UNITED STATES DEPARTMENT OF THE INTERIOR

US GEOLOGICAL SURVEY

[Reports - Open file series]

STANFORD CLAY DEPOSIT, LATAH COUNTY, IDAHO

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U. S. Geological Survey
OPEN FILE REPORT
This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

May 1951

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Abstract

The Stanford clay deposit, Latah County, Idaho, is about 4 miles northwest of Deary, 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 10 holes and made chemical analyses on the samples for available alumina and available ferric oxide, and also measured the ignition loss.

The deposit contains three types of clay: 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. Only the transported clays are considered as a potential source of available alumina and ceramic-grade clay in the Stanford deposit.

The Stanford deposit averages 24.8 percent available alumina and 2 percent available ferric oxide.

Transported clays containing more than 15 percent available alumina and less than 5 percent available ferric oxide would be suitable for many ceramic products and some may meet the requirements of high-heat or super-heat duties. Therefore, the clays are usable for ceramic structural ware such as bricks, terra cotta, and drain tile.

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 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 a deposit of high-alumina clay 4 miles northwest of Deary, Latah County, Idaho.

The Stanford clay deposit is in secs. 1, 2, 3, 4, 9, 10, 11, and 12, T. 40 N., R. 3 W., and secs. 6 and 7, T. 40 N., R. 2 W., Boise Meridian, Latah County, Idaho (pl. 1). State highway 42, an all-weather road, crosses the deposit, and the Washington, Idaho, and Montana Railroad has a station at Stanford. Power is available from a 22,000-volt transmission line of the Washington Water Power Co.

The deposit is in a part of the Columbia River Plateau physiographic province that is characterized by broad, gently rounded hills and fairly broad, even-floored valleys. The area is drained by the Big Bear Creek and its tributaries.

Field Work and Acknowledgments

The senior author examined and sampled some of the clay outcrops in the Stanford area during the summer of 1938, as part of a study of clay in northern Idaho for the Idaho Bureau of Mines and Geology. An exploratory drilling program was conducted in the summer of 1943 by the U. S. Bureau of Mines, under the supervision of S. H. Lorain, District Engineer, and Miro Mihelich, Project Engineer. Ten hand auger holes were drilled totaling 187.7 feet and chemical assays were made on samples representing 99.3 feet. In cooperation with the U. S. Bureau of Mines, the U. S. Geological Survey supervised the drill hole logging and the geologic studies of the deposit. I. G. Sohn mapped the geology of the area during the summer and fall of 1944.

The authors are 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. The writers are indebted to the University of Idaho for use of office space while preparing portions of the report.

GEOLOGY

Regional Geology

The high-alumina clays of Latah County, Idaho, and adjacent areas are divisible into three types: residual clay derived by weathering of granitic rocks, residual clay derived by weathering of basaltic rocks, and transported clay. The transported clays are derived primarily from granitic residual clays that have been transported and deposited in water with other materials to form the Latah formation.

An understanding of the clay deposits is best obtained by a brief summary of the regional geology (pl. 1). The Belt series of pre-Cambrian

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Plate 1. Geologic and index map of Latah County, Idaho, clay district.

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age, consisting of quartzites, mica schists, and minor amounts of gneisses, form the mountainous country to the east and north of the clay district. Locally the eroded surface of the Belt rocks, a series of volcanic flows, was extruded in Permian(?) time. Two types of volcanic rocks are recognized at the largest outcrop in the vicinity of Potato Hill; one type consists of pink, gray, and dark purple porphyritic lavas varying in composition from rhyolite to dacite; the second type is a dark purple to black quartz-bearing flow breccia. In late Jurassic or early Cretaceous time, the older rocks were cut by large masses of granodiorite and related igneous rocks that are tentatively considered to be part 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. The related igneous rocks consist of hornblende syenite at Gold Hill (pl. 1) and minor amounts of adamellite, tonalite, and granite with small pegmatite, aplite, and lamprophyre dikes. 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 basalt, 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, 1946, p. 19). During the Excelsior interval, the climate was very warm and humid, with conditions that permitted complete oxidation and the formation of the residual clays. The greatest thickness of residual clays was formed upon a land surface of low to moderate relief. The results of other intraflow 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 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, and is now thickest beneath the hills. The Latah formation is composed of lacustrine and stream deposits of interbedded clays, sand, 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 highlands of older rocks and youthfully 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 from the west (Bryan, 1927, p. 41). The original deposition of the loess material was thickest on the lee sides of the hills. Subsequent erosion has removed more material from the valleys than from the hills so that the formation is now thicker on the hills than in the valleys. Terrace deposits of late Pleistocene age and alluvium of Recent age are found in the valleys of the major streams. The materials of these deposits resemble and blend with the Palouse formation, so that these deposits have been mapped on the basis of topography.

Geology of the Stanford Clay Deposit

The Stanford clay deposit occurs in the northwestern corner of the Avon embayment (pl. 1), a relatively flat area underlain by Columbia River basalts and sediments of the Latah formation and partly surrounded by hills of older rocks. To the east, the embayment is limited by Potato Hill that is underlain by Permian(?) volcanics; to the northeast and west, it is limited by granodiorite hills; and to the north it is limited by hills underlain by the Belt series. The regional distribution of these rocks is shown on plate 1, and the local distribution is shown on plate 2.

Plate 2. Map showing areal and economic geology of the Stanford clay deposit, Latah County, Idaho.

Rocks of the Belt series do not occur within the area of detailed mapping (pl. 2), but crop out about a mile north of the deposit. These rocks have contributed very little except quartz and muscovite to the sedimentary beds of the Latah formation.

The Permian(?) volcanic rocks, also, are not exposed in the area of detailed mapping and they have probably contributed very little to the sedimentary beds of the Latah formation.

The granodiorite and related igneous rocks are well exposed in the western portion of the deposit (pl. 2). The weathering and decomposition of these rocks supplied practically all of the kaolinite for the transported clay beds of the deposit. The contact of the granodiorite with the overlying basalt (pl. 2) is concealed beneath the Latah formation and/or the Palouse formation.

The Columbia River basalts form the floor of the major portion of the Avon embayment. The upper basalts cannot be distinguished from the lower basalts where the Excelsior surface is not exposed, or where there is no upper Latah formation dividing them. On plate 2, however, both the upper and lower members of the Columbia River basalt are shown because they occur at different altitudes and the Latah formation lies between them.

The lower Latah member occurs as minor lenses within the lower Columbia River basalt and does not crop out within the mapped area (pl. 2). The upper Latah formation was deposited upon the Excelsior surface and occurs throughout the mapped area, but rarely crops out.

The Palouse formation forms the bulk of the overburden in the deposit area. The greatest thickness of this formation encountered by drilling is 18.0 feet at drill hole Stan-3, and the average thickness based on drilling information is approximately 11 feet.

Deposits of alluvium border several of the streams in the area. The largest area of this material is in the valley of the Middle Fork of Big Bear Creek. Other areas of alluvium are in the valleys of Big Bear Creek and Howell Creek (pl. 2).

The U. S. Bureau of Mines drilled 10 holes for a total of 187.7 feet in the vicinity of the Stanford deposit. 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. Twenty-two samples (1 granitic and 21 transported clay) were assayed for available alumina and available ferric oxide.

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 kind and amount 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.

Granitic Residual Clay

The amount of granitic residual clay in the Stanford area is quite small. It was identified in the basal 5.0 feet of drill hole Stan-7. A thin zone of granitic residual clay is probably present beneath the transported clays in the southwestern edge of the West Block. The thinness and the low grade of the granitic residual clays suggest that it may be correlative with the lower grade granitic residual clay near the base of the weathering profile at the Benson deposit, where the residual clay has a maximum thickness of more than 100 feet (Wilson and Goodspeed, 1934, p. 80).

The granitic residual clays, derived from the granodiorite and related rocks, preserve the texture of the original rocks, and they grade downward into hard, unweathered rock. The best grades of these clays are white to gray in color, but are locally stained yellow or brown by iron oxides. Kaolinite, the principal clay mineral, is formed from feldspar and to a minor extent from muscovite and biotite. Quartz remains unaltered and occurs abundantly throughout the granitic residual clay.

One sample of granitic residual clay was assayed by the U. S. Bureau of Mines. This sample contained 11.5 percent available alumina, and 0.9 percent available ferric oxide.

Basaltic Residual Clay

The basaltic residual clays are the result of the weathering of the lower Columbia River basalts during the Excelsior interval. If the drainage was poor, the plagioclase and basaltic glass were altered to nontronite (Allen and Scheid, 1946, p. 209); but if the drainage was good, kaolinite was formed from plagioclase and migrated along cracks and open cavities. Good drainage was usually present in the upper part of the weathering profile during the Excelsior interval, and poor drainage was usually present in the lower part of the profile.

The residual clay retains the original basaltic texture to some degree. The fine- and even-grained texture is sharply defined by the abundant, small, uniformly disseminated flakes of blue-black ilmenite. Thus, the texture in the residual clay is more sharply defined than in the fresh basalt, in which the texture is locally indistinct when examined with a hand lens. The best high-alumina basaltic residual clays are composed almost entirely of kaolinite and unaltered ilmenite, and are plastic. The residual clays are bluish gray from the metallic blue-black ilmenite. In places they are stained yellow or tan by alteration products derived from ilmenite.

No assays were made of basaltic residual clay.

Transported Clay

The transported clays of the Upper Latah formation comprise potentially all the high-alumina and ceramic grade clays of the Stanford deposit. The Latah formation is composed primarily of weathered debris from the Belt rocks, the granodiorite and related rocks, and to some extent the volcanic 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, light gray or yellow, and occasionally pink. Kaolinite is the principal clay mineral in the transported clays. It resulted from the weathering of feldspar and to a minor extent from the weathering of muscovite and biotite of the older formations. The kaolinite was formed before being transported and deposited. The clays also contain a certain amount of fine-grained quartz and muscovite flakes. Many sandy and pebbly beds exist in the lower part of the upper Latah formation.

Twenty-one samples of transported clay were assayed. The average values are as follows: available alumina, 17.2 percent and available ferric oxide, 2.0 percent.

Ceramic data

Information published by Skeels (1920, p. 38) shows that there are many deposits of clays throughout Latah County usable for most ordinary ceramic uses. Skinner and Kelly (1949, p. 37), furthermore, made many ceramic tests on a large number of samples of high-alumina transported clays of the Olson deposit. They demonstrated that a high degree of correlation existed between the refractoriness and the percentage of available ferric oxide and available alumina (Skinner and Kelly, 1949, p. 8). Many of the clays at the Olson deposit were shown to be suitable for intermediate heat duty (pyrometric cone equivalent of 26 to 31) and high heat duty (P. C. E. 31-33), while some were suitable for super heat duty (P. C. E. 33). The transported clays of the Stanford deposit are very similar to those of the Olson deposit, and they would probably yield similar ceramic results. Judging from the work of Skinner and Kelly, nearly all clays containing more than 12 percent available alumina and not more than 5 percent available ferric oxide would be usable for ceramic products.

CLAY DEPOSIT

General Features

The Stanford clay deposit consists entirely of transported clay of the upper Latah formation. There are, however, both granitic residual and basaltic residual clays in the area surrounding the Stanford deposit.

The granitic residual clay is the product of the weathering of granitic rocks in place, and the basaltic residual clay is the product of the weathering of basalt in place. The transported clays are derived primarily from the weathered debris of the granitic rocks that has been transported and deposited in water.

For purposes of discussion, the deposit has been divided into the West, Middle, and East Blocks. The lateral extent of the deposit is limited mainly by the present stream valleys. The minable limit of the high-alumina clays in the West and Middle Blocks has been determined from the chemical assays.

The overburden is composed mostly of the Palouse formation, which averages about 11 feet in thickness. The ratio of overburden to high-alumina clay is about 0.8 to 1.

CONCLUSION

Under emergency conditions the Stanford clay deposit could serve as a source of aluminum. The deposit contains large reserves of clay for ceramic wares such as: brick, terra cotta, and drain tile.

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APPENDIX: DRILL HOLE LOGS AND ASSAYS

Formation	Interval (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill Hole Stan-1: Coord. 27,410 N, 6,750 E.		
Qp	0.0-16.2	Soil and Palouse formation. Drilling stopped because of hardness.		
		Drill Hole Stan-2: Coord. 26,310 N, 4,950 E.		
Qp	0.0- 5.7	Soil and Palouse formation.		
Tlu	5.7- 8.0	Clay, transported, tan sandy, slightly micaceous, thin limonite band.	7.7	18.1
	8.0-15.2	Clay, transported, light to dark gray.	1.4	29.8
	15.2-17.4	Clay, transported, light gray, pinkish gray-streaked, many small kaolin lumps.	1.1	33.8
	17.4-25.0	Clay, transported, light yellow, sandy, slightly micaceous, iron-stained layers.	1.0	18.3
		Drill Hole Stan-3: Coord. 27,150 N, 7,440 E.		
Qp	0.0-18.0	Soil and Palouse formation		
Tce	18.0-22.0	Clay, residual, basaltic, green.		
	22.0	Basalt.		

Formation	Interval (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill Hole Stan-4: Coord. 26,730 N, 12,070E.		
Qp	0.0 - 12.0	Soil and Palouse formation; 1/4 inch limonite band.		
Tlu	12.0 - 16.0	Clay, transported, white, hard, dry.	2.1	17.0
	16.0 - 17.0	Clay, transported, white, iron-stained, hard dry Drilling stopped because of hardness.	7.3	15.9
		Drill Hole Stan-5: Coord. 31,170 N, 9,230 E.		
Qp	0.0 - 10.0	Soil and Palouse formation.		
Tlu	10.0 - 17.0	Clay, transported, micaceous, iron-stained; one thin limonite band.	4.6	15.1
		Drill Hole Stan-6: Coord. 28,640 N, 9,340 E; Elev. 2789.7 ft.		
Tlu	0.0 - 10.0	Clay, transported, gray and white, plastic.	2.0	25.5
	10.0 - 14.0	Clay, transported, sandy, micaceous, iron-stained.	2.7	9.0
	14.0 - 20.0	Sand, transported, yellow, micaceous.	1.0	4.5
	20.0 - 24.0	Sand, transported, yellow, micaceous. Drilling stopped because of inadequate equipment.	1.0	4.2

Formation	Interval (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill Hole Stan-7: Coord, 26,940 N, 2,120 E.		
Qp	0.0 - 13.0	Soil and Palouse formation; last 2 feet contains 1/2 inch quartz pebbles.		
Kg	13.0 - 17.0	Clay, residual, granitic, fine-grained toward bottom. Drilling stopped because of inadequate equipment.	0.9	11.5
		Drill Hole Stan-8: Coord. 26,610 N, 3,670 E.		
Tlu	0.0 - 6.0	Clay, transported, iron-stained to white.	1.4	21.5
	6.0 - 10.0	Clay, transported, dark gray.		
	10.0 - 12.0	Clay, transported.		
	12.0 - 15.5	Clay, transported, sandy, iron-stained. Drilling stopped because of hardness.	2.6	19.6
		Drill Hole Stan-9: Coord. 26,620 N, 3,730 E.		
Tlu	0.0 - 8.0	Clay, transported, sandy, iron-stained, 1/4 inch limonite band.	2.1	18.7
	8.0 - 9.0	Clay, transported.		
	9.0 - 11.0	Clay, transported, white to yellow, sandy.	1.1	14.1
	11.0 - 14.0	Clay, transported, white, sandy.	0.5	12.1
	14.0 - 18.0	Clay, transported, yellow, sandy; 4-inch beds of waxy white clay. Layer of white quartz grains at bottom. Drill stopped because of inadequate equipment.	0.7	17.4

Formation	Interval (feet)	Description	Available Fe_2O_3	Available Al_2O_3
		Drill Hole Stan-10: Coord. 30,890 N, 10,080 E.		
Qp	0.0 - 2.0	Soil and Palouse formation		
	2.0 - 2.5	Limonite.		
Tlu	2.5 - 5.0	Clay, transported, yellow, iron-stained.	7.0	11.9
	5.0 - 10.0	Clay, transported, white, micaceous.	1.0	10.3
	10.0 - 15.0	Clay, transported, white, plastic.	0.9	15.9
	15.0 - 16.0	Clay, transported, iron-stained, thin limonite bands.	4.4	7.8