71	72	73	74	75	76	77	78	79	80	81	82	83
	$15F_211$-3	$15F_211$-5	$15F_211$-8	$15F_211$-6	$15F_211$-7	$15F_213$-8	$15F_214$-10	$15F_216$-3	$15F_218$-5	$15F_218$-6	$15F_218$-8	$15F_218$-7	$15F_218$-10
SiO_2	0.16	0.29	[1] 8.00	[1] 0.32	3.99	1.64	2.31	4.04	[1] 3.34	3.69	5.52	4.92	5.27
Al_2O_3	[2] .37	[2] .08	} .69	{ .17	[2] 2.92	1.28	[2] .61	[2] 1.14	} 1.69	{ [2] .98	[2] 1.21	.62	1.07
Fe_2O_3	[4] .11	[4] .16	}	{	[4] 1.23	1.98	[4] .34	[4] 1.29	}	{ [4] .50	[4] .86	.78	.71
FeO	......	......	......	.20	......	......	......	......	......	......	......	......	.32
MgO	.12	.43	[5] .38	.35	1.43	18.02	.77	1.92	[5] .45	.72	.75	.05	.56
CaO	55.01	55.01	[5] 51.16	55.25	49.77	31.54	52.82	49.99	[5] 52.65	52.56	51.15	52.46	50.36
Na_2O	......	......	......	......	......	......	......	......	......	......	......	......	.20
K_2O	......	......	......	......	......	......	......	......	......	......	......	......	.10
H_2O+	......	......	......	......	......	......	......	......	......	......	......	......	} .78
H_2O-	......	......	......	......	......	......	......	......	......	......	......	[8] .23	}
P_2O_5	.01	.01	......	......	.17	......	.02	.05	......	.01	.02	......	.06
MnO	......	......	......	.02	......	......	......	......	......	......	......	......	......
S [9]	......	(.02)	......	......	(.14)	......	(.02)	(.12)	......	Nil	......	......	......
SO_3	.15	Nil	......	......	Tr.	......	.08	Nil	......	.08	.09	......	.07
Ignition loss	[6] 43.56	[6] 43.81	......	[10] 43.79	[6] 40.96	46.34	[6] 42.48	[6] 41.24	......	[6] 42.15	[6] 40.37	[11] 41.30	[12] 40.34
Total	99.49	99.79	60.23	100.10	[13] 100.47	100.80	99.43	99.67	58.13	100.69	99.97	100.36	99.84
Class	0,1,98	0,1,99	(7,2)90	(0,0)99	0,7,91	0,5,94	1,3,96	1,7,92	(1,5)94	1,4,95	2,6,90	3,4,93	3,5,91
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcareous dolomite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	58	59	60	61	62	63	64	65	68	69	72	75	77
B	–	–	–	0.0003	–	–	–	–	Tr.	–	–	–	–
Ti	0.01	0.015	0.003	.004	0.002	0.002	0.003	–	0.0015	Tr.	–	0.005	0.015
V	.0024	.0013	.002	.003	.0015	.005	.002	0.0012	.002	0.015	0.003	.005	.0036
Cr	–	–	–	–	–	Tr.	–	–	–	–	–	.0003	–
Mn	.006	.005	.005	.015	.01	.006	.055	.007	.005	.25	.079	.20	.005
Ni	–	.0001	Tr.	.0005	–	.0001	Tr.	Tr.	.00005	.001	–	.001	.0001
Cu	.000025	.00002	.000025	.00004	.000013	.0001	.000025	.00002	.000025	.00002	.000013	.0002	.000013
Zn	.001	.00005	–	.0002	.0001	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	–	.013	–	–	.011
Mo	–	–	–	.00005	–	–	.0001	–	–	–	–	–	–
Ag	–	–	–	.00005	–	.000025	–	–	–	.00005	–	–	–
Sn	–	–	–	–	–	–	–	–	–	–	–	–	–
Ba	–	–	–	–	–	.002	–	–	–	.10	–	.1	–
Pb	–	.0001	–	.007	–	.0001	Tr.	Tr.	.0005	.0002	–	–	–

	78	80	81		78	80	81
B	–	0.001	–	Zn	–	–	–
Ti	0.002	.013	0.03	Sr	–	–	0.014
V	.0025	.01	.001	Mo	0.0002	–	–
Cr	–	.002	–	Ag	.0005	0.00005	.00005
Mn	.05	.015	.0035	Sn	.003	–	.001
Ni	.002	.001	.005	Ba	–	–	–
Cu	.0001	.0001	.001	Pb	.005	–	.005

[1] Reported as insoluble.
[2] Includes MnO, ZrO_3, V_2O_5, and TiO_2 if present.
[3] Includes TiO_2.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] 105°-1,000° C.
[7] 100.03 in text.
[8] At 140° C.
[9] Not included in total, included in ignition loss.
[10] Reported as CO_3, calculated from bases by Clarke (1891, p. 125).
[11] At 1,000° C.
[12] Reported as CO_2.
[12] 100.37 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

58-59. Chase County. Permian. Winfield limestone, Cresswell limestone member. (Runnels and Schleicher, 1956, table 2, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1951, p. 17-19, 24, 25, pls. 1, 2. Limestone, outcrop samples. Geologic map, economic map, geologic cross sections. Use: Building stone. Possible use: Agricultural limestone, crushed rock, riprap. No footnotes given for Al_2O_3, Fe_2O_3 or ignition loss; sample 58, Al_2O_3, 0.85 percent; TiO_2, 0.21 percent; sample 59, Al_2O_3, 1.72 percent; TiO_2, 0.56 percent.)

58. SW¼NW¼ sec. 16, T. 22 S., R. 6 E. Lab. No. C-15.

59. NE¼NW¼ sec. 17, T. 22 S., R. 7 E. Lab. No. C-5, 6.

60-63. Chase County. Permian. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

60. Red Eagle limestone, Glenrock limestone member. SE¼NW¼ sec. 26, T. 19 S., R. 7 E. Lab. No. C-19. (See also Runnels, 1951, p. 88, 85, 91, 102. NE¼SW¼ sec. 26. Locality 3. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.05 percent; sulfide sulfur as S, trace; sulfate sulfur as S, 0.048 percent; P_2O_5, 0.140 percent; P, 0.061 percent; ignition loss at 1,000° C., sample dried at 105° C.) (See also O'Connor and others, 1951, p. 17, 19. Limestone, composite of upper 5.95 ft bed. Use: Road metal. Possible use: Lime, flux, agricultural limestone, building stone, riprap. Al_2O_3, 0.76 percent; Al_2O_3 includes TiO_2; CaO, 52.89 percent; ignition loss, 42.07 percent; no footnotes for Fe_2O_3 or ignition loss; S, not reported.)

61. Neva limestone. SW¼NW¼ sec. 23, T. 19 S., R. 8 E. Lab. No. C-2. (See also O'Connor and others, 1951, p. 17, 19. Limestone; composite of middle part of formation; 3.8 ft thick. Use: Agricultural limestone, road metal. Possible use: Building stone, riprap. No footnote for Fe_2O_3 or ignition loss; Al_2O_3, 2.31 percent; includes TiO_2; CaO, 50.04 percent; ignition loss, 37.04 percent.)

62. Neva limestone. SW¼NW¼ sec. 23, T. 19 S., R. 8 E Lab. No. C-3. (See also O'Connor and others, 1951, p. 17, 18, 24, 25, pls. 1, 2. Limestone; composite of upper bed; 5.1 ft thick. Use: Agricultural limestone, road metal. Possible use: Building stone, riprap. No footnote for Fe_2O_3 or ignition loss; S, not reported.)

63. Eskridge shale. SW¼NW¼ sec. 23, T. 19 S., R. 8 E. Lab. No. C-4. (See also O'Connor and others, 1951, p. 17, 18, 24, 25, pls. 1, 2. Limestone, 3.9 ft thick. Possible use: Agricultural limestone, road metal, riprap. No footnote for Al_2O_3, Fe_2O_3, or ignition loss.)

64-65. Chase County. Permian, Cottonwood limestone. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 6 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

64. SE¼SE¼ sec. 30, T. 19 S., R. 7 E. Lab. No. C-7. (See also O'Connor and others, 1951, p. 17, 18. Limestone, composite of complete member. Possible use: Building stone, riprap, road metal. No footnote for Al_2O_3, Fe_2O_3 or ignition loss; Al_2O_3, 1.74 percent; TiO_2, 0.69 percent; CaO, 50.09 percent; ignition loss, 40.71 percent.)

65. NW¼ sec. 36, T. 19 S., R. 8 E. Lab. No. C-9.

66. Chase County. Cottonwood limestone. NE¼NW¼ sec. 36, T. 19 S., R. 8 E. (O'Connor and others, 1951, p. 17, 18.) Limestone, composite of complete member; about 5 ft thick. Use: Agricultural limestone, building stone, road metal. Possible use: Riprap.

67. Chase County. Cottonwood limestone (R. T. Runnels, written communication, 1953). (T. 19 S., R. 8 E.), Strong City. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 78, 76.) Limestone, fossiliferous; average from 6 blocks. Physical properties; bulk density, 2.61. Use: Building stone.

68. Chase County. Cottonwood limestone. SW¼ sec. 3, T. 22 S., R. 9 E. Lab. No. C-16. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, 3.2 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

69-72. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

69. Chautauqua County. Pennsylvanian, Oread limestone, Plattsmouth limestone member. Sec. 33, T. 33 S., R. 11 E. Lab. No. 52270. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 20 ft thick.

Kansas--Continued

70. Cherokee County. Mississippian, Burlington-Keokuk limestone. NE¼ sec. 26, T. 34 S., R. 25 E. Lab. No. 52137. (Runnels and Schleicher, 1956, table 29, pl. 3, p. 86.) Limestone, 12 ft thick.

71. Cherokee County. Burlington-Keokuk limestone. NE¼ sec. 34, T. 34 S., R. 25 E. Lab. No. 51130. (Runnels and Schleicher, 1956, table 29, pl. 3, p. 86.) Limestone, 12 ft thick.

72. Cherokee County. Burlington-Keokuk limestone. NW¼NE¼ sec. 2, T. 35 S., R. 25 E. Lab. No. 5127. (Runnels and Schleicher, 1956, table 29, pl. 3, p. 86, 97.) (See also Runnels, 1951, p. 87, 83, 85, 91, 99, 101. Keokuk limestone. Locality No. 5. Limestone, gray-white, massive, crinoidal; 14 ft thick, crystalline on freshly broken surface. Chemical analysis of calcined base also given. Index map. Possible use: Lime, metallurgical limestone, manufacture of glass, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.02 percent; sulfide sulfur as S, 0.02 percent; sulfate sulfur as S, trace; P_2O_5, 0.01 percent; P, 0.004 percent; CaO, 55.0 percent; ignition loss at 1,000° C.; sample dried at 105° C.)

73. Cherokee County. Keokuk limestone (R. T. Runnels, written communication, 1953). (T. 34 S., R. 25 E.) town of Galena. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 78, 74, 76.) Limestone. General description: Light-blue, highly crystalline, compact, fossiliferous. Physical properties. Bulk density, 2.66. Use: Building stone. Possible use: Cement material (Haworth, 1903, p. 53). CaO calculated from reported $CaCO_3$ by Haworth and others (1904, p. 77); $CaCO_3$ reported as 97.32 percent by Day (1895, p. 505).

74. Cherokee County. (Burlington limestone) reported as Cherokee limestone. (T. 35 S., R. 25 E.) quarry on Short Creek, near Spring River. Analyst, Eakins. Lab. No. 1184. (Clarke, 1891, p. 125; Clarke, 1915, p. 234.) Limestone.

75. Cherokee County. Pennsylvanian, Cherokee formation, Verdigris member. Sec. 22, T. 31 S., R. 23 E. Lab. No. 53246. (Runnels and Schleicher, 1956, table 29, pl. 3, p. 86, 97.) Limestone, 3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

76. Clark County. Permian, Day Creek dolomite. T. 32 S., R. 23 W. (Jewett and Schoewe, 1942, p. 111, 110, 162.) Dolomite, generally about 2.5 ft thick. Estimated tonnage, small amount of overburden. Index and outcrop map. Possible use: Source of magnesium.

77. Clay County. Permian, Fort Riley limestone. NE¼SW¼ sec. 17, T. 9 S., R. 4 E. Lab. No. 517. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 10.7 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also Runnels, 1951, p. 88, 83, 85, 91, 102. Locality 6. Limestone, creamy to light-gray, sugary texture. Maximum overburden, 8.5 ft. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.05 percent; sulfide sulfur as S, 0.02 percent; sulfate sulfur as S, 0.030 percent; P_2O_5, 0.023 percent; P, 0.010 percent; ignition loss at 1,000° C.; sample dried at 105° C.)

78. Coffey County. Oread limestone, Plattsmouth limestone member. NW¼ sec. 14, T. 21 S., R. 15 E. Lab. No. 52278. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 13 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

79. Cowley County. Possibly Cottonwood limestone (R. T. Runnels, written communication, 1954). (T. 31 S., R. 7 E.) town of Cambridge, Heddeman quarry. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 78, 75, 76.) Limestone, fossiliferous; average of 5 blocks. General description: White or light-cream, fine, noncrystalline. Average thickness, 5-8 ft. Physical properties; bulk density, 12.63. Use: Building stone.

80-81. Cowley County. Fort Riley limestone. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results.

80. NW¼ sec. 22, T. 32 S., R. 4 E. Lab. No. 53172. Limestone, 8 ft thick.

81. SW¼ sec. 28, T. 34 S., R. 5 E. Lab. No. 53181. Limestone, 8.5 ft thick.

82. Cowley County. Fort Riley limestone. T. 34 S., R. 5 E., (R. T. Runnels, written communication, 1957). Analyst, Runnels. (Garrels and others, 1949, p. 1812, 1815.) Limestone. Physical tests.

83. Cowley County. Fort Riley limestone (R. T. Runnels, written communication, 1953). (T. 34 S., R. 5 E.) town of Silverdale. Analyst, Catlett. Lab. No. 967. (Clarke, 1890, p. 46; Clarke, 1915, p. 234.) Limestone.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	84	85	86	87	88	89	90	91	92	93	94	95	96
	$15F_218$-9	$15F_219$-10	$15F_219$-11	$15F_219$-9	$15F_222$-24	$15F_222$-22	$15F_222$-23	$15F_222$-25	$15F_222$-26	$15F_223$-10	$15F_223$-13	$15F_223$-11	$15F_223$-12
SiO_2	[1] 4.25	4.46	6.16	1.82	1.39	1.13	1.71	5.86	3.63	2.11	3.23	2.17	3.01
Al_2O_3	.85	[2] .16	[2] .46	[2] .36	[2] .57	[2] .45	[2] .60	[2] 1.04	[2] 1.35	[2] .52	[2] .97	[2] .73	[2] 1.46
Fe_2O_3		[3] .16	[3] 1.65	[3] 1.33	[3] 1.86	[3] .66	[3] 2.63	[3] 1.97	[3] 1.41	[3] .63	[3] .88	[3] .56	[3] 1.35
MgO	[4] .30	.32	2.80	1.27	1.32	.55	.71	.73	2.53	.82	.72	.89	2.23
CaO	[4] 52.69	53.28	48.13	52.50	52.97	54.12	52.02	50.56	49.64	52.79	52.51	53.29	49.49
P_2O_5	......	Tr.	.02	.03	.04	.04	.02	.02	.05	.04	.01	.01	.03
S	......	......	Tr.	[5] (.07)	......	......	......	[5] (.61)	......	[5] (.06)	[5] (.05)	......	[5] (.07)
SO_3	......	Tr.	Tr.	Nil	.01	......	.19	.23	.12	.08	Tr.	Tr.	Nil
Ignition loss[6]	......	41.96	40.93	42.49	42.17	43.17	42.03	39.92	41.36	42.50	41.39	42.28	41.97
Total	58.09	100.34	100.15	[7] 99.80	100.33	100.12	99.91	100.33	100.09	99.49	99.71	99.93	99.54
Class	(3,2)95	4,1,95	3,5,91	0,4,95	0,3,95	0,2,98	0,3,94	2,8,89	0,7,92	0,3,96	1,5,93	0,4,95	0,6,93
	calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	magnesian calcite

	97	98	99	100	101	102	103	104	105	106	107	108
	$15F_223$-17	$15F_223$-18	$15F_223$-15	$15F_223$-16	$15F_223$-20	$15F_223$-21	$15F_223$-14	$15F_223$-19	$15F_223$-23	$15F_223$-24	$15F_223$-22	$15F_223$-25
SiO_2	3.22	3.48	3.16	3.18	5.86	6.41	[1] 2.29	[1] 3.53	2.11	3.49	2.70	4.66
Al_2O_3	[2] .61	[2] 1.17	[2] .82	.37	[2] .87	[2] 1.44	1.79	1.07	[2] .71	[2] 1.25	[2] .55	[2] 1.62
Fe_2O_3	[3] 5.10	[3] 1.08	[3] .54	2.18	[3] 1.07	[3] .44			[3] .89	[3] 5.06	[3] 1.69	[3] 1.15
MgO	9.39	.55	.54	.55	.31	.97	[4] .38	[4] .55	......	3.64	.54	.79
CaO	38.60	52.34	53.11	51.88	50.94	50.44	[4] 53.23	[4] 52.76	53.27	46.48	53.35	51.27
H_2O-, at 140° C	......	......	......	.08	......	......	......	......	......	......	......	......
P_2O_5	Nil	.02	.01	......	.06	.02	......	......	Tr.	Tr.	.07	.06
S	......	......	......	......	[5] (.04)	......	......	......	Nil	......	......	......
SO_3	Tr.	Nil	Nil	.20	Tr.	.13	......	......	Nil	.15	Tr.	Tr.
Ignition loss	[6] 42.46	[6] 41.25	[6] 41.87	[8] 40.71	[6] 40.61	[6] 40.32	......	......	[6] 41.88	[6] 40.47	[6] 41.90	[6] 40.50
Total	[9] 99.38	99.89	100.05	99.15	99.72	100.17	57.69	57.91	[10] 98.86	100.54	100.80	100.05
Class	0,8,89	0,6,92	1,4,94	0,6,92	3,5,91	3,5,90	(0,4)95	(2,3)95	0,4,94	0,7,89	0,5,94	1,8,90
CaO/MgO	calcareous dolomite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Zn looked for in all samples but not detected]

	85	86	87	88	90	91	92	93	94	95	96
B	0.0003	–	–	–	–	–	–	–	–	–	–
Ti	.0015	Tr.	0.009	0.001	0.001	0.001	0.004	0.015	0.003	0.002	0.01
V	.0032	–	.25	.002	.002	–	.01	.0013	.003	.005	.05
Cr	.0003	–	.002	.0002	–	–	.0003	.0003	.0005	–	–
Mn	.017	0.05	.08	.25	.14	.60	.06	.075	.06	.04	.0005
Ni	.0001	.0005	.002	–	.003	–	.001	.003	.0005	–	.003
Cu	.000013	.000025	.00005	.0005	.000013	.001	.001	.000025	.00003	.00005	.0001
Sr	–	.046	–	.0036	–	.023	–	.03	.098	–	–
Mo	–	–	–	–	–	–	–	.00005	–	–	–
Ag	–	–	.0001	–	–	–	.00005	–	–	.00005	.00005
Sn	–	–	.003	–	–	–	.001	–	.0003	–	–
Ba	.007	–	–	–	.05	–	–	.04	–	–	–
Pb	–	–	.001	–	–	.0005	–	.0006	.0003	–	.002

	101	105	106	107		101	105	106	107
B	–	–	0.001	–	Sr	0.058	–	–	0.029
Ti	0.004	0.003	.015	0.0015	Mo	–	–	0.001	.0005
V	.0025	.0022	.005	.0044	Ag	–	–	.00005	.00001
Cr	–	.0003	.001	–	Sn	–	–	.001	–
Mn	.006	.12	.50	.12	Ba	–	–	.01	.01
Ni	–	.001	.001	.0005	Pb	–	Tr.	.003	.0002
Cu	.0001	.00002	.0001	.000025					

[1] Insoluble residue.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Total iron.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Not included in total, included in ignition loss.
[6] 105° - 1,000° C.
[7] 99.82 in text.
[8] At 1,000° C.
[9] 99.58 in text.
[10] 99.02 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

84. Cowley County. Permian, Winfield limestone (R. T. Runnels, written communication, 1953). (T. 32 S., R. 4 E.) town of Winfield. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77.) Limestone. Physical properties; bulk density, 2.52. Use: Building stone.

85-87. Crawford County. Pennsylvanian. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

85. Fort Scott limestone, Higginsville limestone member. NE¼NE¼ sec. 5, T. 29 S., R. 23 E. Lab. No. 50202. Limestone, 17 ft thick. (See also Runnels, 1951, p. 87, 83, 85, 91, 101. Altamont limestone, Worland limestone member. Locality No. 7, J. J. Stark Construction Co. quarry. Limestone, minor amount of chert; 10 ft thick. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.06 percent; sulfide sulfur as S, 0.012 percent; sulfate sulfur as S, 0.048 percent; P_2O_5, 0.031 percent; P, 0.013 percent; ignition loss at 1,000° C., sample dried at 105° C.)

86. Fort Scott limestone, Higginsville limestone member. SW¼ sec. 29, T. 29 S., R. 24 E. Lab. No. 52286. Limestone, 9.5 ft thick.

87. Pawnee limestone, Laberdie limestone member. Sec. 31, T. 27 S., R. 24 E. Lab. No. 52279. Limestone, 18 ft thick.

88-90. Doniphan County. Pennsylvanian, Lawrence shale, Amazonia limestone member. T. 3 S., R. 22 E. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

88. NE¼ sec. 15. Lab. No. 51312. Limestone, 9 ft thick.

89. SW¼ sec. 33. Lab. No. 5151. Spot sample.

90. SW¼ sec. 33. Lab. No. 51119. Limestone, 10 ft thick.

91. Doniphan County. Pennsylvanian, Oread limestone, Leavenworth limestone member. NW¼ sec. 13, T. 5 S., R. 21 E. Lab. No. 51317. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 1.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

92. Doniphan County. Pennsylvanian, Deer Creek limestone, Ervine Creek limestone member. NW¼ sec. 2, T. 2 S., R. 20 E. Lab. No. 51296. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, 15 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

93-96. Douglas County. Pennsylvanian, Stanton limestone, Stoner limestone member. T. 13 S., R. 21 E. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

93. NE¼NE¼ sec. 4. Lab. No. 5112. Limestone, 14 ft thick. (See also Runnels, 1951, p. 88, 83, 85, 91, 97. Locality No. 10. Limestone, from quarry. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.08 percent; sulfide sulfur as S, 0.06 percent; sulfate sulfur as S, 0.030 percent; P_2O_5, 0.039 percent; P, 0.017 percent; ignition loss at 1,000° C., sample dried at 105° C.)

94. SE¼ sec. 15. Lab. No. 53170. Limestone, 15.3 ft thick.

95. SE¼ sec. 18. Lab. No. 52135. Limestone, 17 ft thick.

96. NW¼ sec. 20. Lab. No. 53215. Limestone, 13.2 ft thick.

97-99. Douglas County. Oread limestone, Toronto limestone member. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86.) Limestone. Chips from continuous surface. Index map.

Kansas--Continued

97. SE¼ sec. 36, T. 12 S., R. 19 E. Lab. No. 4766. Limestone, 3 ft thick. (See also Garrels and others, 1949, p. 1812-1814. Analyst, Runnels. Lab. No. B. Physical tests. Al_2O_3, 0.71 percent; Fe_2O_3, 5.20 percent; H_2O- at 140° C., 0.07 percent; ignition loss at 1,000° C.; P_2O_5, SO_3, and S not reported; no footnote for Al_2O_3 or Fe_2O_3.)

98. NW¼ sec. 35, T. 13 S., R. 19 E. Lab. No. 54372. Limestone, 3.6 ft thick.

99. SE¼ sec. 19, T. 14 S., R. 20 E. Lab. No. 54371. Limestone, 4.2 ft thick.

100. Douglas County. Oread limestone, Leavenworth limestone member. SE¼ sec. 36, T. 12 S., R. 19 E., (R. T. Runnels, written communication, 1957). Analyst, Runnels. Lab. No. A. (Garrels and others, 1949, p. 1812-1814.) Limestone. Physical tests.

101-102. Douglas County. Oread limestone, Plattsmouth limestone member. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map.

101. NE¼ sec. 32, T. 12 S., R. 18 E. Lab. No. 53217. Limestone, 14.5 ft thick. Résumé of spectrographic results.

102. NE¼ sec. 22, T. 14 S., R. 18 E. Lab. No. 54370. Limestone, 10.3 ft thick.

103-104. Douglas County. (T. 12 S., R. 20 E.) town of Lawrence. Analyst, under supervision of Bailey. Collector, Williston. Physical properties. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

103. Oread limestone, probably lower part of Plattsmouth limestone member (R. T. Runnels, written communication, 1953). (Day, 1895, p. 505; Haworth, 1898, p. 79.) Limestone, fossiliferous. Bulk density, 2.67.

104. Oread limestone (R. T. Runnels, written communication, 1953). (Day, 1895, p. 504; Haworth, 1898, p. 77.) Limestone, fossiliferous. Bulk density, 2.68.

105-107. Douglas County. Deer Creek limestone. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

105. Ozawkie limestone member. Center south line sec. 36, T. 11 S., R. 17 E. Lab. No. 50554. (See also Runnels, 1951, p. 87, 83, 85, 91, 97. Locality No. 8. Limestone, 5 ft thick. Chemical analysis of calcined base also given. Possible use: Metallurgical lime, glass manufacture. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.04 percent; sulfide sulfur as S, 0.004 percent; sulfate sulfur as S, 0.036 percent; P_2O_5, 0.041 percent; P, 0.018 percent; ignition loss at 1,000° C., sample dried at 105° C.)

106. Rock Bluff limestone member. SW¼ sec. 32, T. 11 S., R. 18 E. Lab. No. 49446. Limestone, 3 ft thick.

107. Ervine Creek limestone member. SE¼SW¼ sec. 32, T. 11 S., R. 18 E. Lab. No. 49452. Limestone, 8 ft thick. (See also Runnels, 1951, p. 87, 83, 85, 91, 97. Locality No. 9. Chemical analysis of calcined base also given. Possible use: Metallurgical lime, glass manufacture. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.07 percent; sulfide sulfur as S, 0.03 percent; sulfate sulfur as S, 0.04 percent; P_2O_5, 0.015 percent; P, 0.007 percent; ignition loss at 1,000° C., sample dried at 105° C.)

108. Douglas County. Pennsylvanian, Topeka limestone, Curzon limestone member. Sec. 11, T. 12 S., R. 17 E. Lab. No. 54369. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86.) Limestone, 3 ft thick. Chips from continuous surface. Index map.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas											
	109	110	111	112	113	114	115	116	117	118	119	120
	15F₂25-14	15F₂25-15	15F₂25-16	15F₂25-9	15F₂25-10	15F₂25-11	15F₂25-12	15F₂25-13	15F₂26-18	15F₂26-15	15F₂26-7	15F₂26-9
SiO_2	1.70	1.62	2.63	[1]0.66	0.69	0.95	1.33	[1]1.34	4.32	3.69	1.09	2.12
Al_2O_3	[2].71	[2].51	[2].74	2.13	1.76	2.26	3.42	.56	[3]1.71	[3]2.75	[3].48	[3].62
Fe_2O_3	[4]1.44	[4].62	[4].67						1.41		.43	1.17
MgO	1.23	.94	.55	[5]1.45	[5].24	[5].20	[5].19	[5].48	.23	.38	.13	.12
CaO	52.75	53.83	52.89	[5]52.37	[5]54.00	[5]53.13	[5]52.16	[5]53.61	51.53	51.76	54.63	53.21
Na_2O	.04	......	.03	......	......	......	......	......	......	......	......	......
K_2O	.03	......	.03	......	......	......	......	......	......	......	......	......
P_2O_5	.06	.01	.03	......	......	......	......	......	Nil	.20	Nil	Nil
S	Nil	Tr.	Nil	......	......	......	......	......	Nil	Nil	.13	Nil
SO_3	Nil	Nil	Nil	.36	......	......	......	......	......	......	......	......
Ignition loss	[6]42.08	[6]42.67	[6]42.09	......	......	......	......	......	[7]40.29	[7]40.70	[7]42.34	[7]41.81
Total	100.04	100.20	99.66	56.97	56.69	56.54	57.10	55.99	99.49	99.48	99.23	99.05
Class	0,3,94	0,3,96	1,4,95	(0,1)97	0,1,97	0,2,95	0,2,94	(0,2)97	0,8,90	0,6,91	0,2,96	0,4,94
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite
	121	122	123	124	125	126	127	128	129	130	131	132
	15F₂26-12	15F₂26-19	15F₂26-17	15F₂26-16	15F₂26-10	15F₂26-13	15F₂26-14	15F₂26-11	15F₂26-8	15F₂28-2	15F₂28-1	15F₂30-5
SiO_2	2.66	4.99	3.87	3.79	2.30	3.46	3.47	2.38	1.87	3.48	3.38	[8]1.18
Al_2O_3	.34	[3]2.91	[3]2.62	1.47	.47	1.90	[3]1.29	[3]1.57	[3].79	.92	1.17	2.38
Fe_2O_3	[3]1.60			[3]1.97	1.48	1.56	1.12	.56	1.00	[3].43	[3].51	
MgO	......	......	......	......	.17	.81	......	.59	.17	......	.34	[5].51
CaO	52.63	50.63	51.64	52.04	53.43	51.53	52.88	52.48	53.56	52.34	53.31	[5]53.09
P_2O_5	Nil	Nil	Nil	Nil	Nil	Tr.	Nil	Nil	Nil	.07	Nil	......
S	.02	.01	.10	.01	Nil	Nil	Nil	Nil	Nil	Nil	Nil	......
Ignition loss [7]	41.79	40.47	40.70	40.69	41.23	40.11	40.43	40.95	41.59	41.07	41.76	......
Total	99.04	99.01	98.93	99.97	99.08	99.37	99.19	98.53	98.98	98.31	100.47	57.16
Class	0,5,94	0,9,90	0,7,91	0,7,91	0,5,93	0,6,90	0,6,91	0,4,92	0,4,94	1,4,93	1,5,94	(0,2)96
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite
	133	134	135	136	137	138	139	140	141	142	143	144
	15F₂30-6	15F₂30-7	15F₂30-8	15F₂30-9	15F₂30-10	15F₂30-11	15F₂30-13	15F₂30-12	15F₂30-14	15F₂30-15	15F₂30-16	15F₂31-5
SiO_2	[8]3.82	[8]3.94	[8]4.79	2.31	3.27	3.43	3.84	1.72	4.23	5.22	[1]8.00	2.14
Al_2O_3	[9].77	1.20	1.18	[2].54	[2]1.00	[2].91	[2]1.14	[2].39	[2].89	[2].17	1.35	[2].62
Fe_2O_3				[4]1.46	[4]1.32	[4]1.38	[4].74	[4].50	[4]1.13	[4].71		[4].38
MgO	[5].62	[5].57	[5].60	2.09	2.77	2.45	1.16	.51	.80	Tr.	[5].06	.95
CaO	[5]52.78	[5]52.44	[5]52.27	50.90	48.97	49.58	51.63	53.97	51.67	52.70	[5]50.42	53.40
P_2O_5	......	......	......	.12	.03	.11	Tr.	Tr.	.03	.04	......	Tr.
S	......	......	......	......	[10](.13)	......	Tr.	......	[10](.06)	Nil	......	Nil
SO_3	......	......	......	.51	.14	.33	.06	Tr.	Nil	Tr.	.02	.08
Ignition loss [6]	......	......	......	42.03	41.76	41.53	41.42	42.50	40.77	41.30	......	42.38
Total	57.99	58.15	58.84	99.96	[11]99.26	99.72	99.99	99.59	99.52	100.14	[12]59.85	99.95
Class	(3,2)95	(2,4)94	(3,3)93	0,5,94	0,6,93	0,6,92	1,5,93	1,2,97	1,5,91	4,2,93	(6,4)90	1,3,95
CaO/MgO	calcite	calcite	calcite	magnesian calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite

See following page for footnotes.

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	109	110	111	136	137	138	139	140	141	142	144
B	–	–	–	–	–	–	–	Tr.	0.001	–	0.0005
Ti	0.004	–	–	0.001	0.002	0.003	0.013	0.006	.017	Tr.	.02
V	.005	0.015	0.007	.002	.002	.001	.0025	.002	.0025	0.0025	.025
Cr	–	–	–	–	–	–	.0005	–	.002	.0003	.0001
Mn	.25	.05	.10	.20	.02	.04	.03	.08	.07	.05	.025
Ni	.004	.0005	.00005	.001	.0005	.0005	.0005	.00005	.002	.0002	.001
Cu	.001	.000013	.001	.0005	.0001	.0001	.00005	.00004	.0001	.00003	.00004
Zn	–	–	–	–	–	–	–	.0005	–	–	–
Sr	–	–	.046	–	.078	–	–	–	.045	.1	–
Mo	–	–	–	–	–	–	–	–	–	–	–
Ag	.00005	–	–	–	.0001	–	–	.00004	.00002	–	–
Ba	–	–	–	–	–	–	–	–	.01	–	–
Sn	.001	–	–	.001	–	.0005	–	–	–	–	–
Pb	.0005	.0025	–	.001	.0005	.001	–	.0001	–	–	.0005

Spectrographic analyses

[Li, Na, K, Sr, Zr, and Ba may be present but not shown on spectrograph; Mg, small but positive]

	124	127		124	127		124	127
P........................	Very faint trace	May be present	Ti........................	Small but positive	Very faint trace	Mn........................	Very faint trace	Small but positive

[1] Insoluble.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Includes TiO_2.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] 105° -1,000° C.
[7] 140° -1,000° C.
[8] Reported as insoluble residue. Reported as SiO_2 by Haworth and Schrader (1905, p. 509) and Schrader and Haworth (1906, p. 57).
[9] In ferrous state (Haworth, 1898, p. 79).
[10] Not included in total, included in ignition loss.
[11] 99.23 in text.
[12] Insoluble and $CaCO_3$ reported as whole numbers, Williston reported as analyst by Day (1895, p. 504, 505).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

109-111. Elk County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
109. Stranger formation, Haskell limestone member. NE¼ sec. 21, T. 31 S., R. 13 E. Lab. No. 5374. (Runnels and Schleicher, 1956, pl. 2, table 17, p. 86, 97.) Limestone, 1.3 ft thick.
110. Oread limestone, Plattsmouth limestone member. SE¼ sec. 21, T. 29 S., R. 13 E. Lab. No. 52361. (Runnels and Schleicher, 1956, pl. 2, table 16, p. 86, 97.) Limestone, 9 ft thick.
111. Oread limestone, Plattsmouth limestone member. NE¼ sec. 3, T. 30 S., R. 12 E. Lab. No. 5377. (Runnels and Schleicher, 1956, pl. 2, table 16, p. 86, 97.) Limestone, 12 ft thick.
112. Elk County. Pennsylvanian, Deer Creek limestone (R. T. Runnels, written communication, 1953). (T. 31 S., R. 10 E.) town of Moline. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79.) Limestone, fossiliferous. Physical properties. Bulk density, 2.66. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).
113-116. Elk County. Deer Creek limestone (R. T. Runnels, written communication, 1957). Moline, Moline Lime, Stone, and Cement Co. quarry. Analyst, Bailey. (Burchard, 1912, p. 668.) Limestone.
117-129. Ellis County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. (Runnels and Dubins, 1949, p. 22, 4, 9, 12, 17, 25.) Chalk, white. Index map. Possible use: Whiting.
117. Sec. 27, T. 11 S., R. 18 W. Lab. No. El-3-1b. From upper part of bed. Insoluble residue, 8.02 percent.
118. Sec. 13, T. 11 S., R. 19 W. Lab. No. El-2-1b. From upper part of bed. Insoluble residue, 7.40 percent. (For another analysis from same measured section see sample 75, group F_1, of this compilation.)
119. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-0. Composite sample of two beds.
120. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-5.
121. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-6.
122. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-7.
123. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-8.
124. Sec. 36, T. 11 S., R. 19 W. Lab. No. El-4-9.
125. Sec. 3, T. 13 S., R. 18 W. Lab. No. El-6-0. Quarry, bed, 2 ft thick. Use: Building stone.
126. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-3. Chalk, 33 ft thick in area. Columnar section. Possible use: Whiting. (For analyses from same measured section see following samples: 127-129 and samples 76, 77, group F_1 of this compilation.)
127. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-5. Chalk, 33 ft thick in area. Columnar section.
128. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-7. Chalk, 33 ft thick in area. Columnar section. Insoluble residue, 3.60 percent.
129. Sec. 11, T. 13 S., R. 20 W. Lab. No. El-1-11. Chalk, 33 ft thick in area. Columnar section.
130-131. Finney County. Niobrara formation, Fort Hays limestone member. SW¼NW¼ sec. 22, T. 22 S., R. 30 W. (Runnels and Dubins, 1949, p. 22, 4, 9, 12.) Chalk, white, few concretions; spot samples from quarry; reserves moderate. Index map. Use: Building stone. Possible use: Lime, whiting.
130. Lab. No. Fn-1-0.
131. Lab. No. Fn-1-1.

Kansas--Continued

132-135. Franklin County. Pennsylvanian, probably Plattsburg limestone (R. T. Runnels, written communication, 1953). (T. 18 S., R. 21 E.) town of Lane, Hanway quarry. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone, fossiliferous. Physical properties. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).
132. Bulk density, 2.68.
133. Bulk density, 2.72.
134. Bulk density, 2.69.
135. Bulk density, 2.69.

136-140. Franklin County. Pennsylvanian, Stanton limestone. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
136. Captain Creek limestone member. SW¼ sec. 6, T. 17 S., R. 19 E. Lab. No. 49221. Limestone, 10 ft thick.
137. Captain Creek limestone member. SW¼ sec. 6, T. 17 S., R. 19 E. Lab. No. 53199. Limestone, 10.3 ft thick.
138. Captain Creek limestone member. SW¼ sec. 6, T. 17 S., R. 19 E. Lab. No. 49220. Limestone, 14 ft thick.
139. Stoner limestone member. SW¼ sec. 22, T. 16 S., R. 20 E. Lab. No. 53186. Limestone, 11.5 ft thick.
140. Stoner limestone member. SW¼ sec. 6, T. 17 S., R. 19 E. Lab. No. 49223. Limestone, 12 ft thick. (See also Runnels, 1951, p. 87, 83, 85, 91, 95. T. 16 S., R. 19 E., town of Ottawa, Ross quarry. Locality 11. Limestone, near surface. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; P_2O_5, 0.019 percent; P, 0.008 percent; total sulfur as S, 0.03 percent; sulfide sulfur as S, 0.01 percent; sulfate sulfur as S, 0.016 percent; ignition loss at 1,000° C., sample dried at 105° C.)
141-142. Franklin County. Stanton limestone, Stoner limestone member. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
141. NE¼ sec. 23, T. 18 S., R. 19 E. Lab. No. 53175. Limestone, 10.5 ft thick.
142. NW¼ sec. 33, T. 18 S., R. 21 E. Lab. No. 53198. Limestone, 22 ft thick. (See also Ives, 1955, p. 32, 27, 39. Lab. No. O22. Limestone, fossiliferous; outcrop sample; mineralogy. Bulk density, average of four determinations, 2.44. Ignition loss at 1,000°C., sample dried at 105° C.; no other footnotes given.)
143. Franklin County. (Stanton limestone, Stoner limestone member. T. 16 S., R. 19 E.) town of Ottawa. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone, average from three blocks, fossiliferous. Physical properties. Bulk density, 2.65. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

144. Geary County. Permian, Fort Riley limestone. Sec. 3, T. 13 S., R. 8 E. Lab. No. 52297. (Runnels and Schleicher, 1956, pl. 1, table 4, p. 86, 97.) Limestone, 3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	145	146	147	148	149	150	151	152	153	154	155	156	157
	$15F_237$-6	$15F_237$-8	$15F_237$-9	$15F_237$-7	$15F_237$-10	$15F_238$-8	$15F_238$-7	$15F_238$-6	$15F_238$-5	$15F_238$-4	$15F_238$-10	$15F_238$-9	$15F_242$-4
SiO_2	4.77	3.36	2.48	2.56	3.55	[1] 4.81	[1] 3.61	[1] 3.18	[1] 2.72	[1] 1.79	2.48	2.28	[1] 5.06
Al_2O_3	[2] .93	[2] 1.04	[2] .18	1.55	[2] .50	} 3.07					[3] 1.37	[3] 1.10	2.08
Fe_2O_3	[4] 2.98	[4] 1.30	[4] 1.38	.50	[4] .51	}	......	......	......	......			
FeO	......	......	......	.47	......	......	......	......	......	......	......	......	......
MgO	.72	1.28	.70	.06	.49	[5] .40	.32	.47	.49	.40	.43	.32	[5] .42
CaO	50.13	51.24	53.01	51.98	52.60	[5] 50.77	52.58	52.26	52.26	52.99	53.56	54.00	[5] 51.15
H_2O-	......	......	......	[6] 1.36	......	.08	......	......	......	......	......	......	.44
P_2O_5	.05	.05	Tr.	......	.02	......	......	......	......	......	Nil	Nil	......
S	Nil	[7] (.06)	Nil	......	Tr.	......	......	......	......	......	Nil	Nil	......
SO_3	Nil	.05	Nil	......	Tr.	......	......	......	......	......	......	......	......
Ignition loss	[8] 40.33	[8] 41.69	[8] 42.26	[9] 41.13	[8] 41.81	......	42.04	42.35	42.32	43.39	[10] 41.73	[10] 42.04	......
Total	99.91	100.01	100.01	99.61	99.48	59.13	98.55	98.26	97.79	98.57	99.57	99.74	59.15
Class	0, 9, 89	0, 6, 93	1, 4, 95	0, 6, 93	2, 3, 94	(0, 8) 91	(4, 0) 95	(3, 1) 94	(3, 1) 94	(2, 1) 95	0, 4, 94	0, 3, 95	(2, 7) 92
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	158	159	160	161	162	163	164	165	166	167	168	169	170
	$15F_244$-6	$15F_244$-7	$15F_244$-8	$15F_245$-22	$15F_245$-28	$15F_245$-41	$15F_245$-34	$15F_245$-30	$15F_245$-42	$15F_245$-32	$15F_245$-24	$15F_245$-23	$15F_245$-29
SiO_2	2.47	3.52	[1] 6.98	2.22	3.16	4.84	4.52	3.68	4.68	3.72	2.64	2.32	3.22
Al_2O_3	[2] .73	[2] .77	} 1.04	[11] 2.72	[11] 3.86	[11] 3.52	[11] 3.10	[11] 3.42	[11] 3.96	[11] 3.74	[11] 3.28	[11] 2.94	[11] 2.40
Fe_2O_3	[4] 1.56	[4] 2.20	}										
MgO	3.41	2.02	[5] .79	[5] .26	[5] .25	[5] .22	[5] .24	[5] .34	[5] .23	[5] .49	[5] .18	[5] .21	[5] .19
CaO	49.88	49.42	[5] 50.43	[5] 52.35	[5] 51.15	[5] 50.50	[5] 50.43	[5] 51.60	[5] 49.95	[5] 50.90	[5] 51.65	[5] 52.95	[5] 52.40
P_2O_5	.07	.03	......	......	......	......	......	......	......	......	......	......	......
S	[7] (.04)	......	......	......	......	......	......	......	......	......	......	......	......
SO_3	.04	.56	......	......	......	......	......	......	......	......	......	......	......
Ignition loss	[8] 41.34	[8] 41.43	......	[12] .94	[12] .62	[12] .82	[12] 1.29	[12] Tr.	[12] 1.40	[12] .40	[12] 1.54	[12] Tr.	[12] Tr.
Total	99.50	99.95	59.24	58.49	59.04	59.90	59.58	59.04	60.22	59.25	59.29	58.42	58.21
Class	0, 5, 92	0, 7, 92	(5, 3) 92	0, 4, 94	0, 6, 92	0, 9, 89	0, 9, 90	0, 6, 92	0, 10, 89	0, 7, 91	0, 6, 92	0, 4, 94	0, 6, 94
CaO/MgO	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	171	172	173	174	175	176	177	178	179	180	181	182	183
	$15F_245$-33	$15F_245$-25	$15F_245$-26	$15F_245$-27	$15F_245$-51	$15F_245$-52	$15F_245$-53	$15F_245$-31	$15F_245$-36	$15F_245$-35	$15F_245$-39	$15F_245$-40	$15F_245$-38
Insoluble [13]	......	......	......	......	......	......	......	(7.73)	(4.09)	(2.92)	(7.05)	(8.65)	......
SiO_2	3.80	2.80	2.85	3.00	2.15	2.51	3.98	3.70	1.73	1.51	3.63	4.62	3.35
Al_2O_3	.30	.30	1.30	1.50	} .93	1.91	{ 3.15	} [3] 3.60	{ .74	.75	1.28	1.00	[3] 1.44
Fe_2O_3	1.70	1.50	1.80	2.30	}		{ 1.85	}	{ [3] 1.20	[3] .55	[3] 1.34	[3] 2.51	1.12
MgO	.35	.80	.75	.90	[5] .21	[5] .12	.20	......	.65	.20	.26	.06	Nil
CaO	52.50	52.80	51.55	51.00	[5] 53.62	[5] 53.02	49.58	51.45	53.23	54.54	52.73	51.65	51.52
Na_2O+K_2O	Tr.	None	None	None	[14] .51	......	.25	......	......	......	......	......	......
P_2O_5	......	......	......	......	......	......	......	Nil	Tr.	Nil	Nil	Nil	.04
S	......	......	......	......	......	......	......	Nil	.23	.01	Tr.	.01	Nil
SO_3	Tr.	Tr.	Tr.	Tr.	.27	.30	Tr.	......	......	......	......	......	......
Ignition loss	41.10	41.70	42.10	41.06	......	......	[9] 40.84	40.48	[10] 41.38	[10] 41.56	[10] 40.64	[10] 39.64	[10] 40.26
Total	99.75	99.90	100.35	99.76	57.69	57.86	99.85	99.23	99.16	99.12	99.88	99.49	97.73
Class	1, 5, 92	1, 5, 94	0, 6, 94	0, 6, 72	1, 3, 96	0, 4, 95	0, 7, 91	0, 6, 91	0, 3, 93	0, 3, 94	0, 7, 91	0, 9, 88	0, 6, 90
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (—) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Sn looked for in all samples but not detected]

	145	146	147	149	158	159		145	146	147	149	158	159
B	—	—	—	0.001	—	0.0005	Zn	—	—	—	—	0.001	0.0007
Ti	0.002	0.003	0.01	.004	0.05	.065	Sr	0.037	—	—	—	.045	.048
V	.005	.0005	.005	.005	.0016	.002	Mo	.0003	—	0.0005	—	—	.0002
Cr	—	.0005	.0003	—	—	.0003	Ag	.00005	—	.00005	—	—	.00007
Mn	.06	.07	.005	.01	.008	.023	Ba	.01	0.01	—	—	—	.02
Ni	.001	.001	.001	.0005	—	.0005	Pb	—	.0005	.0005	—	—	.001
Cu	.00004	.00005	.00002	.00002	.000025	.00003							

[1] Insoluble.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Includes TiO_2.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] Reported as H_2O.
[7] Not included in total, included in ignition loss.
[8] 105° -1,000° C.
[9] Reported as CO_2.
[10] 140° -1,000° C.
[11] Reported as oxide of iron and alumina.
[12] Reported as H_2O- and organic matter.
[13] Not included in total.
[14] Reported as alkali and organic matter.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

145-147. Greenwood County. Pennsylvanian, Oread limestone. (Runnels and Schleicher, 1956, pl. 2, table 16, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
 145. Toronto limestone member. NW¼ sec. 10, T. 26 S., R. 13 E. Lab. No. 52294. Limestone, 9 ft thick.
 146. Plattsmouth limestone member. NE¼ sec. 3, T. 28 S., R. 12 E. Lab. No. 53174. Limestone, 7.1 ft thick.
 147. Plattsmouth limestone member. SW¼ sec. 11, T. 28 S., R. 12 E. Lab. No. 52295. Limestone, 7 ft thick.

148. Greenwood County. Oread limestone (R. T. Runnels, written communication, 1953) reported as probably Painterhood limestone. SE¼ sec. 13, T. 28 S., R. 12 E., near town of Fall River. Analyst, Steiger. Lab. No. 2295. (Burchard, 1907, p. 380; Clarke, 1915, p. 234.) Limestone. Possible use: Glass making.

149. Greenwood County. Permian, Foraker limestone, Long Creek limestone member. SE¼ sec. 31, T. 27 S., R. 9 E. Lab. No. 52293. (Runnels and Schleicher, 1956, pl. 1, table 11, p. 86, 97.) Limestone, 10 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

150. Hamilton County. Upper Cretaceous, Benton shale. (T. 23 S., R. 43 W.), town of Coolidge. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 78, 76.) Limestone, fossiliferous. Use: Building stone.

151-154. Hamilton County. Upper Cretaceous, Greenhorn limestone. Analyst, Wheeler. Lab. No. 2878. (Wells, 1937, p. 53.) Limestone.
 151. (T. 24 S., R. 39 W.) northwest of town of Kendall.
 152. (T. 24 S., R. 40 W.) quarry at town of Syracuse. (See also Darton, 1920, p. 8, 3. Approximate analysis to one decimal place. $MgCO_3$ and $CaCO_3$ determined. Geologic maps, generalized columnar section. Use: Building stone. Possible use: Portland cement.)
 153. (T. 24 S., R. 41 W.) well or ledges southwest of Syracuse. (See also Darton, 1920, p. 8, 3. Approximate analysis to one decimal place. $MgCO_3$ and $CaCO_3$ determined. Geologic maps; generalized columnar section. Use: Building stone. Possible use: Portland cement.)
 154. (T. 24 S., R. 41 W.), 18 miles southwest of Syracuse.

155-156. Hamilton County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. Sec. 3, T. 22 S., R. 43 W. (Runnels and Dubins, 1949, p. 22, 4, 9, 10.) Chalk, bluish-gray; few isolated outcrops. Thin-section description. Index map. Possible use: Whiting, lime.
 155. Lab. No. Ha-2-6.
 156. Lab. No. Ha-2-7.

157. Hodgeman County. Greenhorn limestone (R. T. Runnels, written communication, 1953). (T. 23 S., R. 23 W.) town of Jetmore. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 78.) Limestone, fossiliferous. Use: Building stone.

158. Jefferson County. Pennsylvanian, Deer Creek limestone, Ervine Creek limestone member. SE¼ sec. 5, T. 9 S., R. 18 E. Lab. No. 51133. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, 12 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

Kansas--Continued

159. Jefferson County. Pennsylvanian, Topeka limestone, Curzon limestone member. Sec. 19, T. 8 S., R. 18 E. Lab. No. 51121. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, 13 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

160. Jefferson County. Pennsylvanian, Burlingame limestone. (T. 8 S., R. 19 E.), town of Winchester. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone, fossiliferous. Physical properties. Bulk density, 2.72. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

161-177. Jewell County. Niobrara formation. Sec. 5, T. 1 S., R. 7 W., Nebraska Portland Cement Co. quarry. Limestone. Index map, outcrop map. Estimated tonnage. Possible use: Cement material.
 161-170. (Barbour, 1913, p. 107, 93, 95, 108.) General description of limestone: Soft, porous. General discussion of physical tests.
  161. W½SE¼ sec. 5. Depth, 10 ft below surface.
  162. W½SE¼ sec. 5. Depth, 10 ft below surface.
  163. North line NE¼SE¼ sec. 5.
  164. South line NE¼SW¼ sec. 5.
  165. NE¼SW¼ sec. 5.
  166. NE¼SW¼ sec. 5.
  167. NE¼SW¼ sec. 5.
  168. SE¼SW¼ sec. 5.
  169. W½E½SW¼ sec. 5.
  170. E½SW¼ sec. 5.
 171. S½ sec. 5. Lab. No. N-58. (Barbour, 1913, p. 103, 93, 95, 104.) Limestone, light-cream, soft, chalky, uniform.
 172-174. S½ sec. 5. (Barbour, 1913, p. 102, 93, 95.) Possible use: Portland cement.
  172. Lab. No. M-604.
  173. Lab. No. M-605.
  174. Lab. No. M-606.
 175-176. S½ sec. 5. Analyst, Robinson. (Barbour, 1913, p. 96, 93, 95.)
 177. S½ sec. 5. Analyst, Robinson. (Barbour, 1913, p. 98, 93, 95, 104.)

178-183. Jewell County. Niobrara formation, Fort Hays limestone member. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 14, 24, 32, 33.) Chalk. Description of thin section. Index map. Possible use: Whiting, lime.
 178. NW¼ sec. 9, T. 2 S., R. 7 W. Lab. No. Jw-2-1b. From upper part of basal bed. Petrographic analysis.
 179. NW¼SW¼ sec. 10, T. 2 S., R. 8 W. Lab. No. Jw-1-4a. From lower part of bed; 39 ft thick in quarry face at this locality. Columnar section. (For analyses from same measured section see samples 180-182 below, and sample 88, group F_1, of this compilation.)
 180. NW¼SW¼ sec. 10, T. 2 S., R. 8 W. Lab. No. Jw-1-6. Chalk; 39 ft thick in quarry face at this locality. Bed sampled, 3 ft 8 in. thick. Columnar section.
 181. NW¼SW¼ sec. 10, T. 2 S., R. 8 W. Lab. No. Jw-1-9. Deposit 39 ft thick in quarry face at this locality. Columnar section.
 182. NW¼SW¼ sec. 10, T. 2 S., R. 8 W. Lab. No. Jw-1-10. Deposit 39 ft thick in quarry face at this locality. Columnar section.
 183. Sec. 27, T. 4 S., R. 8 W. Lab. No. Jw-3-1a. (Probably sample No. Jw-3-1b, insoluble residue, 7.88 percent.) From lower part of basal bed.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	184	185	186	187	188	189	190	191	192	193	194	195	196
	$15F_2$45-37	$15F_2$46-8	$15F_2$46-9	$15F_2$46-11	$15F_2$46-12	$15F_2$46-10	$15F_2$46-13	$15F_2$46-14	$15F_2$46-17	$15F_2$46-21	$15F_2$46-20	$15F_2$46-18	$15F_2$46-19
SiO_2	3.3	3.11	5.04	1.46	1.10	1.27	3.37	1.33	1.11	1.69	1.33	1.28	1.30
Al_2O_3	1.6	[1].89	[1].74	[1].15	[1].46	[1].42	[1].92	[1].40	[1].28	[1].55	[1].42	[1].36	[1].42
Fe_2O_3	1.1	[2].84	[2].66	[2].34	[2].95	[2]2.06	[2].46	[2].64	[2]1.46	[2].72	[2].51	[2].32	[2].57
MgO	.3	1.32	.66	.58	2.83	1.40	.92	1.50	1.26	1.18	1.10	.56	.57
CaO	52.0	52.11	51.95	53.76	51.56	52.50	52.49	52.86	53.18	53.33	53.33	54.45	53.80
Na_2O	......	......	......	......	.06	......	.06	......	......	......	......	......	......
K_2O	......	......	......	......	.06	......	.08	......	......	......	......	......	......
P_2O_5	......	.12	.11	.04	.02	.02	.05	.03	.07	.06	.02	Tr.	.04
S	......	[3](.02)	[3](.02)	......	Nil	Tr.	Nil	......	[3](.04)	[3](.04)	......	......	......
SO_3	......	.05	.05	Nil	.30	Tr.	.10	Nil	Tr.	.06	Tr.	Nil	Nil
Ignition loss	41.5	[4]41.84	[4]40.83	[4]42.81	[4]43.38	[4]42.39	[4]41.90	[4]42.88	[4]42.50	[4]42.44	[4]42.77	[4]42.84	[4]42.73
Total	99.8	100.28	[5]100.04	99.14	100.72	100.06	100.35	99.64	99.86	100.03	99.48	99.81	99.43
Class	0, 6, 93	1, 5, 94	3, 4, 92	1, 1, 97	0, 2, 97	0, 3, 95	1, 4, 94	0, 3, 96	0, 2, 96	0, 3, 95	0, 2, 96	0, 2, 97	0, 2, 96
CaO/MgO	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	197	198	199	200	201	202	203	204	205	206	207	208	209
	$15F_2$46-15	$15F_2$46-16	$15F_2$ 46-22	$15F_2$46-23	$15F_2$46-24	$15F_2$46-27	$15F_2$46-25	$15F_2$46-26	$15F_2$50-6	$15F_2$50-8	$15F_2$50-9	$15F_2$50-7	$15F_2$50-5
SiO_2	0.49	0.79	0.59	4.35	2.17	3.26	2.78	3.85	7.70	4.87	2.18	3.58	2.20
Al_2O_3	[1].26	[1].30	[1].27	[1].81	[1].40	[1].86	[1].81	[1]1.13	[1].44	[1]1.03	[1].53	[1].60	[1]2.27
Fe_2O_3	[2].35	[2].49	[2].88	[2]1.16	[2].80	[2].67	[2].82	[2].86	[2].49	[2]1.01	[2]1.19	[2].71	[2].82
MgO	.47	.61	.83	1.04	.51	.78	1.26	1.29	.59	1.05	1.21	.98	.39
CaO	55.13	54.61	54.03	50.92	53.37	52.34	52.65	50.80	50.22	50.04	52.61	52.29	51.73
Na_2O	.08	......	......	......	......	......	......	......	......	......	......	......	......
K_2O	.04	......	......	......	......	......	......	......	......	......	......	......	......
P_2O_5	Tr.	Tr.	.05	.03	.03	Tr.	.10	.01	Nil	.09	.04	.01	.02
S	Nil	Tr.	[3](.06)	[3](.04)	Tr.	[3](.10)	......	[3](.14)	Nil	......	......	......	......
SO_3	Nil	Nil	Nil	Tr.	Tr.	.04	.17	.09	Nil	Tr.	.01	Nil	Nil
Ignition loss[4]	43.59	43.14	42.91	41.19	42.40	41.85	42.06	41.23	40.27	40.94	42.29	41.73	42.16
Total	100.41	99.94	99.56	99.50	99.68	[6]99.80	[7]100.65	99.26	99.71	99.03	100.06	99.90	99.59
Class	0, 1, 99	0, 2, 98	0, 1, 97	2, 5, 92	1, 3, 96	1, 4, 94	0, 4, 94	1, 5, 92	6, 2, 91	2, 6, 92	0, 4, 95	2, 4, 94	0, 5, 93
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	185	186	187	188	189	190	191	192	193	194	195	196
B	–	0.001	–	–	0.001	–	–	–	–	–	–	–
Ti	0.013	.02	0.003	0.015	.004	0.02	0.015	0.01	Tr.	0.004	0.003	0.005
V	.01	.0017	.01	.003	.01	.001	.015	.0016	0.002	.015	.02	.02
Cr	.0003	.0002	.001	.0003	.0003	.0003	.001	–	.003	.001	.001	.001
Mn	.02	.01	.035	.025	.10	.015	.05	.044	.006	.06	.05	.05
Ni	.0005	.0003	.0004	.0003	.0005	.001	.0004	.001	.001	.0004	.0002	.0003
Cu	.0005	.000015	.00005	.00004	.00005	.00004	.00005	.000025	.000013	.00005	.00005	.000025
Zn	–	.002	–	–	–	–	–	–	–	–	–	–
Sr	–	.05	–	.029	.047	–	–	.053	–	.02	–	–
Mo	.0001	.0001	–	–	–	–	–	–	–	–	–	–
Ag	–	.00005	.00005	–	.00003	–	.000025	–	–	.000025	.000025	.000025
Sn	–	–	.0001	–	–	–	.0003	–	–	.0003	.0001	.0001
Ba	–	.10	–	.02	–	–	–	–	–	–	–	–
Pb	–	.0008	.0002	–	Tr.	–	.0002	–	–	.0002	–	–

	197	198	199	200	201	202	204	205	206	207	208	209
B	–	–	–	0.00005	–	0.001	–	–	–	–	–	0.0002
Ti	0.01	Tr.	0.002	.01	0.003	.01	0.035	Tr.	0.0015	0.001	0.002	.015
V	.002	0.02	.01	.003	.002	.005	.03	0.01	.0017	.0025	.01	.02
Cr	–	.0005	.0003	.0005	–	.0005	–	–	–	–	–	–
Mn	.05	.025	.10	.05	.05	.05	.05	.02	.05	.30	.03	.40
Ni	.0003	.0005	.0001	.0005	.001	.001	.001	.001	.0004	.0005	.001	.0008
Cu	.000013	.00003	.00002	.0001	.0001	.00003	.0001	.00002	.00004	.001	.0001	.000025
Zn	–	–	–	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	–	.045	.20	–
Mo	–	–	–	–	.0003	–	–	–	–	–	–	–
Ag	.00001	.0001	.00005	.0001	.00005	–	–	–	–	–	–	–
Sn	–	–	–	Tr.	–	–	–	–	–	–	–	–
Ba	–	–	–	.001	–	–	–	–	.015	.02	–	–
Pb	.0005	–	–	.0005	.0005	–	–	–	–	–	–	.001

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[2] Total iron.
[3] Not included in total, included in ignition loss.
[4] 105°-1,000° C.
[5] 100.08 in text.
[6] 99.88 in text.
[7] 100.60 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

184. Jewell County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. SE corner sec. 16, T. 3 S., R. 7 W., near town of Mankato. Lab. No. 1. (Wilson and Skinner, 1937, p. 33, 39, 50, 70, 74, 88, 92, 124.) Chalk, yellow-brown, soft, fossiliferous; from lower 30 ft of member. Physical properties and tests; pH, 8.1. Possible use: Filler, pigment.

185-186. Johnson County. Pennsylvanian. T. 12 S., R. 25 E. Chips from continuous surface. Index map, résumé of spectrographic results.

185. Cherryvale shale, Westerville limestone member. NW¼ sec. 35. Lab. No. 51294. (Runnels and Schleicher, 1956, table 24, pl. 3, p. 86, 97.) Limestone, 18 ft thick.

186. Drum limestone, Dewey limestone member. NE¼ sec. 35. Lab. No. 51295. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.) Limestone, 8 ft thick.

187-193. Johnson County. Pennsylvanian, Wyandotte limestone. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

187. Argentine limestone member. NE¼ sec. 32, T. 13 S., R. 24 E. Lab. No. 54234. Limestone, 6 ft thick.

188. Argentine limestone member. SW¼ sec. 31, T. 14 S., R. 25 E. Lab. No. 52309. Limestone, 18 ft thick.

189. Argentine limestone member. NW¼NW¼ sec. 20, T. 14 S., R. 25 E. Lab. No. 53184. Limestone, 10 ft thick. (See also Ives, 1955, p. 32, 27, 36. Lab. No. O4. Limestone, fossiliferous; outcrop sample; mineralogy. Bulk density, average of 4 determinations, 2.54. No footnote given for Al_2O_3 or Fe_2O_3; sulfide sulfur as S; ignition loss at 1,000° C., sample dried at 105° C.)

190. Argentine limestone member. SW¼ sec. 31, T. 14 S., R. 25 E. Lab. No. 52324. Limestone, 22 ft thick.

191. Farley-Argentine limestone members. NE¼ sec. 32, T. 13 S., R. 23 E. Lab. No. 54230. Limestone, 35 ft thick.

192. Farley limestone member. NE¼ sec. 16, T. 13 S., R. 22 E. Lab. No. 51135. Limestone, 12 ft thick.

193. Farley limestone member. NE¼ sec. 16, T. 13 S., R. 22 E. Lab. No. 51136. Limestone, 10 ft thick.

194-198. Johnson County. Wyandotte limestone, Farley limestone member. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

194. NE¼ sec. 32, T. 13 S., R. 23 E. Lab. No. 54231. Limestone, 24 ft thick.

195. NE¼ sec. 32, T. 13 S., R. 24 E. Lab. No. 54233. Limestone, 17 ft thick.

196. NE¼ sec. 32, T. 13 S., R. 24 E. Lab. No. 54232. Limestone, 6 ft thick.

197. SW¼ sec. 31, T. 14 S., R. 25 E. Lab. No. 52325. Limestone, 22 ft thick.

Kansas--Continued

198. SE¼SE¼ sec. 31, T. 14 S., R. 25 E. Lab. No. 53168. Limestone, 21 ft thick. (See also Ives, 1955, p. 32, 38. Lab. No. O13. Limestone, fossiliferous; outcrop sample; mineralogy. No footnote given for Al_2O_3 of Fe_2O_3; sulfide sulfur as S; ignition loss at 1,000° C., sample dried at 105° C.)

199-200. Johnson County. Pennsylvanian, Plattsburg limestone, Spring Hill limestone member. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

199. SW¼SW¼ sec. 8, T. 15 S., R. 23 E. Lab. No. 53188. Limestone, 11.1 ft thick. (See also Ives, 1955, p. 32, 39. Lab. No. O19. Limestone, fossiliferous; outcrop sample; mineralogy. No footnote given for Al_2O_3 or Fe_2O_3; sulfide sulfur as S; ignition loss at 1,000° C., sample dried at 105° C.)

200. SE¼ sec. 27, T. 13 S., R. 23 E. Lab. No. 53167. Limestone, 12.2 ft thick.

201-204. Johnson County. Pennsylvanian, Stanton limestone. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

201. Captain Creek limestone member. SE¼NE¼ sec. 7, T. 12 S., R. 24 E. Lab. No. 53193. Limestone, 4.5 ft thick. (See also Ives, 1955, p. 32, 37. Lab. No. O9. Limestone, fossiliferous; outcrop sample; mineralogy. No footnote given for Al_2O_3 or Fe_2O_3; sulfide sulfur as S; ignition loss at 1,000° C., sample dried at 105° C.)

202. Stoner limestone member. NW¼ sec. 13, T. 14 S., R. 22 E. Lab. No. 53178. Limestone, 15.3 ft thick.

203. Stoner limestone member. NE¼ sec. 3, T. 14 S., R. 23 E. Lab. No. 49281. Limestone, 7 ft thick.

204. Stoner limestone member. NE¼ sec. 3, T. 14 S., R. 23 E. Lab. No. 53187. Limestone, 12 ft thick.

205. Labette County. Pennsylvanian, Fort Scott limestone, Higginsville limestone member. SE¼ sec. 29, T. 34 S., R. 20 E. Lab. No. 52290. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone, 8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

206-209. Labette County. Pennsylvanian. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

206. Altamont limestone, Worland limestone member. NE¼ sec. 12, T. 32 S., R. 19 E. Lab. No. 49404. Limestone, 11 ft thick.

207. Altamont limestone, Worland limestone member. NE¼ sec. 12, T. 32 S., R. 20 E. Lab. No. 51298. Limestone, 10.5 ft thick.

208. Altamont limestone, Worland limestone member. NW¼ sec. 35, T. 33 S., R. 18 E. Lab. No. 52136. Limestone, 10.5 ft thick.

209. Lenapah limestone, Idenbro limestone member. NE¼ sec. 12, T. 32 S., R. 19 E. Lab. No. 52287. Limestone, 10 ft thick.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	210	211	212	213	214	215	216	217	218	219	220	221	222
	·15F$_2$50-10	15F$_2$51-3	15F$_2$51-2	15F$_2$52-12	15F$_2$52-11	15F$_2$52-13	15F$_2$52-14	15F$_2$52-15	15F$_2$54-6	15F$_2$54-7	15F$_2$54-8	15F$_2$54-9	15F$_2$54-10
SiO_2	3.00	5.27	3.55	1.30	0.93	2.13	7.03	[1] 5.91	2.34	4.81	2.54	5.26	3.53
Al_2O_3	[2] .60	.67	.97	[2] .30	[2] .45	[2] .38	[2] 1.02	2.47	[2] .43	[2] .85	[2] .72	[2] 1.21	[2] .61
Fe_2O_3	[3] 2.94	[4] 1.54	[4] 1.82	[3] .39	[3] .53	[3] .47	[3] .84		[3] .55	[3] 2.69	[3] .53	[3] 2.00	[3] 1.16
MgO	2.41	.30	.11	.98	.75	1.56	1.09	[5] .53	.69	.54	.27	.61	.78
CaO	48.95	51.01	51.78	54.04	54.41	52.58	49.03	[5] 50.35	53.32	50.60	53.33	50.46	52.06
Na_2O	.06	......	......	......	......	......	......	......	......	......	......	......	......
K_2O	.08	......	......	......	......	......	......	......	......	......	......	......	......
P_2O_5	.04	.14	.13	Tr.	.04	.11	.06	......	.02	Tr.	.10	.10	.10
S	[6] (.04)	Nil	Nil	......	......	......	......	......	Nil	......	......	......	......
SO_3	Tr.	......	......	.10	.17	Tr.	.42	.38	Nil	Tr.	Tr.	Tr.	.10
Ignition loss	[7] 41.61	[8] 40.02	[8] 41.11	[7] 42.87	[7] 41.92	[7] 42.54	[7] 39.53	......	[7] 42.27	[7] 40.45	[7] 42.02	[7] 40.17	[7] 41.65
Total	99.69	98.95	99.47	99.98	99.20	99.77	99.02	59.64	99.62	99.94	99.51	[9] 99.81	[10] 99.99
Class	0,6,92	2,6,90	0,7,92	0,2,97	0,2,95	1,2,96	4,5,88	(2,7) 90	1,3,95	0,9,90	1,3,95	1,8,89	1,5,93
CaO/MgO	magnesian calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	223	224	225	226	227	228	229	230	231	232	233	234
	15F$_2$54-11	15F$_2$54-12	15F$_2$54-13	15F$_2$54-15	15F$_2$54-14	15F$_2$54-16	15F$_2$54-17	15F$_2$54-18	15F$_2$56-12	15F$_2$56-13	15F$_2$56-14	15F$_2$56-15
SiO_2	3.08	4.12	5.73	2.79	2.53	6.25	3.48	2.12	4.44	4.75	3.55	4.22
Al_2O_3	[2] .41	[2] .36	[2] .67	[2] .51	[2] .34	[2] .91	[2] .91	[2] .72	[11] 1.56	[2] .73	[2] .98	[2] 1.49
Fe_2O_3	[3] .57	[3] .69	[3] .86	[3] .49	[3] .89	[3] .89	[3] .78	[3] 1.16	3.44	[3] .99	[3] 1.23	[3] 2.12
MgO	.44	.49	.12	.57	.73	.78	.36	1.28	2.74	.70	.81	.79
CaO	53.54	52.63	51.73	53.09	53.34	50.40	52.39	52.05	47.55	51.75	52.19	51.60
Na_2O	.06	.04	......	......	......	......	.10	......	......	......	......	......
K_2O	.03	.04	......	......	......	......	.10	......	......	......	......	......
P_2O_5	Tr.	.01	.10	.04	.04	.18	Tr.	Tr.	.10	.11	.04	.07
S	Nil	Tr.	......	Nil	Tr.	......	Tr.	[6] (.07)	......	......	Tr.	......
SO_3	Nil	Tr.	......	Nil	Tr.	.10	Tr.	Nil	.13	.08	.19	Nil
Ignition loss	[7] 42.27	[7] 41.60	[7] 40.74	[7] 42.29	[7] 42.36	[7] 40.37	[7] 41.45	[7] 42.16	40.53	[7] 40.67	[7] 41.63	[7] 40.54
Total	100.40	99.98	[12] 99.95	99.78	100.23	[13] 99.88	99.57	99.49	100.49	99.78	100.62	100.83
Class	2,3,95	3,3,94	4,4,92	1,3,95	1,3,95	4,5,90	1,5,93	0,4,94	0,9,89	2,5,91	0,6,93	0,8,90
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	210	213	216	218	219	220	221	223
B	0.0003	0.0005	–	0.001	–	–	–	–
Ti	.002	.003	0.004	.007	0.008	0.002	0.003	0.001
V	.02	.0019	.003	.002	.002	.0017	.001	.005
Cr	–	.0002	.001	.0003	.002	–	.0003	–
Mn	.15	.05	.03	.15	.30	.21	.25	.20
Ni	.0008	.00005	–	.001	.0005	.00003	.0005	.001
Cu	.000015	.00002	.00001	.000015	.00005	.000025	.0001	.00003
Zn	–	.008	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	.042
Ag	–	.00005	–	.00005	–	–	–	–
Mo	–	–	–	–	–	–	–	–
Sn	–	–	–	.0007	–	–	–	–
Ba	–	.007	–	–	–	–	–	–
Pb	.0005	.005	–	.001	–	–	–	.001

	224	226	227	229	230	232	233	234
B	–	–	–	–	–	–	–	–
Ti	Tr.	0.01	0.003	0.02	0.003	0.007	0.005	0.10
V	0.015	.005	.0025	.0025	.002	.007	.005	.015
Cr	–	–	–	.002	.0008	–	–	–
Mn	.10	.004	.07	.05	.25	.15	.10	.20
Ni	–	.0005	.0005	.001	.0008	–	.0005	.0002
Cu	.00003	.00008	.00002	.00004	.00002	.0005	.002	.001
Zn	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–
Ag	–	–	–	.00005	.00005	–	–	–
Mo	.0001	–	.0001	–	–	–	–	–
Sn	–	–	–	–	.0007	–	–	–
Ba	–	–	–	–	.02	–	.25	–
Pb	.0005	.004	.0005	.0025	.0015	–	.002	.001

[1] Reported as insoluble residue.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Total iron.
[4] Includes TiO_2.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] Not included in total, included in ignition loss.
[7] 105° -1,000° C.
[8] 140° -1,000° C.
[9] 99.76 in text.
[10] 99.89 in text.
[11] Includes MnO and TiO_2.
[12] 99.85 in text.
[13] 99.83 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

210. Labette County. Pennsylvanian, Swope limestone, Bethany Falls limestone member. SW¼ sec. 24, T. 32 S., R. 17 E. Lab. No. 52292. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone, 7 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

211-212. Lane County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. Sec. 28, T. 20 S., R. 27 W. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 14.) Chalk. Petrographic analysis, thin section description. Index map. Possible use: Lime, whiting.

211. Lab. No. Ln-1-1a. From lower part of basal bed. Insoluble residue, 8.69 percent.

212. Lab. No. Ln-1-1b. From upper part of basal bed. Insoluble residue, 6.67 percent.

213-216. Leavenworth County. Pennsylvanian. SW¼ sec. 13, T. 12 S., R. 22 E. Limestone. Chips from continuous surface. Index map.

213. Wyandotte limestone, Farley limestone member. Lab. No. 49276. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone 22 ft thick, résumé of spectrographic results. (See also Runnels, 1951, p. 87, 83, 85, 91, 97, 98, 102. SE¼ sec. 14, Loring quarry. Locality 12. Limestone. Chemical analysis of calcined base also given. Index map, columnar section. Al_2O_3 contains MnO and TiO_2 if present; total sulfur as S, 0.07 percent; sulfide sulfur as S, 0.03 percent; sulfate sulfur as S, 0.036 percent; P, trace; ignition loss at 1,000° C., sample dried at 105° C. Use: Lime, flux. Possible use: Glass manufacture.)

214. Wyandotte limestone, Farley limestone member. Lab. No. 50351. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86.) Limestone, 21 ft thick.

215. Wyandotte limestone, Farley limestone member. Lab. No. 49224. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86.) Limestone, 5 ft thick.

216. Plattsburg limestone, Spring Hill limestone member. Lab. No. 50350. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 18 ft thick. Index map, résumé of spectrographic results.

217. Leavenworth County. Pennsylvanian, Stanton limestone (R. T. Runnels, written communication, 1953). (T. 9 S., R. 23 E.) town of Lansing. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Limestone, fossiliferous; physical properties. Bulk density, 2.70. Use: Building stone. Possible use: Cement material (Haworth, 1903, p. 53).

218. Linn County. Pennsylvanian, Altamont limestone, Worland limestone member. SW¼ sec. 12, T. 23 S., R. 23 E. Lab. No. 52357. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86, 97.) Limestone, 5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

219-221. Linn County. Pennyslvanian, Hertha limestone. T. 21 S., R. 24 E. (Runnels and Schleicher, 1956, table 27, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

219. Critzer limestone member. SW¼ sec. 27. Lab. No. 49377. Limestone, 10 ft thick.

220. Sniabar limestone member. SW¼ sec. 27. Lab. No. 49364. Limestone, 5 ft thick. (See also Runnels, 1951, p. 87, 83, 85, 91, 101, 102. Locality No. 13. Chemical analysis of calcined base also given. Possible use: Lime, flux. Al_2O_3 contains MnO and TiO_2 if present. Total sulfur as S, 0.03 percent; sulfide sulfur as S, nil; sulfate sulfur as S, 0.028 percent; P, 0.44 percent; ignition loss at 1,000° C., sample dried at 105° C.)

221. Sniabar limestone member. SE¼ sec. 27. Lab. No. 49378. Limestone, 5 ft thick.

222-225. Linn County. Swope limestone. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map.

222. Middle Creek limestone member. SW¼ sec. 27, T. 21 S., R. 24 E. Lab. No. 49361. Limestone, 2.6 ft thick.

Kansas--Continued

223. Bethany Falls limestone member. NE¼ sec. 26, T. 19 S., R. 24 E. Lab. No. 52371. Limestone, 8 ft thick. Résumé of spectrographic results.

224. Bethany Falls limestone member. NE¼ sec. 22, T. 19 S., R. 25 E. Lab. No. 52334. Limestone, 11 ft thick. Résumé of spectrographic results.

225. Bethany Falls limestone member. NW¼ sec. 8, T. 22 S., R. 23 E. Lab. No. 48165. Limestone, 7 ft thick.

226-227. Linn County. Pennsylvanian, Dennis limestone, Winterset limestone member. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

226. NE¼ sec. 14, T. 20 S., R. 23 E. Lab. No. 52277. Limestone, 11 ft thick.

227. NE¼ sec. 25, T. 21 S., R. 22 E. Lab. No. 52274. Limestone, 16 ft thick.

228. Linn County. Pennsylvanian, Drum limestone, Dewey limestone member. Sec. 17, T. 21 S., R. 22 E. Lab. No. 49360. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86.) Limestone, 2.5 ft thick. Chips from continuous surface. Index map.

229. Linn County. Pennsylvanian, Iola limestone, Raytown limestone member. SW¼ sec. 24, T. 20 S., R. 21 E. Lab. No. 52311. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) Limestone, 6 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

230. Linn County. Plattsburg limestone, Spring Hill limestone member. SE¼NW¼ sec. 23, T. 19 S., R. 21 E. Lab. No. 52360. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 22 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also Ives, 1955, p. 32, 39. Lab. No. O21. Limestone, fossiliferous, outcrop sample. Mineralogy. *No footnote for* Al_2O_3 *or* Fe_2O_3*; sulfide sulfur as S, 0.07 percent; ignition loss at 1,000° C., sample dried at 105° C.)*

231. Lyon County. Pennsylvanian, Wabaunsee group, Reading limestone. SW¼SE¼ sec. 33, T. 21 S., R. 11 E. (O'Connor and others, 1953, p. 25, 26, 32, 33, pls. 1, 2.) Limestone, outcrop sample, composite of bed 2.75 ft thick. Geologic and economic maps, geologic cross section. Use: Building stone. Possible use: Agricultural limestone, road metal.

232. Lyon County. Wabaunsee group, Reading limestone. SW¼SE¼ sec. 33, T. 21 S., R. 11 E. Lab. No. 49393. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, composite of upper part of bed 5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1953, p. 25, 26, 32, 33, pls. 1, 2. Limestone, outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone. Possible use: Agricultural limestone, road metal. No footnote for Fe_2O_3 or ignition loss; Al_2O_3 includes MnO and TiO_2; S not reported.)

233. Lyon County. Wabaunsee group, Grandhaven limestone. NE¼NE¼ sec. 21, T. 17 S., R. 12 E. Lab. No. 51269. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, composite of upper bed, 2.6 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1953, p. 25, 26, 32, 33, pls. 1, 2. Limestone, outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, concrete aggregate, road metal. Possible use: Agricultural limestone. No footnote for Fe_2O_3 or ignition loss; Al_2O_3 includes MnO and TiO_2; S not reported.)

234. Lyon County. Wabaunsee group, Grandhaven limestone, upper part. SE¼SW¼ sec. 29, T. 19 S., R. 11 E. Lab. No. 49394. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, composite of upper 7.5 ft of bed. Chips from continuous surface. Index map, résumé of spectrographic results. (See also O'Connor and others, 1953, p. 25, 26, 32, 33, pls. 1, 2. Limestone, outcrop sample. Geologic and economic maps, geologic cross section. Use: Building stone, concrete aggregate, road metal. Possible use: Agricultural limestone. No footnote for Fe_2O_3 or ignition loss; Al_2O_3 includes MnO and TiO_2; S not reported.)

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	235	236	237	238	239	240	241	242	243	244	245	246	247
	$15F_256$-16	$15F_256$-17	$15F_256$-20	$15F_256$-18	$15F_256$-19	$15F_256$-21	$15F_256$-22	$15F_256$-23	$15F_256$-24	$15F_258$-6	$15F_258$-7	$15F_259$-9	$15F_261$-5
SiO_2	1.99	[1] 4.52	5.40	3.92	4.18	5.97	5.65	3.61	4.99	[2] 5.13	[2] 6.75	1.01	[2] 1.35
Al_2O_3	[3] .61	[3] .75	[3] .74	[3] .93	[3] .62	[3] 1.09	[3] .37	[3] .98	[3] 1.25	} 3.15	1.59	{ [3] .57	} 1.32
Fe_2O_3	[4] 1.24	[4] .72	[4] .27	[4] .53	[4] .46	[4] .37	[4] .42	[4] 1.12	[4] 1.01			[4] .42	
MgO	.62	.73	.73	.77	.64	.65	.82	.74	.79	[5] 18.32	[5] 19.36	.54	[5] .48
CaO	53.12	51.63	51.97	52.07	52.25	51.22	51.93	51.78	50.72	[5] 29.78	[5] 28.60	54.37	[5] 53.83
P_2O_5	.06	.39	.01	.05	.03	[6] .12	.05	[7] .01	.06	......	......	Tr.	......
S	Tr.	[8] (.08)	Tr.	[8] (.02)	[8] (.03)	[8] (.02)	[8] (.02)	[8] (.02)	[8] (.05)	......	......	Nil	......
SO_3	.04	.14	.07	.02	.03	.12	.08	[7] .08	.02	......	......	.06	......
Ignition loss [9]	42.17	40.68	41.33	41.53	41.42	40.65	41.14	41.25	40.46	......	......	42.60	......
Total	99.85	99.56	100.52	99.82	99.63	[10] 100.19	100.46	99.57	99.30	56.38	56.30	99.57	56.98
Class	0, 4, 95	2, 4, 91	4, 3, 93	2, 4, 93	3, 3, 93	4, 4, 91	5, 2, 93	1, 6, 92	2, 6, 90	(0, 9) 90	(4, 5) 91	0, 2, 96	(0, 2) 97
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	dolomite	calcite	calcite

	248	249	250	251	252	253	254	255	256	257	258	259	260
	$15F_261$-6	$15F_261$-7	$15F_261$-8	$15F_261$-11	$15F_261$-9	$15F_261$-13	$15F_261$-12	$15F_261$-14	$15F_262$-2	$15F_263$-9	$15F_263$-10	$15F_263$-11	$15F_263$-12
SiO_2	[2] 1.50	[2] 2.44	4.00	2.34	0.63	3.43	2.73	3.65	2.03	3.47	1.69	3.81	1.10
Al_2O_3	} .95	.82	{ [3] .92	[3] .64	[3] .16	[3] .82	[3] .88	[3] .79	......	[3] .96	[3] .72	[3] 1.36	[3] .36
Fe_2O_3			[4] .91	[4] .35	[4] .97	[4] 1.04	[4] .70	[4] .66	[11] 1.07	[4] 1.75	[4] .52	[4] 1.26	[4] .61
MgO	[5] .35	[5] .38	.33	.57	.54	1.13	.52	.69	1.32	.94	.74	1.13	.31
CaO	[5] 54.06	[5] 53.54	52.15	53.40	54.01	51.89	52.94	52.35	52.99	51.52	53.09	50.28	54.65
Na_2O	......	......	.05	.04	......	......	......	......	......	......	......	......	......
K_2O	......	......	.10	.07	......	......	......	......	......	......	......	......	......
P_2O_5	......	......	Tr.	Tr.	.04	Tr.	.03	.06	......	.06	.07	.06	Nil
S	......	......	Tr.	......	Nil	Nil	[8] (.01)	Tr.	......	[8] (.12)	[8] (.04)	[8] (.08)	Nil
SO_3	......	......	Tr.	Tr.	Nil	Nil	.06	.06	......	Nil	.21	Nil	Nil
Ignition loss	......	......	[9] 41.20	[9] 42.33	[9] 43.17	[9] 41.69	[9] 42.15	[9] 41.40	[12] 42.59	[9] 41.12	[9] 42.58	[9] 41.30	[9] 42.78
Total	56.86	57.18	99.66	99.74	99.52	100.00	100.01	99.66	100.00	99.82	99.62	99.20	99.81
Class	(0, 3) 97	(1, 2) 96	1, 5, 93	1, 3, 95	0, 1, 98	1, 5, 93	0, 4, 95	2, 4, 93	2, 0, 96	0, 7, 92	0, 3, 96	0, 7, 92	0, 2, 97
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Zn looked for in all samples but not detected]

	235	236	237	238	240	246	250	251	252	253	254	255
B	–	0.001	–	0.001	–	–	–	–	–	–	–	–
Ti	0.009	.0015	0.0015	.05	0.003	0.007	0.02	0.005	Tr.	0.02	0.002	0.06
V	.005	.003	.005	.01	.001	.007	.025	.0025	0.0025	.005	.003	.0013
Cr	.0003	.0003	.0003	.001	–	.0005	–	–	–	–	–	–
Mn	.25	.10	.05	.005	.02	.02	.03	.03	.05	.05	.055	.006
Ni	.001	.001	.0005	.001	.001	.0003	.001	.0005	.0001	.001	.0005	–
Cu	.0005	.00005	.002	.001	.0001	.00002	.00002	.00004	.000025	.000025	.00002	.00004
Sr	–	–	–	–	–	–	–	–	–	–	.086	–
Mo	–	–	–	.0002	–	–	–	.0001	–	–	–	–
Ag	.00005	–	–	.0001	–	–	–	–	–	–	–	–
Sn	.001	–	–	.0005	–	–	–	–	–	–	–	–
Ba	.02	–	–	–	–	–	–	–	–	–	–	–
Pb	.0025	–	–	.002	.001	–	.001	.001	–	.0001	–	Tr.

	257	258	259	260		257	258	259	260
B	0.001	–	0.0005	–	Sr	–	0.068	–	–
Ti	.02	0.02	.06	0.001	Mo	0.0001	–	–	–
V	.0025	.0032	.01	.025	Ag	.0001	–	–	–
Cr	–	.0006	.0001	–	Sn	.004	–	–	0.005
Mn	.10	.069	.01	.035	Ba	.08	–	–	–
Ni	.001	.0035	.002	.0003	Pb	.0025	–	0.0005	–
Cu	.00004	.00015	.00005	.000025					

[1] Reported as 4.25 percent by O'Connor and others (1953, p. 25).
[2] Reported as insoluble residue.
[3] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[4] Total iron.
[5] Calculated from reported $MgCO_3$ or $CaCO_3$.
[6] Reported as 0.08 percent by O'Connor and others (1953, p. 25).
[7] P_2O_5 reported as 0.03 percent, SO_3 as 0.09 percent by O'Connor and others (1953, p. 25).
[8] Not included in total, included in ignition loss.
[9] 105° -1,000° C.
[10] 100.15 in text.
[11] Reported as FeO.
[12] Reported as CO_2.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

235-243. Lyon County. Permian. (O'Connor and others, 1953, p. 25, 26, 32, 33, pls. 1, 2.) Limestone, outcrop samples. Geologic and economic maps, geologic cross section. Use: Building stone. Possible use: Agricultural limestone, road metal. Al_2O_3 includes MnO and TiO_2; S, not reported; no footnote for Fe_2O_3 or ignition loss.

235. Aspinwall limestone. NE¼SW¼ sec. 16, T. 18 S., R. 11 E. Lab. No. 51272. (Runnels and Schleicher, 1956, table 11, pl. 1, p. 86, 97.) Limestone, composite of upper 4.6 ft of bed. Chips from continuous surface. Index map, résumé of spectrographic results.

236. Foraker limestone, Americus limestone member. SW¼SE¼ sec. 4, T. 20 S., R. 10 E. Lab. No. 51263. (Runnels and Schleicher, 1956, table 11, pl. 1, p. 86, 97.) Limestone, composite of lower bed, 1.8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

237. Red Eagle limestone, Howe limestone member. SE¼NE¼ sec. 34, T. 15 S., R. 11 E. Lab. No. 51270. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone, composite of lower 4.0 ft of 4.4 ft bed. Chips from continuous surface. Index map, résumé of spectrographic results.

238. Neva limestone. NW¼SW¼ sec. 20, T. 16 S., R. 11 E. Lab. No. 51279. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone, composite of middle bed, 5.7 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

239. Neva limestone. NW¼SW¼ sec. 20, T. 16 S., R. 11 E. Lab. No. 51262. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86.) Limestone, composite of bed 1.7 ft thick. Chips from continuous surface. Index map.

240. Cottonwood limestone. SW¼NW¼ sec. 7, T. 18 S., R. 10 E. Lab. No. 51277. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Limestone, composite of upper 4.7 ft of member. Chips from continuous surface. Index map, résumé of spectrographic results.

241. Beattie limestone, Morrill limestone member. SW¼NE¼ sec. 17, T. 16 S., R. 11 E. Lab. No. 51278. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86.) Limestone, composite of bed 2.4 ft thick. Chips from continuous surface. Index map.

242. Garrison shale, upper part of Crouse limestone member. NE¼NW¼ sec. 15, T. 16 S., R. 10 E. Lab. No. 51261. (Runnels and Schleicher, 1956, table 8, pl. 1, p. 86.) Limestone, composite of lower 2.9 ft of bed. Chips from continuous surface. Index map.

243. Funston limestone. NE¼ sec. 18, T. 16 S., R. 10 E. Lab. No. 51259. (Runnels and Schleicher, 1956, table 7, pl. 1, p. 86.) Limestone, composite of middle detrital bed, 2.0 ft thick. Chips from continuous surface. Index map.

244-245. Marion County. Permian, Herington limestone (R. T. Runnels, written communication, 1954). (T. 19 S., R. 4 E.) Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 504; Haworth, 1898, p. 77, 76.) Physical properties. Use: Building stone.

244. Town of Marion. Dolomite, gray, fossiliferous, fine-grained. Bulk density, 2.67.

245. Locality, 5 miles northeast of Marion, I. Kuhn and Co. Limestone, fossiliferous; average of 5 blocks. Bulk density, 2.73.

246. Marshall County. Permian, Fort Riley limestone. NE¼ sec. 34, T. 5 S., R. 6 E. Lab. No. 53190. (Runnels and Schleicher, 1956, table 4, pl. 1, p. 86, 97.) Limestone, 7.3 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

Kansas--Continued

247-249. Miami County. Pennsylvanian, Dennis or Swope limestone (R. T. Runnels, written communication, 1953). (T. 19 S., R. 23 E.) town of Fontana. Analyst, under supervision of Bailey. Collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Limestone, fossiliferous. Physical properties. Use: Building stone. Possible use: Portland cement (Haworth, 1903, p. 53).

247. Bulk density, 2.65.
248. Bulk density, 2.50.
249. Bulk density, 2.33.

250-255. Miami County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

250. Iola limestone, Raytown limestone member. Sec. 13, T. 18 S., R. 21 E. Lab. No. 52326. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) Limestone, 11 ft thick.

251. Wyandotte limestone, Argentine limestone member. NW¼NW¼ sec. 14, T. 16 S., R. 24 E. Lab. No. 52281. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone, 17 ft thick. (See also Ives, 1955, p. 32, 36. Lab. No. O2. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3, Fe_2O_3 or S., ignition loss at 1,000° C., sample dried at 105° C.)

252. Wyandotte limestone, Argentine limestone member. NE¼ sec. 12, T. 17 S., R. 22 E. Lab. No. 52304. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86, 97.) Limestone, 8 ft thick. (See also Ives, 1955, p. 32, 36. NW¼NW¼ sec. 12. Lab. No. O3. Limestone, fossiliferous; outcrop sample. Mineralogy. No footnote for Al_2O_3, Fe_2O_3 or S., ignition loss at 1,000° C., sample dried at 105° C.)

253. Stanton limestone, Stoner limestone member. NW¼ sec. 35, T. 15 S., R. 21 E. Lab. No. 52271. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 13 ft thick.

254. Stanton limestone, Stoner limestone member. NE¼ sec. 1, T. 16 S., R. 21 E. Lab. No. 518. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) (See also Runnels, 1951, p. 88, 83, 85, 91, 99, 102. Near town of Wellsville, Killough quarry. Locality No. 14. Limestone, 14 ft thick in quarry face. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 contains MnO and TiO_2 if present; total sulfur as S, 0.03 percent; sulfide snlfur as S, 0.01 percent; sulfate sulfur as S, 0.020 percent; P_2O_5, 0.033 percent; P, 0.014 percent; ignition loss at 1,000° C., sample dried at 105° C.)

255. Stanton limestone, Stoner limestone member. NE¼ sec. 1, T. 16 S., R. 21 E. Lab. No. 5190. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 14 ft thick.

256. Mitchell County. (Recent. T. 6 S., R. 10 W.), 2.5 miles southeast of town of Cawker, "Great Spirit" Spring. Analyst, Patrick. (Patrick, 1881, p. 25.) Travertine (R. T. Runnels, written communication, 1954) porous. Hardness, 4-5.

257-260. Montgomery County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

257. Cherryvale shale, Block limestone member, NE¼ sec. 33, T. 33 S., R. 16 E. Lab. No. 52285. (Runnels and Schleicher, 1956, table 24, pl. 3, p. 86, 97.) Limestone, 9 ft thick.

258. Drum limestone, Corbin City limestone member. NW¼ sec. 5, T. 33 S., R. 16 E. Lab. No. 5193. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.) Limestone, 40 ft thick.

259. Drum limestone, Corbin City limestone member. NW¼ sec. 5, T. 33 S., R. 16 E. Lab. No. 52291. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.) Limestone, 11 ft thick.

260. Plattsburg limestone, Spring Hill limestone member. NW¼ sec. 28, T. 31 S., R. 15 E. Lab. No. 52284. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 7 ft thick.

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	261	262	263	264	265	266	267	268	269	270	271	272	273
	$15F_263$-14	$15F_263$-13	$15F_264$-6	$15F_264$-5	$15F_264$-1	$15F_266$-5	$15F_267$-4	$15F_267$-5	$15F_267$-6	$15F_267$-7	$15F_267$-8	$15F_268$-3	$15F_268$-4
SiO_2	1.56	2.32	6.41	5.67	3.01	2.19	3.32	1.54	1.94	1.54	2.51	2.90	3.25
Al_2O_3	[1] .55	[1] .91	[1] 1.08	[1] 2.00	11.73	[1] .87	[1] .80	[1] .41	[1] .41	[1] .66	[1] .72	1.50	1.52
Fe_2O_3	[2] .73	[2] .56	[2] .54	[2] .76	Tr.	[2] 3.56	[2] 1.67	[2] 1.34	[2] .54	[2] .93	[2] .93	[3] .70	[3] .56
MgO	.46	.74	.98	2.32	Tr.	1.03	.28	.49	.17	.63	1.59	1.47	.74
CaO	53.66	52.64	49.95	49.25	[4] 48.37	51.13	52.34	53.51	54.32	53.42	51.50	51.21	52.17
Na_2O	......	......	......	......	......	......	......	.03	......	......	......	......	......
K_2O	......	......	......	......	......	......	......	.02	......	......	......	......	......
P_2O_5	.02	.03	.01	.19	......	.10	.09	.01	.03	.05	.06	Nil	Nil
CO_2	......	......	......	......	38.32	......	......	......	......	......	......	......	......
S	Nil	Tr.	Nil	......	......	[5] (.02)	Nil	Tr.	Nil	......	[5] (.08)	Nil	Nil
SO_3	Nil	Tr.	.16	......	......	Nil	.11	Tr.	Nil	.02	......	......	......
Ignition loss	[6] 42.57	[6] 42.13	[6] 40.48	[6] 40.31	......	[6] 41.03	[6] 41.47	[6] 42.42	[6] 42.79	[6] 42.35	[6] 42.30	[7] 41.85	[7] 41.69
Total	99.55	99.33	99.61	100.50	101.43	99.91	100.08	99.77	100.20	99.60	99.61	99.63	99.93
Class	0, 3, 96	0, 4, 95	4, 5, 91	1, 8, 89	0, 5, 87	0, 4, 92	0, 6, 93	0, 3, 96	1, 3, 97	0, 3, 95	0, 4, 95	0, 5, 94	0, 6, 93
CaO/MgO	calcite	calcite	calcite	magnesian calcite	calcite	calicte	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	274	275	276	277	278	279	280	281	282	283	284	285	286
	$15F_269$-27	$15F_270$-8	$15F_270$-9	$15F_270$-10	$15F_270$-11	$15F_270$-12	$15F_270$-13	$15F_270$-16	$15F_270$-15	$15F_270$-14	$15F_270$-17	$15F_270$-18	$15F_270$-19
SiO_2	[8] 8.29	3.89	3.87	2.77	0.74	0.82	2.88	3.61	3.45	2.14	4.89	5.75	2.17
Al_2O_3	......	[1] 1.04	[1] .82	[1] .85	[1] [9] .34	[1] .25	[1] 3.89	[1] .81	[1] .75	[10] .50	[10] 1.06	[10] 1.76	[10] 1.57
Fe_2O_3	[11] .90	[2] 1.32	[2] 2.73	[2] 1.32	[2] .53	[2] .67	[2] 5.01	[2] 1.22	[2] .66	.67	1.21	1.08	1.42
MgO	[4] .96	2.15	.88	1.03	.51	.53	13.54	.47	.96	.75	1.38	.91	1.32
CaO	[4] 49.86	49.59	51.28	52.12	54.37	54.56	30.77	52.75	51.84	53.20	49.43	49.50	51.73
P_2O_5	......	Tr.	Tr.	Tr.	.07	.08	.20	.11	.06	.07	.06	.10	.10
S	......	[5] (.20)	......	......	......	......	......	......	......	.03	......	......	......
SO_3	......	.16	Tr.	Tr.	Nil	Nil	.13	Tr.	Tr.	......	.32	.37	.47
Ignition loss	......	[6] 41.24	[6] 40.81	[6] 42.02	[6] 43.13	[6] 43.07	[6] 42.59	[6] 41.18	[6] 41.62	[6] 42.35	40.73	39.90	41.90
Total	60.01	99.39	100.39	100.11	[12] 99.69	99.98	99.01	100.15	99.34	99.71	99.08	99.37	100.68
Class	(8, 0) 91	1, 6, 92	0, 8, 91	0, 5, 94	0, 1, 98	0, 2, 97	0, 9, 83	1, 5, 92	1, 4, 93	1, 3, 95	2, 6, 91	1, 8, 89	0, 4, 94
CaO/MgO	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcareous dolomite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (-) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	261	262	263	264	266	268	269	270	271	275	276	277	279	282
B	–	–	–	0.002	0.002	–	–	–	–	–	–	–	–	–
Ti	0.004	0.015	0.01	.0085	.011	0.004	0.01	0.005	0.35	0.02	0.005	0.02	0.002	0.002
V	.002	.01	.003	.0011	.005	.01	.015	.005	.0017	.01	.04	.005	.002	.0026
Cr	–	–	–	Tr.	.0003	–	–	–	–	.0005	.0003	.0005	–	–
Mn	.03	.035	.005	.009	.25	.10	.03	.25	.007	.05	.045	.05	.21	.095
Ni	.0002	.0005	.0005	.0003	.001	.0003	.0005	.0005	–	.001	.0005	.002	–	–
Cu	.000015	.000025	.0001	.00005	.0005	.00002	.000025	.0001	.00002	.00005	.00005	.0001	.000025	.000015
Zn	–	–	–	.003	–	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	.20	–	–	–	.067	.011
Mo	–	.0005	–	–	.0005	–	–	–	–	–	–	–	–	–
Ag	–	–	–	.00005	.00005	.00005	.002	.00005	–	–	–	–	–	–
Sn	–	–	.001	–	.001	–	–	–	–	–	–	–	–	–
Ba	–	–	–	.02	.05	–	–	.02	–	–	–	–	–	–
Pb	.0005	–	.003	.0008	.002	.0008	.0005	–	–	–	–	–	–	–

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[2] Total iron.
[3] Includes TiO_2.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Not included in total, included in ignition loss.
[6] 105° -1,000° C.
[7] 140° -1,000° C.
[8] Reported as insoluble residue.
[9] Reported as 0.24 percent by O'Connor and others (1955, p. 21).
[10] Includes TiO_2 and MnO if present.
[11] Iron in ferrous state (Day, 1895, p. 505).
[12] 99.59 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

261-262. Montgomery County. Pennsylvanian, Stanton limestone. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results.

261. Captain Creek limestone member. NW¼ sec. 8, T. 32 S., R. 15 E. Lab. No. 52288. Limestone, 12.5 ft thick.

262. Stoner limestone member. NE¼ sec. 15, T. 32 S., R. 14 E. Lab. No. 52289. Limestone, 10.5 ft thick.

263-264. Morris County. Permian. (Runnels and Schleicher, 1956, table 9, pl. 1, p. 86, 97.) Chips from continuous surface. Index map, résumé of spectrographic results.

263. Cottonwood limestone. SE¼ sec. 33, T. 16 S., R. 9 E. Lab. No. 53183. Limestone, 5.1 ft thick.

264. Beattie limestone, Morrill limestone member. SE¼ sec. 34, T. 17 S., R. 9 E. Lab. No. C-17. Limestone, 4 ft thick.

265. Morris County. Permian (Wreford limestone) reported as Strong flint. (T. 16 S., R. 8 E.), 2 miles northeast of town of Council Grove. Analyst, Finney. (Prosser, 1895, p. 781.) Limestone, light-gray, cherty; contains flint in regular layers, two strata separated by massive, whitish limestone.

266-271. Pennsylvanian. Limestone. Chips from continuons surface. Index map, résumé of spectrographic results.

266. Nemaha County. Wabaunsee group, Elmont limestone. NE¼ sec. 29, T. 1 S., R. 12 E. Lab. No. 51320. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 2 ft thick.

267. Neosho County. Altamont limestone, Worland limestone member. SW¼ sec. 5, T. 29 S., R. 21 E. Lab. No. 50553. (Runnels and Schleicher, 1956, table 28, pl. 3, p. 86.) Limestone, 8 ft thick.

268. Neosho County. Swope limestone, Bethany Falls limestone member. NW¼ sec. 33, T. 30 S., R. 19 E. Lab. No. 52337. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone, 5 ft thick.

269. Neosho County. Dennis limestone, Winterset limestone member. NE¼ sec. 5, T. 29 S., R. 19 E. Lab. No. 52303. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 8 ft thick.

270. Neosho County. Drum limestone, Dewey limestone member. Sec. 26, T. 30 S., R. 18 E. Lab. No. 51297. (Runnels and Schleicher, 1956, table 23, pl. 3, p. 86, 97.) Limestone, 5 ft thick.

271. Neosho County, Iola limestone, Raytown limestone member. SW¼ sec. 18, T. 27 S., R. 18 E. Lab. No. 5126. (Runnels and Schleicher, 1956, table 22, pl. 3, p. 86, 97.) (See also, Runnels, 1951, p. 88, 83, 85, 91, 102. Town of Chanute, Ash Grove Lime and Cement Co. quarry. Locality No. 15. Limestone, maximum thickness 25 ft. Chemical analysis of calcined base also given. Index map. Possible use: Flux, lime. Al_2O_3 contains MnO and TiO_2 if present. Total sulfur as S, 0.08 percent; P, 0.026 percent. Sample dried at 105° C., ignition loss at 1,000° C.)

272-273. Ness County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. Sec. 33, T. 18 S., R. 26 W. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 34.) Chalk, lower part of formation. Thin section description. Index map. Possible use: Lime, whiting.

272. Lab. No. Ns-1-2.

273. Lab. No. Ns-1-3.

274. Norton County. Tertiary, Loup Fork beds. (T. 2 S., R. 23 W.) town of Norton. Analyst under supervision of Bailey, collector, Williston. (Day, 1895, p. 505; Haworth, 1898, p. 78.) Limestone, fossiliferous; average from 4 blocks. Physical properties. Bulk density, 2.51. Use: Building stone.

275-280. Osage County. Pennsylvanian. Analyst under supervision of Runnels. (O'Connor and others, 1955, p. 21, 5, 20, 26, 27, pls. 1, 2.) Limestone, outcrop samples. Index map, geologic and economic maps, geologic cross section, generalized columnar section. Possible use: Riprap, crushed rock, agricultural limestone. Al_2O_3 includes MnO and TiO_2, ignition loss at 1,000° C., no other footnotes given.

Kansas--Continued

275. Oread limestone, Plattsmouth limestone member. NW¼SW¼ sec. 3, T. 18 S., R. 16 E. Lab. No. 54224. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, composite of bed 20.2 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

276. Deer Creek limestone, Ozawkie limestone member. NW¼NE¼ sec. 4, T. 15 S., R. 17 E. Lab. No. 54222. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, composite of 11.7 ft. Chips from continuous surface. Index map, résumé of spectrographic results.

277. Deer Creek limestone, Ervine Creek limestone member. NE¼NW¼ sec. 32, T. 14 S., R. 17 E. Lab. No. 54223. (Rnnnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone, composite of 9.8 ft. Chips from continuous surface. Index map, résumé of spectrographic results.

278. Topeka limestone, Hartford limestone member. NW¼SE¼ sec. 12, T. 18 S., R. 14 E. Lab. No. 49383. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86.) Chips from continuous surface, index map.

279. Topeka limestone, Hartford limestone member. SE¼SW¼ sec. 14, T. 18 S., R. 14 E. Lab. No. 49381. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, lower 5 ft of 8.5-ft bed. Chips from continuous surface. Index map, résumé of spectrographic results.

280. Topeka limestone, Hartford limestone member. SE¼SW¼ sec. 14, T. 18 S., R. 14 E. Lab. No. 49388. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86.) Limestone, upper 3.5 ft of 8.5-ft bed. Chips from continuous surface, index map.

281-282. Osage County. Pennsylvanian, Topeka limestone, Curzon limestone member. Analyst under supervision of Rnnnels. (O'Connor and others, 1955, p. 21, 5, 20, 26, 27, pls. 1, 2.) Limestone, outcrop samples. Index map, geologic and economic maps, geologic cross section, generalized columnar sections. Possible use: Riprap, crushed rock, agricultural limestone. Al_2O_3 includes MnO and TiO_2; ignition loss at 1,000° C., no other footnotes given.

281. SE¼NE¼ sec. 27, T. 15 S., R. 15 E. Lab. No. 49382. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86.) Limestone, composite of 6-ft bed. Chips from continuous surface, index map.

282. SE¼SW¼ sec. 14, T. 18 S., R. 14 E. Lab. No. 49387. (Runnels and Schleicher, 1956, table 13, pl. 2, p. 86, 97.) Limestone, composite of 5.8-ft bed. Chips from continnous surface. Index map, résumé of spectrographic results.

283. Osage County. Topeka limestone, Curzon limestone member. Sec. 14, T. 18 S., R. 14 E. Locality No. 16. (Runnels, 1951, p. 88, 83, 85, 91, 102.) Limestone, 8 ft thick; composite of two samples. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Total sulfur as S, 0.03 percent; sulfide sulfur as S, nil; sulfate sulfur as S, 0.036 percent; P, 0.031 percent. Sample dried at 105° C.

284-286. Osage County. Pennsylvanian, Wabaunsee group, Elmont limestone member. NW¼NE¼ sec. 23, T. 16 S., R. 13 E. Analyst under supervision of Runnels. (O'Connor and others, 1955, p. 21, 5, 20, 26, 27, pls. 1, 2.) Limestone, outcrop samples. Index map, geologic and economic maps, geologic cross section, generalized columnar sections. Possible use: Riprap, crushed rock, agricultural limestone.

284. Limestone, composite of 3.5-ft bed, lower part of formation.

285. Limestone, 1.5-ft bed, middle part of formation.

286. Limestone, 1.5-ft bed, upper part of formation.

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas										
	287	288	289	290	291	292	293	294	295	296	297
	15F₂70-20	15F₂71-8	15F₂71-10	15F₂71-11	15F₂71-6	15F₂71-7	15F₂71-12	15F₂71-13	15F₂71-9	15F₂74-21	15F₂75-2
Insoluble [1]	......	......	......	......	......	(2.62)	(7.10)	(9.03)	(6.77)	(6.79)	......
SiO_2	4.46	2.47	3.14	3.43	0.93	1.00	4.38	4.63	2.53	3.05	3.27
Al_2O_3	[2] 1.34	[3] 2.26	[3] 1.91	[3] 3.92	[3] .96	[3] .49	[3] 1.40	[3] 2.32	.83	[3] .85	[2] .44
Fe_2O_3	[4] 1.23					.79	1.03	1.87	[3] 1.90	1.80	[4] .71
MgO	1.26	.32	.18	.40	.30	.22	.16	.25	.14	.36	.75
CaO	49.98	53.34	52.73	51.67	54.63	54.26	51.92	50.74	52.59	52.60	52.09
Na_2O	......	......	......	......	......	......	......	......	......	......	.06
K_2O	......	......	......	......	......	......	......	......	......	......	.03
P_2O_5	.08	Nil	Nil	Nil	Nil	Tr.	Nil	Tr.	Nil	Nil	.01
S	......	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	......
SO_3	.37	......	......	......	......	......	......	......	......	......	.10
Ignition loss	[5] 40.81	[6] 41.56	[6] 41.46	[6] 40.78	[6] 42.73	[6] 42.67	[6] 40.95	[6] 40.06	[6] 40.72	[6] 41.08	[5] 41.80
Total	99.53	99.95	99.42	100.20	99.55	99.43	99.84	99.87	98.71	99.74	99.26
Class	1, 7, 91	0, 4, 94	0, 5, 93	0, 6, 91	0, 2, 97	0, 2, 97	1, 7, 92	0, 9, 89	0, 5, 91	0, 6, 92	2, 3, 94
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	298	299	300	301	302	303	304	305	306	307	308
	15F₂80-8	15F₂80-9	15F₂80-10	15F₂80-11	15F₂80-12	15F₂81-8	15F₂81-6	15F₂81-9	15F₂81-10	15F₂81-11	15F₂81-12
SiO_2	2.48	2.52	2.68	3.04	4.26	4.63	6.79	3.06	4.34	2.76	5.01
Al_2O_3	2.61	2.89	2.54	1.43	5.34	[2] 1.68	[2] 1.89	[2] .62	[2] 1.27	[2] .99	[2] 1.27
Fe_2O_3	.35	.35	.54	.53	.98	[4] 2.32	[4] .45	[4] .53	[4] .16	[4] .92	[4] .83
MgO	14.08	13.52	15.35	14.40	16.33	16.88	.57	.22	.43	5.38	1.67
CaO	35.92	36.44	33.82	36.22	29.66	31.24	49.20	52.60	51.63	46.95	50.01
Na_2O	......	......	......	......	......	......	......	......	......	......	.04
K_2O	......	......	......	......	......	......	......	......	......	......	.12
P_2O_5	......	......	......	......	......	.10	.05	.03	.05	.03	.02
S	......	......	......	......	......	......	......	......	......	......	Nil
SO_3	......	......	......	......	......	......	.08	.14	.13	.06	.13
Ignition loss	43.46	43.29	43.25	41.40	41.02	[5] 42.96	[5] 39.68	[5] 41.99	[5] 41.30	[5] 42.76	[5] 40.72
Total	98.90	99.01	98.18	97.02	97.59	[7] 99.81	98.71	99.19	99.31	99.85	99.82
Class	0, 4, 93	0, 4, 92	0, 5, 92	0, 5, 88	0, 7, 86	0, 9, 89	3, 7, 89	1, 3, 94	2, 4, 93	0, 5, 94	2, 6, 91
CaO/MgO	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcite	calcite	calcite	magnesian calcite	calcite

	309	310	311	312	313	314	315	316	317	318	319
	15F₂82-14	15F₂82-4	15F₂82-6	15F₂82-7	15F₂82-5	15F₂82-13	15F₂82-11	15F₂82-9	15F₂82-8	15F₂82-10	15F₂82-12
Insoluble [1]	(28.4)	(3.89)	(3.95)	(4.96)	(7.50)	(7.46)	......	......	......	......	......
SiO_2	4.32	1.52	1.93	2.13	1.70	4.08	3.14	2.53	2.15	2.97	4.00
Al_2O_3	.42	[3] 1.03	[3] 1.27	[3] .79	[3] 3.12	[3] 2.88	[3] 1.78	[3] 1.76	[3] .67	[3] .72	[3] .75
Fe_2O_3	[3] 3.64	.94	1.79	1.03	2.57	1.21		1.32	1.35	1.73	2.33
MgO	.13	.23	.40	.13	.26	(8)	.68	.07	.58	.82	.81
CaO	50.15	54.00	52.61	53.41	52.51	51.07	51.85	50.98	52.16	51.37	50.45
P_2O_5	.09	Nil	Nil	Nil	Nil	.07	Tr.	.10	.06	.10	.16
S	Nil	Nil	Nil	Nil	Nil	Nil	Nil	.10	Tr.	Tr.	.02
Ignition loss [6]	39.39	42.11	42.02	41.55	40.74	40.15	41.64	41.24	41.89	41.46	40.65
Total	98.14	99.83	100.02	99.04	100.90	99.46	99.09	98.10	98.86	99.17	99.17
Class	0, 9, 87	0, 3, 95	0, 4, 95	0, 4, 94	0, 3, 92	0, 7, 90	0, 5, 93	0, 5, 91	0, 4, 94	0, 6, 93	0, 8, 90
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

See following page for footnotes.

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not determined. B and Zn looked for in all samples but not detected]

	287	297	306	308		287	297	306	308
Ti	0.012	0.004	0.3	0.04	Mo	–	0.0003	–	–
V	.005	.07	.02	.0025	Ag	–	.0001	–	–
Cr	.0003	–	.001	.0003	Sn	0.001	.005	–	0.0005
Mn	.04	.02	.025	.01	Ba	.10	–	–	–
Ni	.001	.0005	.0005	.0003	Pb	.003	.003	–	.003
Cu	.0002	.000025	.00002	.00005					

Spectrographic analyses

[Li, Na, K, Sr, Zr, and Ba may be present but not shown on spectrograph]

	290	291		290	291		290	291
P............	Very faint trace	Very faint trace	Ti...........	Small but positive	Very faint trace	Mn...........	Small but positive	Small but positive

[1] Not included in total.
[2] Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
[3] Includes TiO_2.
[4] Total iron.
[5] 105° -1,000° C.
[6] 140° -1,000° C.
[7] 99.71 in text.
[8] Lost.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

287. Osage County. Pennsylvanian, Wabaunsee group, Elmont limestone member. Sec. 23, T. 16 S., R. 13 E. Lab. No. 49384-6. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone, 6.5 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

288-291. Osborne County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. NW¼ sec. 13, T. 7 S., R. 15 W. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 17, 32.) Chalk, about 40 ft thick. Index map. Thin section description. Possible use: Whiting.
- 288. Lab. No. Ob-1-2.
- 289. Lab. No. Ob-1-3.
- 290. Lab. No. Ob-1-4.
- 291. Lab. No. Ob-1-5.

292-293. Osborne County. Niobrara formation, Fort Hays limestone member. Secs. 19 and 30, T. 9 S., R. 12 W. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 25, 32.) Chalk, 33 ft thick. Index map, columnar section. Thin section description. Possible use: Whiting.
- 292. Lab. No. Ob-4-7.
- 293. Lab. No. Ob-4-10.

294. Osborne County. Niobrara formation, Fort Hays limestone member. Sec. 31, T. 9 S., R. 12 W. Lab. No. Ob-3-1b. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 32.) Chalk, from upper part of basal bed. Index map. Thin section description. Possible use: Whiting. (For another analysis from same measured section, see sample 257, group B of this compilation.)

295-296. Niobrara formation, Fort Hays limestone member. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 32, 34.) Chalk, from upper part of basal bed. Index map. Thin section description.
- 295. Osborne County. Secs. 19, 20, 29, and 30, T. 10 S., R. 15 W. Lab. No. Ob-2-1b. Possible use: Whiting. (For another analysis from same measured section, see sample 138, group F_1, of this compilation.)
- 296. Phillips County. SE¼SW¼ sec. 36, T. 4 S., R. 18 W. Lab. No. Ph-1-1b. Petrographic analysis also given. Possible use: Development improbable. (For another analysis from same measured section, see sample 139, group F_1 of this compilation.)

297. Pottawatomie County. Permian, Wreford limestone, Threemile limestone member. SW¼ sec. 15, T. 7 S., R. 12 E. Lab. No. 53200. (Runnels and Schleicher, 1956, table 6, pl. 1, p. 86, 97.) Limestone, 4.8 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

298-302. Rice County. Permian, Stone Corral dolomite. T. 20 S., R. 6 W. (Jewett and Schoewe, 1942, p. 111, 110, 162.) Dolomite, little overburden, estimated tonnage. Index map, economic map. Possible use: Magnesium.

303-308. Riley County. Permian. Chips from continuous surface. Index map.
- 303. Foraker limestone, Long Creek limestone member. SE¼ sec. 7, T. 10 S., R. 8 E. Lab. No. 48166. (Runnels and Schleicher, 1956, table 11, pl. 1, p. 86.) (Calcareous dolomite), 4.9 ft thick.
- 304. Garrison shale, Crouse limestone member. Sec. 7, T. 11 S., R. 8 E. Lab. No. 48178. (Runnels and Schleicher, 1956, table 8, pl. 1, p. 86.) Limestone, 7 ft thick.
- 305. Funston limestone. Sec. 7, T. 11 S., R. 8 E. Lab. No. 48177. (Runnels and Schleicher, 1956, table 7, pl. 1, p. 86.) Limestone, 3.3 ft thick.
- 306. Matfield shale, Kinney limestone member. Sec. 27, T. 7 S., R. 6 E. Lab. No. 49362. (Runnels and Schleicher, 1956, table 5, pl. 1, p. 86, 97.) Limestone, 5 ft thick. Résumé of spectrographic results.
- 307. Doyle shale, Towanda limestone member. Sec. 17, T. 7 S., R. 6 E. Lab. No. 48174. (Runnels and Schleicher, 1956, table 3, pl. 1, p. 86.) Limestone, 11 ft thick.
- 308. Doyle shale, Towanda limestone member. SE¼ sec. 11, T. 9 S., R. 4 E. Lab. No. 53179. (Runnels and Schleicher, 1956, table 3, pl. 1, p. 86, 97.) Limestone, 6.5 ft thick. Résumé of spectrographic results.

309. Rooks County. Niobrara formation, Fort Hays limestone member. SW¼ sec. 34, T. 7 S., R. 19 W. Lab. No. Ro-4-A1b. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 13, 32, 35.) Chalk, from upper part of basal bed. Index map. Thin section description. Possible use: Whiting. (For another analysis from same measured section see sample 37, group C of this compilation.)

310-314. Rooks County. Niobrara formation, Fort Hays limestone member. Sec. 26, T. 10 S., R. 17 W., roadcut south of town of Codell. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 13, 25, 32, 35.) Chalk, 56 ft section. Index map, columnar section. Thin section description. Possible use: Whiting. (For another analysis from same measured section see sample 35, group E of this compilation.)
- 310. Lab. No. Ro-3-A4. About 16 ft from base of section.
- 311. Lab. No. Ro-3-6. About 20 ft from base of section.
- 312. Lab. No. Ro-3-11. Middle of section.
- 313. Lab. No. Ro-3-22. About 13 ft from top of section.
- 314. Lab. No. Ro-3-26. Top of section. Petrographic analysis.

315-319. Rooks County. Niobrara formation, Fort Hays limestone member. Sec. 35, T. 10 S., R. 17 W. Chalk. Index map. Thin section description. Possible use: Whiting.
- 315. Lab. No. Ro-1-1. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 32, 35.) From basal bed.
- 316. Lab. No. Ro-1-2w. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 32, 35.)
- 317. Lab. No. Ro-1-4w. (Runnels and Dubins, 1949, p. 22, 4, 9, 10, 32, 35.)
- 318. Lab. No. Ro-1-5w. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 32, 35.)
- 319. Lab. No. Ro-1-6w. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 32, 35.)

TABLE 16.— Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas												
	320	321	322	323	324	325	326	327	328	329	330	331	332
	15F$_2$89-11	15F$_2$89-9	15F$_2$89-10	15F$_2$89-13	15F$_2$89-12	15F$_2$89-14	15F$_2$89-15	15F$_2$92-13	15F$_2$92-14	15F$_2$92-11	15F$_2$92-4	15F$_2$92-10	15F$_2$92-6
Insoluble [1]	......	......	......	......	......	......	......	(7.88)	(10.12)	(4.59)	(1.96)	(3.79)	......
SiO_2	4.08	3.54	3.63	4.71	2.19	3.85	3.36	4.10	5.84	2.51	1.09	2.43	1.50
Al_2O_3	[2] .87	[2] .87	[2] .93	[2] 1.47	[2] .51	[2] .86	[2] 1.16	1.71	1.74	.64	.50	1.20	1.35
Fe_2O_3	[3] 1.37	[3] 1.65	[3] 1.15	[3] 2.91	[3] 3.23	[3] 1.86	[3] 6.72	[4] .66	[4] .65	[4] .53	[4] .10	[4] .46	.55
MgO	.51	.65	1.30	.89	3.25	2.18	.91	2.63	1.38	1.05	1.08	1.11	.55
CaO	52.53	52.05	51.15	49.29	48.41	49.75	48.71	50.39	49.75	52.65	55.01	53.64	54.80
P_2O_5	.08	.03	.03	.05	.10	.15	Nil	Tr.	Tr.	Tr.	Tr.	Tr.	......
S	......	Tr.	[5] (.08)	[5] (.19)	......	[5] (.01)	......	Nil	Nil	Nil	Nil	Nil	......
SO_3	Nil	Nil	.12	Tr.	.05	.12	Nil	......	......	......	......	......	......
Ignition loss	[6] 41.33	[6] 41.03	[6] 41.57	[6] 39.75	[6] 42.04	[6] 40.81	[6] 39.31	[7] 40.52	[7] 39.86	[7] 41.75	[7] 42.96	[7] 42.01	42.18
Total	100.77	99.82	99.88	[8] 99.07	[9] 99.78	99.58	100.17	100.01	99.22	99.13	100.74	100.85	100.93
Class	1,6,93	0,7,92	1,6,93	0,9,88	0,4,93	0,7,90	0,7,87	0,7,90	2,7,89	1,3,94	0,2,97	0,4,94	0,3,95
CaO/MgO	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite	calcite	magnesian calcite	calcite	calcite	calcite	calcite	calcite

	333	334	335	336	337	338	339	340	341	342	343	344	345
	15F$_2$92-12	15F$_2$92-8	15F$_2$92-3	15F$_2$92-5	15F$_2$92-7	15F$_2$92-9	15F$_2$98-3	15F$_2$98-4	15F$_2$99-5	15F$_2$99-6	15F$_2$99-7	15F$_2$99-9	15F$_2$103-20
Insoluble	[1] (7.27)	[1] (4.17)	[1] (2.36)	[1] (2.91)	[1] (4.17)	......	......	......	......	3.27	6.22	......	3.11
SiO_2	3.37	1.68	1.02	1.38	1.58	1.78	1.66	2.82	2.17	......	......	1.75	
Al_2O_3	1.74	.82	.49	.57	1.05	.63	[4] .29	[4] 1.41	[2] .54	2.61	1.74	[2] .36	1.06
Fe_2O_3	[4] 1.77	[4] 1.14	[4] .48	[4] 1.09	[4] .85	[4] .65	.64		[3] .37			[3] .33	
MgO	.79	.03	.25	.30	1.29	.10	.19	.49	.82	[10] .77	[10] .95	1.28	Tr.
CaO	51.88	53.25	53.91	53.58	52.02	54.62	53.45	52.91	53.45	[10] 51.82	[10] 50.24	53.67	52.40
P_2O_5	Nil	Nil	Nil	Nil	Nil	Tr.	Nil	Nil	.01	......	......	.07	......
S	Nil	Nil	Nil	Nil	Nil	Tr.	Tr.	Nil	Tr.	......	......	Tr.	......
SO_3	......	......	......	......	......	......	......	......	Tr.	......	......	.13	None
Ignition loss	[7] 40.87	[7] 42.49	[7] 42.91	[7] 42.62	[7] 42.22	[7] 41.30	[7] 41.61	[7] 41.48	[6] 42.50	......	......	[6] 42.83	42.45
Total	100.42	99.41	99.06	99.54	99.01	99.08	97.84	99.11	99.86	58.47	59.15	100.42	99.02
Class	0,6,91	0,4,95	0,2,97	0,3,96	0,3,95	0,3,93	0,2,94	0,4,93	1,3,96	(0,6)93	(3,5)92	1,2,97	1,4,94
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

See following page for footnotes.

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined. Zn looked for in all samples but not detected]

	320	321	322	323	324	325	326	341	344
B	–	0.001	–	–	–	0.001	0.002	–	–
Ti	0.004	.004	0.01	0.005	0.006	.015	.042	0.002	–
V	.005	.002	.0025	.0005	.005	.001	.01	.005	0.05
Cr	–	.0003	.0003	–	–	.001	.01	.0003	–
Mn	.10	.04	.10	.01	.20	.05	.20	.025	.03
Ni	.0004	.002	.0005	.001	.0005	.001	.0005	.0003	.0005
Cu	.00003	.0001	.00005	.0001	.00003	.0001	.0003	.00003	.000025
Mo	–	–	–	–	–	–	.0002	–	–
Ag	–	.00005	–	–	–	.00005	.00005	–	–
Sr	–	–	–	–	–	–	–	–	.054
Sn	–	–	.0005	.0005	–	–	–	–	–
Ba	–	–	–	–	.06	.07	.02	–	–
Pb	–	.0015	.0003	.003	–	.002	.0025	–	.0025

Spectrographic analyses

[Li, Na, K, Sr, Zr, and Ba may be present but not shown on spectrograph]

	327	329	330	331	338	339
P	Small but positive	Very faint trace	(11)	Small but positive	(11)	Very faint trace
Ti	Small but positive	Small but positive	Very faint trace	Small but positive	Very faint trace	Very faint trace
Mn	Small but positive	Small but positive	Small but positive	Small but positive	Small but positive	Small but positive

1 Not included in total.
2 Includes MnO, ZrO_2, V_2O_5, and TiO_2 if present.
3 Total iron.
4 Includes TiO_2.
5 Not included in total, included in ignition loss.
6 105°-1,000° C.
7 140°-1,000° C.
8 99.02 in text.
9 99.88 in text.
10 Calculated from reported $MgCO_3$ or $CaCO_3$.
11 May be present but not shown on spectrograph.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

320-322. Shawnee County. Pennsylvanian, Deer Creek limestone, Ervine Creek limestone member. (Runnels and Schleicher, 1956, table 14, pl. 2, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
 320. SE¼ sec. 14, T. 11 S., R. 16 E. Lab. No. 49455. Limestone, 10 ft thick.
 321. NW¼ sec. 4, T. 12 S., R. 17 E. Lab. No. 53213. Limestone, 6.9 ft thick.
 322. SE¼ sec. 10, T. 13 S., R. 16 E. Lab. No. 53214. Limestone, 8.8 ft thick.

323-324. Shawnee County. Pennsylvanian, Burlingame limestone. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
 323. NW¼ sec. 26, T. 10 S., R. 15 E. Lab. No. 53210. Limestone, 4.5 ft thick.
 324. SW¼ sec. 31, T. 11 S., R. 15 E. Lab. No. 49453. Limestone, 4 ft thick.

325-326. Shawnee County. Pennsylvanian, Wabaunsee group. T. 11 S., R. 14 E. (Runnels and Schleicher, 1956, table 12, pl. 1, p. 86, 97.) Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.
 325. Auburn limestone member. NE¼ sec. 35. Lab. No. 53209. Limestone, 4.1 ft thick.
 326. Tarkio limestone member. SW¼ sec. 29. Lab. No. 49444. Limestone, 3 ft thick.

327-331. Smith County. Upper Cretaceous, Niobrara formation, Fort Hays limestone member. SW¼ sec. 36, T. 4 S., R. 15 W., Cedar quarry. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 13, 14, 17, 24, 35, pl. 1.) Chalk. Index map, columnar section. Thin section description. Photomicrograph of thin section from this measured section. Use: Whiting.
 327. Lab. No. Sm-2-1b. Chalk; 6 ft from bottom of basal bed. Petrographic analysis.
 328. Lab. No. Sm-2-4.
 329. Lab. No. Sm-2-9.
 330. Lab. No. Sm-2-14.
 331. Lab. No. Sm-2-15.

332. Smith County. Niobrara formation, Fort Hays limestone member. Probably SW¼ sec. 36, T. 4 S., R. 15 W., (R. T. Runnels, written communication, 1954). Analyst, Thompson. (Jewett and Schoewe, 1942, p. 128, 162.) Chalk. Estimated tonnage. Index map, economic map. Possible use: Whiting.

Kansas--Continued

333-338. Smith County. Niobrara formation, Fort Hays limestone member. NE¼ sec. 32, T. 5 S., R. 13 W. (Runnels and Dubins, 1949, p. 23, 4, 9, 10, 13, 17, 24, 35.) Chalk, section measures 38 ft; index map, columnar section; thin section description. Possible use: Whiting, lime. (For another analysis from same measured section see sample 39, group C of this compilation.)
 333. Lab. No. Sm-1-1b. From upper part of basal bed.
 334. Lab. No. Sm-1-2.
 335. Lab. No. Sm-1-6.
 336. Lab. No. Sm-1-9.
 337. Lab. No. Sm-1-12.
 338. Lab. No. Sm-1-13. From upper bed.

339-340. Trego County. Niobrara formation, Fort Hays limestone member. T. 15 S., R. 23 W. (Rnnnels and Dubins, 1949, p. 23, 4, 9, 10, 35.) Chalk. Index map, thin section description. Possible use: Whiting, lime.
 339. NE¼SE¼ sec. 1. Lab. No. Tr-1-15. Incomplete section, 55 ft.
 340. Secs. 4, 5, 8, and 9. Lab. No. Tr-2-1. Chalk, from basal bed.

341. Wabaunsee County. Permian, Neva limestone. SW¼ sec. 30, T. 14 S., R. 12 E. Lab. No. 52298. (Runnels and Schleicher, 1956, table 10, pl. 1, p. 86, 97.) Limestone, 9 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results.

342-343. Wabaunsee County. Permian, Cottonwood limestone (R. T. Runnels, written communication, 1953). Analyst, under supervision of Bailey. Collector, Williston. Limestone, fossiliferous. Physical properties. Use: Building stone.
 342. (T. 11 S., R. 10 E.) town of McFarland. (Day, 1895, p. 505; Haworth, 1898, p. 79, 76.) Average from 5 blocks. Bulk density, 2.50.
 343. (T. 12 S., R. 10 E.) town of Alma. (Day, 1895, p. 504; Haworth, 1898, p. 78, 76.) Bulk density, 2.67.

344. Wabaunsee County. Permian, Wreford limestone, Threemile limestone member. SE¼ sec. 26, T. 13 S., R. 9 E. Lab. No. 52343. (Runnels and Schleicher, 1956, table 6, pl. 1, p. 86, 97.) Limestone, 25 ft thick. Chips from continuous surface. Index map; résumé of spectrographic results.

345. Wilson County. Pennsylvanian (Plattsburg limestone) reported as Allen limestone. (T. 30 S., R. 16 E.) town of Neodesha. Analysts, Lathbury and Spackman. Lab. No. 1256. (Haworth, 1903, p. 49-51; Schrader and Haworth, 1906, p. 56.) Limestone. Physical tests of cement mixture. Possible use: Portland cement.

TABLE 16.—Analyses of samples from Kansas containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Kansas									
	346	347	348	349	350	351	352	353	354	355
	$15F_2103$-18	$15F_2103$-19	$15F_2103$-21	$15F_2103$-22	$15F_2103$-23	$15F_2103$-24	$15F_2103$-25	$15F_2103$-27	$15F_2103$-26	$15F_2104$-7
SiO_2	3.95	4.80	1.21	2.02	3.92	5.24	5.65	1.83	3.64	2.15
Al_2O_3	[1]1.32	[1]1.73	[1].74	} 2.65	{ [1]1.21	[1]1.62	[1]1.76	[1]1.10	[1]1.50	[1].72
Fe_2O_3	[2].80	[2]1.09	[2].40		[2]1.27	[2]2.05	[2]1.24	[2]1.42	[2]1.21	[2]1.37
MgO	1.48	1.75	.53	[3].05	.99	1.06	1.09	1.94	.95	.88
CaO	50.65	49.65	54.73	[3]53.82	51.27	49.08	50.22	50.99	52.09	52.20
Na_2O	......	.06	......	......	.07	.07	.03	.02	.01	.07
K_2O	......	.22	......	......	.12	.16	.18	.09	.13	.04
P_2O_5	.07	Tr.	.06	......	.06	.05	Tr.	Tr.	Tr.	.10
S	[4](.08)	[4](.10)	Nil	......	Tr.	[4](.08)	......	[4](.14)	......	Nil
SO_3	.04	.06	.03	......	Tr.	Nil	Nil	Nil	Nil	Nil
Ignition loss [5]	41.27	40.77	42.80	......	41.31	40.24	40.27	41.82	41.32	42.43
Total	[6]99.58	100.13	100.50	58.54	100.22	99.57	100.44	[7]99.21	100.85	99.96
Class	1,6,92	1,8,90	0,2,97	0,4,94	0,7,92	0,10,89	1,8,89	0,3,94	0,7,92	0,4,95
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcite	calcite

	356	357	358	359	360	361	362	363	364	365
	$15F_2104$-6	$15F_2105$-4	$15F_2105$-5	$15F_2105$-6	$15F_2105$-9	$15F_2105$-7	$15F_2105$-8	$15F_2105$-12	$15F_2105$-10	$15F_2105$-11
SiO_2	1.95	2.99	3.48	3.24	3.67	2.98	7.05	2.84	1.30	3.15
Al_2O_3	[1].54	[1]1.22	[1].91	[1].30	[1].91	[8]1.61	[1]1.02	} .82	{ [1].85	[1].88
Fe_2O_3	[2]1.39	[2].69	[2]1.02	[2].94	[2]1.55	.48	[2].99		[2]1.80	[2]1.32
MgO	.91	.76	1.43	.82	1.09	.08	1.71	[3].09	.20	1.30
CaO	52.33	52.15	50.99	52.66	50.31	52.69	49.58	[3]53.78	53.60	51.35
Na_2O	.06	......	......	......	......	......	......	......	......	......
K_2O	.04	......	......	......	......	......	......	......	......	......
P_2O_5	.06	.01	.05	.10	.20	.12	.06	......	......	.03
S	[4](.05)	[4](.05)	[4](.03)	......	......	[9].140	[4](.04)	......	......	[4](.01)
SO_3	.09	Nil	Nil	.10	.28	......	.06	......	......	.06
Ignition loss [5]	42.43	41.96	41.49	42.01	40.69	41.51	39.89	......	42.28	41.82
Total	[10]99.80	99.78	99.37	100.17	98.70	99.61	[11]100.36	57.53	100.03	99.91
Class	0,4,95	0,5,94	1,5,93	2,3,94	0,6,91	0,5,93	4,5,89	1,2,96	0,3,96	0,6,93
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

Spectrochemical analyses

[Standard purity graphite electrodes used. A dash (–) indicates element not present in detectable amount, except Sr present in all samples but not always determined]

	346	347	350	351	352	353	354	355	356	357	358	359	365
B	0.0003	–	0.001	0.0008	–	–	–	0.005	–	0.0005	0.0005	0.002	0.00005
Ti	.03	0.001	.003	.002	0.002	0.004	0.003	.015	0.015	.001	.001	.027	.015
V	.0025	.0025	.001	.002	.003	.005	.003	.002	.001	.001	.001	.0025	.001
Cr	.0002	–	–	–	–	.0004	.0003	.01	–	.0003	.0003	.001	–
Mn	.007	.20	.15	.20	.30	.30	.20	.30	.10	.03	.03	.05	.005
Ni	.0003	.0008	.002	.001	–	.0002	.0001	.001	.001	.001	.001	.001	.00007
Cu	.000025	.0001	.000015	.000015	.000025	.0005	.0002	.000035	.00004	.00005	.00005	.0005	.00004
Zn	.0015	–	–	–	–	–	–	–	–	–	–	–	–
Sr	–	–	.05	.061	.072	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	.0001	–	.0001	–	–	–	–	–
Ag	.00005	–	.00005	.00005	–	–	–	.00005	–	–	–	.00003	–
Sn	–	–	.003	.0015	–	–	–	.002	.0007	–	–	–	–
Ba	.02	–	.15	.02	–	.02	.002	–	–	–	–	–	–
Pb	.0005	–	.008	.0015	–	–	–	.003	.005	.0005	.0005	–	.0008

[1] Includes MnO, ZrO_2, V_2O_5, and TiO_3 if present.
[2] Total iron.
[3] Calculated from reported $MgCO_3$ or $CaCO_3$.
[4] Not included in total, included in ignition loss.
[5] 105° -1,000° C.
[6] 99.53 in text.
[7] 99.35 in text.
[8] Includes TiO_2 and MnO if present.
[9] Sulfate sulfur as S.
[10] 99.71 in text.
[11] 99.36 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

346-348. Wilson County. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

346. Plattsburg limestone, Spring Hill limestone member. NW¼ sec. 18, T. 30 S., R. 16 E. Lab. No. 5192. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 50 ft thick.

347. Plattsburg limestone, Spring Hill limestone member. NW¼ sec. 18, T. 30 S., R. 16 E. Lab. No. 52348. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86, 97.) Limestone, 65 ft thick.

348. Stanton limestone, Stoner limestone member. SE¼ sec. 25, T. 30 S., R. 14 E. Lab. No. 51292. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86.) Limestone, 4 ft thick.

349. Wilson County. (Stanton limestone) reported as Piqua limestone. (T. 27 S., R. 17 E.) town of Vilas. (Haworth and Schrader, 1905, p. 509.) Limestone. Possible use: Portland cement.

350-360. Pennsylvanian. Limestone. Chips from continuous surface. Index map, résumé of spectrographic results.

350. Wilson County. Stranger formation, Haskell limestone member. NW¼ sec. 5, T. 27 S., R. 14 E. Lab. No. 52338. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 1 ft thick.

351. Wilson County. Stranger formation, Haskell limestone member. SW¼ sec. 19, T. 28 S., R. 14 E. Lab. No. 52347. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 6 ft thick.

352. Wilson County. Oread limestone, Toronto limestone member. Sec. 23, T. 27 S., R. 13 E. Lab. No. 52204. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 95.) Limestone, 4 ft thick.

353. Wilson County. Oread limestone, Leavenworth limestone member. SW¼ sec. 23, T. 27 S., R. 13 E. Lab. No. 52200. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 97.) Limestone, 1.4 ft thick.

354. Wilson County. Oread limestone, Plattsmouth limestone member. SW¼ sec. 23, T. 27 S., R. 13 E. Lab. No. 52205. (Runnels and Schleicher, 1956, table 16, pl. 2, p. 86, 95.) Limestone, 3 ft thick.

355. Woodson County. Stranger formation, Haskell limestone member. SE¼ sec. 28, T. 26 S., R. 15 E. Lab. No. 52384. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 3 ft thick.

356. Woodson County. Stranger formation, Haskell limestone member. SW¼ sec. 29, T. 26 S., R. 15 E. Lab. No. 52329. (Runnels and Schleicher, 1956, table 17, pl. 2, p. 86, 97.) Limestone, 1.5 ft thick.

357. Wyandotte County. Swope limestone, Bethany Falls limestone member. NW¼SW¼ sec. 23, T. 11 S., R. 24 E. Lab. No. 53208. (Runnels and Schleicher, 1956, table 26, pl. 3, p. 86, 97.) Limestone, 13.5 ft thick. (See also Ives, 1955, p. 32, 36. Lab. No. O5. Limestone, uniform, outcrop sample. Mineralogy. No footnote for Al_2O_3, Fe_2O_3, or S. Loss on ignition at 1,000° C., sample dried at 105° C.)

Kansas--Continued

358. Wyandotte County. Dennis limestone, Winterset limestone member. SW¼ sec. 23, T. 11 S., R. 24 E. Lab. No. 53189. (Runnels and Schleicher, 1956, table 25, pl. 3, p. 86, 97.) Limestone, 11 ft thick.

359. Wyandotte County. Cherryvale shale, Westerville limestone member. SW¼ sec. 12, T. 11 S., R. 24 E. Lab. No. 48340. (Runnels and Schleicher, 1956, table 24, pl. 3, p. 86, 97.) Limestone, 5 ft thick.

360. Wyandotte County. Wyandotte limestone, Frisbie limestone member. Sec. 23, T. 11 S., R. 23 E. Lab. No. 48195. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86.) Limestone, 3 ft thick.

361. Wyandotte County. Wyandotte limestone, Argentine limestone member. Sec. 23, T. 11 S., R. 23 E. Lab. No. 17. (Runnels, 1951, p. 88, 83, 85, 91, 102.) Limestone, 13 ft thick. Chemical analysis of calcined base also given. Index map. Sample dried at 105° C. Possible use: Lime, flux.

362. Wyandotte County. Wyandotte limestone, Argentine limestone member. SW¼NW¼ sec. 29, T. 11 S., R. 25 E. Lab. No. 53182. (Runnels and Schleicher, 1956, table 20, pl. 3, p. 86.) Limestone, 26 ft thick. Chips from continuous surface. Index map. (See also Ives, 1955, p. 32, 27, 36. Lab. No. O1. Limestone, fossiliferous, outcrop sample. Mineralogy. Bulk density, average of four determinations, 2.53. No footnote for Al_2O_3, Fe_2O_3; sulfide sulfur as S; CaO, 48.58 percent; ignition loss at 1,000° C., sample dried at 105° C.)

363. Wyandotte County. Pennsylvanian, Kansas City group (R. T. Runnels, written communication, 1957). (T. 10 S., R. 25 E.), Kansas City, Phelps Stone and Supply Co. (Burchard, 1912, p. 668.) Limestone, from quarry.

364. Wyandotte County. Plattsburg limestone, Merriam limestone member. Sec. 23, T. 11 S., R. 23 E. Lab. No. 48162. (Runnels and Schleicher, 1956, table 19, pl. 2, p. 86.) Limestone, 3 ft thick. Chips from continuous surface. Index map.

365. Wyandotte County. Stanton limestone, Stoner limestone member. SE¼SW¼ sec. 36, T. 10 S., R. 23 E. Lab. No. 5111. (Runnels and Schleicher, 1956, table 18, pl. 2, p. 86, 97.) Limestone, 12 ft thick. Chips from continuous surface. Index map, résumé of spectrographic results. (See also Runnels, 1951, p. 88, 83, 85, 91, 102. Locality No. 18. Chemical analysis of calcined base also given. Index map. Possible use: Lime, flux. Al_2O_3 includes MnO and TiO_2 if present; total sulfur as S, 0.03 percent; sulfide sulfur as S, 0.01 percent; sulfate sulfur as S, 0.020 percent; P_2O_5, 0.030 percent; P, 0.013 percent; ignition loss at 1,000° C., sample dried at 105° C.)

TABLE 17.— Analyses of samples from Montana, Nebraska, and North Dakota containing more than 90 percent carbonates (Group F_2) common rock category

[Analyses arranged by State, county, and stratigraphic position]

	Montana											
	1	2	3	4	5	6	7	8	9	10	11	12
	25F$_2$1-12	25F$_2$1-11	25F$_2$1-9	25F$_2$1-10	25F$_2$1-16	25F$_2$1-15	25F$_2$1-14	25F$_2$1-13	25F$_2$1-17	25F$_2$2-1	25F$_2$4-8	
Insoluble	0.6	1.0	2.4	4.5	3.0	2.0	6.5	0.6	0.2	[1] 0.43	[2] 4.75	[2] 14.00
Al_2O_3	......	......	......	......	......	......	......	......	......	.42		
Fe_2O_3	......	......	......	......	......	......	......	......	......	......	} 2.18	3.30
FeO	[3] .4	[3] .3	[3] .4	[3] .3	[3] .3	[3] .3	[3] .3	[3] .3	[3] .5	[3] .04		
MgO	20.1	21.4	19.7	19.3	14.8	17.5	18.4	19.9	19.7	19.93	1.25	12.20
CaO	30.0	30.2	29.8	28.4	35.4	32.1	29.6	29.7	29.9	31.72	50.5	31.00
H_2O+	......	......	......	......	......	......	......	......	......	[4] .34	......	......
H_2O-	......	......	......	......	......	......	......	......	......	.02	......	......
CO_2	......	......	......	......	......	......	......	......	......	46.91	......	......
Total	51.1	52.9	52.3	52.5	53.5	51.9	54.8	50.5	50.3	[5] 100.00	58.7	60.50
Class	(1,0)96	(1,0)99	(2,0)94	(4,1)91	(3,0)94	(2,0)94	(7,0)91	(1,0)95	(0,1)95	0,1,99	1,6,92	......
CaO/MgO	dolomite	dolomite	dolomite	dolomite	calcareous dolomite	calcareous dolomite	dolomite	dolomite	dolomite	dolomite	calcite	......

	13	14	15	16	17	18	19	20	21	22	23
	25F$_2$4-6	25F$_2$4-3	25F$_2$4-4	25F$_2$4-7	25F$_2$4-5	25F$_2$4-2	25F$_2$4-1	25F$_2$5-1	25F$_2$5-2	25F$_2$5-3	25F$_2$5-6
Insoluble	2.3	0.4	1.1	4.2	1.1	3.9	3.5	......	......	......	......
Al_2O_3	......	......	......	......	......	......	......	} 0.85	1.25	1.40	2.20
Fe_2O_3	......	......	......	......	......	......	......				
FeO	[3] .3	[3] .3	[3] .3	[3] .5	[3] .1	[3] .5	[3] .5	......	......	......	......
MgO	.6	.9	.3	.7	.9	3.9	17.6	......	......	......	......
CaO	53.7	54.4	53.4	52.0	52.9	49.4	32.8	[6] 55.44	[6] 55.14	[6] 55.04	[6] 54.72
Total	56.9	56.0	55.1	57.4	55.0	57.7	54.4	56.29	56.39	56.44	56.92
Class	(2,0)97	(0,0)99	(1,0)96	(4,0)94	(1,0)96	(4,0)95	(4,0)95	0,0,99	0,0,98	0,0,98	0,0,98
CaO/MgO	calcite	calcite	calcite	calcite	calcite	magnesian calcite	calcareous dolomite	calcite	calcite	calcite	calcite

	24	25	26	27	28	29	30	31	32	33	34
	25F$_2$5-4	25F$_2$7-3	25F$_2$12-6	25F$_2$14-4	25F$_2$16-16	25F$_2$16-15	25F$_2$16-12	25F$_2$16-14	25F$_2$16-13	25F$_2$16-17	25F$_2$16-18
Insoluble	[7] 1.5	0.80	0.45	[8] 0.95	5.4	2.2	1.0	1.4	1.3	6.2	5.2
Al_2O_3	......	.20	......	......	......	......	......	......	......	......	......
FeO	......	......	......	[9] .20	[3] .6	[3] .6	[3] .4	[3] .3	[3] .3	[3] .4	[3] .6
MgO	[6] .67	3.20	6.46	.51	1.4	2.9	3.6	2.5	1.2	1.3	1.6
CaO	[6] 54.40	51.80	44.33	53.7	49.5	50.4	51.5	52.3	53.6	49.5	48.5
Ignition loss	......	[10] 44.10	......	......	......	......	......	......	......	......	......
Total	56.6	100.10	51.24	55.4	56.9	56.1	56.5	56.5	56.4	57.4	55.9
Class	(2,0)99	(0,1)99	(1,0)93	1,1,97	(5,0)91	(2,0)96	(1,0)98	(1,0)98	(1,0)98	(6,0)91	(5,0)90
CaO/MgO	calcite	magnesian calcite	magnesian calcite	calcite	calcite	magnesian calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite

	35	36	37	38	39	40	41	42	43	44	45
	25F$_2$16-19	25F$_2$16-20	25F$_2$16-22	25F$_2$16-24	25F$_2$20-10	25F$_2$20-11	25F$_2$20-9	25F$_2$20-7	25F$_2$20-8	25F$_2$20-6	25F$_2$20-12
Insoluble	7.3	[11] 0.34	[11] 5.99	1.6	2.4	3.1	1.8	0.4	0.9	9.0	6.4
$Al_2O_3+Fe_2O_3$	......	.22	.58	......	......	......	......	......	......	......	......
FeO	[3] .4	......	......	......	[3] .6	[3] .5	[3] .4	[3] .4	[3] .4	[3] .4	[3] .5
MgO	.8	[6] 20.86	[6] .64	.7	19.8	20.1	20.9	22.1	21.8	1.2	13.3
CaO	48.8	[6] 30.55	[6] 51.52	54.9	30.1	30.8	31.0	32.0	31.2	49.5	37.3
Total	57.3	51.97	58.73	57.2	52.9	54.5	54.1	54.9	54.3	60.1	57.5
Class	(7,0)89	(0,1)98	(5,2)93	(2,0)97	(2,0)95	(3,0)96	(2,0)96	(0,0)95	(1,0)96	(9,0)90	(6,0)92
CaO/MgO	calcite	dolomite	calcite	calcite	dolomite	dolomite	dolomite	dolomite	dolomite	calcite	calcareous dolomite

[1] Reported as SiO_2 and insoluble by Wells (1937, p. 54).
[2] Reported as insoluble, probably SiO_2.
[3] Calculated from reported Fe.
[4] Includes organic matter.
[5] Total includes TiO_2, 0.01 percent; SO_3, 0.03 percent; Cl, 0.06 percent; SrO, 0.09 percent; P_2O_5, trace; MnO, trace.
[6] Calculated from reported $MgCO_3$ or $CaCO_3$.
[7] Reported as insoluble material (silica, iron oxide, and alumina) by Perry (1949, p. 36).
[8] Reported as SiO_2.
[9] Reported as iron oxide by Perry (1949, p. 32).
[10] Reported as 44.0 percent by Perry (1949, p. 40).
[11] Reported as insoluble (silica) by Peale (1893, p. 28).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Montana

1-4. Beaverhead County. Cambrian, Meagher(?) limestone. Sec. 2, T. 3 S., R. 11 W., east face of Lion Mountain. Analyst, Bartzen. (Hanson, 1952, p. 42, 26, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps; detailed measured sections, correlated columnar sections, correlation chart.
1. Lab. No. H-1C1. Dolomitic marble, white, sugary; 103 ft thick.
2. Lab. No. H-1C3. Dolomitic marble, white, massive, sugary; metacrysts; 195 ft thick.
3. Lab. No. H-1C8. Dolomitic marble, white, medium-bedded; 16 ft thick.
4. Lab. No. H-1C9. Dolomitic marble, light-gray, fine, sugary; metacryst clusters; 3 ft thick.

5-7. Beaverhead County. Cambrian, Pilgrim(?) limestone. Sec. 2, T. 3 S., R. 11 W., east face of Lion Mountain. Analyst, Bartzen. (Hanson, 1952, p. 43, 26, pls. 4, 5A, 5B, 8A, 9.) Index map, isopach maps; detailed measured sections, correlated columnar sections, correlation chart.
5. Lab. No. H-1E5a. Dolomitic marble, buff, thin-bedded; bed 5, 34.5 ft thick; 1.5 ft of medium-gray dolomitic marble at base.
6. Lab. No. H-1E5B. Remarks as in sample 5.
7. Lab. No. H-1E6. Dolomitic marble, medium-gray, thin-bedded; 1.5 ft thick.

8-9. Beaverhead County. Pilgrim limestone. Sec. 27, T. 9 S., R. 8 W., about 15 miles south of town of Dillon. Analyst, Bartzen. (Hanson, 1952, p. 43, 26, 27, pls. 4, 5A, 5B, 8A, 9.) Dolomite, light-gray, massive, medium-crystalline; 137 ft thick. Index map, isopach maps; detailed measured sections, correlated columnar sections, correlation chart.
8. Lab. No. D-1E1.
9. Lab. No. D-1E2.

10. Big Horn County. Lower Mississippian, Madison limestone, lower member. Sec. 18 or 19, T. 6 S., R. 31 E., (U. M. Sahinen, written communication, 1955) mouth of Big Horn Canyon, south of town of Hardin. Analyst, Erickson; collector, Heald. Lab. No. C-304. (Thom and others, 1935, p. 34, 11, pls. 1, 6; Wells, 1937, p. 54.) Limestone, in part dark-gray, hard, moderately massive. Index map, geologic map, correlated columnar sections.

11. Broadwater County. Meagher limestone. Sec. 4, T. 5 N., R. 1 E., Vermont Marble quarry. Analyst, Hartzell. (Ruppel, 1950, p. 18, 17, pl. 1.) Limestone, mottled. Bulk of rock, gray, fine-textured. Geologic map, detailed measured section. Use: Building stone.

12. Same sample as 11. Analysis of light-colored portion.

13-17. Broadwater County. Meagher limestone. S½ Sec. 34, T. 7 N., R. 1 E., 3 miles west of Townsend. Analyst, Bartzen. (Hanson, 1952, p. 42, 34, 35, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps; detailed measured section, correlated columnar sections, correlation chart.
13. Lab. No. T-1C2. Limestone, dark-gray, some tan mottling, massive; 163 ft thick.
14. Lab. No. T-1C3. Limestone; mostly medium-gray, oolitic, massive; some darker nonoolitic limestone; 44 ft thick.
15. Lab. No. T-1C4a. Limestone, dark-gray, tan mottling, thin-to thick-bedded; upper 20 ft fossiliferous; 186 ft thick.
16. Lab. No. T-1C4b. Description as in sample 15.
17. Lab. No. T-a-1. Limestone, black; segregated portions of mottled limestone.

18-19. Broadwater County. Pilgrim limestone. S½ sec. 34, T. 7 N., R. 1 E., 3 miles west of Townsend. Analyst, Bartzen. (Hanson, 1952, p. 43, 34, 35, pls. 4, 5A, 5B, 8A, 9.) Index map, isopach maps; detailed measured section, correlated columnar sections, correlation chart.
18. Lab. No. T-1E1a. Limestone, medium-to dark-gray, some tan mottling; massive; 195 ft thick. Fossils collected 27 ft from top of unit.
19. Lab. No. T-1E2. Dolomite, medium-to dark-gray; massive, crystalline; oolites in darker portions; 112 ft thick.

20-23. Carbon County. Probably Madison limestone. Tps. 6 and 7 S., R. 25 E., (U. M. Sahinen, written communication, 1955). (Burchard, 1912, p. 675.) Limestone.
20. Town of Bridger.
21-23. Town of Bowler.

24. Carbon County. Madison limestone, upper part. (T. 8 S., R. 25 E.) about 4 miles northeast of town of Warren, Great Western Sugar Co. quarry. (Perry, 1949, p. 36, 29, 34, 35, pl. 6.) Limestone. Index map, outcrop map; generalized stratigraphic table. Use: Lime, sugar industry.

25. Cascade County. Madison limestone, upper part. (T. 16 N., R. 6 E.), Albright, Boston Montana Co. quarry. (Burchard, 1912, p. 675; Perry, 1949, p. 40, 29, 34, 39, pls. 3, 6.) Limestone. Index map, outcrop maps; generalized stratigraphic table. Use: Flux, sugar industry.

26. Deer Lodge County. Cambrian, Hasmark formation. (T. 5 N., R. 12 W.), 3 miles southeast of town of Cable. Analyst, Schaller. (Emmons and Calkins, 1913, p. 58, 33, 49, 57, 59, pls. 1, 2.) Magnesian limestone. Sample, typical specimen. General description: Blue-gray, weathers light dirty bluish-gray; uniform, moderately fine, compact, crystalline. Index map, geologic map, topographic map; detailed measured section, columnar section, generalized stratigraphic table.

Montana--Continued

27. Fergus County. Recent, T. 17 N., Rs. 17 and 18 E., (U. M. Sahinen, written communication, 1955) about 12 miles north of Lewiston. (Blixt, 1933, p. 18, 1, 11, pl. 2; Perry, 1949, p. 32, 29, 34.) Travertine. Underlies about 6 square miles; thickness as much as 250 ft. Index map, geologic map; cross sections, generalized stratigraphic table. Possible use: Lime.

28-35. Gallatin County. Cambrian. T. 2 N., R. 3 E., (U. M. Sahinen, written communication, 1957) near town of Logan. Analyst, Bartzen. Limestone. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For another analysis from same measured section see sample 3, group F_1 of this compilation.)
28. Meagher limestone. Lab. No. L-1C5. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.)
29. Meagher limestone. Lab. No. L-1C7. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.)
30. Meagher limestone. Lab. No. L-1C8. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.)
31. Meagher limestone. Lab. No. L-1C14. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.) Limestone, dark-gray to dark brownish-gray, massive, finely crystalline, 190 ft thick.
32. Meagher limestone. Lab. No. L-1C15. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.) Limestone, thin-bedded, 24 ft thick, similar to sample 31.
33. Pilgrim limestone. Lab. No. L-1E7. (Hanson, 1952, p. 43, 36, pls. 2H, 4, 5A, 5B, 8A, 9.) Limestone, medium to dark brownish-gray; thin-to massive-bedded; 25 ft thick; photomicrograph.
34. Red Lion formation. Lab. No. L-1F6. (Hanson, 1952, p. 43, 36, pls. 4, 5A, 5B, 8B, 9.) Limestone, purple-gray, with maroon argillaceous partings, thin-bedded, finely crystalline, 2 ft thick.
35. Red Lion formation. Lab. No. L-1F7. (Hanson, 1952, p. 43, 36, pls. 4, 5A, 5B, 8B, 9.) Limestone, brownish-and purplish-gray, 1 ft thick.

36-37. Gallatin County. T. 2 N., R. 2 E., (U. M. Sahinen, written communication, 1955). Analyst, Catlett; collector, Peale. Lab. Nos. 890, 905. Geologic map, generalized cross sections, columnar sections.
36. Devonian, Jefferson limestone (U. M. Sahinen, written communication, 1955). North of East Gallatin River (near town of Three Forks). (Peale, 1893, p. 28, pls. 1-4; Clarke, 1915, p. 238.) Dolomite, brownish-black.
37. Madison limestone. North of Gallatin River. (Peale, 1893, p. 36, pls. 1-4; Clarke, 1915, p. 238.) Limestone, massive; from middle of formation.

38. Gallatin County. Mississippian, Mission Canyon limestone. (T. 1 S., R. 1 W.) quarry about 2 miles east of town of Sappington. (Perry, 1949, p. 41, 29, pl. 6.) Limestone. Outcrop map, generalized stratigraphic table. Use: Sugar refining.

39-43. Granite County. Hasmark formation. SW¼ sec. 14, SE¼ sec. 15, T. 8 N., R. 13 W., near town of Princeton. Analyst, Bartzen. (Hanson, 1952, p. 42, 25, pls. 4, 5A, 5B, 9.) Index map, isopach map, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see samples 44 and 45 below, and samples 7-11, group F_1 of this compilation.)
39. Lab. No. P-3C2. Dolomite, medium-to dark-gray, brownish tinge; saccharoidal, medium-to massive-bedded, 409.5 ft thick.
40. Lab. No. P-3C3. Dolomite, light- and medium-gray, weathers light gray, finely crystalline, medium- to thick-bedded; some dark chert in lenses; 49.5 ft thick.
41. Lab. No. P-3C5. Dolomite, medium- to dark-gray, brownish tinge; saccharoidal, medium- to massive-bedded, 154 ft thick.
42. Lab. No. P-3C7. Dolomite, medium-to dark-gray, brownish tinge; saccharoidal, medium- to massive-bedded, 80.6 ft thick.
43. Lab. No. P-3C10. Dolomite, light-gray and pinkish-gray; alternating beds of finely crystalline and saccharoidal dolomite; medium- to massive-bedded, 318 ft thick.

44-45. Granite County. SW¼ sec. 14, SE¼ sec. 15, T. 8 N., R. 13 W., near Princeton. Analyst, Bartzen. (Hanson, 1952, p. 43, 25, pls. 4, 5A, 5B, 8B, 9.) Index map, isopach map, detailed measured section, correlated columnar sections, correlation chart.
44. Red Lion formation. Lab No. P-3D8. Limestone, medium-gray, medium- to thick-bedded, 19 ft thick.
45. Jefferson dolomite. Lab. No. P-3F. Dolomite, dark-gray; weathers drab, finely crystalline.

TABLE 17.— Analyses of samples from Montana, Nebraska, and North Dakota containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Montana											
	46	47	48	49	50	51	52	53	54	55	56	57
	25F$_2$20-13	25F$_2$22-5	25F$_2$22-21	25F$_2$22-3	25F$_2$22-4	25F$_2$22-6	25F$_2$22-7	25F$_2$22-9	25F$_2$22-10	25F$_2$22-11	25F$_2$22-12	25F$_2$22-13
Insoluble	7.18	8.4	[1] 1.40	[1] 1.45	[2] 2.70	[3] 1.78	......	......	......	......	......	......
Al_2O_3	......	......	......	.16	......	} .40	0.86	0.96	1.06	1.20	1.22	1.30
Fe_2O_3	......	......	......	.76	} .50							
FeO	......	[4] .5	......	......		......	......	......	......	......	......	......
MgO	.74	1.8	2.00	[4] 2.72	2.85	[4] 20.37	[4] 1.32	[4] 1.26	[4] 1.24	[4] 1.72	[4] .70	[4] .67
CaO	50.48	46.6	52.80	[4] 49.44	52.40	[4] 30.55	[4] 53.98	[4] 53.98	[4] 53.70	[4] 53.03	[4] 54.51	[4] 54.37
CO_2	......	......	43.80	......	......	......	......	......	......	......	......	......
Total	58.40	57.3	100.00	[5] 54.53	58.45	53.10	56.16	56.20	56.00	55.95	56.43	56.34
Class	(7,0)92	(8,0)87	1,0,99	0,2,94	(2,1)93	(1,1)97	0,0,99	0,0,99	0,0,98	0,0,98	0,0,99	0,0,98
CaO/MgO	calcite	magnesian calcite	magnesian calcite	magnesian calcite	magnesian calcite	dolomite	calcite	calcite	calcite	calcite	calcite	calcite

	58	59	60	61	62	63	64	65	66	67	68	69
	25F$_2$22-14	25F$_2$22-15	25F$_2$22-16	25F$_2$22-17	25F$_2$22-18	25F$_2$22-22	25F$_2$22-8	25F$_2$25-9	25F$_2$25-6	25F$_2$25-5	25F$_2$25-2	25F$_2$25-4
Insolnble	......	......	......	......	......	[6] 1.6	[1] 0.4	4.8	0.8	0.8	0.4	0.8
$Al_2O_3+Fe_2O_3$	1.48	1.62	1.78	1.86	1.89	......	.3	......	......	......	......	......
FeO	......	......	......	......	......	......	......	[4] .5	[4] .3	[4] .3	[4] .5	[4] .5
MgO	[4] 1.10	[4] .97	[4] 1.24	[4] 1.65	[4] 1.81	[4] .67	[4] .62	1.0	.6	1.8	20.7	20.1
CaO	[4] 53.50	[4] 53.11	[4] 53.39	[4] 52.91	[4] 52.30	[4] 54.90	[4] 54.90	49.9	52.8	51.3	30.2	29.3
Total	56.08	55.70	56.41	56.42	56.00	57.2	56.2	56.2	54.5	54.2	51.8	50.7
Class	0,0,98	0,0,97	0,0,98	0,0,98	0,0,97	(2,0)97	0,1,99	(5,0)91	(1,0)96	(1,0)95	(0,0)97	(1,0)94
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	dolomite

	70	71	72	73	74	75	76	77	78	79	80	81
	25F$_2$25-8	25F$_2$25-7	25F$_2$25-10	25F$_2$25-11	25F$_2$25-3	25F$_2$29-7	25F$_2$29-5	25F$_2$29-4	25F$_2$29-6	25F$_2$29-8	25F$_2$29-17	25F$_2$29-21
Insoluble	0.9	0.9	7.4	1.3	0.6	0.6	0.4	0.4	0.6	0.6	1.2	3.6
FeO[4]	.4	.3	.6	.3	.3	.4	.4	.3	.3	.3	.3	.5
MgO	19.0	19.6	16.5	19.0	20.2	2.8	2.5	5.8	1.8	1.6	1.6	.5
CaO	32.4	31.5	31.0	30.2	30.8	50.5	50.5	47.0	51.0	52.3	52.4	52.2
Total	52.7	52.3	55.5	50.8	51.9	54.3	53.8	53.5	53.7	54.8	55.5	56.8
Class	(1,0)98	(1,0)97	(7,0)90	(1,0)94	(1,0)97	(1,0)96	(0,0)95	(0,0)96	(1,0)95	(1,0)97	(1,0)97	(4,0)94
CaO/MgO	calcareous dolomite	dolomite	calcareous dolomite	dolomite	dolomite	magnesian calcite	magnesian calcite	magnesian calcite	calcite	calcite	calcite	calcite

	82	83	84	85	86	87	88	89	90	91	92	93
	25F$_2$29-18	25F$_2$29-9	25F$_2$29-19	25F$_2$29-24	25F$_2$29-10	25F$_2$29-11	25F$_2$29-16	25F$_2$29-25	25F$_2$29-23	25F$_2$29-20	25F$_2$29-22	25F$_2$29-15
Insoluble	1.5	1.2	2.0	7.6	1.2	3.6	1.1	8.6	5.3	3.2	4.1	1.0
FeO[4]	1.0	.1	.4	1.3	.4	.6	.3	.6	.9	.6	1.0	1.5
MgO	12.6	Nil	.8	1.1	15.7	3.8	.5	.6	.8	.7	2.0	3.6
CaO	38.5	54.1	52.2	49.5	36.0	48.0	53.5	48.6	50.3	51.5	49.6	49.0
Total	53.6	55.4	55.4	59.5	53.3	56.0	55.4	58.4	57.3	56.0	56.7	55.1
Class	(2,0)95	(1,0)97	(2,0)95	(8,0)91	(1,0)97	(4,0)94	(1,0)97	(9,0)88	(5,0)91	(3,0)93	(4,0)93	(1,0)95
CaO/MgO	calcareous dolomite	calcite	calcite	calcite	calcareous dolomite	magnesian calcite	calcite	calcite	calcite	calcite	magnesian calcite	magnesian calcite

[1] Reported as SiO_2.

[2] Reported as insoluble (silica and clay).

[3] Reported as insoluble (silica) by Peale (1893, p. 28).

[4] Calculated from reported Fe, $MgCO_3$, or $CaCO_3$.

[5] Zn, He, Au, each reported as trace.

[6] Reported as insoluble material (silica, iron oxide, and alumina) by Perry (1949, p. 41).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Montana--Continued

46. Granite County. Lower Mississippian, Madison limestone. Sec. 36, T. 6 N., R. 13 W., (U. M. Sahinen, written communication, 1955) east of Warm Spring Creek. Analyst, Schaller. (Emmons and Calkins, 1913, p. 68, 33, 69, pls. 1, 2.) Limestone, black, shaly; stratigraphic description. Index map, geologic map, topographic map; generalized stratigraphic table.

47. Jefferson County. Cambrian, Meagher limestone. T. 2 N., R. 4 W., (U. M. Sahinen, written communication, 1957), Whitetail Deer Creek. Analyst, Bartzen. Lab. No. J-A-1. (Hanson, 1952, p. 42, pls. 4, 5A, 5B, 7A, 9.) (Limestone.) Gray segregated portion of mottled rock. Index map, isopach maps; detailed measured section, correlated columnar sections, correlation chart. (For another analysis from same measured section see sample 12, group F_1 of this compilation.)

48-49. Jefferson County. Meagher limestone, sec. 7, T. 9 N., R. 2 W., (U. M. Sahinen, written communication, 1955) near town of East Helena, American Smelting and Refining Co. quarry. (Burchard, 1912, p. 675.) Limestone.

50. Jefferson County. Meagher limestone. (T. 9 N., R. 2 W., 2.5 miles south of East Helena) American Smelting and Refining Co. quarry. (Perry, 1949, p. 39, 29, 34, pls. 7, 8.) Limestone, average analysis. Index map, outcrop map, geologic maps; generalized stratigraphic table. Use: Flux.

51. Jefferson County. Middle Devonian, Jefferson limestone, T. 2 N., R. 3 or 4 W., (U. M. Sahinen, written communication, 1957) west of North Boulder River. Analyst, Catlett. Collector, Peale. Lab. No. 890. (Peale, 1893, p. 28, pls. 1-4; Clarke, 1915, p. 238.) Dolomite, black. Geologic map; columnar section, generalized cross sections.

52-62. Jefferson County. Madison limestone, Mission Canyon formation. Sec. 18, T. 1 N., R. 2 W., (U. M. Sahinen, written communication, 1955), Lime Spur, East Montana Smelting Co. quarry. (Burchard, 1912, p. 675.) Limestone.

63. Jefferson County. Madison limestone, upper part. T. 1 N., R. 1 W., about 2 miles east of Sappington, Great Western Sugar Co. quarry. (Perry, 1949, p. 41, 29, 34, pl. 6.) Limestone. Index map, outcrop map, generalized stratigraphic tables. Use: Sugar industry.

64. Jefferson County. Madison limestone. T. 1 N., R. 3 W., 4.5 miles east of Cardwell (Lime Spur), East Butte Copper Mining Co. quarry. (Minister, 1930, p. 109, 108.) Limestone, massive; from bed 90-100 ft thick. Use: Flux, concrete aggregate; sugar, and glass industry.

65-67. Lewis and Clark County. Meagher limestone. T. 9 or 10 N., R. 4 W., (U. M. Sahinen, written communication, 1957), Nelson Gulch, 6 miles west of town of Helena. Analyst, Bartzen. (Hanson, 1952, p. 42, 31, 32, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart.

- 65. Lab. No. HN-1C3. Limestone, medium-gray, mottled; faint or no mottling in upper half; 120 ft thick.
- 66. Lab. No. HN-1C4. Limestone, medium-gray; some oolitic limestone in upper part; 33 ft thick.
- 67. Lab. No. HN-1C7. Limestone, dark-gray, mottled with lighter gray and tan-gray; 47 ft thick.

68-74. Lewis and Clark County. Cambrian, Pilgrim limestone. Sec. 36, T. 10 N., R. 4 W., (U. M. Sahinen, written communication, 1957), Grizzly Gulch, near Helena. Analyst, Bartzen. (Hanson, 1952, p. 43, 32, pls. 4, 5A, 5B, 8A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart.

- 68. Lab. No. HG-1E1. Dolomite, medium-gray, mottled with dark-gray, massive, medium-crystalline; 193 ft thick.
- 69. Lab. No. HG-1E2. Dolomite, medium- to light-gray; weathers light gray; thick-bedded, medium-crystalline; 26 ft thick.
- 70. Lab. No. HG-1E3. Dolomite, medium- and dark-gray mottled, medium- to thick-bedded, oolitic; 7 ft thick.
- 71. Lab. No. HG-1E4. Dolomite, medium- to light-gray, mottled, oolitic in part, medium-crystalline, medium- to thick-bedded; 13 ft thick.
- 72. Lab. No. HG-1E5. Dolomite, medium- and dark-gray, mottled, oolitic, thin- to medium-bedded; 23 ft thick.
- 73. Lab. No. HG-1E6. Dolomite, medium- to light-gray; 80.0 ft thick.
- 74. Lab. No. HG-1E7. (Dolomite.)

Montana--Continued

75-83. Madison County. Meagher limestone. Sec. 21, T. 1 S., R. 3 W., South Boulder Creek. Analyst, Bartzen. (Hanson, 1952, p. 42, 32, 33, pls. 2F, 4, 5A, 5B, 7A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. Photomicrograph.

- 75. Lab. No. S-1-C4. Limestone, medium-gray, massive, oolitic; local cross-bedding; 34 ft thick.
- 76. Lab. No. S-1C9. Limestone, medium-gray, some faint mottling of brownish-gray, massive, finely crystalline; 6 ft thick.
- 77. Lab. No. S-1C10. Limestone, mostly massive, oolitic, 19 ft thick.
- 78. Lab. No. S-1C11. Limestone, medium-gray, faint mottling of brownish-gray, massive, finely crystalline, 13 ft thick.
- 79. Lab. No. S-1C12. Limestone, medium- to dark-gray, some beds mottled with brownish-gray, thin- to medium-bedded, fine- and medium-crystalline; 27 ft thick.
- 80. Lab. No. S-1C(a) No. 1. Limestone, gray, segregated portion of mottled rock.
- 81. Lab. No. S-1C(b) No. 1. Limestone, gray, segregated portion of mottled rock.
- 82. Lab. No. S-1C(a) No. 2. Limestone, tan, segregated portion of mottled rock.
- 83. Lab. No. S-C-1. Limestone, gray, segregated portion of mottled rock.

84-85. Madison County. Meagher limestone. Secs. 22 and 23, T. 5 S., R. 1 E., about 8 miles northeast of town of Ennis. Analyst, Bartzen. (Hanson, 1952, p. 42, 37, 38, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section; see sample 94, Bighorn dolomite, of this group and sample 15, Meagher formation, group F_1 of this compilation.)

- 84. Lab. No. E-1C2. Limestone, medium-gray, some mottling; mostly thick to massive bedding, 149 ft thick. Lower few feet, dark-gray, tan partings; thin-bedded, fossil fragments, some oolitic limestone.
- 85. Lab. No. E-1C3. Limestone, medium-gray, tan mottling; finely crystalline; some beds oolitic; fossil fragments common; 3-inch pisolitic beds near top; 102 ft thick.

86-88. Madison County. Meagher limestone. S½ sec. 36, T. 7 S., R. 2 W., and N½ sec. 1, T. 8 S., R. 2 W., south of Ennis. Analyst, Bartzen. (Hanson, 1952, p. 42, 33, 34, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart.

- 86. Lab. No. E-2C2 and 3. Dolomite. Bed 2: Brownish-gray, tan mottling, calcareous, massive, fine- to medium-grained; 70 ft thick. Bed 3: Brownish-gray to grayish-brown, massive, medium-grained; some oolitic beds with cross-bedding; 5 ft thin-bedded zone near top; 77 ft thick.
- 87. Lab. No. E-2C8. Limestone, brownish-gray, tan mottling; finely crystalline; massive when fresh; 9 ft thick.
- 88. Lab. No. E-2C12. Limestone, light to medium brownish-gray; thin-bedded, finely crystalline; 22 ft thick.

89-93. Madison County. Meagher limestone. W½ sec. 23, T. 9 S., R. 2 E., Taylor Peak area. Analyst, Bartzen. (Hanson, 1952, p. 42, 38, pls. 4, 5A, 5B, 7A, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For another analysis from same measured section see sample 14, group F_1 of this compilation.)

- 89. Lab. No. X-1B1. Limestone, similar to sample 90, but more distinct bedding; 75 ft thick.
- 90. Lab. No. X-1B2a. Limestone, brownish-gray, tan mottling; fine-grained; thin-bedded; fossil zone in upper 2 ft; 33 ft thick.
- 91. Lab. No. X-1B2b. Remarks as in sample 90.
- 92. Lab. No. X-1B4. Limestone, brownish-gray, tan mottling; massive, occasionally thin-bedded; finely crystalline, pisolitic and thin glauconitic zones in upper part; 308 ft thick.
- 93. Lab. No. X-1C. Limestone. Mottled oolitic limestone in talus. About 50 ft thick.

TABLE 17.—Analyses of samples from Montana, Nebraska, and North Dakota containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Montana									
	94	95	96	97	98	99	100	101	102	103
	$25F_229$-31	$25F_229$-26	$25F_229$-27	$25F_229$-28	$25F_229$-14	$25F_229$-13	$25F_229$-12	$25F_229$-29	$25F_230$-2	$25F_230$-3
Insoluble	1.1	1.4	7.0	0.8	1.6	0.6	......	......	4.2	5.6
$Al_2O_3 + Fe_2O_3$	......	......	......	......	......	......	0.80	3.35	......	......
FeO[1]	.5	.3	.4	.4	.3	.3	......	......	.3	.3
MgO	18.8	20.2	15.7	20.2	17.1	17.3	......	......	.4	.5
CaO	30.2	30.4	31.4	30.8	33.3	33.0	[2] 55.24	[2] 53.80	52.2	51.4
Total	50.6	52.3	54.5	52.2	52.3	51.2	56.04	57.15	57.1	57.8
Class	(1,0)93	(1,0)97	(7,0)89	(1,0)97	(2,0)95	(1,0)95	0,0,99	0,0,96	(4,0)94	(6,0)93
CaO/MgO	dolomite	dolomite	calcareous dolomite	dolomite	calcareous dolomite	calcareous dolomite	calcite	calcite	calcite	calcite

	Montana									
	104	105	106	107	108	109	110	111	112	113
	$25F_230$-4	$25F_234$-2	$25F_234$-3	$25F_234$-4	$25F_234$-5	$25F_234$-6	$25F_234$-7	$25F_234$-8	$25F_234$-9	$25F_234$-10
SiO_2	[3] 2.6	......	......	Tr.	0.05	0.05	0.2	0.4	0.5	0.6
Al_2O_3	......	1.65	3.40	......	......	......	<.05	<.05	<.05	.3
Fe_2O_3	......			0.40	.04	.04	<.005	.03	.11	.02
FeO	.8	......	......	......	......	......	......	......	......	......
MgO	11.7	......	......	[2] .25	[2] .03	[2] .03	.3	.1	.2	.05
CaO	38.5	[2] 54.72	[2] 53.96	[2] 55.42	[2] 55.88	[2] 55.73	55.3	55.5	55.3	55.2
P	......	......	......	.00	.00	.00	......	......	......	......
SO_3	......	......	......	[4] .00	[4] .00	[5] .25	......	......	......	......
Organic matter	......	......	......	.00	.00	.00	......	......	......	......
Ignition loss	......	......	......	......	......	......	43.7	43.7	43.6	43.5
Total	53.6	56.37	57.36	56.07	56.00	56.10	< 99.6	< 99.8	< 99.8	99.7
Class	(3,0)93	0,0,98	0,0,96	0,0,99	0,0,100	0,0,100	0,0,99	0,0,99	0,0,99	0,1,99
CaO/MgO	calcareous dolomite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	Montana							Nebraska		
	114	115	116	117	118	119	120	121	122	123
	$25F_234$-11	$25F_234$-12	$25F_239$-1	$25F_247$-2	$25F_247$-3	$25F_247$-4	$25F_247$-5	$26F_213$-2	$26F_213$-3	$26F_213$-4
SiO_2	0.9	1.5	[3] 1.0	[3] 0.7	[3] 2.0	[3] 2.0	[3] 3.0	0.9	0.9	1.1
Al_2O_3	<.05	<.05	......	......	......	......	......	.2	.3	.1
Fe_2O_3	.21	<.005	......	......	......	......	......	.15	.15	.18
FeO	......	......	[6] Tr.	[1] .5	[1] 2.3	[1] .5	[1] .3	......	......	......
MgO	.1	<.05	[2] .5	19.6	8.1	19.4	19.6	.1	<.05	.1
CaO	55.2	55.3	[2] 54.9	31.0	43.6	30.5	29.8	55.0	54.9	54.7
Ignition loss	43.4	42.9	......	......	......	......	......	43.4	43.3	43.2
Total	< 99.9	< 99.8	56.4	51.8	56.0	52.4	52.7	99.8	< 99.6	99.4
Class	1,1,99	2,0,98	(1,0)99	(1,0)96	(2,0)95	(2,0)95	(3,0)94	0,1,98	0,1,98	1,1,98
CaO/MgO	calcite	calcite	calcite	dolomite	magnesian calcite	dolomite	dolomite	calcite	calcite	calcite

	Nebraska			North Dakota						
	124	125	126	127	128	129	130	131	132	133
	$26F_213$-6	$26F_213$-5	$26F_265$-15	$33F_221$-41	$33F_221$-43	$33F_221$-45	$33F_221$-44	$33F_221$-42	$33F_221$-46	$33F_221$-47
SiO_2	1.8	1.4	1.5	4.94	4.16	6.43	4.31	4.02	7.00	7.61
Al_2O_3	.5	.2	1.8	.95	1.80	.88	1.54	.61	.49	1.20
Fe_2O_3	.3	.17	.4							
MgO	.6	<.05	.4	......	......	......	......	......	......	......
CaO	54.1	54.7	53.6	50.33	50.86	49.25	48.83	50.61	48.59	48.97
H_2O -	......	......	......	[7] (1.38)	[7] (.84)	[7] (1.46)	[7] (.62)	[7] (1.10)	[7] (.57)	[7] (1.09)
S	......	......	.0	......	......	......	......	......	......	......
SO_3	......	......	.03	......	......	......	......	......	......	......
Organic matter	......	......	.7	......	......	......	......	......	......	......
Ignition loss	42.9	43.0	[8] 42.5	40.66	41.18	38.83	40.51	40.50	39.64	39.18
Total	100.2	< 99.5	100.9	96.88	98.00	95.39	95.19	95.74	95.72	96.96
Class	1,2,97	1,1,98	0,3,96	3,4,90	1,6,91	5,3,88	2,6,87	3,2,90	6,3,87	6,4,87
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

[1] Calculated from reported Fe.
[2] Calculated from reported $MgCO_3$ or $CaCO_3$.
[3] Reported as insoluble.
[4] Reported as sulphate lime, 0.00 percent; sulphate anhydrate, 0.00 percent.
[5] Reported as sulphate lime, 0.00 percent; sulphate anhydrate, 0.25 percent.
[6] Reported as iron and aluminum oxide.
[7] Not included in total.
[8] Reported as CO_2.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Montana--Continued

94-99. Madison County. Analyst, Bartzen. (Hanson, 1952, p. 43, 28, 29, 32-34, pls. 4, 5A, 5B, 9.) Index map, detailed measured sections, correlated columnar sections, correlation chart.

94. Ordovician, Bighorn dolomite. Secs. 22 and 23, T. 5 S., R. 1 E., about 8 miles northeast of town of Ennis. Lab. No. E-1G. Dolomite, light-gray, medium-crystalline; 10 ft thick. (For other analyses from same measured section, Meagher formation, see samples 84-85 this group, and sample 15, group F_1, of this compilation.)

95. Madison County. Bighorn(?) dolomite. T. 6 S., R. 5 W., (U. M. Sahinen, written communication, 1957), 18 miles northeast of town of Dillon. Lab. No. R-1F3. Dolomite, white, massive; 35 ft thick. (For another analysis from same measured section see sample 16, group F_1 of this compilation.)

96. Upper Cambrian, Red Lion formation and Devonian(?), Maywood formation. Sec. 21, T. 1 S., R. 3 W., South Boulder Creek. Lab. No. S-1F9. Dolomite, cream-colored; 7 ft thick. Isopach map.

97. Middle Devonian, Jefferson dolomite. Sec. 21, T. 1 S., R. 3 W., South Boulder Creek. Lab. No. S-1G. Dolomite, dark-gray.

98-99. Jefferson dolomite. S½ sec. 36, T. 7 S., R. 2 W., and N½ sec. 1, T. 8 S., R. 2 W., south of Ennis. Dolomitic limestone, dark to medium brownish-gray, massive; fossiliferous.

98. Lab. No. E-2D1.

99. Lab. No. E-2D3.

100-101. Madison County, Lower Mississippian, Madison limestone, sec. 33, T. 1 S., R. 1 W., (U. M. Sahinen, written communication, 1955) town of Sappington. (Burchard, 1912, p. 675.) Limestone.

102-104. Meagher County. Sec. 32, T. 8 N., R. 7 E., 10 miles sonth of town of White Sulphur Springs. Analyst, Bartzen. (For another analysis from same measured section see sample 17, group F_1 of this compilation.)

102-103. Cambrian, Meagher limestone. (Hanson, 1952, p. 42, 36, pls. 4, 5A, 5B, 7A, 9.) Limestone, gray, segregated portion of mottled limestone. Index map, isopach maps, detailed measured section; correlated columnar sections, correlation chart.

102. Lab. No. W-b-1.

103. Lab. No. W No. 2.

104. Maywood formation. Lab. No. W-2F10. (Hanson, 1952, p. 43, 35, pls. 4, 5A, 5B, 7A, 9.) Dolomite. Index map, detailed measured section, isopach map, correlated columnar sections, correlation chart.

105-106. Park Connty. Madison limestone, upper part. (T. 2 S., R. 9 E.) town of Livingston. (Burchard, 1912, p. 675.) Limestone.

107-109. Park County. Recent (U. M. Sahinen, written communication, 1955). Secs. 14, 15, 22-24, T. 9 S., R. 8 E., near town of Gardiner. (Mansfield, 1933, p. 8, 6, 9, pl. 1.) Travertine, up to 20 ft thick, hard, generally compact. Bulk density, 2.69. Physical tests. Index and topographic map. Use: Lime, cement, ornamental stone.

110-115. Park County. (Recent.) T. 9 S., R. 8 E., Northwestern Improvement Co. quarries. (Wilson and Skinner, 1937, p. 33, 70, 75, 132.) Travertine, spring deposit. General data for whitings and putties. Physical properties. Use: Decorative building stone, filler, pigment.

110. Sec. 24, Dolly Placer claim. Lab. No. 4. Travertine, pale-gray, porous; from 12-ft exposure.

111. NW¼SW¼ sec. 14, Big Boulder quarry. Lab. No. 3. Travertine, white, cream, and grayish-cream; from upper 25 ft of total 40 ft.

112. SW¼SE¼ sec. 14, Northeast quarry. Lab. No. 6. Travertine, grayish-cream, pale grayish-yellow and shades of purplish-pink; 25 ft thick.

113. SE¼SW¼ sec. 14, East quarry. Lab. No. 1. Travertine, white, light-gray, and cream; 30 ft thick.

114. SE¼SE¼ sec. 15, Sienna quarry. Lab. No. 5. Travertine, pale-gray, grayish-cream, and brownish-yellow or sienna; from upper 15 ft of exposure; impure travertine below.

115. NE¼NW¼ sec. 23, Roadside quarry. Lab. No. 2. Travertine, white, cream, and grayish-cream; banded; about 15 ft thick.

116. Powell County. Madison limestone, upper part. Sec. 6, T. 9 N., R. 6 W., (U. M. Sahinen, written communication, 1955) quarry 1 mile east of Elliston station. (Perry, 1949, p. 35, 29, 34, pl. 6.) Limestone, average analysis. Index map, outcrop map; generalized stratigraphic table. Use: Quicklime, hydrated lime.

Montana--Continued

117-120. Silver Bow County. Sec. 20, T. 2 S., R. 8 W., 4 miles east of town of Melrose. Analyst, Bartzen. Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart.

117. Meagher limestone. Lab. No. C-1C3. (Hanson, 1952, p. 42, 28, pls. 4, 5A, 5B, 7A, 9.) Dolomite, medium-to dark-gray, some beds slightly mottled. Thin-to thick-bedded, medium-crystalline; 241 ft thick.

118. Cambrian, Park shale. Lab. No. C-1D3. (Hanson, 1952, p. 42, 28, pls. 4, 5A, 5B, 7B, 9.) Limestone, 1 ft thick.

119. Cambrian, Pilgrim limestone. Lab. No. C-1E1. Dolomite, medium-gray, fine- to medium-crystalline, medium- to massive-bedded; 58 ft thick.

120. Pilgrim limestone. Lab. No. C-1E2. (Hanson, 1952, p. 43, 28, pls. 4, 5A, 5B, 8A.) Dolomite, light-gray, weathers light to medium gray; medium- crystalline, 141 ft thick.

Nebraska

121-125. (Cass County.) Pennsylvanian, Deer Creek limestone. (T. 10 N., R. 13 E., Weeping Water Valley.) (Wilson and Skinner, 1937, p. 33, 70, 75, 133-135.) Limestone. General data for whitings and putties. Physical properties. Possible use: Whiting.

121. Lab. No. 5. Limestone, cream-colored, hard.

122. Lab. No. 4. Limestone, cream-colored, hard.

123. Lab. No. 3. Limestone, cream-colored.

124. Lab. No. 2. Limestone, cream-colored. Photomicrograph.

125. Lab. No. 1. Limestone, cream-gray, hard, uniformly crystalline.

126. Nuckolls County. Upper Cretaceous, Niobrara formation, near base. (T. 1 N., R. 7 W.), 5 miles southwest of town of Superior. (Darton, 1910, p. 385, 383, 386.) Limestone, massive. Outcrop map. Possible use: Cement material.

North Dakota

127-133. Hettinger County. Oligocene, White River formation. Analyst under supervision of Burr. Overburden, estimated tonnage. Index maps, geologic maps, measured sections or logs of drill holes, correlation (fence) diagram. Use: Generally not desirable as cement material; contains chert or beds too thin. (SiO_2, Al_2O_3, Fe_2O_3, and CaO given as whole numbers in text, Hansen, 1953. Additional information on percentages of these chemical constituents, and amounts of MgO, CO_2, and ignition loss received from Miller Hansen, written communication, 1954.)

127. (White River formation) reported as Eocene, Fort Union formation, Tongue River member. NW¼SE¼ sec. 17, T. 136 N., R. 93 W., Colgrove Butte. Lab. No. 9-2. (Hansen, 1953, fig. 7A, p. 44, 104, 134, 135, 154, figs. 6, 7.) (Limestone.)

128. NE¼ sec. 16, T. 136 N., R. 93 W., Colgrove Butte. Lab. No. 4-5. (Hansen, 1953, fig. 7A, p. 44, 104, 134, 135, 152, figs. 6, 7.) Limestone, top of section; 10 in. thick. (For another analysis from same measured section, see sample 22, group F_1 of this compilation.)

129. Cen. S. line SE¼NE¼ sec. 17, T. 136 N., R. 93 W., Colgrove Butte. Lab. No. 47-1. (Hansen, 1953, fig. 7C, p. 44, 104, 134, 135, 144, figs. 6, 7.) Limestone. (For another analysis from same drill hole, see sample 59, group E of this compilation.)

130. Sec. 18, T. 136 N., R. 93 W., Bull Butte. Lab. No. 31-2. (Hansen, 1953, fig. 5, p. 44, 104, 134, 135, 150, fig. 4.) Limestone, tan, dense; calcite crystals; 1 ft 2 in. thick. Use: Deposit small, but of comparatively good quality. (For another analysis from same measured section, see sample 63, group E of this compilation.)

131. NE¼ sec. 3, T. 136 N., R. 94 W., Straight Butte. Lab. No. 71-3. (Hansen, 1953, fig. 13A, p. 44, 104, 134, 135, 162, figs. 12, 13.) Limestone, 0.5 ft thick.

132. SE¼NW¼ sec. 3, T. 136 N., R. 94 W., Straight Butte. Lab. No. 69-2. (Hansen, 1953, fig. 13A, p. 44, 104, 134, 135, 162, figs. 12, 13.) Limestone, gray, hard; 1 ft 4 in. thick.

133. SE¼ sec. 4, T. 136 N., R. 94 W., Straight Butte. Lab. No. 72-2. (Hansen, 1953, fig. 13A, p. 44, 104, 134, 135, 162, figs. 12, 13.) Limestone, gray, dense; 1.5 ft thick.

TABLE 18.—Analyses of samples from South Dakota and Wyoming containing more than 90 percent carbonates (Group F_2) common rock category

[Chemical analyses arranged by State, county, and stratigraphic position]

	South Dakota										
	1	2	3	4	5	6	7	8	9	10	11
	40F$_2$5-4	40F$_2$5-6	40F$_2$5-8	40F$_2$5-7	40F$_2$5-5	40F$_2$17-10	40F$_2$17-11	40F$_2$17-13	40F$_2$17-12	40F$_2$17-16	40F$_2$18-13
Insoluble	2.67	4.35	6.39	4.98	3.58	[1] Tr.	[1] 0.56	[1] 0.91	[1] 0.90	[2] 1.14	[1] 2.10
Al_2O_3	.68	.76	1.25	.81	2.31		.06		.12		.88
Fe_2O_3	......	......	......	......	......	[3] 0.12	.20	[3] .29	.14	[3] .36	2.24
FeO	1.37	1.62	1.04	2.45	5.50		......		......		......
MgO	......	......	......	......	......	.16	1.64	1.18	.36	[4] .32	.22
CaO	[4] 47.75	[4] 47.41	[4] 49.79	[4] 50.78	[4] 46.52	56.08	53.98	55.06	55.24	[4] 54.83	51.91
P	......	......	......	......	......	Tr.	......	......	......	......	......
SO_3	......	......	......	......	......	......	Tr.	......	Tr.	......	.02
S in FeS_2	......	......	......	......	......	......	......	......	......	......	[5] .01
Ignition loss	[6] 5.60	[6] 3.93	[6] 1.13	[6] 1.74	[6] 3.15	43.72	43.77	43.62	43.25	......	43.03
Total	58.07	58.07	59.60	60.76	61.06	100.08	100.21	[7] 101.06	100.01	56.65	100.41
Class	(1,7)85	(3,6)85	(4,5)89	(4,4)89	(0,9)83	0,0,99	0,1,99	0,1,99	1,1,98	1,1,98	0,6,93
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	12	13	14	15	16	17	18	19	20	21	22
	40F$_2$18-15	40F$_2$18-16	40F$_2$18-18	40F$_2$18-14	40F$_2$18-19	40F$_2$18-17	40F$_2$24-10	40F$_2$41-6	40F$_2$41-5	40F$_2$47-3	40F$_2$47-6
SiO_2	3.16	[8] 3.41	[8] 4.72	3.06	4.92	4.56	1.12	[2] 0.42	1.92	2.12	[2] 2.5
Al_2O_3	.62	.88	1.60	1.52	2.10	1.26		......		[9] .60	
Fe_2O_3	1.68	......	......	1.12	1.40	2.38	[10] .36	.40	.28	......	.9
FeO	......	1.37	1.98	......	......	......		......		.42	
MgO	.26	......	......	.32	.78	.33	19.85	[4] 17.16	.71	.39	[4] .5
CaO	53.17	[4] 52.20	[4] 51.74	51.38	50.42	50.85	31.51	[4] 35.19	54.96	53.91	[4] 53.5
H_2O+	......	......	......	......	......	......	[11] 1.18	......	......	......	......
H_2O-	......	[6] 1.25	[6] 1.72	......	......	......	[11] .07	......	......	......	......
SO_3	.03	......	......	.03	.19	.04	.07	......	Tr.	.08	.1
S in FeS_2	[5] .00	......	......	[5] .00	[5] .00	[5] .00	......	......	......	......	......
Ignition loss	41.37	......	......	41.64	40.36	40.57	[12] 45.66	......	43.00	42.74	......
Total	100.29	59.11	61.76	99.07	100.17	99.99	[13] 99.82	53.17	[14] 100.87	100.26	57.5
Class	0,6,93	(2,4)93	(2,6)87	0,6,92	0,9,90	0,9,90	1,2,96	0,1,99	1,1,97	1,2,97	1,3,96
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	calcareous dolomite	calcite	calcite	calcite

	23	24	25	26	27	28	29	30	31	32
	40F$_2$52-50	40F$_2$52-49	40F$_2$52-51	40F$_2$52-40	40F$_2$52-41	40F$_2$52-47	40F$_2$52-45	40F$_2$52-44	40F$_2$52-43	40F$_2$52-42
SiO_2	[2] 2.10	[2] 2.92	[2] 1.24	1.21	1.22	3.62	1.78	1.72	1.56	1.42
Al_2O_3		.54		.47	.34	.82	.42	.38	.26	.16
Fe_2O_3	[15] .36	.46	[15] .24	.16	.44	.52	.36	.30	.36	.36
MgO	[4] 14.13	.46	[4] .47	.41	.48	.54	.49	.45	.47	.45
CaO	[4] 38.02	53.40	[4] 55.08	54.56	54.46	52.66	53.97	54.07	54.18	54.50
H_2O+	......	......	......	[11] .91	......	......	......	......	......	......
CO_2	......	......	......	42.30	......	......	......	......	......	......
SO_3	......	.06	......	[16] .11	.03	.11	.05	.03	.07	.05
Ignition loss	......	42.37	......	[17] (42.95)	42.95	41.75	42.93	42.97	42.94	43.17
Total	54.61	100.21	57.03	[18] 100.13	99.92	100.02	100.00	99.92	99.84	100.11
Class	2,1,97	1,3,96	1,1,97	0,3,96	0,2,97	2,4,94	1,2,97	1,2,97	1,2,97	1,1,98
CaO/MgO	calcareous dolomite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	33	34	35	36	37	38	39	40	41	42
	40F$_2$52-46	40F$_2$52-53	40F$_2$67-23	40F$_2$67-20	40F$_2$67-18	40F$_2$67-28	40F$_2$67-26	40F$_2$67-11	40F$_2$67-16	40F$_2$67-17
Insoluble	[1] 1.88	[2] 0.76	4.12	3.84	3.70	6.20	5.05	1.61	3.34	5.06
Al_2O_3	.52		1.28	1.19	1.03	1.15	.55	.25	.59	.60
Fe_2O_3	.80	[3] .46	......	......	......	......	......	......	......	......
FeO	......		1.16	1.44	1.37	1.29	.61	.57	2.41	1.94
MgO	.53	[4] .46	......	......	......	......	......	......	......	......
CaO	53.32	[4] 55.01	[19] 51.94	[4] 51.97	[4] 52.10	[4] 50.72	[4] 51.96	[4] 54.50	[4] 51.64	[4] 50.22
SO_3	.19	None	......	......	......	......	......	......	......	......
Ignition loss	42.71	......	[6] 1.57	[6] 1.14	[6] 1.14	[6] 1.39	[6] 3.30	[6] .76	[6] 1.67	[6] 3.70
Total	99.95	56.69	60.07	59.58	59.34	60.75	61.47	57.69	59.65	61.52
Class	0,3,96	0,1,98	(2,5)91	(2,4)92	(2,4)92	(4,5)89	(4,5)88	(1,1)96	(2,3)92	(4,5)88
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

[1] Reported as SiO_2.
[2] Reported as silica and silicates.
[3] Reported as oxide of iron and alumina.
[4] Calculated from reported $MgCO_3$ or $CaCO_3$.
[5] Reported as S in pyrites.
[6] Reported as volatile matter.
[7] 100.84 in text.
[8] Reported as insoluble.
[9] Includes Fe_2O_3.
[10] Reported as alumina, iron, etc.
[11] H_2O- below 100° C.; H_2O+ above 100° C.
[12] Reported as CO_2. Corrected from 44.66 percent (Clarke, 1915, p. 237).
[13] Na_2O, K_2O, and MnO; each reported as none.
[14] 100.75 in text.
[15] Includes FeO.
[16] Reported as S.
[17] Not included in total.
[18] Na_2O, K_2O, TiO_2, and P_2O_5; each reported as trace.
[19] Calculated from reported $CaCO_3$. CaO, 52.30 percent; CO_2, 40.42 percent (Rothrock, 1931, p. 3).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

South Dakota

1-5. Bon Homme County. Upper Cretaceous, Niobrara formation. Springfield-Running Water area. Analyst, under supervision of Frary; collector, Kirby. Index and outcrop maps; measured sections. Possible use: Whiting.
- 1. NE¼ sec. 17, T. 92 N., R. 60 W. Lab. No. 24. (Rothrock, 1931, p. 23, 8, 25.) Chalk, creamy to white, some patches of dark-gray, weathers white or gray; fairly thick-bedded, from bed, 27.5 ft thick.
- 2. Lab. No. 25. Information as in sample 1.
- 3. NW¼ sec. 27, T. 93 N., R. 60 W. Lab. No. 20. (Rothrock, 1931, p. 22, 8, 24.) Chalk, white; bed 20 ft thick; some black chalk in lower 3 ft. (Bed 40 ft below sample 4, see following sample.)
- 4. NW¼ sec. 27, T. 93 N., R. 60 W. Lab. No. 19. (Rothrock, 1931, p. 22, 8, 24.) Chalk, white, weathers light buff; from lower part of 25 ft white zone. (Bed underlies sample 5, see following sample.)
- 5. NW¼ sec. 27, T. 93 N., R. 60 W. Lab. No. 18. (Rothrock, 1931, p. 21, 22, 8, 24.) Chalk, buff, weathers dark reddish buff; many calcite veins; fossiliferous; 25 ft thick, from middle of buff zone.

6-9. Custer County. Lower Mississippian, Pahasapa limestone. Limestone. Generalized columnar section.
- 6. (T. 3 S., R. 3 or 4 E.), 10 miles west of town of Custer. Analyst, Herz. (Connolly and O'Harra, 1929, p. 341, pl. 2.) Limestone, fine-grained, compact, occasional fine veinlets of calcite. Possible use: Lithographic stone.
- 7. (T. 5 S., R. 4 E.), 1.5 miles west-southwest of town of Pringle, Black Hills Lime Co. quarry. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 286, pl. 2.) Use: Lime, sugar manufacture.
- 8. Near Pringle. Analyst, Sharwood. (Connolly and O'Harra, 1929, p. 288, pl. 2.) Use: Lime, sugar manufacture.
- 9. South of Pringle, west of Loring siding, Erpelding quarry. Analyst, Bentley. (Connolly and O'Harra, 1929, p. 286, pl. 2.) Use: Lime, sugar manufacture.

10. Custer County. Pahasapa limestone. Near Pringle. Analyst, Bentley. (Lincoln, 1929, p. 43; Tullis and Gries, 1938, p. 243, 240, 241.) Limestone. General description: Fine-grained, massive, fossiliferous. Outcrop map. Use: Lime, sugar manufacture. Possible use: Flux, concrete aggregate, ballast, riprap, road metal, portland cement, decorative stone.

11-17. Davison County. Niobrara formation. Analyst, under supervision of Frary. Collector, Kirby. Index and outcrop maps.
- 11-14. Enemy Creek area. General description of chalk: In outcrop, white or light-cream; face of exposure, reddish and buff color. Impurities, clayey bands often contain gypsum; secondary gypsum found. Thickness 130-135 ft, 30 ft accessible; overburden, 20 ft or less. Estimated tonnage. Possible use: Filler; not desirable as a cement material.
  - 11. Secs. 22, 27, T. 102 N., R. 61 W. (Rothrock, 1931, p. 30, 8, 28, 29, 32, 33.) Chalk, lower part of exposure.
  - 12. Secs. 22, 27, T. 102 N., R. 61 W. (Rothrock, 1931, p. 29, 8, 28, 32, 33.) Chalk, white; 15 ft from top of 30 ft exposure.
  - 13. NE¼ sec. 24, T. 102 N., R. 62 W., south bluff, Enemy Creek. Lab. No. 16. (Rothrock, 1931, p. 32, 8, 33.) Chalk.
  - 14. NE¼ sec. 24, T. 102 N., R. 62 W., north bluff, Enemy Creek. Lab. No. 17. (Rothrock, 1931, p. 33, 8, 32.) Chalk.
- 15. SW cor. NE¼ sec. 34, T. 104 N., R. 60 W., James River area. (Rothrock, 1931, p. 27, 8.) General description of chalk: White or buff in weathered outcrop; fresh rock, blue or dull gray; contains some clay; small amount of pyrite concretions. Sample typical of white chalk in area, from lower part of 22 ft exposure; overburden 18 ft. Possible use: Whiting, cement.
- 16. Information as in sample 15. Top of same exposure.
- 17. NW cor. sec. 34, T. 104 N., R. 61 W., Firesteel Creek area. (Rothrock, 1931, p. 29, 8, 28.) General description: Chalk not more than 50 ft thick; contains iron concretions and gypsum-bearing clayey bands. Sample: White, leached; 5 ft below top of exposure; overburden 8-12 ft of gravel. Possible use: Whiting, not useful for cement material, contains concretions. (For analysis of lower part, unweathered chalk, see analysis 57, group F_1 of this compilation.)

18. Fall River County. Permian, Minnekahta limestone. T. 7 S., R. 5 E., (A. F. Agnew, written communication, 1957) east of Cascade. Analyst, Steiger. Collector, Richardson. Lab. No. 1854. (Darton, 1901, p. 515; Clarke, 1915, p. 237.) Limestone, purple, thin-bedded; typical sample.

19. Lawrence County. Upper Ordovician, Whitewood limestone. (T. 5 N., R. 3 E.) town of Deadwood, Golden Reward Mining Co. Analyst, Bentley. (Lincoln, 1929, p. 43, 44.) Limestone; maximum thickness, 80 ft. Use: Flux. Possible use: Riprap, road metal, portland cement, lime, concrete aggregate.

20. Lawrence County. Minnekahta limestone. (T. 6 N., R. 2 E.) near mouth of Spearfish Canyon. Analyst, Sharwood. (Connolly and O'Harra, 1929, p. 288, 274, pl. 2.) Limestone. Outcrop map, generalized columnar section. Use: Lime.

South Dakota--Continued

21. Meade County. Minnekahta limestone. (T. 4 N., R. 6 E.), 3.5 miles northwest of town of Piedmont. Analyst, Sharwood. (Connolly and O'Harra, 1929, p. 288, 274, pl. 2.) Limestone, sample of entire face. Outcrop map, generalized columnar section. Use: Lime.

22. Meade County. Minnekahta limestone. (T. 4 N., R. 6 E.) near Piedmont, Homestack Mining Co. (Lincoln, 1929, p. 43, 44, 46.) Limestone, 22-32 ft thick. Use: Chemical lime. Possible use: Flux, concrete aggregate, riprap, road metal, portland cement.

23. Pennington County. Pahasapa limestone. (T. 1 or 2 N., R. 7 E.), 7 miles west of Rapid City, Dark Canyon Stone Co. (Lincoln, 1927c, p. 57; Lincoln, 1929, p. 43; Tullis and Gries, 1938, p. 243.) Limestone. General description: Fine-grained, fossiliferous, massive; quarry face, 300 ft. Use: Road metal, concrete aggregate. Possible use: Flux, riprap, portland cement, lime.

24. Pennington County. Minnekahta limestone. Deposit 2.5 miles northwest of Rapid City, State cement quarry. Analyst, Bentley. (Lincoln, 1925, p. 365; Lincoln, 1927b, p. 37; Lincoln, 1929, p. 43.) Limestone, General remarks: Light-gray with pinkish to purplish cast; hard, thin-bedded; abont 40 ft thick; underlain by shale; abont 2 ft overburden. Analysis, average of three 38 ft drill holes. Use: Portland cement. Possible use: Flux, concrete aggregate, riprap, road metal, lime.

25. Pennington County. Minnekahta limestone. Locality, 4 miles northwest of Rapid City, Northwestern Cement Company. (Lincoln, 1929, p. 43; Caspers and others, 1936, p. 61, 63.) Limestone, average of several analyses; from beds 40 ft thick. Use: Lime, sugar manufacture. Possible use: Flux, concrete aggregate, riprap, road metal, portland cement.

26. Pennington County. Minnekahta limestone. Locality, 4 miles west of Rapid City. Analyst, Coolbaugh. (O'Harra and others, 1908, p. 14, 39, 13.) Limestone, outcrop sample. Possible use: Portland cement, lime.

27. Pennington County. Minnekahta limestone. West of Rapid City, State cement quarry. Analyst, Ernst. (Connolly and O'Harra, 1929, p. 275, 273, 274, pl. 2.) Limestone; outcrop map, generalized columnar section. Use: Cement material.

28-33. Pennington County. Minnekahta limestone. (T. 1 N., R. 7 E.) near Rapid City, State cement quarry. (O'Harra, 1924, p. 62, 58, 60, 61.) Limestone. General description: Gray, slight pink to purple tinge; close-texture, thin-bedded. Drill hole samples from lowest to highest point; each sample represents about 5 ft. Outcrop map. Use: High-grade lime, portland cement.
- 28. DH-8-6.
- 29. DH-8-5.
- 30. DH-8-4.
- 31. DH-8-3.
- 32. DH-8-2.
- 33. DH-8-1.

34. Pennington County. Minnekahta limestone. About 2.5 miles northwest of Rapid City, Black Hills Marble Quarries Corp. Analyst, Bentley. (Lincoln, 1929, p. 43.) Limestone. Use: Lime. Possible use: Flux, concrete aggregate, portland cement, riprap, road metal.

35-42. Yankton County. Niobrara formation. Analyst, under supervision of Frary; collector, Kirby. Index and outcrop maps, measured sections. Possible use: Whiting.
- 35. NE¼ sec. 17, T. 93 N., R. 56 W., old cement plant quarry, Yankton area. Lab. No. 9. (Rothrock, 1931, p. 17, 8, 19.) Chalk, white, some gray patches; fossiliferous; 39 ft thick. (For another analysis from same measured section see sample 62, group F_1 of this compilation.)
- 36. NE¼ sec. 22, T. 93 N., R. 57 W., Big Cliff, 9 miles west of town of Yankton. Lab. No. 11. (Rothrock, 1931, p. 17, 8, 19.) Chalk, weathers very light buff; 145 ft thick, thin overburden.
- 37. NW¼ sec. 1, T. 94 N., R. 54 W., old quarry, Turkey Ridge area. Lab. No. 2. (Rothrock, 1931, p. 10, 8, 13.) Chalk, bedrock, white, weathers gray or buff, 6 ft thick. Estimated tonnage.
- 38. NW¼ sec. 1, T. 94 N., R. 54 W. Lab. No. 3. (Rothrock, 1931, p. 10, 8, 13.) Chalk, white; 14 ft thick; top of section. Estimated tonnage.
- 39. SE¼ sec. 26, T. 95 N., R. 54 W. Lab. No. 8. (Rothrock, 1931, p. 11, 8, 15.) Chalk, white; 15 ft thick, dense beds 1-2 in. thick.
- 40. Cen. sec. 35, T. 95 N., R. 54 W. Lab. No. 6. (Rothrock, 1931, p. 11, 12, 8, 15.) Chalk, 18 ft thick, mostly talus, close to bed rock.
- 41. NE¼ sec. 35, T. 95 N., R. 54 W. Lab. No. 7. (Rothrock, 1931, p. 11, 8, 15.) Chalk, mostly white, some weathering on vertical joints; 25 ft exposed.
- 42. SE¼ sec. 35, T. 95 N., R. 54 W. Lab. No. 5. (Rothrock, 1931, p. 11, 8, 14.) Chalk, white, 25 ft thick. (For analysis from same measured section see sample 65, group F_1 of this compilation.)

TABLE 18.—Analyses of samples from South Dakota and Wyoming containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	South Dakota									Wyoming
	43	44	45	46	47	48	49	50	51	52
	$40F_267$-25	$40F_267$-15	$40F_267$-22	$40F_267$-21	$40F_267$-12	$40F_267$-13	$40F_267$-14	$40F_267$-24	$40F_267$-19	$49F_21$-20
SiO_2	4.5	2.9	4.1	3.9	2.4	2.5	2.6	[1] 4.14	3.83	3.65
Al_2O_3	2.1	.9	1.9	.6	1.3	1.1	1.2	1.81	2.31	.87
Fe_2O_3	2.12	.54	3.12	.56	.88	.69	.70	2.72	......	
MgO	.3	.5	.3	.5	.6	.2	.2	Tr.	.14	[2] .24
CaO	50.1	52.5	50.0	52.3	52.9	53.1	52.8	51.00	52.16	[2] 53.39
$Na_2O + K_2O$	......	......	......	......	......	......	......	Tr.	......	......
SO_3	......	......	......	......	......	......	......	[3] .50	.20	......
Ignition loss	40.8	41.9	40.2	41.4	42.3	42.2	42.2	[4] 39.99	[4] 41.64	......
Total	99.9	99.2	99.6	99.3	100.4	99.8	99.7	100.16	100.28	58.15
Class	0, 9, 90	1, 4, 94	0, 8, 90	2, 3, 93	0, 4, 95	0, 5, 95	0, 5, 95	0, 7, 91	0, 6, 94	2, 3, 95
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	Wyoming									
	53	54	55	56	57	58	59	60	61	62
	$49F_21$-12	$49F_21$-14	$49F_21$-16	$49F_21$-17	$49F_21$-18	$49F_21$-19	$49F_21$-21	$49F_22$-1	$49F_24$-4	$49F_24$-6
SiO_2	0.05	0.43	4.8	1.02	1.28	3.96	[5] 7.57	[6] 0.24	0.32	[5] 0.45
Al_2O_3	.43	.10	1.0	......	......	......	.98	.08	Tr.	......
Fe_2O_3	(7)	......	.4	......	......	......			.30	......
FeO	[8] .02	[2] .07	......	......	......	......	......	......	......	......
FeS_2	.10	.02	......	.34	......	......	......	......	......	......
MgO	[2] .22	[2] .22	.3	[2] .34	[2] .36	[2] .25	None	19.44	[2] .20	[2] .23
CaO	[2] 55.37	[2] 55.37	51.9	[2] 53.83	[2] 54.94	[2] 53.57	50.10	32.95	[2] 55.29	[2] 55.48
Na_2O	......	......	.1	......	......	......	......	......	......	......
H_2O	......	[9] .05	......	......	......	......	......	......	.27	......
TiO_2	......	......	.1	......	......	......	......	......	......	......
Ignition loss	......	......	41.2	......	......	......	[4] 38.63	......	......	......
Total	56.19	56.26	99.8	55.53	56.58	57.78	97.28	52.71	56.38	56.16
Class	0, 0, 99	0, 0, 99	3, 4, 93	1, 0, 97	1, 0, 99	4, 0, 96	(6, 3) 88	(0, 0) 99	0, 1, 99	(0, 0) 100
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	dolomite	calcite	calcite

	Wyoming									
	63	64	65	66	67	68	69	70	71	72
	$49F_24$-5	$49F_24$-7	$49F_26$-1	$49F_26$-2	$49F_27$-3	$49F_27$-5	$49F_27$-4	$49F_27$-6	$49F_27$-17	$49F_27$-18
Insoluble	0.44	0.65	......	[10] 1.37	......	......	......	[11] (3.80)	0.4	0.9
SiO_2			0.89	......	0.6	1.4	0.6	2.30	......	......
Al_2O_3	......	.40	.58	......	.5	.5	.5	1.50	[12] .4	[12] .3
Fe_2O_3	......		......	......	......	......	......			
FeO	......	......	.02	......	[13] .13	[13] .06	[13] .71	......	......	......
MgO	[2] .21	Tr.	None	20.46	20.3	20.7	20.3	20.19	1.0	.8
CaO	[2] 54.83	[2] 55.32	55.01	31.28	32.2	31.2	32.5	29.35	54.5	53.9
H_2O+	......	......	[14] .15	[10] .64	......	......	......	......	......	......
H_2O-	......	......	.04	[10] .22	......	......	......	......	......	......
TiO_2	......	......	.01	......	......	......	......	......	......	......
P_2O_5	......	......	Tr.	......	......	......	......	......	......	......
MnO	......	......	Tr.	......	......	......	......	......	......	......
SO_3	......	......	.08	.71	......	......	......	......	......	......
Cl	......	......	.03	......	......	......	......	......	......	......
SrO	......	......	.07	......	......	......	......	......	......	......
Ignition loss	......	......	[4] 43.30	[4] 45.68	[4] 47.2	[4] 47.0	[4] 47.5	[15] 45.60	43.4	43.2
Total	55.48	56.37	100.18	100.36	100.9	100.9	102.1	98.94	99.7	99.1
Class	(0, 0) 98	(0, 1) 99	0, 2, 98	(1, 1) 96	0, 1, 99	1, 1, 98	0, 1, 99	0, 4, 94	(0, 1) 98	(0, 1) 96
CaO/MgO	calcite	calcite	calcite	dolomite	dolomite	dolomite	dolomite	dolomite	calcite	calcite

	Wyoming									
	73	74	75	76	77	78	79	80	81	82
	$49F_27$-19	$49F_27$-21	$49F_27$-22	$49F_27$-23	$49F_29$-8	$49F_29$-6	$49F_29$-5	$49F_29$-4	$49F_29$-7	$49F_29$-3
SiO_2	[6] 1.6	[6] 3.3	[6] 1.0	[6] 1.3	2.0	0.8	0.8	0.6	1.4	0.4
Al_2O_3	[12] .3	[12] .5	[12] .4	[12] .4	.65	.5	.3	.35	.55	.45
Fe_2O_3					......	......	......	......	......	......
FeO	......	......	......	......	[13] .45	[13] .13	[13] .13	[13] .06	[13] .19	[13] .06
MgO	20.6	20.3	21.0	20.7	20.9	20.8	21.1	21.1	20.3	21.1
CaO	30.6	29.2	29.9	30.0	30.6	31.8	31.8	31.7	32.0	32.2
Ignition loss	46.4	45.0	46.2	46.2	[4] 46.7	[4] 47.5	[4] 47.8	[4] 47.8	[4] 47.1	[4] 48.2
Total	99.5	98.3	98.5	98.6	101.3	101.5	101.9	101.6	101.5	102.4
Class	(1, 1) 97	(2, 1) 94	(0, 1) 97	(1, 1) 97	1, 2, 97	0, 1, 99	0, 1, 99	0, 1, 99	0, 2, 98	0, 1, 99
CaO/MgO	dolomite	dolomite	dolomite	dolomite	dolomite	dolomite	dolomite	dolomite	dolomite	dolomite

[1] Reported as silica and silicates by Lincoln (1929, p. 43).
[2] Calculated from reported $FeCO_3$, $MgCO_3$, or $CaCO_3$.
[3] Reported as sulfur by Lincoln (1929, p. 43).
[4] Reported as CO_2. In sample 50: CO_2 reported as 37.99 percent, total 98.16 percent by Eckel (1905, p. 301).
[5] Reported as SiO_2 and insoluble.
[6] Reported as insoluble.
[7] Fe_2O_3 reported as 0.02 percent by Knight (1929, p. 53).
[8] Reported as $FeCO_3$ by Knight (1893, p. 199); FeO reported as 0.10 percent by Knight (1929, p. 53).
[9] Reported as H_2O-.
[10] From files of U. S. Geol. Survey.
[11] Not included in total.
[12] Reported as R_2O_2.
[13] Calculated from reported Fe.
[14] Includes organic matter.
[15] Reported as CO_3. Reported as 45.00 percent by Osterwald and Osterwald (1952, p. 52).

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

South Dakota--Continued

43-49. Yankton County. Upper Cretaceous, Niobrara formation. Turkey Ridge area. Collector, Kirby. General data for whiting and putties. Physical properties. Possible use: Filler.

43. NW¼ sec. 1, T. 94 N., R. 54 W., old quarry. Lab. No. 7. (Wilson and Skinner, 1937, p. 34, 50, 71, 76, 145.) Chalk, light red-brown, very soft; limonite streaks; from top of 143 ft section.

44. NW¼ sec. 1, T. 94 N., R. 54 W., old quarry. Lab. No. 6. (Wilson and Skinner, 1937, p. 34, 71, 76, 145.) Chalk, light-gray to brown, soft, uniform texture and appearance; from top 23 ft. (Lies above sample 43.)

45. NW¼ sec. 19, T. 95 N., R. 53 W. Lab. No. 5. (Wilson and Skinner, 1937, p. 34, 71, 76, 143, 145.) Chalk, red-brown, soft; streaks of limonite; from 10-ft exposure. Weathered; thick glacial drift overburden.

46. NE¼ sec. 24, T. 95 N., R. 53 W. Lab. No. 4. (Wilson and Skinner, 1937, p. 33, 71, 76, 143.) Chalk, dark grayish-white, pinkish-buff patches; gritty. Overburden.

47-49. NE¼ sec. 35, T. 95 N., R. 54 W. (Wilson and Skinner, 1937, p. 33, 50, 71, 76, 143, 144.) Overburden.

47. Lab. No. 1. Chalk, dark-gray, fairly hard; spots of limonite.

48. Lab. No. 2. Chalk, brownish-white, pink patches; limonite streaks; slightly gritty. Photomicrograph.

49. Lab. No. 3. Chalk, gray, pink, and cream; gritty.

50. Yankton County. Niobrara formation. (T. 93 N., R. 55 W.) town of Yankton, Western Portland Cement Co. (Smith, 1893, p. 52; Lincoln, 1929, p. 43.) Chalk. Use: Portland cement. Possible use: Flux, concrete aggregate, riprap, road metal, lime.

51. Yankton County. Niobrara formation. Near Yankton. Analyst, McVay. (Eckel, 1905, p. 301.) Chalk. Use: Portland cement.

Wyoming

52. Albany County. Pennsylvanian, Fountain formation. Sec. 23, T. 12 N., R. 75 W., Camel Rock. (Knight, 1929, p. 28, 7, 12.) Limestone, pink and gray mottled; nonfossiliferous, fine-grained. Lens in clastic sediments from base of section. Index map.

53. Albany County. Pennsylvanian, Casper formation. Sec. 35, T. 16 N., R. 73 W., Jack Rabbit Canyon, near town of Laramie. (Knight, 1893, p. 199; Knight, 1929, p. 53, 7, 12.) Limestone, index map. Use: Glass.

54. Albany County. Casper formation (H. D. Thomas, written communication, 1956). East of Laramie. (Rickets, 1888, p. 59.) Limestone. Use: Lime, glass manufacture.

55. Albany County. Casper formation (H. D. Thomas, written communication, 1957). Laramie. Analyst, Slavin. Lab. No. B-69. (Brown and others, 1947, p. 6.) Limestone.

56-58. Albany County. Permian, Forelle(?) limestone. Near Laramie. (Osterwald and Osterwald, 1952, p. 151, 3.) Limestone. Generalized geologic map. Possible use: Riprap.

Wyoming--Continued

59. Albany County. Niobrara limestone. (Sec. 31, T. 22 N., R. 75 W.), 3 miles southwest of Rock Creek Station. Analyst, Wells. Lab. No. 2387. (Clarke, 1915, p. 237.) Chalk.

60. Big Horn County. Ordovician, Bighorn dolomite, T. 55 N., R. 91 W., (H. D. Thomas, written communication, 1957), Hunt Mountain. Analyst, Hillebrand; collector, Darton. Lab. No. 2250. (Clarke, 1910, p. 201.) Limestone.

61. Carbon County. Lower Mississippian, Madison(?) limestone (H. D. Thomas, written communication, 1956). (T. 21 N., R. 87 W.) town of Rawlins. (Burchard, 1912, p. 697.) Limestone.

62-64. Carbon County. Madison limestone (H. D. Thomas, written communication, 1956). Near Rawlins. (Osterwald and Osterwald, 1952, p. 151, 3.) Limestone. Estimated tonnage; generalized geologic map. Possible use: Flux, building stone.

62. Sec. 1, T. 21 N., R. 88 W.

63. Sec. 3, T. 21 N., R. 88 W.

64. Sec. 31, T. 22 N., R. 87 W.

65. Crook County. Permian, Minnekahta limestone. (T. 51 N., R. 63 W.), 0.5 mile north of town of Sundance. Analyst, Erickson; collector, Heald. Lab. No. C-304. (Wells, 1937, p. 62.) Limestone.

66. Crook County. Minnekahta limestone. SW¼ sec. 13, T. 52 N., R. 62 W., (from files of U. S. Geol. Survey). Analyst, Fairchild; collector, Rubey. Lab. No. C-941. (Wells, 1937, p. 62.) Dolomite, grading upward into gypsum of Spearfish formation, and downward into limestone (from files of U. S. Geol. Survey).

67-69. Fremont County. Bighorn dolomite. (Osterwald and Osterwald, 1952, p. 52, 3.) Dolomite; generalized geologic map. Possible use: Building stone, crushed stone, fertilizer.

67. (T. 39 N., R. 94 W.), 13 miles north of town of Shoshone.
68. Location, 13 miles north of Shoshone.
69. Location, 15 miles north of Shoshone.

70. Fremont County. Bighorn dolomite. T. 2 N., R. 3 W., Bull Lake, Wind River Mountains. Analyst, Fairchild. Lab. No. 2530. (Clarke, 1915, p. 237; Osterwald and Osterwald, 1952, p. 52, 3.) Dolomite.

71-76. Fremont County. Madison limestone. (Deiss, 1949.)

71-73. (T. 32 N., R. 101 W.), 10 miles southwest of town of Lander, middle fork of Popo Agie River, Wind River Mountains.

71. Lab. No. 4241. Limestone.
72. Lab. No. 4242. Limestone.
73. Lab. No. 4243. (Dolomite).

74-76. (T. 35 N., R. 4 E.) south end of Wind River Canyon. Dolomite.

74. Lab. No. 4295.
75. Lab. No. 4296.
76. Lab. No. 4297.

77-82. Hot Springs County. Bighorn dolomite. (T. 7 N., R. 5 E.), Wind River Canyon, 9 miles south of town of Thermopolis. (Osterwald and Osterwald, 1952, p. 52, 3.) Dolomite, sampled at 20 ft intervals from bottom to top of 120 ft of formation. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

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TABLE 18.—Analyses of samples from South Dakota and Wyoming containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Wyoming								
	83	84	85	86	87	88	89	90	91
	$49F_29$-9	$49F_211$-8	$49F_211$-7		$49F_212$-105	$49F_213$-9	$49F_213$-10	$49F_213$-11	$49F_213$-12
Insoluble	......	0.34	......	......	[1] (5.90)	0.9	4.5	1.2	3.5
SiO_2	2.0	......	[2] 1.49	1.52	4.82	......	......	......	......
Al_2O_3	.85	} .16	{	......	1.1	} .8	1.0	.6	1.1
Fe_2O_3	......		.37	.31	.5				
FeO	[3] .19	......	......	......	......	......	......	......	......
MgO	18.7	17.36	.15	.15	1.8	18.6	20.2	20.9	19.5
CaO	32.7	34.95	54.16	54.18	50.22	33.0	29.2	29.9	30.2
Na_2O	......	......	......	......	.60	......	......	......	......
K_2O	......	......	......	......	.72	......	......	......	......
H_2O+	......	} .23	......	......	{ [4] .77	......	......	......	......
H_2O-	......				.13	......	......	......	......
TiO_2	......	......	......	......	.03	......	......	......	......
P_2O_5	......	......	......	......	.36	......	......	......	......
CO_2	45.9	46.55	[5] 43.68	[5] 43.69	40.2	......	......	......	......
MnO	......	......	.15	......	......	......	......	......	......
SO_3	......	......	......	......	.44	......	......	......	......
V_2O_5	......	......	......	......	.06	......	......	......	......
F	......	......	......	......	.06	......	......	......	......
Chem. U	......	......	......	......	.001	......	......	......	......
Ignition loss	......	......	......	......	[1] (41.1)	46.3	44.8	46.4	45.2
Subtotal	......	......	......	......	101.811	......	......	......	......
Less O	......	......	......	......	[6] .03	......	......	......	......
Total	100.3	[7] 99.59	100.00	99.85	101.8	99.6	99.7	99.0	99.5
Class	1, 2, 97	(0, 1) 99	1, 1, 98	......	2, 5, 91	(0, 2) 98	(3, 3) 94	(0, 2) 97	(2, 3) 95
CaO/MgO	calcareous dolomite	calcareous dolomite	calcite	calcite	calcite	calcareous dolomite	dolomite	dolomite	dolomite

	92	93	94	95	96	97	98	99	100
	$49F_213$-13	$49F_213$-14	$49F_213$-15	$49F_213$-16	$49F_213$-17	$49F_213$-18	$49F_213$-6	$49F_213$-7	$49F_213$-8
Insoluble	0.5	1.4	1.2	1.6	0.8	0.5	[8] 1.2	[8] 1.6	[8] 1.6
Al_2O_3	} .3	.7	.9	.4	.7	.3	{ .35	.55	.7
Fe_2O_3							......	......	......
FeO	......	......	......	......	......	......	[3] .06	[3] .06	[3] .13
MgO	.3	.6	19.7	.5	14.1	.5	12.3	20.2	18.2
CaO	55.2	53.5	30.6	54.0	38.8	55.3	41.5	32.1	34.3
Ignition loss	43.5	43.0	46.4	43.0	45.5	42.4	[9] 45.8	[9] 47.0	[9] 46.6
Total	99.8	99.2	98.8	99.5	99.9	99.0	101.2	101.5	101.5
Class	(0, 1) 98	(0, 3) 96	(0, 3) 96	(1, 1) 97	(0, 1) 98	(0, 1) 96	1, 1, 98	1, 2, 97	0, 2, 98
CaO/MgO	calcite	calcite	dolomite	calcite	calcareous dolomite	calcite	calcareous dolomite	dolomite	calcareous dolomite

	101	102	103	104	105	106	107	108	109
	$49F_215$-15	$49F_215$-11	$49F_215$-13	$49F_215$-18	$49F_215$-22	$49F_215$-21	$49F_215$-20	$49F_215$-12	$49F_215$-19
Insoluble	4.3	2.2	3.7	5.4	9.4	0.8	7.1	3.1	6.4
FeO [3]	.39	1.80	.51	1.03	.77	.51	.51	.51	.64
MgO	.4	.1	.3	.5	.7	1.3	.4	.5	.6
CaO	51.2	50.9	52.7	49.6	47.5	51.5	49.4	52.5	49.8
Total	56.3	55.0	57.2	56.5	58.4	54.1	57.4	56.6	57.4
Class	(4, 0) 92	(2, 0) 91	(4, 0) 95	(5, 0) 90	(9, 0) 86	(1, 0) 95	(7, 0) 89	(3, 0) 95	(6, 0) 90
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	110	111	112	113	114	115	116	117	118
	$49F_215$-16	$49F_215$-17	$49F_215$-14	$49F_215$-34	$49F_215$-33	$49F_215$-30	$49F_215$-26	$49F_215$-27	$49F_215$-32
SiO_2	[10] 5.0	[10] 5.1	[10] 4.2	1.0	1.0	0.8	0.6	0.6	1.0
Al_2O_3	......	......	......	1.05	.6	.55	.55	.45	.6
FeO [3]	.51	.77	1.29	.19	.26	.19	.19	.06	.26
MgO	.6	.1	5.2	20.6	7.1	8.1	9.4	9.5	14.6
CaO	52.2	51.2	45.1	30.6	46.4	45.4	44.2	44.1	38.2
CO_2	......	......	......	46.3	43.9	44.2	44.7	44.8	45.7
Total	58.3	57.2	55.8	99.7	99.3	99.2	99.6	99.5	100.4
Class	(5, 0) 94	(5, 0) 92	(4, 0) 91	0, 2, 97	0, 2, 97	0, 1, 97	0, 1, 98	0, 1, 98	0, 2, 98
CaO/MgO	calcite	calcite	magnesian calcite	dolomite	magnesian calcite	magnesian calcite	magnesian calcite	magnesian calcite	calcareous dolomite

See following page for footnotes.

Semiquantitative spectrographic analysis of sample 87

[E= 0.01-0.1; F= 0.001-0.01; G= less than 0.001. Li, Be, Ni, Co, Zn, Ga, As, Sr, Mo, Ag, Cd, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, Pb, and Bi looked for but not detected]

B	F	Mn	E	Zr	F
Cr	E	Cu	G	Cb	E

[1] Not included in total.
[2] Reported as insoluble residue, (King, 1878, table 6A).
[3] Calculated from reported Fe.
[4] (Calculated by compilers; ignition loss, less CO_2, and less H_2O-; probably contains some F and S.)
[5] Includes H_2O.
[6] (Calculated from F by compilers.)
[7] 100.11 in text.
[8] Reported as SiO_2.
[9] Reported as CO_2.
[10] Reported as insoluble.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

83. Hot Springs County. (Pennsylvanian or Permian, Park City formation) reported as Embar formation. Location, 6 miles south of town of Thermopolis on Wind River. (Osterwald and Osterwald, 1952, p. 52, 3.) Dolomite, upper part of measured section, sampled from 36-48 ft. No overburden. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

84. Laramie County. (Pennsylvanian, Casper formation) reported as Paleozoic. (T. 13 N., R. 69 W., near town of Granite Canyon.) Analyst, Woodward or Brewster. Lab. No. 82. (Hague, 1877, p. 32, 30, 31; King, 1878, table 6B.) Dolomite, compact, very fine grained, uneven fracture. Measured section.

85. Laramie County. Miocene or Pliocene, Ash Hollow formation (H. D. Thomas, written communication, 1957) reported as Pliocene, Niobrara formation. (T. 13 N., R. 66 W.) chalk bluffs, 5 miles south of town of Cheyenne. Analyst, Woodward. Lab. No. 64. (Hague, 1877, p. 70, 69; King, 1878, table 6A.) Limestone, cream-colored, hard; traversed by thin seams of quartz.

86. (Probably another analysis of sample 85.) Analyst, Woodward or Brewster. (Hague, 1877, p. 70, 69; Eckel, 1913, p. 375.) Limestone. Possible use: Cement material.

87. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Lab. No. VEM-45-47. (McKelvey and others, 1953, p. 13, 17, 2, 22, pl. 1; Gulbrandson, 1958, p. 12, 5, pl. 1.) Limestone, light brownish gray, fossiliferous. Modal grain size. Trench sample. Bed P-76, 1.6 ft thick, 50 ft from top of member. Index map, outcrop map; generalized columnar section, detailed columnar section. Mineralogy. (For other analyses from same measured section see samples in Lincoln County in other groups of this compilation.)

88. Natrona County. Lower Mississippian, Madison limestone. (T. 31 N., R. 77 W.), 25 miles southeast of town of Casper. Lab. No. 4285. (Deiss, 1949.) Dolomite.

89-97. Natrona County. Madison limestone. (T. 33 N., R. 79 W.) south of Casper. (Deiss, 1949.)

- 89. Lab. No. 4260. Dolomite.
- 90. Lab. No. 4261. Dolomite.
- 91. Lab. No. 4262. Dolomite.
- 92. Lab. No. 4263. Limestone.
- 93. Lab. No. 4264. Limestone.
- 94. Lab. No. 4265. Dolomite.
- 95. Lab. No. 4266. Limestone.
- 96. Lab. No. 4267. Dolomite.
- 97. Lab. No. 4268. Limestone.

98-100. Natrona County. (T. 33 N., R. 79 W.), 10 miles southwest of Casper. (Osterwald and Osterwald, 1952, p. 53, 3.) Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

- 98. Madison(?) limestone, Casper(?) formation. Dolomite, upper 30 ft.
- 99. Casper formation. Dolomite, 15-30 ft from top.
- 100. Casper formation. Dolomite, top 15 ft.

Wyoming--Continued

101-105. Park County. Cambrian. Sec. 31, T. 58 N., R. 105 W., (unsurveyed), Beartooth Butte. Analyst, Bartzen. (Hanson, 1952, p. 43, 41, pls. 5A, 5B, 8A, 8B, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same section, see samples, Park County, group F_1 of this compilation.)

- 101. Snowy Range formation. Lab. No. B-2F2. Limestone, light pinkish-gray, 10 ft thick, massive, lithographic; in columnar trunk-like structures, fossil zone at top.
- 102. Snowy Range formation. Lab. No. B-2F3. Limestone conglomerate, pinkish-gray, thin-bedded, 5 ft thick; matrix lithographic to coarsely crystalline, fossiliferous.
- 103. Snowy Range formation. Lab. No. B-2F5. Limestone, light-gray, lithographic, 3 ft thick.
- 104. Snowy Range formation. Lab. No. B-2F7. Interbedded light-gray lithographic and coarse-grained fossiliferous limestone, 2 ft thick.
- 105. Pilgrim limestone. Lab. No. B-2E1. Limestone, light-gray, medium-to massive-bedded, finely crystalline, 17 ft thick; contains pebbles.

106-112. Park County. Cambrian. T. 58 N., R. 107 W., (unsurveyed), (U. M. Sahinen, written communication, 1957) along Fox Creek, about 0.5 mile southeast of Index Creek. Analyst, Bartzen. (Hanson, 1952, p. 43, 39, 40, pls. 5A, 5B, 8A, 8B, 9.) Index map, isopach maps, detailed measured section, correlated columnar sections, correlation chart. (For other analyses from same measured section see sample 84, group C, and samples, Park County, group F_1 of this compilation.)

- 106. Pilgrim limestone. Lab. No. I-2E. Limestone, medium- to light-gray, medium-crystalline, thin-bedded, 42 ft thick. Limestone interbedded with shale and conglomerate.
- 107. Snowy Range formation. Lab. No. I-2F4. Limestone, greenish-gray, lithographic, 10.5 ft thick; made up of columnar structures 0.5-1 ft in diameter.
- 108. Snowy Range formation. Lab. No. I-2F7. Limestone, thin-bedded, lithographic; 3 beds of conglomerate 0.5-1 ft thick, total thickness 4 ft.
- 109. Snowy Range formation. Lab. No. I-2F9. Limestone conglomerate, gray, fossiliferous zone at top; 1.5 ft thick.
- 110. Snowy Range formation. Lab. No. I-2F16. Limestone, lithographic, 3 ft thick; contains a few limestone pebbles.
- 111. Snowy Range formation. Lab. No. I-2F17. Limestone, lithographic, 16 ft thick; contains a few pebbles.
- 112. Grove Creek formation. Lab. No. I-2G1. Limestone, brownish-gray, thick-bedded, crystalline; total thickness of formation at this locality, 20 ft.

113-118. Park County. Ordovician, Bighorn dolomite. (T. 52 N., R. 102 W.) reported as west of Bridge. (Osterwald and Osterwald, 1952, p. 54, 3, 53.) Dolomite, sampled at 25-ft intervals from base to 150 ft of formation. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

TABLE 18.— Analyses of samples from South Dakota and Wyoming containing more than 90 percent carbonates (Group F_2) common rock category--Continued

	Wyoming								
	119	120	121	122	123	124	125	126	127
	$49F_215$-36	$49F_215$-31	$49F_215$-28	$49F_215$-29	$49F_215$-37	$49F_215$-24	$49F_215$-23	$49F_215$-35	$49F_215$-25
SiO_2	3.0	0.8	0.8	0.8	4.0	0.6	0.4	2.4	0.6
Al_2O_3	1.5	.4	.5	.5	.7	.3	.55	1.2	.6
FeO	[1] .64	[1] .26	[1] .13	[1] .13	[1] .13	[1] .13	[1] .32	[1] .39	[1] .26
MgO	10.9	12.0	13.5	12.5	12.0	12.6	20.0	6.5	21.3
CaO	40.7	41.3	39.8	41.2	39.7	41.1	30.9	46.1	30.9
CO_2	42.6	45.3	45.8	45.8	44.1	45.8	45.9	43.1	47.3
Total	99.3	100.1	100.5	100.9	100.6	100.5	98.1	99.7	101.0
Class	0, 5, 93	0, 1, 98	0, 1, 99	0, 1, 99	3, 2, 95	0, 1, 99	0, 1, 97	0, 4, 95	0, 1, 99
CaO/MgO	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	calcareous dolomite	dolomite	magnesian calcite	dolomite

	128	129	130	131	132	133	134	135	136
	$49F_215$-38	$49F_215$-40	$49F_216$-1	$49F_216$-2	$49F_216$-3	$49F_218$-1	$49F_218$-2	$49F_220$-1	$49F_220$-2
SiO_2	1.2	2.4	[2] 0.16	0.30	0.39	[2] 0.53	[2] 4.67	[2] 0.35	[2] 0.42
Al_2O_3	.65	.65	} .34	.22	.11	.22	......	Tr.	......
Fe_2O_3	......	......							
FeO	[1] .06	[1] .19	......	......	......	......	......	......	......
MgO	16.6	20.9	......	......	......	20.76	18.41	20.32	20.85
CaO	35.3	30.4	[3] 55.58	[3] 55.70	[3] 55.68	31.17	30.14	30.62	30.43
CO_2	45.6	47.5	......	......	......	47.75	44.24	46.92	47.10
P	......	......	......	.001	......	......	......	......	......
Total	99.4	102.0	56.08	56.22	56.18	100.43	97.46	98.21	98.80
Class	0, 2, 97	1, 2, 97	(0, 0) 99	0, 1, 99	0, 0, 99	(0, 1) 99	(5, 0) 93	(0, 0) 98	(0, 0) 98
CaO/MgO	calcareous dolomite	dolomite	calcite	calcite	calcite	dolomite	dolomite	dolomite	dolomite

	137	138	139	140	141	142	143	144	145
	$49F_223$-24	$49F_223$-25	$49F_223$-26	$49F_224$-41	$49F_224$-42	$49F_224$-44	$49F_224$-45	$49F_224$-36	$49F_224$-39
SiO_2	4.02	1.08	1.42	0.06	0.08	0.15	0.26	0.01	0.05
Al_2O_3	.10	.33	.68	} [4] .14	[4] .15	[4] .49	[4] .11	.05	.11
Fe_2O_3	.94	.77	.40						
MgO	14.14	.57	.72	.06	.90	.42	[5] .60	.07	.90
CaO	36.68	53.40	52.85	55.02	53.83	[6] 53.46	54.06	55.02	52.46
Na_2O	.33	.36	.76	......	......	[7] .03	......	......	.33
K_2O	.09	.16	.30	......	......	.01	......	.04	.71
H_2O	[8] .25	[8] .20	[8] .10	1.06	1.43	2.44	1.19	1.61	[9] 1.02
MnO	.22	.46	.11	......	......	......	......	......	......
CO_2	[10] 43.65	[10] 42.92	[10] 42.78	42.25	41.79	41.96	42.14	42.25	40.88
SO_3	.05	.12	.12	.70	1.72	.55	1.34	.49	1.82
KCl	......	......	......	.08	......	......	......	......	......
NaCl	......	......	......	.20	.02	.13	.26	.12	1.45
Organic matter [11]	......	......	......	.41	.36	.63	None	.19	.51
Total	100.47	100.37	100.24	99.98	100.28	100.27	99.96	99.85	100.24
Class	3, 3, 93	0, 2, 97	0, 3, 96	0, 1, 96	0, 2, 95	0, 3, 95	0, 1, 96	0, 2, 96	0, 1, 93
CaO/MgO	calcareous dolomite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

	146	147	148	149	150	151	152	153	154
	$49F_224$-43	$49F_224$-37	$49F_224$-67	$49F_224$-40	$49F_224$-38	$49F_224$-84	$49F_224$-66	$49F_224$-47	$49F_224$-46
SiO_2	0.09	0.03	[2] 0.10	0.05	0.25	......	[12] 0.04	1.52	0.67
$Al_2O_3+Fe_2O_3$	.11	.04	.10	.06	.45	......	.10	Tr.	.19
MgO	.35	.19	.58	.26	[3] .65	Tr.	.08	Tr.	.78
CaO	55.37	55.64	55.34	55.34	[3] 54.23	54.2	52.90	54.26	53.89
Na_2O	......	......	.06	......	......	......	......	......	......
K_2O	.04	Tr.	.04	......	......	......	......	......	......
H_2O	[9] .32	[9] .45	.14	[9] 1.39	.50	.3	.03	2.89	[9] 1.27
P_2O_5	......	......	......	Tr.	......	......	......	......	......
CO_2	43.11	43.35	43.32	42.78	......	......	43.20	40.76	41.95
MnO	......	......	Tr.	......	......	......	3.29	.29	......
Mn_2O_3 (?)	......	......	......	......	......	......	[13] .54	......	......
SO_3	.44	.24	.32	.32	......	......	.02	Tr.	1.25
NaCl	.10	.09	[14] .05	.03	......	......	[14] Tr.	......	.06
Organic matter	[11] .29	[11] .24	[11] None	[11] .07	......	......	None	......	[11] .44
Total	100.22	100.27	100.05	100.30	56.08	54.5	100.20	99.72	100.50
Class	0, 1, 98	0, 1, 98	(0, 0) 99	0, 2, 97	0, 1, 98	0, 0, 97	0, 0, 95	2, 3, 93	0, 2, 95
CaO/MgO	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite	calcite

See following page for footnotes.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

119-127. Park County. Ordovician, Bighorn dolomite. (T. 52 N., R. 103 W.) west of Shoshone dam. (Osterwald and Osterwald, 1952, p. 54, 3, 53.) Dolomite, sampled at 25-ft intervals from base to 150 ft and from 300-375 ft of formation. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

128. Park County. (Pennsylvanian or Permian, Park City formation) reported as Embar formation. (T. 52 N., R. 102 W.), 4 miles south of town of Cody. (Osterwald and Osterwald, 1952, p. 54, 3.) Dolomite with limestone nodules. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

129. Park County. (Recent.) Southwest of Cody. (Osterwald and Osterwald, 1952, p. 54, 3.) Dolomite, small spring deposit. Generalized geologic map.

130-132. Platte County, Mississippian and Pennsylvanian, Hartville formation (H. D. Thomas, written communication, 1957). (T. 27 N., R. 66 W.), Guernsey Lime Co. (Burchard, 1912, p. 697.) Limestone.

130. Town of Hartville.

131. Hartville.

132. Town of Guernsey.

133-134. Sublette County. Bighorn dolomite. (Osterwald and Osterwald, 1952, p. 55, 3.) Dolomite. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

133. Probably T. 27 N., R. 113 W., (H. D. Thomas, written communication, 1956), Labarge Mountain. Analyst, Fairchild.

134. T. 39 N., R. 112 W., (H. D. Thomas, written communication, 1956), Doubletop Mountain. Analyst, Palmer.

135-136. (Teton County.) Bighorn dolomite (H. D. Thomas, written communication, 1956). (Osterwald and Osterwald, 1952, p. 55, 3.) Dolomite. Generalized geologic map. Possible use: Building stone, fertilizer, crushed stone.

135. T. 39 N., R. 113 W., (H. D. Thomas, written communication, 1956), Shoal Creek. Analyst, Fairchild.

136. (T. 45 N., R. 118 W.), Leigh Creek. Analyst, Wheeler.

137. Weston County. Lower Mississippian, Pahasapa limestone. (T. 45 N., R. 61 W.) about 1.5 miles west of Stockade Beaver Creek. Analyst, Bates. (Ball, 1907, p. 235, 233, 236.) Limestone. Geologic map. Use: Magnesia content too high for portland cement.

Wyoming--Continued

138-139. Weston County. Permian, Minnekahta limestone. (T. 45 N., R. 60 W.) on east side of Stockade Beaver Creek (5 miles east) of town of Newcastle. (Ball, 1907, p. 235, 233.) Limestone, light-gray or purple, thin-bedded; contains few flint nodules, average thickness less than 40 ft. Geologic map. Possible use: Portland cement material.

138. Analyst, Bates.

139. Analyst, Phillips.

140-151. Yellowstone National Park. (Recent.) Mammoth Hot Springs Basin.

140-144. Analyst, Whitfield. (Weed, 1889a, p. 646; Clarke, 1915, p. 238.)

140. Near Blue Springs. Extinct spring, main terrace. Travertine, white, fibrous, fan-shaped masses.

141. From slopes below hotel terrace. Travertine, yellowish, compact.

142. Cupid's Cave. Travertine, crystalline deposit on walls.

143. Ridge west of Blue Springs. Travertine.

144. Near Sulfur Spring No. 246. Travertine, mushroom-shaped mass.

145-147. (Clarke, 1915, p. 238.) Travertine.

145. Cavity near Pulsating Geyser. Analyst, Whitfield. Lab. No. 239.

146. Caps Terrace Mountains. Analyst, Gooch. Lab. No. 257.

147. Edge of old cave, highest terrace. Analyst, Gooch. Lab. No. 246.

148. Liberty Cap. Analyst, Allen. (Allen and Day, 1935, p. 377, 232.) Travertine. Index map. (Possibly analysis of same material as sample 149.)

149. Analyst, Gooch. Lab. No. 93. (Clarke, 1915, p. 238.) Calcareous tufa.

150. (Leffmann, 1883b, p. 351.) Geyser deposit. Incrustations in white masses; radiated structure.

151. Analyst, Leffmann. (Peale, 1883, p. 406.) Travertine.

152-154. Yellowstone National Park. (Recent.)

152. East end of Firehole Lake, old travertine terraces. (Allen and Day, 1935, p. 346, 232.) Travertine, dark-brown, banded, crystalline, dense, covers area 200 x 50 yds. Index map.

153. Hot Lakes. Analyst, Whitfield. Lab. No. 862. (Clarke, 1915, p. 238.) Calcareous sinter. Bulk density, 2.857.

154. From bank of Hot River. Analyst, Whitfield. Lab. No. 241. (Clarke, 1915, p. 238.) Travertine.

Footnotes of analyses on preceding page:

[1] Calculated from reported Fe.
[2] Insoluble.
[3] Calculated from reported $MgCO_3$ or $CaCO_3$.
[4] Reported as Al_2O_3 by Clarke (1915, p. 238).
[5] MgO reported as 0.66 percent by Clarke (1915, p. 238).
[6] CaO reported as 53.41 percent by Clarke (1915, p. 238).
[7] Not reported by Weed (1889a, p. 646).
[8] Reported as H_2O- at 100° C.
[9] Includes H of organic matter.
[10] Reported as ignition loss.
[11] Calculated by compilers from reported C (organic). For samples 143 and 148, C (organic) reported as none.
[12] Reported as siliceous residue.
[13] Insoluble brown oxide remaining when travertine is dissolved in diluted nitric acid.
[14] Reported as Cl.

TABLE 19.—Analyses from Colorado, Kansas, and South Dakota of clays in which (2.178 x Al_2O_3) + H_2O (however determined) is 50 percent or more of the sample (Group Hk) special rock category

[Kaolin-like clays (kaolinite only, no "bauxite"). SiO_2/Al_2O_3 weight ratio from 1.178 to 1.768. Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado											
	1	2	3	4	5	6	7	8	9	10	11	12
	5Hk14-1	5Hk14-2	5Hk21-8	5Hk21-13	5Hk22-8	5Hk22-14	5Hk22-15	5Hk22-10	5Hk22-9	5Hk22-6	5Hk23-4	5Hk26-1
SiO_2	51.02	52.96	52.39	49.21	50.98	46.80	54.50	51.93	51.00	48.48	48.80	50.60
Al_2O_3	34.44	33.83	31.91	33.03	34.88	37.24	42.74	31.93	31.26	35.12	35.70	35.59
Fe_2O_3	.40	.53	1.84	1.22	1.62	2.05	1.09	2.22	1.71	1.53	5.20	.91
MgO	None	None	......	.14	Tr.	.22	.58	.02	.16	.18	Tr.	1.18
CaO	None	None	.99	.98	.21	Tr.	.36	.21	.21	.35	1.05	.32
Na_2O	......	......	Tr.	.21	......	......	......	......	......	......	......	Tr.
K_2O	......	......	Tr.	.15	......	......	......	......	......	......	......	.47
H_2O-	......	......	.87	[1] 1.45	......	......	......	......	......	......	......	1.86
TiO_2	.80	1.14	......	1.50	......	......	......	.69	.79	.51	......	......
Ignition loss	13.08	10.48	11.34	12.27	11.98	14.98	......	13.31	13.27	13.96	[2] 10.25	10.07
Total	99.74	98.94	99.34	100.16	[3] 99.67	[4] 101.29	99.27	[5] 100.31	98.40	100.13	101.00	101.00
Class	0,93,0	0,94,0	0,94,2	0,90,2	0,92,0	0,89,0	0,86,0	0,95,0	0,93,1	0,90,1	0,87,2	0,90,3

	13	14	15	16	17	18	19	20	21	22	23
	5Hk26-3	5Hk28-6	5Hk28-7	5Hk28-13	5Hk30-35	5Hk30-36	5Hk30-39	5Hk30-37	5Hk30-41	5Hk36-5	
SiO_2	47.28	50.93	52.49	51.22	51.23	50.35	52.41	49.54	46.88	61.98	55.09
Al_2O_3	36.19	32.79	31.43	33.75	33.26	33.64	32.21	34.04	35.42	37.51	33.34
Fe_2O_3	Tr.	1.46	.73	2.02	.54	.75	.66	[6] .88	[6] 1.74	.45	.40
MgO	Tr.	Tr.	.19	.50	......	Tr.	.06	.36	.20	.09	.08
CaO	.42	.66	.41	.22	.91	......	.20	.61	.44	.19	.17
Na_2O	.51	Tr.	......	......	.31	.09	......	Tr. (Na_2O + K_2O)	1.19 (Na_2O + K_2O)	......	......
K_2O	5.74	Tr.	......	......	.17	.49	.61				
H_2O	8.72	[7] 1.32	......	......	[7] .53	[8] 13.88	14.05	13.91	14.10	......	......
TiO_2	......	......	1.17	......	......	.80	......	......	......	......	......
P_2O_5	.57	......	......	......	......	......	......	......	......	......	......
SO_3	......	Tr.	......	......	......	......	......	......	......	......	......
Ignition loss	......	11.28	13.24	12.83	13.14	......	......	[9] .27	......	[10] (12.51)	11.12
Total	99.43	98.44	99.66	100.54	100.09	100.00	100.20	99.61	99.97	100.22	100.20
Class	0,83,0	0,92,1	0,95,1	0,92,1	0,93,2	0,93,0	0,96,0	0,92,1	0,88,0	......	0,97,0

	24	25	26	27	28	29	30	31	32	33	34
	5Hk51-25	5Hk51-68	5Hk51-42	5Hk51-30	5Hk51-34	5Hk51-35	5Hk51-32	5Hk51-55	5Hk51-57	5Hk51-53	5Hk51-28
SiO_2	48.91	52.31	48.72	50.24	51.04	52.35	50.71	46.83	48.03	45.88	49.60
Al_2O_3	35.19	31.24	35.31	34.85	33.12	29.64	33.74	37.42	36.10	37.47	32.36
Fe_2O_3	.83	.64	.37	.55	.92	1.29	.16	.58	.30	.70	1.10
MgO	.12	.30	.02	None	None	.47	.26	None	None	None	.32
CaO	None	None	None	None	None	.91	.38	None	None	None	.64
TiO_2	1.02	.88	.72	.96	.92	1.17	.50	.86	.74	.80	1.00
Ignition loss	13.82	13.77	14.64	13.75	14.24	14.52	14.42	14.51	14.56	15.34	14.45
Total	99.89	99.14	99.78	100.35	100.24	100.35	100.17	100.20	99.73	100.19	99.47
Class	0,90,0	0,96,1	0,91,0	0,93,0	0,94,0	0,96,3	0,93,1	0,88,0	0,90,0	0,87,0	0,92,2

[1] At 100° C.
[2] Includes H_2O- and alkalies.
[3] 95.67 in text.
[4] 100.49 in text.
[5] 99.47 in text.
[6] Reported as FeO.
[7] Reported as moisture.
[8] Includes organic matter.
[9] Reported as organic matter.
[10] Not included in total.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1-2. Custer County. Upper Cretaceous, Dakota sandstone, Dry Creek Canyon member. Wetmore area. Analyst, Cress. (Waagé, 1953, p. 97, 3, 6, 38, 53, 86, 87, 100.) General remarks: Flint clay, light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Index map, outcrop map; generalized columnar section, mineralogy. Use: Development improbable.

1. SW corner SE¼NE¼ sec. 33, T. 21 S., R. 69 W., Middle Hardscrabble Creek. Lab. No. 85. Channel sample, 2.5-ft bed of flint and sandy flint clay, overlain by 20 ft of sandstone.

2. SE¼SE¼ sec. 11, T. 22 S., R. 69 W., south bank of South Hardscrabble Creek. Lab. No. 84. Flint clay, 2 or more ft thick.

3. El Paso County. Upper Cretaceous and Eocene, Dawson arkose. T. 12 S., R. 61 W., 3 miles east of town of Calhan. Analyst, Tremaine. Lab. No. 173. (Butler, 1915, p. 343, 188, 200, 306, 324, 325.) Clay, white, brown, and red, sandy, hard, fine-grained; 6 ft thick, overburden 10 ft. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile, refractories.

4. El Paso Connty. (Dawson arkose. T. 12 S., R. 61 W.) southeast of Calhan. (Richardson, 1911, p. 295, 293.) Clay, gray, fine-textured. Ceramic tests. Possible use: Fire brick.

5-10. Fremont County. Dakota sandstone, Dry Creek Canyon member. Diamond Fire Brick Co. (Waagé, 1953, p. 96, 3, 6, 21, 31, 38, 40-42, 53, 81-83, 100.) General remarks: Flint clay, light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Index map, outcrop map; generalized columnar sections, composite stratigraphic section, detailed measured section. Mineralogy. Use: High-grade refractories. Possible use: Source of alumina.

5-8. SW¼SW¼ sec. 4, T. 18 S., R. 70 W., Diamond Flint mine. Face of mine: Clay, 6-7 ft thick; nonsandy flint clay, 3-4 ft thick. In mine: Gray flint clay, few sandy streaks.

5. Lab. No. 68. Probably spot sample of best flint clay.

6. Lab. No. 69. Probably spot sample of best flint clay.

7. Lab. No. 70. Probably spot sample of best flint clay.

8. Lab. No. 64. Flint and sandy flint clay. Channel sample, upper 6 ft of clay zone. Ceramic tests, physical properties.

9. SE¼SE¼ sec. 4, T. 18 S., R. 70 W., Deer Hill mine. Analyst, Davidson. Lab. No. 65. Flint clay, gritty to very sandy; streaks of nonsandy flint clay. Sample from upper half of clay bed.

10. Deer Hill mine. Analyst, Davidson. Lab. No. 66. Flint clay, light-gray, porcelaneous, nonsandy; spot sample from upper half of clay bed.

11. Garfield County. Pennsylvanian, probably Paradox formation, 18 miles southeast of town of Glenwood Springs (N. W. Bass, written communication, 1956). Analyst, Tremaine. Lab. No. 203. (Butler, 1915, p. 343, 208, 209, 306, 326, 327.) Shale and clay, gray, fine-grained, soft; 20 ft sampled from much thicker exposure. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, tile.

12. Gunnison County. Dakota sandstone. (T. 50 N., R. 1 E.), 2.5 miles east of town of Gunnison. Analyst, Tremaine. Lab. No. 220. (Butler, 1915, p. 343, 214, 307, 326, 327.) Clay, dark-gray and dark-brown, very fine grained, hard; 6 ft exposed of possible 8-10 ft; underlies 10 ft of sandstone. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

13. Gunnison County. Upper Cretaceous, Laramie formation, T. 13 S., R. 87 W., (P. C. Patton, written communication, 1957) Redwell Basin, Waterfall mine. (Eakins, 1890, p. 136.) Kaolin, white, fine; galena and pyrite crystals scattered throughout.

14. Huerfano County. Lower Cretaceous, Purgatoire formation. T. 25 S., R. 66 W., about 9 miles east of mouth of Apache Creek. Analyst, Tremaine. Lab. No. 235. (Butler, 1915, p. 343, 216, 219, 307, 328, 329.) Ball clay, white, very fine grained, soft, occurs as plastic streaks, 2-6 inches wide; in black fine-grained shale. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick, earthenware, unvitrified and vitrified floor tile, stoneware, refractories.

15. Huerfano County. Dakota sandstone, Dry Creek Canyon member. SE¼NW¼ sec. 19, T. 26 S., R. 64 W. Analyst, Brannock. Lab. No. 86. (Waagé, 1953, p. 97, 3, 6, 21, 38, 40-44, 53, 90, 91, 100.) Gray flint clay and sandy flint clay, 4.5 ft thick. General remarks: Light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Index map, outcrop map, geologic map; generalized columnar sections, correlated columnar sections, detailed measured section. Ceramic tests, physical properties, mineralogy. Use: High-grade refractories. Possible use: Source of alumina.

16. Huerfano County. Dakota sandstone, top of formation. SW corner sec. 3, T. 25 S., R. 65 W., Capers area, Shamblin mine, Standard Fire Brick Co. Lab. No. 3. (Waagé, 1953, p. 95, 3, 6, 53, 88, 98.) Clay, light-blue, brittle, laminated; sample from upper half of bed 4.5-6 ft thick, 3-4 ft below surface. Index map, outcrop map; generalized columnar sections. Use: Mine inactive. Possible use: Semirefractories. (For an analysis of lower half of clay bed, see sample 24, group D of this compilation.)

Colorado--Continued

17. Jefferson County. Purgatoire formation. T. 2 S., R. 70 W., near Coal Creek. Analyst, Tremaine. Lab. No. 293. (Butler, 1915, p. 344, 223, 232, 308, 330, 331.) Clay and shale, drab, fine- to coarse-grained, soft. Index map. Ceramic tests, physical properties, mineralogy. Possible use: Brick.

18. Jefferson County. Dakota sandstone. T. 3 S., R. 70 W., 2 miles north of town of Golden, Denver Fire Clay Co. Analyst, Hillebrand. (Emmons and others, 1896, p. 390, 387-389, pl. 10.) Fire clay. General remarks: Gray, hard, compact, fine-grained, laminated. Analysis calcnlated on basis of kaolinite composition also given. Geologic map and cross sections. Use: Refractories.

19. Jefferson County. Probably Dakota sandstone (K. M. Waagé, written communication, 1958). Near Golden, Duncan and Co. (Wilber, 1883, p. 473.) Fire clay. Use: Refractories.

20-21. Jefferson County. Laramie formation (K. M. Waagé, written communication, 1958). Golden. Fire clay.

20. (Ries, 1897, p. 1150.)

21. Analyst, Crossley. (Crossley, 1888, p. 24, 25.)

22. Las Animas County. Dakota sandstone. (T. 27 S., R. 60 W.) canyon near Juan Baca ranch. Analyst, Stokes. (Stose, 1912, p. 11.) Clay. Geologic maps. Firing tests. Possible use: Refractories.

23. Analysis of sample 22 recalculated by compilers to include ignition loss.

24-34. Pueblo County. Dakota sandstone, Dry Creek Canyon member. Estimated tonnage. Index map, outcrop map; generalized columnar section, correlated columnar sections; mineralogy. General remarks for flint clay: Light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Use: High-grade refractories. Possible use: Source of alumina. General remarks for plastic clay: Varies from light-gray and blue-gray to black; generally massive to blocky, compact and tough, splintery to rough, blocky fracture. Use: Refractories.

24. SE¼ sec. 13, T. 18 S., R. 67 W., Turkey Creek district, Hell Canyon area. Lab. No. 76. Analyst, Cress. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38-44, 53, 76, 100, pls. 1, 4.) Flint clay, sparsely scattered sand grains; composite sample of upper 2-3 ft of exposed bed. Ceramic tests, physical properties.

25. SE¼ sec. 13, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 81. (Waagé, 1953, p. 97, 3, 6, 21, 36-38, 53, 68, 100, pls. 1, 4.) Plastic clay, 3 ft thick; overlies flint clay.

26. NE¼NW¼ sec. 24, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 78. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38, 53, 66, 100, pls. 1, 4.) Flint clay, scattered sand grains; 5 ft exposed, 4.5 ft sampled.

27. NW¼NW¼ sec. 24, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 79. (Waagé, 1953, p. 97, 3, 6, 21, 31, 38-44, 65-70, 96, 100, pls. 1, 4.) Flint clay, scattered sand grains; 4.5 ft thick. Ceramic tests, physical properties.

28. SE¼NW¼ sec. 24, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 77. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38, 53, 66, 100, pls. 1, 4.) Flint clay, 4 ft thick.

29. Center NW¼ sec. 24, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 80. (Waagé, 1953, p. 97, 3, 6, 21, 36-38, 53, 66, 100, pls. 1, 4.) Plastic clay, scattered sand grains; lower 3 ft of 4 ft bed, overlying flint clay.

30. Center NW¼ sec. 24, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 75. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38-44, 53, 66, 100, pls. 1, 4.) Flint clay, scattered sand grains; 4 ft thick. Ceramic tests, physical properties.

31. NE¼SW¼ sec. 25, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 72. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38-44, 53, 67, 100, pls. 1, 4.) Flint clay, lower 2.5 ft of 5-ft bed; selected sample. Ceramic tests, physical properties.

32. NE¼SW¼ sec. 25, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 71. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 38-44, 53, 67, 100, pls. 1, 4.) Flint clay, upper 2.5 ft of 5-ft bed (overlies sample 31). Selected sample. Ceramic tests, physical properties.

33. NW¼SE¼ sec. 25, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 73. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 44, 53, 67, 100, pls. 1, 4.) Flint clay, channel sample of 5-ft bed.

34. SW¼SE¼ sec. 25, T. 18 S., R. 67 W., Hell Canyon area. Analyst, Cress. Lab. No. 74. (Waagé, 1953, p. 96, 3, 6, 21, 31-33, 44, 53, 68, 100, pls. 1, 4.) Flint clay, upper 4 ft of 5-ft bed.

TABLE 19.—Analyses from Colorado, Kansas, and South Dakota of clays in which (2.178 x Al_2O_3) + H_2O (however determined) is 50 percent or more of the sample (Gronp Hk) special rock category--Continued

	Colorado											
	35	36	37	38	39	40	41	42	43	44	45	46
	5Hk51-36	5Hk51-27	5Hk51-33	5Hk51-26	5Hk51-23	5Hk51-58	5Hk51-21	5Hk51-24	5Hk51-29	5Hk51-52	5Hk51-56	5Hk51-22
SiO_2	53.03	49.58	51.02	49.41	48.30	50.30	47.77	48.69	49.78	45.49	47.43	48.13
Al_2O_3	30.74	33.57	33.32	33.51	34.14	36.88	35.21	33.67	30.77	36.35	33.51	32.15
Fe_2O_3	.77	.70	.06	.94	.89	1.23	.55	1.03	2.87	1.03	1.32	1.77
MgO	.47	.35	Tr.	.32	.25	.36	.39	.36	.05	.02	.05	.36
CaO	.43	.36	None	.19	.16	......	.60	.16	.24	.44	.49	.05
TiO_2	1.08	1.12	1.00	1.05	1.04	......	1.32	1.22	1.03	1.27	1.15	1.02
Ignition loss	13.54	14.17	14.50	14.32	14.82	10.60	14.58	14.46	14.56	15.02	14.40	14.15
Total	100.06	99.85	99.90	99.74	99.60	99.37	100.42	99.59	99.30	99.62	98.35	97.63
Class	0,96,2	0,91,1	0,94,0	0,91,1	0,90,1	0,89,1	0,89,2	0,90,1	0,93,1	0,86,1	0,89,1	0,90,1

	Colorado							Kansas			South Dakota	
	47	48	49	50	51	52	53	54	55	56	57	58
	5Hk51-51	5Hk51-54	5Hk51-43		5Hk51-59		5Hk51-49	15Hk27-75	15Hk27-77	15Hk53-30	40Hk12-1	40Hk41-4
SiO_2	44.25	46.47	58.86	49.22	54.93	47.03	61.	55.35	55.76	45.83	43.25	46.50
Al_2O_3	35.51	35.81	39.17	32.76	43.65	37.37	35.	31.90	33.06	37.75	33.42	39.24
Fe_2O_3	2.22	1.55	.55	.46	.69	.59	.25	.94	.97	.05	[1] Tr.	[2] Tr.
MgO	.01	.01	.45	.38	.05	.04	......	.12	.50	.80	......	.80
CaO	.72	.08	1.08	.90	.64	.55	......	.45	.31	.58	5.60	......
Na_2O+K_2O	......	......	......	......	......	......	......	......	.42	1.20	Tr.	......
H_2O	......	......	......	......	......	......	[3] 3.75	......	......	......	11.02	13.75
TiO_2	1.28	1.39	......	......	......	......	......	.60	.34	.34	......	......
CO_2	......	......	......	......	......	......	......	......	......	......	4.40	......
Ignition loss	15.10	14.45	[4] (19.58)	16.37	[4] (16.80)	14.38	......	10.97	8.87	13.41	[5] 2.32	......
Total	99.09	99.76	[6] 100.11	100.09	99.96	99.96	100.	100.33	100.23	99.96	[7] 100.01	100.29
Class	0,84,1	0,88,0	......	0,92,2	......	0,88,2	0,99,0	0,97,1	0,96,2	0,84,3	0,81,10	0,87,0

[1] Reported as iron.
[2] Reported as FeO.
[3] Includes organic matter.
[4] Not included in total.
[5] Reported as oil.
[6] 99.81 in text.
[7] 99.01 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado--Continued

35-42. Pueblo County. Upper Cretaceous, Dakota sandstone, Dry Creek Canyon member. T. 18 S., R. 67 W., Tnrkey Creek district, Stone City area. (Waagé, 1953, p. 95, 3, 6, 21, 31-33, 40-44, 46, 53, 59-61, 98, pls. 1-3.) Estimated tonnage. Index map, ontcrop map; geologic cross section, generalized columnar section, correlated columnar sections; mineralogy. General remarks for flint clay: Light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Use: High-grade refractories. Possible use: Source of alumina. General remarks for semiplastic clay: Black, fairly hard, dense; splintery to poorly developed conchoidal fracture; contains carbonaceous matter. Use: Refractories.

35. SW¼SE¼ sec. 26, Dry Creek Canyon mine, Pueblo Clay Products Co. Analyst, Brannock. Lab. No. 10. Flint clay, channel sample.
36. SW¼SE¼ sec. 26, Dry Creek Canyon mine. Analyst, Brannock. Lab. No. 11. Flint clay.
37. SW¼SE¼ sec. 26, Dry Creek Canyon mine. Lab. No. 20. Semiplastic clay, composite sample, probably contains some overlying plastic clay.
38. Center NE¼NE¼ sec. 35, Pueblo Clay Products Co. Analyst, Brannock. Lab. No. 14. Flint clay, some sandy flint clay; channel sample.
39. SW¼NW¼ sec. 36, Nellie Helen mine. Analyst, Brannock. Lab. No. 13. Flint clay; ceramic tests, physical properties.
40. SW¼NW¼ sec. 36, Nellie Helen mine. Lab. No. 22. Flint clay.
41. SW¼NW¼ sec. 36, Nellie Helen mine. Lab. No. 21. Flint clay.
42. SE¼SE¼ sec. 36, abandoned U. S. Zinc Co. mine. Analyst, Brannock. Lab. No. 15. Flint clay.

43-48. Pueblo County. Dakota sandstone, Dry Creek Canyon member. T. 22 S., R. 67 W., Beulah district, Rock Creek area, Rock Creek mines, Standard Fire Brick Co. Analyst, Davidson. (Waagé, 1953, p. 95, 1, 3, 6, 40-44, 53, 73, 74, 98, 99, pl. 5.) Flint clay, average thickness about 2.5 ft. Estimated tonnage. Index map, outcrop map; detailed measured section, generalized columnar section, correlated columnar sections; mineralogy. General remarks for flint clay: Light-gray to light blue-gray, fine-grained, hard, conchoidal to semiconchoidal fracture; sandy at base of member, locally sandy. Use: High-grade refractories. Possible use: Source of alumina.

43. SE¼SW¼ sec. 26. Lab. No. 26. Flint clay, channel sample, 2.5 ft thick.
44. NW corner NE¼ sec. 35. Lab. No. 32. Flint clay, npper 1.5 ft.
45. NW corner NE¼ sec. 35. Lab. No. 27. Flint clay, slightly sandy; spot sample, upper 1 ft. (For other analyses from same measured section, see sample 99, gronp B, and samples 35, 36, group D, of this compilation.)
46. NW corner NE¼ sec. 35. Lab. No. 31. Flint clay, blue, sandy, upper 1.5 ft.
47. NW corner NE¼ sec. 35. Lab. No. 33. Flint clay, upper 1.5 ft.
48. NW corner NE¼ sec. 35. Lab. No. 34. Flint clay, 2.5 ft thick. Ceramic tests, physical properties.

49-52. Pueblo County. Dakota sandstone, possibly top of Purgatoire formation. (Sec. 36, T. 25 S., R. 62 W.), 2 miles west of Haystack Butte. Analyst, Stokes. (Stose, 1912, p. 11.) Clay. Geologic maps, generalized columnar section; firing tests. Possible use: Refractories.

49. Clay.
50. Analysis of sample 49, calculated by compilers to include ignition loss.
51. Clay.
52. Analysis of sample 51, caculated by compilers to include ignition loss.

53. Pueblo County. Upper Cretaceous, Pierre shale (K. M. Waagé, written communication, 1958). (T. 20 S., R. 64 W.) town of Pueblo, Standard Fire Brick Co. (Ries, 1895, p. 564, 565.) Clay. Use: Brick.

DESCRIPTIVE NOTES--Continued

Kansas

54-56. Dakota sandstone. Analysts, Thompson and Runnels. Index map, outcrop map, correlated outcrop sections.

54. Ellsworth County. Terra Cotta clay member, lower part. Sec. 25, T. 15 S., R. 7 W. Lab. No. El-14-04. (Plummer and Romary, 1947, p. 64, 10, 42, 43, 62, 65, pl. 1.) Kaolin, very light-gray to white, some yellow joint stain, conchoidal fracture; 1.5 ft thick. Ceramic tests. Possible use: Fire clay. (For another analysis from same measured section, see sample 93, group B of this compilation.)

55. Ellsworth County. Terra Cotta clay member. NW¼ sec. 19, T. 16 S., R. 7 W. Lab. No. El-52-3. (Plummer and Romary, 1947, p. 79, 10, 42, 43, 69, 80-83, pl. 1.) Ball clay, nearly white, plastic, very smooth; 2.8 ft thick. Composite sample from 6 pits. Ceramic tests, physical properties. Possible use: Refractories, brick, structural tile.

Kansas--Continued

56. Lincoln County. Janssen clay member. NE¼ sec. 32, T. 10 S., R. 6 W. Lab. No. L-30-4. (Plummer and Romary, 1947, p. 64, 10, 42, 43, 63, 65, pl. 1.) Kaolin, white, conchoidal fracture; 0.6 ft thick. Ceramic tests. Possible use: Fire clay.

South Dakota

57. Charles Mix County. Pierre shale. T. 96 N., R. 68 W., (E. P. Rothrock, written communication, 1955) bluffs near Wheeler. Analyst, Kuever. (Rothrock, 1944, p. 180.) Shale. Possible use: Cement material.

58. Lawrence County. Precambrian, T. 4 N., R. 2 E., (E. P. Rothrock, written communication, 1955) near town of Terry, Trojan gold mine. Analyst, Wiegand. (Connolly and O'Harra, 1929, p. 311, 310, 313.) Kaolin, white, compact, conchoidal fracture; in seams parallel to bedding. (Probably weathered from porphyry dike.) Geologic cross section. Possible use: Ceramics, quantity limited.

TABLE 20.—Analyses from Kansas, Montana, South Dakota, and Wyoming of clays in which $Al_2O_3 + SiO_2 + H_2O$ (however determined) is 50 percent or more of the sample (Group Ha) special rock category

[High-alumina clays (kaolinite predominant, "bauxite" subordinate). SiO_2/Al_2O_3 weight ratio from 0.371 to 1.178. Chemical analyses arranged by State, county, and stratigraphic position]

	Kansas		Montana		S. Dak.	Wyoming		
	1	2	3	4	5	6	7	8
	15Ha53-29	15Ha70-6	25Ha14-2	25Ha14-3	40Ha41-3	49Ha24-49	49Ha24-50	49Ha24-85
SiO_2	45.60	27.50	45.41	46.71	46.14	28.2	32.6	44.61
Al_2O_3	39.50	39.50	39.1	39.74	39.88	58.6	52.4	45.09
Fe_2O_3	.67	[1] 18.05	.57	.18	......	[2] .6	......	1.86
MgO	......	[3] .18	.32	......	Tr.	......	......	2.66
CaO	.16	[3] 1.6[illegible]	.35	......	2.75	4.2	8.3	Tr.
Na_2O	......	......	.43	......	......	......	} 4.2	{ Tr.
K_2O	......	......	.37	......	......	......	}	{ ......
H_2O	......	[4] 8.50	......	......	9.07	[5] 1.4	......	8.65
TiO_2	......	......	.26	......	......	......	......	......
SO_3	......	[3] 2.66	......	......	......	......	......	......
B_2O_3	......	......	......	......	......	[5] 1.8	......	......
Ignition loss	14.00	[6] 2.00	[7] 13.68	[7] 13.68	......	[7] 5.2	[7] 2.5	......
Total	99.93	100.00	100.5	100.31	97.84	100.0	100.0	102.87
Class	0,85,0	0,53,0	0,84,1	0,87,0	0,81,5	0,51,3	0,54,0	0,80,0

[1] Reported as protoxide.
[2] Reported as oxide of iron.
[3] Calculated from reported $MgSO_4$ and (or) $CaSO_4$.
[4] At 100° C.
[5] Calculated from reported boracic acid.
[6] Reported as organic matter.
[7] Includes H_2O.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

1. Lincoln County. Upper Cretaceous, Dakota sandstone, Janssen clay member; NE¼ sec. 32, T. 10 S., R. 6 W., (Plummer and Romary, 1947, p. 63). Analyst, Thompson. Lab. No. L-30-4. (Jewett and Schoewe, 1942, p. 102.) High-alumina clay. Estimated tonnage. Index map. Possible use: Source of alumina.
2. Osage County. Pennsylvanian, Howard limestone, Aarde shale member, Nodaway underclay (R. T. Runnels, written communication, 1954). T. 14 S., R. 15 E., town of Carbondale. (Saunders, 1875, p. 8.) Fire clay, above coal bed.

Montana

3-4. Fergus County. Mississippian, Heath formation. SW¼ sec. 12, T. 16 N., R. 17 E., 3 miles northeast of town of Hanover. (Dougan, 1947, p. 8, 1-7, pl. 1.) Dickite. General description of deposit: Chalky-white, massive; angular inclusions of black shale. X-ray, petrographic, dehydration, and ceramic data. Index map, geologic map, cross section. Possible use: Refractories, whiteware.

3. Analyst, Smothers.
4. Analyst, Turner.

South Dakota

5. Lawrence County. Precambrian, T. 4 N., R. 2 E., (E. P. Rothrock, written communication, 1955) near town of Terry, Trojan gold mine. Analyst, Enos. (Connolly and O'Harra, 1929, p. 311, 310, 313.) Kaolin, white, compact, conchoidal fracture; in seams parallel to bedding. (Probably weathered from porphyry dike.) Geologic cross section. Possible use: Ceramics, quantity limited.

Wyoming

6-7. Yellowstone National Park. (Recent. West Thumb), Yellowstone Lake. Analyst, Steitz. (Hayden, 1872, p. 130; Langford, 1905, p. 94, 93.) Sediment from mud springs.

6. Sediment, lavender, soft.
7. Sediment, pink, soft.

8. Yellowstone National Park. (Recent.) Lower Geyser Basin. Analyst, Endlich. (Peale, 1883, p. 416.) Mud puffs, pink.

TABLE 21.—Analyses from Kansas containing 50 percent or more of NaCl (Group Na) special rock category

[Chemical analyses arranged by county and stratigraphic position]

	Kansas											
	1	2	3	4	5	6	7	8	9	10	11	12
	15Na27-95		15Na27-96		15Na27-97	15Na27-98	15Na27-99	15Na27-100	15Na48-1	15Na48-2	15Na48-3	15Na61-15
Insoluble	......	......	......	......	[1] 0.08	[1] 0.13	[1] 0.29	0.27	0.01	0.09	0.20	......
Fe_2O_3	......	......	......	......	......	......	......	......	......	......	.11	[2] 0.500
Na	38.6	......	38.4	......	......	......	......	......	......	......	......	......
K	.1	......	Tr.	......	......	......	......	......	......	......	......	......
Mg	.1	......	Tr.	......	......	......	......	......	......	......	......	......
Ca	.4	......	.8	......	......	......	......	......	......	......	......	......
H_2O	......	......	......	......	......	......	......	.19	......	......	......	......
Cl	60.0	......	60.0	......	......	......	......	......	......	......	......	......
SO_4	.8	......	.8	......	......	......	......	......	......	......	......	......
NaCl	......	[3] 98.10	......	[3] 97.57	97.23	97.94	96.99	95.76	99.87	99.44	97.51	97.947
Na_2SO_4	......	......	......	......	.41	.10	......	......	......	.28	.57	.365
KCl	......	.19	......	Tr.	......	......	......	.67	......	......	......	......
$MgCl_2$	......	.39	......	Tr.	.24	.05	.12	......	.05	.12	.10	.482
$MgSO_4$	......	......	......	......	......	......	......	.09	......	......	......	......
$CaCl_2$	......	.18	......	1.29	......	......	......	.99	......	......	......	.706
$CaSO_4$	......	1.14	......	1.14	2.04	1.78	2.60	1.21	.07	.07	1.51	......
$CaCO_3$	......	......	......	......	......	......	......	Tr.	......	......	......	......
Total	100.0	100.00	100.0	100.00	100.00	100.00	100.00	99.18	100.00	100.00	100.00	100.000

	13	14	15	16	17	18	19	20	21	22	23	24
	15Na75-1		15Na78-8	15Na78-9		15Na78-10	15Na78-11	15Na78-12	15Na78-13		15Na78-14	
Insoluble in water[4]	......	......	(4.24)	......	......	(4.639)	(5.964)	(0.018)	(1.678)	......	(0.934)	......
Insoluble in acid	......	......	[4] (1.32)	0.28	0.06	[4] (.030)	[4] (1.312)	[4] (.009)	[4] (.005)	......	[4] (.066)	......
Fe_2O_3	......	......	.01	.02	.024	.030	.081	.001	[2] .003	......	[2] .007	......
Fe_2O_3, water soluble	......	......	......	......	......	.00008	......	.00010	......	......	......	......
K_2O	......	......	......	.40	1.77	......	......	......	......	......	......	......
MgO	......	......	......	.21	.53	......	......	......	......	0.04	......	0.05
CaO	......	......	......	2.76	4.10	......	......	......	......	[5] 1.79	......	[5] 1.28
SrO	......	......	......	.49	.76	......	......	......	......	......	......	......
H_2O-	[6] 6.905	......	[7] .07	......	......	[7] .031	[7] .157	[7] .023	[7] .031	[8] .027	[7] .069	[8] .269
SO_3	......	......	......	4.31	6.42	......	......	......	......	2.07	......	1.89
NaCl	90.314	97.012	92.67	......	......	86.919	92.693	99.787	98.838	[9] 96.06	96.985	[9] 96.63
Na_2SO_4	......	......	......	......	......	1.450	......	......	......	......	.154	......
$MgCl_2$	.612	.658	.18	......	......	......	.880	.043	.126	......	......	......
$MgSO_4$	......	......	.21	......	......	......	......	.017	.008	......	.509	......
$CaCl_2$	1.793	1.926	......	......	......	1.926	.089	......	......	......	......	......
$CaSO_4$	.376	.404	5.61	......	......	9.671	4.945	8.143	3.020	......	2.279	......
Total	100.000	100.000	98.75	8.47	13.66	100.027	98.845	108.014	102.026	99.99	100.003	100.12

	25	26	27	28	29	30
	15Na78-15		15Na78-16		15Na78-17	
Insoluble in water[4]	(2.119)	......	(2.026)	......	(1.505)	......
Insoluble in acid[4]	(.032)	......	(.264)	......	(.319)	......
Fe_2O_3	[2] .005	......	[2] .034	......	[2] .034	......
MgO	......	0.06	......	0.13	......	0.06
CaO[5]	......	1.47	......	1.11	......	.72
H_2O	[7] .062	[8] .058	[7] .088	[8] .051	[7] .089	[8] .068
SO_3	......	1.81	......	1.34	......	.74

	25	26	27	28	29	30
NaCl	96.151	[9] 96.56	95.852	[9] 97.08	94.250	[9] 98.06
$MgCl_2$	.125	......	.382	......	.288	......
$MgSO_4$	.105	......	......	......	......	......
$CaCl_2$	......	......	.420	......	.025	......
$CaSO_4$	3.582	......	3.047	......	2.084	......
Total	100.030	99.96	99.823	99.71	96.770	99.65

See following page for footnotes.

Spectrographic analyses

[Graphite electrodes used. A, analysis of insoluble fraction; B, analysis of least soluble fraction; C, analysis of most soluble fraction. Elements not listed may occur in undetectable amounts. A dash (–) indicates element not present or element present in undetectable concentration. Many elements, notably halogens, oxygen, and nitrogen, not detectable with available spectrographic equipment. The numbers in the table represent approximately the following percentages (Runnels and others, 1952, p. 191-193):

10	1.0	6	0.0001	3	0.0000001
9	.1	5	.00001	2	.00000001
8	.01	4	.000001	1 and .5	<.00000001]
7	.001				

	21-22			23-24			25-26			27-28			29-30		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
B	......	......	......	......	......	......	4	......	3	5	......	5	7	......	2
Na	–	9	9	1	8	9	2	10	8	4	7	8	5	10	9
Mg	6	4	6	5	5	8	6	6	6	8	5	7	9	4	7
Al	5	2	–	6	.5	–	6	2	2	6	4	5	7	1	4
Si	5	4	4	6	3	4	4	4	–	5	5	6	7	3	4
K	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–
Ca	12	10	9	12	9	8	10	10	7	10	10	10	9	10	9
Ti	3	4	4	2	3	.5	6	3	2	7	4	5	8	4	6
V	4	5	4	5	4	.5	3	5	6	5	4	7	4	3	8
Cr	2	.5	......	1	–	......	1	–	......	3	–	......	3	–	......

Spectrographic analyses--Continued

	21-22			23-24			25-26			27-28			29-30		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Mn	4	......	–	4	......	–	5	......	–	7	......	–	7	......	–
Fe	5	1	3	6	.5	1	8	1	4	10	2	3	12	1	4
Cu	5	2	5	6	2	5	5	3	5	4	3	6	6	2	5
Zn[10]	–	......	......	–	......	......	–	......	......	–	......	......	–	......	......
Sr	6	5	4	7	5	5	6	5	5	5	5	5	5	5	5
Ag	–	–	–	–	–	–	–	–	2	–	–	5	–	–	4
Sn[10]	2	......	......	3	......	......	4	......	......	1	......	......	–	......	......
Pb[10]	–	......	......	–	......	......	3	......	......	2	......	......	3	......	......

[1] Insoluble in acid.
[2] Reported as oxide of iron or iron oxide.
[3] By difference.
[4] Not included in total.
[5] Strontium oxide not separated.
[6] Reported as water.
[7] Reported as moisture as received.
[8] H_2O at 105° -110° C.
[9] Calculated (Runnels and others, 1952, p. 197).
[10] Probably derived from plant equipment.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

1-4. Ellsworth County. Permian, Wellington formation, Hutchinson salt member. (T. 15 S., R. 8 W.) town of Kanopolis. Analyst, Gardiner. Rock salt. Samples represent entire thickness of salt bed, from floor to roof in working face of mine. Analyses presented as radicals of material soluble in water, very little insoluble material. Map showing salt marshes and areas underlain by rock salt, geologic cross section.

1. Royal Rock Salt Co. mine. (Phalen, 1919, p. 216, pls. 7, 9; Phalen, 1937, p. 644.)
2. Conventional combinations of sample 1. (Phalen, 1937, p. 644.)
3. Crystal Rock Salt Co. mine. (Phalen, 1919, p. 216, 92, 93, pls. 7, 9; Phalen, 1937, p. 644.) Logs of wells.
4. Conventional combinations of sample 3. (Phalen, 1937, p. 644.)

5-11. Wellington formation, Hutchinson salt member. Rock salt. Generalized cross section, isopachous map, map showing areal extent of underground salt deposits. Use: Livestock and domestic purposes. (Most of information from Taft, 1946, p. 235-240.)

5-7. Ellsworth County. Kanopolis, Rock Salt Co. mine. Analysts, Bailey and Case. (Bailey, 1893, p. 172, 170; Bailey, 1902, p. 74, 73.) Dried samples.

8. Ellsworth County. (T. 15 S., R. 8 W.) town of Ellsworth. Analyst, Bailey. (Hay, 1889, p. 195, 194; Bailey, 1889, p. 9.) Salt, dry, hard, crystalline. In 2 beds separated by 5 ft of gray slate, at depth of 730 ft; upper bed, 50 ft thick; lower bed, 90 ft thick. Log of drill hole. Sample somewhat contaminated with scrapings of overlying slate and shale and is not as pure as salt beds from which it comes.

9-11. Kingman County. (T. 27 S., R. 7 W.) town of Kingman. Analysts, Bailey and Case. (Bailey, 1893, p. 170, 172; Bailey, 1902, p. 73, 74.) Salt, dried, average samples.

12. Miami County. (Recent. T. 18 S., R. 22 E.) town of Osawatomie. Analyst, Jackson. (Mudge, 1866, p. 47.) Salt, at spring.

13-14. (Pottawatomie County.) Carboniferous. (T. 10 S., R. 12 E.) town of St. Marys. (Hay, 1889, p. 196, 197.) Possible use: Commercial grade.

13. Salt in crude form.
14. Salt, dried.

Kansas--Continued

15-30. Reno County. Wellington formation, Hutchinson salt member. (T. 23 S., R. 6 W.) near town of Hutchinson, Carey Salt Co.

15-20. Hutchinson mine. General description: No. 2 rock salt, mixture of colorless, red or pink salt, and black shaly particles, but mostly colorless salt.

15. Analyst, Jobes. (Runnels and others, 1952, p. 196, 189, 194, 198.) Rock salt, average sample.
16. Lab. No. 50-29. (Runnels and others, 1952, p. 197, 189, 194, 198.) Rock salt; polyhalite, 2.6 percent.
17. Lab. No. 50-29R. (Runnels and others, 1952, p. 197, 189, 194, 198, pl. 1.) Selected parts of sample 16. Analysis of red and opaque particles; polyhalite, 11.3 percent. Photomicrographs.
18. Analyst, Jobes. (Runnels and others, 1952, p. 196, 189, 194, 198.) Rock salt, analysis of red particles.
19. Analyst, Jobes. (Runnels and others, 1952, p. 196, 189, 194, 198.) (Shale) analysis of black shaly particles found in rock salt.
20. Analyst, Jobes. (Runnels and others, 1952, p. 196, 189, 194, 198.) Rock salt, analysis of colorless portion.

21. Analyst, Jobes. Lab. No. 50-35. (Runnels and others, 1952, p. 196, 189, 192, 193.) Rock salt, 0-2 ft from mine floor.
22. (Runnels and others, 1952, p. 197, 189, 192, 193.) Partial chemical analysis of sample 21 (presnmably for check of accuracy).
23. Analyst, Jobes. Lab. No. 50-36. (Runnels and others, 1952, p. 196, 189, 192, 193.) Rock salt, 2-4 ft from mine floor.
24. (Runnels and others, 1952, p. 197, 189, 192, 193.) Partial chemical analysis of sample 23 (presumably for check of accuracy).
25. Analyst, Jobes. Lab. No. 50-37. (Runnels and others, 1952, p. 196, 189, 192, 193.) Rock salt, 4-6 ft from mine floor.
26. (Runnels and others, 1952, p. 197, 189, 192, 193.) Partial chemical analysis of sample 25 (presumably for check of accuracy).
27. Analyst, Jobes. Lab. No. 50-38. (Runnels and others, 1952, p. 196, 189, 192, 193.) Rock salt, 6-8 ft from mine floor.
28. (Runnels and others, 1952, p. 197, 189, 192, 193.) Partial chemical analysis of sample 27 (presumably for check of accuracy).
29. Analyst, Jobes. Lab. No. 50-39. (Runnels and others, 1952, p. 196, 189, 192, 193.) Rock salt, 8-10 ft from mine floor.
30. (Runnels and others, 1952, p. 197, 189, 192, 193.) Partial chemical analysis of sample 29 (presumably for check of accuracy).

TABLE 21.—Analyses from Kansas containing 50 percent or more of NaCl (Group Na) special rock category--Continued

	Kansas									
	31	32	33	34	35	36	37	38	39	40
	15Na78-18	15Na78-19	15Na78-20	15Na79-10	15Na80-9	15Na80-10	15Na80-11	15Na80-12	15Na80-13	15Na80-14
Insoluble in water	0.37	......	0.09	......	[1] 0.02	[1] 0.08	[1] 0.09	[1] 0.14	......	[1] 0.17
Insoluble in acid	......	0.464	......	0.23	......	......	......	......	0.01	......
Fe_2O_3	......	.008	......	[2] .13	......	.03	[2] .02	.07	.55	......
Na_2O	32.52	......	......	......	......	......	......	......	......	......
K_2O	3.18	......	......	......	......	......	......	......	......	......
MgO	2.27	......	......	......	......	......	......	......	......	......
CaO	[3] 9.32	......	......	......	......	......	......	......	......	......
H_2O	1.21	[4] (.04)	.92	......	......	......	......	......	......	......
Cl	34.77	......	......	......	......	......	......	......	......	......
SO_3	22.46	......	......	......	......	......	......	......	......	......
NaCl	......	97.414	97.27	71.82	98.20	96.85	97.39	97.95	99.78	98.03
Na_2SO_4	......	......	......	21.98	......	2.00	.46	Tr.	.10	.64
Na_2CO_3	......	......	......	[5] 3.56	......	......	......	......	......	......
$MgCl_2$	......	.056	.25	......	.02	.07	.02	.14	.03	.06
$MgSO_4$	......	.125	......	1.29	......	......	......	......	......	......
$CaCl_2$	......	......	......	......	.51	......	......	......	......	.51
$CaSO_4$	......	1.933	1.47	.99	1.25	.97	2.02	1.70	.08	1.20
Total	[6] 106.10	100.000	100.00	100.00	100.00	100.00	100.00	100.00	100.55	100.61

	41	42	43	44	45	46	47	48	49	50
	15Na80-15		15Na80-16		15Na80-17	15Na80-18	15Na80-19	15Na80-20	15Na80-21	15Na80-22
Insoluble in water	......	......	......	......	0.84	1.48	0.18	1.63	1.53	2.02
Na	38.3	......	38.3	......	......	......	......	......	......	......
K	Tr.	......	Tr.	......	......	......	......	......	......	......
Mg	Tr.	......	.3	......	......	......	......	......	......	......
Ca	.8	......	.4	......	......	......	......	......	......	......
H_2O- [7]	......	......	......	......	.09	.20	1.40	.18	.27	.07
Cl	60.0	......	60.2	......	......	......	......	......	......	......
SO_4	.8	......	.6	......	......	......	......	......	......	......
NaCl	......	[8] 97.47	......	[8] 97.36	96.63	95.82	97.08	96.00	95.71	95.83
Na_2SO_4	......	......	......	......	.01	.64	......	......	.05	......
KCl	......	Tr.	......	Tr.	......	......	......	......	......	......
$MgCl_2$	......	Tr.	......	1.17	.21	......	.21	......	.05	......
$CaCl_2$	......	1.29	......	.42	......	......	.20	.02	......	......
$CaSO_4$	......	1.14	......	.85	2.18	1.84	.93	2.16	2.41	2.07
Total	99.9	99.90	99.8	99.80	99.96	99.98	100.00	99.99	100.02	99.99

Spectrographic analyses

[Graphite electrodes used. A, analysis of insoluble fractiou; B, analysis of least soluble fraction; C, analysis of most soluble fraction. Elements not listed may occur in uudetectable amouuts. A dash (–) indicates element not present or element present in undetectable conceutration. Many elements, notably halogens, oxygen, and nitrogen, not detectable with available spectrographic equipment. The numbers in the table represent approximately the following percentages (Runnels and others, 1952, p. 191-193):

10	1.0	6	0.0001	3	0.0000001
9	.1	5	.00001	2	.00000001
8	.01				
7	.001	4	.000001	1 aud .5	<.00000001]

	45			46			47			48			49			50		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
B	4	–	–	7	–	–	2	0.5	–	–	–	–	2	–	–	3	–	–
Na	6	11	12	7	8	11	11	10	9	4	9	12	7	8	11	11	9	10
Mg	8	8	8	9	6	8	9	8	7	7	7	9	10	7	8	9	7	7
Al	7	5	2	7	3	4	8	4	1	6	3	1	8	5	1	8	5	1
Si	7	3	2	7	3	3	7	4	2	7	2	2	8	5	1	8	2	1
K	3	–	.5	4	–	.5	9	–	–	–	–	–	4	–	.5	10	–	–
Ca	13	9	9	12	6	10	10	7	7	13	6	9	13	7	9	10	7	7
Ti	6	–	2	5	2	.5	6	–	.5	6	–	1	7	–	2	6	1	.5
V	8	3	3	5	6	2	7	.5	1	6	–	4	7	1	3	8	5	1
Cr	–	–	–	–	–	–	1	–	–	–	–	......	2	–	......	2	–	......
Mn	5	–	–	7	–	–	8	–	–	5	......	–	9	......	–	8	......	–
Fe	7	3	1	9	3	2	6	3	.5	5	4	2	10	5	1	5	2	1
Cu	8	5	4	8	3	4	8	4	4	7	5	5	9	5	5	9	5	6
Zn [9]	1	–	–	.5	–	–	<.5	–	–	2	......	......	–	......	......	.5	......	......
Sr	8	6	5	8	5	7	2	5	4	6	5	4	7	5	4	9	5	4
Ag	2	.5	–	6	–	–	2	–	–	3	–	–	8	–	–	1	–	–
Sn [9]	8	–	–	9	–	–	10	–	–	5	......	......	7	......	......	10	......	......
Pb [9]	7	–	–	7	–	–	7	–	–	6	......	......	7	......	......	8	......	......

[1] Reported as insoluble.
[2] Includes Al_2O_3.
[3] Includes Sr.
[4] Not included in total; moisture as received.
[5] Includes organic matter.
[6] 98.11 in text; total obtained by converting oxides to elements aud SO_3 to SO_4.
[7] Reported as moisture as received.
[8] By difference.
[9] Probably derived from plant equipment.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

31-33. Reno County. Permian, Wellington formation, Hutchinson salt member. (T. 23 S., R. 6 W.) near town of Hutchinson, Carey Salt Co.

31. (Swineford and Runnels, 1953, p. 368, 366-369.) Polyhalite, pink or yellow to nearly colorless; selected sample from No. 2 rock salt. X-ray spectrogoniometer patterns; mineralogy.

32. (Taft, 1946, p. 236, 234-240.) Rock salt at depth of 430 ft; 250 ft thick. Soluble in water, 98.9 percent. Generalized cross section, map showing areal extent of salt deposits, isopachous map. Use: Livestock and domestic purposes.

33. Analyst, Chatard. Lab. No. 815. (Hay, 1889, p. 196; Irving, 1890, p. 171.) Salt.

34. Republic County. (Recent.) T. 4 S., R. 2 W., Tuthill marsh. (Bailey, 1902, p. 70, 69, 72; Clarke, 1924, p. 231.) Salt, incrustation; deposit covers 1,000 acres.

35-40. Rice County. Wellington formation, Hutchinson salt member. (T. 20 S., R. 8 W.) near town of Lyons.

35-38. Analysts, Bailey and Case. (Bailey, 1893, p. 172, 170; Bailey, 1902, p. 73.) Rock salt, from vein 8 ft thick. General remarks: Salt in veins separated by soft shale or clay; 793 ft below surface, 275 ft thick. Generalized cross section, map showing areal extent of salt deposits, isopachous map. Dried samples. Use: Livestock and domestic purposes. (Most of information from Taft, 1946, p. 235-240.)

Kansas--Continued

39. (Bailey, 1902, p. 73.) Rock salt, from vein 8 ft thick. General remarks: Salt in veins separated by soft shale or clay. Dried sample.

40. (Runnels and others, 1952, p. 196.) Rock salt, average sample.

41-44. Rice County. Wellington formation, Hutchinson salt member. Near Lyons, Bevis Rock Salt Co. Analyst, Gardiner. Rock salt. Analyses presented as radicals of material soluble in water; very little insoluble material.

41. (Phalen, 1919, p. 216; Phalen, 1937, p. 644.) Rock salt, very few impurities; represents bed 16 ft thick.

42. Conventional combinations of sample 41. (Phalen, 1937, p. 644.)

43. (Phalen, 1919, p. 216; Phalen, 1937, p. 644.) Rock salt, fine salt screened from coarse.

44. Conventional combinations of sample 43. (Phalen, 1937, p. 644.)

45-50. Rice County. Wellington formation, Hutchinson salt member. Lyons, Carey Salt Co. Analyst, Thompson. (Runnels and others, 1952, p. 196, 188, 192, 193.) Rock salt. Mine floor 1,027 ft below top of shaft.

45. Lab. No. RES-2. Shaly salt, just above mine floor.

46. Lab. No. RES-3. Shaly salt, 3 ft above floor.

47. Lab. No. RES-4. Shaly salt, 6 ft above floor.

48. Lab. No. RES-5. Shaly salt, 6.75 ft above floor.

49. Lab. No. RES-7. Shaly salt, 10 ft above floor.

50. Lab. No. RES-8. Shaly salt, 12 ft above floor.

TABLE 22.—Analyses from Colorado, Kansas, Montana, South Dakota, and Wyoming containing 50 percent or more gypsum, gypsite, or anhydrite (Group G) special rock category

[Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado					Kansas					
	1	2	3	4	5	6	7	8	9	10	11
	5G19-11	5G19-12	5G19-13	5G19-14	5G19-15	15G4-9	15G4-10	15G4-11		15G8-13	15G14-11
Insoluble	......	......	......	......	......	0.19	None	0.14	0.11	2.31	18.69
SiO_2	4.38	0.24	0.2	Tr.	0.05			.08	.06		
$Al_2O_3 + Fe_2O_3$	1.86	.18	.1	Tr.	.13	[1] .10	......	[2] .22	.17	[1] .37	[1] 1.21
MgO	......	......	......	......	......	.16	......	......	......	.25	.43
CaO	30.74	32.60	[3] 32.5	40.61	32.94	32.53	32.72	[4] 32.43	[4] 25.50	34.52	26.71
H_2O	18.62	19.62	20.9	1.87	20.30	20.46	[5] 20.80	[4] 20.84	[4] 16.39	17.72	15.29
SO_3	40.40	43.80	[3] 46.3	56.82	44.23	45.73	46.53	[4] 46.30	[4] 36.41	39.95	33.27
Organic matter	.75	1.11	......	.46	.25	......	......	......	......	......	......
Ignition loss	......	......	......	......	......	......	......	[6] (21.36)	21.36	......	......
Total	96.75	97.55	100.0	99.76	97.90	99.17	100.05	100.01	100.00	95.12	95.60

[1] Reported as iron and aluminum oxides.
[2] Reported as R_2O_3.
[3] Calculated from reported $CaCO_3$ and (or) $CaSO_4$.
[4] Calculated from reported gypsum.
[5] Reported as water, organic, loss on ignition, etc., (H_2O) by Stone and others (1920, p. 28).
[6] Not inclnded in total.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1-5. Eagle County. Pennsylvanian, Minturn formation (Ogden Tweto, written communication, 1956). Analyst, Fairchild. Outcrop map.

1. (T. 5 S., R. 85 W.), 3 miles southwest of town of Eagle. Lab. No. 5. (Burchard, 1911, p. 365, 358, 360.) Gypsum, gray to white, 80-100 ft thick. Possible use: Plaster.

2. (T. 5 S., R. 85 W.), 0.5 mile south of town of Gypsum. Lab. No. 1. (Burchard, 1911, p. 365, 358, 360.) Gypsum, gray, lighter on unweathered surface; 150 ft thick. Overlain by 1-10 ft of impure gypsite. Use: Cement material. Possible use: Plaster.

3. Less than 1 mile southeast of Gypsum. (Burchard, 1911, p. 358, 360.) Description and nse as in sample 2.

4. Locality, 2.5 miles east of Gypsum. Lab. No. 2. (Burchard, 1911, p. 365, 360.) Anhydrite associated with gypsum. General remarks: Dark-gray, shaly; 140 ft thick. Measured section.

5. (T. 8 S., R. 84 W.) town of Ruedi, Roaring Fork Plaster Co. quarry. Lab. No. 6. (Burchard, 1911, p. 365, 360.) Gypsum, white, light- and dark-gray, fine-grained, hard, jointed and fractured; thick beds. Use: Plaster.

Kansas

6. Barber County. Permian (Blaine formation) reported as Cave Creek formation, Medicine Lodge gypsum member by Grimsley and Bailey (1899, p. 44). (T. 32 S., R. 12 W.), Medicine Lodge mill, Best Brothers. Collector, Grimsley. (Bailey and Whitten, 1897, p. 30, 29.) Gypsum rock. Average sample, air-dried. Use: Cement. (See also Grimsley, 1897, p. 240, 235, pl. 21. General description: White; lower portion, very compact; upper portion, sugary. Outcrop map. See also Grimsley and Bailey, 1899, p. 147, 44, 71, 108, 148, pls. 1, 4. From mines about 6 miles southwest of town of Medicine Lodge. Analysts, Bailey and Whitten. Outcrop maps, columnar section. Possible use: Plaster.)

Kansas--Continued

7. Barber County. Blaine formation, Medicine Lodge gypsum member. Kling, Best Brothers quarry. (Stone and others, 1920, p. 28, 118, 119, pl. 17.) Gypsum, 20-25 ft thick; lower 3 ft, hard, darker, not qnarried; overburden 30 ft. Outcrop map. Use: Cement.

8. County, formation, and locality as in sample 6. (Clemmer and DeVaney, 1941, p. 4.) Gypsum, white, crystalline.

9. (Analysis of sample 8 calculated by compilers to include ignition loss.)

10. Butler County. (Recent. T. 23 S., R. 4 E.), 7.5 miles southwest of town of Burns. Analysts, Bailey and McFarland. (Grimsley and Bailey, 1899, p. 154, 67, 68.) Gypsite, white, uniform; perfect, minute crystals, fine texture; averages 6 ft thick over 2 acres, thinner beyond; overburden 1 inch - 2 ft soil. Possible use: Plaster.

11. Clay County. (Permian, Wellington(?) formation. T. 10 S., R. 1 E.) town of Longford. Analysts, Bailey and Stafford. (Bailey and Whitten, 1897, p. 33.) (See also Grimsley, 1897, p. 240, 233, 235, pl. 21. Gypsum or gypsum dirt, dark, light ash-gray when dry, soft, incoherent. Mineralogy. Outcrop map. Use: Plaster.)

TABLE 22.—Analyses from Colorado, Kansas, Montana, South Dakota, and Wyoming containing 50 percent or more gypsum, gypsite, or anhydrite (Group G) special rock category--Continned

	Kansas												
	12	13	14	15	16	17	18	19	20	21	22	23	24
	15G21-4	15G21-5	15G21-6	15G21-7	15G21-8	15G21-9	15G21-10	15G21-11	15G21-12	15G21-13	15G21-14	15G58-8	15G58-9
SiO_2 + insoluble	0.55	0.38	1.18	0.35	0.34	0.52	0.41	3.18	17.10	6.49	12.13	15.76	4.82
$Al_2O_3+Fe_2O_3$ [1]	.23	.16	.15	.12	.16	.26	.29	.95	2.04	1.04	.99	.49	.79
MgO	.22	.46	[2] .25	.27	.62	.98	.29	.15	.59	[2] .13	.42	......	[2] .16
CaO	32.64	32.04	[2] 32.35	32.57	32.64	32.28	32.53	32.16	27.62	[2] 31.07	29.14	[2] [3] 27.57	[2] 30.60
H_2O	19.54	20.37	20.00	19.96	19.63	19.47	19.70	19.44	15.16	18.56	16.75	18.64	20.41
SO_3	45.95	45.77	[2] 45.89	46.12	45.28	44.61	46.03	41.00	33.28	[2] 38.80	37.49	[2] 35.24	[2] 40.07
Total	99.13	99.18	99.82	99.39	98.67	98.12	99.25	96.88	95.79	96.09	96.92	97.70	96.85

	25	26	27	28	29	30	31	32	33	34	35	36	37
	15G58-10	15G58-11	15G58-12	15G59-10	15G59-11	15G59-12	15G59-13	15G85-4	15G85-5	15G85-6	15G85-7	15G85-8	15G87-1
SiO_2 + insoluble	4.25	5.14	11.78	0.35	0.40	0.65	0.70	4.54	7.65	13.50	3.62	15.08	2.17
$Al_2O_3+Fe_2O_3$	[1] .53	[1] .67	[1] 1.87	[1] .12	[1] .19	[1] .17	.35	[1] .54	.52	1.05	.45	.44	.24
MgO	[2] .10	.53	.48	.12	.17	.19	[2] .17	.28	[2] .30	[2] .36	[2] .16	......	.45
CaO	[2] 30.62	31.56	28.64	32.44	32.28	33.51	[2] 32.23	32.31	[2] 31.20	[2] 29.03	[2] 31.92	[2] [3] 28.86	32.42
H_2O	20.82	19.95	18.25	20.52	20.36	[4] 18.84	[4] 20.50	17.82	18.39	17.05	19.87	17.46	19.40
SO_3	[2] 40.88	39.20	35.04	46.24	45.96	46.65	[2] 45.69	42.10	[2] 38.06	[2] 35.44	[2] 42.31	[2] 35.58	44.18
Total	97.20	97.05	96.06	99.79	99.36	100.01	99.64	97.59	96.12	96.43	98.33	97.42	98.86

	Montana				South Dakota				
	38	39	40	41	42	43	44	45	46
	25G5-7	25G7-4	25G7-5	25G30-10	40G24-11	40G24-12	40G24-13	40G47-4	40G47-5
SiO_2	......	[5] 0.49	......	0.01	0.12	0.09	0.10	0.16	1.00
Al_2O_3	......	......	......	......	[6] .12	.06	.12	.12	.46
Fe_2O_3	......	......	......	.02			......		
MgO	......	......	......	.20	.10	.28	.33	[2] .28	Tr.
CaO	33.023	32.95	33.101	32.2	33.00	32.89	32.44	44.59	[2] 33.76
H_2O	21.042	[4] 20.44	20.960	20.0	......	......	20.80	......	......
CO_2	......	......	......	.26	......	......	.85	......	......
SO_3	45.935	47.10	45.939	46.1	[6] 47.77	44.86	45.45	32.27	[2] 41.70
NaCl	......	......	......	.002	......	......	......	......	......
Ignition loss	......	......	......	......	20.85	21.41	......	20.48	20.14
Total	100.000	100.98	100.000	98.8	[6] 101.96	[7] 99.59	100.09	97.90	97.06

	Wyoming										
	47	48	49	50	51	52	53	54	55	56	57
	49G1-23	49G1-65	49G1-66	49G2-2	49G2-3	49G2-4	49G6-3	49G6-4	49G9-10	49G10-1	49G23-29
SiO_2	0.2	5.5	......	0.05	0.06	0.01	[8] 0.24	0.36	0.25	0.07	0.1
Al_2O_3	.3	.6	......	.03	.05	.17	......	.43	[9] .10	.11	.12
Fe_2O_3	Tr.	......	......				Tr.				......
MgO	......	1.5	......	......	......	......	.41	.24	......	......	.3
CaO	32.5	37.1	[2] 32.17	32.92	32.72	33.74	32.72	33.37	34.20	32.81	34.4
K_2O	......	......	......	......	......	......	......	......	......	None	......
H_2O	20.8	6.9	21.21	[10] 19.99	[10] 20.03	[10] 19.50	20.20	[11] 20.76	[11] 20.00	[11] 20.40	20.8
MnO	......	......	......	.44	.42	.98	......	......	None	None	......
CO_2	......	......	......	[12] Tr.	Tr.	[13] Pres.	1.18	......	......	Tr.	.55
SO_3	46.3	43.4	[2] 45.94	45.74	45.18	43.92	45.33	44.24	45.50	45.42	45.5
Cl	......	......	......	None	None	None	Tr.	......	None	None	......
Total	100.1	95.0	99.32	99.17	98.46	98.32	100.08	99.40	100.05	98.81	101.8

[1] Reported as iron and aluminum oxides.
[2] Calculated from reported $MgCO_3$, $CaCO_3$, and (or) $CaSO_4$.
[3] Includes some MgO.
[4] Reported as water, organic, loss on ignition, etc., (H_2O) by Stone and others (1920, p. 28).
[5] Reported as SiO_2 and insoluble.
[6] Reported as $Al_2O_3+Fe_2O_3$, 0.13 percent; SO_3, 45.77 percent; total, 99.97, by Ziegler (1914, p. 213).
[7] 98.59 in text.
[8] Insoluble.
[9] Reported as 0.01 percent by Wells (1937, p. 122).
[10] At 300° C.
[11] Reported as ignition loss.
[12] Reported as small amount.
[13] Determined qualitatively.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas--Continued

12-15. Dickinson County. Permian, Wellington(?) formation, Solomon gypsum bed.

12. (T. 14 S., R. 1 E.) abandoned mine 6 miles southwest of town of Solomon, Crown Plaster Co. Analysts, Bailey and Whitten. (Bailey and Whitten, 1897, p. 31; Grimsley and Bailey, 1899, p. 148, 58-60.) Gypsum. General description: Lower part, very compact, filled with oval crystals of yellowish-brown selenite, conchoidal fracture; upper part, white, less compact, no crystals. Columnar section. Use: Plaster.

13. (T. 14 S., R. 1 E.), 0.25 mile east of Solomon mill. Analysts, Bailey and Whitten. (Bailey and Whitten, 1897, p. 31; Grimsley and Bailey, 1899, p. 148, 58-60.) Use: Plaster.

Kansas--Continued

14. (T. 16 S., R. 2 E.), 4 miles south of town of Dillon. Analysts, Bailey and Franklin. (Grimsley and Bailey, 1899, p. 146.)

15. (T. 16 S., R. 3 E.) small quarry south of Dillon. Analysts, Bailey and Whitten. (Bailey and Whitten, 1897, p. 31; Grimsley and Bailey, 1899, p. 146.)

16-18. Dickinson County. Wellington formation. (T. 16 S., R. 3 E.) Kansas Cement Plaster Co. Analysts, Bailey and Whitten. (Bailey and Whitten, 1897, p. 30; Grimsley and Bailey, 1899, p. 147, 58-60.) Use: Plaster.

16. Hope or Solomon gypsum bed. Locality, 1.75 miles west of town of Hope. Gypsum, white, traversed by dark, wavy lines; 14 ft thick. In lower part, rounded selenite crystals with dark, mottled surfaces. From shaft 80 ft deep.

DESCRIPTIVE NOTES--Continued

Kansas--Continued

17. Hope or Solomon gypsum bed. Hope shaft, 1.75 miles west of Hope. Gypsum, white, compact, associated with satin spar; composite sample, about 5 ft thick. Thin shaly gypsum overlies bed.

18. Greeley gypsum bed. Quarry, 1.5 miles west of Hope. Gypsum, white, compact, about 5 ft thick. Thin shaly gypsum overlies bed.

19-20. Dickinson County. (Recent. T. 16 S., R. 2 E.), 3.5 miles southwest of Dillon, Aetna or Aluminite Cement Plaster Co. (Grimsley and Bailey, 1899, p. 150, 65, pl. 20.) Gypsite or gypsum earth, surface deposit, 5 ft thick; part under water. Index map. Use: Plaster.
19. Analysts, Bailey and Stafford.
20. Analysts, Bailey and Whitten.

21. Dickinson County. (Recent. T. 16 S., R. 3 E.) near Dillon, Agatite Cement Plaster Co. Analyst, Bailey. (Grimsley and Bailey, 1899, p. 82,64, pl. 18.) Gypsite; impurities of sand, clay, and lime; thin soil overburden; maximum thickness, 18 ft; deposit covers 40 acres. Index map. Use: Plaster.

22. Dickinson County. (Recent.) Near Dillon. Analysts, Bailey and Whitten. (Grimsley and Bailey, 1899, p. 149.) (See also Grimsley, 1897, p. 240, 227, 233, 235. Gypsite or gypsum dirt, dark, light ash-gray when dry, soft, incoherent. Mineralogy. Outcrop map.)

23-25. Marion County. (Recent. T. 17 S., R. 2 E.), Rhodes farm, Acme Cement Plaster Co. Analyst, Wilkinson. (Grimsley and Bailey, 1899, p. 150, 65, pl. 22.) Gypsite, surface deposit, 6-10 ft thick.
23. Gypsite, base of bed.
24. Gypsite, 8 ft from surface.
25. Gypsite, 4 ft from surface.

26-27. Marion County. (Recent.) Rhodes farm, Acme Cement Plaster Co. Analysts, Bailey and Stafford. (Grimsley and Bailey, 1899, p. 151, 65, pl. 22.) Gypsite, surface deposit, 6-10 ft thick.
26. Average crude material. Use: Plaster.

28-30. Marshall County. Permian, Easley Creek shale. (T. 4 S., R. 7 E.) near town of Blue Rapids. Analyst, Bartow. (Grimsley and Bailey, 1899, p. 145, 53, 56.)
28. Locality, 2.5 miles northwest of Blue Rapids, Fowler's mine, Blue Rapids Plaster Co. Gypsum, gray, mottled, sugary, traversed irregularly by blue clay seams; vertical, slightly curved, white, selenite needles at top of bed; 8.5 ft thick; overburden, columnar section. Use: Plaster.
29. Two miles west of Blue Rapids, Winter's mine. Gypsum, 8-9 ft thick; overburden, 38 ft, columnar section. Gypsum similar to sample 28.
30. One mile north of Blue Rapids, Great Western mine. Gypsum, sugary, no perfect crystals; 8.5-9 ft thick. Outcrop map, columnar section. (See also Stone and others, 1920, p. 28, pl. 17.)

31. County, formation, and locality as in samples 28-30. (Stone and others, 1920, p. 28, pl. 17.) Gypsum. Outcrop map.

32. Saline County. (Recent. T. 15 S., R. 1 W.), Tinkler farm near Gypsum City. Analysts, Bailey and Whitten. (Bailey and Whitten, 1897, p. 32; Grimsley and Bailey, 1899, p. 153, 63, 64.) Gypsite, surface deposit, contains organic matter; averages 8 ft thick over 12 acres; maximum thickness 17 ft.

33-36. Saline County. (Recent.) Near Gypsum City. Analyst, Wilkinson. (Grimsley and Bailey, 1899, p. 153.) Use: Plaster.
33. Gypsite, center of bed, 4 ft below surface.
34. Gypsite, surface of bed.
35. Gypsite, surface deposit, average material.
36. Gypsite, surface deposit.

37. Sedgwick County. (Recent. T. 29 S., R. 2 E.) about 2.5 miles northeast of town of Mulvane, American Cement Plaster Co. Analysts, Bailey and McFarland. (Grimsley and Bailey, 1899, p. 155, 68, 69.) Gypsite, surface deposit, about 12 ft thick. Estimated tonnage. Use: Plaster.

Montana

38. Carbon County. Triassic (and Permian) Chugwater formation. (T. 7 S., R. 25 E.), 1.5 miles from town of Bowler. Analyst, Dickinson. (Rowe, 1905, p. 113, pl. 7; Rowe, 1908, p. 39.) Gypsum, 15-20 ft thick, locally interstratified with clay. Generalized outcrop map. Possible use: Plaster.

39. Cascade County. Pennsylvanian and Upper Mississippian, Quadrant formation. Otter shale member; sec. 24, T. 17 N., R. 6 E., 1 mile east of town of Riceville (U. M. Sahinen, written communication, 1955). (Stone and others, 1920, p. 28, 132.) Gypsum. Measured section.

40. Cascade County. Quadrant formation, Otter shale member; secs. 1 and 2, T. 18 N., R. 6 E., (U. M. Sahinen, written communication, 1955), 6 miles south of town of Armington, Kibby plant. Analyst, Dickinson. (Rowe, 1905, p. 113, 106, 108, pl. 7; Rowe, 1908, p. 34, 39.) Gypsum, locally interstratified with clay; 25-30 ft thick, 100-300 ft below surface. Generalized outcrop map. Use: Plaster, stucco.

Montana--Continued

41. Meagher County. Quadrant formation, Kibbey sandstone member (U. M. Sahinen, written communication, 1955). Sec. 17, T. 13 N., R. 3 E., north of Freeman Creek. (Roby, 1950, p. 39, fig. 2.) Gypsum, not bedded; about 80 ft thick, underlies about 2 square miles. Generalized geologic map.

South Dakota

42-44. Fall River County. Triassic(?), Spearfish formation. (T. 7 S., R. 5 E.) near town of Hot Springs.
42. Analyst, Coolbaugh. (O'Harra and others, 1908, p. 26, 25; Ziegler, 1914, p. 213.) Gypsum, nearly pure white; 13-ft bed near bottom of exposure. Outcrop map. Use: Plaster, stucco.
43. Analyst, Coolbaugh. (O'Harra and others, 1908, p. 26, 25.) Gypsum, nearly pure white, 4 ft thick; separated from sample 42 by 1 ft of red shale containing thin seams of gypsum. Outcrop map. Use: Plaster, stucco.
44. Analyst, Steiger. (Darton, 1902, p. 6; Richardson, 1903, p. 377, 367, 369, 370; O'Harra and others, 1908, p. 27, 26.) Gypsum, white; lenses in red shale. Geologic map, outcrop map, measured section. Use: Plaster.

45-46. Meade County. Spearfish formation. (T. 2 N., R. 7 E.) town of Black Hawk. Analyst, Ehle. (Ziegler, 1914, p. 213.) Gypsum. General description: White to gray, frequently mottled brown or red by iron oxides. Use: Plaster, stucco.

Wyoming

47. Albany County. Permian, Satanka shale. (Sec. 7, T. 13 N., R. 73 W.), 1 mile south of Red Buttes station. Analyst, O'Brine. (Siebenthal, 1906a, p. 405; Osterwald and Osterwald, 1952, p. 79.) Gypsum, 15-20 ft thick, from abandoned quarry. Former use: Plaster.

48. Albany County. (Satanka shale.) Sec. 4, T. 16 N., R. 73 W., south of town of Laramie. (Osterwald and Osterwald, 1952, p. 80.) Gypsite; 9 ft thick, sectioned from top to bottom as follows:

7 ft .... gypsite,
5 in .... red layer,
1 ft or more .... gypsite, white; on gravel or red clay.

Use: Plaster.

49. Albany County. (Chugwater formation. T. 21 N., R. 71 W.), Red Valley, near northern end of Laramie Hills. (Hague, 1877, p. 37.) Gypsum.

50. Big Horn County. Chugwater formation. NW¼NW¼ sec. 33, T. 49 N., R. 89 W., about 5 miles southeast of town of Hyattville. Analyst, Wheeler. (Lupton and Condit, 1917, p. 148, pls. 3, 5.) Gypsum, white, pure; beds 1.8-13 ft thick; total thickness exposed, 43 ft. Outcrop map, correlated columnar sections.

51. Big Horn County. (Chugwater formation) reported as Embar formation. SE¼ sec. 34, T. 49 N., R. 89 W. Analyst, Wheeler. (Lupton and Condit, 1917, p. 151, 152, pls. 3, 5.) Gypsum, 10 ft thick. Layers of gypsum 4-10 ft thick alternating with red shale and laminae of limestone. Outcrop map, correlated columnar sections.

52. Big Horn County. Chugwater formation, upper part. T. 53 N., R. 94 W., about 0.5 mile west of Stucco station. Analyst, Wheeler. (Lupton and Condit, 1917, p. 147.) Gypsum. Outcrop map, correlated columnar sections.

53. Crook County. Pennsylvanian, Minnelusa sandstone, upper part. (SW¼ sec. 10, T. 52 N., R. 61 W.), Sundance Canyon, near Rocky Ford. Analyst, Fairchild; collector, Rubey. Lab. No. C-941. (Wells, 1937, p. 122.) Gypsum, from bed 60 ft thick.

54. Crook County. Spearfish formation. (T. 49 N., R. 62 W.) near Inyan Kara Mountain. Analyst, Enos. (Connolly and O'Harra, 1929, p. 284, 278, 280.) Gypsum, transparent; thin veins in red shale. Average of two samples. Outcrop map. Use: None, quantity limited.

55. Hot Springs County. Chugwater formation. NW¼SW¼ sec. 21, T. 43 N., R. 93 W., few miles east of town of Thermopolis. Analyst, Wheeler. (Lupton and Condit, 1917, p. 150; Wells, 1937, p. 122.) Gypsum, upper bed, 10 ft thick; lower bed, 42 ft thick; separated by 33 ft of sandstone and shale.

56. Johnson County. (Chugwater formation) reported as Embar formation. T. 47 N., R. 83 W., near Middle Fork Crazy Woman Creek. Analyst, Wheeler. (Lupton and Condit, 1917, p. 154.) Gypsum, white, fine-textured, clean. Total thickness at least 150 ft.

57. Weston County. Spearfish formation, middle part. Locality, 5 miles northeast of LAK ranch (probably T. 45 N., R. 60 W., east of town of Newcastle). (Osterwald and Osterwald, 1952, p. 85.) Gypsum.

TABLE 23.—Analyses from Colorado, Montana, Nebraska, North Dakota, and Wyoming containing 50 percent or more miscellaneous sulfate-, carbonate-, and nitrate-bearing material (Group S) special rock category

[Chemical analyses recorded here as given in the original publication; no calculations or recalculations have been made by the compilers. Analyses arranged by State and county. Minor discrepancies occur in naming of constituents and in their amounts when more than one version of the analysis is found in the literature]

	Colorado							Montana				Nebraska	
	1	2	3	4	5	6	7	8	9	10	11	12	13
	5S2-1		5S15-6	5S23-14	5S23-15	5S30-54	5S30-55	25S22-20		25S47-9		26S81-1	26S81-2
Insoluble in water	[1] 50.04	......	2.72	0.14	6.77	......	......	......	......	......	......	......	......
Soluble in H_2O	......	......	......	......	......	......	......	88.27	......	[2] (86.09)	......	......	......
SiO_2	......	......	......	......	......	5.20	......	[3] 6.01	0.25	......	......	......	......
Al_2O_3	......	......	6.71	None	None	[4] 14.40 (with Fe_2O_3)	......	......	......	......	......	......	......
Fe_2O_3	......	......	1.16	None	None								
FeO	......	......	Tr.	......	......	......	......	......	......	......	......	......	......
Na_2O	......	......	4.68	......	......	19.10	......	......	......	16.72	......	25.55	25.31
K_2O	[5] 2.86	[6] 5.71	.32	......	......	......	......	......	......	22.05	......	27.98	30.85
MgO	......	......	3.33	......	......	3.90	......	......	......	......	......	......	......
CaO	......	......	.69	......	......	8.80	......	[7] 5.72	......	4.63	......	......	......
H_2O	......	......	[8] 49.41	......	......	[9] 19.10	21.88	......	[10] 9.39	......	......	......	......
Cl	.35	.70	......	......	......	2.40	......	......	......	8.61	......	2.20	4.07
SO_3	......	......	32.89	......	......	[11] 25.80	......	......	......	8.19	......	16.35	13.77
CO_2	[12] 14.15	[13] 28.28	......	......	......	......	......	......	1.96	......	......	22.77	19.79
HCO_3	14.43	28.82	......	......	......	......	......	......	......	......	......	......	[14] 7.74
N_2O_5	......	......	......	......	......	......	......	......	......	40.05	1.19	......	......
NaCl	......	......	......	......	......	......	......	......	1.09	......	20.42	......	......
Na_2SO_4	......	......	......	......	......	......	63.87	......	47.25	......	3.30	......	......
$NaHCO_3$	......	......	......	[15] 91.90	[15] 88.29	......	......	......	......	......	......	......	......
Na_2CO_3	......	......	......	[16] 6.62	[16] 4.78	......	......	......	28.33	......	......	......	......
$NaNO_3$	......	......	......	......	......	......	......	......	......	......	21.77	......	......
KNO_3	......	......	......	......	......	......	......	......	......	......	39.48	......	......
$CaSO_4$	......	......	......	......	......	......	9.70	......	......	......	13.94	......	......
Total	81.83	......	[17] 101.91	[18] 98.66	[19] 99.84	98.70	[20] 95.45	100.00	88.27	[21] 100.25	100.10	94.85	101.53

	North Dakota				Wyoming								
	14	15	16	17	18	19	20	21	22	23	24	25	26
	33S31-2	33S34-1	33S51-6	33S53-1	49S1-24	49S1-25	49S1-26	49S1-27	49S1-28	49S1-29	49S1-30		49S1-31
Insoluble	[22] 1.80	[23] 49.13	[22] 4.43	[22] 2.41	0.87	5.25	5.16	8.40	7.03	0.43	0.10	......	15.04
Al_2O_3	......	34.87	......	......	......	......	......	......	......	......	......	......	......
Fe_2O_3	......	4.39	......	......	......	......	......	......	......	......	......	......	......
Na_2O	......	......	......	......	41.10	34.98	35.60	33.92	36.10	36.85	......	......	23.75
MgO	......	......	......	......	1.43	2.01	1.49	2.64	1.33	.40	......	......	2.36
CaO	......	1.17	......	......	.00	1.20	1.61	.97	.80	1.43	......	......	3.61
H_2O	[24] 67.03	[25] 5.79	[26] 65.12	38.17	[27] .64	[27] .90	[27] .66	[27] 1.18	[27] .59	[27] .18	55.94	......	[27] 1.05
Cl	......	......	......	......	.16	.22	.16	.26	.06	.10	......	......	.28
SO_3	......	4.65	......	......	55.40	52.20	52.90	50.01	52.85	56.10	......	......	50.65
NaCl	.03	......	.12	.60	......	......	......	......	......	......	.12	0.28	......
Na_2SO_4	27.69	......	27.51	[28] 49.22	......	......	......	......	......	......	41.02	95.46	......
$NaHCO_3$	.17	......	.14	......	......	......	......	......	......	......	......	......	......
Na_2CO_3	.06	......	.06	.01	......	......	......	......	......	......	......	......	......
$KHCO_3$	.01	......	.11	.23	......	......	......	......	......	......	......	......	......
$MgSO_4$	3.01	......	2.35	8.37	......	......	......	......	......	......	1.82	4.26	......
$CaSO_4$	.20	......	.16	.99	......	......	......	......	......	......	......	......	......
Total	100.00	100.00	100.00	100.00	99.60	96.76	97.58	97.38	98.76	95.49	99.00	100.00	96.74

	Wyoming												
	27	28	29	30	31	32	33	34	35	36	37	38	39
	49S1-32	49S1-33	49S1-34	49S1-35		49S1-36		49S1-37	49S1-38		49S1-39		49S1-40
Insoluble	10.56	7.61	0.16	2.24	......	0.11	......	0.39	0.02	......	0.51	......	0.08
Na_2O	31.20	35.32	41.30	......	......	......	......	23.34	......	......	......	......	......
MgO	2.13	3.22	.64	......	......	......	......	13.76	......	......	......	......	......
CaO	2.64	2.70	.52	......	......	......	......	.00	......	......	......	......	......
H_2O	[27] .95	[27] 1.44	[27] .29	55.43	......	44.41	......	[27] 6.14	75.89	......	49.29	......	54.60
Cl	.14	.28	.10	......	......	......	......	.18	......	......	......	......	......
SO_3	49.18	46.42	56.16	......	......	......	......	54.56	......	......	......	......	......
NaCl	......	......	......	.12	0.28	.28	0.50	......	.45	1.86	.50	1.00	1.13
Na_2SO_4	......	......	......	39.17	92.54	28.24	50.90	......	11.50	47.74	19.67	39.18	44.17
Na_2CO_3	......	......	......	......	......	......	......	......	.06	.24	......	......	......
$MgSO_4$	......	......	......	2.24	5.29	26.96	48.60	......	12.08	50.16	30.03	59.82	......
$CaSO_4$	......	......	......	.80	1.89	......	......	......	......	......	......	......	......
Total	96.80	96.99	99.17	100.00	100.00	100.00	100.00	98.37	100.00	100.00	100.00	100.00	99.98

See following page for footnotes.

Summary or recast analyses

	14	16	17	18	19	20	21	22	23	26	27	28	29
$Na_2SO_4 \cdot 10H_2O$	62.81	62.40	68.27	95	87	88	82	90	92	70	83	86	96
$MgSO_4 \cdot 7H_2O$	......	......	......	4	6	4	8	4	1	8	7	9	2

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1. Alamosa County. (Recent. T. 40 N., R. 11 E.) Soda Lake, San Luis Valley. Analyst, Hicks. Collector, Larsen. (Gale, 1919, p. 105.) Salt at bottom of lake; about an acre in area. Use: Deposit too small to be of value as source of potash.
2. Analysis of material insoluble in water, sample 1.
3. Delta County. (Recent. T. 14 S., R. 93 W.) Alum Spring, Donghty Springs, near town of Hotchkiss. (Headden, 1905, p. 305, 304.) (Sinter) white, pasty deposit associated with well-defined gyspum crystals; air-dried. Mineralogy.

4-5. Garfield County. Eocene, Green River formation, Parachute Creek member. (T. 6 S., R. 93 W.), U. S. Bur. Mines Oil-Shale demonstration mine, Anvil Points, 10 miles west of town of Rifle. (Ertl, 1947, p. 118, 117.) Nahcolite, in layers and concretions. In layers as much as 4 inches thick: Pure white, translucent, fibrous crystals, pearly opalescent. In concretions from size of pea to 5 ft in diameter: Colorless to white, yellow, brown and black, most often dirty brown because of bitumen.

6. Jefferson County. (Recent. Tps. 4 and 5 S., R. 70 W.), Burdsall's Lake, near town of Morrison. (Williams, 1883, p. 604.) Sodium sulfate. Use: Glass.
7. Jefferson County. (Recent.) T. 5 S., R. 70 W., (P. C. Patton, written communication, 1957) Soda Lake, 12 miles southwest of Denver. (Hayden, 1871, p. 187.) (Sodium sulfate) white, efflorescent.

Montana

8. Jefferson County. (Recent. T. 6 N., R. 4 W.), 3 miles from town of Boulder. (Weed, 1900, p. 244, 235, 239.) Hot spring deposit forming on walls of tunnel used for development of hot springs, almost pure white, stained in some places; moss-like appearance. Index maps.
9. Analysis of material soluble in water; sample 8.
10. Silver Bow County. (Recent.) T. 2 S., R. 8 W., on Camp Creek, about 3.5 miles northeast of town of Melrose. Analyst, Bailey. Lab. No. R430. (Richards, 1914, p. 471, 470.) Niter, snowy-white to slightly yellowish mass of needle-like crystals. Only the purest material collected; analysis of water-soluble portion. Index map.
11. Analysis in form of salts; sample 10.

Nebraska

12-13. Sheridan County. (Recent. T. 25 N., R. 46 W.), Jesse Lake, about 3 miles north of town of Hoffland. (Ziegler, 1915, p. 20.) Alkali crust from 25 sq ft of surface mud at margin of lake covering 240 acres.

- 12. Analyst, Show.
- 13. Analyst, Reinbold.

North Dakota

14. Mountrail County. (Recent.) Tps. 156 and 157 N., Rs. 91 and 92 W., White Lake. Analyst, Feinstein. (Binyon, 1952, p. 23, 11, 12, figs. 1-3.) Glanber salt, average analysis, intermittent crystals; 0.875 ft thick, lake covers 2,647 acres; estimated tonnage. Index map, log of drill hole.
15. Pembina County. Upper Cretaceous, Pierre shale. T. 163 N., R. 56 W., southeast of town of Walhalla. Analyst, Babcock. (Barry and Melsted, 1908, p. 172, pl. 28.) Weathered bentonite in pyritic shale (H. A. Tourtelot, personal communication, 1963) reported as alum shale, dark-blue, weathers yellow, very fine. All constituents soluble in HCl except silica; considerable portion of alumina soluble in warm water. Geologic map.

North Dakota--Continued

16-17. (Recent.) Analyst, Feinstein. Glauber salt, average analyses. Estimated tonnage. Index maps, logs of drill holes.

- 16. Ward County. Secs. 26, 27, 34, and 35, T. 152 N., R. 85 W., Douglas A Lake. (Binyon, 1952, p. 28, 19, 20, figs. 1-3.) Glauber salt, intermittent crystals; 0.27 ft thick, lake covers 309 acres.
- 17. Williams County. Sec. 5, T. 159 N., R. 103 W., Stink Lake. (Binyon, 1952, p. 27, 16, 17, figs. 1, 2, 4.) Glauber salt crust, lake covers 87 acres.

Wyoming

18-23. Albany County. (Recent.) SW¼ sec. 15, T. 13 N., R. 75 W., North Downey Lake. Analyst, Beath. (Knight, 1934, p. 7, 2, 4, pl. 1.) Mirabilite, with some epsomite; 0-8 ft thick; oven-dried. Auger-drill samples. Estimated tonnage, index and isopach map.

- 18. Station 1. Lab. No. 16. Depth below surface, 6 ft.
- 19. Station 1. Lab. No. 15. Depth below surface, 4 ft.
- 20. Station 1. Lab. No. 14. Depth below surface, 2 ft.
- 21. Station 4. Lab. No. 21. Depth below surface, 4 ft.
- 22. Station 4. Lab. No. 20. Depth below surface, 2 ft.
- 23. Station 4. Lab. No. 19. Surface sample.

24-25. Albany County. (Recent.) North Downey Lake. Analyst and collector, Slosson. (Knight and Slosson, 1901, p. 110.) Index map.

- 24. Lab. No. 182. Sodium sulfate, purest crystals obtainable; from north end of lake.
- 25. Analysis calculated as dry salts; sample 24.

26-29. Albany County. (Recent.) SW¼ sec. 15 and NW¼ sec. 22, T. 13 N., R. 75 W., Middle Downey Lake, station 8. Analyst, Beath. (Knight, 1934, p. 7, 4, pl. 2; Osterwald and Osterwald, 1952, p. 133.) Mirabilite, with some epsomite; solid, compact to depth of 6 ft; oven-dried. Deposit covers 32.8 acres. Estimated tonnage. Index and isopach map.

- 26. Lab. No. 25. Depth below surface, 6 ft.
- 27. Lab. No. 24. Depth below surface, 4 ft.
- 28. Lab. No. 23. Depth below surface, 2 ft.
- 29. Lab. No. 22. Surface sample.

30-33. Albany County. (Recent.) Middle Downey Lake. Analyst, Slosson. (Knight and Slosson, 1901, p. 110.) Index map.

- 30. Collector, Slosson. Lab. No. 178. Mirabilite crystals mixed with mud and water; 6 ft below surface.
- 31. Analysis calculated as dry salts; sample 30.
- 32. Collector, Knight. Lab. No. 162. Sodium and magnesium sulfate, crystallized salt collected from under water.
- 33. Analysis calculated as dry salts; sample 32.

34. Albany County. (Recent. Sec. 21, T. 13 N., R. 75 W.), Sonth Downey Lake. Analyst, Beath. Lab. No. 18. (Knight, 1934, p. 7, 4, pl. 2; Osterwald and Osterwald, 1952, p. 133.) Mirabilite-epsomite, surface sample, thin crust. Deposit covers 38.3 acres.
35. Albany County. (Recent.) South Downey Lake. Analyst and collector, Slosson. Lab. No. 173. (Knight and Slosson, 1901, p. 110.) (Magnesium sulfate-sodium sulfate.) Analysis of water. Bulk density, 1.261. Index map.
36. Analysis calculated as dry salts; sample 35.
37. Albany County. (Recent.) Near South Downey Lake. Analyst and collector, Slosson. (Knight and Slosson, 1901, p. 110.) Sodium sulfate; crystallized salts.
38. Analysis calculated as dry salts; sample 37.
39. Albany County. (Recent. T. 13 N., R. 75 W.) Downey group of lakes. (Knight, 1893, p. 184; Knight, 1898, p. 616, 613.) Sodium sulfate, mostly solid. Estimated area, 100 acres; maximum thickness, 12 ft. Index map.

Footnotes of analyses on preceding page:

[1] Solids at 180° C.
[2] Not inclnded in total.
[3] Reported as insoluble in HCl (equals SiO_2, etc.), 90 percent silica, by Weed (1900, p. 244).
[4] Reported as alumina and oxide of iron.
[5] Reported as K_2O equivalent to K; K, 2.37 percent.
[6] Reported as K_2O equivalent to K; K, 4.73 percent.
[7] Reported as soluble in hydrochloric acid (equals $CaCO_3$) by Weed (1900, p. 244).
[8] Reported as 29.61 percent, loss in water oven (presumably about 100° C.); 15.35 percent, loss at 147° C.; 4.45 percent loss on ignition with addition of lead oxide.
[9] Includes organic matter.
[10] Reported as difference, mainly H_2O.
[11] Reported as sulfuric acid.
[12] Reported as CO_2 equivalent to CO_3; CO_3, 19.30 percent.
[13] Reported as CO_2 equivalent to CO_3; CO_3, 38.56 percent.
[14] Reported as HCO_2.
[15] Reported as calculated from total HCO_3.
[16] Reported as calculated from total CO_3.
[17] Includes Li_2O, heavy trace.
[18] Acid insoluble reported as 0.14 percent; CaO (acid soluble), 0.14 percent.
[19] Acid insoluble reported as 4.47 percent; CaO (acid soluble), 1.16 percent.
[20] Difference between total and 100 percent, 4.55 percent, reported as chloride of sodium, sulfate of magnesia, etc.
[21] 99.25 in text.
[22] Reported as insoluble in water.
[23] Reported as SiO_2.
[24] Total water; free water, 31.91 percent.
[25] (By difference) reported as alkalies and undetermined moisture.
[26] Total water; free water, 30.23 percent.
[27] Combined H_2O as $MgSO_4 \cdot H_2O$.
[28] Part of Na_2SO_4 probably thenardite and part Glauber salt.

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TABLE 23.—Analyses from Colorado, Montana, Nebraska, North Dakota, and Wyoming containing 50 percent or more miscellaneous sulfate-, carbonate-, and nitrate-bearing material (Group S) special rock category--Continued

	Wyoming												
	40	41	42	43	44	45	46	47	48	49	50	51	52
	49S1-41	49S1-42	49S1-43		49S1-44	49S1-45	49S1-46				49S1-47	49S1-48	49S1-49
Insoluble	0.47	0.10	0.09	......	3.8	0.56	13.86	......	13.86	......	[1] 0.16	[1] Tr.	1.39
Na_2O	......	......	......	......	......	......	......	......	......	......	14.78	12.40	8.79
MgO	......	......	......	......	......	......	......	......	......	......	11.06	11.90	24.85
CaO	......	......	......	......	......	......	......	......	......	......	......	......	.0
H_2O	54.98	55.83	55.55	......	54.79	59.66	......	......	46.87	......	32.43	33.50	[2] 11.08
Cl	......	......	......	......	......	......	......	......	......	......	......	......	1.28
SO_3	......	......	......	......	......	......	......	......	......	......	41.19	40.12	51.98
NaCl	......	......	.70	1.58	......	......	.21	0.21	1.16	3.14	......	......	......
Na_2SO_4	44.55	44.03	42.75	96.37	41.41	39.78	81.63	36.00	34.85	94.23	......	......	......
Na_2CO_3	......	.04	......	......	......	......	......	......	......	......	......	......	......
$MgCl_2$	......	......	......	......	......	......	1.64	.77	......	......	......	......	......
$MgSO_4$	......	......	.91	2.05	......	......	......	......	.97	2.63	......	......	......
$CaSO_4$	......	......	......	......	......	......	1.82	1.45	1.45	......	......	......	......
Total	100.00	100.00	100.00	100.00	100.0	100.00	99.16	38.43	99.16	......	99.62	97.92	99.4

	53	54	55	56	57	58	59	60	61	62	63	64	65
	49S1-50	49S1-51		49S1-52		49S1-53		49S1-54	49S1-55	49S1-56	49S1-57	49S1-58	49S1-59
Insoluble	[1] 3.38	0.08	......	1.13	......	0.58	......	0.0	0.05	0.11	0.46	0.3	0.0
Na_2O	.07	......	......	......	......	......	......	4.5	12.19	1.97	2.92	8.9	1.1
MgO	15.62	......	......	......	......	......	......	24.8	21.00	28.25	27.91	21.1	27.3
CaO	......	......	......	......	......	......	......	.0	.0	.0	.0	.0	.0
H_2O	48.90	48.03	......	51.08	......	49.66	......	[2] 11.2	[2] 9.36	[2] 12.60	[2] 12.46	[2] 9.5	[2] 12.2
Cl	......	......	......	......	......	......	......	.8	1.80	.76	.34	1.0	1.0
SO_3	31.33	......	......	......	......	......	......	54.5	52.85	55.07	55.77	53.9	54.6
NaCl	.44	.24	0.46	.46	0.95	.42	0.84	......	......	......	......	......	......
Na_2SO_4	......	24.49	47.19	10.22	21.41	40.52	81.43	......	......	......	......	......	......
$MgSO_4$	......	27.16	52.35	37.11	77.64	8.82	17.73	......	......	......	......	......	......
Total	99.74	100.00	100.00	100.00	100.00	100.00	100.00	95.8	97.2	98.8	99.9	94.7	96.2

	66	67	68	69	70	71	72	73	74	75	76	77	78
	49S1-60	49S1-61	49S1-62		49S1-63	49S4-10		49S4-11	49S4-12		49S4-13		49S4-14
Insoluble	0.0	0.11	0.65	......	0.08	......	......	0.60	10.52	10.52	8.57	......	11.06
Na_2O	2.8	.43	......	......	......	20.48	......	......	......	......	......	......	......
MgO	25.9	16.26	......	......	......	16.09	......	......	......	......	......	......	......
CaO	.0	......	......	......	......	1.84	......	......	......	......	......	......	......
H_2O	[2] 11.6	49.75	44.50	......	47.83	......	......	45.67	39.52	39.52	35.18	......	.49
Cl	1.2	......	......	......	......	.57	......	......	......	......	......	......	......
SO_3	52.7	33.08	......	......	......	[3] 60.76	......	......	......	......	......	......	......
NaCl	......	.21	.38	0.69	[4] .42	......	0.74	......	4.41	1.82	3.75	2.35	Tr.
Na_2SO_4	......	......	12.13	22.13	......	......	46.27	......	42.51	44.51	38.22	88.92	88.45
$NaHCO_3$	......	......	......	......	......	......	......	......	......	......	......	......	None
Na_2CO_3	......	......	......	......	......	......	......	......	......	......	......	......	None
$MgCl_2$	......	......	......	......	......	......	......	.38	......	......	......	......	......
$MgSO_4$	......	......	42.34	77.18	[5] 51.22	......	48.28	53.89	......	2.12	1.01	8.73	......
$CaSO_4$	......	......	......	......	......	......	4.45	......	......	......	13.27	......	......
Ignition loss	......	......	......	......	.45	......	......	......	......	......	......	......	......
Total	94.2	99.84	100.00	100.00	[6] 100.00	[7] 99.74	99.74	100.54	96.96	98.49	100.00	100.00	100.00

	79	80	81	82	83	84	85	86	87	88	89	90	91	92
	49S4-15		49S4-16		49S4-17		49S4-18	49S4-19	49S4-20	49S4-21	49S4-22	49S4-23	49S4-24	49S4-25
Insoluble	10.71	......	1.79	......	4.15	......	[8] 22.7	[8] 1.1	[8] 2.4	[8] 19.1	[8] 19.6	[8] 9.6	[8] 9.1	[8] 16.7
H_2O	17.08	......	42.99	......	46.99	......	54.0	70.0	70.0	39.1	40.0	45.6	56.0	42.3
NaCl	.84	1.16	.17	0.32	1.32	2.69	......	......	......	......	......	......	......	......
Na_2SO_4	69.16	95.78	55.05	99.68	44.92	91.94	21.7	28.2	26.7	41.4	39.8	44.1	34.5	40.4
$MgSO_4$	2.21	3.06	Tr.	......	2.62	5.37	......	......	......	......	......	......	......	......
Other salts	......	......	......	......	......	......	1.6	.7	.9	.4	.6	.7	.4	.6
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

	93	94	95	96	97	98	99	100	101	102	103	104	105
	49S4-26	49S4-27	49S4-28	49S4-29	49S4-30	49S4-31	49S4-32	49S4-33	49S4-34	49S4-35	49S4-36	49S4-37	49S4-38
Insoluble in water	11.6	9.6	10.8	11.0	4.6	5.1	21.7	13.9	14.8	17.9	18.3	17.7	17.5
H_2O	44.5	41.9	43.5	31.6	40.1	38.1	39.6	46.2	44.8	44.7	44.7	30.0	30.4
Na_2SO_4	43.3	47.8	44.7	55.9	54.6	55.9	37.9	38.9	38.6	35.8	35.8	51.2	50.9
Other salts	.6	.7	1.0	1.5	.7	.9	.8	1.0	1.8	1.6	1.2	1.1	1.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

See following page for footnotes.

Summary or recast analyses

	52	60	61	62	63	64	65	66	67
$Na_2SO_4 \cdot 10H_2O$	21.00	12.3	28.00	5.00	8.00	24.2	3.0	7.7	0.03
$MgSO_4 \cdot 7H_2O$	75.00	79.5	65.00	89.00	87.00	67.3	88.4	83.6	96.8

[1] Insoluble in hot water.
[2] Combination water as $MgSO_4 \cdot H_2O$.
[3] Reported as sulfuric acid.
[4] Includes $CaCl_2$ and $MgCl_2$.
[5] Contains small amount of $CaSO_4$ and Na_2SO_4.
[6] Iron, trace.
[7] Soluble matter, 48.36 percent; K_2O, trace; phosphoric acid, trace.
[8] Insoluble in water.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

40-49. Albany County. (Recent.) Secs. 2-5, T. 14 N., R. 75 W., Union Pacific Lakes, 13 miles southwest of town of Laramie. Sodium sulfate, estimated area about 60 acres; 0-40 ft thick. Estimated tonnage. Use: Salt cake, glass manufacture. (Most of information from Osterwald and Osterwald, 1952, p. 133, 134.)
- 40. (Weeks, 1886, p. 551; Osterwald and Osterwald, 1952, p. 134, 133.)
- 41. (Knight, 1893, p. 184.)
- 42. Analyst, Slosson. Lab. No. 172. (Knight and Slosson, 1901, p. 112.) Index map. Water of crystallization calculated and added to dried soda (following sample).
- 43. Analysis of sample 42, represents dried soda as put on market. Prepared from purest crystals of lake.
- 44. (Weeks, 1886, p. 551; Osterwald and Osterwald, 1952, p. 134, 133.)
- 45. (Weeks, 1886, p. 551.)
- 46. Analysts, Pemberton and Tucker. (Pemberton and Tucker, 1893, p. 19.) Greenish crystals mixed with black slimy mud; below top layer of white sulfate soda. Average thickness, 2.5 ft; maximum thickness, 15 ft.
- 47. Analysis of sample 46, anhydrous soda.
- 48. Another analysis of sample 46. (Knight and Slosson, 1901, p. 112.) The magnesium which Pemberton and Tucker report as chloride has been recalculated to sulfate by Knight and Slosson. Index map. Average sample.
- 49. Analysis calculated as dry salts; sample 48. (Knight and Slosson, 1901, p. 112.)

50-51. Albany County. (Recent.) T. 23 N., R. 76 W., Rock Creek Lakes group, Chicago claim. Analyst, Ricketts. (Ricketts, 1888, p. 55, 54.) Magnesium and sodium sulfates, deep-blue, clear. Lake area 10 acres; salt 4-6 ft thick.

52. Albany County. (Recent.) SE¼ sec. 20 and SW¼ sec. 21, T. 23 N., R. 76 W., Rock Creek Lakes group, Philadelphia Lake. Analyst, under supervision of Beath. Lab. No. 9. (Knight, 1939, p. 8, 2-5; Osterwald and Osterwald, 1952, p. 139-140.) Epsomite-mirabilite, crystalline. Surface sample, lake area about 40 acres. Index map.

53. Albany County. (Recent.) Philadelphia Lake. Analyst, Ricketts. (Ricketts, 1888, p. 54, 55; Knight, 1939, p. 6, 2.) Magnesium sulfate; less than 1 ft - 6.5 ft thick, underlies black mud of lake floor. Lake area about 40 acres. Index map.

54-59. Albany County. (Recent.) Philadelphia Lake. Analyst, Slosson. Collector, Knight. (Knight and Slosson, 1901, p. 114.) Index map.
- 54. Lab. No. 89. (Sodium and magnesium sulfate.)
- 55. Analysis calculated as dry salts; sample 54.
- 56. Lab. No. 90. (Epsomite-mirabilite.)
- 57. Analysis calculated as dry salts; sample 56.
- 58. Lab. No. 91. (Mirabilite.)
- 59. Analysis calculated as dry salts; sample 58.

60-66. Albany County. (Recent.) Rock Creek Lakes group. Analyst, under supervision of Beath. (Knight, 1939, p. 8, 2-5.) Epsomite, surface samples; 26 small lakes in area. Index map.
- 60. SE¼ sec. 20, Rock Creek Lake No. 1. Lab. No. 5.
- 61. SE¼ sec. 20, Rock Creek Lake No. 2. Lab. No. 6. Epsomite-mirabilite.
- 62. SE¼ sec. 20 and NE¼ sec. 29, Rock Creek Lake No. 3. Lab. No. 7.
- 63. SE¼ sec. 20 and NE¼ sec. 29, Rock Creek Lake No. 4. Lab. No. 8.
- 64. SE¼ sec. 20 and NW¼ sec. 29, Long Lake. Lab. No. 2. Epsomite-mirabilite.
- 65. SW¼ sec. 28 and NW¼ sec. 33, Brooklyn Lake. Lab. No. 4. Salt crust 0-6 in thick; overlies black mud layer containing salt, 0-6 ft thick. Lake area, 116.4 acres. Estimated tonnage. Index and topographic map.
- 66. Information as in sample 65. Lab. No. 3.

67. Albany County. (Recent.) Brooklyn Lake. Analyst, Ricketts. (Ricketts, 1888, p. 54, 55; Knight, 1939, p. 3, 2-5.) Epsomite-mirabilite, estimated tonnage. Index map, index and topographic map.

68. Albany County. (Recent.) Brooklyn Lake. Analyst, Slosson. Lab. No. 88. (Knight and Slosson, 1901, p. 114.) (Epsomite) surface sample. Index map.

69. Analysis calculated as dry salts; sample 68. Collector, Knight. (Knight and Slosson, 1901, p. 114; Knight, 1939, p. 5, 2, 4.) Estimated tonnage. Index map.

Wyoming--Continued

70. Albany County. (Recent.) Brooklyn Lake. (Knight, 1893, p. 185.) Epsomite.

71. Carbon County. (Recent.) T. 21 N., R. 82 W., small pond, 5 miles south of town of Percy. Analyst, Woodward. (Hague, 1877, p. 148.) Sodium sulfate-magnesium sulfate. Analysis of soluble matter in clay from shore of small pond. Soluble matter, 48.36 percent. (Some of information from Osterwald and Osterwald, 1952, p. 134.)

72. Analysis calculated as dry salts; sample 71. (Wells, 1923, p. 30.)

73. Carbon County. (Recent. T. 22 N., R. 78 W.) playa lake near town of Medicine Bow. (Osterwald and Osterwald, 1952, p. 140.) Magnesium sulfate.

74. Carbon County. (Recent. T. 22 N., R. 86 W.), Rankin claim, northwest of Brown's Canon. (Knight, 1893, p. 184.) Sodium sulfate.

75. Presumably same sample as 74. Rankin claim. (Knight, 1898, p. 616.) Deposit, solid and aqueous, estimated area 10 acres.

76. Carbon County. (Recent.) T. 22 N., R. 86 W., (Osterwald and Osterwald, 1952, p. 134), Dillon deposit, 7 miles northeast of town of Rawlins. Analyst, Slosson. Lab. No. 168. (Knight and Slosson, 1901, p. 115.) Sodium sulfate, surface sample. Index map.

77. Analysis calculated as dry salts; sample 76. (Knight and Slosson, 1901, p. 115; Osterwald and Osterwald, 1952, p. 134.)

78. Carbon County. (Recent.) Secs. 22, 23, and 26, T. 25 N., R. 89 W., alkali lake. Analyst, Wells. Lab. No. D-9. (Wells, 1937, p. 125.) Thenardite.

79-84. Carbon County. (Recent.) Secs. 22, 23, and 26, T. 25 N., R. 89 W., Bothwell deposit or Bull Springs soda lake. Analyst, Slosson; collectors, Knight and Paulson. (Knight and Slosson, 1901, p. 115, 96.) Sodium sulfate. Deposit, 250 x 515 yards in extent, 2 ft thick; estimated tonnage. Index map, mineralogy.
- 79. Lab. No. 160. Sampled at depth of 2 ft.
- 80. Analysis calculated as dry salts; sample 79. (Osterwald and Osterwald, 1952, p. 134.)
- 81. Lab. No. 159. Sampled at depth of 1 ft.
- 82. Analysis calculated as dry salts; sample 81. (Osterwald and Osterwald, 1952, p. 134.)
- 83. Lab. No. 158. Surface sample.
- 84. Analysis calculated as dry salts; sample 83. (Osterwald and Osterwald, 1952, p. 134.)

85-105. Carbon County. (Recent.) Secs. 22, 23, 26, and 27, T. 25 N., R. 89 W., Bull Lake, Iowa Soda Products Co. Mirabilite. Lake covers abont 82 acres. Index maps, outcrop map, logs of drill holes. Use: Stock feed. Possible use: Salt cake.
- 85-90. DH-1. (Young, 1951, p. 7, 1, 2, 4.)
  - 85. Thin salt seam in gray shale; 34.8 - 35 ft below surface.
  - 86. Thin salt seam in gray shale; 31 - 31.5 ft below surface.
  - 87. Thin salt seam in gray shale; 29.5 - 29.8 ft below surface.
  - 88. Vuggy, somewhat sandy; 7 - 8 ft below surface.
  - 89. Vuggy, 2 - 7 ft below surface.
  - 90. Vuggy, 0 - 2 ft below surface.
- 91-94. DH-2. (Young, 1951, p. 7, 1, 2, 5.) Somewhat vuggy; clear.
  - 91. Depth below surface, 4.4 - 6.4 ft.
  - 92. Depth below surface, 3.3 - 4.4 ft.
  - 93. Depth below surface, 2.7 - 3 ft.
  - 94. Depth below surface, 0.8 - 2.7 ft.
- 95-98. DH-3. (Young, 1951, p. 8, 1, 2, 5.) Vuggy.
  - 95. Depth below surface, 2.1 - 4 ft; sand at 3 ft.
  - 96. Depth below surface, 1.4 - 2.1 ft.
  - 97. Depth below surface, 0.7 - 1.4 ft.
  - 98. Depth below surface, 0 - 0.7 ft.
- 99. DH-4. (Young, 1951, p. 8, 1, 2, 5.) Depth below surface, 2.2 - 3 ft.
- 100. DH-6. (Young, 1951, p. 8, 1, 2, 6.) Vuggy, clear; 0.1 - 4.6 ft below surface.
- 101. DH-8. (Young, 1951, p. 9, 1, 2, 6.) Vuggy, 5 - 8.2 ft below surface.
- 102. DH-8. (Young, 1951, p. 9, 1, 2, 6.) Vuggy, 3.5 - 5 ft below surface.
- 103. DH-9. (Young, 1951, p. 9, 1, 2, 6.) Depth below surface, 6 - 9 ft.
- 104. DH-9. (Young, 1951, p. 9, 1, 2, 6.) Depth below surface, 1 - 6 ft.
- 105. DH-10. (Young, 1951, p. 9, 1, 2, 7.) Depth below surface, 1 - 5.5 ft.

TABLE 23.—Analyses from Colorado, Montana, Nebraska, North Dakota, and Wyoming containing 50 percent or more miscellaneous sulfate-, carbonate-, and nitrate-bearing material (Group S) special rock category-- Continued

	Wyoming												
	106	107	108	109	110	111	112	113	114	115	116	117	118
	49S7-24	49S7-25	49S13-19	49S13-20		49S13-21		49S13-22	49S13-23	49S13-24		49S13-25	
Insoluble	......	......	[1] (9.23)	9.14	......	0.74	......	......	19.03	0.33	......	9.67	......
K_2O	0.00	0.00	......	......	......	......	......	0.00	......	......	......	......	......
H_2O	......	......	......	51.99	......	55.10	......	......	......	53.02	......	47.58	......
NaCl	3.95	11.63	1.83	2.90	7.47	.28	0.60	3.85	2.52	3.81	8.20	.77	1.80
Na_2SO_4	82.23	88.93	39.04	21.42	55.14	42.34	95.80	73.17	72.40	36.80	78.86	40.86	95.58
Na_2CO_3	[2] 14.82	......	59.00	14.55	37.42	1.54	3.60	[2] 22.98	5.10	6.04	12.94	1.12	2.62
Total	101.00	100.56	99.87	100.00	100.03	100.00	100.00	100.00	99.05	100.00	100.00	100.00	100.00

	119	120	121	122	123	124	125	126	127	128	129	130	131
	49S13-26	49S13-27		49S13-28		49S13-29		49S13-30	49S13-31		49S13-32		49S13-33
Insoluble	22.82	25.40	......	0.43	......	0.41	......	1.08	7.01	......	3.06	......	2.43
H_2O	......	40.70	......	6.93	......	53.89	......	51.06	51.21	......	53.87	......	10.16
NaCl	1.83	.45	1.33	1.55	1.68	.77	1.68	2.16	2.63	6.30	2.66	6.16	2.09
Na_2SO_4	71.37	32.28	95.24	84.86	91.60	43.93	96.14	45.17	15.61	37.36	14.75	34.27	34.33
$NaHCO_3$	......	......	......	......	......	......	......	......	2.54	6.08	......	......	......
Na_2CO_3	3.10	1.17	3.43	6.23	6.72	1.00	2.18	......	21.00	50.26	[3] 25.66	59.57	50.12
Total	99.12	100.00	100.00	100.00	100.00	100.00	100.00	99.47	100.00	100.00	100.00	100.00	99.13

	132	133	134	135	136	137	138	139	140	141	142
	49S13-34		49S13-35		49S13-36		49S13-37		49S13-38	49S13-39	49S13-40
Insoluble	18.29	......	19.04	......	0.71	......	0.97	......	......	1.20	......
H_2O	53.17	......	49.97	......	45.21	......	36.67	......	......	......	......
NaCl	1.16	4.05	1.50	4.84	.05	0.09	4.83	7.74	0.32	.65	0.81
Na_2SO_4	4.66	16.36	2.94	9.49	6.85	12.67	25.88	41.51	65.08	59.29	17.02
$NaHCO_3$	5.41	18.97	......	......	......	......	4.82	7.73	......	......	......
Na_2CO_3	17.31	60.62	26.55	85.67	47.18	87.24	26.83	43.02	16.70	27.60	80.60
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	82.10	88.74	98.43

	143	144	145	146	147	148	149	150	151	152	153
	49S13-41	49S13-42	49S15-41	49S15-42		49S19-7	49S19-8		49S19-9	49S19-10	49S24-88
Insoluble	2.61	......	0.3	8.01	8.01	0.06	1.10	27.0	......	......	[4] 18.28
Al_2O_3	......	......	......	......	......	11.57	......	[5] 6.0	......	......	.99
Fe_2O_3	......	......	[6] None	......	......	Tr.	[6] .05	1.8	......	......	......
Na_2O	......	......	......	[6] 19.66	......	.21	......	......	[6] 0.07	32.09	.08
K_2O	......	......	......	[6] Tr.	[7] Tr.	Tr.	......	4.5	44.91	4.97	.08
MgO	......	......	[6] None	[6] 2.25	......	.13	......	13.0	......	......	.01
CaO	......	......	[6] None	[6] 2.89	......	Tr.	......	18.0	1.09	.24	.06
H_2O	9.01	1.61	49.5	......	10.93	47.82	15.40	[8] 2.0	.63	.68	1.17
Cl	......	......	None	1.02	......	Tr.	.09	......	.09	Tr.	......
SO_3	......	......	......	[9] 55.56	......	35.11	[9] .03	......	1.59	.33	[10] 78.40
CO_2	......	......	[11] None	......	......	......	......	25.0	......	......	......
N_2O_5	......	......	......	......	......	......	......	......	[12] 51.49	[13] 61.58	......
$(NH_4)_2O$	......	......	......	......	......	5.23	......	......	......	......	......
FeS_2	......	......	......	......	......	......	......	......	......	......	1.07
NaCl	2.13	.54	......	......	1.68	......	......	......	......	......	......
Na_2SO_4	25.75	94.50	50.2	......	58.66	......	......	......	......	......	......
$NaHCO_3$	30.09	......	......	......	......	......	35.90	......	......	......	......
Na_2CO_3	30.62	......	......	......	......	......	45.30	......	......	......	......
$MgSO_4$	......	2.52	......	......	11.23	......	......	......	......	......	......
$CaSO_4$	......	......	......	......	9.81	......	......	......	......	......	......
Ignition loss	......	......	......	10.93	......	......	......	......	......	......	......
Total	100.21	99.17	100.0	100.32	......	100.13	97.87	......	99.87	99.89	100.14

	154	155	156	157	158
	49S24-89	49S24-90	49S24-91	49S24-92	49S24-93
Al	6.98	7.22	8.24	10.05	11.61
Fe^{+3}	.50	.49	.58	.64	1.48
Fe^{+2}	1.37	.73	.58	.37	.74
Na	.25	.49	.10	1.19	.74
K	1.25	1.10	3.45	2.93	1.80

	154	155	156	157	158
Mg	0.25	0.12	0.19	0.18	0.23
Ca	.50	.49	.38	.37	.40
H	.95	.82	.75	.45	.25
SO_4	87.95	88.54	85.73	83.82	82.75
Total	100.00	100.00	100.00	100.00	100.00

[1] Not included in total.
[2] By loss.
[3] Reported as 59.55 percent.
[4] Reported as SiO_2.
[5] Reported as R_2O_3.
[6] Reported as the element.
[7] Reported as K_2SO_4.
[8] Reported as organic.
[9] Reported as SO_4.
[10] Reported as S.
[11] Reported as CO_3.
[12] Reported as calculated for K_2O.
[13] Reported as calculated for $Na_2O + K_2O$.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

106-107. Fremont County. (Recent.) Analyst, Ford. (Hayden, 1871, p. 188.)
106. (T. 27 N., R. 102 W.) lake near Pacific Springs. (Williams, 1883, p. 601.) (Sodium sulfate-sodium carbonate.)
107. (T. 29 N., R. 97 W.) lake 7 miles west of Saint Mary's Station. (Williams, 1883, p. 603.) Alkaline efflorescence on damp ground.

108-119. Natrona County. (Recent. Independence group, Dupont Lakes.)
108. Secs. 2, 3, 10, and 11, T. 29 N., R. 86 W., Wilmington soda mine. Analyst, Ricketts. (Weeks, 1886, p. 554; Knight, 1898, p. 616.) Sodium sulfate-sodium carbonate. Analysis of dried sample. Estimated area of deposit, 160 acres.
109. Locality as in sample 108. Analyst, Slosson. Lab. No. 152. (Knight and Slosson, 1901, p. 121.) Sodium sulfate-sodium carbonate from shore of lake. Index map.
110. Analysis calculated as dry salts; sample 109.
111. Information as in sample 109. Lab. No. 153. Sample from bottom of lake.
112. Analysis calculated as dry salts; sample 111.
113. (Sec. 11, T. 29 N., R. 86 W.) lake 2 miles east of Independence Rock. Analyst, Ford. (Hayden, 1871, p. 187; Williams, 1883, p. 602, 603.) Sodium sulfate.
114. Sec. 12, T. 29 N., R. 87 W., New York claim. (Weeks, 1886, p. 554; Knight, 1898, p. 616.) Sodium sulfate, deposit 0 - 20 ft thick, estimated area, 70 acres. Dried sample. (Some information from Osterwald and Osterwald, 1952, p. 131, 135.)
115. New York claim. Analyst and reference as in sample 109. Lab. No. 149. Sodium sulfate, surface sample.
116. Analysis calculated as dry salts; sample 115.
117. Information as in sample 115. Lab. No. 151. Sodium sulfate at depth of 4 - 12 in.
118. Analysis calculated as dry salts; sample 117.
119. Sec. 12, T. 29 N., R. 87 W., Philadelphia claim. (Weeks, 1886, p. 554; Knight, 1893, p. 184; Knight, 1898, p. 616.) Sodium sulfate deposit, 0 - 20 ft thick, estimated area, 80 acres. (Some information from Osterwald and Osterwald, 1952, p. 131, 135.)

120-125. Natrona County. (Recent.) Secs. 19, 20, T. 29 N., R. 88 W., Morgan deposit, dry soda lake. Analyst, Attfield. (Schultz, 1910, p. 580, 575, 577.) Sodium sulfate, deposit covers 110 acres; area of deep soda, 6 acres. Index maps. Use: Deposit too small to be of commercial use.
120. (Attfield, 1895, p. 4, 5.) Old deposit; sample effloresced after collection and before analysis. Bnlk of sand-free sulfate yielded 54 - 55 percent volatile matter.
121. Analysis calculated as dry salts; sample 120.
122. (Attfield, 1895, p. 4, 5.) Top crust; effloresced sodium sulfate.
123. Analysis calculated as dry salts; sample 122.
124. (Attfield, 1895, p. 4, 5.) New deposit, sodium sulfate which solidified from ooze which filled hole made in deposit.
125. Analysis calculated as dry salts; sample 124.

126. Natrona County. (Recent. T. 29 N., R. 88 W.), Morgan group of deposits, near Split Rock. (Knight, 1898, p. 616.) Sodium sulfate, deposit solid and aqueous; estimated area 100 acres.

127-131. Natrona County. (Recent.) NE¼ T. 30 N., R. 86 W., Independence group of lakes, Berthaton claim. Sodium sulfate-sodium carbonate, area 80-640 acres.
127. Analyst, Slosson; collector, Knight. Lab. No. 80. (Knight and Slosson, 1901, p. 121, 118.) Surface sample from small lake, clear crystals.
128. (Knight and Slosson, 1901, p. 121; Osterwald and Osterwald, 1952, p. 135.) Analysis calculated as dry salts; sample 127.
129. Analyst, Slosson; collector, Knight. Lab. No. 81. (Knight and Slosson, 1901, p. 121, 118.) Representative sample of deposit in Yale Lake.
130. (Knight and Slosson, 1901, p. 121; Osterwald and Osterwald, 1952, p. 135.) Analysis calculated as dry salts; sample 129.
131. Syndicate Improvement Co. (Knight, 1898, p. 616.) Sample nearly dry; deposit solid and aqueous.

132-139. Natrona County. (Recent.) Sec. 34 or 35, T. 30 N., R. 86 W., Independence group, Dupont Lakes, Omaha soda deposit. Analyst, Slosson. (Knight and Slosson, 1901, p. 121, 118.) Sodium sulfate-sodium carbonate; deposit covers 4 - 20 acres, 0 - 8 ft thick. (Some information from Osterwald and Osterwald, 1952, p. 131, 136.)
132. Lab. No. 76. Average of 14 - 17 inches below surface of deposit.
133. Analysis calculated as dry salts; sample 132. (Osterwald and Osterwald, 1952, p. 136, 131.)
134. Lab. No. 77. Average of 10 - 14 inches below surface of deposit.
135. Analysis calculated as dry salts; sample 134.
136. Lab. No. 78. Average of upper 10 inches of deposit.
137. Analysis calculated as dry salts; sample 136.
138. Lab. No. 79. Surface sample.
139. Analysis calculated as dry salts; sample 138.

140. Natrona County. (Recent.) Omaha soda deposit. (Osterwald and Osterwald, 1952, p. 136.) Sodium sulfate-sodium carbonate. Sample from 5 ft below surface. Analysis of dry salts.

141. Natrona County. (Recent.) Omaha soda deposit. (Weeks, 1886, p. 553; Osterwald and Osterwald, 1952, p. 136.) Sodium sulfate-sodium carbonate, near surface. Analysis of dry salts contains 56.3 percent H_2O in natural state.

142. Natrona County. (Recent.) Omaha soda deposit. (Osterwald and Osterwald, 1952, p. 136.) Sodium sulfate-sodium carbonate, surface sample. Analysis of dry salts.

143. Natrona County. (Recent.) Omaha soda deposit. (Weeks, 1886, p. 553; Knight, 1898, p. 616.) Sodium sulfate-sodium carbonate, surface sample, nearly dry. Estimated area, 5 acres.

144. Natrona County. (Recent.) Sec. 26, T. 35 N., R. 78 W., Gill Lakes, about 8 or 10 miles northeast of town of Casper. (Ricketts, 1888, p. 52; Knight, 1898, p. 616.) Sodium sulfate; very clear, surface sample, nearly dry. Deposit, 4 lakes, 80 - 90 acres; soda as much as 12 - 16 ft thick. Possible use: Glass.

145. Park County. (Recent.) S½ NE¼ sec. 14, T. 52 N., R. 102 W., lake south of town of Cody. Analyst, Wells. Lab. No. C-666. (Wells, 1937, p. 124, 123.) Mirabilite, partly dried.

146. Park County. (Recent.) Sec. 14, T. 52 N., R. 102 W., soda lake. Analyst, Fairchild; collector, Northrop. Lab. No. C-619. (Wells, 1937, p. 124.) Saline crust.

147. Hypothetical combinations of sample 146.

148. Sweetwater County. Eocene, Wasatch formation. T. 19 N., R. 94 W., (H. D. Thomas, written communication, 1957), 4 miles southwest of town of Wamsutter. (Dietz, 1929, p. 101.) Tschermigite, in lignitic coal seam. Estimated tonnage. Possible use: Source of nitrogen.

149. Sweetwater County. Eocene, Green River formation. T. 19 N., R. 110 W., Intermountain Chemical Corp. (Lindeman, 1954, p. 8, 2, 6, 9, fig. 1.) Trona, light amber; interbedded with oil shale; approximate analysis. Insoluble from 3.50 to 15.00 percent depending on amount of shale in sample. Estimated tonnage. Index maps, generalized columnar section. Possible use: Chemical industry.

150. Analysis of insoluble fraction of sample 149; approximate percentages.

151. Sweetwater County. (Recent. T. 22 N., R. 104 W.), North Table Butte. Analyst, Eakins. (Cross, 1897, p. 118.) Potash nitre, white, coarse, granular; occurs as partial crust in cavity and as filling for irregular fissures.

152. Sweetwater County. (Recent. T. 22 N., R. 104 W.), Boar's Tusk, about 20 miles north of town of Rock Springs. Analyst, Eakins. (Cross, 1897, p. 120, 119.) Soda nitre, scanty white coating on protected rock faces of cavernous breccia.

153. Yellowstone National Park. (Recent.) Norris Geyser Basin. (Allen and Day, 1935, p. 484, 232, 483, 485.) Lab. No. 65. Spring sediment. Index map.

154-158. Yellowstone National Park. (Recent.) Norris Geyser Basin. (Allen and Day, 1935, p. 141, 140, 232.) Salt incrustations, products of fumarole action. Analysis of fractions soluble in H_2O (percent of insoluble not given). Index map, mineralogy.
154. Small area east of terrace, north of Porcelain Basin.
155. East side of ridge, east of Big Mud-Pot.
156. Outlet of Crystal Spring, east side of Ragged Hills.
157. Barren slope between Fissure or New Crater and Harding Geyser.
158. Location, 140 yards northwest of Tantalus Creek, western edge of One-hundred-spring Plain (active part).

TABLE 24.—Analyses of phosphate rock or nodules from Kansas, Montana, and Wyoming containing 21.1 percent or more P_2O_5 (Group P) special rock category

[Most of these analyses report 21.1 percent P_2O_5 or more, corresponding to 50 percent fluorapatite ($9CaO \cdot 3P_2O_5 \cdot CaF_2$). Chemical analyses arranged by State, county, and stratigraphic position]

	Kansas										
	1	2	3	4	5	6	7	8	9	10	11
	15P19-12	15P19-13	15P23-26	15P50-11	15P50-12	15P50-13	15P50-14	15P50-15	15P54-19	15P103-28	15P105-13
SiO_2	18.94	8.86	6.73	12.29	10.37	6.93	4.07	6.93	11.33	7.10	0.93
Al_2O_3	6.12	2.59	5.08	6.75	6.03	2.64	1.25	2.57	6.18	3.94	2.99
Fe_2O_3, total iron	3.42	2.38	.48	1.26	1.04	1.77	2.47	6.65	[1] 1.72	4.02	.30
MgO	.05	.20	.35	.77	.08	.32	.11	.11	.81	.37	.64
CaO	35.02	43.74	46.38	39.78	42.12	44.71	47.77	42.32	44.27	42.11	52.46
Na_2O	.22	.04	.36	.05	.05	.21	.05	.25	......	.30	.07
K_2O	.29	.03	.26	.08	.03	.31	.03	.24	......	.45	.09
TiO_2	.57	.43	.36	.24	.37	.54	.37	.21	......	......	.21
P_2O_5	24.72	30.44	31.95	28.62	29.01	30.88	34.10	27.22	28.23	29.93	37.34
S	.96	.70	.05	.15	.09	.63	......	2.53	.21	.03	.30
SO_3	.17	.12	.44	.11	.13	.15	Nil	.94	Nil	1.05	Nil
F	2.45	3.43	3.24	2.76	2.99	3.40	3.62	2.84	3.51	2.94	4.03
U_3O_8	.010	.021	.017	.024	.010	.029	.020	.011	.007	.007	.03
Ignition loss [2]	9.68	10.39	6.29	8.97	9.71	11.14	6.81	11.71	7.19	9.51	4.55
Subtotal	102.62	103.37	101.99	101.85	102.03	103.66	100.67	104.53	103.46	101.76	103.94
Less O [3]	1.03	1.44	1.36	1.16	1.26	1.43	1.52	1.20	1.48	1.24	1.70
Total	101.59	101.93	100.63	100.69	100.77	102.23	99.15	103.33	101.98	100.52	102.24

	Montana								
	12	13	14	15	16	17	18	19	20
	25P1-18	25P1-19	25P1-20	25P1-21	25P1-22	25P1-23	25P1-24	25P1-25	25P12-7
Insoluble in acid	[4] 4.49	[4] 3.64	18.3	11.9	23.7	21.2	13.8	25.0	10.8
Al_2O_3	2.20	.81	4.80	2.6	6.8	5.6	3.9	......	3.60
Fe_2O_3	.10	.82	1.45	1.0	1.7	1.5	1.9	......	1.45
CaO	51.15	51.40	......	......	......	......	......	......	......
P_2O_5	35.09	34.80	30.1	32.3	21.3	24.0	31.9	32.6	30.6
Ignition loss	......	......	2.04	7.1	20.0	16.8	8.1	......	10.72
Total	93.03	91.47	56.7	54.9	73.5	69.1	59.6	57.6	57.2

	21	22	23	24	25	26	27	28
	25P39-2	25P39-3	25P39-4	25P39-5	25P39-6	25P47-6	25P47-7	25P47-8
SiO_2	17.30	4.90	15.29	[5] 6.00	[6] 8.4	[6] 7.5	[6] 24.5	[6] 15.3
Al_2O_3	.99	.54	1.91	1.10	......	1.8	4.9	3.2
Fe_2O_3	[7] 2.16	[7] .56	[7] 2.11	.45	......	1.3	2.1	2.0
MgO	.00	.03	.22	.30	......	......	......	......
CaO	44.65	52.02	43.74	46.90	......	......	......	......
Na_2O	.16	.40	.28	......	......	......	......	......
K_2O	.22	.26	.58	......	......	......	......	......
TiO_2	......	.04	.07	......	......	......	......	......
P_2O_5	27.63	37.47	31.39	32.10	37.5	35.2	26.2	31.2
CO_2	.75	1.18	1.00	2.20	......	......	......	......
MnO	......	.028	.042	......	......	......	......	......
S	......	[8] .01	[8] .01	......	......	......	......	......
SO_3	[8] .13	[8] .28	[8] .14	2.10	......	......	......	......
V_2O_5	......	.04	.05	......	......	......	......	......
F	6.98	3.83	3.19	......	......	3.16	2.3	2.78
Cl	.01	.01	.01	......	......	......	......	......
Cr_2O_3	......	.05	.07	......	......	......	......	......
CuO	......	......	.003	......	......	......	......	......
ZnO	......	......	.025	......	......	......	......	......
As_2O_3	.0088	.0024	.0140	......	......	......	......	......
Ignition loss	[9] 1.40	[9] .70	[9] 1.25	[10] 1.45	......	2.2	2.7	2.2
Subtotal	102.39	102.35	[11] 101.39	......	......	51.16	62.7	56.68
Less O [3]	......	......	......	......	......	1.33	1.0	1.17
Total	[12] 99.44	[12] 100.74	[12] 100.01	92.60	45.9	49.8	61.7	55.5

See following page for footnotes.

Semiquantitative spectrographic analyses

[A = more than 10 percent; C = 1-5 percent; D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Be, Co, Ga, Ge, As, Cd, In, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, Pb, and Bi looked for in all samples but not detected]

	15	16	17	18	26	27	28		15	16	17	18	26	27	28
B	F	F	F	F	F	F	F	Ni	E	E	E	E	E	E	E
Na	E	E	D	D	E	E	E	Cu	G	G	G	G	G	G	G
Mg	D	D	D	D	D	C	C	Zn	ND	E	E	E	E	E	E
Ca	A	A	A	A	A	A	A	Sr	ND	ND	E	E	E	E	E
Ti	E	E	E	E	E	D	D	Zr	F	F	E	E	E	E	E
V	E	D	D	D	D	D	D	Cb	ND	ND	E	E	ND	ND	ND
Cr	E	E	D	E	E	E	E	Mo	F	E	E	E	F	F	F
Mn	E	E	F	F	F	F	F	Ag	G	G	F	F	G	F	F

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Kansas

1-11. Pennsylvanian. (Runnels and others, 1953, p. 99, 94-103.) Phosphate nodules in shale. Graphs showing relationships of certain chemical constituents. Mineralogy. X-ray diffraction analysis of samples 3, 8, and 11.

1. Crawford County. Cherokee shale, above Mulky coal. SW¼SE¼ sec. 16, T. 31 S., R. 23 E. Lab. No. 50545. Nodules from black fissile shale; shale 3 ft thick.
2. Crawford County. Altamont limestone, Lake Neosha shale member. SW¼NW¼ sec. 30, T. 29 S., R. 21 E. Lab. No. 50548. Nodules, fresh; from shale 4 ft thick.
3. Douglas County. Oread limestone, Heebner shale member. SW¼ sec. 25, T. 12 S., R. 19 E. Lab. No. 52263. Nodules from fresh outcrop of black shale; shale 3 ft thick.
4. Labette County. Cherokee shale, above Mulky coal. SE¼NE¼ sec. 16, T. 33 S., R. 21 E. Lab. No. 5022. Nodules from black fissile shale; shale 3 ft thick.
5. Labette County. Cherokee shale, above Mulky coal. NE¼NW¼ sec. 2, T. 35 S., R. 20 E. Lab. No. 50546. Nodules from black fissile shale; shale 3 ft thick.
6. Labette County. Fort Scott limestone, Little Osage shale member. NW¼SW¼ sec. 9, T. 34 S., R. 20 E. Lab. No. 50547. Nodules from shale; shale 4 ft thick.
7. Labette County. Pawnee limestone, Little Anna shale member. NW¼SW¼ sec. 3, T. 33 S., R. 20 E. Lab. No. 50549. Nodules from shale; shale 4 ft thick.
8. Labette County. Pleasanton group. SE¼SE¼ sec. 17, T. 32 S., R. 19 E., quarry near town of Parsons. Lab. No. 5021. Nodules from black, fissile, bituminous shale. Many nodules have core of iron sulfide; nodules in 6-16 ft of shale. Estimated tonnage.
9. Linn County. Altamont limestone, Lake Neosho shale member. NE¼NE¼ sec. 8, T. 22 S., R. 24 E. Lab. No. 5023. Nodules from weathered remnant of shale.
10. Wilson County. Iola limestone, Muncie Creek shale member. NE¼SW¼ sec. 29, T. 29 S., R. 17 E. Lab. No. 52331. Nodules from shale; shale 3 ft thick.
11. Wyandotte County. Iola limestone, Muncie Creek shale member. Sec. 12, T. 11 S., R. 24 E. Lab. No. 5020. Nodules from shale; shale 3 ft thick.

Montana

12-19. Beaverhead County. Permian, Phosphoria formation.

12. E½ sec. 17, T. 2 S., R. 9 W. Analyst, Fairchild. (Gale, 1911, p. 442.) Phosphate rock. General description: Dark-gray to black, bluish-white on weathered surface; oolitic. Index map. Possible use: Fertilizer.
13. Sec. 12, T. 2 S., R. 10 W. Other information as in sample 12.
14. SE¼ sec. 9, T. 5 S., R. 8 W., 1 mile south of Big Hole River. Lab. No. 5406-JAP. (Peterson and others, 1954, p. 24, 2, 3.) Phosphate rock, trench sample 0.2 ft thick. Outcrop map, generalized columnar section.

15-18. NW¼SW¼ sec. 23, T. 9 S., R. 9 W. Spectrographic analyst, Mortimer. (Swanson and others, 1953b, p. 17, 2, 21, pl. 1.) Trench samples. Index and outcrop map, generalized columnar section. (For other analyses from same measured section see samples 47, 48 group A, samples 1-3 group B, and sample 1 group D of this compilation.)

Montana--Continued

15. Lab. No. DAB-38, bed D-11. Phosphate rock, 0.54 ft thick, 44.79 ft from top of member.
16. Lab. No. DAB-32, bed D-17. Phosphate rock and mudstone, 0.85 ft thick, 37.35 ft from top of member.
17. Lab. No. LAT-31, bed D-18. Phosphate rock, argillaceous, 1.55 ft thick, 35.80 ft from top of member.
18. Lab. No. LAT-30, bed D-19. Phosphate rock, 0.65 ft thick, 35.15 ft from top of member.
19. Sec. 26, T. 9 S., R. 11 W. Collector, Kelleher. Lab. No. ETR-569, bed D-28. (Klepper and others, 1953, p. 21, 2, 3.) Phosphate rock, trench sample, 0.7 ft thick, 34.35 ft from top of member. Index and outcrop map, generalized columnar section.

20. Deerlodge County. Phosphoria formation. Sec. 23, T. 5 N., R. 12 W. Lab. No. 5894-RWS, bed D-5. (Swanson and others, 1953a, p. 7, 2, 3.) Phosphate rock, trench sample, bed 1.2 ft thick, 6.3 ft from top of member. Index and outcrop map, generalized columnar section.

21-23. Powell County. (Phosphoria formation. T. 9 N., R. 10 W.) near town of Garrison. (Jacob and others, 1933, p. 22, 2, 11, 16, 30, 36, 51, 55, 72.) Phosphate, prospect samples. Estimated tonnage. Possible use: Fertilizer, feed, phosphate chemicals.

21. Lab. No. 1011. Macrocrystalline fluorapatite and coarsely crystalline fluorite present. (See also Hendricks and others, 1931, p. 1414-1417. Fluorapatite predominant constituent. Powder-diffraction photograph, microscopic and X-ray diffraction data.)
22. Lab. No. 1010. Iodine present in 0.8 ppm.
23. Lab. No. 1009. Iodine present in 0.8 ppm.

24. Powell County. Phosphoria formation. (T. 10 N., R. 9 W.), Warm Spring Creek, near Garrison. Analyst, Rosenkranz. (Pardee, 1917, p. 221, 195, 219, 223, pl. 8.) Phosphate rock, general description of deposit given; estimated tonnage. Index map, geologic map. Possible use: Fertilizer.

25. Powell County. Phosphoria formation. Sec. 2, T. 10 N., R. 9 W., Graveley mine, Montana Phosphate Products Co. Lab. No. MRK-298, bed D-3. (Klepper and others, 1953, p. 7, 2, 3.) Phosphate rock, 1 ft thick, 1.35 ft from top of member. Index and outcrop map, generalized columnar section.

26-28. Silver Bow County. Phosphoria formation. NW¼ sec. 5, T. 2 S., R. 9 W., Melrose property, Anderson Phosphate Mines, Inc. Spectrographic analyst, Mortimer; collector, Payne. (Klepper and others, 1953, p. 11, 2, 3, 12.) Index and outcrop map, generalized columnar section. (For another analysis from same measured section see sample 6, group B of this compilation.)

26. Lab. No. MRK-285, bed D-2. Phosphate rock, 0.9 ft thick, 8.40 ft from top of member.
27. Lab. No. MRK-286, bed D-3. Mudstone and phosphate rock, 1.2 ft thick, 7.20 ft from top of member.
28. Lab. No. MRK-287, bed D-4. Phosphate rock, 0.6 ft thick, 6.60 ft from top of member.

Footnotes of analyses on preceding page:

[1] Inclndes TiO_2.
[2] 105° - 1,000° C.
[3] (Calculated from F by compilers.)
[4] Insoluble in HNO_3.
[5] Reported as silica (SiO_2) and insoluble matter.
[6] Acid insolnble.
[7] Total Fe.
[8] Total sulfates reported as SO_3; S = acid insoluble sulfide. Further explanation see Jacob and others (1933, p. 22, 49).
[9] Total water, organic carbon, and nitrogen; inclndes water derived from combustion of organic matter but does not inclnde water at 105° C. Further explanation see Jacob and others (1933, p. 22, 51).
[10] Reported as water (H_2O).
[11] 101.35 in text.
[12] Total (as reported) corrected for O equivalent of F, Cl, and pyritic S.

TABLE 24.—Analyses of phosphate rock or nodules from Kansas, Montana, and Wyoming containing 21.1 percent or more P_2O_5 (Group P) special rock category--Continued

	Wyoming												
	29	30	31	32	33	34	35	36	37	38	39	40	41
	49P7-37	49P7-38	49P7-39	49P7-40	49P7-41	49P7-42	49P7-43	49P7-44	49P7-45	49P7-46	49P7-47	49P7-48	49P7-49
Insoluble	[1](20.3)	[1](18.1)	[1](11.0)	[1](12.9)	[1](12.0)	[1](12.5)	[2] 13.5	[2] 11.0	[1](14.3)	[2] 11.9	[2] 17.2	[2] 18.0	[2] 13.5
SiO_2	17.4	15.4	8.9	10.5	9.7	10.4	......	......	14.4	......	......	......	......
Al_2O_3	2.15	2.15	1.9	2.5	2.15	1.9	} [3] 1.7	[3] 1.5	[3] 1.2	} [3] 1.5	[3] .8	[3] 1.5	[3] 1.4
Fe_2O_3	[4] .86	[4] 1.22	[4] 1.43	[4] 1.00	[4] .86	[4] 1.00			[1](.8)				
MgO	2.5	1.0	2.15	.75	1.60	1.80	1.5	1.1	1.8	2.6	1.2	1.5	1.4
CaO	37.5	40.2	42.4	43.0	42.7	42.3	40.8	43.4	40.6	41.5	40.9	39.5	41.8
H_2O-	......	......	......	......	......	......	......	......	[5] .8	......	......	......	......
TiO_2	......	......	......	......	......	......	......	......	.10	......	......	......	......
P_2O_5	23.6	26.6	26.4	28.8	26.4	25.6	25.6	28.8	27.1	24.0	26.9	24.8	26.0
CO_2	......	......	......	......	......	......	......	......	5.5	......	......	......	......
S	.95	1.30	1.50	1.40	1.15	1.15	......	......	......	......	......	......	......
SO_3	......	......	......	......	......	......	3.5	3.3	3.6	......	......	......	......
V_2O_5	.01	.01	.01	.01	.01	.01	......	......	None	......	......	......	......
F	2.67	3.00	3.00	3.22	3.03	2.96	......	......	......	......	......	......	......
F_2	......	......	......	......	......	......	3.2	3.6	3.4	2.8	3.0	3.4	3.4
Cl_2	......	......	......	......	......	......	......	......	Tr	......	......	......	......
Cr_2O_3	......	......	......	......	......	......	......	......	Tr.	......	......	......	......
Ignition loss	......	......	......	......	......	......	......	......	[1](7.3)	......	......	......	......
Subtotal	87.64	90.88	87.69	91.18	87.60	87.12	89.8	92.7	98.5	84.3	90.0	88.7	87.5
Less O[6]	1.12	1.26	1.26	1.36	1.28	1.25	1.3	1.5	1.4	1.2	1.3	1.4	1.4
Total	86.5	89.6	86.4	89.8	86.3	85.9	88.5	91.2	97.1	83.1	88.7	87.3	86.1

	42	43	44	45	46	47	48	49	50	51	52	53	54
	49P7-50	49P7-51	49P7-52	49P7-53	49P12-108	49P12-109	49P12-110	49P12-111	49P12-112	49P12-113	49P12-114	49P12-115	49P12-116
Acid insoluble	11.5	13.4	9.8	12.1	18.3	6.4	[1](8.3)	[1](26.4)	[1](7.9)	......	[1](18.5)	[1](18.5)	[1](12.3)
SiO_2	......	......	......	......	......	......	10.20	26.27	10.09	16.13	16.64	18.16	13.36
Al_2O_3	} [3] .6	[3] 1.2	[3] 1.3	[3] 2.3	2.9	1.2	2.5	3.2	1.1	......	3.1	2.0	1.9
Fe_2O_3					.69	.85	.7	1.6	.7	......	1.3	1.0	.8
MgO	2.8	3.1	1.6	1.4	......	......	1.9	.57	.6	4.21	2.4	2.2	.80
CaO	42.3	41.5	44.3	42.7	......	......	42.24	31.1	43.82	31.48	36.40	35.4	41.2
Na_2O	......	......	......	......	......	......	.95	.79	1.09	.65	.83	.83	.95
K_2O	......	......	......	......	......	......	.40	1.58	.45	1.16	1.52	1.51	1.07
H_2O+	......	......	......	......	......	......	[7] 1.88	[7] 5.28	[7] 4.70	......	[7] 4.09	[7] 4.32	[7] 4.28
H_2O-	......	......	......	......	......	......	.42	1.82	.70	......	.71	1.48	1.22
TiO_2	......	......	......	......	......	......	.07	.19	.16	.08	.15	.16	.12
P_2O_5	26.7	25.0	25.6	28.3	28.8	32.6	29.05	20.6	28.9	18.48	21.55	21.1	26.7
CO_2	......	......	......	......	......	......	5.1	1.9	3.7	......	7.1	6.4	3.6
S as SO_3	......	......	......	......	......	......	2.2	3.7	3.5	......	2.6	3.1	3.1
V_2O_5	......	......	......	......	......	......	.10	.17	.11	.10	.05	.10	.14
F	......	......	......	......	......	......	2.9	2.2	3.4	2.01	2.5	2.1	2.7
F_2	3.3	3.1	3.4	3.6	......	......	......	......	......	......	......	......	......
Chem. U	......	......	......	......	......	......	.005	.007	.013	......	.003	.010	.013
Ignition loss	......	......	......	......	3.82	3.88	[1](7.4)	[1](9.0)	[1](9.1)	4.64	[1](11.9)	[1](12.2)	[1](9.1)
Subtotal	87.2	87.3	86.0	90.4	......	......	100.615	100.977	103.033	[8]<79.1724	[8]100.9433	99.870	101.953
Less O[6]	1.4	1.3	1.4	1.5	......	......	1.22	.93	1.43	.85	1.05	.88	1.14
Total	85.8	86.0	84.6	88.9	54.5	44.9	99.4	100.0	101.6	[8] 78.32	99.9	99.0	100.8

See following page for footnotes.

Semiquantitative spectrographic analyses

[A = more than 10 percent; D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. As, Sb, Ta, Pt, Hg, and Bi looked for in all samples (except 51) but not detected; Sc, Ge, Rb, Cs, Ce, Nd, Re, Tl, and Th looked for in samples 46 and 47 but not detected; Li and Au looked for in samples 48-54 (except 51) but not detected. Elements in sample 51 determined chemically; Mn, Cr, and Mo reported as MnO, Cr_2O_3, and MoO_3 respectively]

	46	47	48	49	50	51	52	53	54
Be	ND	ND	G	ND	ND	......	ND	ND	ND
B	ND	ND	F	F	F	......	F	F	F
Na	D	D	......	......	......	......	......	......	......
Mg	E	D	......	......	......	......	......	......	......
Ca	A	A	......	......	......	......	......	......	......
Ti	E	E	......	......	......	......	......	......	......
V	D	ND	......	......	......	......	......	......	......
Cr	E	D	E	E	E	0.12	E	E	E
Mn	D	F	E	F	F	.035	F	F	F
Ni	E	F	E	E	E	.039	E	E	E
Co	F	ND	ND	ND	ND	.004	ND	ND	ND
Cu	F	F	F	G	G	.020	G	G	G
Zn	E	F	F	E	E	.002	ND	E	E
Ga	F	......	ND	ND	ND	......	ND	ND	ND
Sr	D	D	D	E	E	......	E	E	E
Y	E	E	......	......	......	......	......	......	......

Semiquantitative spectrographic analyses--Continued

	46	47	48	49	50	51	52	53	54
Zr	E	E	E	E	E	......	E	E	F
Cb	ND	ND	ND	E	D	......	ND	E	F
Mo	ND	ND	F	F	F	0.002	F	F	F
Ag	G	G	G	G	G	.0004	[9] 0.0003	G	G
Cd	F	ND	ND	ND	ND	......	ND	ND	ND
In	G	ND	......	......	......	......	......	......	......
Sn	ND	F	ND	ND	ND	......	ND	ND	ND
Ba	E	F	E	E	E	......	E	ND	ND
La	E	E	......	......	......	......	......	......	......
Yb	G	......	......	......	......	......	......	......	......
W	ND	ND	ND	ND	ND	<.005	ND	ND	ND
Pb	E	E	E	E	ND	.005	ND	E	ND

[1] Not included in total.
[2] Acid insoluble.
[3] Reported as R_2O_3.
[4] Calculated from reported Fe.
[5] At 110° C.
[6] (Calculated from F by compilers.)
[7] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[8] See spectrographic analysis for other constituents included in total.
[9] Determined chemically, composite of four samples, spectrographic determination, G.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming

29-34. Fremont County. Permian, Phosphoria formation. (King and Schumacher, 1949, p. 9, 5, 10, 11, figs. 1-3.) Phosphate rock, core samples; general description of formation given. Index maps, logs of drill holes.

29-32. Sec. 11, T. 30 N., R. 99 W., Twin Creek area. DH-1. (For another analysis from same measured section see sample 71, group F_1 of this compilation.)

29. Phosphate rock, 89-92 ft from top of formation.
30. Phosphate rock, 87-89 ft from top of formation.
31. Phosphate rock, 86-87 ft from top of formation.
32. Phosphate rock, 84-85.1 ft from top of formation.

33-34. Sec. 8, T. 31 N., R. 99 W., Macfie ranch. DH-1.

33. Phosphate rock, 264.5-266 ft from top of formation.
34. Phosphate rock, 261.2-264.5 ft from top of formation.

35-45. Fremont County. Phosphoria formation. Phosphate rock, trench samples; few to abundunt fossils. Estimated tonnage. Index map, geologic map, cross section, correlated columnar sections. Use: Beds thin, relatively poor grade.

35. Sec. 8, T. 31 N., R. 99 W., Little Popo Agie River, 13 miles south of town of Lander. Lab. No. A 5, bed 20. (King, 1947, p. 25, 28, 79, 80, figs. 2-4, 6.) Phosphate rock, gray-black to black; oolitic, some pisolites; some glauconite in lower part; about 2 ft 4 in. thick.

36. Little Popo Agie River, 13 miles south of Lander. Lab. No. A 6, bed 22. (King, 1947, p. 25, 28, 79, 80, figs. 2-4, 6.) Phosphate rock, black, calcareous, trace of glauconite; oolitic and pisolitic; grades into phosphatic limestone in upper part; about 10 inches thick.

37. (King, 1947, p. 29, 79, 80, figs. 2-4, 6.) One ton composite sample, equivalent to samples 35 and 36.

38. East line, sec. 17, T. 31 N., R. 99 W., north bank of Cherry Creek. Lab. No. X 2, bed 1. (King, 1947, p. 71, 72, 79, 80, figs. 3, 4, 6.) Phosphate rock, brown-black, gray-black; granular, some pisolites, some glauconite grains, thin and poorly bedded; from 1 ft 10 in. to 2 ft 3 in. thick.

39. NW¼SE¼ sec. 1, T. 31 N., R. 100 W., north of Mat Weed Canyon. Lab. No. O1, bed 1. (King, 1947, p. 68, 79, 80, figs. 3, 4.) Phosphate rock, greenish-brown, very sandy, somewhat dolomitic, granular; some oolites, some glauconite grains, much iron stain; about 5.5 inches thick.

40. S½SE¼ sec. 12, T. 31 N., R. 100 W., north of Little Popo Agie River. Lab. No. P1, bed 1. (King, 1947, p. 69, 70, 79, 80, figs. 3, 4.) Phosphate rock, gray-black phosphate in light-gray matrix; sandy, calcareous, granular; few oolites, some green clay; thin to platy bedded; 1 ft 5 in. thick.

41. SE¼ sec. 6, T. 32 N., R. 100 W., tip of flatiron. Lab. No. J4, bed 3. (King, 1947, p. 60, 61, 79, 80, figs. 3, 4.) Phosphate rock, mostly light-gray, some gray-black; somewhat calcareous; dense to granular; some oolites, trace of glauconite; 2 inches thick.

42. NW¼NW¼ sec. 9, T. 32 N., R. 100 W., Sinks Canyon. Lab. No. C2, bed 2. (King, 1947, p. 44, 45, 79, 80, figs. 3, 4.) Phosphate rock, brown-black; slightly calcareous, granular, some oolites, some glauconite; platy to wavy bedded; 1 ft 2 in. thick.

43. N½SE¼ sec. 28, T. 32 N., R. 100 W., near Table Mountain. Lab. No. L2, bed 1. (King, 1947, p. 62, 63, 79, 80, figs. 3, 4.) Phosphate rock, resembles yellowish sand; deeply weathered, 2 ft thick; contains calcareous nodules.

44. N½SE¼ sec. 28, T. 32 N., R. 100 W., near Table Mountain. Lab. No. L3, bed 2. (King, 1947, p. 62, 63, 79, 80, figs. 3, 4.) Phosphate rock, light-gray, some iron stain, granular to finely pisolitic, deeply weathered, very thin bedded; 9 inches thick.

Wyoming--Continued

45. SW¼ sec. 19, T. 33 N., R. 100 W., gully between Squaw and Baldwin Creeks. Lab. No. G4, bed 3. (King, 1947, p. 54, 55, 79, 80, figs. 3, 4.) Phosphate rock, gray-black, granular, thin-bedded to shaly, 9 inches thick; contains silt streaks, pellets or pisolites, limonite nodules.

46. (Lincoln County) reported as Uinta County. Phosphoria formation, Meade Peak member. Secs. 10 and 15, T. 21 N., R. 120 W., 4 miles west of town of Sage; Leefe open pit mine, San Francisco Chemical Co. Lab. No. RMC-137-47, bed P-3. (McKelvey and others, 1953, p. 33, 2, 35, pl. 1.) Phosphate rock, argillaceous, 1.2 ft thick, 10.2 ft from top of member. Index and outcrop map, generalized columnar section.

47. Lincoln County. Phosphoria formation, Meade Peak member. Sec. 35, T. 25 N., R. 118 W. Lab. No. LES-37-47, bed P-64. (McKelvey and others, 1953, p. 30, 2, 32, pl. 1.) Phosphate rock, trench sample; bed 1.0 ft thick, 18.9 ft from top of member. Index and outcrop map, generalized columnar section.

48-54. Lincoln County. Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Spectrographic analyst, Mortimer. Phosphate rock, trench samples. Index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

48-50. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 15, 19, 2, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, pl. 1.) Modal grain size, index map, detailed columnar section; mineralogy.

48. Lab. No. VEM-1-47, bed P-1. Phosphate rock, light brownish-gray, oolitic, fossiliferous, 0.2 ft thick, 143.55 ft from top of member; contains pellets.
49. Lab. No. 2065, bed P-8. Phosphate rock, argillaceous, brownish-black, 0.4 ft thick, 137.05 ft from top of member.
50. Lab. No. VEM-8-47, bed P-11. Phosphate rock, brownish-black, 0.7 ft thick, 134.55 ft from top of member. (See sample 62, group B of this compilation for analysis of adjoining bed; for an analysis of the composite of the two beds, see the following sample.)

51. Lab. No. 2067, beds P-10 and P-11. (McKelvey and others, 1953, p. 20, 2, 15, pl. 1.) Phosphate rock and mudstone, 1.1 ft thick, 134.55 ft from top of member. (Composite of samples 50 above and sample 62, group B of this compilation.)

52. Lab. No. VEM-12-47, bed P-15. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 15, 19, 2, 23, pl. 1; Gulbrandsen, 1958, p. 14, 5, pl. 1.) Phosphate rock, dusky-brown, 1.3 ft thick, 131.35 ft from top of member. Modal grain size, index map, detailed columnar section.

53-54. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 14, 18, 2, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) Phosphate rock, brownish-black; contains pellets. Modal grain size, index map, detailed columnar section; mineralogy.

53. Lab. No. 2075, bed P-22. Bed 0.8 ft thick, 123.95 ft from top of member.
54. Lab. No. 2076, bed P-23. Bed 1.7 ft thick, 122.25 ft from top of member.

TABLE 24.—Analyses of phosphate rock or nodules from Kansas, Montana, and Wyoming containing 21.1 percent or more P_2O_5 (Group P) special rock category--Continued

	Wyoming											
	55	56	57	58	59	60	61	62	63	64	65	66
	49P12-117	49P12-118	49P12-119	49P12-120		49P12-121	49P12-122	49P12-123	49P12-124	49P12-125	49P12-126	49P12-127
Acid insoluble [1]	(10.5)	(10.9)	(13.6)	......	(14.6)	(33.3)	(9.4)	(25.2)	(8.9)	(10.0)	(3.46)	(10.08)
SiO_2	11.63	12.04	14.06	12.63	15.75	30.01	10.75	23.70	9.50	12.80	5.17	11.50
Al_2O_3	1.4	1.1	1.6	......	2.1	2.0	1.8	3.7	1.2	2.3	1.3	3.1
Fe_2O_3	.7	.7	.9	......	1.1	1.8	.7	1.3	1.0	1.2	.9	1.4
MgO	.60	.59	1.5	.22	.46	.39	.19	.41	.57	.58	.39	.98
CaO	42.3	42.9	39.7	38.96	37.5	27.2	43.65	34.40	43.73	38.80	45.45	40.37
Na_2O	.90	.72	.77	.91	.95	.86	1.08	1.00	.97	1.35	1.00	1.56
K_2O	.88	.99	1.36	1.16	1.35	1.81	.51	1.40	.54	.79	.49	.95
H_2O+ [2]	3.63	3.61	3.31	......	5.88	8.20	5.28	5.83	5.11	10.14	5.69	7.27
H_2O-	.87	.99	1.09	......	1.52	2.10	.72	.77	.79	1.46	1.01	.53
TiO_2	.10	.10	.13	.08	.16	.33	.08	.22	.11	.15	.07	.16
P_2O_5	28.6	29.5	26.1	26.33	26.3	18.1	30.00	23.34	29.26	26.24	28.85	26.01
CO_2	3.3	2.5	4.9	......	2.0	1.3	1.6	1.6	2.8	2.0	4.3	3.4
S as SO_3	2.8	2.4	2.8	......	3.5	3.7	3.4	2.9	3.0	3.8	2.7	3.0
V_2O_5	.09	.08	.17	.28	.30	.42	.09	.06	.13	.25	.08	.06
F	2.6	3.0	2.4	2.61	2.4	1.8	3.2	2.3	3.2	2.9	3.3	2.9
Cl	......	......	......	.004	......	......	......	......	......	......	......	......
Co	......	......	......	.004	......	......	......	......	......	......	......	......
Chem. U	.010	.007	.007	......	.020	.014	.007	.002	.010	.012	.008	.002
Ignition loss	[1] (7.8)	[1] (7.1)	[1] (9.3)	[3] 5.82	[1] (9.4)	[1] (11.6)	[1] (7.6)	[1] (8.2)	[1] (8.7)	[1] (13.6)	[1] (11.0)	[1] (11.2)
Subtotal	100.410	101.227	[4] 100.7973	[4] 89.1188	101.290	100.034	103.057	102.932	101.92	104.772	100.708	103.192
Less O [5]	1.09	1.26	1.01	1.10	1.01	.76	1.35	.97	1.35	1.22	1.39	1.22
Total	99.3	100.0	99.8	[4] 88.02	100.3	99.3	101.7	102.0	100.6	103.6	99.3	102.0

	67	68	69	70	71	72	73	74	75	76	77	78
	49P12-128	49P12-129	49P12-130		49P12-131	49P12-132	49P12-133	49P12-134	49P12-135	49P12-136	49P12-137	49P12-138
Acid insoluble [1]	(16.55)	(11.68)	......	(5.62)	(11.80)	(11.3)	(13.9)	(29.2)	(4.7)	(10.6)	(22.2)	(5.2)
SiO_2	15.53	[6] 10.60	2.43	7.70	13.20	14.10	15.50	27.70	6.70	12.90	27.10	6.49
Al_2O_3	2.8	4.5	......	1.9	2.3	1.4	2.1	4.4	.8	2.0	4.2	1.2
Fe_2O_3	1.7	1.7	......	2.1	1.7	1.1	1.2	1.6	.8	2.3	1.7	.5
MgO	.77	1.0	2.36	.43	.26	.29	.31	.42	.41	.33	.39	.24
CaO	36.45	32.82	42.10	42.10	44.00	44.18	41.60	31.46	48.42	42.24	32.40	45.7
Na_2O	1.15	.75	.80	.90	.94	1.20	1.25	1.09	1.14	1.00	1.20	1.16
K_2O	1.12	1.20	.55	.67	.62	.40	.70	1.24	.45	.77	1.80	.54
H_2O+ [2]	8.46	15.50	......	9.65	2.63	2.82	5.11	5.63	2.64	7.01	6.58	3.68
H_2O-	1.24	1.00	......	1.55	.47	.58	.89	.87	.56	.89	1.12	1.02
TiO_2	.25	.13	.04	.14	.15	.16	.16	.32	.08	.14	.26	.05
P_2O_5	24.35	21.00	29.89	28.67	29.41	27.44	27.45	21.03	24.09	29.3	21.6	32.7
CO_2	2.2	2.4	......	1.9	2.3	4.7	2.1	1.8	11.8	1.6	1.3	2.2
S as SO_3	3.1	3.9	......	3.5	1.6	2.3	2.9	2.5	2.3	3.2	2.8	3.5
V_2O_5	.08	.09	.05	.11	.05	.06	.06	.11	.06	.10	.16	.15
F	2.6	2.1	3.13	2.8	3.2	3.0	2.9	1.9	2.6	3.0	2.2	3.4
Chem. U	.003	.003	......	.004	.006	.004	.005	.003	.003	.007	.008	.019
Ignition loss	[1] (11.9)	[1] (18.9)	[3] 7.18	[1] (13.1)	[1] (5.4)	[1] (8.1)	[1] (8.1)	[1] (8.3)	[1] (15.0)	[1] (9.5)	[1] (9.0)	[1] (6.9)
Subtotal	101.803	98.693	[4] <88.8742	104.124	102.836	103.734	104.235	102.073	102.853	106.787	104.818	102.549
Less O [5]	1.09	.88	1.32	1.18	1.35	1.26	1.22	.80	1.09	1.26	.93	1.43
Total	100.7	97.8	[4] 87.55	102.9	101.5	102.5	103.0	101.3	101.8	105.5	103.9	101.1

See following page for footnotes.

Semiquantitative spectrographic analyses

[D = 0.1-1 percent; E = 0.01-0.1 percent; F = 0.001-0.01 percent; G = less than 0.001 percent; ND = not detected. Li, Co, Ga, As, Cd, Sn, Sb, Ta, W, Pt, Au, Hg, and Bi looked for in all samples (except 58 and 69) but not detected. Elements in samples 58 and 69 determined chemically; Mn, Cr, and Mo reported as MnO, Cr_2O_3, and MoO_3 respectively]

	55	56	57	58	59	60	61	62	63	64	65	66
Be	ND	ND	ND	......	ND	ND	G	ND	ND	ND	ND	G
B	F	F	F	......	F	F	F	F	F	F	F	E
Cr	E	E	E	0.08	E	E	E	E	E	E	E	D
Mn	F	F	F	.005	F	F	F	F	ND	ND	F	E
Ni	E	E	E	.002	E	E	E	E	E	E	E	E
Cu	G	G	G	.0006	G	G	F	G	G	G	G	F
Zn	E	E	E	.010	D	E	E	ND	E	E	ND	F
Sr	E	E	E	......	E	E	E	ND	ND	ND	E	E
Zr	F	F	F	......	F	E	E	E	F	F	F	E
Cb	F	F	E	......	E	E	ND	ND	ND	E	ND	ND
Mo	F	F	F	.012	F	F	E	F	F	E	F	F
Ag	G	G	[7] 0.0003	.0002	G	G	G	G	G	G	G	G
Ba	ND	ND	E	......	ND	E	E	ND	ND	ND	E	E
Pb	ND	ND	ND	.001	ND	ND	E	ND	ND	ND	ND	E

Semiquantitative spectrographic analyses--Continued

	67	68	69	70	71	72	73	74	75	76	77	78
Be	ND	ND	......	ND	ND	ND	ND	ND	ND	ND	G	ND
B	F	F	......	F	F	F	F	F	F	F	E	F
Cr	E	E	0.28	E	E	E	E	E	E	E	D	E
Mn	F	F	.009	F	F	F	F	F	F	F	E	ND
Ni	E	E	.023	E	F	F	F	E	ND	F	E	F
Co	ND	ND	.006	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	G	G	.013	G	G	G	G	G	G	G	F	G
Zn	E	E	.001	ND	ND	ND	ND	E	ND	ND	E	E
Sr	E	E	......	E	D	E	E	D	E	E	E	ND
Zr	E	E	......	F	F	F	F	E	F	F	E	F
Cb	E	E	......	E	ND	ND	ND	E	ND	ND	ND	ND
Mo	F	F	.002	F	F	ND	ND	F	ND	F	E	F
Ag	G	ND	.0002	G	G	G	G	G	ND	G	G	G
Ba	E	E	......	E	ND	ND	E	E	ND	ND	E	ND
W	ND	ND	<.005	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	.005	ND	ND	ND	ND	ND	ND	ND	E	ND

[1] Not included in total.
[2] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[3] Reported as organic matter. CO_2 and S reported as present.
[4] See spectrographic analysis for other constituents included in total.
[5] (Calculated from F by compilers.)
[6] SiO_2 amount reported as probably in error by McKelvey and others (1953, p. 18).
[7] Determined chemically; spectrographic determination, F.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

55-70. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Spectrographic analyst, Mortimer. Phosphate rock, trench samples. Index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

55-57. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 14, 18, 2, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) Modal grain size, index map, detailed columnar section; mineralogy.

55. Lab. No. 2077, bed P-24. Phosphate rock, brownish-gray, fossiliferous, 1.7 ft thick, 120.55 ft from top of member; contains pellets.

56. Lab. No. 2078, bed P-25. Phosphate rock, brownish-black, 0.3 ft thick, 120.25 ft from top of member; contains incipient pellets.

57. Lab. No. 2079, bed P-26. Phosphate rock, brownish-black, 2.1 ft thick, 118.15 ft from top of member; contains pellets.

58. Lab. No. 2080, bed P-27. (McKelvey and others, 1953, p. 20, 2, pl. 1.) Phosphate rock, 1.2 ft thick, 116.95 ft from top of member.

59-64. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 14, 18, 2, 22, 23, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) Modal grain size, index map, detailed columnar section; mineralogy.

59. Another analysis of sample 58. Phosphate rock, brownish-black; contains pellets.

60. Lab. No. 2084, bed P-31. Phosphate rock, argillaceous, brownish-black, 1 ft thick, 112.55 ft from top of member; contains incipient pellets.

61. Lab. No. VEM-13-47, bed P-34. Phosphate rock, brownish-gray, 0.6 ft thick, 109.35 ft from top of member; contains pellets.

62. Lab. No. LES-1-47, bed P-35. Phosphate rock, argillaceous, brownish-gray, 0.4 ft thick, 108.95 ft from top of member; contains few pellets.

63. Lab. No. LES-9-47, bed P-43. Phosphate rock, brownish-black, 0.7 ft thick, 95.55 ft from top of member; contains pellets.

64. Lab. No. LES-10-47, bed P-44. Phosphate rock, brownish-black, 1.3 ft thick, 94.25 ft from top of member; contains pellets.

65. Analyst, under supervision of Walthall. Lab. No. VEM-14-47, bed P-45. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 13, 5, pl. 1.) Phosphate rock, brownish-black, 0.8 ft thick, 93.45 ft from top of member; contains pellets. Modal grain size, index map, detailed columnar section; mineralogy.

66-68. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 14, 18, 2, 22, pl. 1; Gulbrandsen, 1958, p. 12, 5, pl. 1.) Phosphate rock, brownish-black; contains pellets. Modal grain size, index map, detailed columnar section; mineralogy.

Wyoming--Continued

66. Lab. No. VEM-18-47, bed P-49. Phosphate rock, 0.6 ft thick, 89.55 ft from top of member.

67. Lab. No. VEM-20-47, bed P-51. Phosphate rock, 0.3 ft thick, 87.95 ft from top of member.

68. Lab. No. VEM-22-47, bed P-53. Phosphate rock and phosphatic mudstone, 2.5 ft thick, 84.75 ft from top of member.

69. Lab. No. VEM-47-47, bed P-78. (McKelvey and others, 1953, p. 20, 2, pl. 1.) Phosphate rock, 0.4 ft thick, 47.5 ft from top of member.

70. Another analysis of sample 69. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 13, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) Phosphate rock, brownish-black; contains pellets. Modal grain size, index map, detailed columnar section; mineralogy.

71-78. Lincoln County. Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Analyst, under supervision of Walthall. Spectrographic analyst, Mortimer. Trench samples, modal grain size, index map, outcrop map; generalized columnar section, detailed columnar section; mineralogy. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

71. Lab. No. VEM-52-47, bed P-83. (McKelvey and others, 1953, p. 13, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, 108, pl. 1.) Phosphate rock, limestone, and mudstone; brownish-gray, fossiliferous, 1.0 ft thick, 41 ft from top of member.

72. Lab. No. VEM-54-47, bed P-85. References as in sample 71. Phosphate rock, dusky-brown, oolitic, 0.9 ft thick, 38.3 ft from top of member; contains pellets. Photomicrograph.

73. Lab. No. VEM-55-47, bed P-86. References as in sample 71. Phosphate rock, dusky-brown, 0.5 ft thick, 37.8 ft from top of member; contains pellets.

74. Lab. No. VEM-56-47, bed P-87. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) Phosphate rock, argillaceous, brownish-gray, 0.6 ft thick, 37.2 ft from top of member; contains pellets.

75. Lab. No. VEM-57-47, bed P-88. References as in sample 74. Phosphate rock, calcareous, brownish-gray, 0.9 ft thick, 36.3 ft from top of member; contains pellets; includes limestone lens 0.0-0.3 ft thick.

76. Lab. No. VEM-58-47, bed P-89. References as in sample 74. Phosphate rock, brownish-gray, 0.7 ft thick, 35.6 ft from top of member; contains incipient pellets.

77. Lab. No. VEM-61-47, bed P-92. References as in sample 74. Phosphate rock, argillaceous, brownish-gray, 1.1 ft thick, 32.2 ft from top of member; contains incipient pellets.

78. Lab. No. 2058, bed P-93. References as in sample 74. Phosphate rock, brownish-black, 0.8 ft thick, 31.4 ft from top of member; contains incipient pellets.

TABLE 24.—Analyses of phosphate rock or nodules from Kansas, Montana, and Wyoming containing 21.1 percent or more P_2O_5 (Group P) special rock category--Continued

	Wyoming								
	79	80	81	82	83	84	85	86	87
	49P12-139	49P12-140	49P12-141		49P12-142	49P12-143	49P12-144	49P12-145	49P12-146
Acid insoluble	[1](11.4)	[1](7.2)	......	[1](12.4)	[1](3.2)	[1](8.2)	[1](19.0)	[1](17.8)	6.1
SiO_2	13.28	8.85	10.06	13.87	4.73	9.91	17.70	17.80	......
Al_2O_3	2.1	1.5	......	2.3	.9	1.4	3.6	4.1	2.5
Fe_2O_3	1.0	.7	......	1.1	.6	.8	1.1	1.5	4.89
MgO	.36	.34	.20	.37	.20	.24	.39	.47	......
CaO	39.7	44.1	41.73	39.8	49.1	46.2	40.80	39.40	......
Na_2O	.91	1.03	.73	.76	1.01	.83	1.09	1.50	......
K_2O	.92	.67	.96	1.10	.39	.60	.80	1.20	......
H_2O+[2]	5.97	4.44	......	5.43	2.94	1.30	2.08	2.93	......
H_2O-	1.73	1.26	......	1.47	.46	.50	.62	.67	......
TiO_2	.12	.07	.06	.16	.07	.09	.17	.20	......
P_2O_5	26.9	29.8	28.77	27.2	32.9	29.8	25.9	25.45	20.8
CO_2	1.9	2.3	......	1.7	2.0	4.4	3.8	2.6	......
S as SO_3	4.0	3.2	......	2.9	2.9	2.3	2.0	2.3	......
V_2O_5	.24	.26	.31	.23	.10	.07	.04	.05	......
F	2.7	3.1	3.03	2.9	3.8	3.1	2.4	2.5	......
Cl	......	......	.004	......	......	......	......	......	......
Se	......	.001	......	.002	<.001	<.001	......	......	......
Chem. U	.019	.028	......	.034	.021	.008	.003	.003	......
Ignition loss	[1](9.6)	[1](8.0)	[3]5.28	[1](8.6)	[1](5.4)	[1](6.2)	[1](6.5)	[1](6.2)	17.6
Subtotal	101.849	101.649	[4]91.2971	101.326	<102.122	[4]<101.5491	102.493	102.673	......
Less O[5]	1.14	1.31	1.27	1.22	1.60	1.31	1.01	1.05	......
Total	100.7	100.3	[4]90.03	100.1	100.5	100.2	101.5	101.6	51.9

	88	89	90	91	92	93	94	95	96
	49P12-147	49P12-148	49P12-149	49P12-150	49P12-151	49P12-152	49P12-153	49P12-154	49P12-155
Acid insoluble	9.9	9.5	31.1	[1](30.6)	[1](25.1)	[1](25.8)	[1](23.8)	10.00	......
SiO_2	......	......	......	34.00	27.60	24.86	23.48	None	[6]7.19
Al_2O_3	1.9	1.5	2.8	4.4	1.4	3.7	4.3	.89	1.19
Fe_2O_3	.79	4.48	4.02	2.8	2.0	3.3	3.4	.73	[7].87
MgO	......	......	......	.59	.27	.62	.45	.28	.08
CaO	......	......	......	30.40	37.10	35.60	37.18	45.34	46.22
Na_2O	......	......	......	.57	.53	.85	1.00	1.10	[8].64
K_2O	......	......	......	1.70	.75	1.30	1.05	.48	[8].35
H_2O+	......	......	......	[2]2.62	[2]1.43	[2]1.72	[2]2.76	1.14	......
H_2O-	......	......	......	.68	.27	.48	.54	1.04	......
TiO_2	......	......	......	.20	.13	.14	.25	None	.10
P_2O_5	29.6	29.8	21.0	16.7	25.5	22.5	24.8	27.32	30.19
CO_2	......	......	......	1.6	1.7	4.5	1.6	6.00	4.13
MnO	......	......	......	......	......	......	......	......	.004
S	......	......	......	......	......	......	......	......	[8,9].69
SO_3	......	......	......	[10].95	[10]1.0	[10]1.0	[10]1.2	1.59	[8]1.35
V_2O_5	......	......	......	.11	.04	.06	.07	......	[8].12
F	......	......	......	2.1	2.4	2.1	2.5	.60	3.54
Cl	......	......	......	......	......	......	......	Tr.	[8].03
Cr_2O_3	......	......	......	......	......	......	......	......	.12
Ignition loss	8.30	6.6	6.4	[1](4.9)	[1](3.4)	[1](6.7)	[1](4.9)	......	[11]7.52
Subtotal	......	......	......	99.42	102.12	102.73	104.58	96.51	104.334
Less O	......	......	......	[5].88	[5]1.01	[5].88	[5]1.05	[5].25	[12]5.62
Total	50.5	51.9	65.3	98.5	101.1	101.8	103.5	96.26	[13]99.65

See following page for footnotes.

Semiquantitative spectrographic analyses

[A=more than 10 percent; D=0.1-1 percent; E=0.01-0.1 percent; F=0.001-0.01 percent; G=less than 0.001 percent; ND=not detected. As, Sb, Ta, W, Pt, Hg, and Bi looked for in all samples (except 81) but not detected. Li, Ga, and Au looked for in samples 79-86 (except 81) but not detected; Sc, Ge, Rb, In, Cs, Ce, Nd, Re, Tl, and Th looked for in samples 87-90 but not detected. Elements in sample 81 determined chemically; Mn, Cr, and Mo reported as MnO, Cr_2O_3 and MoO_3]

	79	80	81	82	83	84	85	86	87	88	89	90
Be	ND	ND	......	G	G	ND	ND	ND	ND	ND	ND	ND
B	F	F	......	E	E	F	F	F	F	F	F	F
Na	......	......	......	......	......	......	......	......	ND	D	D	D
Mg	......	......	......	......	......	......	......	......	D	D	D	D
Ca	......	......	......	......	......	......	......	......	A	A	A	A
Ti	......	......	......	......	......	......	......	......	E	E	E	E
V	......	......	......	......	......	......	......	......	E	D	D	D
Cr	E	E	0.14	D	D	E	E	E	D	E	E	E
Mn	ND	F	.003	E	E	F	F	F	E	E	E	E
Ni	E	E	.002	E	E	F	F	E	E	E	E	E
Co	ND	ND	.004	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	G	G	.003	F	F	G	G	G	F	E	F	E

Semiquantitative spectrographic analyses--Continued

	79	80	81	82	83	84	85	86	87	88	89	90
Zn	E	E	0.008	E	F	ND	ND	ND	E	E	E	E
Sr	ND	ND	......	E	E	ND	ND	ND	D	D	D	D
Y	......	......	......	......	......	......	......	......	E	E	E	E
Zr	F	F	......	E	E	E	E	E	F	F	F	F
Cb	E	E	......	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mo	F	F	.002	E	F	F	F	F	F	F	F	F
Ag	G	G	.0001	G	G	[14] 0.0001	ND	ND	G	G	G	G
Cd	ND	ND	......	ND	ND	ND	ND	ND	F	E	F	F
Sn	ND	ND	......	ND	ND	ND	ND	ND	F	F	F	E
Ba	ND	ND	......	E	E	ND	ND	ND	F	F	D	E
La	......	......	......	......	......	......	......	......	E	F	E	E
Pb	ND	ND	.001	E	E	ND	ND	ND	F	E	E	E

[1] Not included in total.
[2] (Calculated by compilers; ignition loss less CO_2 and less H_2O-; probably contains some F and S.)
[3] Reported as organic matter. CO_2 and S reported as present.
[4] See spectrographic analysis for other constituents included in total.
[5] (Calculated from F by compilers.)
[6] Reported as 5.69 percent without regard for F; 7.54 percent insoluble in 1:1 HCl; by Hill and others (1931, p. 1123).
[7] Total Fe.
[8] Not reported by Hill and others (1931, p. 1123). V_2O_3 reported, not V_2O_5.
[9] Reported as S (volatiles as H_2S), 0.17 percent; S (pyrites), 0.52 percent by Hendricks and others (1931, p. 1416).
[10] S as SO_3.
[11] At 1,000° C. Reported as 6.78 percent by Hill and others (1931, p. 1123).
[12] Reported as CO_2, oxygen equivalent of F and Cl.
[13] Reported as total corrected with certain assumptions concerning the behavior of FeS_2.
[14] Determined chemically, spectrographic determination, E.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Wyoming--Continued

79-86. Lincoln County. Permian, Phosphoria formation, Meade Peak member. Sec. 7, T. 26 N., R. 119 W. Spectrographic analyst, Mortimer. Phosphate rock, trench samples. Index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

79-80. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, 26, 27, pl. 1.) Phosphate rock, brownish-black; contains incipient pellets. Modal grain size, index map, detailed columnar section; mineralogy.

79. Lab. No. 2059, bed P-94. Phosphate rock, 0.5 ft thick, 30.9 ft from top of member.

80. Lab. No. 2060, bed P-95. Phosphate rock, 0.6 ft thick, 30.3 ft from top of member.

81. Lab. No. 2061, bed P-96. (McKelvey and others, 1953, p. 20, 2, pl. 1.) Phosphate rock, 0.7 ft thick, 29.6 ft from top of member.

82-85. Analyst, under supervision of Walthall. (McKelvey and others, 1953, p. 12, 17, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, 26, 27, 108, pl. 1.) Modal grain size, index map, detailed columnar section; mineralogy.

82. Another analysis of sample 81. Phosphate rock, brownish-black, oolitic; contains pellets.

83. Lab. No. 2062, bed P-97. Phosphate rock, brownish-black, oolitic, 1.9 ft thick, 27.7 ft from top of member; contains pellets. Photomicrograph.

84. Lab. No. 2063, bed P-98. Phosphate rock, brownish-gray, 1.1 ft thick, 26.6 ft from top of member.

85. Lab. No. DML-2-47, bed P-100. Phosphate rock, brownish-gray, 0.4 ft thick, 24.8 ft from top of member; contains some pellets.

86. Analyst, under supervision of Walthall. Lab. No. DML-8-47, bed P-106. (McKelvey and others, 1953, p. 12, 16, 2, 21, pl. 1; Gulbrandsen, 1958, p. 11, 5, pl. 1.) Phosphate rock, brownish-gray, 0.3 ft thick, 18.7 ft from top of member; contains pellets. Modal grain size, index map, detailed columnar section; mineralogy.

Wyoming--Continued

87-90. Lincoln County. Phosphoria formation, Meade Peak member. Secs. 19 and 30, T. 27 N., R. 119 W. (McKelvey and others, 1953, p. 6, 2, 9, pl. 1.) Trench samples, index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

87. Lab. No. RAH-168-47, bed P-85. Calcareous phosphate rock and limestone, 0.5 ft thick, 35.75 ft from top of member.

88. Lab. No. RAH-158-47, bed P-95. Phosphate rock, 2.3 ft thick, 19.45 ft from top of member.

89. Lab. No. RAH-156-47, bed P-97. Phosphate rock, 1.4 ft thick, 14.95 ft from top of member.

90. Lab. No. RAH-155-47, bed P-98. Phosphate rock and mudstone, 1.15 ft thick, 13.8 ft from top of member.

91-94. Lincoln County. Phosphoria formation, upper shale member. Sec. 7, T. 26 N., R. 119 W. (McKelvey and others, 1953, p. 11, 16, 2, pl. 1.) Trench samples, index and outcrop map, generalized columnar section. (For other analyses from same measured section see analyses in Lincoln County in this and other groups of this compilation.)

91. Lab. No. VEM-70-47, bed U-1. Phosphate rock, argillaceous, 0.4 ft thick, 57.2 ft below top of member.

92. Lab. No. VEM-71-47, bed U-2. Phosphate rock, cherty, 0.6 ft thick, 56.6 ft below top of member.

93. Lab. No. VEM-75-47, bed U-6. Phosphate rock, cherty, 2.3 ft thick, 51.2 ft below top of member.

94. Lab. No. VEM-96-47, bed U-27. Phosphate rock, argillaceous, 1.7 ft thick, 1.7 ft from top of member.

95. Lincoln County. (Phosphoria formation) reported as Park City formation. T. 24 N., R. 119 W., about 2.5 miles northeast of town of Cokeville. Analyst, Steiger. (Gale and Richards, 1910 p. 465, 459, 464, 466, 503-508, pl. 9.) Phosphate rock. General remarks: Contains specks of fluorite; estimated tonnage. Outcrop map, geologic map and cross section; detailed measured section, correlated columnar sections; mineralogy.

96. Lincoln County. (Phosphoria formation.) Near Cokeville. Lab. No. 948. (Hill and others, 1931, p. 1123, 1120; Hendricks and others, 1931, p. 1416, 1417.) Analysis and footnotes from second reference unless otherwise stated. Phosphate rock, from shipment of commercial material. Additional chemical analyses of sized fractions of sample, physical composition, microscopic and X-ray diffraction characteristics. Results calculated to moisture-free basis. Dried at 105° C.

TABLE 25.—Analyses of iron-rich rocks from Colorado, Montana, South Dakota, and Wyoming; most of which contain 50 percent or more of ferrous oxide or ferric oxide (Group Fe) special rock category

[Chemical analyses arranged by State, county, and stratigraphic position]

	Colorado					Montana			S. Dak.	Wyoming			
	1	2	3	4	5	6	7	8	9	10	11	12	13
	5Fe26-8	5Fe26-9	5Fe36-16	5Fe41-15	5Fe41-16	25Fe7-6	25Fe22-19	25Fe30-11	40Fe52-38	49Fe4-41	49Fe4-42	49Fe4-43	49Fe4-44
Insoluble	......	......	......	......	......	......	......	[1] (12.30)	......	......	......	......	......
SiO_2	0.82	2.50	9.19	2.67	7.13	3.04	2.55	9.1	33.10	3.32	10.20	0.72	1.11
Al_2O_3	......	.28	6.29	......	......	Tr.	......	2.65	17.28	......	......	.21	1.74
Fe_2O_3	39.01	72.47	[2] 45.04	68.84	67.55	[3] 79.06	68.53	[4] 76.22	30.32	[4] 98.27	[4] 89.39	[5] 96.65	[5] 86.97
MgO	6.03	.12	1.37	......	......	None	Tr.	......	.51	......	......	.68	3.25
CaO	19.55	.22	4.02	.81	1.22	.56	.28	.20	3.17	......	......	1.23	5.79
Na_2O	......	......	......	......	......	......	} Tr.	......	{ .31	......	......	......	......
K_2O	......	......	......	......	......	......	}		{ 6.33	......	......	......	......
TiO_2	......	......	......	......	......	......	......	......	......	......	......	.04	.43
P_2O_5	......	.333	1.055	1.90	1.82	[6] None	4.06	[6] .04	2.96	[6] .015	[6] .040	......	......
MnO	13.92	......	......	......	......	[7] .30	......	......	......	......	......	......	......
SO_3	......	......	......	......	......	[8] .09	3.24	[8] .15	.54	......	[8] .026	......	......
ZnO	......	......	......	......	......	......	.40	......	......	......	......	......	......
As_2O_5	......	......	......	......	......	......	Tr.	......	......	......	......	......	......
Ignition loss	[9] 21.05	[10] 23.97	[11] 33.035	[10] 26.00	[10] 23.37	[12] 17.00	[12] 20.01	......	5.23	......	......	......	......
Total	100.38	99.89	100.00	100.22	[13] 101.09	100.05	[14] 99.07	88.4	99.75	101.60	99.66	99.53	99.29

	Wyoming												
	14	15	16	17	18	19	20	21	22	23	24	25	26
	49Fe4-45	49Fe4-46	49Fe4-47	49Fe4-48	49Fe4-49	49Fe4-50	49Fe4-58	49Fe4-59	49Fe4-60	49Fe4-61	49Fe4-62	49Fe4-63	49Fe4-64
SiO_2	1.19	5.18	6.11	12.17	4.30	20.10	......	......	3.16	17.73	25.36	30.10	1.68
Al_2O_3	.54	2.20	2.18	.01	......	......	......	......	......	......	......	......	2.46
Fe_2O_3	[5] 97.27	[5] 87.81	[5] 88.75	[5] 84.75	[4] 98.10	[15] 79.21	[4] 95.86	[4] 95.58	[4] 92.84	[4] 78.92	[4] 72.77	[4] 67.91	93.30
MgO	.02	2.03	1.23	.50	......	......	......	......	......	......	......	......	......
CaO	.51	2.33	1.01	2.21	......	......	......	......	1.46	......	......	......	.38
TiO_2	.03	......	......	Tr.	Tr.	......	......	......	......	......	......	......	......
P	......	......	......	......	None	......	.013	.006	.013	.015	.015	.016	......
MnO	......	......	......	......	......	......	......	......	......	......	......	......	.65
S	......	......	......	......	Tr.	......	......	......	.011	......	......	......	......
Ignition loss	......	......	......	......	......	......	......	......	[16] 2.84	......	......	......	[17] .22
Total	99.56	99.55	99.28	99.64	102.40	99.31	95.87	95.59	100.32	96.66	98.14	98.03	98.69

	Wyoming												
	27	28	29	30	31	32	33	34	35	36	37	38	39
	49Fe4-65	49Fe4-66	49Fe4-67	49Fe4-68	49Fe13-19	49Fe13-20	49Fe16-24	49Fe16-25	49Fe16-26	49Fe16-27	49Fe16-28	49Fe24-86	49Fe24-87
SiO_2	9.63	1.71	[18] 7.2	9.74	1.66	0.97	1.90	2.40	1.82	1.50	35.50	17.16	20.23
Al_2O_3	5.10	......	......	5.57	4.07	3.60	......	......	1.86	1.42	3.66	5.94	5.83
Fe_2O_3	80.30	94.22	90.2	1.93	......	......	[19] 96.50	[20] 94.42	[4] 97.83	[4] 96.60	[21] 56.00	54.51	56.87
FeO	......	......	......	38.67	52.72	52.31	......	......	......	......	......	.14	......
MgO	......	......	......	1.20	.50	.75	......	......	Tr.	Tr.	......	.07	Tr.
CaO	.71	......	[22] 1.4	7.64	.80	1.20	......	......	Tr.	Tr.	......	2.00	.47
Na_2O	......	......	......	} .46	......	......	......	......	......	......	......	{ .08	......
K_2O	......	......	......	}							......	{ .09	......
H_2O	2.68	.37	1.2	Tr.	.86	.65	......	......	......	......	[23] 2.00	19.31	10.70
TiO_2	......	None	......	......	......	......	None	None	None	None	......	None	......
P_2O_5	......	[6] Tr.	......	Tr.	Tr.	.01	[6] Tr.	[6] .07	[6] .035	[6] .008	[24] 1.01	......	......
CO_2	.61	......	......	32.04	33.98	34.04	......	......	......	......	......	......	......
MnO	.75	......	......	2.38	[7] 1.97	[7] 1.48	......	......	......	......	......	1.02	......
S	......	1.24	......	......	......	......	None	None	.019	.054	......	......	None
SO_3	......	......	......	......	......	......	......	......	......	......	......	......	1.40
Cu	......	......	......	......	......	......	None	None	......	......	......	......	......
Organic	......	......	......	Tr.	[25] 2.65	[25] 4.21	......	......	......	......	......	......	......
As_2O_5	......	......	......	......	......	......	......	......	......	......	......	......	4.96
Total	99.78	97.54	100.0	99.63	99.21	99.22	98.40	96.89	101.56	99.58	98.17	[25] 100.32	100.46

[1] Not included in total.
[2] Reported as FeO.
[3] Metallic iron, 55.00 percent.
[4] Calculated from reported Fe.
[5] Reported as Fe and O.
[6] Reported as P.
[7] Reported as manganese.
[8] Reported as S.
[9] Reported as carbonic acid.
[10] Reported as water and organic matter.
[11] By difference, reported as carbonic acid and organic matter by Chauvenet (1886, p.11).
[12] Reported as H_2O.
[13] 100.09 in text.
[14] 99.58 in text.
[15] Reported as metallic iron, 55.30 percent; oxygen, 23.91 percent.
[16] Reported as CO_2.
[17] Reported as loss.
[18] Reported as insoluble matter.
[19] Metallic iron (computed) reported as 67.55 percent.
[20] Metallic iron (computed) reported as 66.09 percent.
[21] Reported as tenic oxide; metallic iron (computed) 39.20 percent.
[22] Reported as sulfur and lime.
[23] Reported as water of constitution.
[24] Calculated by compilers from reported P.
[25] Reported as carbonaceous matter.
[26] 100.35 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Colorado

1. Gunnison County. Pennsylvanian, Weber formation. T. 12 S., R. 84 W., Taylor River iron deposit (J. C. Olson, written communication, 1956). Analyst, Chauvenet. (Chauvenet, 1888, p. 20.) Calcareous iron-bearing rock. Possible use: Iron products.

2. Gunnison County. (Recent. T. 14 S., R. 86 W.) about 3 miles west of town of Crested Butte. Analyst, Chauvenet; collector, Lakes. (Chauvenet, 1886, p. 15, 16.) Bog iron, deposit covers about 0.5 mile square. Index map. Possible use: Pig iron.

3. Las Animas County. Upper Cretaceous, Laramie formation. (T. 33 S., R. 64 W.), Gray Creek, near town of Trinidad. Analyst, Chauvenet. (Chauvenet, 1886, p. 11; Emmons and others, 1896, p. 76.) Iron carbonate concretions, concentric structure, spheroidal weathering; occurs near base of foothills, usually over coal. Iron intercalated with clay and shale; nearly 40 ft thick in places. Use: No longer of economic value.

4-5. Park County. Recent. (T. 7 S., R. 75 W.) few miles west of town of Webster. Analyst, Chauvenet. Bog iron. Use: Probably of no economic value.
- 4. (Chauvenet, 1887, p. 18.)
- 5. (Chauvenet, 1887, p. 19.)

Montana

6. Cascade County. Upper Jurrassic, Morrison formation (U. M. Sahinen, written communication, 1957). (T. 19 N., R. 3 E.) near Great Falls, Sand Coulee region. Analyst, Dodge. (Chisolm, 1890, p. 34.) Limonite, bog iron.

7. Jefferson County. (Recent. T. 4 N., R. 9 W.), Silverbow mine, Butte district. Analyst, Hillebrand. (Weed, 1912, p. 82, 159.) Limonite stalactite, 900-ft level of mine. General description of limonite stalactites.

8. Meagher County. Precambrian, Belt series. Secs. 26 and 34, T. 12 N., R. 6 E., Sheep Creek iron deposits. Analyst, under supervision of Rice. (Reed, 1949, p. 4, 2, 6-9, figs. 1, 2.) Iron-bearing rock, large composite sample. Index map, topographic and outcrop map, beneficiation tests.

South Dakota

9. Pennington County. Upper Cambrian, Deadwood formation. (T. 1 N., R. 7 E.) west of Rapid City on Rapid Creek. Analyst, Coolbaugh. (Ziegler, 1914, p. 98.) Hematite, red, oolitic; grades into impure, soft, earthy ocher.

Wyoming

10-19. Carbon County. Precambrian, Seminoe formation. Hematite, replacement of magnetite and jasper; infolded with, and lies unconformably on, greenstone schists. Description of deposits. Possible use: Iron ore. (Information from Lovering, 1930, p. 221, 224, 225, 232.)

10-11. Sec. 12, T. 25 N., R. 86 W., about 0.3 mile west of Iron Hill. Analyst, Henderson. (Lovering, 1930, p. 232, 204, 230, 235, pl. 46.) Hard, dark-colored hematite in red and gray-banded jasper; from test pit.

12-17. Secs. 7 and 18, T. 25 N., R. 85 W.; secs. 1 and 12, T. 25 N., R. 86 W., base of Bradley Peak, Seminoe Mountains. (Aughey, 1886, p. 101.) Hematite, specular.

18-19. Locality as in samples 12-17.
- 18. (Ricketts, 1890, p. 62.)
- 19. Analyst, Wood. (Ricketts, 1890, p. 61.)

Wyoming--Continued

20-29. Carbon County. Cambrian, upper shaly layers; Lower Mississippian, Madison limestone, lower part. Secs. 4, 5, 8, and 9, T. 21 N., R. 87 W., or sec. 31, T. 22 N., R. 87 W., near town of Rawlins. General description: Mostly soft powdery hematite, density 3.5-5. Thickness 2-30 ft. Hematite bodies small and scattered. Index map. Former use: Flux, paint. (Information from Lovering, 1930, p. 204, 209, 210, 213, 214.)

20-25. (Lovering, 1930, p. 214, 204, 209, 210, 213.)
- 20. Collector, Winchell. Hematite, 6 ft thick.
- 21. Collector, Winchell. Hematite, 4 ft thick.
- 22. Average sample of hematite.
- 23-25. Collector, Brewer.

26-27. (Osterwald and Osterwald, 1952, p. 91.) Hematite, irregularly shaped masses in shaly limestone. General description given.

28. (Knight, 1893, p. 174.)

29. (Benjamin, 1886, p. 531.) Hydrated iron oxide, dark red.

30. Carbon County. (Probably Upper Cretaceous, Lance formation) reported as Fort Benton group. (T. 20 N., R. 82 W.), 9 miles south of town of Percy, east of Sheep Butte. Analyst, Brewster. (Hague, 1877, p. 151, 150.) Clay ironstone, steel-black; weathers brownish-black, crystalline texture, conchoidal fracture, hardness about 4, massive and in nodules. Observed deposits not extensive.

31-32. Natrona and Johnson Counties. (Probably Lance formation) reported as Fort Benton group. Secs. 17-20 and 30, Tps. 40, 41 N., R. 81 W., Powder River Basin. (Aughey, 1886, p. 107.) Siderite, dark-brown, blackish and black; bedded; 1-4 ft thick. Possible use: Production of iron.

33-37. Platte County. Precambrian, Whalen group. Hartville district.

33-34. Sec. 7, T. 27 N., R. 65 W., Sunrise mine. Analyst, Hodges; collector, Jenney. (Ricketts, 1890, p. 55, 51-54.) Hematite, average samples. General description of district. Use: Iron ore.

35-36. Sunrise mine. Analyst, Hodges. (Snow, 1895, p. 321, 320; Osterwald and Osterwald, 1952, p. 95.) Hematite, lenticular ore body. Mineralogy. Possible use: Iron ore. (Minor discrepancies occur in naming of constituents when more than one version of the analysis is found in the literature.)

37. (Probably sec. 12, T. 27 N., R. 66 W.), Mayflower claim. (Ricketts, 1890, p. 57, 51-54.) Hematite, impure; stratified deposit. General description of district. Use: Of no commercial value.

38-39. Yellowstone National Park. (Recent.)

38. Chocolate Pots, 3 miles south of Norris Junction. (Allen and Day, 1935, p. 358, 232, 357.) Sinter, rich brown with black streaks, homogeneous, very fine-grained. Analysis of water also given. Index map.

39. Norris Geyser Basin, Echinus Geyser. (Allen and Day, 1935, p. 484, 232, 485.) Sinter, rich dark-red. Index map.

TABLE 26.—Analyses of manganese-bearing rocks and nodules from North Dakota, South Dakota, and Wyoming (Group Mn) special rock category

[These analyses are included here because they do not meet the criteria for inclusion in the common or mixed rock categories. Chemical analyses arranged by State, county, and stratigraphic position]

	North Dakota								
	1	2	3	4	5	6	7	8	9
	33Mn40-1	33Mn40-2	33Mn40-3	33Mn40-4	33Mn40-5	33Mn40-6	33Mn40-7	33Mn40-8	33Mn40-9
SiO_2	1.48	0.31	0.72	0.41	1.62	0.71	1.20	0.52	[1] 3.65
Al_2O_3	.36	.21	.33	.11	.42	.06	.39	.67	.19
Fe_2O_3	.23	.09	.11	.03	.13	.04	.08	.65	.30
MgO	......	......	......	......	......	......	......	......	.97
CaO	26.71	50.38	47.65	48.39	26.20	35.76	42.38	49.80	9.43
Na_2O	......	......	......	......	......	......	......	......	.74
K_2O	......	......	......	......	......	......	...	......	.74
H_2O+	......	......	......	......	......	......	......	......	10.45
H_2O-	......	......	......	......	......	......	......	......	3.95
TiO_2	......	......	......	......	......	......	......	......	None
P_2O_5	.04	.03	.07	.06	.05	.01	.05	.02	None
CO_2	......	......	......	......	......	......	......	......	2.60
Mn	23.76	3.18	5.32	5.07	18.31	13.76	7.51	2.91	[2] 1.37
MnO_2	......	......	......	......	......	......	......	......	66.26
Li_2O	......	......	......	......	......	......	......	......	.005
NiO	......	......	......	......	......	......	......	......	.12
CoO	......	......	......	......	......	......	......	......	.06
CnO	......	......	......	......	......	......	......	......	None
BaO	......	......	......	......	......	......	......	......	.07
PbO	......	......	......	......	......	......	......	......	.05
Bi_2O_3	......	......	......	......	......	......	......	......	.17
Total	......	......	......	......	......	......	......	......	[3] 101.12

	South Dakota								
	10	11	12	13	14	15	16	17	18
	40Mn43-14	40Mn43-15	40Mn43-16	40Mn43-17	40Mn43-18	40Mn43-19	40Mn43-20	40Mn43-21	40Mn43-22
SiO_2	58.4	6.76	15.2	67.48	32.76	13.22	9.23	9.2	29.2
Al_2O_3	17.8	2.41	2.5	16.78	3.97	1.81	1.84	4.0	3.2
Fe_2O_3	......	......	......	4.56	......	......	......	......	......
Fe	2.4	19.08	6.6	......	6.21	12.92	12.41	10.8	2.6
MgO	.6	6.64	2.5	1.0	2.54	3.77	4.51	1.5	1.4
CaO	1.6	7.68	11.4	.78	4.90	8.85	7.98	11.3	9.0
TiO_2	......	......	.33	......	......	......	......	......	......
P	......	......	.43	......	......	......	......	.76	.40
Mn	.5	13.59	18.3	.22	20.35	17.27	18.02	19.2	14.4
S	......	......	.10	......	......	......	......	.07	.03
Ignition loss	11.6	32.49	28.7	9.17	16.46	28.52	31.82	29.3	24.9

	South Dakota							Wyoming
	19	20	21	22	23	24	25	26
	40Mn43-23	40Mn43-24	40Mn43-25	40Mn43-26	40Mn43-27	40Mn43-28	40Mn43-29	49Mn24-74
SiO_2	16.1	22.8	26.4	21.6	57.5	13.30	39.26	6.56
Al_2O_3	3.7	15.0	3.7	8.2	21.3	2.69	9.92	1.24
Fe_2O_3	......	......	......	......	......	......	......	1.60
Fe	7.9	3.7	3.1	4.9	1.5	11.14	13.08	......
MgO	1.5	1.2	2.0	1.5	2.0	1.80	2.56	None
CaO	10.5	10.4	9.1	20.1	2.0	15.00	4.60	6.52
Na_2O	......	......	......	......	......	......	......	.52
K_2O	......	......	......	......	......	......	......	.64
H_2O	......	......	......	11.6	20.6	......	......	16.48
P	.63	.43	.25	.44	.09	.43	......	......
CO_2	......	......	......	......	......	......	......	None
MnO	......	......	......	......	......	......	......	9.45
MnO_2	......	......	......	......	......	......	......	56.83
Mn	17.5	16.5	15.0	16.4	1.4	15.71	3.90	......
S	.06	.05	.09	.06	.09	......	......	None
Cl	......	......	......	......	......	......	......	None
Ignition loss	27.8	26.7	25.2	26.6	13.6	26.00	17.49	......

[1] Reported as insoluble, largely organic matter.
[2] Reported as MnO.
[3] 101.42 in text.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

North Dakota

1-9. Rolette County. (Recent.) N½NE¼ sec. 22, T. 162 N., R. 73 E., Mineral Spring.

1-8. Analyst, North; collector, Hendricks. (Hendricks and Laird, 1943, p. 599, 594-597.) Porous wad and calcareous tufa, brownish-black, soft, finely flaky; cold spring deposit; maximum thickness, 15 ft; area about 150 x 260 ft. Estimated tonnage. Index map. Possible use: Source of low-grade manganese.

1. Lab. No. 1.
2. Lab. No. 2.
3. Lab. No. 3.
4. Lab. No. 4.
5. Lab. No. 5.
6. Lab. No. 6.
7. Lab. No. 8.
8. Lab. No. 15.

9. Analyst, Fleischer. (Hendricks and Laird, 1943, p. 602.) Analysis of flotation concentrate of rancieite.

South Dakota

10-23. Lyman County. Upper Cretaceous, Pierre shale, Sully member, Oacoma zone. T. 104 N., R. 72 W., 8 miles west of town of Chamberlain. (Dupuy and others, 1946, p. 4, 9, 11-14, 17, 20, 21, 24, figs. 1-3, 6, 7.) Analyses of bentonitic shale, manganese-bearing nodules, parts of nodules. Nodules at surface, black, hard; immediately beneath surface, brown to yellow; unweathered, gray to white, soft. Nodules in layers 1-4 inches thick; average diameter of nodules ½ - 3 inches. Shale matrix varies in color from light green to gray green and dark green, approaching blue-black; very compact, fine-grained. Mineralogy. Thickness of manganiferous beds, 26-64 ft; average thickness, 40 ft. Estimated tonnage. Index map, outcrop map; generalized columnar section. Chart showing distribution of nodules, chart comparing distribution and grade of nodules; summary of trench sampling; beneficiation methods discussed; thin section description.

10. (Dupuy and others, 1946, p. 13.) Bentonitic shale, very compact, typical sample. No nodules. Mineralogy. (For an analysis of this shale containing nodules see sample 19, group B of this compilation.)

11. (Dupuy and others, 1946, p. 11.) Nodules, gray or greenish-gray to light-tan, comparatively homogeneous; from poorer portion of deposit; air-dried; hardness, 5-5.5; bulk density, 3.3; fusibility, about 4.

South Dakota--Continued

12. (Dupuy and others, 1946, p. 11.) Typical analysis of clean nodules.

13. (Dupuy and others, 1946, p. 12.) Acid insoluble residue of powdered nodular material, probably clay of the montmorillonite-beidellite series of minerals.

14. (Dupuy and others, 1946, p. 12.) Black shell of nodule.

15. (Dupuy and others, 1946, p. 12.) Intermediate or brown material of nodule.

16. (Dupuy and others, 1946, p. 12.) Tan core of nodule.

17-22. (Dupuy and others, 1946, p. 14.) Nodules, hand-picked, scrubbed, screened.

17. Plus 2-inch nodules, hardness 5, bulk density 3.1.
18. Plus 2-inch nodules, light-brown, hardness 3, bulk density 2.8.
19. Composite, plus 2-inch nodules.
20. Minus 2-inch plus 3/4-inch nodules, light-brown, hardness 3, bulk density 2.8.
21. Minus 3/4-inch nodules, light-brown, hardness 3, bulk density 2.8.
22. Composite of nodules.

23. (Dupuy and others, 1946, p. 14.) Sample of shale reject associated with samples 17-22 above.

24. Lyman County. Pierre shale. Near Chamberlain. (DeVaney and others, 1942, p. 4, 3.) Manganese nodules in shale, bed 35-40 ft thick. Nodules average 16 percent manganese; constitute 5-6 percent of total weight. Estimated tonnage. Beneficiation tests. Screen and partial chemical analyses of samples from 5 ft sections also given.

25. Lyman County. Pierre shale, Sully member, Verendrye zone. Sec. 36, T. 104 N., R. 74 W. Analyst, Barrett. Lab. No. S68a. (Pesonen and others, 1949, p. 65, 41, 42, 87, figs. 1, 2, 11, 15.) Hard shale envelope on concretion from DH-191; depth 39 ft. Estimated tonnage; overburden. Index and outcrop maps, generalized stratigraphic table. (For another analysis from DH-191 see sample 30, group B of this compilation.)

Wyoming

26. Yellowstone National Park. Recent. Firehole Pool. (Allen and Day, 1935, p. 348, 232.) Precipitate of manganese dioxide, black; loose or clinging to silica or travertine in pools. Sample washed and dried; X-ray data; index map.

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TABLE 27.—Analyses of coal and coal ash, oil shale and oil shale ash, barites, nodules, and granodiorite and its weathered products, from Colorado, Nebraska, North Dakota, and Wyoming; miscellaneous group (Group M) special rock category

[These analyses are included here because they do not meet the criteria for inclusion in the common or mixed rock categories. Samples 1-6, proximate analyses of clean lump coal from which ash was probably obtained; 7-10, 17-21, proximate analyses of coal with moisture as received; 11-16, proximate analyses of lignite with moisture as received; 22-26, proximate analyses of oil-shale; 27-30, baritic sinter; 31, barite nodule; 32, nodules; 33-43, granodiorite and its weathered products. Analyses of the ash is indicated by an "a" following sample number. Chemical analyses arranged by rock type, State, county, and stratigraphic position]

	Colorado										North Dakota		
	1	2	3	4	5	6	7	8	9	10	11	12	13
	5M36-10	5M36-11	5M36-12	5M36-13	5M36-14	5M36-15	5M41-1	5M54-3	5M54-4	5M54-5	33M4-4	33M8-2	33M12-1
Fixed carbon	51.45	54.18	57.07	57.39	57.80	59.19	45.0	42.9	48.5	46.5	25.73	28.06	30.83
Combined carbon...	22.74	22.18	17.56	16.19	16.74	17.55	......	......	......	......	......	......	......
Disposable hydrogen	3.98	4.37	3.67	3.65	4.05	4.21	......	......	......	......	......	......	......
Hydrogen with oxygen	1.08	1.00	.99	1.18	.89	.77	......	......	......	......	......	......	......
Oxygen	8.64	8.01	7.89	9.41	7.11	6.21	......	......	......	......	......	......	......
Nitrogen	.84	1.16	.47	.31	.92	1.06	......	......	......	......	......	......	......
Sulfur	.64	.64	.55	.63	.59	.61	[1] (.6)	[1] (.5)	[1] (2.2)	[1] (.5)	[1] (14.03)	[1] (.52)	[1] (.56)
Moisture	1.68	2.36	.75	.44	.40	1.63	20.1	11.6	9.1	8.4	29.57	38.99	35.19
Volatile matter	[1,2] (37.92)	[1,2] (37.36)	[1,3] (31.13)	[1,3] (31.37)	[1,3] (30.30)	[1,2] (30.41)	30.4	31.8	36.5	38.3	24.02	25.56	25.81
Ash	8.95	6.10	11.05	10.80	11.50	8.77	4.5	13.7	5.9	6.8	20.68	7.39	8.17
Total.........	100.00	100.00	100.00	100.00	100.00	100.00	100.0	100.0	100.0	100.0	100.00	100.00	100.00

	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12a	13a
SiO_2..............	65.65	58.40	68.42	65.02	60.18	68.60	18.8	51.8	34.5	48.9	4.76	7.70	36.20
Al_2O_3.............	21.63	27.80	17.33	24.73	25.14	19.94	[4] 12.1	[5] 26.5	[4] 20.1	[5] 38.4	9.56	11.71	17.90
Fe_2O_3.............	5.30	7.32	11.50	7.56	9.12	[6] 6.42	10.6	8.7	30.9	3.4	66.10	5.41	8.60
MgO..............	......	Tr.	.21	.30	Tr.	Tr.	6.6	1.7	1.1	.8	1.87	19.04	5.45
CaO..............	3.06	3.52	.66	.16	1.72	1.30	23.4	5.2	5.3	3.4	7.76	47.21	16.34
Na_2O	2.59	.80	1.49	2.22	2.12	1.46	......	......	......	......	} [7] 8.06	[7] 4.30	[7] 15.28
K_2O	.88	.62	.71	.52	.78	1.32	......	......	......	......			
TiO_2	......	......	......	......	......	......	.5	......	.7	......	......	......	......
P_2O_5.............	[8] .32	[8] .120	[8] .080	[8] .095	[8] .659	......	......	......	......	......	......	......	......
SO_3	[9] 1.04	[9] 1.76	[9] .37	[9] .32	[9] .76	[9] .34	26.5	4.9	4.8	2.4	......	......	......
Total.........	100.47	100.34	100.77	100.92	100.48	99.38	98.5	98.8	97.4	97.3	98.11	95.37	99.77

	North Dakota			Wyoming					Colorado			Wyoming	
	14	15	16	17	18	19	20	21	22	23	24	25	26
	33M31-1	33M45-174	33M51-4	49M3-1	49M19-11	49M19-12	49M19-13	49M19-14	5M39-5	5M39-6	5M39-7	49M19-15	49M19-16
Fixed carbon	28.57	26.24	29.06	32.2	45.5	46.2	46.4	48.9	[10] 40.00	......	......	[10] 34.95	[10] 48.05
Nitrogen[1]	......	......	......	......	......	......	......	......	......	......	......	(.35)	(.83)
Sulfur[1]	(.28)	(1.01)	(.12)	(.7)	(1.0)	(.8)	(.7)	(.9)	......	......	......	......	......
Moisture	42.13	42.91	42.05	26.5	14.3	11.0	10.5	11.8	[11] .60	[11] 0.59	0.4	.25	.15
Volatile matter	24.74	24.12	25.99	33.7	38.0	38.0	37.8	35.2	......	[12] 39.70	37.6	......	......
Ash	4.56	6.73	2.90	7.6	2.2	4.8	5.3	4.1	59.40	59.71	62.0	64.8	51.8
Total.........	100.00	100.00	100.00	100.0	100.0	100.0	100.0	100.0	100.00	100.00	[13] 100.0	100.0	100.0

	14a	15a	16a	17a	18a	19a	20a	21a	22a	23a	24a	25a	26a
SiO_2	7.60	24.80	0.00	31.6	42.7	17.5	63.8	43.2	44.70	45.10	49.8	38.9	41.9
Al_2O_3	4.75	15.91	15.38	[5] 19.8	[5] 21.0	[5] 13.3	[5] 22.9	[5] 33.0	} 25.60	26.35	{ 10.2	} 12.4	18.8
Fe_2O_3	8.48	9.43	7.94	5.7	26.5	8.3	5.3	17.9			{ 4.5		
MgO..............	1.70	6.66	14.25	4.5	1.7	3.1	1.3	1.3	5.28	5.35	7.5	4.9	10.9
CaO..............	29.00	15.04	52.00	17.9	4.0	44.2	2.3	2.5	17.65	18.35	20.7	38.3	17.6
Na_2O	} [7] 43.95	[7] 26.52	[7] 10.15	......	......	......	......	......	......	......	{ 2.5	......	......
K_2O				......	......	......	......	......	......	......	{ 1.8	......	......
P_2O_5	......	......	......	......	......	......	......	......	......	......	.8	......	......
SO_3	......	......	......	19.2	2.5	12.7	1.0	1.7	......	......	......	......	......
Total.........	95.48	98.36	99.72	98.7	98.4	99.1	96.6	99.6	93.23	95.15	97.8	94.5	89.2

[1] Not included in total.
[2] Reported as volatile combustible.
[3] Reported as volatile hydrocarbons.
[4] Includes P_2O_5.
[5] Includes TiO_2 and P_2O_5.
[6] Includes phosphoric acid.
[7] Computed as chlorides.
[8] Reported as phosphoric acid.
[9] Reported as sulfuric acid.
[10] Reported as volatiles and fixed carbon.
[11] At 110° C.
[12] Reported as ignition loss.
[13] In raw shale, N, 0.78 percent; S, 1.20 percent.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Coal and coal ash

1-6. Colorado, Las Animas County. Upper Cretaceous, Laramie formation. Coal and coal ash. Geologic maps, generalized columnar sections.

1. Berwind Aguilar group. T. 29 S., R. 65 W., Santa Clara mine. (Hills, 1901, p. 7.) Bulk density, 1.316.

2. Berwind Aguilar group. T. 30 S., R. 65 W., Aguilar Peerless mine. (Hills, 1901, p. 7.) Bulk density, 1.309. Detailed columnar section.

3. Engle group. T. 33 S., R. 63 W., Engle mine. Analyst, Hills. (Hills, 1899, p. 5, 3.) Clean lump coal, from bed 6-7 ft thick. Bulk density, 1.287.

4. Engle group. T. 33 S., Rs. 63, 64 W., Starkville mine. Analyst, Hills. (Hills, 1899, p. 5, 3.) Clean lump coal. Bulk density, 1.303.

5. Sopris group. T. 33 S., R. 64 W., Sopris mine. (Hills, 1901, p. 7.) Coal analysis of average sample and ash analysis of combined sample from 100 cars of coke. Bulk density, 1.318. Detailed columnar section.

6. Morley seam. T. 34 S., R. 64 W., near town of Morley. Analyst, Hills. (Hills, 1899, p. 5, 3; Hills, 1901, p. 7.) Clean lump coal, from bed 6 ft thick. Bulk density, 1.358.

7. Colorado, Moffat County. (Upper Cretaceous, Laramie formation) Kimberly coal bed. (Sec. 29, T. 7 N., R. 90 W.), Hindman mine. Lab. No. 37641. (Selvig and Gibson, 1956, p. 11, 24, 10.) Subbituminous coal and coal ash; mine sample. Fusibility of ash.

8-10. Colorado, Routt County. (Upper Cretaceous, Mesa Verde formation.) (Selvig and Gibson, 1956, p. 11, 24, 10.) Bituminous coal and coal ash; mine samples.

8. Wolf Creek coal bed. (Sec. 9, T. 6 N., R. 86 W.), McGregor strip mine. Lab. No. 46498.

9. Lenox coal bed. (Sec. 10, T. 6 N., R. 87 W.), Lenox strip mine. Lab. No. 46401.

10. Wadge coal bed. (Sec. 10, T. 6 N., R. 87 W.), Wadge mine. Lab. No. 46497.

11-16. North Dakota. Eocene, Fort Union formation (Tongue River member). Lignite and ash. Analysis of gas given; char and gas tests. Index maps.

11. Billings County. Medora coal bed. NE¼ and N½SE¼ sec. 26, T. 140 N., R. 102 W., High Grade mine. Lab. No. 5516. (Leonard and others, 1925, p. 180, 38, pls. 1, 21.) Lignite and ash, about 8 ft thick. Measured section.

12. Burleigh County. Wilton coal bed. SW¼ sec. 8, T. 142 N., R. 79 W., Eckland mine. Lab. No. 5532. (Leonard and others, 1925, p. 196, 116, 117, pls. 1, 21.) Lignite and ash, 8-14 ft thick.

13. Divide County. Noonan coal bed. SE¼ sec. 3, T. 162 N., R. 95 W., Lorbeski mine. Lab. No. 5520. (Leonard and others, 1925, p. 184, 78, pls. 1, 21.) Lignite and ash, 7 ft thick.

Coal and coal ash--Continued

14. Mountrail County. Williston coal bed. Sec. 19, T. 154 N., R. 94 W., White Earth River district. Lab. No. 5554. (Leonard and others, 1925, p. 218, 163, pls. 1, 16, 21.) Lignite and ash, about 10 ft thick.

15. Stark County. Heart River coal bed. Sec. 28, T. 140 N., R. 99 W., Lerfald mine. Lab. No. 5538. (Leonard and others, 1925, p. 202, 143, pl. 1.) Lignite and ash, overlain by 6-12 ft of shale. Measured section.

16. Ward County. Coteau coal bed. NW¼ sec. 30, T. 152 N., R. 81 W., Tree-Bausch mine. Lab. No. 5549. (Leonard and others, 1925, p. 213, 151, pls. 1, 21.) Lignite and ash, at least 10 ft thick, lower part not exposed.

17. Wyoming, Campbell County. (Eocene, Fort Union formation), Roland-Smith coal bed. (T. 50 N., R. 72 W.), Wyodak mine near town of Gillette. Lab. No. 46398. (Selvig and Gibson, 1956, p. 23, 29, 22.) Subbituminous coal and coal ash; mine sample.

18-20. Wyoming, Sweetwater County. (Upper Cretaceous, Mesa Verde formation. Sec. 19, T. 21 N., R. 102 W.), D. O. Clark mine. (Selvig and Gibson, 1956, p. 23, 29, 22.) Bituminous coal and coal ash; mine samples.

18. Lab. No. 46206. Bed 7½.

19. Lab. No. 46207. Bed 7.

20. Lab. No. 48316.

21. Wyoming, Sweetwater County. (Upper Cretaceous, Mesa Verde formation. Sec. 19, T. 21 N., R. 102 W.), "D" mine. Lab. No. 46568. Bed 1. (Selvig and Gibson, 1956, p. 23, 29, 22.) Bituminous coal and coal ash; mine sample.

Oil shale and oil shale ash

22-24. Colorado, Mesa County. Eocene, Green River formation. (T. 8 S., R. 97 W.) Parachute Creek, near town of DeBeque. (For other analyses of oil shale see sample 20 group D and sample 6 group E of this compilation.)

22. (Gavin and Sharp, 1920, p. 2-7; Gavin, 1922, p. 156.) Oil shale. Data on tests of oil shales; oil yield, 42.7 gallons per ton.

23. Information as in sample 22.

24. (Probably from near DeBeque.) (Guthrie, 1938, p.109, 108, 123.) Oil shale; oil yield, 36 gallons per ton. Mineralogy. Ultimate analysis of kerogen also given.

25-26. Wyoming, Sweetwater County. Green River formation. (T. 18 N., R.107 W.) near town of Green River. Analyst, Brighton. (Gavin, 1922, p. 30, 29, 18, 28, 31-34, 37.) Oil shale, organic matter occurs in irregular dark streaks; contains yellow particles. Solubilities of oil shale in petroleum solvents; yield and nature of oil.

25. Lab. No. P1014.

26. Lab. No. P1015.

TABLE 27.—Analyses of coal and coal ash, oil shale and oil shale ash, barites, nodules, and granodiorite and its weathered products, from Colorado, Nebraska, North Dakota, and Wyoming; miscellaneous group (Group M) special rock category--Continued

	Colorado				Nebraska
	27	28	29	30	31
	5M15-2	5M15-3	5M15-4	5M15-5	26M27-1
SiO_2	......	......	......	3.25	4.00
Al_2O_3	......	......	......	} .80	......
Fe_2O_3	......	......	......		
MgO	......	Tr.	......	Tr.	......
CaO	[1]24.31	[1]1.03	[1]14.82	.30	.50
Na_2O	Tr.	Tr.	......	[2].29	......
K_2O	Tr.	Tr.	......	.17	......

	27	28	29	30	31
CO_2	[1]19.08	[1]0.81	[1]11.64	......	......
SO_3	[1]16.73	[1]32.45	[1]22.97	32.25	33.25
BaO	[1]32.06	[1]62.17	[1]44.01	63.00	62.17
SrO	Tr.	......	......	.45	......
Li	Tr.	Tr.	......	Tr.	......
Organic matter	[3]7.82	[4]3.11	[4]3.43	......	......
Total	100.00	99.57	96.87	100.51	99.92

	Colorado											
	32	33	34	35	36	37	38	39	40	41	42	43
	5M12-2	5M7-25	5M7-26	5M7-27	5M7-28	5M7-29	5M7-30	5M7-31	5M7-32	5M7-33	5M7-34	5M7-35
SiO_2	39.8	67.92	55.46	57.69	58.66	58.54	61.49	65.46	68.15	67.26	65.12	69.33
Al_2O_3	6.06	14.70	21.37	18.44	18.02	19.08	14.35	13.22	14.26	16.03	16.34	14.52
Fe_2O_3	3.9	.91	8.65	6.85	6.55	6.46	4.65	2.79	2.24	2.48	2.64	2.33
FeO	......	2.61	.37	1.04	.82	.44	.78	.74	1.03	1.00	1.77	.95
MgO	1.23	.98	.56	2.71	1.69	2.01	2.18	1.31	1.19	.74	1.30	.27
CaO	26.1	2.94	.38	.76	.58	.83	1.75	2.04	1.17	1.61	2.32	1.61
Na_2O	......	3.31	.49	.54	.57	.61	.42	.53	1.95	3.38	3.03	2.94
K_2O	......	4.38	6.48	5.94	7.10	6.71	6.90	5.59	4.76	4.08	4.73	4.35
H_2O+	......	.80	3.58	4.03	3.32	3.25	5.81	5.64	3.54	2.05	1.91	1.85
H_2O-	......	.36	.97	.93	1.33	1.14	.43	.48	.48	.34	.55	.94
TiO_2	......	.55	1.53	1.34	1.21	1.12	.78	.44	.55	.54	.64	.48
P_2O_5	.17	.18	.20	.32	.29	.38	.24	.13	.12	.16	.22	.16
MnO	......	.03	.03	.03	.03	.02	.05	.05	.04	.04	.06	.02
CO_2	20.65	None	None	None	None	None	.90	2.26	.10	Tr.	Tr.	None
Total	[5]98.4	99.67	100.07	100.62	100.17	100.59	100.73	100.68	99.58	99.71	100.63	99.75

[1] Calculated from reported $CaCO_3$ or $BaSO_4$.
[2] Na_2O includes heavy trace of lithia.
[3] Reported as organic matter, etc.
[4] Includes some sulfur.
[5] Includes 0.45 percent organic matter.

DESCRIPTIVE NOTES

[First page number in reference indicates source of analysis]

Barite

27-30. Colorado, Delta County. (Recent. T. 14 S., R. 93 W.), Doughty Springs, about 4.5 miles from town of Hotchkiss. Baritic sinter.

27. Baritic sinter, from cone of Bird's Nest Spring. (Headden, 1905, p. 308.)

28. Baritic sinter, near rim of Drinking Spring. (Headden, 1905, p. 307.)

29. Baritic sinter, 8-10 ft from Drinking Spring. (Headden, 1905, p. 307.)

30. Baritic sinter, analysis of insoluble portion of sample from Bath Tub Spring. (Headden, 1905, p. 308.) Percentages of soluble and insoluble material from Bath Tub Spring:

Soluble in acetic acid	15.46
Soluble in HCl concentrate, not soluble in acetic acid	1.33
Insoluble, $BaSO_4$	83.21

31. Nebraska, Dodge County. (Recent. T.17 N., R.8 E.) near town of Fremont. (Knerr, 1898, p.80.) Barite nodule, crystalline, in wood at depth of 40 ft.

Nodules

32. Colorado, Costilla County. Pennsylvanian, Sangre de Cristo formation. (T. 30 S., R. 70 W.), La Veta Pass, along highway, 2.2 miles west of summit. Analyst, Schroder. Lab. No. 8. (Johnson, 1940, p. 593, 573, 578, 579, 591.) Nodules; mass of twisted algal tubes which envelop brachiopods and other organic fragments. Description of nodules, index map, detailed measured section.

Granodiorite and its weathered products

33-43. Colorado, Boulder County. Precambrian, Boulder Creek granite gneiss and weathered products. (T. 1 N., R. 71 W.), Flagstaff Mountain, near town of Boulder. Analyst, Wahlstrom. Geologic cross section.

33. Lab. No. 11. (Wahlstrom, 1948, p.1184, 1174-1183.) Granodiorite, medium-gray. Analysis of micaceous minerals also given.

34-38. (Wahlstrom, 1948, p. 1178, 1174-1184.) Granodiorite, altered by pre-Fountain weathering. From red-stained rock just below Fountain arkose. Analyses recalculated on dry basis and without minor oxides also given.

34. Lab. No. 1. Photomicrograph of mica. Analysis of micaceous minerals also given.
35. Lab. No. 2.
36. Lab. No. 3.
37. Lab. No. 4. Photomicrograph of mica. Analysis of micaceous minerals also given.
38. Lab. No. 5.

39-40. (Wahlstrom, 1948, p. 1178, 1174-1184.) Granodiorite, altered by pre-Fountain weathering. From bleached rock below red-stained rock. General remarks: Light-gray or pinkish-gray, almost white; slightly mottled rock. Analyses recalculated on dry basis and without minor oxides also given.

39. Lab. No. 6. Photomicrograph of mica. Analysis of micaceous minerals also given.
40. Lab. No. 7.

41-43. (Wahlstrom, 1948, p. 1184, 1174-1183.) Granodiorite, recently weathered. From brown-stained rock below bleached rock. General remarks: Loosely coherent, crumbly.

41. Lab. No. 8.
42. Lab. No. 9.
43. Lab. No. 10.

CALCULATIONS FOR CLASSIFYING ANALYSES

The analyses are classified into groups—on the basis of calculations that have determined relative abundance of the three main components of most sedimentary rocks—as uncombined silica, "clay," and carbonate minerals. (See p. 4.) The assumed clay composition is highly conventionalized, and the composition of the calculated carbonate mineral is also arbitrary.

The constituents used in the calculations are SiO_2, Al_2O_3, Fe_2O_3, H_2O, CaO, MgO, and CO_2. These constituents appear in the analyses in many forms; for example, SiO_2 reported as insoluble; Al_2O_3 and Fe_2O_3 reported as R_2O_3; and H_2O and CO_2 necessarily inferred from reported ignition loss. The calculations are analogous to those for calculating norms, and a worksheet has been utilized for desk calculations. (See worksheet of table 28.) Because of the variability in form of the analyses, simple gravimetric factors based on the formulas of the mineral components are used rather than modal numbers.

Corrections for phosphate and sulfate minerals need to be made before calculations can be made for uncombined silica, clay, and carbonate minerals.

1. If P_2O_5 equals or exceeds 0.42 percent (0.42 P_2O_5 equals 1.0 percent fluorapatite) multiply P_2O_5 by 1.317, and subtract product from determined CaO.
2. If SO_3 equals or exceeds 1.0 percent, a significant amount of gypsum may be present. Multiply SO_3 by 0.700, and subtract product from determined CaO.
3. If SO_3 is greater than 2.5 percent, multiply SO_3 by 0.450, and subtract the product from amount of water, either determined or estimated from the difference between 100 and the sum of the analysis, but not from the amount of water estimated from $\frac{1}{4}(Al_2O_3+Fe_2O_3)$.

The following schedule of calculations is keyed to the worksheets accompanying table 28. Analyses used to illustrate the calculations are shown in table 28. (If any step in the calculations results in a negative number, this negative number is treated as zero.)

1. Prepare worksheet by recording code number on sheet and entering the appropriate constituents in column A, as indicated.

SiO_2 (uncombined silica)

2. Multiply Al_2O_3 by 1.768 and enter product on line 3, column B.
3. Multiply Fe_2O_3 by 1.128 and enter product on line 5, column B.
4. If $Al_2O_3+Fe_2O_3$ is given, multiply by 1.673 and enter product on both line 6, column B, and line 7, column C. (Omit step 5.)
5. Add products from lines 3 and 5 and enter on line 7, column C.
6. Subtract $SiO_{2\ (clay)}$, line 7, from total SiO_2, line 1; enter on line 8, column E. (If $SiO_{2\ (clay)}$ is greater than SiO_2, enter a zero on line 8, column E, and proceed through steps 7–10.)

Excess Al_2O_3 and Fe_2O_3

7. Divide total SiO_2 by $SiO_{2\ (clay)}$ and enter ratio on line 9, column A.
8. Multiply Al_2O_3, line 2, by ratio, line 9, and enter product on line 10, column A.
9. Multiply Fe_2O_3, line 4, by ratio, line 9, and enter product on line 11, column A. If $Al_2O_3+Fe_2O_3$ given, multiply by ratio, line 9, and enter product on line 12, column A.
10. Subtract $Al_2O_{3\ (clay)}$ from Al_2O_3 and enter as excess Al_2O_3, line 13, column D. Subtract $Fe_2O_{3\ (clay)}$ from Fe_2O_3 and enter as excess Fe_2O_3, line 14, column D. Or, subtract $(Al_2O_3+Fe_2O_3)_{(clay)}$ from $Al_2O_3+Fe_2O_3$ and enter as excess $Al_2O_3+Fe_2O_3$, line 15, column D.

$R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ (clay)

11. Alternatives:
    a. Enter H_2O+ on line 16, column A, and H_2O- (or moisture) on line 17, column A. (If total H_2O is given, use this amount and bracket H_2O+ and H_2O-.)
    b. If (H_2O+ and H_2O-) or (total H_2O) are not given (or if only H_2O- was determined), add $Al_2O_{3\ (clay)}$ and $Fe_2O_{3\ (clay)}$, lines 2 and 4; or if calculation shows no uncombined SiO_2 in sample, add lines 10 and 11; and enter $\frac{1}{4}(Al_2O_3+Fe_2O_3)_{(clay)}$ as a tentative $H_2O_{(estimated)}$ on line 18, column A. For such analyses, postpone step 12 and proceed through steps 13–18 before returning for revised estimate of H_2O after other items are tabulated.
12. Alternatives:
    a. If uncombined SiO_2 is present in sample, add: Al_2O_3, line 2; Fe_2O_3, line 4; $SiO_{2\ (clay)}$, line 7; and H_2O, regardless of how determined; and enter as $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$, on line 20, column E.
    b. If no uncombined SiO_2 is present in samples, add total SiO_2, line 1; $Al_2O_{3\ (clay)}$, line 10; $Fe_2O_{3\ (clay)}$, line 11; or $(Al_2O_3+Fe_2O_3)_{(clay)}$, line 12; and H_2O, regardless of how determined; and enter as $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$, on line 20, column E.
    c. If organic matter is determined separately, enter amount with notation, "plus organic

TABLE 28.—*Chemical analyses and description of dolomite, limestone, chalk, and bentonite*

Chemical constituent	1	2	3	4
	$25F_22$–1	$25F_222$–3	$40F_118$–9	49D1–8
SiO_2	0.43	1.45	6.38	60.18
Al_2O_3	.42	.16	3.56	26.58 (})
Fe_2O_3		.76	1.40	
FeO	.04			
MgO	19.93	[a] 2.72	.31	1.01
CaO	31.72	[a] 49.44	46.93	.23
Na_2O				1.23
H_2O+	[b] .34			10.26 (})
H_2O-	.02			
TiO_2	.01			
P_2O_5	Tr.			
MnO	Tr.			
CO_2	46.91			
SO_3	.03		.46	
Cl	.06			
SrO	.09			
S in FeS_2			.48	
Ign. loss			40.03	
Total	100.00	54.33	99.55	99.49
Class	0, 1, 99	0, 2, 94	0, 13, 84	16, 81, 1

[a] Calculated from $MgCO_3$ or $CaCO_3$.
[b] Includes organic matter.

DESCRIPTIVE NOTES

1. Montana, Big Horn County. Mississippian, Madison limestone. Sec. 18 or 19, T. 6 S., R. 31 E. Analyst, Erickson. (Thom and others, 1935, p. 34.) Dolomite.
2. Montana, Jefferson County. Middle Cambrian, Meagher limestone. Sec. 7, T. 9 N., R. 2 W. Analyst, Starz. (Burchard, 1912, p. 675.) Limestone. Use: Smelter flux.
3. South Dakota, Davison County. Upper Cretaceous, Niobrara formation. NW¼ sec. 34, T. 104 N., R. 61 W. (Rothrock, 1931, p. 29.) Chalk.
4. Wyoming, Albany County. Upper Cretaceous, Benton shale, corresponds to Graneros shale, but above Mowry shale. N½ sec. 10, T. 22 N., R. 76 W. Analyst, Read. (Siebenthal, 1906, p. 446.) Bentonite. Use: Drilling mud, binder, filler.

WORKSHEETS

Code number	25F₂2-1 A	B	C	D	E	F
1. SiO_2	0.43					
2. Al_2O_3	.42					
3. 1.768 Al_2O_3		0.74				
4. Fe_2O_3						
5. 1.128 Fe_2O_3						
6. 1.673 (Al_2O_3+Fe_2O_3)						
7. SiO_2 (clay)			0.74			
8. SiO_2 (uncombined silica)					0	0
9. SiO_2/SiO_2 (clay)	.5811					
10. Al_2O_3 (clay)		.24				
11. Fe_2O_3 (clay)						
12. (Al_2O_3+Fe_2O_3) (clay)						
13. Excess Al_2O_3				0.18		
14. Excess Fe_2O_3						
15. Excess (Al_2O_3+Fe_2O_3)						
16. H_2O+	*.34					
17. H_2O−	.02					
18. H_2O (estimated) from ¼ (Al_2O_3+Fe_2O_3) (clay)						
19. H_2O (estimated) from difference						
20. $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ (clay)					1.03	1.03
21. CaO	31.72					
22. $(CO_2)_{Ca}$= 0.785 CaO		24.90				
23. $CaCO_3$ (calculated)			56.62			
24. MgO	19.93					
25. $(CO_2)_{Mg}$=1.092 MgO		21.76				
26. $MgCO_3$ (calculated)			41.69			
27. $(CO_2)_{Ca+Mg}$ (calculated)		46.66				
28. CO_2 (actual) from direct determination	46.91					
29. CO_2 (estimated) from ignition loss						
30. CO_2 (estimated) from 100−Σ						
31. CO_2 (actual or estimated)/CO_2 (calculated)		1.00+				
32. ($CaCO_3$+$MgCO_3$) (calculated)			98.31			
33. Total ($CaCO_3$+$MgCO_3$) (corrected) (carbonate)					98.56	98.97
34. Total					99.59	100.00
35. CaO/MgO	1.592					

Code number	25F₂22-3 A	B	C	D	E	F
1. SiO_2	1.45					
2. Al_2O_3	.16					
3. 1.768 Al_2O_3		0.28				
4. Fe_2O_3	.76					
5. 1.128 Fe_2O_3		.86				
6. 1.673 (Al_2O_3+Fe_2O_3)						
7. SiO_2 (clay)			1.14			
8. SiO_2 (uncombined silica)					0.31	0.32
9. SiO_2/SiO_2 (clay)						
10. Al_2O_3 (clay)						
11. Fe_2O_3 (clay)						
12. (Al_2O_3+Fe_2O_3) (clay)						
13. Excess Al_2O_3						
14. Excess Fe_2O_3						
15. Excess (Al_2O_3+Fe_2O_3)						
16. H_2O+						
17. H_2O−						
18. H_2O (estimated) from ¼ (Al_2O_3+Fe_2O_3) (clay)	.23					
19. H_2O (estimated) from difference						
20. $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ (clay)					2.29	2.37
21. CaO	49.44					
22. $(CO_2)_{Ca}$= 0.785 CaO		38.81				
23. $CaCO_3$ (calculated)			88.25			
24. MgO	2.72					
25. $(CO_2)_{Mg}$=1.092 MgO		2.97				
26. $MgCO_3$ (calculated)			5.69			
27. $(CO_2)_{Ca+Mg}$ (calculated)		41.78				
28. CO_2 (actual) from direct determination						
29. CO_2 (estimated) from ignition loss						
30. CO_2 (estimated) from 100−Σ	45.47−	.23=	45.24			
31. CO_2 (actual or estimated)/CO_2 (calculated)		1.00+				
32. ($CaCO_3$+$MgCO_3$) (calculated)			93.94			
33. Total ($CaCO_3$+$MgCO_3$) (corrected) (carbonate)					93.94	97.31
34. Total					96.54	100.00
35. CaO/MgO	18.18					

Code number	40F₁18-9 A	B	C	D	E	F
1. SiO_2	6.38					
2. Al_2O_3	3.56					
3. 1.768 Al_2O_3		6.29				
4. Fe_2O_3	1.40					
5. 1.128 Fe_2O_3		1.58				
6. 1.673 (Al_2O_3+Fe_2O_3)						
7. SiO_2 (clay)			7.87			
8. SiO_2 (uncombined silica)					0	0
9. SiO_2/SiO_2 (clay)	.8107					
10. Al_2O_3 (clay)		2.89				
11. Fe_2O_3 (clay)		1.13				
12. (Al_2O_3+Fe_2O_3) (clay)						
13. Excess Al_2O_3				0.67		
14. Excess Fe_2O_3				.27		
15. Excess (Al_2O_3+Fe_2O_3)						
16. H_2O+						
17. H_2O−						
18. H_2O (estimated) from ¼ (Al_2O_3+Fe_2O_3) (clay)	1.00					
19. H_2O (estimated) from difference		2.85				
20. $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ (clay)					13.25	13.57
21. CaO	46.93					
22. $(CO_2)_{Ca}$= 0.785 CaO		36.84				
23. $CaCO_3$ (calculated)			83.77			
24. MgO	.31					
25. $(CO_2)_{Mg}$=1.092 MgO		.34				
26. $MgCO_3$ (calculated)			.65			
27. $(CO_2)_{Ca+Mg}$ (calculated)		37.18				
28. CO_2 (actual) from direct determination						
29. CO_2 (estimated) from ignition loss	40.03	38.42	37.18			
30. CO_2 (estimated) from 100−Σ						
31. CO_2 (actual or estimated)/CO_2 (calculated)		1.00				
32. ($CaCO_3$+$MgCO_3$) (calculated)			84.42			
33. Total ($CaCO_3$+$MgCO_3$) (corrected) (carbonate)					84.42	86.43
34. Total					97.67	100.00
35. CaO/MgO	151.39					

Code number	49D1-8 A	B	C	D	E	F
1. SiO_2	60.18					
2. Al_2O_3	†26.58					
3. 1.768 Al_2O_3						
4. Fe_2O_3						
5. 1.128 Fe_2O_3						
6. 1.673 (Al_2O_3+Fe_2O_3)		44.47				
7. SiO_2 (clay)			44.47			
8. SiO_2 (uncombined silica)					15.71	16.04
9. SiO_2/SiO_2 (clay)						
10. Al_2O_3 (clay)						
11. Fe_2O_3 (clay)						
12. (Al_2O_3+Fe_2O_3) (clay)						
13. Excess Al_2O_3						
14. Excess Fe_2O_3						
15. Excess (Al_2O_3+Fe_2O_3)						
16. H_2O+	}10.26					
17. H_2O−						
18. H_2O (estimated) from ¼ (Al_2O_3+Fe_2O_3) (clay)						
19. H_2O (estimated) from difference						
20. $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ (clay)					81.31	82.94
21. CaO	.23					
22. $(CO_2)_{Ca}$= 0.785 CaO		.18				
23. $CaCO_3$ (calculated)			.41			
24. MgO	1.01					
25. $(CO_2)_{Mg}$=1.092 MgO		1.10				
26. $MgCO_3$ (calculated)			2.11			
27. $(CO_2)_{Ca+Mg}$ (calculated)			1.28			
28. CO_2 (actual) from direct determination						
29. CO_2 (estimated) from ignition loss						
30. CO_2 (estimated) from 100−Σ	.51					
31. CO_2 (actual or estimated)/CO_2 (calculated)		.3984				
32. ($CaCO_3$+$MgCO_3$) (calculated)			2.52			
33. Total ($CaCO_3$+$MgCO_3$) (corrected) (carbonate)					1.00	1.02
34. Total					98.02	100.00
35. CaO/MgO						

†Includes Fe_2O_3.
*Includes organic matter.

matter," on line 19, column D, and include in sum, $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$, on line 20, column E.[1]

$CaCO_3+MgCO_3$ (carbonate)

13. Multiply CaO by 0.785 and enter as $(CO_2)_{Ca}$, line 22, column B.
14. Add CaO and $(CO_2)_{Ca}$ and enter as $CaCO_{3\,(calculated)}$ on line 23, column C.
15. Multiply MgO by 1.092 and enter as $(CO_2)_{Mg}$ on line 25, column B.
16. Add MgO and $(CO_2)_{Mg}$ and enter as $MgCO_{3\,(calc)}$ on line 26, column C.
17. Add $(CO_2)_{Ca}$ and $(CO_2)_{Mg}$ and enter as $(CO_2)_{Ca+Mg(calc)}$ on line 27, column B. Add $CaCO_{3\,(calc)}$ from line 23 and $MgCO_{3\,(calc)}$ from line 26 and enter as $(CaCO_3+MgCO_3)_{(calc)}$ on line 32, column C.
18. Alternatives:
    a. If CO_2 was determined directly, enter on line 28, column A. If neither total H_2O nor H_2O+ was determined, compare $\frac{1}{4}(Al_2O_3+Fe_2O_3)$ with the difference between 100 and the sum of the analysis. Use whichever of the two is smaller for $H_2O_{(estimated)}$ on line 18, or 19, column B.
    b. If CO_2 was not determined but ignition loss was determined, enter ignition loss on line 29, column A, and then add $CO_{2\,(calc)}$, from line 27, and $\frac{1}{4}(Al_2O_3+Fe_2O_3)$, from line 18, and enter sum on line 29, column B.
        (1) Where ignition loss is less than this sum, $[CO_{2(calc)}+\frac{1}{4}(Al_2O_3+Fe_2O_3)]$, accept $\frac{1}{4}(Al_2O_3+Fe_2O_3)$ or ignition loss, whichever is smaller, as $H_2O_{(estimated)}$ on line 18, column B, and enter the difference, [ignition loss minus $\frac{1}{4}(Al_2O_3+Fe_2O_3)$] as $CO_{2\,(estimated)}$ on line 29, column C.
        (2) Where ignition loss exceeds $[CO_{2\,(calc)}+\frac{1}{4}(Al_2O_3+Fe_2O_3)]$, accept $CO_{2\,(calc)}$ as $CO_{2\,(estimated)}$ on line 29, column C, and enter the difference, [ignition loss minus $CO_{2\,(calc)}$] as $H_2O_{(estimated)}$ on line 18, column B. (If H_2O- was determined, use this same procedure to estimate H_2O+, and enter on line 16, column B.)
    c. If neither CO_2 nor ignition loss was determined, enter the difference between 100 and the sum of the analysis on line 30, column A, provided it is not a negative quantity. Then:
        (1) If H_2O+ and H_2O- or total H_2O was determined, accept the difference between 100 and the sum of the analysis as $CO_{2\,(estimated)}$.
        (2) If H_2O was not determined, compare $\frac{1}{4}(Al_2O_3+Fe_2O_3)$ with the difference between 100 and the sum of the analysis.
            (a) Use whichever of the two is smaller for $H_2O_{(estimated)}$ on line 18, column B, the difference between 100 and the sum of the analysis.
            (b) If the difference between 100 and the sum of the analysis exceeds $\frac{1}{4}(Al_2O_3+Fe_2O_3)$, use the difference between the two as $CO_{2\,(estimated)}$ on line 30, column B.
19. Calculate ratio, $CO_{2\,(actual)}/CO_{2\,(calc)}$, from lines 28 and 27, or ratio $CO_{2\,(estimated)}/CO_{2\,(calc)}$, from lines 29 or 30, and 27, and enter on line 31, column B. If $CO_{2\,(actual)}/CO_{2\,(calc)}$ equals or exceeds 1.00, add CaO, MgO, and CO_2, from direct determinations, and enter as total $(CaCO_3+MgCO_3)_{(corrected)}$ on line 33, column E.
20. If CO_2 is not determined directly, multiply $(CaCO_3+MgCO_3)_{(calc)}$ from line 32, column C, by fraction from line 31. Enter product as total $(CaCO_3+MgCO_3)_{(corrected)}$ on line 33, column E. If ratio exceeds one, accept $(CaCO_3+MgCO_3)_{(calc)}$ as total $(CaCO_3+MgCO_3)_{(corrected)}$.
21. Add uncombined SiO_2 from line 8, $R_2O_3 \cdot 3SiO_2 \cdot nH_2O$ from line 20, and total $(CaCO_3+MgCO_3)_{(corrected)}$ from line 33. Enter as total on line 34, column E.
22. Recalculate entries in column E to 100 percent and enter directly opposite in column F.
23. For analyses in which total $(CaCO_3+MgCO_3)_{(corrected)}$ exceeds 33 percent, compute ratio CaO/MgO and enter on line 35, column A.

[1] The chief justification for this step is the fact that few analyses of rocks containing more than 1 percent organic matter are included in this compilation and that most of the components of organic matter are included in H_2O or in loss on ignition where organic matter is not determined separately. Because the more clayey rocks generally contain more organic matter than dolomite or sandstone, the generally slight increase in relative abundance of clay compared to uncombined silica and carbonate minerals resulting from this procedure is of little importance. Theoretically, an oil-stained sandstone could be classified as a clayey rock, if the procedure were followed routinely.

CODES FOR PERMANENT NUMBERS ASSIGNED TO ANALYSES

Given in the following lists are the code numbers of the States and counties, respectively, represented by the sample data in this report.

STATE CODES

5. Colorado
15. Kansas
25. Montana
26. Nebraska
33. North Dakota
40. South Dakota
49. Wyoming

COUNTY CODES

Colorado

1. Adams
2. Alamosa
6. Bent
7. Boulder
8. Chaffee
12. Costilla
14. Custer
15. Delta
16. Denver
17. Dolores
18. Douglas
19. Eagle
21. El Paso
22. Fremont
23. Garfield
25. Grand
26. Gunnison
28. Huerfano
29. Jackson
30. Jefferson
33. Lake
34. La Plata
35. Larimer
36. Las Animas
38. Logan
39. Mesa
40. Mineral
41. Moffat
42. Montezuma
43. Montrose
44. Morgan
45. Otero
47. Park
49. Pitkin
50. Prowers
51. Pueblo
52. Rio Blanco
54. Routt
57. San Miguel
59. Summit
62. Weld
63. Yuma

Kansas

1. Allen
2. Anderson
3. Atchison
4. Barber
5. Barton
6. Bourbon
7. Brown
8. Butler
9. Chase
10. Chautauqua
11. Cherokee
12. Cheyenne
13. Clark
14. Clay
15. Cloud
16. Coffey
17. Comanche
18. Cowley
19. Crawford
21. Dickinson
22. Doniphan
23. Douglas
25. Elk
26. Ellis
27. Ellsworth
28. Finney
29. Ford
30. Franklin
31. Geary
32. Gove
33. Graham
34. Grant
37. Greenwood
38. Hamilton
39. Harper
42. Hodgeman
43. Jackson
44. Jefferson
45. Jewell
46. Johnson
48. Kingman
49. Kiowa
50. Labette
51. Lane
52. Leavenworth
53. Lincoln
54. Linn
55. Logan
56. Lyon
57. McPherson
58. Marion
59. Marshall
60. Meade
61. Miami

Kansas—Continued

62. Mitchell
63. Montgomery
64. Morris
66. Nemaha
67. Neosho
68. Ness
69. Norton
70. Osage
71. Osborne
72. Ottawa
74. Phillips
75. Pottawatomie
76. Pratt
77. Rawlins
78. Reno
79. Republic
80. Rice
81. Riley
82. Rooks
84. Russell
85. Saline
86. Scott
87. Sedgwick
88. Seward
89. Shawnee
90. Sheridan
92. Smith
96. Sumner
98. Trego
99. Wabaunsee
100. Wallace
101. Washington
103. Wilson
104. Woodson
105. Wyandotte

Montana

1. Beaverhead
2. Big Horn
4. Broadwater
5. Carbon
6. Carter
7. Cascade
12. Deer Lodge
14. Fergus
15. Flathead
16. Gallatin
18. Glacier
20. Granite
22. Jefferson
25. Lewis and Clark
29. Madison
30. Meagher
33. Musselshell
34. Park
39. Powell
41. Ravalli
47. Silver Bow
50. Teton

Nebraska

7. Box Butte
10. Buffalo
11. Burt
13. Cass
16. Cherry
18. Clay
23. Dawes
27. Dodge
28. Douglas
31. Franklin
33. Furnas
35. Garden
42. Harlan
43. Hayes
54. Knox
55. Lancaster
60. Madison
65. Nuckolls
66. Otoe
79. Scotts Bluff
81. Sheridan
83. Sioux
91. Webster

North Dakota

2. Barnes
4. Billings
8. Burleigh
10. Cavalier
13. Dunn
18. Grand Forks
21. Hettinger
28. McLean
29. Mercer
30. Morton
31. Mountrail
34. Pembina
40. Rolette
44. Slope
45. Stark
50. Walsh
51. Ward
53. Williams

South Dakota

5. Bon Homme
8. Brule
10. Butte
12. Charles Mix
17. Custer
18. Davison
21. Dewey
24. Fall River
31. Hanson
32. Harding
34. Hutchinson
41. Lawrence
43. Lyman
47. Meade
52. Pennington
67. Yankton

Wyoming

1. Albany	13. Natrona
2. Big Horn	15. Park
3. Campbell	16. Platte
4. Carbon	17. Sheridan
6. Crook	18. Sublette
7. Fremont	19. Sweetwater
8. Goshen	20. Teton
9. Hot Springs	21. Uinta
10. Johnson	23. Weston
11. Laramie	24. Yellowstone National Park
12. Lincoln	

GRAPHICAL SUMMARIES

The analyses assembled in this report may be considered primarily as individual pieces of information about the composition of particular sedimentary rocks in particular places. Also, they may be thought of collectively as groups of data that tend to cluster around various modal points of composition corresponding to rocks of different lithologic types, geologic ages, economic uses, and the like. Collectively, then, the data of the analyses need to be summarized if any clustering of points or systematic relations that may exist are to be recognized. Otherwise, the large number of individual analyses may seem to be a chaos of particulars without overall meaning.

Earlier in this report, mention was made that many of the samples had been collected for analysis because the rock was, or was thought possibly to be, of economic value. For this reason the resulting analyses do not represent random sampling of all sedimentary rocks of the report region. Yet, despite this systematic bias in the choice of samples, the compilers hope that the wide range in composition of the samples and the various analyses groupings (according to the different rock characteristics) may tend to offset the purely local peculiarities in the data and provide information of more regional interest and utility.

AREAL DISTRIBUTION

Plates 1–5 are maps showing the location of analyzed samples according to the rock-classification groups. Groups A and C (pl. 1) and groups D and E (pl. 3) are combined on their respective plates for convenience, because the data conflict little in plotting. Groups B (pl. 2) and F (pl. 4) and the special-rock category (pl. 5) are shown on separate plates; despite this, the plotting of the data in some areas is very crowded. Accordingly, the symbols may indicate more than one sample; in addition, where symbols are closely spaced on the map, some of them are plotted in the county adjacent to their true location. The maps, thus, are the most useful in showing only the general location of the area in which samples were taken. More detailed locations are given in the descriptive notes accompanying the tables of the analyses.

The data on the geographic distribution of samples that contain more than 75 percent silica (pl. 1) show the kinds of consideration that the maps suggest. Also, inference can be made either that the report region probably contains relatively little highly silicious material or that economic demand for such a resource has been low. The map does not provide a basis for determining which alternative is pertinent, of course, but the user of the report can thus be made aware that the question exists.

Plate 6 shows the location of analyzed samples for which an actual or potential use is reported. Only the principal uses as reported by the original author are plotted, although the principal uses have been grouped under more general headings, such as cement material. A calcareous rock, for example, plotted as usable for cement material may also be suitable for rock-wool production. Cement material may also include virtually noncalcareous clayey rocks that can be combined with nearby pure limestone to make a desirable mix for cement manufacture.

Plates 7–9 show the areal distribution of analyzed samples according to their geologic age. Rocks of different ages are not equally represented in the data, and the extensiveness of the outcrops is in no way related to the data. The Jurassic and Triassic Systems, for instance, are each represented by only six localities. Consequently, the data in this report are not a suitable basis for any generalization about the composition of the rocks of these periods. Data for the rocks of Pennsylvanian and Permian ages in Kansas, however, probably represent the composition of these rocks as adequately as any body of data for which the sampling is not specifically designed.

DISTRIBUTION BY COMPOSITION

Figures 3–9 show how the analyses plot within the fields of the triangular diagram that is the basis for the classification system. The points are plotted as closely as possible; even so, not all points could be shown. More than one sample may be represented by a single symbol in some of the more crowded areas of the diagrams. Some features of the diagrams have already been discussed (p. 3, 4, 7).

Plate 10 shows the distribution of analyses according to the name applied to the rock by the original author and its position within the compositional diagram. Different rock types and names, such as sandstone and bentonite (pl. 10*A*) or dolomite and shale (pl. 10*C*), are combined on the diagrams in order to avoid conflict in

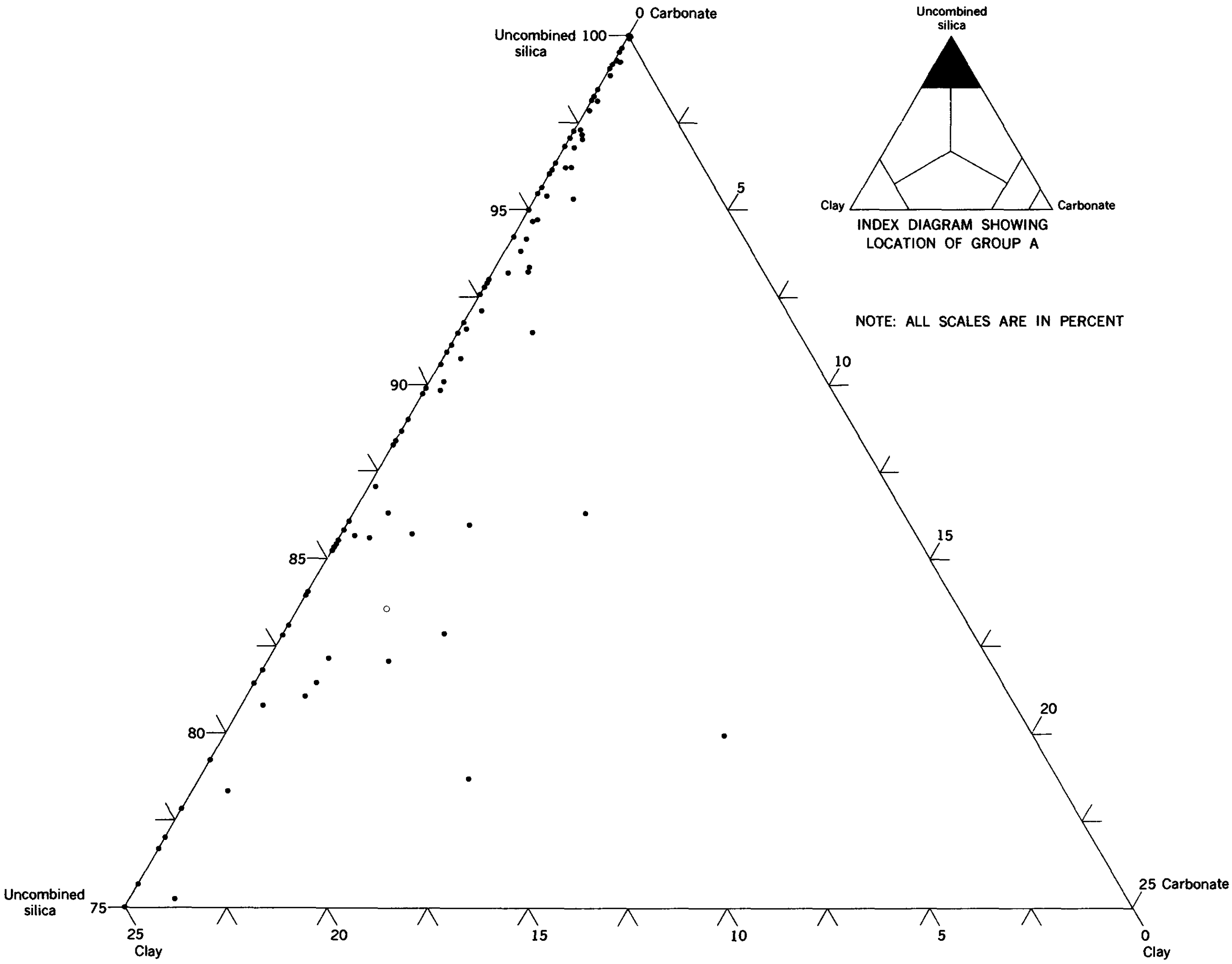


FIGURE 3.—Distribution of analyses of rocks containing more than 75 percent uncombined silica, group A. Solid circle, common-rock category; open circle, mixed-rock category.

plotting and do not imply any relation between the rock types.

The relations between the names applied to the rocks by the original authors and the classification groups are also shown, subdivided by States, in tables 29 and 30.

These summaries emphasize again that many more data are available for some kinds of rocks, notably mixtures of siliceous and clayey materials (group B) and carbonate rocks (group F) than for others. Whether these larger amounts of data are a reflection of the economic value of such rocks or of the relative abundance of the rocks is not certain.

The summaries also emphasize the difficulties of designing a classification system that consistently groups sedimentary rocks according to the names commonly applied to them. Rocks called clay, for example, fall into several of the classification groups when classified according to their chemical composition. The inverse is also true and is perhaps more important—common names for sedimentary rocks are not closely related to the actual rock composition, nor are they always consistently applied.

Tables 31 and 32 categorize the numbers of analyses by classification group and States in different ways that aid in understanding the distribution of data.

Plates 11–14 show the position on the composition diagram of the analyzed samples, according to geologic age. Some of the diagrams show all the samples of a given age, such as Cambrian (pl. 11*A*). Others include more than one system or series where the data permit reasonably uncrowded plotting, such as the samples of Triassic and Jurassic ages (pl. 12*A*), and Paleocene and Eocene ages (pl. 13*A*). Rocks of Cretaceous age, however—because they are abundantly represented in the analyses and consist of generally similar materials

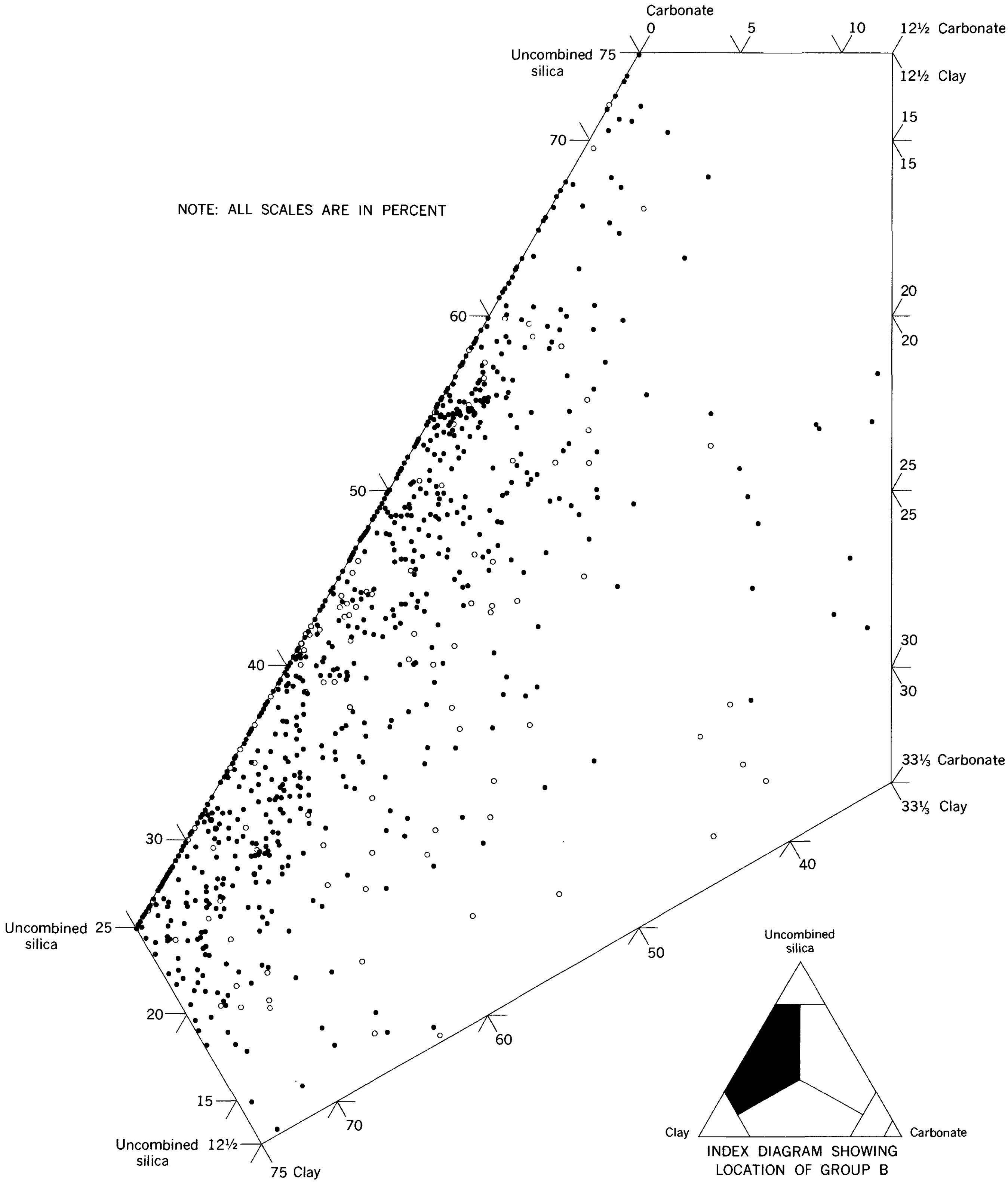


FIGURE 4.—Distribution of analyses of rocks containing uncombined silica and clay, each less than 75 percent; uncombined silica and clay, each more than carbonate, group B. Solid circle, common-rock category; open circle, mixed-rock category.

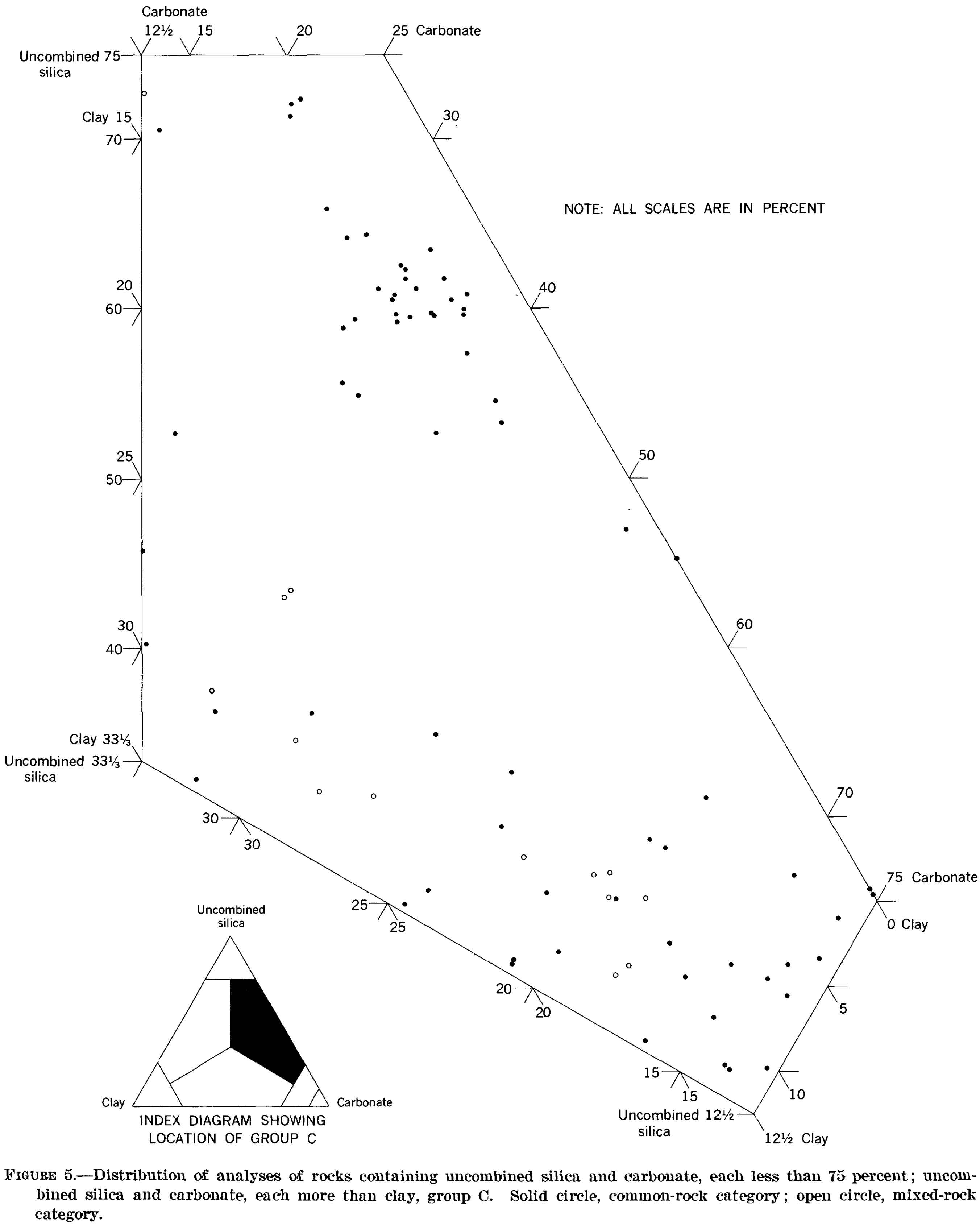


FIGURE 5.—Distribution of analyses of rocks containing uncombined silica and carbonate, each less than 75 percent; uncombined silica and carbonate, each more than clay, group C. Solid circle, common-rock category; open circle, mixed-rock category.

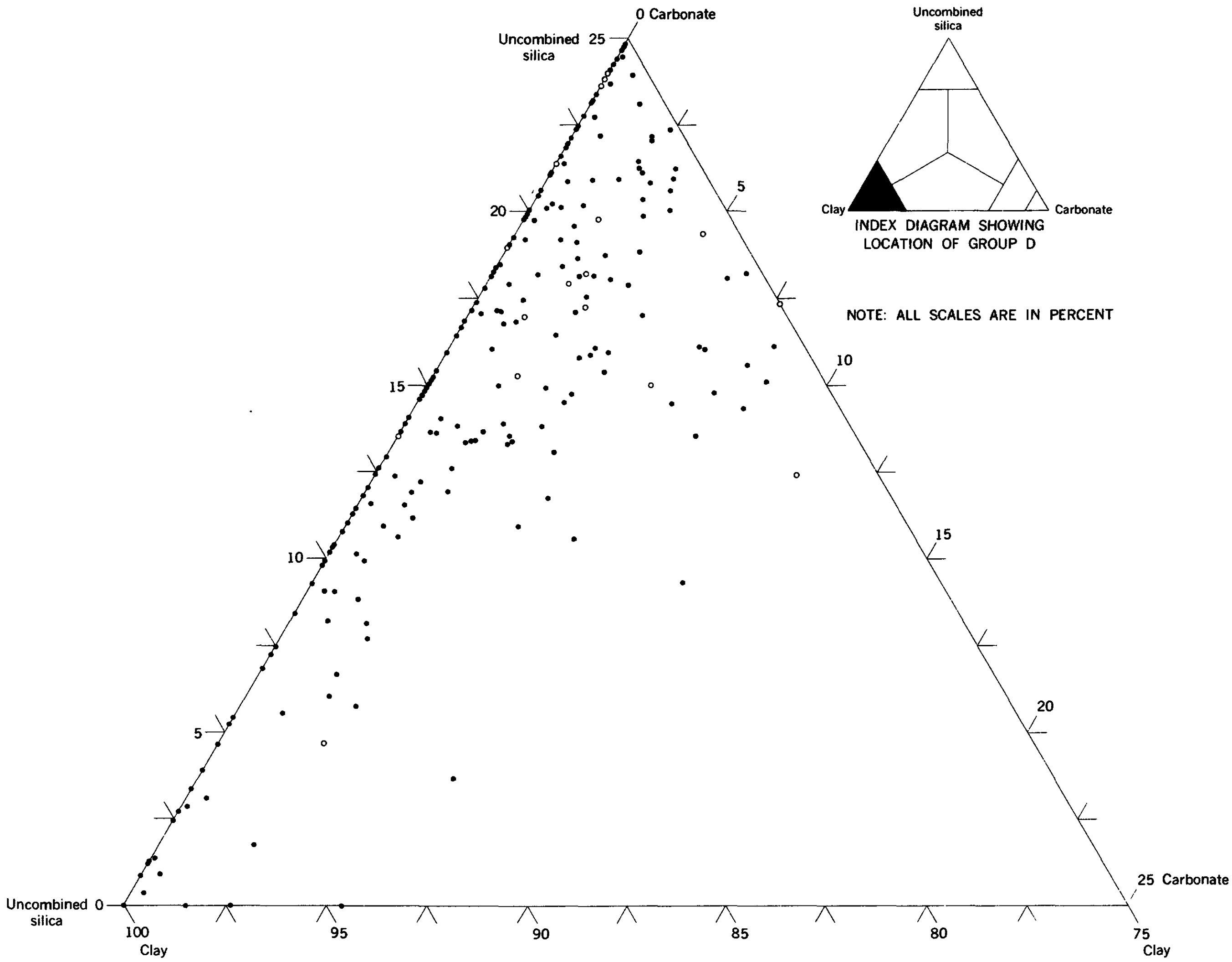


Figure 6.—Distribution of analyses of rocks containing more than 75 percent clay, group D. Solid circle, common-rock category; open circle, mixed-rock category.

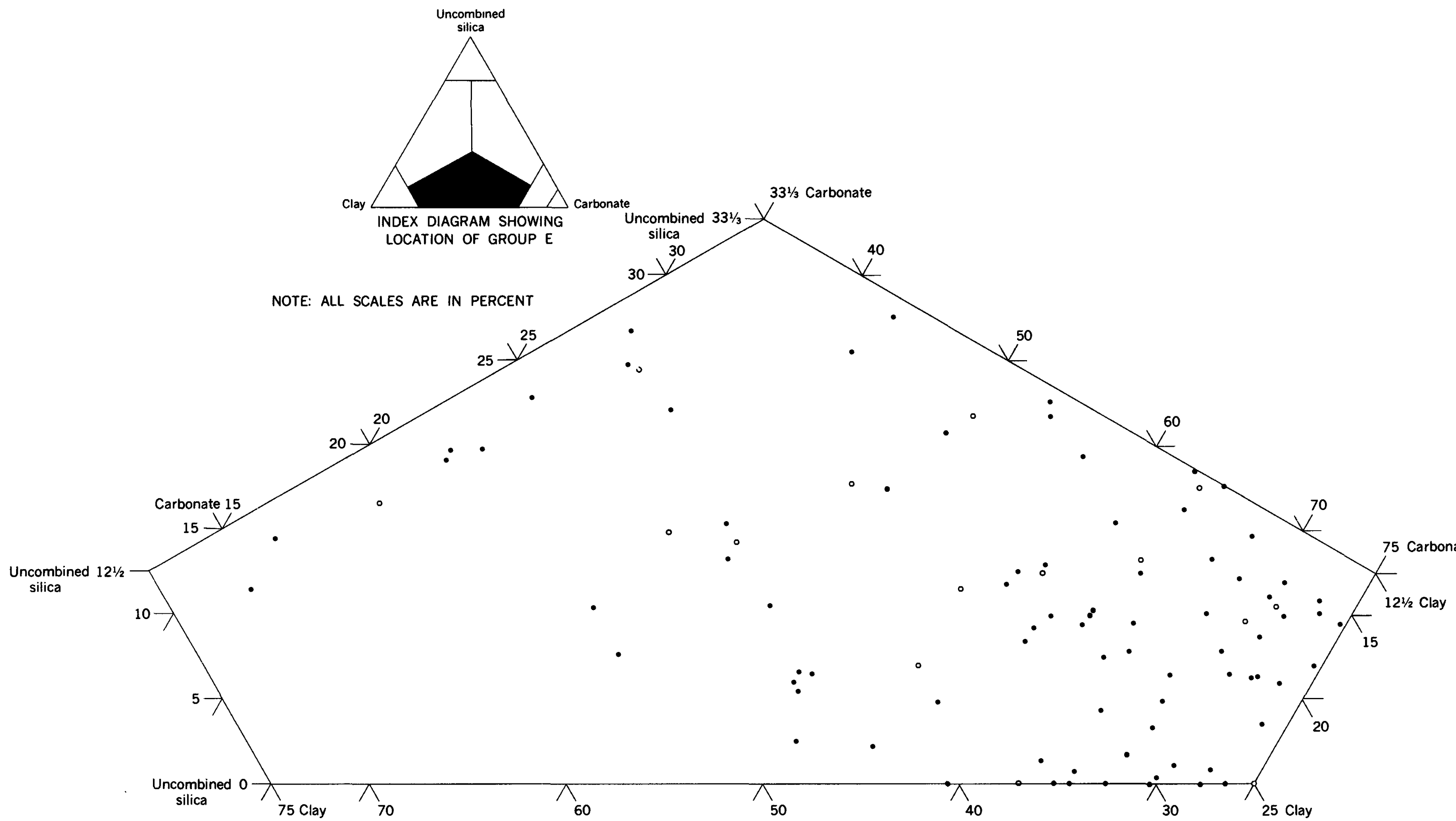


Figure 7.—Distribution of analyses of rocks containing clay and carbonate, each less than 75 percent; clay and carbonate, each more than uncombined silica, group E. Solid circle, common-rock category; open circle, mixed-rock category.

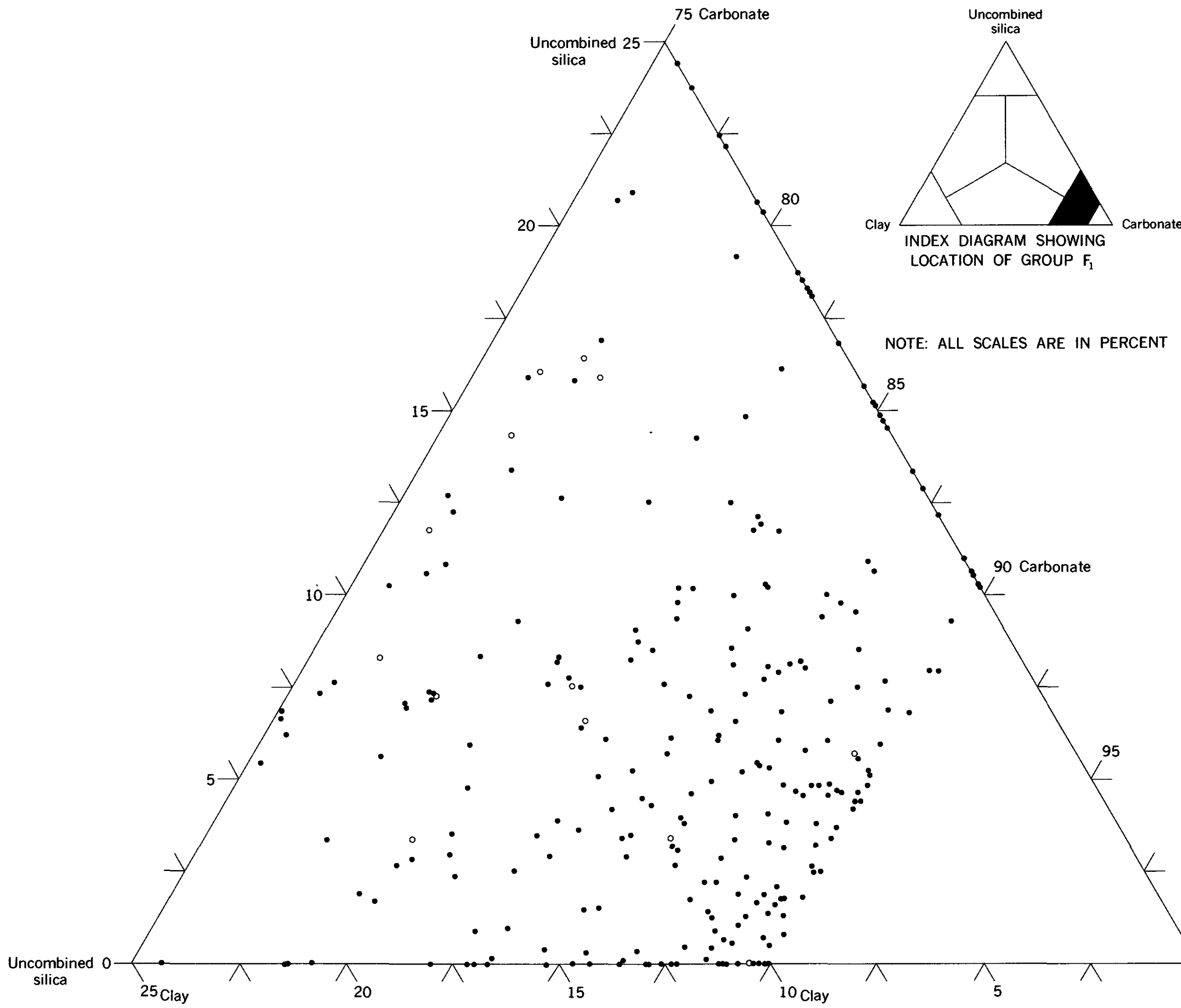


FIGURE 8.—Distribution of analyses of rocks containing carbonate from 75 to 90 percent, group F_1. Solid circle, common-rock category; open circle, mixed-rock category.

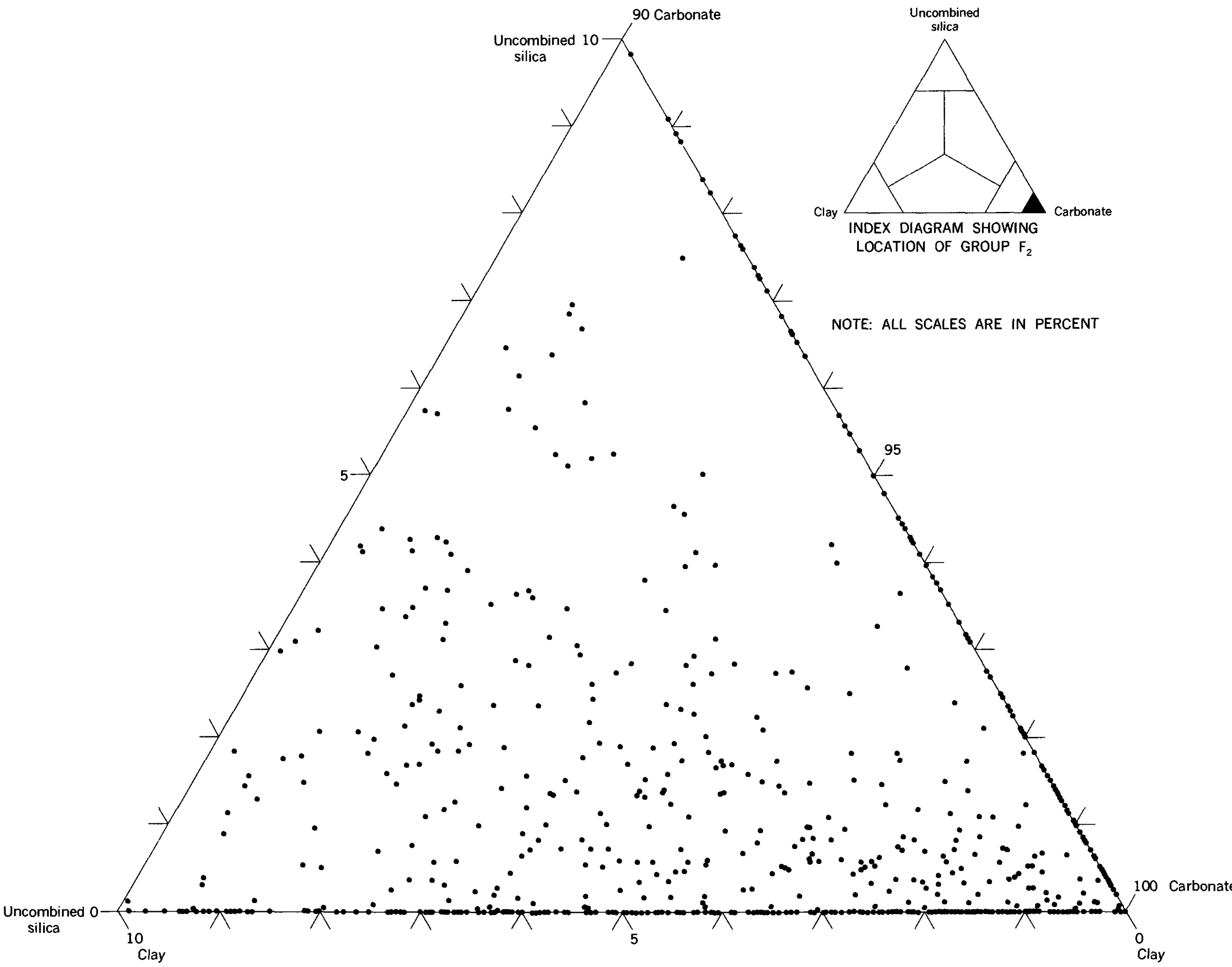


FIGURE 9.—Distribution of analyses of rocks containing carbonate more than 90 percent, group F_2.

TABLE 29.—*Number of samples of various rock types in the classification groups*

Colorado

	A	B	C	D	E	F_1	F_2
Siliceous							
Chert	1						
Clay	1	57		33	3		
Clay, shale		11		1			
Loess		3					
Sand	5						
Sandstone		4	1				
Shale		35		7	6		
Calcareous							
Dolomite						5	38
Limestone			3		6	17	57
Algal limestone		1					
Marl		1					
Spring deposit							5
Total	7	112	4	41	15	22	100

Kansas

	A	B	C	D	E	F_1	F_2
Siliceous							
Bentonite		2		6			
Subbentonite		2					
Chert	5	1	1				
Clay	2	125		66	1		
Underclay		4					
Clay, shale		2		4			
Jasperite	1						
Loess		5					
Manganese wad	1						
Quartzite	8						
Sandstone	18	5	21				
Shale		67	3	29	5		
Silt	1	57					
Siltstone		3					
Volcanic ash		68					
Calcareous							
Chalk			2		9	11	62
Dolomite						9	8
Limestone			9		7	117	294
Marl						1	
Travertine							1
Total	36	341	36	105	22	138	365

Montana

	A	B	C	D	E	F_1	F_2
Siliceous							
Argillite		1					
Chert and quartzite	1						
Clay				2			
Mudstone		2		1			
Mudstone and chert	1						
Mudstone and phosphatic rock		1		1			
Mudstone nodule		1					
Phosphatic rock				1		1	
Sand	1						
Sandstone	1						
Shale				1			
Volcanic ash		8					
Calcareous							
Concretion					1		
Dolomite					1	3	27
Limestone			4		1	12	75
Marble							7
Spring deposit						1	
Travertine							9
Total	4	13	4	6	3	17	118

Nebraska

	A	B	C	D	E	F_1	F_2
Siliceous							
Alluvium		1					
Clay		5					
Loess	4						
Sand	2	2					
Volcanic ash		9					
Calcareous							
Chalk						2	
Limestone					1	2	6
Total	6	17			1	4	6

TABLE 29.—*Number of samples of various rock types in the classification groups*—Continued

North Dakota

	A	B	C	D	E	F_1	F_2
Siliceous							
Bentonite		5					
Clay		199	2	20	7		
Clay, shale		1		1			
Shale		3			4		
Calcareous							
Limestone			6		11	26	7
Marl					1		
Total	0	208	8	21	23	26	7

South Dakota

	A	B	C	D	E	F_1	F_2
Siliceous							
Bentonite		2		10			
Clay	1	13		2			
Clay, shale		1					
Fuller's earth		6		1			
Sandstone	1						
Shale		28		20			
Volcanic ash		1					
Calcareous							
Chalk					11	18	29
Limestone					2	1	22
Marl					2		
Total	2	51		33	15	19	51

Wyoming

	A	B	C	D	E	F_1	F_2
Siliceous							
Bentonite		7		15			
Chert			2				
Clay		2		6	1		
Glauconite				1			
Loess		1					
Mudstone		32	4	1	1		
Mudstone and chert		1					
Phosphatic rock and chert		1					
Phosphatic rock and mudstone		7			2		
Sand	2						
Sandstone	3	1					
Shale	1	12		4	1	1	
Spring deposits	39	19	1	2			
Silt		1					
Tuff		2		1			
Volcanic ash		1					
Calcareous							
Chalk							1
Chert and limestone			7				
Concretion and nodules					2		1
Dolomite			7		5	20	46
Dolomitic mudstone		3					
Limestone			5		4	10	39
Marl			2				
Mudstone		2					
Phosphatic rock			4		2	1	
Phosphatic rock and calcareous mudstone		2					
Shale and limestone			1				
Spring deposits						1	2
Travertine							12
Tufa							1
Total	45	94	33	30	18	33	102

Total for seven States

	A	B	C	D	E	F_1	F_2	Total
Colorado	7	112	4	41	15	22	100	301
Kansas	36	341	36	105	22	138	365	1043
Montana	4	13	4	6	3	17	118	165
Nebraska	6	17	0	0	1	4	6	34
North Dakota	0	208	8	21	23	26	7	293
South Dakota	2	51	0	33	15	19	51	171
Wyoming	45	94	33	30	18	33	102	355
Total	100	836	85	236	97	259	749	2362

throughout the system—are shown in plate 12*B–E* according to broadly applicable subdivisions.

The diagrams differ considerably in their significance for generalizations regarding the bulk composition of rocks of a system. Nearly all the samples of Cambrian age (pl. 11*A*), for example, are from Montana, whereas

TABLE 30.—*Number of samples of various rock types in the special category*

	Hk	Ha	Na	G	S	P	Fe	Mn	M
Colorado									
Clay	48	----	----	----	----	----	----	----	----
Shale and clay	2	----	----	----	----	----	----	----	----
Gypsum	----	----	----	4	----	----	----	----	----
Anhydrite	----	----	----	1	----	----	----	----	----
Sodium sulfate	----	----	----	----	2	----	----	----	----
Sodium-magnesium sulfate	----	----	----	----	1	----	----	----	----
Sodium carbonate	----	----	----	----	2	----	----	----	----
Potassium carbonate	----	----	----	----	1	----	----	----	----
Iron-bearing rock	----	----	----	----	----	----	1	----	----
Bog iron	----	----	----	----	----	----	3	----	----
Concretion	----	----	----	----	----	----	1	----	----
Coal and coal ash	----	----	----	----	----	----	----	----	10
Oil shale and oil shale ash	----	----	----	----	----	----	----	----	3
Baritic sinter	----	----	----	----	----	----	----	----	4
Nodule	----	----	----	----	----	----	----	----	1
Granodiorite and its weathered products	----	----	----	----	----	----	----	----	11
Total	50	----	----	5	6	----	5	----	29
Kansas									
Clay	3	2	----	----	----	----	----	----	----
Rock salt	----	----	39	----	----	----	----	----	----
Gypsum	----	----	----	31	----	----	----	----	----
Phosphate nodules in shale	----	----	----	----	----	11	----	----	----
Total	3	2	39	31	----	11	----	----	----
Montana									
Clay	----	2	----	----	----	----	----	----	----
Sodium sulfate-sodium carbonate	----	----	----	----	1	----	----	----	----
Potassium nitrate	----	----	----	----	1	----	----	----	----
Gypsum	----	----	----	4	----	----	----	----	----
Phosphatic rock	----	----	----	----	----	15	----	----	----
Phosphatic rock and mudstone	----	----	----	----	----	2	----	----	----
Iron-bearing rock	----	----	----	----	----	----	1	----	----
Bog iron	----	----	----	----	----	----	1	----	----
Limonite	----	----	----	----	----	----	1	----	----
Total	----	2	----	4	2	17	3	----	----
Nebraska									
Barite nodule	----	----	----	----	----	----	----	----	1
Alkali crust	----	----	----	----	2	----	----	----	----
Total	----	----	----	----	2	----	----	----	1
North Dakota									
Sodium sulfate	----	----	----	----	3	----	----	----	----
Weathered bentonite	----	----	----	----	1	----	----	----	----
Manganese wad	----	----	----	----	----	----	----	9	----
Lignite and ash	----	----	----	----	----	----	----	----	6
Total	----	----	----	----	4	----	----	9	6
South Dakota									
Clay	1	1	----	----	----	----	----	----	----
Shale	1	----	----	----	----	----	----	3	----
Gypsum	----	----	----	5	----	----	----	----	----
Hematite	----	----	----	----	----	----	1	----	----
Manganese nodules	----	----	----	----	----	----	----	13	----
Total	2	1	----	5	----	----	1	16	----
Wyoming									
Spring deposit	----	3	----	----	6	----	2	1	----
Gypsum	----	----	----	11	----	----	----	----	----
Sodium sulfate	----	----	----	----	61	----	----	----	----
Magnesium sulfate	----	----	----	----	11	----	----	----	----
Sodium-magnesium sulfate	----	----	----	----	10	----	----	----	----
Sodium carbonate	----	----	----	----	1	----	----	----	----
Sodium sulfate-sodium carbonate	----	----	----	----	15	----	----	----	----
Sodium nitrate	----	----	----	----	1	----	----	----	----
Potassium nitrate	----	----	----	----	1	----	----	----	----
Tschermigite	----	----	----	----	1	----	----	----	----
Phosphate rock	----	----	----	----	----	61	----	----	----
Phosphate rock and mudstone	----	----	----	----	----	4	----	----	----
Clay ironstone	----	----	----	----	----	----	1	----	----
Hematite	----	----	----	----	----	----	25	----	----
Siderite	----	----	----	----	----	----	2	----	----
Coal and coal ash	----	----	----	----	----	----	----	----	5
Oil shale and oil shale ash	----	----	----	----	----	----	----	----	2
Total	----	3	----	11	107	65	30	1	7
Total number of analyses (480)	55	8	39	56	121	93	39	26	43

TABLE 31.—*Distribution of samples by States, categories, and groups*

[Total number of analyses]

	Group	Colorado	Kansas	Montana	Nebraska	North Dakota	South Dakota	Wyoming	Total
	Common-rock category								
A	Silica	7	35	4	6	----	2	43	97
B	Mixed silica and clay	111	316	10	16	183	44	47	727
C	Mixed silica and carbonate	4	36	4	----	7	----	20	71
D	Clay	39	96	2	----	21	33	25	216
E	Mixed clay and carbonate	14	20	3	1	19	14	11	82
F_1	Lower carbonate	22	138	16	4	26	17	23	246
F_2	Higher carbonate	100	365	118	6	7	51	102	749
	Total	297	1006	157	33	263	161	271	2188
	Mixed-rock category								
A	Silica	----	1	----	----	----	----	2	3
B	Mixed silica and clay	1	25	3	1	25	7	47	109
C	Mixed silica and carbonate	----	----	----	----	1	----	13	14
D	Clay	2	9	4	----	----	----	5	20
E	Mixed clay and carbonate	1	2	----	----	4	1	7	15
F_1	Lower carbonate	----	----	1	----	----	2	10	13
	Total	4	37	8	1	30	10	84	174
	Special-rock category								
Hk	Kaolinlike clays	50	3	----	----	----	2	----	55
Ha	High-alumina clays	----	2	2	----	----	1	3	8
Na	Rock salt	----	39	----	----	----	----	----	39
G	Gypsum	5	31	4	----	----	5	11	56
S	Sulfates, etcetera	6	----	2	2	4	----	107	121
P	Phosphate rock	----	11	17	----	----	----	65	93
Fe	Iron-rich rocks	5	----	3	----	----	1	30	39
Mn	Manganese-bearing rocks	----	----	----	----	9	16	1	26
M	Miscellaneous:								
	Coal and coal ash	10	----	----	----	6	----	5	21
	Oil shale and oil shale ash	3	----	----	----	----	----	2	5
	Barite	4	----	----	1	----	----	----	5
	Nodule	1	----	----	----	----	----	----	1
	Granodiorite and its weathered products	11	----	----	----	----	----	----	11
	Total	95	86	28	3	19	25	224	480

TABLE 32.—*Distribution of 2,842 samples by State, category, and group*

State

Colorado	396	North Dakota	312
Kansas	1129	South Dakota	196
Montana	193	Wyoming	579
Nebraska	37		

Category

Common rock	2188
Mixed rock	174
Special rock	480

Group

A	100	E	97	Ha	8	P	93
B	836	F_1	259	Na	39	Fe	39
C	85	F_2	749	G	56	Mn	26
D	236	Hk	55	S	121	M	43

other States are scarcely represented. The Cambrian System in Montana probably consists chiefly of carbonate rocks, but the degree to which the available data are representative of this system must be judged by the user. Analyzed samples of rocks of Pennsylvanian and Permian ages are chiefly from Kansas. The many analyses and the fairly wide range in rock composition suggest that the available data are meaningful in reference to the bulk compositions of rocks of the various systems.

Table 33 lists, by State, the number of analyses in each classification group, stratigraphic unit, and county. The stratigraphic units are those of the original author and do not necessarily conform to the usage of the U.S. Geological Survey. The tables are useful for finding the available data on rocks of a particular composition within a reasonably restricted geographic area. Table 33 shows that data on kaolinlike clays (group Hk) are available for samples from Gunnison, Jefferson, Pueblo, and El Paso Counties, and that such materials occur in the Laramie, Pierre, and Dawson formations. A reader interested in such clays in Colorado can thus quickly find the analyses in table 19 and refer to original source information in the descriptive notes accompanying the analyses.

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
									Colorado											
Recent	Bog iron	Gunnison														1			1	3
		Park														2			2	
	Clay	Huerfano		1															1	2
		Pueblo		1															1	
	Sinter or spring deposit	Custer							3										3	9
		Delta							1									4	5	
		El Paso							1										1	
	Saline deposits	Alamosa												1					1	4
		Delta												1					1	
		Jefferson												2					2	
Pleistocene	Peorian loess	Denver		2															2	2
	Loess	Jefferson		1															1	1
Miocene	Creede formation	Mineral		1															1	1
Oligocene	Antero formation	Park	1						1										2	2
Eocene	Green River formation	Garfield				1	1							2					4	7
		Mesa																3	3	
	Wasatch formation	Garfield		1															1	1
Eocene and Cretaceous.	Dawson arkose	Douglas				1													1	9
		El Paso		1		5				2									8	
Cretaceous	Laramie formation	Adams		1															1	31
		Boulder		4		1													5	
		Douglas		1		1													2	
		Gunnison								1									1	
		Jefferson		9		1				2									12	
		Las Animas														1		6	7	
		Logan				1													1	
		Moffat																1	1	
		Weld				1													1	
	Mesaverde formation	Routt																3	3	3
	Fox Hills sandstone	Morgan		1															1	1
	Pierre shale	Boulder		8															8	45
		El Paso		2															2	
		Huerfano		2															2	
		Jefferson		21															21	
		Larimer		3															3	
		Pueblo		2		3	2			1									8	
		Weld		1															1	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group: A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	Totals: County	Formation
		Colorado—Continued																		
Cretaceous—Con.	Mancos shale	Garfield				1													1	5
		Grand		1															1	
		La Plata					1												1	
		Routt		1			1												2	
	Niobrara limestone	Boulder		1			1	2	3										7	18
		Denver						1											1	
		Fremont							1										1	
		Larimer					3	3	2										8	
		Pueblo					1												1	
	Apishapa shale	do							1										1	1
	Timpas limestone	Prowers							1										1	3
		Pueblo							2										2	
	Carlile shale	Bent		1															1	5
		Douglas		1															1	
		Otero		1															1	
		Pueblo		2															2	
	Graneros shale	Boulder		1			1												2	9
		El Paso		1															1	
		Jefferson		1															1	
		Larimer		1															1	
		Pueblo		4															4	
	Dakota sandstone	Bent		1															1	76
		Boulder		1															1	
		Custer				2				2									4	
		Douglas	3	1															4	
		El Paso		1		1													2	
		Fremont				2				6									8	
		Gunnison								1									1	
		Huerfano		1		5				2									8	
		Jefferson								2									2	
		Larimer		2															2	
		Las Animas	1	2		1				1									5	
		Prowers		1															1	
		Pueblo		5		5				27									37	
	Purgatoire formation or Dakota sandstone.	Fremont		1															1	1
	Purgatoire formation	do		1		2													3	13
		Huerfano		1						1									2	
		Jefferson								1									1	
		Pueblo		3		4													7	
Jurassic	Morrison formation	Boulder				1													1	5
		Larimer		2															2	
		Montrose		2															2	
	Flaming Gorge group	Mesa		2															2	2
	La Plata formation	San Miguel		1															1	1
Triassic and Permian	Lykins formation	Douglas	1																1	15
		Jefferson	1					6	5										12	
		Larimer		1			1												2	
Permian or Pennsylvanian.	Jacque Mountain limestone member or Minturn formation.	Summit							1										1	1
Pennsylvanian	Weber formation	Chaffee			1				1										2	7
		Eagle						1											1	
		Gunnison														1			1	
		Park		1	1			1											3	
	Fountain formation	El Paso				1													1	1
	Sangre de Cristo formation	Costilla																1	1	1
	Minturn formation	Eagle						1	1				5						7	21
		Lake							1										1	
		Park							2										2	
		Pitkin						1											1	
		Summit			1				9										10	
	Hermosa formation	Dolores		1	1				1										3	3
	Paradox formation	Garfield		2		1				1									4	4
Mississippian	Leadville limestone	Chaffee							2										2	49
		Eagle					2	2	3										7	
		Fremont							2										2	
		Garfield							5										5	
		Gunnison							4										4	
		Lake						1	11										12	
		La Plata							1										1	
		Park							5										5	
		Pitkin						1	10										11	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
		Colorado—Continued																		
Mississippian or Devonian.	Leadville limestone or Chaffee formation.	Pitkin							2										2	2
Devonian	Quray limestone	Chaffee					1		8										9	9
	Chaffee formation	Pitkin							6										6	6
Ordovician	Tomichi limestone	Chaffee							2										2	2
	Manitou limestone	El Paso							2										2	4
		Lake						2											2	
Precambrian	Boulder Creek granite gneiss and weathered products.	Boulder																11	11	11
		Kansas																		
Recent	Gypsite	Butler											1						1	16
		Dickinson											4						4	
		Marion											5						5	
		Saline											5						5	
		Sedgwick											1						1	
	Travertine	Mitchell							1										1	1
	Spring salt	Miami										1							1	2
		Republic										1							1	
	Terrace deposits	Crawford		2															2	2
Pleistocene	Sanborn formation	Atchison		1															1	63
		Cheyenne		4															4	
		Clay		7															7	
		Doniphan		15															15	
		Johnson		5															5	
		Logan		6															6	
		Norton		12															12	
		Republic		5															5	
		Rice		5															5	
		Scott		1															1	
		Sheridan		1															1	
		Wallace		1															1	
	Volcanic ash	Ottawa		1															1	1
	Meade formation	Chautauqua		1															1	51
		Clark		2															2	
		Comanche		2															2	
		Ellis		1															1	
		Ellsworth		3															3	
		Gove		2															2	
		Graham		1															1	
		Grant		2															2	
		Jewell		6															6	
		Lincoln		2															2	
		Logan		2															2	
		McPherson		11															11	
		Ness		1															1	
		Phillips		2															2	
		Pratt		2															2	
		Rawlins		3															3	
		Reno		3															3	
		Russell		1															1	
		Seward		2															2	
		Sheridan		2															2	
Tertiary	Loup Fork beds	Norton							1										1	1
Pliocene	Ogallala formation	Graham	3																3	29
		Lane				1													1	
		Norton	1	4															5	
		Phillips	3	4															7	
		Rawlins		3	1														4	
		Rooks	1																1	
		Wallace		5		2	1												8	
Cretaceous	Pierre shale	Logan		1															1	2
		Phillips		1															1	
	Between Pierre shale and Niobrara formation.	do		4		4													8	8
	Niobrara formation	Ellis					1	3	13										17	105
		Finney							2										2	
		Hamilton					1	1	2										4	
		Jewell				1	6	6	24										37	
		Lane							2										2	
		Ness							2										2	
		Osborne		1				1	8										10	
		Phillips						1	1										2	
		Rooks			1		1		11										13	
		Smith			1				12										13	
		Trego						1	2										3	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group: A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	Totals: County	Formation
		Kansas—Continued																		
Cretaceous—Con.	Carlile shale	Ellis		1															1	15
		Jewell		11															11	
		Mitchell		1															1	
		Osborne		2															2	
	Greenhorn limestone	Hamilton						1	4										5	6
		Hodgeman							1										1	
	Graneros shale	Ellsworth				1													1	5
		Republic		1		1													2	
		Russell				1													1	
		Washington		1															1	
	Benton shale	Hamilton							1										1	1
	Graneros shale and Dakota sandstone.	Hodgeman		1															1	1
	Dakota sandstone	Barton		2															2	213
		Cloud	1	29		9													39	
		Ellsworth	1	64		19				2									86	
		Ford		2		2													4	
		Hodgeman				2													2	
		Lincoln		9	13	2				1	1								26	
		Ottawa	1	15		7													23	
		Republic				1													1	
		Rice	1																1	
		Russell				3													3	
		Saline		2															2	
		Washington		9	1	14													24	
	Dakota sandstone or Kiowa shale.	Lincoln			1														1	1
	Kiowa shale	Clark		1															1	11
		Ellsworth			2	2													4	
		McPherson			3														3	
		Rice		1	1														2	
		Saline				1													1	
	Cheyenne sandstone	Barber	2																2	4
		Comanche	1																1	
		Kiowa	1																1	
Carboniferous	Salt	Pottawatomie										1							1	1
Permian	Taloga formation	Clark		2															2	2
	Day Creek dolomite	do							1										1	1
	Whitehorse sandstone	do		1			1												2	2
	Whitehorse sandstone or Marlowe sandstone.	Barber	1																1	1
	Blaine formation	do											3						3	3
	Flowerpot shale	do		1															1	1
	Cedar Hills sandstone	do		3															3	3
	Salt Plain shale	Harper		2															2	2
	Stone Corral dolomite	Rice							5										5	5
	Ninnescah shale	Harper		1															1	5
		McPherson		1															1	
		Reno		1		2													3	
	Wellington formation	Clay											1						1	47
		Dickinson											7						7	
		Ellsworth										6							6	
		Kingman										3							3	
		Marion					1												1	
		McPherson		1															1	
		Reno										13							13	
		Rice										14							14	
		Sumner					1												1	
	Herington limestone	Butler						3	1										4	13
		Chase						2											2	
		Clay						1											1	
		Dickinson						3											3	
		Marion						1	2										3	
	Nolans limestone	Chase						2											2	2
	Winfield limestone	Butler						1	1										2	11
		Chase							2										2	
		Cowley						1	1										2	
		Marion						1											1	
		Marshall						4											4	
	Doyle shale	Chase							1										1	4
		Riley						1	2										3	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
									Kansas—Continued											
Permian—Con	Fort Riley limestone	Butler						3	3										6	24
		Chase						1	1										2	
		Clay						1	1										2	
		Cowley						2	4										6	
		Geary					1	2	1										4	
		Marshall							1										1	
		Morris						3											3	
	Barneston limestone	Geary			1														1	4
		Marion			1														1	
		Marshall						1											1	
		Wabaunsee						1											1	
	Matfield shale	Riley							1										1	1
	Wreford limestone	Chase							1										1	7
		Morris						1	1										2	
		Pottawatomie							1										1	
		Riley			1														1	
		Wabaunsee						1	1										2	
	Funston limestone	Chase						1											1	4
		Lyon						1	1										2	
		Riley							1										1	
	Garrison shale	Lyon						1	1										2	3
		Riley							1										1	
	Crouse limestone	Chase							2										2	2
	Easley Creek shale	Marshall											4						4	4
	Beattie limestone	Chase							1										1	5
		Lyon							1										1	
		Marshall						1											1	
		Morris							1										1	
		Riley			1														1	
	Cottonwood limestone	Chase						1	6										7	20
		Cowley							1										1	
		Jackson						1											1	
		Lyon						1	1										2	
		Marshall						2											2	
		Morris							1										1	
		Nemaha			1			1											2	
		Wabaunsee						2	2										4	
	Eskridge shale	Chase							1										1	1
	Neva limestone	do						1	2										3	8
		Jackson						1											1	
		Lyon							2										2	
		Riley						1											1	
		Wabaunsee							1										1	
	Red Eagle limestone	Chase							1										1	2
		Lyon							1										1	
	Foraker limestone	Chase						1											1	4
		Greenwood							1										1	
		Lyon							1										1	
		Riley							1										1	
	Aspinwall limestone	Lyon							1										1	1
Pennsylvanian	Brownville limestone	do						1											1	1
	Caneyville-Pony Creek shale.	Brown				2													2	2
	Grandhaven limestone	Lyon						1	2										3	3
	Dover limestone	do			1														1	1
	Langdon shale	do				2													2	2
	Tarkio limestone	Nemaha						1											1	4
		Osage						1											1	
		Riley						1											1	
		Shawnee							1										1	
	Willard shale	Brown		2															2	2
	Elmont limestone	Nemaha							2										2	6
		Osage							4										4	
	Harveyville shale	Pottawatomie		1															1	2
		Shawnee		1															1	
	Reading limestone	Lyon						1	2										3	4
		Nemaha						1											1	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
								Kansas—Continued												
Pennsylvanian—Con.	Auburn shale member	Brown			1														1	1
	Auburn limestone member	Shawnee							1										1	1
	Wakarusa limestone	Elk						1											1	2
		Lyon						1											1	
	Burlingame limestone	Elk						1											1	5
		Jackson						1											1	
		Jefferson							1										1	
		Shawnee							2										2	
	White Cloud shale	Lyon						1											1	1
	Howard limestone	Atchison				2													2	21
		Chatauqua		2															2	
		Elk					1												1	
		Greenwood		3			1												4	
		Jefferson				3													3	
		Osage		3		2					1								6	
		Shawnee		2		1													3	
	Severy shale	Elk		1															1	1
	Topeka limestone	Doniphan						2											2	15
		Douglas							1										1	
		Elk			1			1											2	
		Jefferson							1										1	
		Osage							6										6	
		Shawnee						3											3	
	Calhoun shale	do				1													1	1
	Deer Creek limestone	Atchison							1										1	18
		Doniphan						1	1										2	
		Douglas							3										3	
		Elk							5										5	
		Jefferson						1	1										2	
		Osage							2										2	
		Shawnee							3										3	
	Lecompton limestone	Elk					1												1	2
		Douglas						1											1	
	Oread limestone	Atchison						1	2										3	40
		Chautauqua							1										1	
		Coffey						1	1										2	
		Doniphan						2	1										3	
		Douglas						5	8						1				14	
		Elk							2										2	
		Greenwood							4										4	
		Jefferson						1											1	
		Leavenworth						4											4	
		Osage							1										1	
		Wilson							3										3	
		Woodson						2											2	
	Lawrence shale	Doniphan				1			3										4	6
		Douglas				1													1	
		Wilson				1													1	
	Lawrence shale and Stranger formation.	Chautauqua	2																2	13
		Greenwood	4																4	
		Montgomery	2																2	
		Wilson	5																5	
	Stranger formation	Coffey						1											1	14
		Douglas				2													2	
		Elk				1			1										2	
		Wilson						4	2										6	
		Woodson			1				2										3	
	Weston shale	Franklin				2													2	6
		Leavenworth				1													1	
		Montgomery		2															2	
		Wilson				1													1	
	Stanton limestone	Allen							2										2	36
		Anderson							5										5	
		Douglas							4										4	
		Franklin		1					7										8	
		Johnson							4										4	
		Leavenworth						1	1										2	
		Miami							3										3	
		Montgomery							2										2	
		Wilson						1	2										3	
		Woodson						2											2	
		Wyandotte							1										1	
	Vilas shale	Leavenworth		1															1	1

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
			Kansas—Continued																	
Pennsylvanian—Con.	Plattsburg limestone	Anderson							3										3	20
		Franklin						1	4										5	
		Johnson							2										2	
		Leavenworth						2	1										3	
		Linn							1										1	
		Montgomery							1										1	
		Wilson						1	3										4	
		Wyandotte							1										1	
	Kansas City group	do							1										1	1
	Bonner Springs shale	Montgomery				1													1	2
		Wilson		1															1	
	Wyandotte limestone	Johnson						1	12										13	23
		Leavenworth			1			1	3										5	
		Miami							2										2	
		Wyandotte							3										3	
	Lane shale	Miami						1											1	1
	Lane-Bonner Springs shale	Allen		3															3	4
		Wilson					1												1	
	Iola limestone	Allen							11										11	22
		Anderson							1										1	
		Linn							1										1	
		Miami						2	1										3	
		Neosho		1					1										2	
		Wilson		1											1				2	
		Wyandotte		1											1				2	
	Drum limestone	Allen							3										3	9
		Johnson							1										1	
		Linn							1										1	
		Montgomery							2										2	
		Neosho							1										1	
		Wilson					1												1	
	Cherryvale shale	Johnson				1			1										2	6
		Miami						1											1	
		Montgomery							1										1	
		Wyandotte		1					1										2	
	Dennis limestone	Allen							3										3	13
		Bourbon						1	3										4	
		Linn						2	2										4	
		Neosho							1										1	
		Wyandotte							1										1	
	Canville limestone	Neosho		1															1	1
	Dennis or Swope limestone	Miami							3										3	3
	Swope limestone	Allen							1										1	10
		Bourbon							2										2	
		Labette							1										1	
		Linn							4										4	
		Neosho							1										1	
		Wyandotte							1										1	
	Hertha limestone	Linn					1	1	3										5	6
		Neosho						1											1	
	Pleasanton group	Labette		2											1				3	3
	Coffeyville formation	Montgomery		1		1													2	2
	Lenapah limestone	Labette							1										1	1
	Altamont limestone	Bourbon							1										1	8
		Crawford													1				1	
		Labette							3										3	
		Linn							1						1				2	
		Neosho							1										1	
	Pawnee limestone	Bourbon							6										6	9
		Crawford							1										1	
		Labette		1											1				2	
	Fort Scott limestone	Bourbon			1		2	9	1										13	19
		Crawford				1		1	2										4	
		Labette						1							1				2	
	Cherokee shale	Bourbon		1		1													2	11
		Cherokee				2			1										3	
		Crawford		2											1				3	
		Labette							1						2				3	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
		Kansas—Continued																		
Mississippian	Warsaw limestone or Keokuk limestone.	Cherokee	6	1	1														8	8
	Keokuk limestone	do							1										1	1
	Keokuk limestone–Burlington limestone.	do							3										3	3
	Burlington limestone	do							1										1	1
		Montana																		
Recent	Limonite stalactite	Jefferson														1			1	1
	Saline deposits	do												1					1	2
		Silver Bow												1					1	
	Hot spring deposit	Jefferson						1											1	1
	Travertine	Fergus							1										1	10
		Park							9										9	
Tertiary	Bozeman "lake beds"	Gallatin		4															4	4
	Sediments	do		1															1	2
		Park		1															1	
Oligocene and (or) Miocene.	Tertiary lake beds	Ravalli		2															2	2
Oligocene	White River formation	Carter					1												1	1
Cretaceous	Eagle sandstone	Fergus	1																1	1
	Pierre shale	Carter					1												1	1
	Kootenai formation	Cascade				2													2	2
Jurassic	Morrison formation	do														1			1	1
Triassic and Permian	Chugwater formation	Carbon											1						1	1
Permian	Phosphoria formation	Beaverhead	2	4		1		1							8				16	28
		Deer Lodge				1									1				2	
		Madison	1																1	
		Powell													5				5	
		Silver Bow				1									3				4	
Mississippian and Pennsylvanian.	Quadrant formation	Cascade											2						2	4
		Gallatin			1														1	
		Meagher											1						1	
Mississippian	Madison limestone	Big Horn							1										1	30
		Carbon							5										5	
		Cascade							1										1	
		Deer Lodge						1											1	
		Gallatin						3	1										4	
		Granite							1										1	
		Jefferson							12										12	
		Madison							2										2	
		Park							2										2	
		Powell							1										1	
	Mission Canyon formation	Gallatin							1										1	1
	Heath formation	Fergus									2								2	2
Devonian	Jefferson limestone	Gallatin							1										1	6
		Granite							1										1	
		Jefferson							1										1	
		Madison							3										3	
	Maywood formation	Meagher							1										1	1
Devonian and Cambrian.	Maywood formation and Red Lion formation.	Madison							1										1	1
Ordovician	Bighorn dolomite	do							2										2	2
Cambrian	Red Lion formation	Gallatin							2										2	6
		Granite						3	1										4	
	Pilgrim limestone	Beaverhead							5										5	18
		Broadwater							2										2	
		Gallatin							1										1	
		Lewis and Clark							7										7	
		Madison						1											1	
		Silver Bow							2										2	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	Totals: County	Totals: Formation
									Montana—Continued											
Cambrian—Con	Park shale	Silver Bow							1										1	1
	Meagher limestone	Beaverhead							4										4	48
		Broadwater							6										6	
		Gallatin						1	5										6	
		Jefferson						1	4										5	
		Lewis and Clark							3										3	
		Madison						1	19										20	
		Meagher						1	2										3	
		Silver Bow							1										1	
	Hasmark formation	Deer Lodge							1										1	8
		Granite						2	5										7	
	Silver Hill formation	Deer Lodge				1													1	1
	Flathead quartzite and Wolsey shale.	Madison						1											1	1
Precambrian	Belt series	Gallatin			1														1	2
		Meagher														1			1	
	Siyeh formation	Flathead			1														1	1
	Newland limestone	Deer Lodge			1														1	1
	Altyn formation	Flathead					1												1	1
	MacDonald formation	do		1															1	1
									Nebraska											
Recent	Alkali crust	Sheridan												2					2	2
	Alluvium	Buffalo		1															1	1
	Barite nodule	Dodge																1	1	1
	Missouri River sand	Douglas		1															1	1
	Platte River sand	do		1															1	1
Pleistocene	Glacial clay	do		2															2	2
	Loess	Buffalo	1																1	4
		Clay	1																1	
		Douglas	1																1	
		Harlan	1																1	
	Loess clay	Madison		1															1	1
Pliocene	Ogallala formation	Cherry		2															2	3
		Garden		1															1	
Miocene	Sheep Creek formation	Box Butte		3															3	4
		Dawes		1															1	
	Harrison formation	Sioux		1															1	1
	Gering formation	Scotts Bluff		1															1	1
Cretaceous	Niobrara formation	Franklin						1											1	6
		Knox						2											2	
		Nuckolls							1										1	
		Webster					1	1											2	
	Dakota sandstone	Burt		1															1	4
		Lancaster	2	1															3	
Pennsylvanian	Deer Creek limestone	Cass							5										5	5
									North Dakota											
Recent	Glauber salt	Mountrail												1					1	3
		Ward												1					1	
		Williams												1					1	
	Spring deposits	Rolette															9		9	9
Pleistocene	Wisconsin drift	Grand Forks		1															1	1
Oligocene	White River formation	Hettinger		1	6		11	12	7										37	248
		Slope		52		3													55	
		Stark		130	2	5	5	14											156	

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
North Dakota—Continued																				
Eocene	Golden Valley formation	Billings		1		1													2	24
		Dunn		3		2													5	
		Hettinger		1		2													3	
		Mercer				2													2	
		Morton		1															1	
		Stark		9		2													11	
	Fort Union formation	Billings		1														1	2	10
		Burleigh																1	1	
		Divide																1	1	
		Mountrail																1	1	
		Stark		1														1	2	
		Ward				2												1	3	
Cretaceous	Lance formation	Burleigh		1															1	1
	Hell Creek formation	Slope		1															1	1
	Pierre shale	Cavalier		1		1													2	4
		Pembina												1					1	
		Walsh		1															1	
	Niobrara formation	Barnes					2												2	8
		Cavalier		1			5												6	
	Benton shale	do		2		1													3	3
South Dakota																				
Oligocene	Chadron formation	Custer		7		1													8	8
Cretaceous	Lance formation	Harding		1															1	1
	Hell Creek formation	Dewey		2															2	2
	Fox Hills sandstone	Pennington		1															1	1
	Pierre shale	Brule		2															2	63
		Charles Mix								1									1	
		Fall River		2		5													7	
		Lyman		12													16		28	
		Pennington		3		17													20	
		Yankton		3			2												5	
	Niobrara formation	Bon Homme						3	5										8	61
		Brule						1											1	
		Brule-Lyman						1											1	
		Custer						1											1	
		Davison					8	4	7										19	
		Hanson					3												3	
		Hutchinson						1											1	
		Meade					1	1											2	
		Pennington					1												1	
		Yankton						7	17										24	
	Graneros shale	Butte				4													4	16
		Fall River				2													2	
		Pennington		7		3													10	
	Benton shale	do		1															1	1
	Fuson shale	Butte		2		1													3	10
		Pennington	1	6															7	
Triassic	Spearfish formation	Fall River											3						3	6
		Lawrence		1															1	
		Meade											2						2	
Permian	Minnekahta limestone	Fall River							1										1	15
		Lawrence							1										1	
		Meade							2										2	
		Pennington							11										11	
Pennsylvanian	Minnelusa sandstone	Fall River	1																1	1
Mississippian	Pahasapa limestone	Custer							5										5	6
		Pennington							1										1	
Ordovician	Whitewood limestone	Lawrence							1										1	1
Cambrian	Deadwood formation	do		1															1	2
		Pennington														1			1	
Precambrian	Kaolin	Lawrence								1	1								2	2

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	Totals County	Formation
Wyoming																				
Recent	Spring deposits	Park							1										1	87
		Yellowstone National Park.	39	19	1	3	1	1	15		3			1		2	1		86	
	Saline deposits	Albany												40					40	104
		Carbon												29					29	
		Fremont												2					2	
		Natrona												24					24	
		Park												2					2	
		Sweetwater												2					2	
		Yellowstone National Park.												5					5	
Pleistocene	Loess	Laramie		1															1	1
Pliocene or Miocene	Ash Hollow formation	do							1										1	1
Miocene	Arikaree sandstone	Goshen					2												2	2
Eocene	Tuff	Fremont		1		1													2	2
	Bridger formation	Sweetwater			2														2	3
		Uinta		1															1	
	Green River formation	Sweetwater		1			2							1				2	6	6
	Fort Union formation	Campbell																1	1	1
	Wasatch formation	Sweetwater												1					1	1
Quaternary or Tertiary.	Volcanic ash	Albany		1															1	1
Cretaceous	Lance formation	Carbon														1			1	3
		Johnson, Natrona														2			2	
	Laramie formation	Sweetwater	1																1	1
	Fox Hills sandstone	Fremont	1																1	1
	Mesaverde formation	Carbon				1													1	5
		Sweetwater																4	4	
	Pierre shale	Carbon				1													1	6
		Laramie				1													1	
		Weston		4															4	
	Niobrara formation	Albany					1	1	1										3	4
		Laramie			1														1	
	Graneros shale	do		1															1	11
		Weston		4		5	1												10	
	Frontier formation	Park		1															1	1
	Benton shale	Albany		1		7													8	10
		Carbon				1													1	
		Weston				1													1	
	Mowry shale	do	1	3		4													8	8
	Thermopolis shale or Mowry shale.	Natrona		1															1	1
	Dakota sandstone	Laramie	1																1	1
Jurassic	Morrison formation	Weston				1													1	1
	Sundance formation	Sheridan				1													1	1
Triassic	Chugwater formation	Albany											1						1	9
		Big Horn											3						3	
		Hot Springs											1						1	
		Johnson											1						1	
		Natrona						3											3	
	Spearfish formation	Crook											1						1	3
		Weston		1									1						2	
Permian	Phosphoria formation	Fremont						1							17				18	176
		Hot Springs						3											3	
		Lincoln		54	27	3	11	11	1						48				155	
	Minnekahta limestone	Crook							2										2	7
		Laramie						2											2	
		Natrona						1											1	
		Weston							2										2	
	Forelle limestone	Albany							3										3	3
	Satanka shale	do											2						2	2

TABLE 33.—*Distribution of samples by State and by age, stratigraphic unit, county, and classification group*—Continued

Age	Stratigraphic unit	County	Classification group																Totals	
			A	B	C	D	E	F_1	F_2	Hk	Ha	Na	G	S	P	Fe	Mn	M	County	Formation
Wyoming—Continued																				
Permian or Pennsylvanian.	Park City formation	Hot Springs							1										1	2
		Park							1										1	
Pennsylvanian	Casper formation	Albany	2						3										5	8
		Laramie							1										1	
		Natrona							2										2	
Pennsylvanian or Mississippian.	Casper formation or Madison limestone.	do							1										1	1
Pennsylvanian	Fountain formation	Albany							1										1	1
Mississippian and Pennsylvanian.	Hartville formation	Platte							3										3	3
Mississippian	Minnelusa sandstone	Crook											1						1	1
	Pahasapa limestone	Weston							1										1	1
	Madison limestone	Carbon							4										4	23
		Fremont						3	6										9	
		Natrona							10										10	
	Madison limestone lower part and Cambrian, upper shaly layers.	Carbon														10			10	10
Ordovician	Bighorn dolomite	Big Horn							1										1	30
		Fremont							4										4	
		Hot Springs							6										6	
		Park							15										15	
		Sublette							2										2	
		Teton							2										2	
Cambrian	Pilgrim limestone	Park							2										2	2
	Grove Creek formation	do							1										1	1
	Snowy Range formation	do			1			3	9										13	13
	Park shale	do			1			3											4	4
	Meagher limestone	do						1											1	1
Precambrian	Seminoe formation	Carbon														10			10	10
	Whalen group	Platte														5			5	5

CUMULATIVE FREQUENCY CURVES

Figures 10–16 are cumulative frequency curves of the constituents determined in all samples of each classification group A–F_2. These curves are drawn on semilog coordinates in order to show on one diagram the wide range in abundance of some of the constituents. That the less abundant constituents generally vary proportionally much more widely than the more abundant major constituents is noteworthy but to be expected.

From these curves, one can estimate the extent to which the different constituents have normal or log-normal distribution (Ahrens, 1957, p. 205–212). If a constituent is distributed normally, the percentages in which it occurs are equally frequent on each side of the median (the 0.5 frequency). For example, the curve for total H_2O on figure 10*B*, group A (p. 218), shows about 11.3 percent at 0.9 frequency, 6.0 percent at 0.5 frequency, and 0.5 percent at 0.1 frequency. The arithmetic mean of 11.3 percent and 0.5 percent, however, is 5.9 percent, which is sufficiently close to 6.0 percent to indicate that the distribution of total H_2O in group A analyses is approximately normal.

If a constituent is distributed log-normally, however, the logarithm of the percentages in which it occurs, rather than the percentages themselves, is equally frequent on each side of the median. For example, the curve for Fe_2O_3 on figure 10*A*, group A (p. 218), shows about 2.7 percent at 0.9 frequency, 0.46 percent at 0.5 frequency, and 0.09 percent at 0.1 frequency. The geometric mean of 2.7 percent and 0.09 percent is $(2.7\times 0.09)^{\frac{1}{2}}$ or 0.49 percent which is sufficiently close to 0.46 percent to indicate that the distribution of Fe_2O_3 in group A analyses is approximately log-normal.

Many of the constituents, particularly those determined in only a few samples, are distributed very irregularly, and several of them do not fit very well into either normal or log-normal distribution. Nevertheless, when comparisons of the kind just mentioned are made for many of the constituents, most of the more abundant major ones are found to have approximately normal

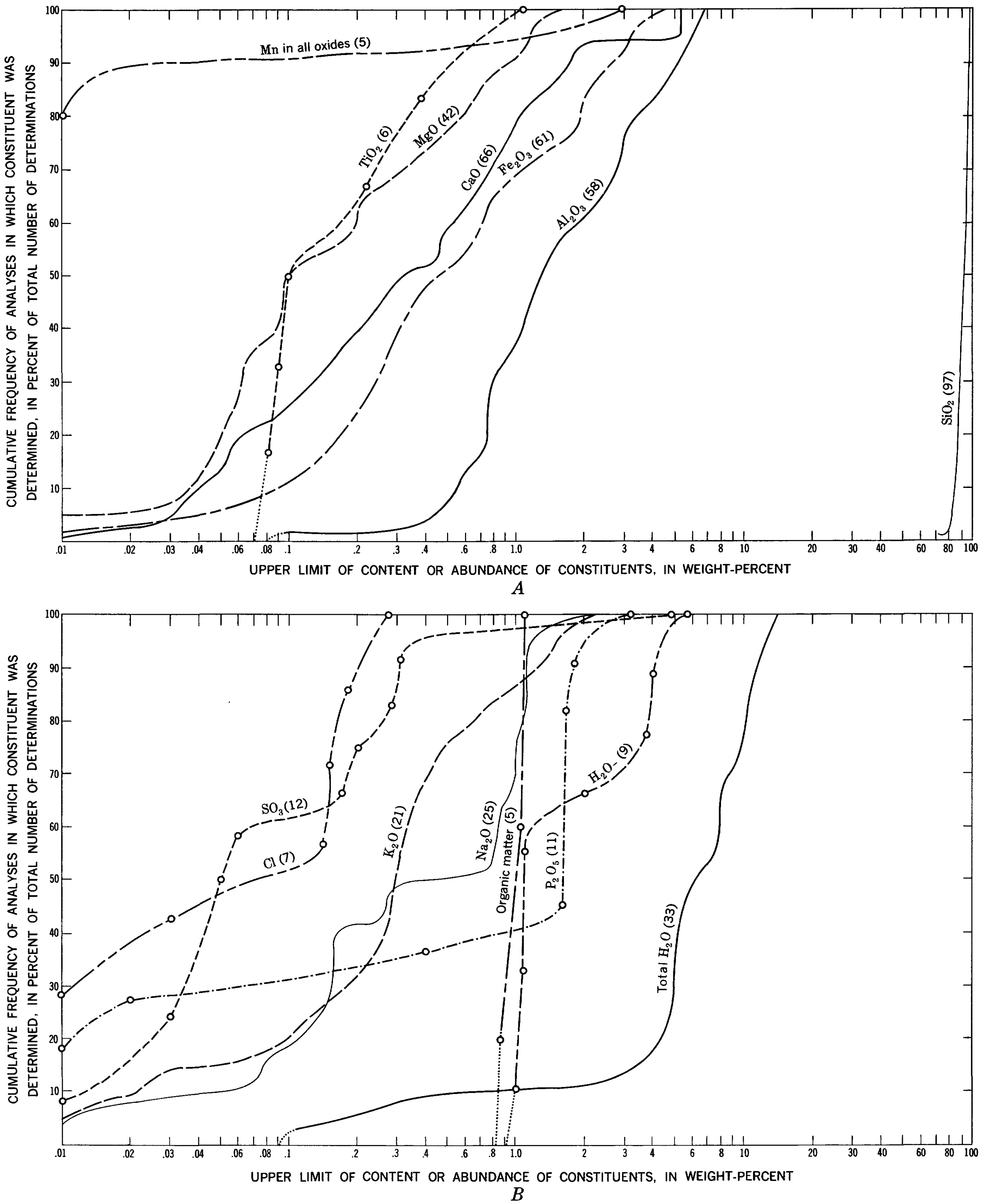


FIGURE 10.—Group A. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked Al_2O_3 in part *A*, above, indicates that all group A analyses in which Al_2O_3 was determined (58 analyses) contain 6.84 percent or less of this constituent and that half of these analyses contain 1.28 percent or less Al_2O_3. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line.

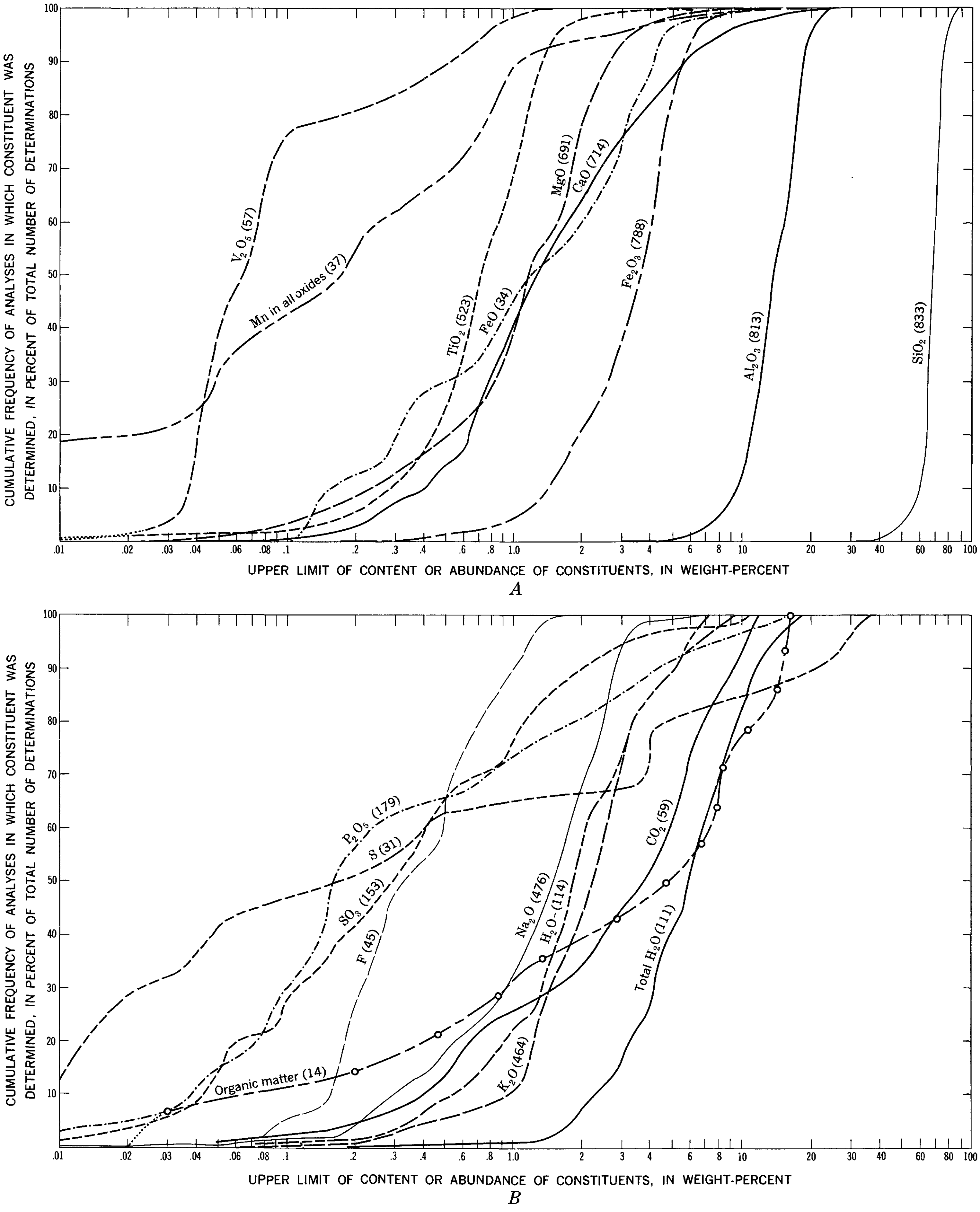


FIGURE 11.—Group B. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked FeO in part *A*, above, indicates that all the group B analyses in which FeO was determined (34 analyses) contain 14.87 percent or less of this constituent and that half of these contain 1.17 percent or less FeO. Total H_2O in part *B*, above, also includes the sums of H_2O+ and H_2O-. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line. Determinations of uranium in group B samples were not plotted because the values fall below the lower limits of the graph.

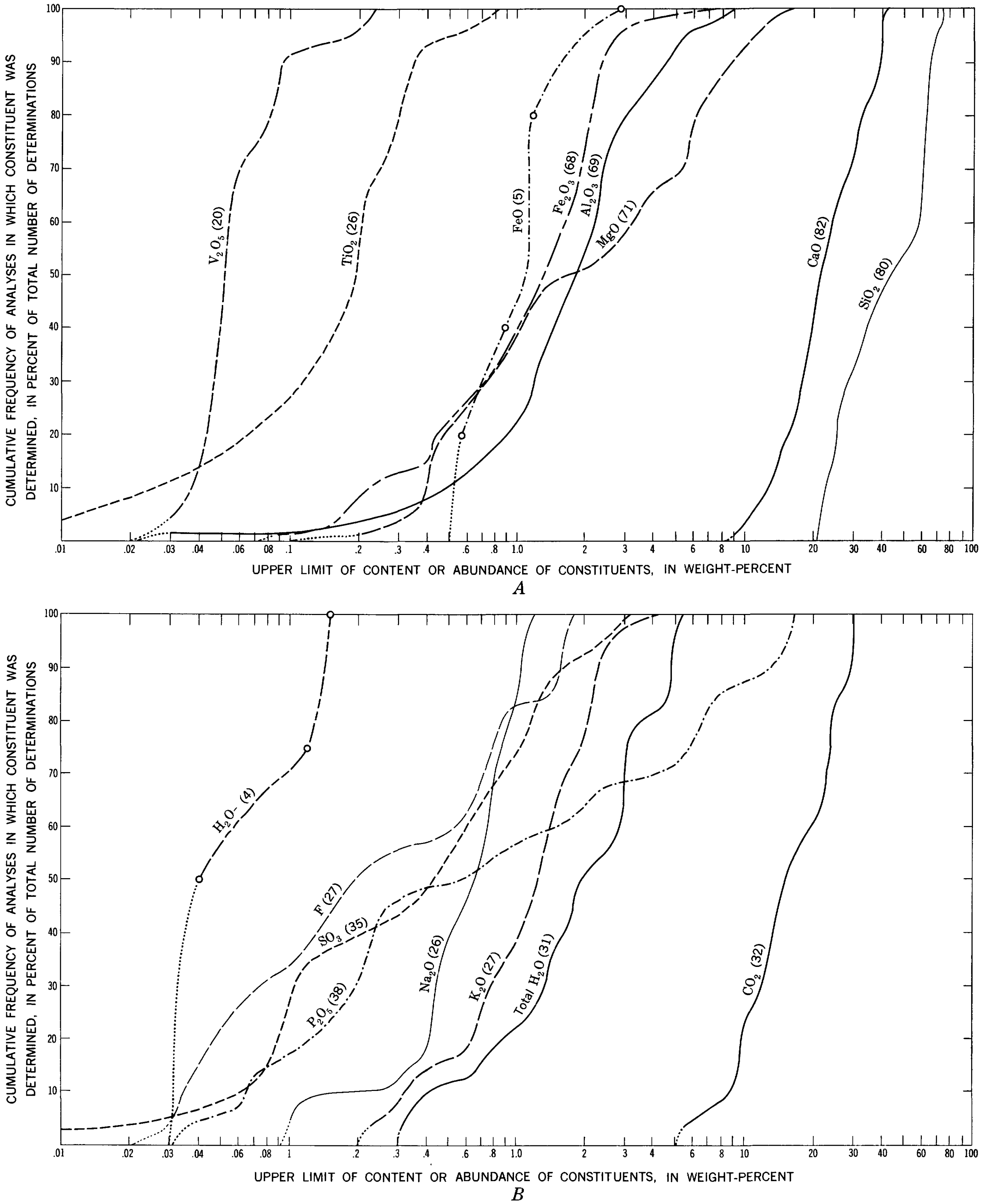


Figure 12.—Group C. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked Fe_2O_3 in part *A*, above, indicates that all the group C analyses in which Fe_2O_3 was determined (68 analyses) contain 7.03 percent or less of this constituent and that half of these contain 1.30 percent or less Fe_2O_3. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line. Determinations of uranium in group C samples were not plotted because the values fall below the lower limits of the graph.

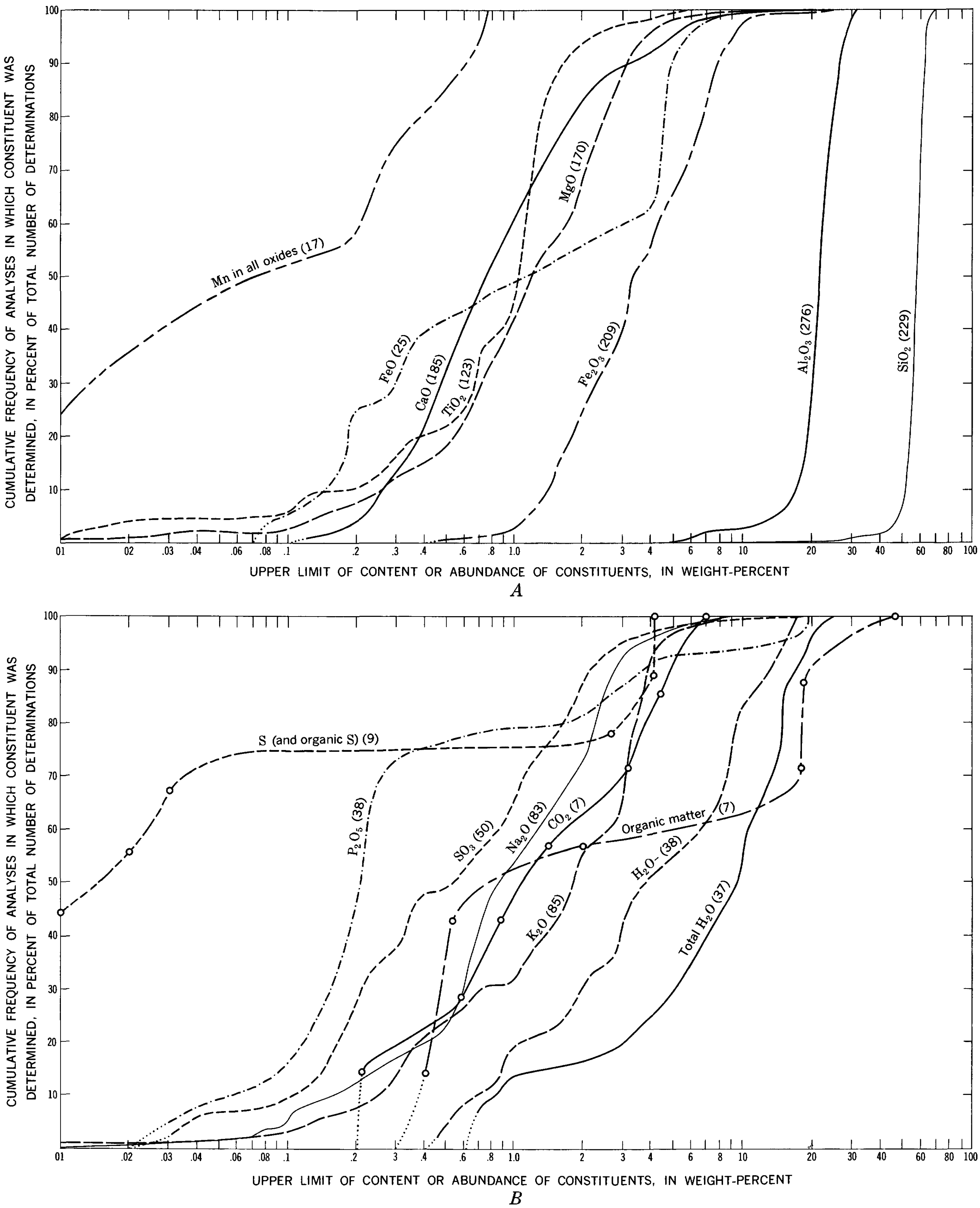
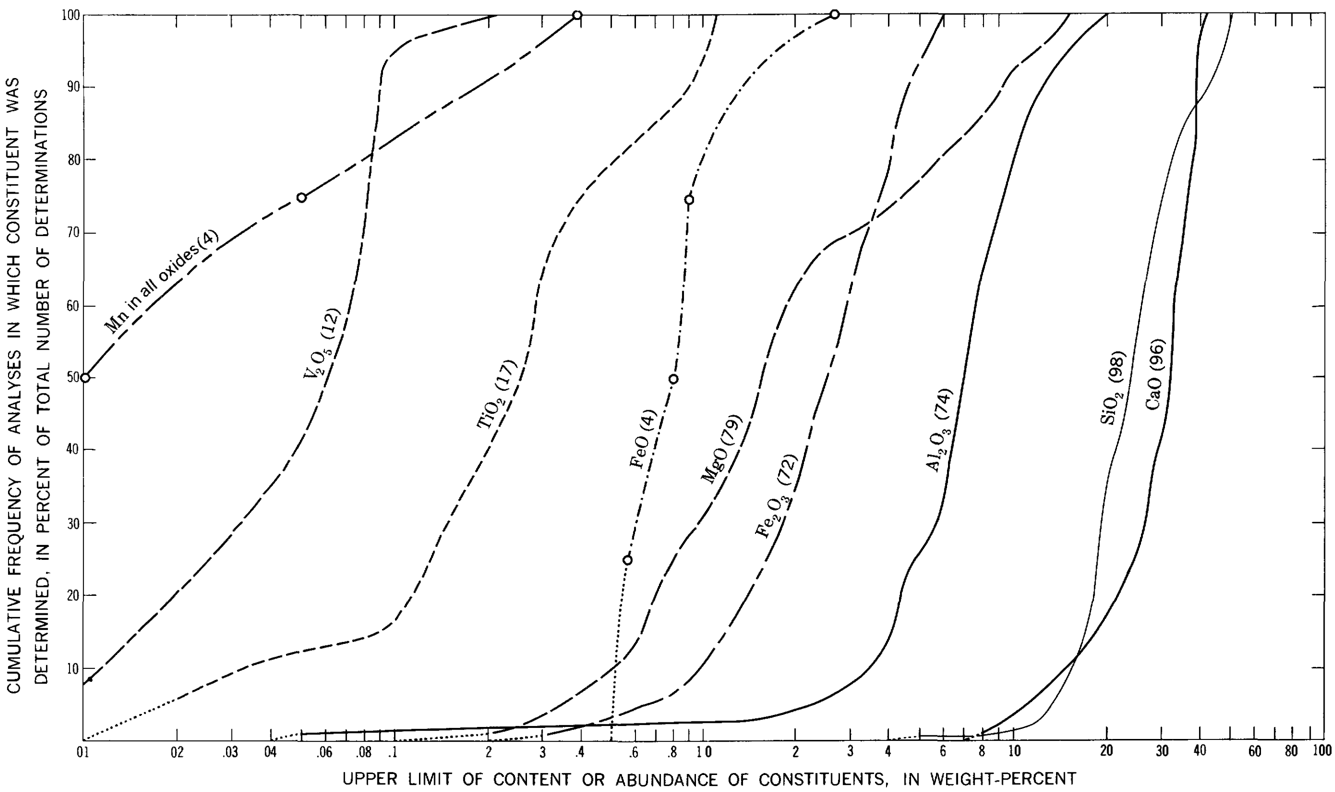
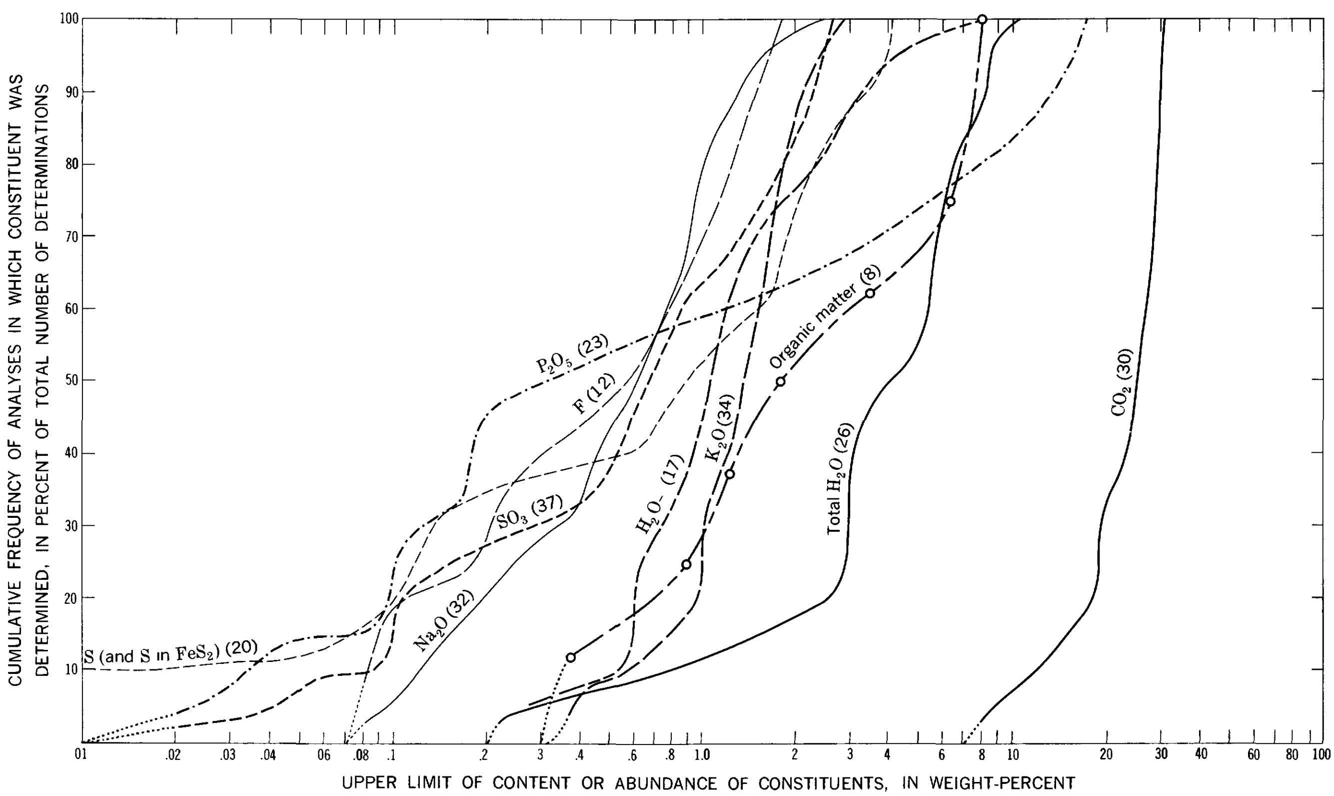


FIGURE 13.—Group D. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked FeO in part *A*, above, indicates that all group D analyses in which FeO was determined (25 analyses) contain 16.70 percent or less of this constituent and that half of these contain 1.09 percent or less FeO. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line.



A



B

FIGURE 14.—Group E. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked TiO_2 in part *A*, above, indicates that all group E analyses in which TiO_2 was determined (17 analyses) contain 1.10 percent or less of this constituent and that half of these contain 0.25 percent or less TiO_2. Total H_2O in part *B*, above, also includes the sums of H_2O+ and H_2O-. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line. Determinations of uranium in group E samples were not plotted because the values fall below the lower limits of the graph.

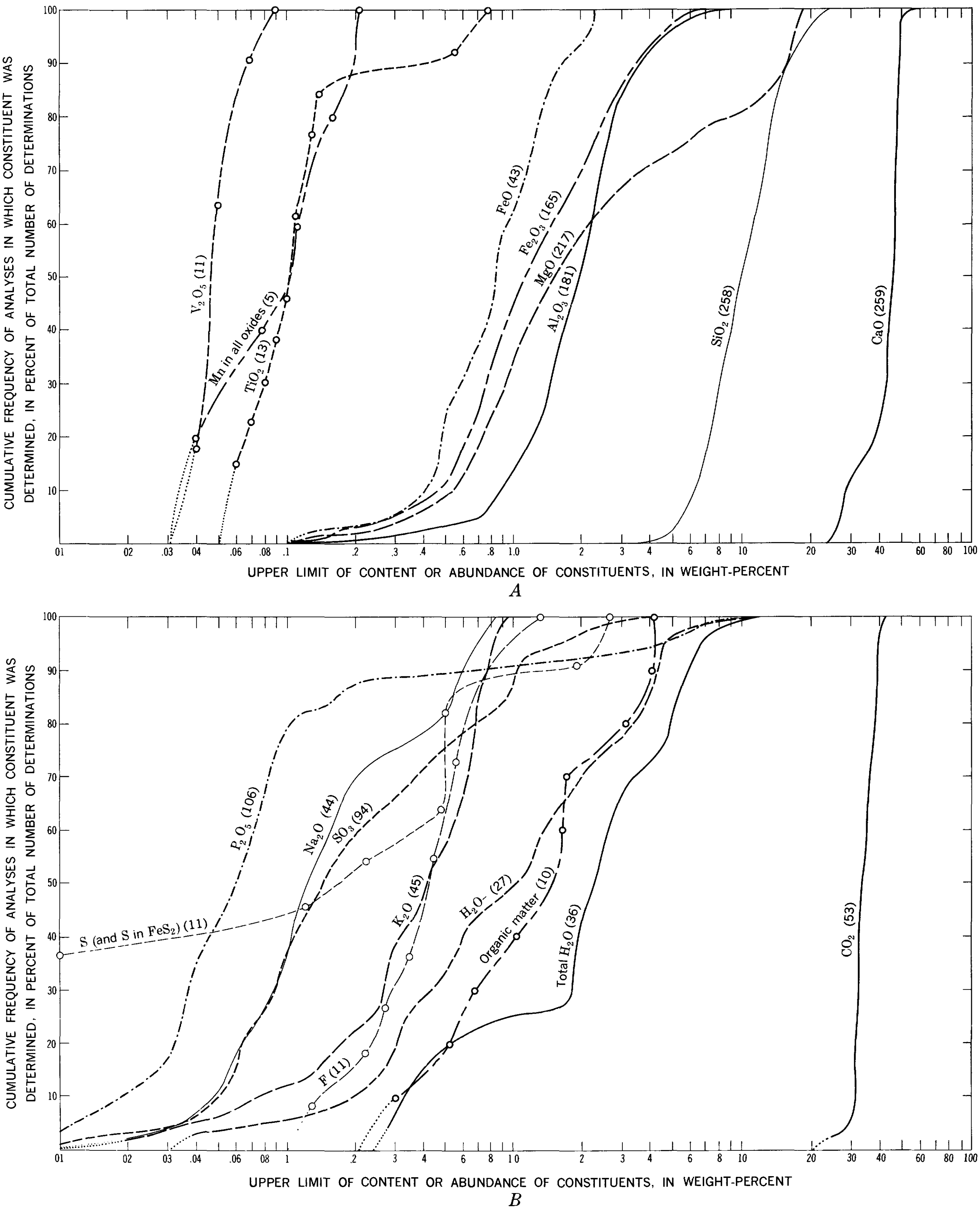


FIGURE 15.—Group F_1. Cumulative frequency curves showing the proportion of all analyses in the common- and mixed-rock categories that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked MgO in part *A*, above, indicates that all the group F_1 analyses in which MgO was determined (217 analyses) contain 18.83 percent or less of this constituent and that half of these analyses contain 1.56 percent or less MgO. Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line. Determinations of silver and uranium in group F_1 samples were not plotted because the values fall below the lower limits of the graph.

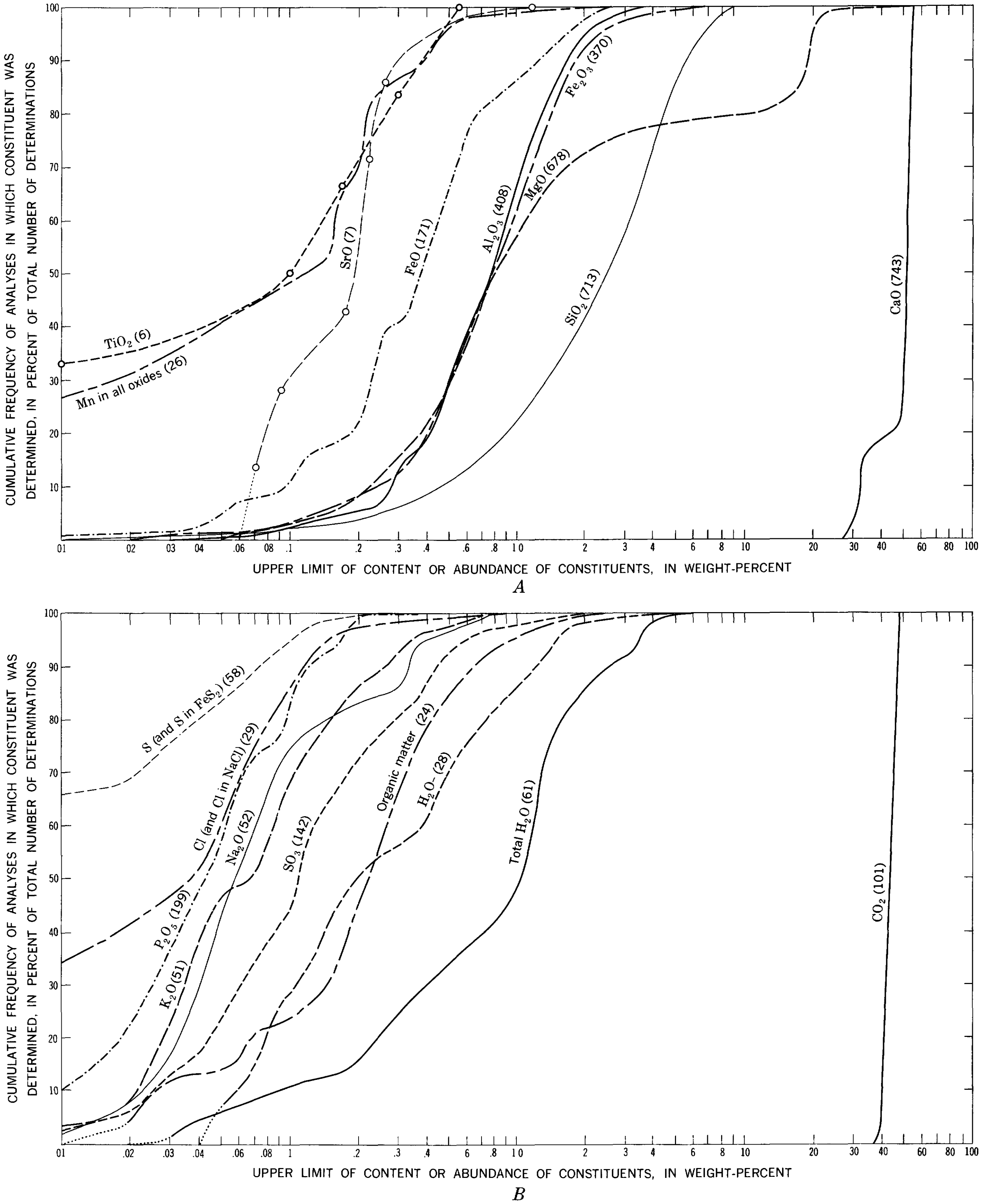


Figure 16.—Group F_2. Cumulative frequency curves showing the proportion of all analyses in the common-rock category that contain up to (but not more than) the indicated percentage of various constituents. For example, the line marked SiO_2 in part *A*, above, indicates that all group F_2 analyses in which SiO_2 was determined (713 analyses) contain 9.40 percent or less of this constituent and that half of these contain 2.48 percent or less SiO_2. Total H_2O in part *B*, above, also includes the sums of H_2O+ and H_2O- Constituents determined in fewer than four analyses were not plotted. Total number of determinations made of each constituent is given in parentheses on each line. Determinations of lithium and phosphate in group F_2 samples were not plotted because the values fall below the lower limits of the graph.

distribution, and many of the minor constituents of intermediate and lesser abundance show a tendency toward log-normal distribution.

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INDEXES

The indexes are provided to make the data as readily available as possible for a variety of purposes without any single index being so large as to be cumbersome. They include indexes to stratigraphic names, geologic ages, actual and possible uses, and minor constituents.

The stratigraphic names indexed here are the names used in the reference from which the analyses were taken. Many of the names do not represent the most recent usage, and none were reviewed for conformity to nomenclature adopted for use by the U.S. Geological Survey. Each page listed in the index refers to the page on which the descriptive notes appear.

The index "Analyses by Geologic Age" provides entries to the epochs of the Tertiary and Cretaceous, but only to the periods of the older rocks. No attempt was made to resolve uncertain age assignments (for example, Mississippian or Devonian) made by the original authors. Pages listed refer to those on which the descriptive notes occur.

The index "Actual and Possible Uses" lists those uses given in the references from which the analyses were taken. For a large number of samples, no use was suggested in the reference. No interpretation was made of the original author's statement.

The index to minor constituents was complex to prepare and not all problems may have been satisfactorily solved from the user's point of view. The ability, however, to find conveniently through indexing those analyses that report arsenic or bismuth is very useful. Similarly, compounds or radicals not commonly reported in analyses of sedimentary rocks, such as potassium sulfate or bicarbonate, would be difficult to find without indexing. Also, an element such as aluminum or calcium is a major constituent in many rocks and of interest as a minor constituent in only a few rocks. The indexing of all analyses in which aluminum is reported is not helpful, but the selection of analyses in which aluminum is of interest as a minor constituent thus depended upon the judgment of the compilers. This selection by the compilers necessarily applies to other elements as well.

As a preliminary guide to the indexing of analyses according to the elements that may be either major or minor constituents (depending on the material) considerable importance was given to analyses in which the element is determined spectrographically, for an element present in a sample in amounts amenable to spectrographic analysis is a minor constituent. The major and (or) minor constituents were divided into two indexes; the first applies to analyses of rocks in the common- and mixed-rock categories and the second to analyses of rocks in the special-rock category.

Elements are indexed without regard to the form in which the element is reported in the analyses. Boron, gallium, and other elements are commonly reported as the element in spectrographic analyses but as the oxide if they are determined chemically. Spectrographic analyses and chemical analyses are separately grouped in the index, however. Compounds such as sodium sulfate are indexed only if they are reported as the compound in the original analyses. Many samples, the analyses of which report sodium oxide and sulfur trioxide, are as likely to contain sodium sulfate as those in which the compound is reported.

The pages listed refer to those on which the analyses occur. For the most part, these are even-numbered pages because of the arrangement of the tables. In a few tables the spectrographic analyses appear on the odd-numbered pages. For a few samples, the data on one or two minor constituents are found in the descriptive notes.

STRATIGRAPHIC NAMES

ANALYSES BY GEOLOGIC AGE

ACTUAL AND POSSIBLE USE

CHEMICAL AND SPECTROGRAPHIC ANALYSES FOR MINOR CONSTITUENTS, COMPOUNDS, AND RADICALS (OXIDES REPORTED AS ELEMENTS) IN ROCKS OF THE COMMON- AND MIXED-ROCK CATEGORIES; REPORTED IN ONLY A FEW ANALYSES

[Constituents looked for and not detected or if below limiting values are given in italics; constituents may appear more than once on a page and may appear in more than one form; spectrographic determinations are noted, all others are chemical determinations]

CHEMICAL AND SPECTROGRAPHIC ANALYSES FOR CONSTITUENTS, COMPOUNDS, AND RADICALS (OXIDES REPORTED AS ELEMENTS) IN ROCKS OF THE SPECIAL-ROCK CATEGORY

[Constituents looked for and not detected are given in italics; constituents may appear more than once on a page and may appear in more than one form; spectrographic determinations are noted, all others are chemical determinations]