UNITED STATES DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

CAMAS PRAIRIE CLAY DEPOSITS

LEWIS AND IDAHO COUNTIES, IDAHO

By

Vernon E. Scheid, I. G. Sohn,

and John W. Hosterman

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CONTENTS

ILLUSTRATIONS

TABLES

ABSTRACT

The Camas Prairie clay deposits are in Lewis and Idaho Counties, in the vicinity of Grangeville, Idaho. During World War II, the area was studied by the U. S. Geological Survey in cooperation with the U. S. Bureau of Mines. The Bureau of Mines hand-augered 4 drill holes and analyzed the samples for ignition loss, available alumina, and available ferric oxide.

Three types of clay exist within the area: granitic residual clay derived from the weathering of Cretaceous granodiorite in place; basaltic residual clay derived from the weathering of Tertiary Columbia River basalts in place; and transported clays of the Latah formation, derived from the weathered debris of the granodiorite and older rocks. Of these, the transported clays are potentially usable for high-alumina or ceramic purposes.

Clays containing more than 15 percent available alumina and less than 5 percent available ferric oxide would be suitable for high-heat or even super-heat ceramic duties. Therefore, clay from nine of the ten deposits studied are usable for many kinds of ceramic structural ware such as bricks, terra cotta, and drain tile.

Six of the deposits are of sufficiently high grade to be classed as high-alumina clay. From 5 to 10 million tons of clay are inferred to be available for aluminum uses.

INTRODUCTION

Purpose and Location

During World War II, the U. S. Geological Survey, in cooperation with the U. S. Bureau of Mines, made an appraisal of the national alumina resources in an attempt to guarantee an adequate domestic supply of aluminum. This report is a part of a study of high-alumina clay resources in the Pacific northwest region, and describes the results of the investigation of high-alumina clay deposits near Grangeville, Idaho.

The location of the Camas Prairie clay deposits is shown on figure 2. U. S. highway 95 crosses the area, and two railroads, the Northern Pacific with its terminus at Sites and the Camas Prairie with its terminus at Grangeville, serve the area.

Camas Prairie is a broad, gently rolling area in the Columbia River Plateau physiographic province. The central portion of the Prairie has an altitude of about 3,000 feet, but the surface rises gently to about 3,300 feet toward the south and west. The Prairie is bounded on the southwest by the canyon of the Salmon River, on the northwest by the canyon country west of Winchester, on the north and northeast by the canyon of the Clearwater River, on the southeast by the canyon of the South Fork of Clearwater River, and on the south by the Idaho Mountains. Camas Prairie is divided into two nearly equal parts by the eastward-flowing Lawyers Creek.

Field Work and Acknowledgments

The existence of potential clay deposits in the Camas Prairie area was first reported by Skeels (1920, p. 59). The senior author examined and sampled some of the clay outcrops in the area for the Idaho Bureau of Mines and Geology during the summer of 1938 and again in April 1943 for the U. S. Geological Survey. An exploratory drilling program was conducted in June 1943 by the U. S. Bureau of Mines, under the supervision of S. H. Lorain, District Engineer, and Miro Mihelich, Project Engineer. Four hand auger holes were drilled totaling 81.1 feet, and chemical assays were made on samples representing 66.6 feet. Geologic study of the deposits was conducted by the junior author in September 1943.

The authors are indebted to Mr. W. H. Hill of Grangeville for his assistance in guiding them to several of the clay localities. They are also indebted to Mr. Lorain and Mr. Mihelich, U. S. Bureau of Mines, for the many courtesies extended and for the chemical data they made available. Mr. A. W. Fahrenwald, Director, Idaho Bureau of Mines and Geology, kindly gave permission to use the unpublished ceramic and field data obtained by the senior author in 1938. The writers are indebted to the University of Idaho for use of office space while preparing portions of the report.

GEOLOGY

Regional Geology

An understanding of the clay deposits is best obtained by a brief summary of the regional geology. The Belt series of pre-Cambrian age, consisting of quartzites, mica schists, and minor amounts of gneisses underlie the southwestern and southeastern portion of Camas Prairie. In late Jurassic or early Cretaceous time, the older rocks were cut by granodiorite and related igneous materials of the Idaho batholith. The typical granodiorite is light gray, medium-grained, and granular with gneissoid and porphyritic textures locally; its chief minerals are quartz, biotite, and both potash and soda-lime feldspars. Post-intrusion erosion exposed the granitic rocks and a mature topography developed.

Beginning in Miocene time, the Columbia River basalts were extruded (Pardee and Bryan, 1926, p. 11-12). These basalts are composed of plagioclase and augite in a glassy groundmass with minor amounts of ilmenite and olivine. Streams dammed by lavas formed lakes in which the Latah formation was deposited (Pardee and Bryan, 1926, p. 8). Thus the Latah formation is interbedded with and contemporaneous with the basalt.

During a protracted lull in the extrusion of the basalts, a weathering surface developed in eastern Washington and northwestern Idaho. This weathering surface, which divides the upper basalts from the lower basalts, was given the name Excelsior surface (Scheid, 1945, p. 19). During the Excelsior interval, the climate was very warm and humid, with conditions that permitted complete oxidation and the formation of residual clays. The greatest thickness of residual clays was formed upon a land surface of low to moderate relief. The results of other intra-flow weathering intervals have been observed, but none approaches the 124-foot maximum depth of weathering or the lateral extent of the Excelsior surface (Scheid, 1947, p. 1224). From drill hole evidence the Excelsior surface is known to be a gently undulating surface beneath the hills and does not rise far above the present valley floors.

Renewed extrusion of basalt brought the Excelsior weathering interval to an end. The upper member of the Latah formation was deposited upon the granitic and basaltic residual clays in lakes that were formed by streams dammed by the post-Excelsior basalt flows. This member contains the principal transported clay deposits. The Latah formation is composed of lacustrine and deposits of interbedded clays, sands, and gravels that were derived primarily from the granitic and metamorphic rocks of the mountainous areas.

By Pleistocene time, the land surface was maturely dissected in the plateau areas of the basalts. The region was then irregularly blanketed by the Palouse formation, which is composed for the most part of wind-blown silt (Bryan, 1927, p. 41). The original deposition of the loess was thickest on the lee sides of hills. Subsequent erosion has removed more of the material from the valleys than from the hills, so that this formation is now thicker on the hills than in the valleys. The rivers and their tributaries have cut deep, steep-sided canyons into the margins of the Prairies.

Geology of Camas Prairie Deposits

The Camas Prairie area is relatively flat with broad-topped very gently rolling hills that are underlain by the Columbia River basalts and sediments of the Latah formation. Transported clay crops out in the walls of the canyons that bound most of Camas Prairie; however, these clay beds are generally far below the surface of the Prairie. Since the transported clay near the top is the only material potentially useful, no field studies of the clay in the canyon areas were made.

Granitic residual clay

Steptoes of granodiorite protrude through the basalt north of Cottonwood along an east-west trending ridge that is now largely buried. Granitic residual clay developed locally, along this ridge but erosion has removed most of it. The granitic residual clays preserve the texture and grade downward into hard, unweathered granodiorite and related rock. The best grades of these clays are white to gray in color, but locally are stained yellow or brown by iron oxides. Kaolinite, the principal clay mineral, is derived from feldspar and to a minor extent from muscovite and biotite. Quartz remains unaltered and occurs abundantly throughout the granite residual clay.

Basaltic residual clay

The Columbia River basalts form the floor of Camas Prairie. Exposures of the basalt in the surrounding canyons show the basalt to be several thousand feet thick. The basalts are shown as a single map unit on plate 1, because of the difficulty of distinguishing the upper basalts from the lower basalts where the Excelsior surface is not exposed.

Drill hole and sample data furnished by the U. S. Bureau of Mines

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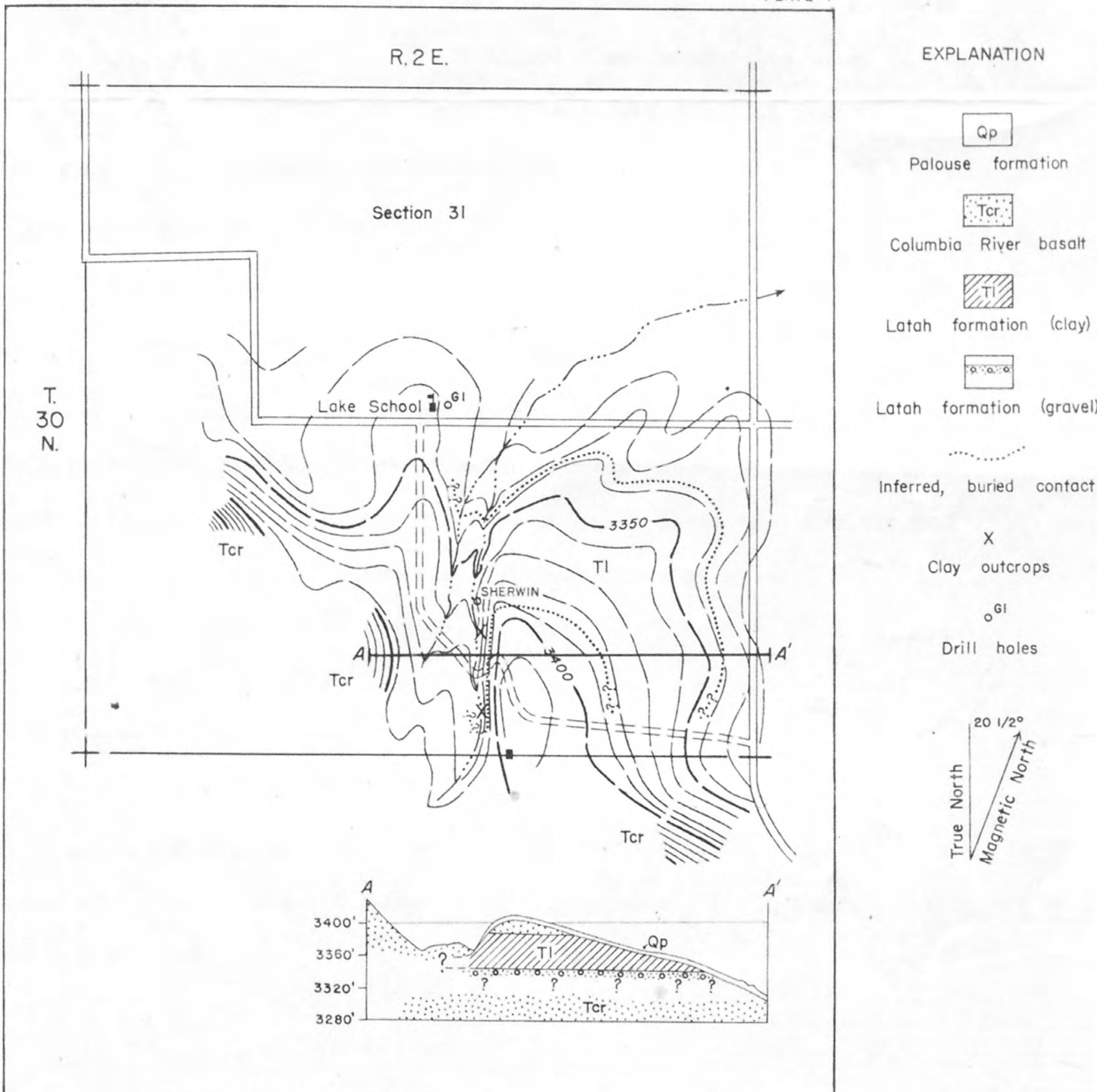
PLATE I



SKETCH MAP OF THE SHERWIN CLAY DEPOSIT IDAHO COUNTY, IDAHO

Geology by
I. G. Sohn, 1943

Compilation by
J. W. Hosterman, 1950

0 1/4 1/2 3/4 1 MILE

Contour interval 10 feet
(DATUM IS APPROXIMATE MEAN SEA LEVEL)

U. S. Geological Survey
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This map or illustration is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

Weathering of these basalts during the Excelsior interval produced the basaltic residual clay. This residual clay retains the original fine- and even-grained basaltic texture. The best grades are composed of kaolinite and some unaltered ilmenite. The clays are plastic and bluish gray in color, except where iron-stained.

Transported clay

The transported clays of the Latah formation occur throughout Camas Prairie. The Latah formation is composed of weathered debris from the Belt rocks and granodiorite and related igneous rocks. It was deposited upon the granitic and basaltic residual clays in lakes that were formed by streams dammed by post-Excelsior interval flows of basalt.

The best high-alumina transported clays are generally plastic, and are light gray, yellow, or locally pink. Kaolinite is the principal clay mineral in the transported clays. It is a weathering product of feldspar or to a minor extent, of muscovite and biotite of the older formations. This kaolinite formed before being transported and deposited. The clays also contain a certain amount of fine-grained detrital quartz and muscovite flakes.

CLAY DEPOSITS

General Features

The clay deposits of Camas Prairie that were studied are not large, and most of the deposits have considerable overburden, either of basalt or Palouse formation. However, several deposits have exceptionally high available alumina content and very low available ferric oxide content. Also, although the deposits studied are small, they occur over a considerable area, and perhaps other larger deposits of high-alumina clay may exist in the area.

Sampling Program

The U. S. Bureau of Mines drilled four holes for a total of 81.1 feet in the vicinity of the Camas Prairie deposits. Drilling was done by hand, using 3-inch post-hole augers of the Iwan type. Logs of the drill holes are in the appendix. Samples were taken at 5-foot intervals or where the material showed a marked change. The samples were prepared in a drying room at Troy, Idaho, and were sent to the Bureau of Mines, Northwest Experiment Station, Seattle, Wash., to be assayed. Sixteen samples (all transported clay) were assayed for ignition loss, available alumina, and available ferric oxide.

The samples were calcined for one hour at 700° C., and the loss in weight, due to the escape of the hydroxyl ion, organic matter, and a small amount of CO_2, is reported as ignition loss. The loss on ignition depends primarily upon the quantity of clay.

Available alumina (Al_2O_3), as defined by Skinner and Kelly (1949, p. 6), is the amount of alumina extracted from clay that has been dried at 130° C. overnight, weighed, calcined at 700° C. for one hour, and boiled in a 20 percent solution of sulfuric acid for one hour. The quantity of available alumina has been shown to depend upon the degree of weathering, and thus on the content of clay minerals. In general, the more complete the weathering, the higher the available alumina content.

The available ferric oxide (Fe_2O_3) is defined as the percentage by weight of ferric oxide in the calcined clay that is soluble in 20 percent solution of sulfuric acid under the same conditions as above. Because ilmenite is not appreciably soluble in sulfuric acid, its iron content, for the most part, is not available; therefore, the quantity of available ferric oxide is mainly dependent on the quantity of limonite and to a minor degree on the quantity of nontronite.

Description of Clay Localities

Locality 2—Sherwin clay deposit

The Sherwin clay deposit (fig. 1) is in the SE¼ sec. 31, T. 30 N., R. 2 E. The deposit is a bed of white to light gray, fine-textured, plastic, transported clay with a maximum thickness of 40 feet.

The clay crops out along the east bank of the creek about a quarter of a mile south of the mid-section road (samples 2 and 3, table 2); about 30 feet of high-alumina clay is present at the Sherwin hole (appendix); a 6-inch white clay bed crops out in the creek bank 900 feet south of the

Sherwin hole (sample 4, table 2); and a similar bed was exposed at the bottom of a 5-foot pit at the top of the hill east of the Sherwin hole. Some of this clay was reported by V. T. Allen to contain montmorillonite.

The valley north and east of the deposit is underlain by gravel, and the hills to the south and west are underlain by basalt. The gravel crops out along the east bank of the creek, is present in drill hole G-1 near the Lake school house, and also in an auger hole three quarters of a mile east of the school house and 50 feet west of the stream.

The clay at the Sherwin deposit is approximately 40 feet thick, and the overburden of gravel and basalt remnants is also about 40 feet thick at the southern end, but it becomes much thinner toward the northern end.

Other Localities

Clays are known to be present at several other localities, but little is known about their extent and quality. Several occurrences of clay were investigated, and they are recorded below.

Locality 20

One foot of light gray and yellow transported clay was encountered in John Dauber's well at a depth of 15 feet. A second well 1,000 feet east and at about the same elevation encountered no clay to a depth of 70 feet.

Locality 9

Waxy, sectile, grayish white, transported clay mixed with detrital quartz and mica was observed on the dump of Taylor G. Burton's 15-foot well. Clay also was reported at a spring 100 feet west of the well. About 350 feet to the south and east of these occurrences the hills are underlain by basalt.

Locality 1

Hole G-3 (appendix) was drilled at the base of a 3-foot clay exposure in a roadcut on U. S. Highway 95. Sample 1 (table 2) is an analysis of the bottom 2 feet of fine-grained, whitish gray, plastic, waxy clay in the cut. The deposit is small because clay is overlain by 4 feet of basalt that increases in thickness to the east and southeast and erosion has removed the clay to the west and north.

Locality 8

Sample 5 (table 2) was taken from a 1.5 foot auger hole that was drilled about 5 feet below the top of a 25-foot clay exposure. The transported clay is blue-gray, plastic, waxy, and sectile. It is overlain by 15 feet of sand and gravel and 60 feet of basalt.

Locality 5

A roadcut exposes 15 feet of plastic, red, transported clay overlain by basalt. Erosion has removed the clay to the north and east. Hole G-2 (appendix) was drilled about 5 feet below the top of the transported clay.

Locality 11

A 4.3-foot auger hole encountered 1.3 feet of dense, waxy, plastic, red transported clay (at locality 11, fig. 2). The chief mineral is kaolinite and sample 6 (table 2) shows the assay results.

Locality 21

A 2-foot channel sample (sample 7, table 2) of a grayish tan, dense, waxy transported clay taken from a 3-foot exposure in a railroad cut. The clay is overlain by 2 feet of yellow sand. About 50 feet to the northwest, 20 feet of basalt (with no clay) is exposed.

Nez Perce clay deposit

Around 1920, a small brick plant operated at the town of Nez Perce. Skeels (1920, p. 59) sampled the pit when the plant was in operation. The senior author obtained a sample from the same pit in 1938, and the results of the chemical analysis and ceramic data (sample 53) are given in tables 1 and 2.

Anderson clay deposit

Mr. Carl F. Anderson of Winchester, Idaho, submitted a sample of transported clay to the senior author. The slightly silty clay consists of kaolinite with beidellite filling the cracks. The clay is waxy, tenacious, extremely plastic, and slacks easily.

Table 1--Laboratory Examination of Sample No. 53

Original Properties: Light gray, waxy; slightly streaked with yellow; minor amount of fine grit.

Screen Analysis (percent): +42 mesh 2.3; + 200 mesh 10.2; -200 mesh 87.5

Workability: Works well, stiff, smooth, plastic, slacks readily.

Water of Plasticity....................	(Percent)...............	31.3
Air Shrinkage, Linear..................	do	5.2
Ignition Loss..........................	do	10.7

Fired Properties

Cone No.	1	2-3	4
Hardness	5	5	6
Modulus of Rupture	787	787	1,065
	Percent	Percent	Percent
Fire Shrinkage	5.8	4.2	4.9
Total Shrinkage	11.0	9.4	10.1
Absorption	15.2	15.2	14.2
Color	Buff	Buff to Light Brown	

Condition: Fair to good, warped, a few cracks, medium-grained texture.

CONCLUSION

The data in table 2 indicate that several deposits contain clays with high available alumina and low available ferric oxide. Although, these deposits are local, they occur over a considerable area and they suggest that larger deposits of high-alumina clay may exist in the area.

Table 2--Analysis of Clays from Camas Prairie, Idaho and Lewis Counties, Idaho

		1	2	3	4	5	6	7	8
Ignition Loss at 700° C					12.6a	12.4	12.2	10.2	12.6b
	SiO_2		48.5						56.8
Available	R_2O_3c				30.07				
	Al_2O_3		34.2						24.8
Available	A_2O_3	34.0		33.1		34.3	28.8	24.6	
	Fe_2O_3		2.1						5.58
Available	Fe_2O_3	1.7		1.7		1.9	9.3	6.7	
	CaO								0.87
	MgO								0.14
Total									100.79

a - Ignition Loss at 800° C.
b - Temperature not stated.
c - Includes available Al_2O_3 and available Fe_2O_3.

DESCRIPTION OF SAMPLES

1. Auger drill sample through 2 feet (1 - 3 feet) of gray, waxy clay from road cut at Locality 1. Collected by Scheid; Sample CP 1. Analysis by Bureau of Mines.

2. Grab sample from 5-foot outcrop at Sherwin drill hole, Locality 2. Collected by W. H. Hill. Analysis by Idaho Bureau of Mines and Geology; Sample 726, October 1942

3. Auger drill sample through 2.5 feet (0.0 - 2.5 feet) of light gray clay from 5-foot outcrop at Sherwin drill hole, Locality 2. Collected by Scheid; Sample CP 2. Analysis by Bureau of Mines.

4. From creek bank at Locality 2; 900 feet south of Sherwin drill hole. Collected by W. H. Hill. Analysis by Kalunite, Inc.; Lab. No. 14368, Sample PT 3, May 1942.

5. Auger drill sample through 1.5 feet (0.0 - 1.5 feet) of blue-gray, plastic, waxy clay, from 5 feet below upper contact at Locality 8. Collected by Sohn; Sample CP 9. Analysis by Bureau of Mines; Sample M-27, Project 1206-2, December 1943.

6. Auger drill sample through 1.3 feet (3.0 - 4.3 feet) of red, plastic clay mixed with white clay, from Locality 11. Collected by Sohn; Sample CP 13. Analysis by Bureau of Mines; Sample M-26, Project 1206-2, December 1943.

7. Vertical channel sample through 2 feet of tan-gray, waxy clay, from railroad cut at Locality 21. Collected by Sohn; Sample CP 25. Analysis by Bureau of Mines; Sample M-25, Project 1206-2, December 1943.

8. Average sample of light gray, waxy clay; slightly streaked with yellow; from clay pit at western edge of Nez Perce, Idaho. Collected by Scheid; Sample No. 53 (1938). Analysis by R. V. Lundquist, Idaho Bureau of Mines and Geology.

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Formation	Interval (Feet)	Description	Ign. Loss	Avail. Fe_2O_3	Avail. Al_2O_3
		Drill Hole G 1: Near middle of sec. 31, T. 30 N., R. 2 E., B.M.; Elev. (barometric) 3340 ft.			
	0.0-2.0	Soil, black, sticky			
Tl	2.0-6.0	Gravel, transported, coarse-grained, clayey.	8.0	8.4	12.2
		Drill Hole G 2: SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 30 N., R. 3 E., B.M.; Elev. (barometric) 3,685 ft.			
	0.0-0.5	Soil			
Tl	0.5-5.5	Clay, transported, red, plastic; white spots	12.5	6.5	32.0
	5.5-8.5	Clay, transported, red, plastic; white spots	12.4	8.1	33.5
	8.5-13.5	Clay, transported, red, plastic; white spots.	12.2	10.8	33.8
	13.5-18.5	Clay, transported, red, plastic; white spots.	12.6	9.3	33.8
	18.5-21.5	Clay, transported, white, brown-stained.	13.0	6.6	34.9
	21.5-28.5	Clay, transported, pink-gray, plastic.	12.8	3.7	33.4

Formation	Interval (Feet)	Description	Ign. Loss	Avail. Fe_2O_3	Avail. Al_2O_3
		Drill Hole G 3: NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, T. 30 N., R. 2 E., B.M.; Elev. (barometric) 3,540 ft.			
Tl	0.0-4.0	Clay, transported, gray.	13.1	2.6	31.3
	4.0-8.5	Clay, transported, gray, brown-stained.	11.9	2.7	32.4
	8.5-10.3	Clay, transported, gray, brown-stained.	11.6	7.0	30.2
	10.3-11.6	Clay, transported, yellow.	11.2	6.1	28.8
Tcr	11.6	Basalt, hard.			
		Drill Hole Sherwin: W $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 31, T. 30 N., R. 2 E., B.M.; Elev. (barometric) 3,360 ft.			
Tl	0.0-12.0	Previously drilled by Mr. Guy Sherwin.			
	12.0-18.5	Clay, transported, gray, plastic.	12.4	2.5	32.8
	18.5-23.0	Clay, transported, gray, brown-stained, plastic.	12.3	3.4	32.6
	23.0-28.5	Clay, transported, light brown.	11.3	3.9	28.5
	28.5-33.5	Clay, transported, brown-stained.	8.7	3.7	21.9
	33.5-35.0	Sand and gravel, transported, quartz, brown.	4.8	4.8	11.6

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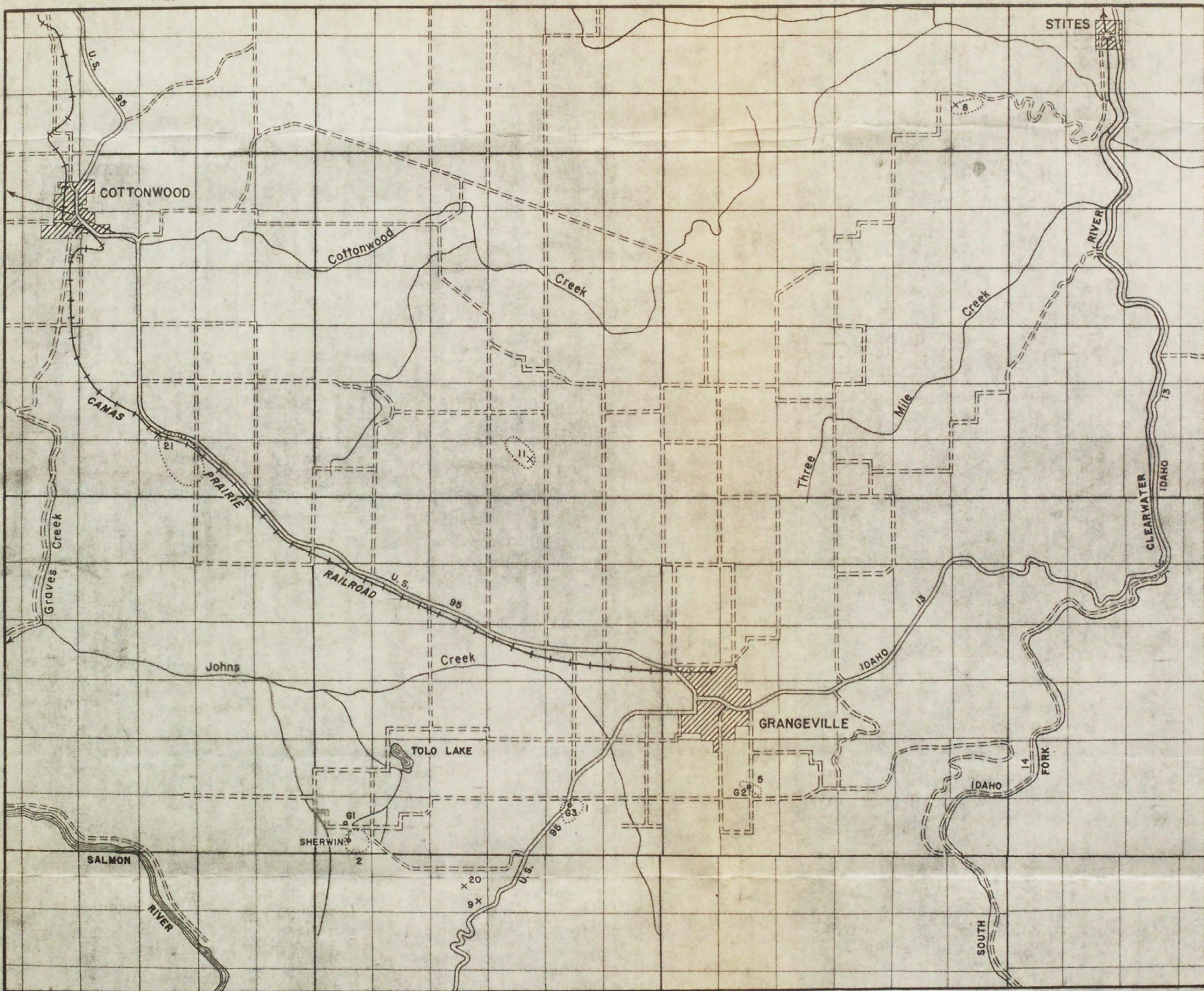
FIGURE 2



EXPLANATION

Clay Localities

Drill Holes

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Base map compiled from Highway Maps

Geology by
I. G. Sohn, 1943

Compilation by
J. W. Hosterman, 1950

INDEX MAP SHOWING LOCATION OF CLAY DEPOSITS
CAMAS PRAIRIE, IDAHO COUNTY, IDAHO

20 1/2°
True North
Magnetic North

0 2 4 6 8 Miles

Drill hole and sample data furnished by the U. S. Bureau of Mines