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CONSTRUCTION MATERIALS IN ROOKS COUNTY, KANSAS

By

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INTRODUCTION

Purpose of the investigation

The U. S. Geological Survey in the summer of 1946 sent a field party into Rooks County, Kans., to investigate sources of engineering construction materials, as part of a Statewide project conducted in cooperation with the State Highway Commission of Kansas. This report is a part of that inventory and a contribution to the geologic mapping and mineral resource investigations being made in connection with studies of the Missouri River Basin.1/

The primary aim of the investigation was to accumulate field and laboratory data pertaining to the geologic materials in Rooks County that would be of use in the construction of dams, irrigation canals, highways, airports, or other engineering structures. Additional geologic data are included in this report only to the extent of providing information useful in the exploitation of the prospects reported or in the location of other sites where materials required to fulfill future engineering needs might be obtained.

Area covered by the investigation

Rooks County is in the second tier of Kansas counties south of the Nebraska border and in the fifth tier east of the Colorado border. (See figure 1.) It has an area of about 900 square miles and comprises 25 townships. The county is bounded by parallels 39°08' and 39°32'30" north latitude, and meridians 98°58' and 99°38' west longitude. It is bordered on the east by Osborne County, on the west by Graham County, on the north by Phillips County, and on the south by Ellis County.

Geography of the area

Rooks County is in the border region of the Great Plains physiographic province. Streams cutting headward from the Central Lowlands province to the east have dissected the border region to one of low to moderate relief. The streams occupy steep-sided valleys, many of which are cut more than 150 feet below the gently rounded upland surface. The areas of greatest relief in Rooks County are along the South Fork Solomon River in the central part of the county, along Bow Creek at the northern edge of the county, and along the tributaries to the Saline River in the southern part of the county.

The South Fork of the Solomon River is the largest stream in Rooks County. It rises about 100 miles farther west, crosses the west boundary slightly north of the middle, and flows generally eastward across the county. Its most important tributaries in Rooks County are northward-flowing streams; these are, in order from west to east, Lost Creek, Box Elder Creek, Elm Creek, and Medicine Creek. The tributaries entering from the north are markedly shorter than those that enter from the south. Bow Creek, the second largest stream in Rooks County, rises about 45 miles to the west, flows eastward, paralleling roughly the northern boundary of the county to a point slightly east of the center line, then turns sharply north into Phillips County. Paradise Creek rises a few miles west of the city of Plainville and flows generally eastward, leaving the county 4 miles north of the southeast corner to join the Saline River, which flows across the northern part of Ellis County. Other southward-flowing tributaries of the Saline River drain the south part of Rooks County.

Rooks County is served by two railroads, A branch line of the Union Pacific Railroad enters the county at about the center of the western border, swings south through the cities of Damar and Palco, and then runs east across the county. A spur line of the Missouri Pacific Railroad starts at Stockton and runs east to the county line. Stockton, the county seat and largest city in the county, and Woodston also are served by the Missouri Pacific Railroad. With the exception of Webster, the remaining cities in Rooks County are located along the branch line of the Union Pacific.

There is a well-developed system of Federal, State, and county roads. The Federal highways are of the black-top type of construction. U. S. 24, a major east-west transcontinental route, crosses the northern part of the county. U. S. 183, an important north-south highway, extends through the center of the county. The two highways intersect at

1/ Missouri River Basin conservation control, and use of water resources: 78th Cong., 2d sess., S. doc. 191, pp. 94, 95, map of Kansas (in pocket). 1944.

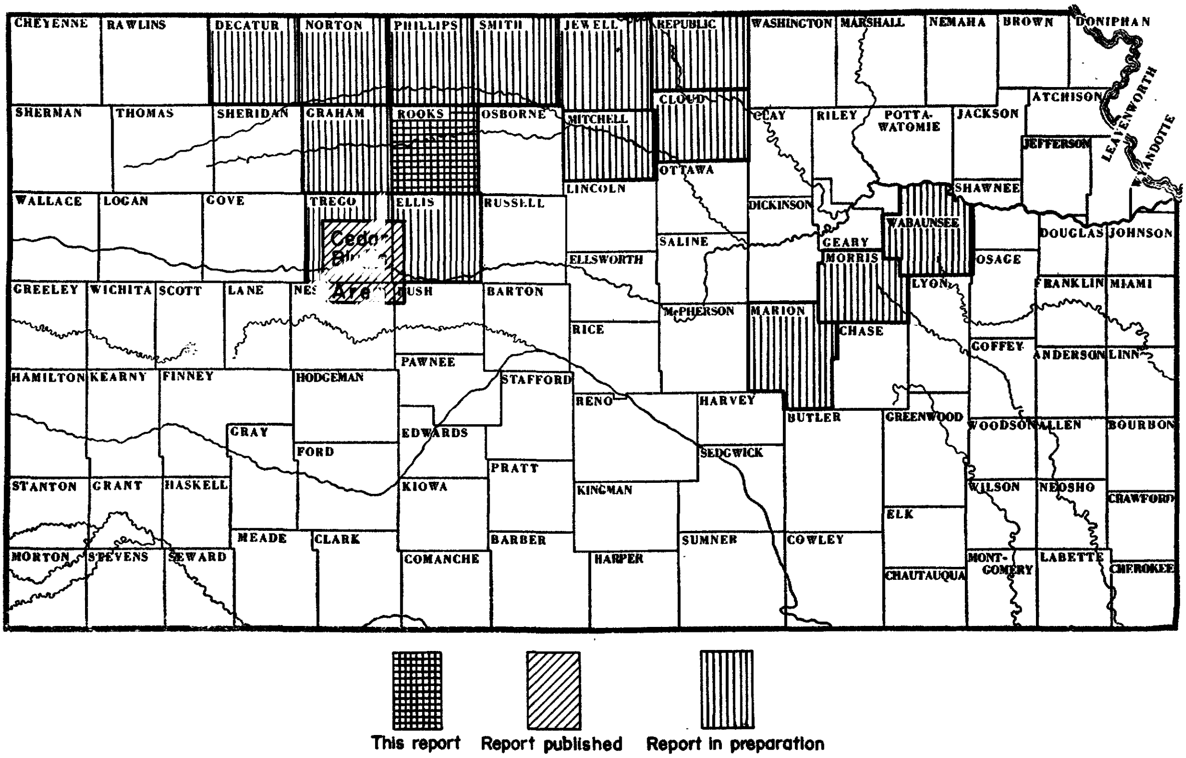


Figure 1.—Index map of Kansas showing areas covered by this and by other construction materials investigations.

Stockton. Kansas State Highway 18 nearly parallels the Union Pacific Railroad through the southern part of the county. The county and township roads follow or parallel section lines except in the more rugged parts of the county. Only a few of these roads are metaled, but most of them are maintained by grading.

Investigation procedure

The field work on which this report is based was of the reconnaissance type. The base map (Highway planning map, scale 1 inch equals 1 mile) was provided by the State Highway Commission of Kansas. Drainage lines were added to the base map for greater ground control in mapping; these were taken from aerial photographs (scale, 1 inch equals 1,000 feet) made available for that purpose by the Soil Conservation Service of the United States Department of Agriculture.

The areal distribution of the stratigraphic units that crop out in Rooks County was then mapped in the field. The mapped stratigraphic units are those recognized as of 1947 by the U. S. Geological Survey and the Kansas Geological Survey. Because the project is primarily concerned with construction materials, no attempt has been made to consider geologic problems not related to the occurrence of these materials.

An effort was made to accumulate all existing data pertaining to construction materials in the county. These data and their sources are incorporated in this report. In addition, the Geological Survey field party collected samples of construction materials not previously reported. The samples of sand and gravel were analyzed at Kansas State College in the laboratory of the Department of Geology. A simplified sieve analysis of a sample was made first. Mineralogical analyses of the resultant coarse fraction (defined as that portion of the sample retained on the no. 4 screen) and fine fractions were then made under a binocular microscope. This information and data from other sources are presented in table 1, Summary of materials tests.

Acknowledgments

Generous assistance in the compilation of the areal map and the data on construction materials was given by the following, to whom acknowledgment is made: State Highway Commission of Kansas at Topeka and Manhattan, Kans., S. E. Horner, chief geologist, R. D. Finney, materials engineer, and associates; State Geological Survey of Kansas, J. C. Frye, executive director; the county engineer of Rooks County; and the Rooks County office of the Soil Conservation Service, U. S. Department of Agriculture.

CHARACTERISTICS OF THE OUTCROPPING STRATIGRAPHIC UNITS

General

This discussion of the geologic formations cropping out in Rooks County emphasizes the areal distribution, general characteristics, and thickness of each stratigraphic unit. A representative measured section is given for each formation or member, and the construction materials in each unit are listed.

The measured sections are not necessarily intended to be complete, their purpose being chiefly that of giving a typical occurrence of a formation or member. The geologic information required for the location and effective exploitation of the construction materials are given in this part of the report.

The relations of the stratigraphic units to one another are illustrated in figure 2, Geologic cross section from Bow Creek south to the South Fork Solomon River, and a summary of the data for each unit is presented in figure 3, Outcropping stratigraphic units in Rooks County, Kans., and their construction materials.

Plate 1, Map showing construction materials and geology of Rooks County, Kans., shows the areal distribution of the local stratigraphic units and operating or prospect pits and quarries for construction materials. Each stratigraphic unit is indicated by an identifying symbol and its outcrop areas are shown by a distinctive pattern. Railroads, roads, and drainage lines are shown to provide a rough basis for evaluating the availability of construction materials sources.

Suitable symbols indicate whether a pit or quarry is operating, has been operated, or is a prospect. Other symbols indicate the type of construction materials available and the quantity of those materials (in units of 10,000 cubic yards) that can be removed under conditions of no more than moderate overburden (unconsolidated sediments less than 6 feet thick). Most of these sources are listed in table 1. The materials sources indicated on the map by inclined symbols have not been tested and are not listed in table 1. The materials listed in table 1 are numbered within each materials classification according to the following plan: The numbering starts in the northeasternmost township and continues along the same tier to the western boundary of the county. The numbering is continued in the next tier south, starting again with the township in the easternmost range and proceeding to the western boundary of the county, and so on. Within a township the sources are numbered in the same sequence as are the sections of the township.

Carlile shale

Areal distribution.—The Carlile shale, of Upper Cretaceous age (see fig. 3), is the oldest formation cropping out in Rocks County and is therefore the lowest exposed unit in the local stratigraphic section. This formation crops out most extensively along the southern border of the county (see pl. 1), where the southward-flowing tributaries of the Saline River have cut their valleys into the formation. This outcrop area extends from the eastern border of the county westward over about two-thirds of the width of the county. The Carlile shale crops out also in the base of the valley walls along the eastern half of the valley of the South Fork Solomon River and in similar topographic positions in the valleys at the mouths of several tributaries to this river. There are narrow outcrop bands of the formation in the eastern part of the valley of Paradise Creek. Elsewhere in the county the Carlile shale is concealed beneath younger formations.

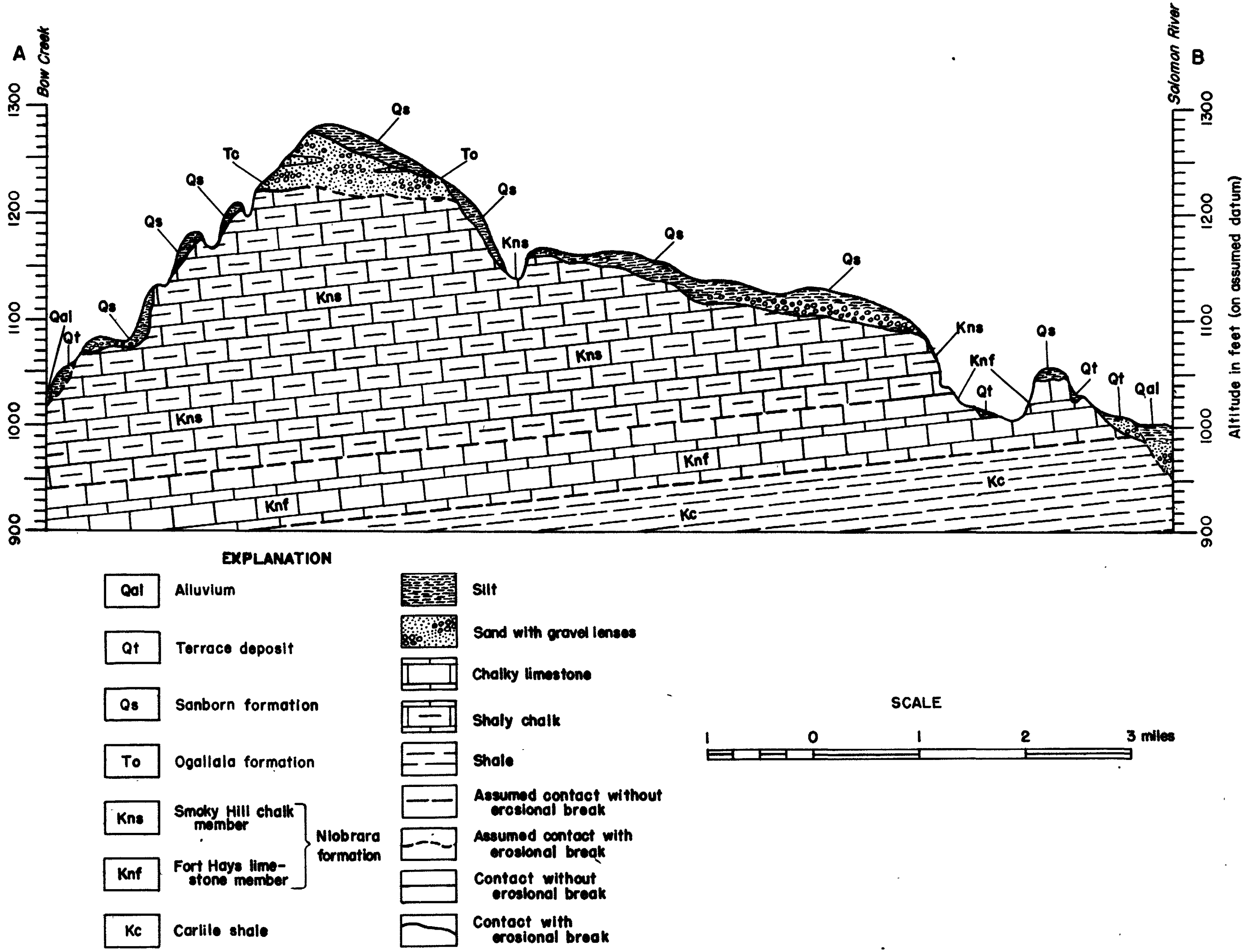
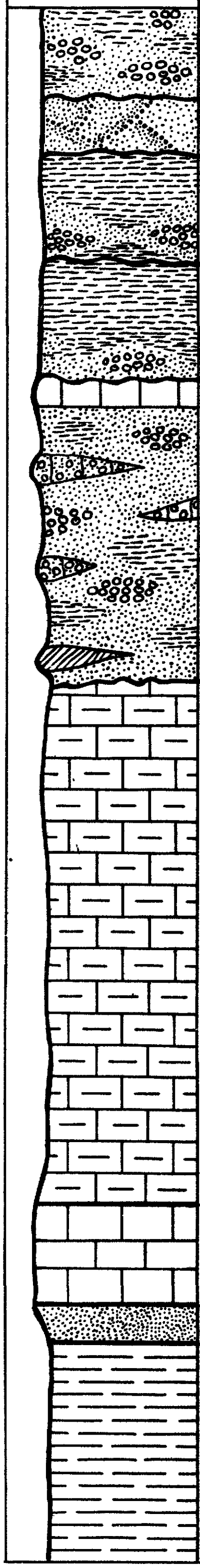


Figure 2.—Geologic cross section from Bow Creek south to the South Fork Solomon River along the line between R. 18 W. and R. 19 W.



Outcrop thickness (feet)	System	Series	Formations and members		Generalized description	Construction materials
0-50	Quaternary	Pleistocene and Recent	Alluvium		Tan to gray silt with interbedded lenses of sand and gravel.	Aggregate Road metal Mineral filler
0-30	Quaternary	Pleistocene and Recent	Dune sand		Light-gray to tan, fine-grained, cross-bedded quartz sand.	Blending sand
0-60	Quaternary	Pleistocene and Recent	Terrace deposits		Upper part, gray-brown silt; lower part, sand and gravel, tan to brown.	Aggregate Road metal Mineral filler
0-60	Quaternary	Pleistocene and Recent	Sanborn formation		Upper part, brown silt; lower part gray-brown silt and sand with lenses of coarse sand, limestone gravel, and volcanic ash.	Aggregate Road metal Volcanic ash Mineral filler
0-175	Tertiary	Pliocene	Ogallala formation		Sand, silt, and gravel, gray to brown; light-gray mortar bed and rusty green quartzite lenses; hard nodular limestone locally at top.	Road metal Riprap Aggregate Structural stone
0-300	Cretaceous	Upper Cretaceous	Niobrara formation	Smoky Hill chalk member	Blue-gray chalky shales interbedded with orange shaly chalks; forms badlands.	Road metal Calcareous binder
0-55	Cretaceous	Upper Cretaceous	Niobrara formation	Fort Hays limestone member	Massive cream to buff limestone separated by thin gray shales.	Structural stone Calcareous binder Road metal
0-20	Cretaceous	Upper Cretaceous	Carlile shale	Codell sandstone member	Gray, fine-grained sandstone.	
125	Cretaceous	Upper Cretaceous	Carlile shale	Blue Hill shale member	Black, thin-bedded clay shales with zones of septarian concretions and gypsum (selenite) crystals; forms badlands.	

Figure 3.—Outcropping stratigraphic units in Rooks County, Kans., and their construction materials

General description.—The Carlile shale was deposited in marine waters. Where it is overlain by the next younger Cretaceous formation, the Niobrara, there is no intervening erosional break; but in places where it is overlain by Tertiary or Quaternary deposits, erosional breaks are present. The Carlile shale is composed of three members; named in order from the base to the top of the formation these are the Fairport chalky shale, the Blue Hill shale, and the Codell sandstone. Only the Blue Hill shale member and Codell sandstone member crop out in Rooks County. The Fairport chalky shale member crops out along the Saline River a few miles to the south in the northeastern part of Ellis County.

The Blue Hill shale member is a thin-bedded to very thin bedded dark-gray to black clay shale. It weathers to a characteristic blue-gray color. Several zones of septarian concretions occur in the member as well as zones in which gypsum in the form of selenite crystals is extremely abundant. This member erodes to form a "badland" type of topography.

The Codell sandstone member overlies the Blue Hill shale member without an intervening erosional break. The upper part of the Codell is composed of fine-grained, clear quartz sand, which ranges in color from gray to tan. The lower part of the Codell is transitional into the underlying Blue Hill shale member. The Codell sandstone member, as defined by Bass,2/ includes two sandstone layers separated by a thick intervening shale layer.

Representative measured section.—The following section, measured in a road cut in the NE¼NE¼ sec. 21, T. 7 S., R. 18 W., shows the base of the Fort Hays limestone member of the Niobrara formation, the full thickness of the Codell sandstone member and the uppermost part of the Blue Hill shale member of the Carlile shale.

	Feet
Niobrara formation:	
Fort Hays limestone member:	
Top eroded. Limestone, chalky, massive, cream weathering buff; Inoceramus and Ostrea..........	3.5
Shale, chalky, very thin bedded, blue gray weathering buff......	.1
Limestone, chalky, massive, cream weathering buff; limonite concretions and stains; Inoceramus and Ostrea.....................	3.0
Shale, chalky, very thin bedded, blue gray weathering buff; limonite-stained...............	.1
Limestone, chalky, massive, cream weathering buff; limonite concretions and stains; silty in basal part; Inoceramus and Ostrea.......................	3.8
Carlile shale:	
Codell sandstone member:	
Sandstone, fine-grained, powdery, rust brown..................	0.3
Shale, clayey, very thin bedded, blue gray.....................	3.0
Shale, silty, blue to gray......	1.2
Shale, clayey, very thin bedded, blue gray.....................	2.1
Carlile shale—Continued	
Codell sandstone member—Continued	
Shale, silty, blocky, blue gray with limonite streaks...........	1.8
Sandstone, powdery, poorly cemented, gray weathering buff; irregular limonite stains.	4.2
Blue Hill shale member:	
Shale, silty, blocky, blue gray...	1.0
Shale, clayey, very thin bedded, blue gray with irregular limonite stains.................	3.0
Base covered.	16.6

2/ Bass, N. W., Geologic investigations in western Kansas, Part 1, Geology of Ellis County: Kansas Geol. Survey Bull. 11, pp. 27-28, 1926.

Thickness.—The outcrops of the Blue Hill shale member range in thickness from 8 feet to a maximum of 75 feet. The aggregate exposed thickness of this member in Rooks County is about 125 feet. The Codell sandstone member ranges from less than 1 foot to a maximum of about 20 feet, the average thickness being about 5 feet. The aggregate total thickness of the Carlile shale, as exposed in Rooks County, is about 145 feet.

Construction materials.—No engineering construction materials were found in the Carlile shale in Rooks County. The Codell sandstone member is too thin or, if thick enough, under an overburden too heavy for economical exploitation.

Fort Hays limestone member of Niobrara formation

Areal distribution.—The Fort Hays limestone member and the Smoky Hill chalk member constitute the Niobrara formation of Upper Cretaceous age. Inasmuch as the Fort Hays limestone is more important than the Smoky Hill chalk as a source of construction materials, the two members are mapped as individual units and will be described separately. (See pl. 1 and fig. 3.) The Fort Hays limestone member crops out along the walls of the major stream valleys and in the mouthward portions of the tributaries in the eastern two-thirds of Rooks County. This member forms conspicuous bluffs along the South Fork Solomon River, along the eastern part of Paradise Creek, and at the heads of tributaries to the Saline River along the southern border of the county.

General description.—The Fort Hays limestone member was deposited in marine waters. It is in contact with the underlying Codell sandstone member of the Carlile shale and with the overlying Smoky Hill chalk member of the Niobrara formation, without intervening erosional breaks. (See fig. 2.) The Fort Hays limestone member is composed predominantly of beds of soft, massive chalk which average about 3 feet in thickness. The chalk beds are separated by thin beds of chalky shale, usually 0.1 foot thick. The chalk is buff-colored on fresh surfaces and weathers to tan gray. The chalky shales are buff to tan gray. The Fort Hays limestone member includes fossil specimens of a clam (Inoceramus deformis) and an oyster (Ostrea congesta), which may be quite abundant in some zones.

Where the Fort Hays limestone member is at the surface, it characteristically weathers to form a "shattered" zone. The shattered zone usually is about 3 feet thick and consists of irregular flattish limestone fragments about 4 to 5 inches long and an inch or two thick.

All exposed stratigraphic units deposited during the Cretaceous period (fig. 3) dip generally toward the northwest, 10 to 15 feet to the mile. Minor faults (fractures) and folds (flexures) were observed in the Niobrara formation but are not mapped, inasmuch as they do not affect the construction materials characteristics of the formation.

Representative measured section.—The upper part of the measured section already given in this report in connection with the discussion of the Carlile shale is representative of the Fort Hays limestone member. A more complete section of the Fort Hays limestone member was found in a cut bank in the NW¼NE¼ sec. 12, T. 6 S., R. 18 W., but will not be cited here, as the section previously presented is thought to be adequate to serve the purpose of field recognition.

Thickness.—Outcrops of the Fort Hays limestone member average about 30 feet in thickness. The aggregate total thickness of the member in Rooks County is about 55 feet. The member is concealed beneath younger formations in most of the county, but along the valleys of the major streams and in the mouthward portions of their tributaries it has been entirely removed by erosion.

Construction materials.—
- Structural stone.
- Road metal.
- Calcareous binder.

Smoky Hill chalk member of Niobrara formation

Areal distribution.—The Smoky Hill chalk member of the Niobrara formation (Upper Cretaceous) crops out extensively in Rooks County. (See pl. 1 and fig. 3.) In the eastern two-thirds of the county this member generally overlies the basal member of the Niobrara formation, the Fort Hays limestone. The Smoky Hill unit crops out higher on the hillsides or nearer the heads of the draws than does the Fort Hays. In the western third of the county the Fort Hays limestone member, because of the regional dip, is well below the land surface, and the Smoky Hill chalk is the only member of the Niobrara formation exposed. The chalk crops out along most of the draws tributary to the major drainage lines. In the divide areas this member is concealed by the younger formations, Ogallala and Sanborn.

General description.—Like the other Cretaceous units that crop out in Rooks County, the Smoky Hill chalk member was deposited in marine waters. It overlies the Fort Hays limestone member without an erosional break, but conspicuous erosional breaks intervene between it and the overlying younger formations.

The Smoky Hill chalk member consists of layers of blocky or massive chalky shale, blue gray in the lower part but becoming orange gray in the upper part. Thin layers of gray to tan-gray massive chalk are interbedded with the chalky shales. Some zones in this member contain numerous specimens of a fossil clam, Inoceramus (Haploscapha) grandis, and an oyster, Ostrea congesta. An extensive outcrop area of the Smoky Hill chalk east of Webster has been eroded to form a badland type of topography. Probably other badland areas in the soft chalky shales of the Smoky Hill lie concealed beneath younger formations.

Representative measured section.—A cut bank in the NW¼SW¼ sec. 32, T. 7 S., R. 20 W., shows the following section:

	Feet
Smoky Hill chalk member of Niobrara formation:	
Top covered.	
Shale, chalky, very thin bedded, light gray weathering buff; limonite streaks; Ostrea	2.0
Shale, chalky, platy, light gray weathering buff, limonite streaks; Ostrea	.9
Shale, chalky, laminated, orange gray; limonite-stained; Ostrea	1.4
Shale, chalky, very thin bedded, orange gray weathering buff; Ostrea	.3
Shale, bentonitic, rust brown	.1
Limestone, chalky, blocky, buff gray	1.4
Shale, chalky, platy, orange and buff gray; Ostrea	3.0
Covered	1.8
Limestone, chalky, platy, buff gray, limonite-stained	.7
Shale, chalky, very thin bedded, buff; Ostrea	.7
Limestone, chalky, platy, light gray to white, weathering buff; Inoceramus, Ostrea	1.0
Shale, chalky, very thin bedded, alternating thin layers buff gray and orange; Inoceramus, Ostrea	4.8
Shale, chalky, platy to very thin bedded, blue gray; occasional pipe-like concretions of limonite; Inoceramus, Ostrea, fragments of fossil wood	15.0
Base covered.	33.1

Thickness.—The aggregate thickness of the Smoky Hill chalk member in Rooks County is thought to be about 300 feet. The maximum thickness exposed in any one outcrop is about 35 feet. The formation has been completely eroded from the valleys of the major streams and from the mouthward portions of their tributaries. It is extensively present under the divide areas but is concealed beneath younger formations.

Construction materials.—
- Road metal.
- Calcareous binder.

Ogallala formation

Areal distribution.—The Ogallala formation, of Pliocene age, crops out only in the higher divide areas in Rooks County. (See pl. 1 and fig. 3.) One such area is the divide in the southern half of the county that separates the streams flowing northward to the South Fork Solomon River from those flowing southward to the Saline River. The Ogallala crops out along the flanks of the divide as a series of thin, ribbon-like belts. At the crest of the divide the Ogallala is covered by the overlying Sanborn formation. There are discontinuous outcrops of the Ogallala near the northern county line on the flank of the divide separating the Bow Creek drainage from that of the South Fork Solomon River. In this area the Ogallala is generally obscured by the overlying Sanborn formation, and the outcrops are more or less isolated from each other.

Certain zones in the Ogallala formation are very similar in physical characteristics to zones in the overlying Sanborn formation, and in some places only an arbitrary line of contact can be drawn between the two formations. The differentiation is based upon the generally more silty character of the Sanborn formation and its more subdued topographic expression in contrast to the somewhat more sandy character of the Ogallala formation, its bolder outcrop expression, and the presence in it of lenses of quartzite and mortar beds.

General description.—The Ogallala formation overlies with an intervening erosional break the Smoky Hill chalk member of the Niobrara formation, the only older unit with which it is found in contact in this county. (See fig. 2.) The Ogallala is overlain by the Sanborn with an erosional break intervening between the two formations.

The Ogallala formation consists of interbedded lenses of sand, gravel, and silt. The lenses vary in thickness and extent. The bulk of the material was stream-deposited, although some of the beds may have been laid down on the floors of shallow lakes. The lower part of the formation is composed of somewhat coarser mineral and rock fragments than is the upper part.

This formation is characterized by "mortar beds," lenses of lime-cemented sand gravel, or sand and gravel. The lenses range in thickness from less than 1 foot to about 12 feet. Mortar beds make bold outcrops high on the flanks of the divides. The constituent rock and mineral fragments have been more or less firmly cemented by deposits of calcium carbonate laid down by percolating subsurface waters. The degree of cementation varies, some of the mortar-bed lenses being extremely well cemented and firm, whereas others are only poorly cemented and are easily crumbled. Mortar-bed ledges usually are light gray in color.

At many places there is a ledge of very dense, hard, compact limestone at the top of the Ogallala formation. The limestone is rather nodular and may be somewhat silicified. Its color usually is white or light gray. It is thought that this bed was deposited as a surface caliche.

Ledges of quartzite characterize the Ogallala formation in Rooks County as well as in adjacent counties. The quartzite is in the form of lenses of variable thickness and extent. The thickest ledge, 6 feet, was found at a locality known as Twin Mounds in the SE¼SE¼ sec. 4, T. 9 S., R. 17 W. The quartzite is the cap rock of the mounds. It is green, fine-grained, and firmly silica-cemented. Another conspicuous green quartzite ledge about 4 feet thick, is in the Ogallala outlier known locally as Sugar Loaf Mound, in the NW¼NW¼ sec. 10, T. 6 S., R. 19 W. This ledge consists of sand and scattered gravel rather firmly cememted by silica. Several small quartzite lenses about 2 feet thick crop out on the south wall of the valley of Bow Creek in the northwest corner of the county. The quartzite there is somewhat coarser than in the other two localities and not quite so well cemented.

Representative measured section.—A representative section of the Ogallala formation was measured by Frye and Swineford 3/ west of Sugar Loaf Mound, in the SE¼ sec. 8, T. 6 S., R. 19 W.

	Feet
Ogallala formation:	
7. Sand, loose, partly covered; contains carbonate nodules. Approximately at the same horizon as the lenticular quartzite forming the caprock of Sugar Loaf Mound...........	5.
6. Sand, loose, green; contains calcium carbonate nodules in lower part; cemented in upper part to a bench-forming ledge; contains root molds...........	4.5
5. Sand, silty, green; poorly cemented with calcium carbonate in lower part; upper 2 feet well cemented to a bench-forming ledge; contains *Celtis willistoni* (Cockerell) Berry..	11.
4. Covered........................	21.
3. Sandstone, cemented with calcium carbonate, silty in upper part, grains of lower part stained green; lower 2 feet green and partly silicified in SE¼NE¼ sec. 8, T. 6 S., R. 19 W..............	10.
2. Covered........................	21.
Niobrara formation:	
1. Chalky shale, blue gray.........	
Total..........................	72.5

Thickness.—The aggregate thickness of Ogallala formation in Rooks County is about 175 feet. Individual outcrops average about 35 feet thick. At one time the formation undoubtedly extended over the entire area of Rooks County, but subsequent erosion has removed it from all areas except the divides.

Construction materials.—
- Road metal.
- Riprap.
- Fine aggregate.
- Mixed aggregate.
- Structural stone.

Sanborn formation

Areal distribution.—The Sanborn formation, of Pleistocene and Recent(?) age, crops out more extensively in Rooks County than any other stratigraphic unit. (See pl. 1.) It overlies all older formations with an intervening erosional break (see fig. 2), although the break between the Sanborn and the Ogallala formations is not conspicuous because the two formations are lithologically similar. The Sanborn is a blanket of variable thickness capping most of the divide areas and forming a layer of material along the sides of many stream valleys. The formation once extended

3/ Frye, J. C., and Swineford, Ada, Silicified rock in the Ogallala formation: Kansas Geol. Survey Bull. 64, pt. 2, p. 44, 1946.

over the entire county but has been eroded along most of the stream courses.

General description.—The Sanborn formation includes unconsolidated sediments deposited by the wind, streams, slope wash, and through the action of gravity. Frye and Fent 4/ have subdivided the formation into members. It was not feasible to attempt to distinguish the various phases of the formation in the field mapping on which this report is based, as to do so would have required a greatly extended field program. The treatment of the Sanborn formation as an undivided unit is believed to be adequate to serve the purpose of this inventory of construction materials.

The upper part of the formation is predominantly silty with particles of sand and fine gravel scattered throughout. Conspicuous amounts of calcium carbonate are also present in the form of pipe-like structures, concretions, or disseminated material. The color of this part of the formation ranges from gray through gray brown to brown. The differences in color are thought to reflect the ground-water drainage conditions. The darker phases of the Sanborn are usually in topographic areas where ground-water drainage is slow. There is a well-developed soil zone at the top of the formation, and Hibbard, Frye, and Leonard 5/ have reported one or more buried soil zones in the formation.

The basal part of the Sanborn formation consists of silt, sand, and fine to medium gravel locally derived from other formations. It is generally coarser than the upper part and includes lenses of interbedded sand and gravel. In the areas where the formation overlies the Fort Hays limestone or the Smoky Hill chalk members of the Niobrara, lenses of limestone gravel, of local extent only, are often found in the base of the formation. Where the Sanborn overlies the Ogallala formation, lenses of sand and gravel, presumably dervied through the weathering and erosion of the Ogallala, are found. Bedding is usually well-developed. The color in this part ranges from tan to light brown.

Lenses of volcanic ash occur at or near the base of the Sanborn formation. The sites of accumulation were placed in the pre-Sanborn topography that were sheltered from the wind. The volcanic ash is fine-grained, white or light gray, and generally free from extraneous materials. Thin lenses of sand and gravel occasionally are interbedded with the ash.

The Sanborn formation is reported to contain fossil shells of snails (gastropods) and fragments of skeletons of vertebrates.

4/ Frye, J. C., and Fent, O. S., Late Pleistocene loesses of central Kansas: Kansas Geol. Survey Bull. 70, pt. 3, pp. 41-51, 1947.

5/ Hibbard, C. W., Frye, J. C., and Leonard, A. B., Reconnaissance of Pleistocene deposits in north-central Kansas; Kansas Geol. Survey Bull. 52, pt. 1, p. 13, 1944.

Representative measured section.—The following section of the Sanborn formation was measured in the SE¼SE¼ sec. 15, T. 6 S., R. 19 W.:

	Feet
Soil zone, dark gray-brown..........	1.1
Sanborn formation:	
Silt, calcareous with numerous nodules of calcium carbonate; gray............................	1.0
Silt, calcareous, nodules and pipes of calcium carbonate; rust gray.......................	2.2
Silt, calcareous, calcium carbonate disseminated and in nodules; light gray.............	3.0
Base covered.	6.2

Thickness.—The thickness of the Sanborn formation varies greatly over the county. It has been eroded from the major stream courses and their tributaries. In some other places there is only a feather edge of the material remaining. The maximum thickness is about 60 feet, the average about 25 feet.

Construction materials.—
- Mixed aggregate.
- Fine aggregate.
- Road metal.
- Volcanic ash.
- Mineral filler.

Terrace deposits

Areal distribution.—The terrace deposits are confined to the valleys of the major streams and their principal tributaries. The terrace deposits were laid down in at least two depositional cycles but are mapped as a single unit. (See pl. 1 and fig. 3.) The older and higher terrace is the more extensive.

The terrace deposits in the valley of South Fork Solomon River range in width from 1 mile to 2 miles, those in the valley of Bow Creek from a quarter of a mile to 1 mile, and those in the valley of Paradise Creek average about half a mile. Finger-like extensions of the terrace deposits project into the valleys of the smaller streams and usually are quite narrow.

General description.—The terrace deposits overlie other formations with an intervening erosional break. (See fig. 2.) The upper part of the terrace deposits is composed predominantly of red-brown to brown silt probably reworked from the Sanborn formation. Only the silty upper part of the terrace deposits is present in valleys other than that of the South Fork Solomon River. In this valley the terrace deposits lie high enough above the present floodplain of the river so that the basal part is exposed. This part is characterized by lenses of sand and gravel interbedded with silt. Much of the coarse material consists of fragments of soft chalky limestone of local origin.

Representative measured section.—Inasmuch as the terrace deposits in Rooks County are generally uniformly silty it is not necessary to cite any one section as typical of the formation.

Thickness.—The thickness of the various terraces could have been determined accurately only by test drilling, and such data are not available for Rooks County. The total thickness of the terrace deposits in the valley of the South Fork Solomon River is estimated to be about 60 feet; in Bow Creek Valley, about 30 feet; and in the valley of Paradise Creek, about 20 feet. The terrace deposits in the small tributary valleys are from 3 feet to about 15 feet thick.

Construction materials.—
Mixed aggregate.
Fine aggregate.
Road metal.
Mineral filler.

Dune sand

Areal distribution.—Three dune sand areas are mapped on plate 1. The most extensive of these is on the south side of Bow Creek in sec. 8, T. 6 S., R. 19 W. The other two areas are along the South Fork Solomon River, one near Webster in the SW¼ sec. 36, T. 7 S., R. 19 W., and the other near Woodston in the E½ sec. 16, T. 7 S., R. 16 W.

General description.—The dune sand (see also fig. 3) is a fine-grained quartz sand, light tan to gray, and cross-bedded. The flood plains of the South Fork Solomon River and Bow Creek are the sources of the material that was reworked by the wind to form the dunes. Dune sand areas are characterized by a hummocky topography. Some of the dunes in the Woodston area are 25 to 30 feet high. Dunes in the other areas have a maximum height of about 10 feet.

Representative measured section.—No section of the dune sand was measured because of the uniformity of the material composing this stratigraphic unit.

Thickness.—The maximum thickness of the dune sand in Rooks County is about 30 feet, the average being 10 to 15 feet.

Construction material.—
Blending sand.

Alluvium

Areal distribution.—The deposits formed by streams in their present gradational cycles are mapped as alluvium. (See pl. 1.) The alluvial deposits and the sand dunes constitute the most recent stratigraphic units in the county. (See fig. 3.) There are alluvial deposits along the South Fork Solomon River and along Bow Creek. The alluvium of the river valley varies in width from a quarter of a mile to three-quarters of a mile. Short extensions of the alluvium project into the valleys tributary to the river and to Bow Creek.

General description.—The material composing the alluvium in Rooks County usually is silty. Locally, the alluvium of the South Fork Solomon River is fine sandy or, in a few places, gravelly. It is probable that at some distance below the floodplain surface the alluvial material is coarser.

Representative measured section.—The relief of the alluvium is so low that a representative section could not be measured.

Thickness.—It is estimated that the maximum thickness of the alluvium in the valley of South Fork Solomon River is about 50 feet. Alluvium in Bow Creek Valley probably is no more than 20 or 25 feet thick.

Construction materials.—
Fine aggregate.
Mixed aggregate.
Mineral filler.

INVENTORY OF CONSTRUCTION MATERIALS

General

This part of the report inventories the construction materials in Rooks County. Its objectives are to establish the bases upon which the construction materials are classified and to establish the geologic pattern required for the location and exploitation of the materials at those places in the county where they may be needed.

All available laboratory test data have been included in the report to aid the engineer in his evaluation of the materials. This information is given in table 1, Summary of materials tests. Data on samples collected by the Geological Survey field party are not so precise as the data on grading and test characteristics developed in a materials-testing laboratory. It is expected that the prospects listed in this report will be proved by subsequent augering, drilling, or test pitting and that the materials themselves will be subjected to laboratory testing prior to exploitation.

Aggregate for concrete

Engineering and geologic characteristics

Aggregates for concrete are distinguished as fine aggregates or mixed aggregates in table 1. The distinction is based on the percentage of material retained on the No. 4 screen. Those materials in which 5 percent or more of the sample was retained are classified as mixed aggregates. For convenience, however, both will be discussed under a single heading, inasmuch as the fine aggregates may be sweetened to the gradings required of mixed aggregates.

Aggregates for concrete consist of particles of hard, durable minerals or rocks of sand or gravel size. The constituent particles are free from adherent coatings that would interfere with the bonding of cement with the material. The operated or prospect pits listed in table 1 or located on plate 1 are those in which the overburden is thin enough to permit profitable exploitation of the material.

Stratigraphic sources and performance characteristics

The following stratigraphic units are actual or potential sources of aggregates for concrete in Rooks County:

(1) Ogallala formation.—Numerous prospect and operated pits for both fine and mixed aggregates are listed in table 1 (fa 12-18, 22-25; ma 1, 2, 9, 14-16) and mapped on plate 1. The Ogallala formation is probably the most important potential source of aggregate for concrete in Rooks County. The coarse fraction of samples of the Ogallala

formation is composed predominantly of silt and clay balls; subordinately of fragments of quartz, chert and opal, and granite, with a minor amount of feldspar. The high percentage of silt and clay balls and of chert and opal fragments might mitigate against the use of this material as aggregate for concrete. The fine fraction of the Ogallala samples is composed predominantly of particles of feldspar, with minor amounts of chert, hornblende, magnetite, and calcite.

The characteristics of the samples tested indicate an average weight of 111 pounds per cubic foot; an average specific gravity of 2.6; a 31 percent loss under the Los Angeles abrasion test; and a soundness ratio of 0.94 after 25 freeze-and-thaw cycles.

Sand and gravel zones are numerous in the Ogallala formation. In many places, however, overlying mortar-bed ledges present problems in removing the overburden. In other places the overlying Sanborn formation is so thick that it obscures Ogallala formation or forms an excessively thick overburden. Intensive exploration of the Ogallala outcrop area extending east and west from the city of Plainville should yield additional pit sites. The Ogallala formation is exposed to best advantage in the headward parts of small tributary valleys. The outcrop area in the northwest corner of the county, along the south wall of the valley of Bow Creek, might also be explored.

(2) Sanborn formation.—Ten prospect or operated pits for fine aggregate (fa 1-5, 8, 11, 19-21) and one for mixed aggregate (ma 13) are listed in table 1 and indicated on plate 1. Analyses of samples indicate that the coarse fraction is composed predominantly of fragments of granite and local limestone, subordinately of particles of quartz and chert or opal, with minor amounts of feldspar and calcite. The fine fraction is composed predominantly of particles of quartz, with a subordinate amount of feldspar, and minor amounts of chert, calcite, magnetite, and hornblende. The abundance of particles of soft local limestone might be deleterious for use of this material as aggregate for concrete.

Laboratory tests of aggregate material in the Sanborn indicate an average weight of 111 pounds per cubic foot; an average specific gravity of 2.7; a 32 percent loss under the Los Angeles abrasion test; and a soundness ratio of 0.96 after 25 freeze-and-thaw cycles.

Prospects for aggregate materials in the Sanborn formation are restricted to its basal part. The sands and gravels occur as lenses, usually of very local extent. Additional pit sites may be found in places where the larger tributaries have cut well down into the formation, thus exposing the coarse basal part.

(3) Terrace deposits.—Four samples classified as fine aggregate (fa 6, 7, 10, and 26, table 1 and plate 1) and seven samples classified as mixed aggregate (ma 3-6, 10-12) were collected from terrace deposits. The coarse fraction of the samples consists predominantly of particles of soft local limestone and fragments of granite; subordinate constituents are particles of quartz, chert, and feldspar. The fine fraction is composed predominantly of quartz, subordinately of feldspar and calcite, with minor amounts of limestone, chert, hornblende, and magnetite. The average test characteristics of the samples of terrace deposits are as follows: Weight, 109 pounds per cubic foot; specific gravity, 2.6; Los Angeles abrasion test, 33 percent loss; and soundness ratio of 0.80 after 25 freeze-and-thaw cycles.

The basal part of the terrace deposits is the productive zone for aggregate; the upper part is composed entirely of silt. In Rooks County the basal part containing the sand and gravel crops out in the valley of South Fork Solomon River. Other pit sites can be located by exploration of outcrops of the basal terrace deposits, particularly in the eastern half of the river valley.

(4) Alluvium.—Several pits have been operated in the alluvium of the South Fork Solomon River. (See table 1 and pl. 1.) The material from one pit (fa 9) is classified as fine aggregate, but the material from two other pits (ma 7 and 8) is classified here as mixed aggregate. No information is available on the mineral composition of the material. The average weight of the three samples is 111 pounds per cubic foot; the average specific gravity is 2.6; the percentage of loss in the Los Angeles abrasion test is 34 percent; and the soundness ration after 25 freeze-and-thaw cycles is 0.77. Other pits could be opened in the alluvial deposits of South Fork Solomon River. The sands and gravels, however, are rather local in extent, the bulk of the alluvium being silt. Surface prospecting should be adequate to locate sites convenient for exploitation.

As far as could be determined by interviews with county officers and with local contractors, the sources of aggregate for concrete listed above have not been so used. The aggregate materials used in Rooks County are procured from areas outside the county.

Road metal

Engineering and geologic characteristics

As defined in this report, road metal is any material that may be applied to roads as a surfacing agent. The materials are widely diverse in their engineering and geologic characteristics. Some of them are quartz sand with a varying content of gravel. Others are crushed rock of various composition. The engineering requirement is that the material added to the road improve the performance characteristics of the road. Many geologic materials fulfill this requirement. The materials discussed previously as aggregate for concrete have been used as road metal on secondary roads in Rooks County. Field observation indicates that they are adequate for this purpose.

Stratigraphic sources and performance characteristics

(1) Sanborn formation.—The basal part of the Sanborn formation yields a material classified by the State Highway Commission of Kansas as limestone gravel. This material consists of rounded fragments of soft local limestones (Niobrara formation) about three-fourths of an inch long, with silt intermixed. Limestone gravel is extensively used throughout north-central Kansas as road metal on secondary roads.

Deposits of limestone gravel are local inasmuch as they occur only as lenses in the basal part of the Sanborn formation. The greatest concentration of this material in the Sanborn formation is in those areas where the formation overlies the Carlile shale. The limestone fragments were derived from beds of the Fort Hays limestone exposed nearby and, to a lesser extent, from chalk beds in the Smoky Hill chalk member of the Niobrara formation.

Characteristics of this material are given in table 1, and seven operated pits are listed.

(2) Ogallala formation.—In addition to sand and gravel, ledges of mortar bed and quartzite in the Ogallala formation are now used or are potentially useful as road metal. Ledges of mortar bed can be crushed in a portable jaw crusher and the resultant material applied to the roads. The sand and gravel particles in the mortar bed would be bound by the calcium carbonate cement to form a traffic-bound macadam. Mortar-bed material has been used in other Kansas counties for this purpose. Mortar-bed ledges are fairly well distributed over the outcrop area of the Ogallala formation.

Ledges of quartzite can be quarried and the material crushed in portable jaw crushers for application as road metal. This use of crushed quartzite was observed in Norton County. Field observation indicates, however, that the quartzite should be crushed so that the largest dimension of the particles is less than half an inch. Particles of larger size tend to "kick out" from the road. It is probable that a binder material added to the crushed quartzite would lessen this tendency. Roads in Wisconsin metaled in this way have given satisfactory performance. The localities in which quartzite crops out are given in this report in the section on the Ogallala formation.

Thin ledges of dense, hard, nodular limestone present at the top of the Ogallala formation might also be used for road metal in the same manner as quartzite. The ledges of nodular limestones, however, are too thin and too small for economical exploitation.

(3) Blue Hill shale member of the Carlile shale.—The thin-bedded clay shales of the Blue Hill shale member of the Carlile shale have been used as road metal in Rooks County. The results have been so unsatisfactory that this use has been abandoned.

(4) Niobrara formation.—Both the Fort Hays limestone member and the Smoky Hill chalk member of the Niobrara formation have been crushed and applied to secondary roads in Rooks County. The material forms a traffic-bound macadam. Field observation of roads of this type indicates that the material produces a good all-weather road. In dry weather, however, traffic causes clouds of fine, white dust to be blown free. It is possible that dry-weather "dusting" could be lessened by impregnating the road with a solution of calcium chloride, providing the humidity is sufficiently high (50 percent or higher).

Additional quarries, as needed, could be opened in this formation throughout most of the extent of its outcrop. (See pl. 1).

Mineral filler

Engineering and geologic characteristics

This material is composed of mineral fragments of silt size. A small percentage of fine sand and a subordinate percentage of clay may be present. To be classified as mineral filler the material must not contain more than a trace of sticks or other organic debris.

Stratigraphic sources and performance characteristics

Mineral filler is the most abundant construction material in Rooks County. It occurs in three stratigraphic units and is almost universally distributed over the county.

(1) Sanborn formation. The upper silty part of the Sanborn formation is the most widespread source of mineral filler in Rooks County. This part of the formation is composed almost entirely of silt-size particles with only minor quantities of particles of sand or gravel size intermixed with the silt. There may be a fairly thick soil zone at the top of the formation and a buried soil zone from 5 to 10 feet below the top. The B zone of the soil profile may contain deleterious amounts of calcium carbonate, either in the form of nodules and pipes or disseminated through the zone. The State Highway Commission of Kansas 6/ recommends that silt from the Sanborn formation be used as mineral filler only if tests of the material indicate a low coefficient of cementation. Mineral filler could be procured from the Sanborn formation over almost the entire area of its outcrop.

(2) Terrace deposits. Terrace deposits are the second most important source of mineral filler in Rooks County. The upper part of the formation is composed entirely of silt-size particles. The principal outcrop areas of the terrace deposits in Rooks County are, in order of importance, in the valleys of South Fork Solomon River, Bow Creek, and Paradise Creek.

(3) Alluvium. Much of the alluvium of the floodplain of South Fork Solomon River is composed of silt-size particles, but with more extensive sources of mineral filler available in the nearby terrace deposits and in the Sanborn formation it is doubtful that it would be worth while to exploit the allivium of South Fork Solomon River for this material.

Blending sand

Engineering and geologic characteristics

Blending sand is composed of sand-size particles, predominantly of quartz. As it occurs in Rooks County the material may be intermixed with a low percentage of silt. The upper part may include a well-developed soil zone.

Stratigraphic source and performance characteristics

Fine dune sand is the only source of blending sand mapped in Rooks County. The material occurs in three areas in the county—

6/ Horner, S. E., chief geologist, State Highway Commission of Kansas, letter dated Jan. 4, 1947.

near Webster, near Woodston, and along Bow Creek. It is probable that a coarser sand for blending can be obtained by screening the material from the aggregate sources mentioned previously.

There is no record of dune sand being used in Rooks County as blending sand.

Volcanic ash

Engineering and geologic characteristics

Volcanic ash consists predominantly of the fine, glass-like shards ejected during the explosive phase of a volcanic eruption. It may include silt-size particles of other origin. Thin seams of gravel and sand are interbedded with the volcanic ash in many places.

Stratigraphic source and performance characteristics

The Sanborn formation is the only stratigraphic unit in Rooks County in which volcanic ash has been found. The material occurs as lenses at or near the base of the formation. Five operated or prospect pits are listed in table 1 and mapped on plate I. The material has been widely used throughout this area in the construction of roads of the black-top type.

Riprap

Engineering and geologic characteristics

Riprap is any material suitable for protecting earthen fills from erosion. To be acceptable for this use the stone must be relatively sound and free from cracks and other structural defects or impurities that would cause it to disintegrate. The stone should be in blocks having approximately rectangular faces 7 inches or more in width. The specific gravity of the rock should be 2.5 or higher.

Stratigraphic sources and performance characteristics

(1) Ogallala formation.—Quartzite lenses in the Ogallala formation are adequate sources of riprap, although the quartzite is difficult to quarry. The material has a fairly high specific gravity, little abrasion loss, and is sound. (See table 1.) Some of the quartzite ledges in Rooks County are sufficiently thick to fulfill the requirement for minimum size of blocks. Smaller fragments of this rock would serve adequately as material for filter bed. Field observation of Logan Lake in Phillips County indicates that the quartzite of the Ogallala is entirely satisfactory when used as riprap. No perceptible deterioration was detected 6 years after installation. The known areas of outcrop of quartzite ledges are given in this report in the section on the Ogallala formation.

(2) Fort Hays limestone member of the Niobrara formation.—Several earthen dams riprapped with limestone blocks from the Fort Hays limestone member were observed in north-central Kansas, including the Lake Stockton dam southwest of Stockton. In all of these the riprap material had deteriorated so markedly, presumably through slaking or freeze-and-thaw, that further use for this purpose is inadvisable.

Structural stone

Engineering and geologic characteristics

Structural stone, as defined in this report, is any hard, uniform-textured rock material that can be quarried and cut to desired size and form. The sources of such material in Rooks County are somewhat deficient in one respect or another, as indicated in the following descriptions.

Stratigraphic sources and performance characteristics

(1) Fort Hays limestone member of the Niobrara formation.--This rock has been used extensively throughout Rooks County as a structural stone for dwellings, farm buildings, and, to a lesser extent, for bridge abutments. The stone hardens after being cut, and structures built of it seem to stand up well in the relatively dry climate of north-central Kansas. Field observations indicate that the Fort Hays limestone should not be used in any place where it is subjected to water saturation unless protected by a cement cover coat, as it deteriorates rapidly when saturated. Additional quarries could be opened at convenient sites in the outcrop area. (See pl. 1.)

(2) Ogallala formation. Quartzite ledges in the Ogallala formation have been quarried extensively in north-central Kansas for structural stone. Numerous city and county buildings and several bridges constructed of this material were observed. It is the opinion of some engineers that the opal of the quartzite is reactive with standard cement to the detriment of a structure in which the quartzite is used as a structural stone or as a constituent of concrete aggregate. No field evidence of this type of failure was observed. The stone, however, is so hard that cutting it to required size and shape is difficult.

Occasional use of hard mortar-bed ledges in the Ogallala formation as a source of structural stone for farm buildings, such as barns, was observed in north-central Kansas. This material is not uniformly hard and appears to deteriorate seriously within a few years.

Calcareous binder

Engineering and geologic characteristics

Calcareous binder includes a variety of geologic materials. They are composed essentially of calcium carbonate, are soft, and are easily pulverized.

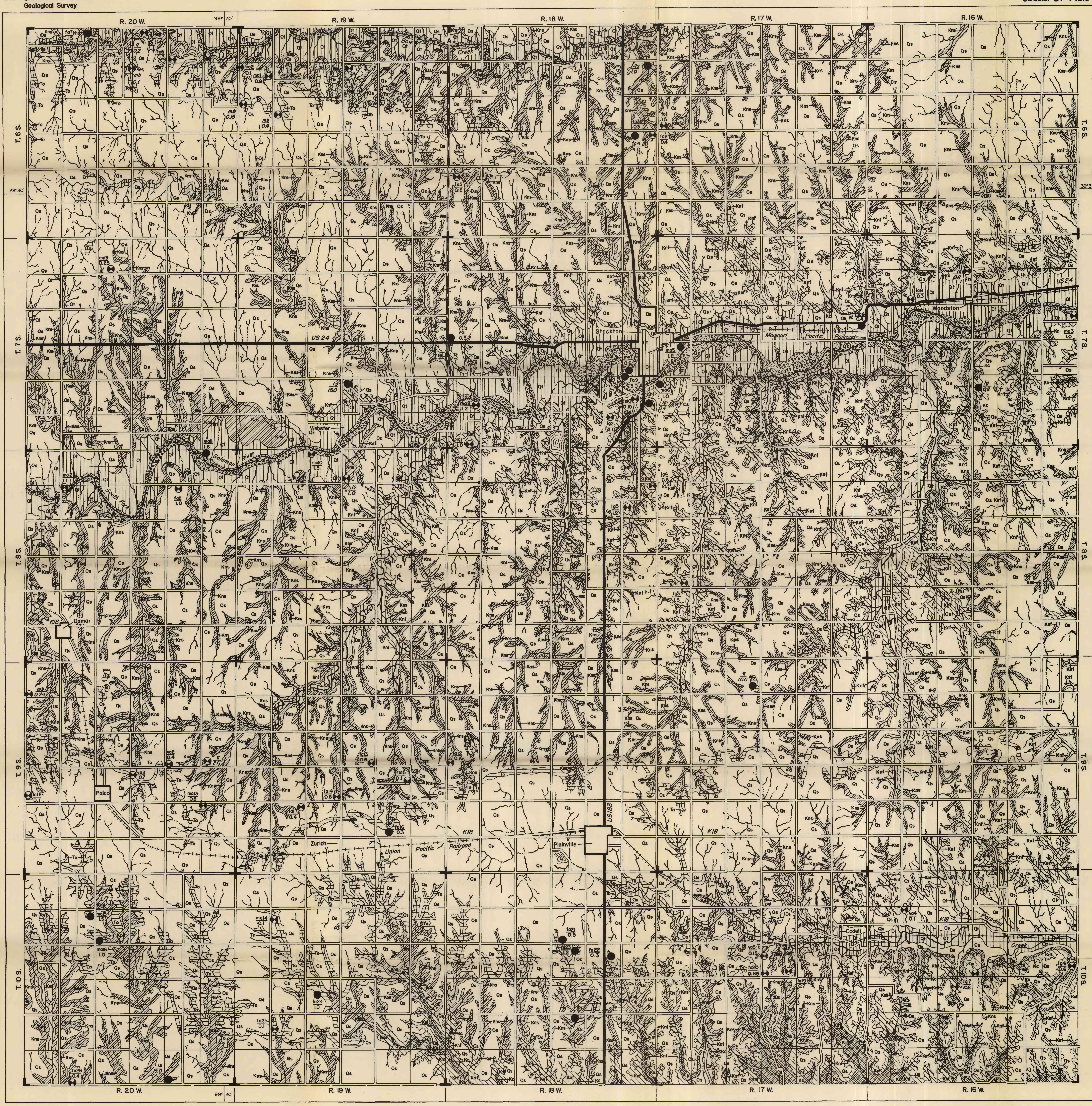
Stratigraphic sources and performance characteristics

(1) Ogallala formation. Lenses of mortar bed described in this report in the section on the Ogallala formation are sources of calcareous binder. Although some of the mortar-bed lenses are perhaps too hard to be so used, many others are soft enough to be easily pulverized and would serve adequately as a binder material.

(2) Niobrara formation.—Both the Smoky Hill chalk and the Fort Hays limestone members of the Niobrara formation have been accepted by the State Highway Commission of Kansas as sources of material suitable for use as calcareous binder. The chalky limestones are soft, easily pulverized, and free from deleterious substances. The Niobrara formation (see pl. 1) is the most widespread source of calcareous binder in Rooks County.

U. S. Department of the Interior
Geological Survey

Circular 27 Plate 1



EXPLANATION

QUATERNARY — Pleistocene and Recent

Alluvium (Qal)
(Tan to brown silt with interbedded lenses of sand and gravel. Source or potential source of *AGGREGATE. ROAD METAL, MINERAL FILLER.*)

Dune sand (Qds)
(Gray to tan, fine-grained, cross-bedded quartz sand. Potential source of *BLENDING SAND.*)

Terrace deposits (Qt)
(Upper part, gray-brown silt; lower part, tan to brown sand and gravel. Source or potential source of *AGGREGATE, ROAD METAL, MINERAL FILLER.*)

Sanborn formation (Qs)
(Upper part, gray to brown silt; lower part, gray-brown silt and sand with lenses of sand, limestone gravel, and volcanic ash. Source or potential source of *AGGREGATE, ROAD METAL, VOLCANIC ASH, MINERAL FILLER.*)

TERTIARY — Pliocene

Ogallala formation (To)
(Sand, silt, and gravel, gray to brown; lenses of light-gray mortar bed and green quartzite; hard nodular limestone locally at top. Source or potential source of *ROAD METAL, RIPRAP, AGGREGATE, STRUCTURAL STONE.*)

CRETACEOUS — Upper Cretaceous

Niobrara formation
Kns, Smoky Hill chalk member
(Blue-gray chalky shales interbedded with orange shaly chalks; forms badlands. Source of: *ROAD METAL, CALCAREOUS BINDER.*)
Knf; Fort Hays limestone member
(Massive cream to buff chalky limestones separated by thin gray shales. Source of *STRUCTURAL STONE, ROAD METAL, CALCAREOUS BINDER.*)

Carlile shale
(Black, thin-bedded clay shale with zones of septarian concretions and selenite (gypsum) crystals; forms badlands; thin tan sandstone at top.)

Geologic boundary
Operated pit or quarry
Prospect pit or quarry
ls Limestone
q Quartzite
mb Mortar bed
fa Fine aggregate
ma Mixed aggregate
va Volcanic ash
lg Limestone gravel
ma Inclined letters indicate materials not tested
ma2 Vertical letters indicate materials listed in table 2 and their sample numbers
1.0 Quantity of material available (in units of 10,000 cubic yards)

Federal (US) highway
Other roads, all classes
Railway
City
Section line
Township corner
Stream, permanent
Stream, intermittent
Lake, artificial
A—B Line of cross section, figure 2 (on north-south road between R. 18 W. and R. 19 W. from Bow Creek south to the Solomon River)

11° True North Magnetic North
Approximate mean declination, 1947

Scale 0 1 2 3 4 miles

Base adapted from maps provided by the State Highway Commission of Kansas
Drainage from aerial photographs provided by U. S. Department of Agriculture

Geology by F. E. Byrne, H. V. Beck, and M. S. Houston

MAP SHOWING CONSTRUCTION MATERIALS AND GEOLOGY OF ROOKS COUNTY, KANSAS

1949

Table 1. Summary of materials tests

(Blank spaces indicate data not available)

Classification of the material	Map number	Location: 1/4 fraction	Location: 1/4 section	Location: Section	Location: Township (S)	Location: Range (W)	Estimated quantity of material (cubic yards)	Average thickness: Material (feet)	Average thickness: Overburden (feet)	Accessibility	Geologic formation or member	Authority for test data[1]	Date of test	Sieve analysis: Percent on 1/2 inch	Percent on 3/8 inch	Percent on No. 4	Percent on No. 16	Percent on No. 100	Percent passed No. 200 (wash)
Fine aggregate	fa1		SW	18	6	17	15,000	9	3	Good	Sanborn	SHCK	2-46	0		2	30	95	3
	fa2	NE	NE	24	6	18	4,000	9	1-4	do	do	do	do	0		3	37	96	3
	fa3	NE	NW	24	6	18	3,000	6	1-4	Fair	do	SHCK USGS	2-47	0		1	15	96	
	fa4		NW	24	6	18	40,000	7	3	Good	do	SHCK	2-46	1		3	33	93	3
	fa5	NE	NW	30	6	18	1,500	5	2-6	do	do	SHCK USGS	2-47	0		0	6	98	
	fa6	SW	SW	2	6	20	3,000	8	2-4	Fair	do	do	do	0		2	23	98	
	fa7	NW	NE	5	6	20	1,500	6	2-6	Good	Terrace deposit	do	do	0		3	20	99	
	fa8	SE	SW	8	7	16	3,000	6	0-3	do	Sanborn	do	do	0		3	25	97	
	fa9		SW NW	24 25	7	18	30,000	22	0	Fair	Alluvium	SHCK	2-46	0		0	1	94	2
	fa10		C	25	7	18	1,500	6	1-6	Good	Terrace deposit	SHCK USGS	2-47	0		2	14	98	
	fa11	NE	NW	11	8	20	1,000	6	4-6	do	Sanborn	do	do	0		1	8	98	
	fa12	SW	SW	18	9	18	1,600	6	1-4	do	Ogallala	do	do	0		1	20	97	
	fa13	SE	SE	15	9	19	8,000	5	1-2	do	do	do	do	0		4	30	98	
	fa14	SE	SE	21	9	19	8,000	6	1-3	do	do	do	do	0		3	36	98	
	fa15	SE	NE	23	9	19	1,000	3	1-2	do	do	do	do	0		3	28	96	
	fa16	SE	SW	26	9	19	3,000	8	1-3	do	do	do	do	0		0	9	98	
	fa17		NE	29	9	19	4,000	9	3-9	do	do	SHCK	2-46	0		4	45	93	4
	fa18	SW	SW	19	9	20	1,000	6	2-5	do	do	SHCK USGS	2-47	0		0	5	95	
	fa19		SE	15	10	17	7,000	5	3	do	Sanborn	SHCK	2-46	0		2	28	93	
	fa20	SW	SW	15	10	17	6,500	7	4	do	do	do	do	0		2	32	92	5
	fa21	SE	SW	10	10	18	3,000	12	2-6	do	do	SHCK USGS	2-47	0		1	25	99	
	fa22	SW	NE	14	10	18	3,000	6	2-4	Good	Ogallala	do	2-47	0		1	17	98	
	fa23		NE	15	10	18	12,000	10	3	do	do	SHCK	2-46	0		2	25	93	4
	fa24	SE	NW	21	10	19	10,000	10	1-3	Fair	do	SHCK USGS	2-47	0		0	23	98	
	fa25	SW	NW	29	10	19	1,000	5	1-4	Good	do	do	do	0		3	7	98	
	fa26	SE	SW	32	10	20	4,000	6	1-4	do	Sanborn	do	do	0		4	12	99	
Mixed aggregate	ma1		NE	7	6	19	8,000	11	1	do	Ogallala	SHCK	2-46	1		4	42	93	5
	ma2	NW	NW	7	6	19	1,000	4	2-4	Fair	do	SHCK USGS	2-47	7		19	40	97	
	ma3		NE	13	7	16	10,000	8	3	do	Terrace deposit	SHCK	2-46	1		6	26	96	3
	ma4	NE	SE	13	7	17	4,000	10	2-5	Good	do	do	do	1		5	35	96	2
	ma5	NW	NE	19	7	17	12,000	12	4-6	do	do	SHCK USGS	2-47	0		6	23	99	
	ma6		NW	30	7	17	10,000	8	0-1	Fair	do	SHCK	2-46	2		6	25	98	1
	ma7	S½	SW	24	7	18	6,000	8	2	Good	Alluvium	do	do	2		6	28	97	2
	ma8		SE	30	7	18	12,000	11	0	Fair	do	do	do	2		5	27	98	1
	ma9	SE	SW	4	7	20	2,500	9	2-4	Good	Ogallala	SHCK USGS	2-47	0		9	24	98	
	ma10		NW	4	8	19	15,000	10	0	Fair	Terrace deposit	SHCK	2-46	2		4	26	98	1
	ma11	NW	NW	1	8	20	16,000	7	1	Good	do	do	do	4		8	33	96	2
	ma12		NW	8	8	20	15,000	10	0	do	do	do	do	2		4	32	98	1
	ma13		NW	25	9	20	8,000	9	4	do	Sanborn	do	do	1		4	43	94	3
	ma14	SW	NW	8	10	19	1,000	4	1-3	do	Ogallala	SHCK USGS	2-47	0		6	16	98	
	ma15	NE	NE	8	10	20	15,000	17	3-5	do	do	do	do	6		11	47	99	
	ma16	SW	SW	9	10	20	10,000	8	2-4	do	do	do	do	0		5	47	98	
Limestone gravel	lg1		SE	31	7	18	10,000	4	1	Fair	Sanborn	SHCK	2-46		9	27	52	70	25
	lg2	NW	NE	35	7	18	40,000	4	1-8	Good	do	do	do		6	20	44	74	23
	lg3		SE	19	8	17	15,000	6	3	do	do	do	do		9	25	53	72	23
	lg4		NE	12	8	18	6,000	6	1	Fair	do	do	do		6	20	45	63	30
	lg5		SW	12	8	18	12,000	5	4	Good	do	do	do		12	24	44	70	25
	lg6		SE	13	10	16	6,000	7	1-2	do	Terrace deposit	do	do		6	23	52	70	25
	lg7		SW	15	10	16	8,000	10	4	Fair	Sanborn	do	do		15	30	55	70	26
Volcanic ash	va1	SW	SW	18	7	18	5,000	15	1-10	Good	do	SHCK USGS	2-47				0	4	65
	va2	SW	SW	14	9	20	4,000	6	0-4	do	do	do	do				0	8	50
	va3	NW	NW	22	9	20	7,000	20	0-5	do	do	do	do				0	6	55
	va4	NW	NW	8	10	16	1,000		0-2	do	do	do	do				0	10	60
	va5	SW	NW	15	10	17	1,500	2	0-4	do	do	do	do				0	20	50
Qtzite	q1	NW	NW	10	6	19	3,500	5	0-2	Fair	Ogallala	CE	9-45	Chemical composition (percent): SiO_2, 96.5; Al_2O_3, 0.78; Fe_2O_3, 0.32; CaO, 0.44; MgO, 0.06; undetermined, 0.58; soluble in HCl acid, 5.10.					

Map number	Description of the material[2]: Fraction	Limestone	Mortar bed	Quartz	Chert	Feldspar	Granite	Quartzite	Shale	Clay and silt pebbles	Sandstone	Calcite	Hornblende	Magnetite	Caliche	Laboratory test data: Weight per cubic ft. (dry)	Specific gravity (sat)	Los Angeles (Percent loss)	Soundness[3] (25 cycles)	Remarks
fa1																117	2.58	32.8	0.93	
fa2	C			20	30	10	35			5						110	2.6	33.4	0.96	This and subsequent mineral analyses by USGS; high percentage of chert fragments in coarse fraction.
	F			70	5	25				Tr			Tr	Tr	Tr					
fa3	C	65		5	5	Tr	10					15								
	F	Tr		60	5	20						10	Tr	5						
fa4																108	2.6			Same location as fa4 but estimated by augering.
fa5	C																			Fine-textured material.
	F	Tr		65	Tr	15				15		Tr	Tr	5						
fa6	C	40		30	20	Tr				10										High percentage of soft local limestone and chert fragments in coarse fraction.
	F			65	5	25				5		Tr	Tr	Tr						
fa7	C	30		5	Tr	5	30			30										High percentage of soft local limestone fragments and pebbles of silt and clay in coarse fraction.
	F	Tr		65	5	25						Tr	Tr	5						
fa8	C	40		15	10	5	25		Tr	Tr		5								Fairly high percentage of soft local limestone fragments in coarse fraction.
	F	5		55	5	20						10	Tr	5						
fa9																				Accepted by SHCI' as filler sand; fine-textured material.
fa10	C	30		5	10	5	40					10								Fairly high percentage of soft local limestone fragments in coarse fraction.
	F	Tr		55	5	20						15	Tr	5						
fa11	C	50		15	Tr	10	5			Tr		20								High percentage of soft local limestone fragments in coarse fraction.
	F	5		60	Tr	20						10	Tr	5						
fa12	C			25	25	10	40								Tr					Fairly high percentage of chert fragments in coarse fraction; overburden is Sanborn formation.
	F			60	10	20						Tr	5	5	Tr					
fa13	C			30	10	20				40										Fairly high percentage of silt and clay pebbles in coarse fraction; overburden is Sanborn formation.
	F			70	Tr	25				5			Tr	Tr						
fa14	C			30	5	20	40			5										Overburden is Sanborn formation.
	F			70	5	25						Tr	Tr	Tr						
fa15	C			20	5	15	50								10					Overburden is Sanborn formation.
	F			70	Tr	20	5			Tr		Tr	Tr	5						
fa16	C																			Fine-textured material.
	F			75	5	20				Tr			Tr	Tr						
fa17																104	2.57	30.4	0.95	Thick overburden (Sanborn formation).
fa18	C																			Fine-textured material.
	F			65	5	20						5	Tr	5						
fa19																110	2.55			
fa20	C															112	2.59	34.6	0.96	No material retained on No. 4 sieve in USGS sample.
	F			70	Tr	20				10			Tr	Tr						
fa21	C			30	10	10	50													
	F			75	5	15							5	Tr						
fa22	C			40	15	10	30			5										
	F			80	Tr	15				Tr			5	Tr						
fa23																116	2.62	31.6	0.95	
fa24	C																			
	F			65		25						Tr	Tr	10						
fa25	C									100										Coarse fraction composed entirely of pebbles of silt and clay.
	F			50		20				15		5	5	5						
fa26	C	60		5	10	5	15					5								High percentage of soft local limestone fragments in coarse fraction.
	F	15		55	Tr	15	5					10		Tr						
ma1																113	2.62	30.8	0.91	Overburden is Sanborn formation.
ma2	C			10	15	5	15			55										High percentage of silt and clay pebbles in coarse fraction; overburden is Sanborn formation.
	F			45	5	20				15		10		5						
ma3																108	2.60	26.2	0.81	
ma4	C	20		10			10		50	Tr		10			Tr					High percentage of shale fragments in coarse fraction.
	F	10		40		20			10	Tr		15	Tr	5						
ma5	C	60		10	5	10	10					5								High percentage of soft local limestone fragments in coarse fraction; fairly thick overburden.
	F	5		55	5	20						5		10						
ma6																108	2.61	33.6	0.79	
ma7																112	2.62	36.0	0.78	
ma8																110	2.62	31.8	0.77	
ma9	C			5			5			90										High percentage of silt and clay pebbles in coarse fraction; overburden is Sanborn formation.
	F			50	5	20				15			5	5						
ma10																109	2.84	38.0	0.87	
ma11	C	60		15	Tr	5	15					5				110	2.57	38.0	0.85	High percentage of local limestone fragments in coarse fraction.
	F	5		60		15						10	5	5						
ma12																110	2.57	30.6	0.58	
ma13																113	2.6	28.2	0.98	
ma14	C			20	10	5	20			45					Tr					High percentage of silt and clay pebbles in coarse fraction.
	F			60	5	20				5		5	Tr	5						
ma15	C	5	Tr	25	25	5	30			5		5			Tr					Fairly high percentage of chert fragments in coarse fraction.
	F	Tr		70	5	20						Tr		5						
ma16	C			35	25	15	5			5	15									Fairly high percentage of chert fragments in coarse fraction.
	F			60	5	20				5		5		5						
lg1																		54.4		Av. cementation 100+; av. slaking 30+ min.
lg2																				Av. cementation 100+; av. slaking 15 min.
lg3																				Av. cementation 100+; av. slaking 25 min.
lg4																				Av. cementation 100+; av. slaking 22 min.
lg5																		53.5		Av. cementation 100+; av. slaking 27 min.
lg6																				Av. cementation 100+; av. slaking 21 min.
lg7																				Av. cementation 100+; av. slaking 30+ min.
va1	White, clean, powdery, non-calcareous.																			
va2	Light gray, silty, slightly cemented with lime.																			
va3	do																			
va4	do																			
va5	Tan, somewhat silty.																			
q1																	2.39			Deval abrasion loss, 8 percent; soundness, 0.77 percent loss after 5 freeze-and-thaw cycles.

1. SHCK, State Highway Commission of Kansas. SHCK and USGS, sieve analysis and laboratory tests by State Highway Commission of Kansas; sample collection and description of material by U. S. Geological Survey. CE, Corps of Engineers, U. S. Army.
2. C, coarse fraction, retained on No. 4 sieve; F, fine fraction, passed through No. 4 sieve; Tr, trace.
3. Loss ratio.