State of Idaho
Robert E. Smylie, Governor

Idaho Bureau of Mines and Geology
J. D. Forrester, Director

CLAY DEPOSITS OF NORTH IDAHO

by

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FOREWORD

This analysis of the geologic occurrence, distribution and economic characteristics of the major known clay deposits of north Idaho has been prepared by Mr. Charles R. Hubbard of the Idaho Bureau of Mines and Geology. It has been written primarily in an attempt to aid in the general industrial development of the State and, as it is being issued in July, 1956, it is particularly timely in view of the active interest being devoted to nonmetallic materials in Idaho by several companies and individuals. The report represents a correlated summary of various separate papers and articles that heretofore have been written about clay occurrences in north Idaho.

J. D. Forrester, Director
Idaho Bureau of Mines and Geology
July, 1956
# CLAY DEPOSITS OF NORTH IDAHO

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Table 1 -- Clay Reserves of North Idaho
SUMMARY

Clay occurrences have been noted over a wide area in north Idaho but exploration and development work has been confined to several deposits in Latah County and one deposit in Kootenai County.

The occurrences shown in Benewah, Nez Perce, Lewis, Idaho, and the other counties are, with one or two exceptions, clay exposures in railroad cuts, road cuts, or banks of streams and rivers. They have been sampled in many cases but the extent of the deposit is completely unknown since they are beneath a covering of soil or overburden and no attempt has been made to delineate the clay body.

Any estimate of clay reserves in all of north Idaho from data available would be unrealistic and might be misleading at this time. However, in Latah County, sufficient exploratory drilling and development work has been done to provide evidence that 250,000,000 tons of clay is a conservative estimate and that a possible 500,000,000 tons of clay may be present in this county.
INTRODUCTION

Clay deposits in north Idaho, as they occur at places along the eastern margins of the Columbia River Plateau physiographic province, have been reported since the beginning of the century by several investigators. It would appear from the close association between the Columbia River lava flows and the deposition of the Latah sediments, which include most of the clay bodies, that clay deposits will be found co-extensive with the basalts.

The map (Plate 1) shows that clay occurrences are known from near Coeur d'Alene, Kootenai County, on the north to near Grangeville, Idaho County, on the south, in a belt approximately 50 miles wide and 130 miles long. The counties of Kootenai, Bonewah, Latah, Nez Perce and Lewis and the western section of Clearwater County and the northwest part of Idaho County are known to contain clay bodies of possible ceramic qualities. Latah County, however, appears to contain by far the largest reserves.

The clay produced during the past 55 years in north Idaho probably does not exceed a total of 250,000 tons. The bulk of the production has been used for refractory products. Firebrick and other refractories have been manufactured in Latah County at Troy, starting about 1910 and at Moscow, beginning about 1913. However, during World War II between 1942 and 1944, a study was made of the high-alumina clays of north Idaho as possible sources of alumina. The U. S. Bureau of Mines and the U. S. Geological Survey cooperated in an extensive investigation of at least six clay deposits occurring in Latah County, one deposit located in Kootenai County, and several occurrences in other parts of the region.

Recent industrial expansion in the Pacific Northwest together with increased aluminum production has again focused attention on the clays of north Idaho for (1) utilization as a source of alumina and (2) ceramic use in manufacture of refractories and other products.

Table I summarizes the data on known clay reserves.
<table>
<thead>
<tr>
<th>Name of Deposit</th>
<th>Location</th>
<th>Estimated Area in Acres</th>
<th>Tonnage - (Dry Tons)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Measured</td>
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<tr>
<td>LATAH COUNTY</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Canfield-Rogers</td>
<td>T.39N., R.54W</td>
<td>8,109</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td>T.40N., R.54W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benson</td>
<td>T.40N., R.3W.</td>
<td>1,200</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Stanford</td>
<td>T.40N., R.3W.</td>
<td>196</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td>T.40N., R.2W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olson</td>
<td>T.40N., R.2W.</td>
<td>928</td>
<td>53,302,000</td>
</tr>
<tr>
<td></td>
<td>T.40N., R.3W.</td>
<td></td>
<td></td>
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<tr>
<td>Olson High-iron</td>
<td>T.40N., R.2W.</td>
<td>1,000</td>
<td>___</td>
</tr>
<tr>
<td>Section</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Deary</td>
<td>T.40N., R.2W.</td>
<td>115</td>
<td>___</td>
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<td>Bovill</td>
<td>T.40N., R.1W.</td>
<td>1,550</td>
<td>___</td>
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<tr>
<td>KOOTENAI COUNTY</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Stockton</td>
<td>T.50N., R.4W</td>
<td>40</td>
<td>___</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
In accord with the policy of the Idaho Bureau of Mines and Geology, this publication has been prepared to acquaint the people of Idaho with the information available on an important mineral resource of current interest.

ORIGIN AND MODE OF OCCURRENCE OF CLAY DEPOSITS

The earlier writers, Lindgren (1) and Russell (2) postulated a theory of origin and deposition of the Latah sediments which was later confirmed in greater detail by Kirkham and Johnson (3).

The Tertiary lava flows advancing from the west dammed the streams and drainage from the higher elevations to the east thus forming lakes and ponds. Debris was then washed down into the lakes to form the lacustrine deposits which have been designated the Latah formation. This formation, then, is composed of interbedded clays, sands, and gravels derived primarily from the granitic and metamorphic rocks of the Clearwater Mountains and related hills to the east of the Columbia River Plateau.

The lava extrusions were not continuous and, during extended periods of inactivity, weathered surfaces developed. Climatic conditions fostered disintegration and alteration of granitic and metamorphic rock masses to form residual clays. Erosional forces removed part of the clay together with sand and gravel from the slopes and deposited it at lower elevation in depressions or lakes on the margin of the basalt plateau. Renewed extrusions covered both transported and residual clay in places with a layer of younger basalt.

The result of this series of events is the occurrence of Latah beds of sand, gravel, and clay interbedded between layers of basalt or on top of the basalt near the margins of the plateau. Residual clays are encountered in foothills of Pre-Tertiary intrusives a little above the main basalt plateau but often covered by a thin layer of younger lava.

Prospecting for clay deposits should be most rewarding if done along the margin of the basalt where it terminates against foothills of granitic intrusive masses. Where the upper basalt flows have invaded old valleys or low lying areas to form tongues or embayments there is a good environment for formation of clay deposits.


TYPES OF CLAY DEPOSITS

Transported clays form the bulk of the known deposits. These are lacustrine or stream deposits in which clay, sand, gravel, some carbonaceous matter, and iron oxide are intermingled and interbedded. Beds of almost pure clay occasionally are formed; the principal clay mineral is kaolin.

Residual clays are found in deposits of economic significance in some cases. Many transported clays were laid down on a residual clay surface. A residual clay deposit may crop out in an area of weathered igneous rocks or occur below a thin layer of basalt. Residual clay bodies may be completely altered to depths of 100 feet or more but eventually grade downward into unaltered rock. The residual clays retain the texture and mineral distribution of the original rock. They are classified as granitic residual and basaltic residual.

Granitic residual clays are white, gray, or pink, locally stained yellow or brown by iron oxide. Kaolinite, the principal clay mineral, is formed from alteration of feldspar, and to a minor degree from muscovite and biotite. The quartz, in the original rock remains unaltered and is disseminated throughout the clay. Most granitic residual clays contain an abundance of quartz which lowers the available alumina and they are therefore unsuitable for high-alumina clay. Dikos in the granitic mass are nearly free of quartz in some cases and weather to almost pure kaolin. These portions of a residual deposit are suitable for paper clays or china clay without further treatment.

The basaltic residual clays are generally darker than granitic clays, having a bluish-gray color sometimes stained yellow or tan by iron oxide. The principal clay mineral is kaolinite; occasionally the plagioclase alters to nontronite. Abundant small flakes of blue-black ilmenite are disseminated through the clay, causing the bluish color and the generally high iron and titanium content.

CLAY DEPOSITS IN LATAH COUNTY

Extent

Latah County contains the most extensive deposits of clay known in north Idaho (Plate 2). A belt approximately 35 miles long and 12 miles wide across the center of the county in the Moscow-Troy-Deary-Boivil region includes the major clay reserves. The region is on the south and east slopes of the Thatuna Hills, an east-west range of hills underlain by granodiorite, weathered portions of which are the principal source of the clay.

North of the Thatuna Hills in the Palouse River basin several clay occurrences are known and a few were exploited in a small way several years ago. Some clay has been mined on the edge of Potlatch and some near Onaway and Palouse, Washington.
GEOLOGIC AND INDEX MAP OF THE LATAH COUNTY, IDAHO CLAY DISTRICT

EXPLANATION

Tcr. Columbia River basalt Tertiary
Gr. Grandonite, etc. Cretaceous (?)
Vp. Volcanic rocks, Permo. (?)
Belt series Pre-Cambrian

Clay deposits investigated by Geological Survey.
Other clay deposits or areas of favorable outcrops.
Transported; Gr. Gravitic, residual; Basaltic, residual.

Compiled by V.E. Scheid from: (1) Tullis, E.L., 1944;
(4) Falk, J.N., 1937; (5) Scheid, V.E. and Sohn, I.G., 1943-44
Reserves

Approximately 300 square miles in Latah County is geologically favorable for clay deposits and it would seem that only 18 to 20 square miles have been investigated thoroughly. Hidden clay bodies beneath overburden of Palouse formation or basalt may, in the aggregate, represent many times the present estimated reserves.

From data available, it is thought that known clay-bearing areas in Latah County contain 53,302,000 dry tons of measured clay reserve, 131,620,000 dry tons of indicated clay reserve, and in the order of 275,000,000 dry tons of inferred clay reserve. The total known reserves in Latah County are thought to be in the order of 465,000,000 dry tons of clay.

Canfield-Rogers Clay Deposit

Location and Accessibility

The Canfield-Rogers clay-bearing area as it occurs in the west central part of Latah county (Plate 3), lies adjacent to the town of Moscow on the east and north in T. 39 N., R. 5 and 6 W., and T. 40 N., R. 5 and 6 W. The south fork of the Palouse river is on the south and east boundary and Paradise creek runs through the center of the area.

This region of low-rolling hills is virtually barren of timber and is composed of small farms and suburban homes. U. S. Highway 95 crosses the northern part and State Highway 8 crosses the southern tip. A network of county roads provides access to the area. Three railroads serve the town of Moscow and provide rail transportation. The Washington Water Power Company has a 22,000-volt transmission line adjacent to the area and can furnish power for mining and processing.

History and Production

A small pit in the Canfield deposit was opened in about 1925 by the former Moscow Fire Brick and Clay Products Company. The pit was located in the valley floor near Paradise creek east of Moscow in NE2, NW2, sec. 16, T. 39 N., R. 5 W. It was abandoned about 1929 because of difficult mining conditions. At that time the pit measured 60 feet long by 30 foot wide and exposed an 8-foot section of transported clay, gray and yellow, with good refractory qualities.

A second pit was started in the side of a small hill in 1930, about 300 feet north of pit No. 1. A face about 100 feet long and 30 to 35 feet high was opened. The lower 20 foot showed white and yellow transported clay intermingled with seams of sand in irregular beds and lomoses. The overburden amounted to 15 feet of sand and soil.

In 1936, a third pit was started in the same hill about 150 feet to the west of pit No. 2. A face about 75 feet long by 15 feet high was opened exposing a 2-foot bed of yellow clay and a 4-foot bed of gray clay separated by about one foot of sand. It is a transported deposit.
EXPLANATION

AREA OF CLAY DEPOSITS

CANFIELD-ROGERS CLAY DEPOSIT, LATAH COUNTY, IDAHO
Samples taken from this pit by Scheid(4) in 1938 gave the following analysis:

Composition of Clay from Canfield Deposit

Sample 4(a)  Sample 5(b)

Al₂O₃ . . . . . 29.1 per cent  28.4 per cent
Fe₂O₃ ........  3.9         2.6
SiO₂ ........ 55.6         58.4
CaO ........  Tr.         Tr.
MgO ........  0.42         0.28
Ign. Loss .... 11.9        11.3

(a) 2-foot bed of yellow clay
(b) 4-foot bed of gray clay

The Moscow Fire Brick Company continued mining clay from pit No. 3 on the Canfield deposit until the brick plant burned and the company ceased operation about 1941. Total production from all three pits is estimated as 5,000 to 7,000 tons of clay.

Clay was mined from the Rogers deposit starting in 1929 with the opening of a small pit in the side of a low hill adjoining the railroad north of Moscow, near the center of sec. 31, T. 40 N., R. 5 W. The Aberdeen Clay and Color Company is reported to have mined several carloads of clay in 1929-30 and shipped them to Aberdeen, Washington, for beneficiation tests. The pit exposed a face about 15 to 20 feet high by about 50 feet long, reported to have shown 12 to 15 feet of white, transported clay which contained about 75 per cent kaolin. Above the clay bed was 5 to 15 feet of sand and Palouse soil overburden. The following analysis was made from samples taken by Scheid in 1938.

Composition of Clay from Rogers Deposit

Al₂O₃ ........ 26.2 per cent  MgO .......... 0.22 per cent
Fe₂O₃ ........  1.13         CaO ..........  0.28
SiO₂ .......... 61.8         Ign. Loss ....  9.9

(4) Scheid, V. E., Clay resources of Latah County, Idaho: Univ. of Idaho Thesis, 1940.
Several small pits have been opened in the hillside above Paradise creek east of Moscow by county road crews to obtain sand and quartz pebbles for road surfacing. The pits in the SW¼, NE¼, of sec. 9, T. 39 N., R 5 W. expose some clay seams of the transported type. No use has been made of the clay.

During the war years 1943-44, the U. S. Geological Survey and the U. S. Bureau of Mines conducted investigations of the Rogers-Canfield clay-bearing area (5). The Bureau drilled 13 auger holes totaling 451 feet and samples were taken every 5 feet or when a change occurred in the formation. Eleven of the holes were put down in the vicinity of the Rogers pit north of Moscow and all of the holes except one were located west of U. S. 95. Two holes were put down east of town near the Canfield pits but were not sampled because of the large flow of water and sand encountered. Later, the limits of the clay-bearing area were delineated by Scheid and Hosterman from drill holes and geologic data gathered in 1944.

Geology and Nature of Deposit

The clay-bearing area lies in the eastern part of the Moscow embayment, an area underlain by nearly horizontal beds of Columbia River basalt and Latah formations, all of Tertiary age. The embayment is limited on the north and east by the pre-Tertiary granodiorite hills of the Thutuia range and on the south by the complex of pre-Cambrian sediments and granodiorite which underlie Paradise Ridge, of which Tamer's Butte is the most prominent landmark. Scheid (6) reports that approximately 83 per cent of the deposit is transported clay. The scorificial texture of the basalt exposed in Paradise creek indicates the front and top of the lava flow which created the lakes and ponds where clay and other Latah beds were deposited. The transported clays are underlain by basaltic residual clay or Latah beds of sand-gravel and below those is a floor of hard unweathered basalt. The underlying basaltic residual clay comprises about 15 per cent of the total clay. In some places the transported clay rests on granitic residual clay which grades downward into granitic sand and eventually into fresh granodiorite. Deposits of granitic residual clays occurring directly beneath the soil overburden exist only in the north and east portions of the area.

Virtually all of the clay beds are covered by top soil of the Palouse formation. This soil is thicker on the hills than in the valleys. The valleys are covered by terrace sands and gravel and recent alluvium. The thickness of the soil overburden ranges from less than one to about 50 feet


(6) op. cit., April, 1951.
and averages approximately 15 feet. The upper limit of the clay may be sharp where covered by Palouse soil or it may grade upward into silt, sand, and gravel.

Reserves

From U. S. Bureau of Mines drill hole information and U. S. Geological Survey geological data, estimated reserves in the Rogers-Canfield clay area are as follows:

**Indicated Clay Reserves - Canfield-Rogers Deposit**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Area in acres</td>
<td>109</td>
</tr>
<tr>
<td>Average thickness of clay in feet</td>
<td>27.7</td>
</tr>
<tr>
<td>Cubic yards of clay in place</td>
<td>4,850,000</td>
</tr>
<tr>
<td>Tons of clay in place</td>
<td>8,700,000</td>
</tr>
<tr>
<td>Tons of clay, loss moisture</td>
<td>6,520,000</td>
</tr>
</tbody>
</table>

Average Al₂O₃ = 21.7%

Average Fe₂O₃ = 2.5%

**Inferred Clay Reserves - Canfield-Rogers Deposit**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in acres</td>
<td>8,000</td>
</tr>
<tr>
<td>Average thickness of clay in feet</td>
<td>11.5</td>
</tr>
<tr>
<td>Cubic yards of clay in place</td>
<td>150,000,000</td>
</tr>
<tr>
<td>Tons of clay in place</td>
<td>270,000,000</td>
</tr>
<tr>
<td>Tons of clay, loss moisture</td>
<td>200,000,000</td>
</tr>
</tbody>
</table>

Average Al₂O₃ = 20%

Average Fe₂O₃ = 3%

**Benson Clay Deposit**

**Location and Accessibility:**

The Benson clay-bearing area is about 4 miles northeast of Troy and about 2 miles north of State Highway 8, which extends between Troy and Deary. It includes the southern part of secs. 27, 28, 29, and the northern part of secs. 32, 33, and 34 in T. 40 N., R. 3 W., in the central part of Latonah Township (Plate 4).

The area is in the upper Little Bear Creek basin and is characterized by low hills and ridges with flat creek bottoms. Some of the slopes are timbered but most of the land has been cleared for agriculture. The area is divided into small private farms. Several well-graveled county roads provide access for the numerous farm families as well as to nearly all parts of the clay area. The nearest railroad is at Troy, a trucking
distance of four to five miles, with a downgrade most of the way in favor of the load. A 22,000-volt transmission line of the Washington Water Power Company follows State Highway 8 and is within a mile or so of the clay deposit.

History and Production

One of the early clay mining operations in northern Idaho, the Johansen pit, was opened in 1913 on the Per Johansen farm in the NW¼ sec. 34, T. 40 N., R. 5 W., in the Benson clay-bearing area by the Idaho Fire Brick and Clay Company of Troy. Mining operations were continued until 1932. The pit at that time consisted of an irregular opening 400 feet long by 150 feet wide in the bank on the west side of Little Bear Creek Valley. The opening exposed a 45-foot section of residual granitic clay altered from a granite cut by a network of pegmatic and aplastic dikes. The overburden ranged from 4 to 6 feet of soil. The Johansen pit was closed down after the Benson pit was opened in 1930. It is reported to have produced about 50,000 tons of clay.

The Idaho Fire Brick Company also opened the Linderman pit in 1918 on the old Otto Linderman farm near the south center of the NW¼ sec. 34, T. 40 N., R. 5 W. about 0.4 mile south of the Johansen pit and worked it until 1928. In 1926, the Linderman pit formed an irregular circle about 150 feet in diameter. The thickness of the section of white plastic clay exposed ranged from 22 feet in the center to 4 feet at the edges with a 100-foot horizontal extent. The overburden consisted of 5 to 20 feet of brown basaltic sand underlain by 1 to 15 feet of white quartz sand. The clay was white (some iron staining), more plastic than the Johansen clay. It probably was used as a plasticizer at the brick plant. The production is probably included in the tonnage figure for the Johansen pit.

Another small pit located about 500 feet north of the Linderman pit was probably on an extension of the same deposit of colluvial clay. This, the middle pit, was about 50 feet in diameter with a maximum depth of 50 feet.

The Benson pit, opened by the company in 1930 was, until fire destroyed the brick plant in 1955, the principal source of clay for the Idaho Fire Brick operation at Troy. The pit is in the NW¼ of NW¼ sec. 33 T. 40 N., R. 3 W., on the former Ole Benson farm. It is a residual granitic clay deposit and in some places shows a gneissic structure. Company drilling disclosed about 6 acres underlain by clay and depths of 100 feet have been reached without encountering fresh granite.

The Benson pit is estimated to have produced about 150,000 tons of clay. Part of this has come from underground mining and part from open pit. Recent operations were open pit.
GEOLOGY AND NATURE OF DEPOSIT

The Benson clay-bearing area is similar to neighboring clay areas in that it lies on the southern slope of the Thatuna Hills and on the border of the Columbia River basalt. However, this area is unique in that it is composed predominantly of residual clay instead of transported clays which make up the bulk of the other deposits. Weathering and alteration apparently has taken place to greater depths than in other localities and erosional agencies have removed less of the surface. A complete study of the factors which may have affected this area has not been made. However, a basalt capping of from 1 to 20 feet which covers most of the clay-bearing area may account for the large amount of clay still found in place.

RESERVES

Estimated measured clay reserves in the proximity of the Benson pit are reported as 2,000,000 tons with an additional 4,000,000 tons of probable clay reserves.

The U. S. Bureau of Mines conducted an exploratory drilling program in the Benson clay area in 1943. Thirty-two holes were drilled totaling 695.8 feet. The inferred reserves were originally estimated as about 130,000,000 tons of residual clay containing about 11 per cent Al₂O₃. The tonnage estimate later was considered much too high in view of the disconnected and irregular nature of the deposits.

STANFORD CLAY DEPOSIT

LOCATION AND ACCESSIBILITY

The Stanford clay-bearing area is in the vicinity of Stanford, a station on the Washington, Idaho, and Montana Railroad between Harvard and Deary, Idaho. It is in secs: 1 and 12, T. 40 N., R. 3 W., and secs. 6 and 7, T. 40 N., R. 2 W., in the central part of Latah County (Plate 5).

The locality is characterized by low rounded hills and relatively flat valleys, and is in the upper part of the Big Bear Creek drainage. There is little timber in the immediate vicinity and the land, divided into small farms, is devoted to agriculture. State Highway 42 crosses the clay-bearing area and access is provided by numerous farm roads. A siding could be placed on the railroad in the deposit. The nearest available power would be the 22,000-volt transmission line at Deary, a distance of about 5 miles to the southeast.

HISTORY AND PRODUCTION

For 45 years or more, clay has been known to occur in railroad cuts along the Washington, Idaho, and Montana Railroad, particularly near Stanford and between Stanford and Deary.
EXPLANATION

AREA OF CLAY DEPOSITS

STANFORD, OLSON, DEARY CLAY DEPOSITS, LATAH COUNTY, IDAHO
A railroad cut less than one mile east of the Stanford station exposes a clay bed for 600 feet horizontally. Under 5 to 10 feet of red soil there are 4 feet of white sandy clay and below that are 20 feet of yellow-stained transported clay. It is reported that several carloads of this material were shipped to the pottery plant at Palouse and to a stoneware plant at Portland.

During 1943 and 1944 the area was investigated by the U. S. Geological Survey in cooperation with the U. S. Bureau of Mines and a drilling program was conducted by the Bureau of Mines in 1943(7). Ten holes were drilled for a total of 187.7 feet and 22 samples were analyzed for available alumina (Al₂O₃) and available ferric oxide (Fe₂O₃).

Geology and Nature of Deposit

The Stanford clay-bearing area is in the northwest corner of the Avon embayment, which is underlain by flat-lying beds of Columbia River basalts and sediments of the Latah formation. The embayment is limited on the north by hills underlain by pre-Cambrian Belt sediments, on the west and northeast by granodiorite hills, and in the east by Perman volcanics underlying Potato Hill. Although only two miles north of the northern limits of the Olson deposit, the Stanford deposit is separated from it by a granite knob.

The bulk of the deposit is composed of transported clays deposited on a basalt floor. Some residual basaltic clay occurs below the transported clay. Weathering and alteration of the granodiorite provided nearly all the material for the transported clays. Granitic residual clay is probably present beneath the transported clays in the extreme southwestern part of the area.

Soil of the Palouse formation forms the greater part of the overburden with some deposits of alluvium bordering the streams. Thickness ranges up to 18 feet and average thickness is about 11 feet.

Reserves

Two holes drilled by the U. S. Bureau of Mines encountered high alumina clay and five holes disclosed clay of ceramic grade. The following reserves are estimated:

Indicated Clay Reserves - Stanford Deposit

Area in acres .................................................. 36
Average thickness of clay in feet ......................... 14.7
Cubic yards of clay in place .............................. 858,000
Tons of clay in place ...................................... 1,540,000
Tons of clay, less moisture .............................. 1,160,000

Average $\text{Al}_2\text{O}_3 = 24.8\%$
Average $\text{Fe}_2\text{O}_3 = 2.0\%$

Inferred Clay Reserves - Stanford Deposit

Area in acres .................................................. 160
Average thickness of clay in feet ......................... 13.5
Cubic yards of clay in place .............................. 3,470,000
Tons of clay in place ...................................... 6,240,000
Tons of clay, less moisture .............................. 4,680,000

Average $\text{Al}_2\text{O}_3 = 20.0\%$
Average $\text{Fe}_2\text{O}_3 = 2.0\%$

Olson Clay Deposit

Location and Accessibility

The Olson clay-bearing area is about seven miles northeast of Troy and on both sides of State Highway 8 between Troy and Deary. It is in the southwestern part of T. 40 N., R. 2 W., and the southeastern part of T. 40 N., R. 3 W., in the east-central part of Latah County (Plate 5).

The area is limited by Big Bear Creek on the east and is in the upper part of the Dry Creek drainage. It is a gently rolling plateau with rounded hills and flat valleys. Some of the hillsides are timbered and the valleys are generally under cultivation. The area is divided into small, private farms and is crossed by three or four county roads which are well maintained to provide access for the numerous farm families. The nearest railroad loading point is at Deary, a small village on the Washington, Idaho and Montana Railroad about four miles' trucking distance to the east. State Highway 8 crossing the southern part of the area is a paved highway. A 22,000-volt transmission line of the Washington Water Power Company follows the highway.

History and Production

Clay mining in the Benson deposit for many years has led to prospecting in nearby areas and the discovery of other clay deposits. The Olson brothers, Robert, living in Troy, and Albert, in Moscow, have been among the most persistent prospectors in this region. In the summer of
1942, the brothers drilled a few holes in the area later known as the Olson deposit. Their work indicated the existence of a large body of clay with alumina content above 20 per cent and it was brought to the attention of the U. S. Bureau of Mines. After preliminary examination, the Bureau started exploratory drilling in the fall of 1942, and drilling was continued on this and nearby areas during 1942 and 1943. Holes were first spaced 1,000 feet apart at the corners of a grid system and later intermediate holes were drilled at 500-foot intervals over the most promising area. Two hundred and sixty-eight holes totaling 12,147 feet were drilled and more than 2,000 samples were assayed for available Al₂O₃ and Fe₂O₃. An area of 928 acres was eventually proved to be underlain by valuable high alumina clay.

The Olsens continued drilling in and adjacent to the area after 1944 and disclosed some extensions to the deposit, especially to the north in sec. 18 and 19, T. 40 N., R. 2 W. The Troy Fire Brick Company leased a part of the Olson holdings in the SW₁/₄ of SW₁/₄ sec. 18 and started stripping operations in 1955. Only a few tons of clay were shipped to the brick plant at Troy before the plant was destroyed by fire in July, 1955.

The Anaconda Company, which has tested clays in north Idaho from time to time over a considerable period, has taken renewed interest in Latah County high alumina clay as a source of alumina for the new reduction plant it recently put into production at Columbia Falls, Montana. A drilling program in the Olson deposit has been carried on by Anaconda during the last two years and samples have been sent to the company laboratory for testing, including a 100-ton metallurgical sample. The company is reported to have purchased options on clay-bearing land and to be contemplating construction of a processing plant.

The Troy Fire Brick Company has recently changed management and it is reported that the A. P. Green Company of Mexico, Missouri, will erect a new and modern brick plant to replace the one destroyed by fire in 1955.

Geology and Nature of Deposit

The Olson deposit is about 2 miles south of the Stanford clay-bearing area and like it is in the Avon embayment. The clay rests on a basalt floor which dips at about one per cent to the southeast. A small area of clay in the northwest corner of the deposit rests on granodiorite. Transported clay comprises the major portion of the deposit and virtually all the clay of 20 per cent or more alumina content is of this type. Some residual granitic clay is reported in the northern part of the area and some transitional or colluvial clays are present.

The clay, a nearly horizontal bed, ranges in thickness from a few inches to 126 feet and averages about 26 feet. This wide disparity in thickness is partly due to erosion before the covering of Palouse soil was deposited. The overburden covering the clay beds ranges from 2 to 35
feet and averages about 16 feet over the entire area. A residual basaltic clay usually occurs below the transported or colluvial clay and separates it from the fresh basalt below. This basaltic clay averages about 7 feet thick and is somewhat higher in iron oxide content. Seams of limonite a few inches thick occur near the upper part of the clay beds. One clay bed, which is a flesh pink plastic clay, averages 9 feet thick and contains 32.3 per cent Al₂O₃ and 2.4 per cent Fe₂O₃. The average composition of the entire deposit calculated from a composite sample of the area is as follows:

```
Average Composition - Olson Deposit

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>25.29</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>5.85</td>
</tr>
<tr>
<td>SiO₂</td>
<td>51.02</td>
</tr>
<tr>
<td>TiO₂</td>
<td>1.65</td>
</tr>
<tr>
<td>K₂O</td>
<td>0.72</td>
</tr>
<tr>
<td>Na₂O</td>
<td>0.23</td>
</tr>
<tr>
<td>C₂O₅</td>
<td>0.36</td>
</tr>
<tr>
<td>CO₂</td>
<td>0.43</td>
</tr>
<tr>
<td>CaO</td>
<td>0.42</td>
</tr>
<tr>
<td>MgO</td>
<td>0.19</td>
</tr>
<tr>
<td>SO₃</td>
<td>0.099</td>
</tr>
<tr>
<td>P₂O₅</td>
<td>0.112</td>
</tr>
</tbody>
</table>

Ign. Loss: 10.60
```

*Calculated from composite sample.

Reserves

Measured clay reserves were calculated by U. S. Bureau of Mines engineers(8). The free moisture content of the clay was estimated to be 24 per cent. A factor of 15 cubic feet equals one ton of clay in place and 20 cubic feet equals one ton of clay, less moisture, was used with the following results:

```
Measured Clay Reserves - Olson Deposit

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in acres</td>
<td>928.37</td>
</tr>
<tr>
<td>Average thickness of clay in feet</td>
<td>26.4</td>
</tr>
<tr>
<td>Cubic yards of clay in place</td>
<td>39,483,000</td>
</tr>
<tr>
<td>Tons of clay in place</td>
<td>71,070,000</td>
</tr>
<tr>
<td>Tons of clay, less moisture</td>
<td>53,302,000</td>
</tr>
</tbody>
</table>

Average Al₂O₃ = 24.3%

Average Fe₂O₃ = 4.7%

Another 16,000,000 tons of clay containing 20 per cent or more Al₂O₃ and less than 5 per cent Fe₂O₃ are indicated to occur around the borders of the measured reserves.

Olson Deposit - High-Iron Section

A high iron content clay area of roughly 1,000 acres adjoins the Olson deposit on the south. The major part is south of State Highway 8 and mostly in sec. 31 and 32, T. 40 N., R. 2 W., (Plate 5). The area is divided into numerous small farms owned by individual families. One gravel road and two unimproved roads cross the deposit and provide access.

The deposit was investigated by the Geological Survey and Bureau of Mines along with the other Latah County deposits in 1942-43. Eighteen holes were drilled in the vicinity. The unique character of this deposit is the presence of a 15-foot layer of nontronite (Fe₂O₃·3SiO₂·H₂O) in the east part of the area.

Average Composition - High-Iron Clay

\[
\begin{align*}
\text{Al}_2\text{O}_3 & : 22.8 \text{ per cent} \\
\text{Fe}_2\text{O}_3 & : 22.4 \\
\text{SiO}_2 & : 38.2 \\
(b)\text{TiO}_2 & : 4.4
\end{align*}
\]

(a) Calculated from composite sample.

(b) TiO₂ in form of ilmenite.

Reserves

From the work done by the Geological Survey and Bureau of Mines the following reserves of clay are estimated:

<table>
<thead>
<tr>
<th>Type</th>
<th>Tons of Clay, less moisture</th>
<th>Average Al₂O₃</th>
<th>Average Fe₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicated</td>
<td>50,000,000</td>
<td>22.4 per cent</td>
<td>20.1</td>
</tr>
<tr>
<td>Inferred</td>
<td>20,000,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The large amount of iron presents a problem in the use of pit-run clay. However, beneficiation might produce a clay suitable for ceramic purposes and a salable ilmenite concentrate as a by-product.

Deary Clay Deposit

Location and Accessibility

The Deary clay deposit on the east side of Bear Creek Valley is about two miles south of the town of Deary and about two miles due east of the high-iron section of the Olson deposit. It is in the NE² of sec. 34 and the SE² of sec. 27, T. 40 N., R. 2 W., in the east-central part
of Latah County (Plate 5). The physiography is characterized by low rounded hills and flat valleys. The altitude ranges from 2,800 to 3,000 feet but the relief locally is seldom more than 80 feet.

State highway 42, an all-weather road between the towns of Deary and Kendrick, passes along the eastern border of the clay-bearing area. County roads encircle the region and provide easy access. The nearest shipping point is on the Washington, Idaho, and Montana Railroad at Deary giving a trucking distance of about two miles from the deposit. A 22,000-volt transmission line of the Washington Water Power Company passes through Deary and two miles of access line would be needed to make power available for mining operations.

History and Production

While investigating the Olson deposit, U. S. Bureau of Mines engineers explored the Deary clay area for evidence of high alumina clay in 1942-43. A drilling program was started in the fall of 1943. Twenty-six holes totaling 918 feet were drilled in the vicinity. Thirty-two samples of basaltic residual clay and 54 samples of transported clays were assayed for ignition loss, available alumina, and available ferric oxido. The U. S. Geological Survey further explored the geology and extent of the deposit in 1944(9).

Geology and Nature of Deposit

The Deary clay area is "T" shaped, roughly 3,200 feet east-west and 2,600 feet north-south. The entire area is underlain by sedimentary beds of the Latah formation which rest on a basalt floor. The deposit is limited by erosion on the northeast and south. To the west the beds become thin and of no economic significance. The transported clay beds are a part of Latah formation and are generally separated from the underlying fresh basalt by a bed of basaltic residual clay. The clay is overlain by sand-gravel or Palouse soil and in some places by a basalt capping. Overburden ranges from one to 20 feet and averages 14 foot in thickness. About 65 per cent of the deposit is transported and 35 per cent is basaltic residual clay.

Reserves

Results of drill hole sampling together with geologic data compiled by the U. S. Geological Survey. indicate an area of 115 acres underlain by high alumina clay. From this data the following reserves are estimated:

Indicated Clay Reserves - Deary Deposit

Area in acres.............................................. 115
Average thickness of clay in feet............. 39.3
Cubic yards of clay in place.................. 7,320,000
Tons of clay in place............................. 13,235,000
Tons of clay, less moisture.................. 10,910,000

Average Al₂O₃ = 24.0 per cent
Average Fe₂O₃ = 3.8

Bovill Clay Deposit

Location and Accessibility

The Bovill clay-bearing area is southwest of the town of Bovill in the southern part of T. 41 N., and the northern part of T. 40 N., R. 1 W., in the eastern part of Latah County (Plate 6). It is west of the West Fork of the Potlatch River and is crossed by several tributary creeks including Hog Meadow Creek. The locality is in a region of low hills with relief seldom exceeding 100 feet. Most of the area is public land belonging to the federal and state governments. The private land is owned in a large part by Potlatch Forest Products, Inc.

State Highway 8 is a paved road passing through the center of the deposit and all portions are within a mile of this highway. The nearest railroad point is at Bovill on two rail lines -- the Chicago, Milwaukee, St. Paul, and Pacific and the Washington, Idaho, and Montana railroads. The trucking distance is three miles. Power for mining operations is available from a 22,000-volt Washington Water Power Company transmission line which crosses the deposit.

History and Production

In conjunction with the investigation of high alumina clay in Latah County in 1942-43 by the U. S. Bureau of Mines, a drilling program was conducted in 1943 in the Bovill clay area. Holes drilled at 1,000 foot intervals disclosed clay underlying an area approximately 8,000 feet by 14,000 feet. Samples were taken at 5-foot intervals or when a change in the formation occurred and were analyzed for ignition loss and available Al₂O₃ and Fe₂O₃. The U. S. Geological Survey made a study of the same area in 1944 delineating the clay-bearing area and studying the geology.(10)

Geology and Nature of Deposit

The Bovill clay deposit is in the northeastern corner of the Helmar embayment, an area underlain by relatively flat-lying beds of Columbia River basalts and Latah sediments. The embayment is limited on the north by granodiorite hills, on the east by hills of pro-Cambrian Belt rocks, and on the west by Permian volcanics underlying Cherry and Potato Hills.

Most of the deposit, about 87 per cent, is transported clay. About 11 per cent is basaltic residual and two per cent is granitic residual clay. The transported clay generally rests on basaltic residual clay. In some places it is on granitic residual clay and in some places it is underlain by Latah beds of sand-gravel. The overburden composed of sand, low grade clay, and Palouse soil ranges up to 20 feet but averages about 10 feet in thickness.

The present streams have apparently dissected the clay formation where they traverse the area. Apparently the clay beds are located above the elevation of the stream channels.

Reserves

From the evidence of 10 holes drilled by the Bureau of Mines and the limits of the clay-bearing area, as delineated by the Geological Survey, estimated clay reserves are as follows:

**Indicated Clay Reserves - Bovill Deposit**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in acres</td>
<td>900</td>
</tr>
<tr>
<td>Average thickness of clay in feet</td>
<td>21</td>
</tr>
<tr>
<td>Cubic yards of clay in place</td>
<td>31,737,000</td>
</tr>
<tr>
<td>Tons of clay in place</td>
<td>57,200,000</td>
</tr>
<tr>
<td>Tons of clay, less moisture</td>
<td>43,030,000</td>
</tr>
</tbody>
</table>

Average $Al_2O_3$ 21.8 per cent

Average $Fe_2O_3$ 4.0 per cent

**Inferred Clay Reserves - Bovill Deposit**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area in acres</td>
<td>650</td>
</tr>
<tr>
<td>Average thickness of clay in feet</td>
<td>20</td>
</tr>
<tr>
<td>Cubic yards of clay in place</td>
<td>20,400,000</td>
</tr>
<tr>
<td>Tons of clay in place</td>
<td>36,600,000</td>
</tr>
<tr>
<td>Tons of clay, less moisture</td>
<td>27,400,000</td>
</tr>
</tbody>
</table>

Average $Al_2O_3$ 20 per cent

Average $Fe_2O_3$ 4 per cent
Other Clay Deposits in Latah County

Joel Deposit

The Joel clay pit of the former Moscow Fire Brick and Clay Products Company is located 3/4 mile north of Joel, a station on the Northern Pacific Railroad about five miles east of Moscow. It is in the NW 1/4 SE 1/4 sec. 18, T. 39 N., R. 4 W., in the west-central part of Latah County (Plate 1 - No. 1). The locality is in the rolling foothill section at the base of the Thatuna Hills. The pit is in the side of one of the low hills and is about ½ mile from a gravelled county road. The former operators erected a 3/4-mile aerial tramway from the pit to the Joel railroad siding. Clay was transferred from the pit to railroad cars by the tramway and thence shipped to the brick plant at Moscow by rail.

The pit was opened in 1916 and was operated between 1916 and 1930. The face of the pit was L shaped, extending about 250 feet east-west and 125 feet north-south. The clay was excavated to a depth of 30 to 50 feet and overburden was 4 to 6 feet of Palouse soil.

The clay is a granitic residual deposit of the same type as the Benson deposit which was worked by the Troy Fire Brick Company. The original rock was probably a granitic gneiss intruded by pegmatitic and aplitic dikes. The kaolinization has been complete although original textures are readily discernible. Some of the dikes were reported to have yielded a white-burning clay. A sample taken by Skoels(11) gave the following analysis:

Analysis Fireclay from Joel Deposit

<table>
<thead>
<tr>
<th>Al₂O₃</th>
<th>SiO₂</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>Ign. Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.15 %</td>
<td>64.9</td>
<td>1.9</td>
<td>1.2 %</td>
<td>1.05</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Drilling tests indicate the clay extends below the floor of the pit for at least 30 feet, making a total thickness of 70 feet. Kaolin rock is exposed in several places over a 40-acre tract, thus implying a large reserve of clay. The pit has been inactive since about 1930.

McKeeshan Deposit

This deposit, on the north side of the old Deary road about one mile north of Troy, is in the SW 1/4 sec. 6, T. 39 N., R. 3 W., Latah County (Plate 1 - No. 2). It is opened by a hillside pit. The clay is below a basalt capping. It is reported to be a colluvial deposit, transported only a short distance from its origin.

About a 10-foot layer of refractory clay is exposed in the pit, and a small amount has been used by the Troy Fire Brick Company. The pit is now inactive. A small creek through this deposit flows south into Little Bear Creek and clay similar to that in the pit has been reported along the banks and in the bed of the creek for a mile or more to the south.

**Deposits near Troy along Little Bear Creek**

The clay exposures along Little Bear Creek near Troy include a hillside pit behind the Troy Fire Brick plant, a 158-foot adit east of Troy in the center of sec. 7, T. 39 N., R. 3 W., and along the banks of Little Bear Creek in secs. 18 and 20, T. 39 N., R. 3 W., (Plate 1 - No. 3).

The clay exposed at all of these locations is residual basaltic type showing various stages of alteration and coloring. The occurrence along the bank of Little Bear Creek in secs. 18 and 20 is thought to show hydrothermal alteration.

An undetermined but small amount of shaley clay has been removed from the pit in the rear of the fire brick plant for use in blending with fire clay from the company's other clay sources. The basaltic clays are generally high in iron content, a chemical analysis of one sample taken on the old Kondrick road gave the following:

**Composition of Basaltic Clay near Troy**

<table>
<thead>
<tr>
<th></th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>24.0</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>17.3</td>
</tr>
<tr>
<td>SiO₂</td>
<td>41.7</td>
</tr>
<tr>
<td>CaO</td>
<td>1.74</td>
</tr>
<tr>
<td>MgO</td>
<td>0.30</td>
</tr>
<tr>
<td>K₂O</td>
<td>3.80</td>
</tr>
<tr>
<td>Ign. Loss</td>
<td>9.50</td>
</tr>
</tbody>
</table>

**Clay Occurrences Near Park**

Park is a small farming community about 5 miles south of Hilmer in the center of the section line between secs. 9 and 16, T. 39 N, R. 1 W., in the southeastern part of Latah County. Numerous clay exposures have resulted from cuts made by the Washington, Idaho, and Montana Railroad branch line. The line runs along the northern edge of the Park embayment, an area underlain by horizontal beds of basalt surrounded on three sides by hills of granodiorite and pre-Cambrian Belt rocks.

Granitic residual clay is exposed in cuts in the SW₁, sec. 11, T. 39 N., R. 1 W., and the SE₁ sec. 6, T. 39 N., R. 1 E. (Plate 1 - No. 4). The granites are decomposed and only partly altered to clay minerals. One cut has been driven into the hill about 100 feet, probably to obtain fill for the roadbed.
Transported clay is exposed in thicknesses from one to two feet in numerous cuts near Park. However, the railroad cuts are low and probably do not expose the true thickness of the clay.

**Composition of Granitic Clay near Park**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>11.3</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>2.58</td>
</tr>
<tr>
<td>SiO₂</td>
<td>70.6</td>
</tr>
<tr>
<td>CaO</td>
<td>1.74</td>
</tr>
<tr>
<td>MgO</td>
<td>0.58</td>
</tr>
<tr>
<td>K₂O</td>
<td>6.32</td>
</tr>
<tr>
<td>Ign. Loss</td>
<td>7.8</td>
</tr>
</tbody>
</table>

**Clay Occurrences between Bovill and Clarkia**

Exposures of granite and quartz monzonite cut by numerous dikes of pegmatite and aplite, in various stages of decomposition, are found in highway and railroad cuts for three miles on each side of the divide between Bovill and Clarkia (Plate 1 - No. 5). It is not known whether sufficient kaolinization has taken place at any point in this area to form clay of economic value. However, the decomposed granite is extensive.

**Clay Occurrences near Deary**

Deary is a small community on the Washington, Idaho, and Montana Railroad and on State Highways 8 and 42 in the NW² sec. 23, T. 40 N., R. 2 W., in east-central Latah County (Plate 1 - No. 6).

Clay is exposed in a railroad cut 200 yards west of the station at Deary. The cut is 800 feet long and 25 to 30 feet high at the highest point. Clay of both residual and transported types are exposed in the same cut. The residual portion seems to be the weathered top of a granite knob which has been covered on flanks and top by 10 to 15 feet of transported clay classed as colluvial. Overlying the clay are 6 to 15 feet of overburden of the Palouse formation. A reported drilling test disclosed residual clay to a depth of 24 feet. This may indicate the residual deposit is of some lateral extent beyond the exposure.

One-fourth mile northwest of the Deary station on the west slope of a hill in sec. 15, T. 40 N., R. 2 W., are the ruins of an old kiln and brickyard. Clay for it was obtained from nearby areas.

One-half mile east of Deary, in sec. 23, T. 40 N., R. 2 W., a 200-foot-long railroad cut exposes two clay beds, the lower a 6-foot bed of creamy gray clay and the upper a 4-foot bed of sandy yellow clay.

The following analysis was made on a composite sample of the upper and lower beds:
Composition of Clay Deposit East of Deary

\[
\begin{align*}
\text{Al}_2\text{O}_3 & : 30.3 \text{ per cent} \quad \text{CaO} & : \text{Tr.} \\
\text{Fe}_2\text{O}_3 & : 4.0 \quad \text{MgO} & : 0.56 \text{ per cent} \\
\text{SiO}_2 & : 52.2 \quad \text{Ign. Loss} & : 14.3
\end{align*}
\]

Clay Occurrence near Vassar

Vassar is a wayside station on the Washington, Idaho, and Montana Railroad in the center of sec. 8, T. 40 N., R. 2 W., Latah County (Plate 1 - No. 7).

One mile to the northwest of Vassar, in sec. 6, are two railroad cuts 500 feet apart. Basaltic clay is exposed in the lower part of both cuts. The clay is residual, retaining all the structures of the original basalt. Part of the clay is capped by an ironstone ledge. The overburden of Palouse soil is 8 feet thick. The clay bed is 12 feet thick in one place.

Composition of Clay Northwest of Vassar

\[
\begin{align*}
\text{Al}_2\text{O}_3 & : 32.1 \text{ per cent} \quad \text{CaO} & : \text{Tr.} \\
\text{Fe}_2\text{O}_3 & : 7.9 \quad \text{MgO} & : 0.51 \text{ per cent} \\
\text{SiO}_2 & : 45.0 \quad \text{TiO}_2 & : 1.0 \\
\text{K}_2\text{O} & : 0.05 \quad \text{Ign. Loss} & : 15.1
\end{align*}
\]

Clay Occurrence near Yale

Yale is a wayside station on the Washington, Idaho, and Montana Railroad four miles south of the town of Harvard in the NE\textsuperscript{2} sec. 34, T. 41 N., R. 3 W., Latah County (Plate 1 - No. 8).

About 300 feet west of the Yale station, in the same section, in a railroad cut 1500 feet long, a 28-foot section of decomposed semi-kaolinized granodiorite is exposed under 5 to 6 feet of Palouse soil. Some colluvial sand-gravel and low grade clay is also exposed in the cut. The clay is a granitic residual deposit of doubtful commercial value.

Clay Occurrence on Highway 95 South of Potlatch

A road cut 3.3 miles south of the Potlatch Junction on U. S. Highway 95 in sec. 16, T. 41 N., R. 3 W. (Plate 1 - No. 9), exposes Latah beds for 450 feet horizontally. The lower 6-foot bed is a light tan compact clay-shale. The upper bed, also 6 feet thick, is composed of sandy clay mixed with yellow sand. A basalt dike is completely weathered to clay and offers the best appearing commercial clay.
Onaway Deposit

The Onaway clay deposit is on the east edge of the community of Onaway, on the south side of main street. Onaway is about one mile northeast of the town of Potlatch in the NW ¼ of sec. 6, T. 41 N., R. 4 W.(Plate 1 - No. 10).

This deposit was worked by means of a 20-foot shaft for two years, around 1902-03. The clay was hauled by wagon to the Palouse Pottery Plant at Palouse, Washington. It has been estimated that 5,000 tons of clay were produced.

The clay is a transported deposit and is white or gray-white. It is free of grit and highly plastic. An average of seven analyses gave the following results:

Composition of Clay - Onaway Deposit

$\text{Al}_2\text{O}_3$ ........... 31.56 per cent  CaO ............... 1.46 per cent
$\text{Fe}_2\text{O}_3$ ........... 1.57  MgO ............... 1.36
$\text{SiO}_2$ ............. 55.96

Little is known of the extent of the deposit. However, Scheid(12) estimates 500,000 assured and 2,500,000 possible tons of clay.

Potlatch Deposit

A hillside pit on the west edge of Potlatch at the junction of U. S. 95 Alternate and the Onaway road in NE ¼ sec. 1, T. 41 N., R. 5 W., marks the location of a former small brick plant which has been removed. (Plate 1 - No. 11). The clay is a residual basaltic deposit and was used for manufacture of common red building brick.

CLAY DEPOSITS IN BENEWAH COUNTY

Extent

Clay exposures have been reported along the St. Joe River Valley in the vicinity of St. Maries, the county seat of Benewah County, and north of Tekoa, Washington, probably on the Idaho border.

Border zones of Columbia River basalts are exposed along the western edge of Benewah County as well as along the sides of the valleys of the St. Joe River and St. Maries River. Geologic conditions are favorable for the occurrence of clay deposits in these localities where pre-

(12) op. cit: Univ. of Idaho Thesis: 1940.
Tertiary intrusives are present in the adjoining hills.

Lack of exploration precludes any estimate at this time of the amount of clay existing in Benewah County.

Description of Occurrence

Clay is exposed in a railroad cut on the Milwaukee Railroad one-fourth mile east of St. Maries in the SW 1/4 of sec. 23, T. 46 N., R. 2 W., in the northeastern part of Benewah County (Plate 1 - No. 13).

The clay is a transported deposit and is exposed the length of the cut of 350 feet. In the bottom of the cut, 4 feet of white clay is revealed overlain by 15 feet of red and yellow clay and 2 feet of soil overburden. Samples by Skeels(13) indicate the clay has economic value for heavy clay products.

Another railroad cut two miles west of St. Maries in sec. 20, T. 46 N., R. 2 W., (Plate 1 - No. 14) discloses a transported deposit of red and yellow clay which is at least 19 feet thick as measured at the highest point of the cut. Also sampled by Skeels, the clay indicates an economic potential for heavy clay products and may have refractory properties. An analysis of a sample from this locality gave the following:

Composition of Clay - West of St. Maries

<table>
<thead>
<tr>
<th>Element</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>24.6 per cent</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>6.6</td>
</tr>
<tr>
<td>SiO₂</td>
<td>59.9</td>
</tr>
<tr>
<td>CaO</td>
<td>0.8 per cent</td>
</tr>
<tr>
<td>MgO</td>
<td>0.4</td>
</tr>
<tr>
<td>Ign. Loss</td>
<td>8.9</td>
</tr>
</tbody>
</table>

A third clay exposure along the railroad is in a cut on the east shore of Benewah Lake in sec. 11, T. 46 N., R. 3 W. (Plate 1 - No. 15). Here an 8-foot bed of white clay is underlain by 8 feet of yellow clay and covered by one foot of overburden. Samples by Skeels were analyzed with the following results:

(13) op. cit.
Composition of Clay - East Shore - Benewah Lake

<table>
<thead>
<tr>
<th>Compounded</th>
<th>White Clay(^{(a)})</th>
<th>Yellow Clay(^{(b)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{Al}_2\text{O}_3)</td>
<td>11.4 per cent</td>
<td>16.7 per cent</td>
</tr>
<tr>
<td>(\text{Fe}_2\text{O}_3)</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>(\text{SiO}_2)</td>
<td>71.3</td>
<td>67.3</td>
</tr>
<tr>
<td>(\text{CaO})</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>(\text{MgO})</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Ign. Loss</td>
<td>5.1</td>
<td>9.3</td>
</tr>
</tbody>
</table>

\(^{(a)}\) 8-foot bed of white clay

\(^{(b)}\) 8-foot bed of yellow clay

A railroad cut on the south shore of Chatcolet Lake in sec. 8, T. 46 N., R. 3 W. (Plate 1 - No. 16) shows 20 feet of transported clay. It is a pink, medium hard clay probably suitable for a number 2 grade refractory.

Clay was reported by Skeels\(^{(14)}\) three miles north of Tekoa, Washington, along a road close to the Idaho border and at other places in this locality (Plate 1 - No. 17). He describes it as white clay, medium hard, fine grained, of possible value for fire brick and stone-ware.

**CLAY DEPOSITS IN KOTENAI COUNTY**

**Extent**

The clay deposits that have been reported in Kootenai County are near Coeur d'Alene in the west-central part of the county.

The Stockton deposit about three miles west of Coeur d'Alene covers about 40 acres in T. 50 N., R. 4 W. It is about one-half mile south of the Spokane River.

The Stanley Hill occurrence is about two miles northeast of the center of Coeur d'Alene in sec. 7, T. 50 N., R. 3 W. (Plate 1 - No. 18).

**Geology and Nature of Deposits**

Geologic conditions in both these localities resemble the conditions present where clay deposits were formed in Latah County. The

\(^{(14)}\) op. cit.
border zones of basaltic flows are in contact with adjoining hills of granodiorite or granite gneiss.

Similar geologic environment exists along the borders of Hayden Lake north of Coeur d'Alene and future prospecting in this area should reveal additional clay-bearing areas in Kootenai County.

**Stockton Clay Deposit**

**Location and Accessibility**

The Stockton clay-bearing area is about three miles west of Coeur d'Alene and about one-half mile south of the Spokane River near its outlet from Coeur d'Alene Lake. It lies in parts of secs. 8, 9, 10, 15 and 16, T. 50 N., R. 4 W. (Plate 7).

The clay area is in low rounded hills which form a terrace or ridge 50 to 150 feet above the Spokane River. The clay occurs in deposits of from 1 to 20 acres scattered over a belt about one-half mile wide and about two miles long paralleling the Spokane River.

The north half of sec. 15 is state-owned but the rest is divided into small private farms. U. S. Highway 95 is less than a mile east of the clay area, and a graveled county road crosses the area and affords easy access. Railroad loading point in Coeur d'Alene is within three miles' trucking distance and power for mining purposes is available from the Washington Water Power Company lines nearby.

**History and Production**

Skews(15) first called attention to the Stockton deposits in 1920. He describes four samples taken from an open cut and from the dumps of two wells and reports white or gray clay to an unknown depth below 4 feet of red soil.

During 1942-43 the U. S. Geological Survey together with the U. S. Bureau of Mines investigated the Stockton deposits as a source of high-alumina clay(16). The Bureau of Mines drilled 162 holes totaling about 1600 lineal feet and samples were taken at 5-foot intervals or where there was a change in the formation. The samples were analyzed for available Al₂O₃ and Fe₂O₃.

No more exploration work and little further interest has been shown in these deposits during the last 10 years. The results of the Bureau work indicated the average alumina content was too low for use as a source of this oxide.

(15) op. cit.

Geology and Nature of Deposit

The Stockton deposits are a few hundred feet west of a large basalt outcrop and the clay, together with other Latah formation, is resting on a basalt floor over a large part of the area. In some parts, Latah beds are underlain by residual granitic clay which grades downward into an unaltered granite gneiss. The basalt, forming an embayment, terminates against granite gneiss hills on the south and west and these hills rise to Mica Peak eight miles to the southwest.

Two types of clay of economic significance are present: granitic residual and transported. The average assay of the granitic residual clay showed 12.1 per cent Al₂O₃ and 2.0 per cent Fe₂O₃. The transported clay showed 15.4 per cent Al₂O₃ and 2.5 per cent Fe₂O₃. The residual clays occur in a narrow strip along the granite gneiss contact with Latah beds and upper basalt beds. The transported clays are more widely distributed, being a portion of the Latah formation. The residual granitic clays preserve the texture of the original rock and are, in general, coarse grained. They are white, gray, or pink in color locally stained yellow or brown by iron oxides. Kaolinite is the principal clay mineral. Quartz is unaltered and occurs abundantly throughout the deposit. The transported clays are usually fairly plastic and are colored gray, yellow, pink, or red. They contain kaolinite as the principal clay mineral and in addition a certain amount of fine-grained quartz and mica flakes. Lenses of sand and limonite occur locally.

Reserves

The highly irregular nature of residual clay deposits and lack of adequate knowledge of the depth to which complete alteration has taken place makes any reserve estimate an arbitrary figure.

The area delineated by the Geological Survey as underlain by clay covers approximately 40 acres. Using a figure of 15 feet for an average depth of commercial clay, the following results are calculated:

Indicated Reserves of Clay - Stockton Deposits

Area in acres................................. 40
Thickness of clay in feet.................... 15
Cubic yds. of clay in place............... 1,172,000
Tons of clay in place...................... 2,102,000
Tons of clay, loose moisture.............. 1,577,000

The assays made by the Bureau of Mines proved the clay in the Stockton deposits, both residual and transported, is too low in available alumina for high-alumina clay. However, more complete analysis of samples taken by Skeels(17) and later by Schoid(18) indicate a clay

(17) op. cit.
(18) op. cit., 1950.
suitable for many ceramic uses, including possibly refractories. Three samples from the area gave the following:

<table>
<thead>
<tr>
<th>Composition of Clay - Stockton Deposit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
</tr>
<tr>
<td>Al₂O₃</td>
</tr>
<tr>
<td>Fe₂O₃</td>
</tr>
<tr>
<td>SiO₂</td>
</tr>
<tr>
<td>CaO</td>
</tr>
<tr>
<td>MgO</td>
</tr>
<tr>
<td>K₂O</td>
</tr>
<tr>
<td>Ign. Loss.</td>
</tr>
</tbody>
</table>

Stanley Hill Deposit

Stanley Hill lies about two miles northeast of the postoffice in Coeur d'Alene. It is in the E₁₂ of sec. 7 and W₁₂ of sec. 8, T. 50 N., R. 3 W. The corner of 15th and Elm Streets is the SW corner of sec. 7.

Scheid(19) estimates an area about 1,000 feet long and 500 feet wide in the N₁₂ of the S₁₂ of sec. 7 is underlain by clay. The deposit is near a paved road and within two miles of a railroad loading point in Coeur d'Alene. A Washington Water Power Company power line is within half a mile.

The clay is a transported deposit between two layers of basalt. It is near a contact with an igneous intrusive which crops out nearby.

A sample of a test pit in the deposit taken by Skoels(20) in 1920 gave the following analysis:

<table>
<thead>
<tr>
<th>Composition of Clay - Stanley Hill Deposit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃........... 29.6 per cent</td>
</tr>
<tr>
<td>Fe₂O₃........... 1.9</td>
</tr>
<tr>
<td>SiO₂........... 58.4</td>
</tr>
</tbody>
</table>

(19) op. cit. 1930
(20) op. cit.
CLAY DEPOSITS IN IDAHO COUNTY

Extent

Clay occurrences have been noted in an area roughly 30 miles east-west by 25 miles north-south in the northwestern corner of Idaho County. (Plate 1)

Geology and Nature of Occurrences

The entire area is blanketed by Columbia River basalt. However, granodiorite protrudes through the basalt in small islands or steptoes at numerous places, the most prominent being a long narrow ridge north of Cottonwood extending east-west for about 15 miles. Some residual granitic clay has been observed along this ridge. The transported clay making up the major part of the known occurrences appears to have been deposited between layers of basalt during periods of inactivity in the lava extrusions. The clay probably originated with the weathering and alteration of granodiorite and metamorphic rocks exposed in the hills bordering the lava plateau. Only the crests of these hills are evident today in the steptoes or islands in the sea of basalt.

Description of Deposits

Occurrence No. 19

Skeels(21) reports a residual deposit of grayish-white clay exposed over an area of half an acre 3½ miles south of Glenwood, probably in sec. 20, T. 33 N., R. 5 E. (Plate 1 - No. 19). At the time of Skeels' investigation (1920), clay was being loaded on wagons, hauled to the railroad, and marketed for medicinal purposes. It is a soft, sandy, light brown clay. Skeels reports a sample analyzed by Anaconda Company with the following results:

Composition of Clay – Near Glenwood

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Al}_2\text{O}_3$</td>
<td>23.4 per cent</td>
</tr>
<tr>
<td>$\text{CaO}$</td>
<td>2.3 per cent</td>
</tr>
<tr>
<td>$\text{Fe}_2\text{O}_3$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\text{MgO}$</td>
<td>0.8</td>
</tr>
<tr>
<td>$\text{SiO}_2$</td>
<td>61.3</td>
</tr>
</tbody>
</table>

There is no record of recent production from this deposit.

In 1943 the Geological Survey in cooperation with the U. S. Bureau of Mines investigated several deposits in this region(22). The Bureau drilled four holes totaling 81 feet and samples were taken at 5-foot (21) op. cit.

intervals. Sixteen samples (all transported clays) were assayed for available alumina and ferric oxide. The following are descriptions of the localities investigated. Plate 1 shows the location according to number.

**Occurrence Number 20**

Three feet of clay is exposed in a road cut on U. S. Highway 95 about three miles southwest of Grangerville, in the NW₁⁄₄, NW₁⁄₂ of sec. 35, T. 30 N., R. 2 E. A drill hole started at the base of the exposure revealed 8 feet of gray transported clay averaging 31.9 per cent Al₂O₃ and 2.7 per cent Fe₂O₃. Below this was three feet of brown and yellow clay averaging 29.5 per cent Al₂O₃ and 6.5 per cent Fe₂O₃. The clay in the cut is a gray plastic waxy clay which assays about 34 per cent Al₂O₃ and 1.7 per cent Fe₂O₃. The deposit is overlain by four feet of basalt where exposed.

**Occurrence Number 21**

Because Mr. Guy Sherwin had done some test work previous to Bureau of Mines drilling, this occurrence was named the Sherwin clay deposit. It is in the SE₁⁄₄ of sec. 31, T. 30 N., R. 2 E. about six miles west and two miles south of Grangerville. A gravel road passes along the north edge of the clay-bearing area. The clay crops out on the east bank of a creek which crosses the road, and about a quarter of a mile south of the road. The maximum thickness of clay is 40 feet. About 33 feet was penetrated in a drill hole in the NE₁⁄₄, SE₁⁄₂ of sec. 31. The hole disclosed 23 feet of gray plastic transported clay averaging 32.7 per cent Al₂O₃ and 3.0 per cent Fe₂O₃, below which was 10 feet of a brown-stained transported clay averaging 25 per cent Al₂O₃ and 3.8 per cent Fe₂O₃. The hole penetrated into sand-gravel of the Lahota formation at 33.5 feet. North and east of the deposit is a valley underlain by gravel and south and west are hills composed of basalt.

**Occurrence Number 22**

A road cut about one mile south of Grangerville in SE₁⁄₄, SW₁⁄₂ of sec. 29, T. 30 N., R. 3 E., exposes 15 feet of plastic red transported clay overlain by basalt. A drill hole cored about 5 feet below the top of the clay exposed in the cut revealed 18 feet of red plastic clay averaging 33 per cent Al₂O₃ and 8 per cent Fe₂O₃. Below the red clay was 10 feet of transported white, pink and gray clay averaging 34 per cent Al₂O₃ and 4.5 per cent Fe₂O₃. The clay may extend some distance to the south and west beneath the basalt.

**Occurrence Number 23**

Occurrence number 23 is a 25-foot clay exposure in the NW₁⁄₂, NW₁⁄₂ of sec. 36, T. 32 N., R. 3 E. The blue-gray plastic clay is a transported deposit. A sample taken from a 14-foot auger hole drilled about 5 feet below the top of the exposure assayed 34.3 per cent Al₂O₃ and 1.9 per cent Fe₂O₃. The clay at this place is overlain by 15 feet of sand-gravel and 60 feet of basalt. The locality is three miles west and about 1½ miles south of Stites.
Occurrence Number 24

At this place a 4.3 auger hole disclosed 1.3 feet of red plastic transported clay assaying 28.8 per cent Al₂O₃ and 9.3 per cent Fe₂O₃. The location is three miles west and four miles north of Grangeville in NE₁₄ sec. 34, T. 31 N., R. 2 E.

Occurrence Number 25

A 3-foot bed of gray waxy transported clay is exposed in a railroad cut on the Camas Prairie Railroad in the SE₁₄, SW₁₄ sec. 27, T. 31 N., R. 1 E., about four miles south and 1/2 mile east of Cottonwood. A 2-foot channel sample assayed 24.6 per cent Al₂O₃ and 3.7 per cent Fe₂O₃.

Occurrence Number 26

Clay is reported in two wells at these locations. About 12 inches of a transported gray-white clay was encountered at about a 15-foot depth in each well.

CLAY DEPOSITS IN NEZ PERCE AND LEWIS COUNTIES

Extent

The geologic environment favorable for formation of clay deposits is widespread in Nez Perce and Lewis counties. The outer and upper edges of basaltic flows in contact with granodiorite, gneiss, and metamorphic rocks are locales for the deposition of lake bed sediments including transported clays.

Clay beds intermingled with sand and gravel have been noted in many places in canyon walls of the Clearwater, the Snake, and tributary streams. However, these deposits are in most instances far below the surface or rim of the canyon and inaccessible for economic exploitation. Other occurrences noted are too small or impure to be of economic value.

Description of Deposits

Occurrence Number 27

A clay deposit on the west edge of the town of Nez Perce was sampled by Skeels (23) in 1920 when a brick plant was in operation. At that time a pit 50 feet long by 30 feet wide exposed an 8-foot bed of clay under 3 feet of soil covering. [23] cp. cit.
The clay is a transported deposit derived mostly from a granitic rock and is capped by decomposed and altered basalt. The gray clay made a buff-colored face brick. Analysis of a sample taken by Scheid(24) in 1938 gave the following:

**Composition of Clay - Deposit near Nez Perce**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al₂O₃</td>
<td>24.8</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>5.58</td>
</tr>
<tr>
<td>SiO₂</td>
<td>56.8</td>
</tr>
<tr>
<td>CaO</td>
<td>0.87</td>
</tr>
<tr>
<td>MgO</td>
<td>0.14</td>
</tr>
<tr>
<td>Ign. Loss</td>
<td>12.6</td>
</tr>
</tbody>
</table>

The site, which is in the NE₁₄ of sec. 6, T. 33 N., R. 2 E. (Plate 1 - No. 27), was examined by the author in 1955. The former pit is caved and filled with debris to such an extent that no sampling was possible. The brick plant was removed so many years ago that few townspeople even remember it. Some of the buildings of Nez Perce are constructed of brick made here. The bricks look well in the buildings and seemingly are of good quality.

**Occurrence No. 28**

A clay seam was noted in a gravel pit along Tammary Creek in the SE₁₄ sec. 21, T. 33 N., R. 5 W., Nez Perce County (Plate 1 - No. 28). The pit has not been used for several years but is still open, exposing a 2-foot bed of white sandy clay. Clay outcrops at about the same elevation as the exposure in the pit were observed along the hillside for about a mile west of the pit. No tests were made of the clay but from observation it appears to be suitable for common brick or heavy clay products.

**CLAY DEPOSITS IN CLEARWATER COUNTY**

**Extent**

Geologic environment existing in the clay belt in Latah County overlaps county lines and extends into the western part of neighboring Clearwater County.

Clay is exposed in a road cut about 1.5 miles south of the town of Elk River (Plate 2). This deposit was investigated by the U. S. Bureau of Mines in cooperation with the U. S. Geological Survey in 1943-44. However, the report of these investigations has not been published and is at present unavailable. An approximate outline of the limits of this clay-bearing area is shown on Plate 2.

(24) op. cit., 1951.
As stated previously, the major use of the clay mined in north Idaho has been for refractory products. Some of the more plastic clays have been used for making pottery and stoneware and some has gone into the manufacture of common building brick.

Clays are generally used as they come from the mine or pit for these purposes. Some selection is practiced in the mining process since impurities characteristically run in streaks or beds. Also some hand sorting is occasionally done to remove stones, sticks, and large pieces of undesirable material. Blending of clays from different deposits or from different parts of the same deposit is commonly done at the brick plant to provide a clay with the desired qualities.

Most of the clays of north Idaho contain impurities. That is, they are mixtures of various proportions of clay minerals (chiefly kaolinite), silica sand, mica, unaltered feldspar, and in lesser amount carbonaceous matter, ilmenite, and iron oxides. In some cases, if treated by some beneficiating process, a high grade almost pure kaolin or china clay can be produced which may be salable at a much higher price than the value of the raw clay. Also, a silica sand and even a mica by-product may add to the total value after treatment.

The residual clays are somewhat better suited for beneficiation than transported because of the great difference in particle size between the clay mineral and the admixed impurities. In the case of transported clays, some water classification has already taken place in nature, the clay minerals are more finely divided, and the particle sizes of some of the impurities are as fine as the clay.

Three beneficiation methods are recognized for the treatment of clay. (1) Wet washing, or water flotation as it is sometimes called, is the most common practice and laboratory tests as well as pilot plant operations, using this method, have been conducted on numerous samples of clays from north Idaho deposits. (25) (2) Air separation or air flotation is a method which is increasing in popularity in other parts of the country and has been tested with some success on samples of Idaho clay. (3) Froth flotation, a method borrowed from metallic ore dressing methods, has been tried using new kinds of flotation reagents.

In the wet washing or water flotation method, details and equipment vary but the three major steps involved always remain the same. (1) The raw clay is disintegrated and dispersed with large quantities of water. (2) The coarse sand, the fine sand and mica, and any other impurities of higher specific gravity than the clay are removed by gravity or sedimentation methods. (3) The water is removed to produce a dry cake or powder.

of purified kaolin or clay. A simplified plant comprises a tank with revolving paddles called a blunger. The tank is filled with water and fed with raw clay which is disintegrated by the action of the paddles. The overflow, as a thick slurry, passes to a classifier which removes coarse sand and pebbles. The slurry then passes over long settling troughs where fine sand and the coarse particles of mica are removed, and thence to a thickener and filter press for removal of most of the water. The filter cake is further dried by air and is then ready for the market.

In air flotation the raw clay must be dried and pulverized before it enters the separator. For best results, the clay should not be too tough or the impurities too friable and it should contain a relatively small amount of heavy minerals. Separation is accomplished by passing the pulverized clay through an air stream directed upward. The heavier minerals pass through the air stream while the lighter clay particles float. This method does not produce as pure a kaolin as the washing method, but it is more economical because it eliminates the costly de-watering process.

Froth flotation holds some possibilities for producing a larger variety of products from the raw material. Unaltered feldspar can be separated from the quartz in the sand product. Different clay minerals contained in the original material may be separated for different qualities. Further experimental work in froth flotation on north Idaho clays seems worth consideration.

Current interest has been directed toward producing alumina (Al₂O₃) by treating some of the high-alumina clays of north Idaho. Many investigations were conducted by government and private organizations to determine its feasibility during the World War II years and several treatment methods were evolved. After the war, interest in high-alumina clays lagged for several years but there has been renewed interest as a result of the expansion of the aluminum industry in the Northwest.

To be considered as a source of alumina, clays should have an available Al₂O₃ content of more than 20 per cent with an available Fe₂O₃ content of less than 10 per cent. Large reserves of clay in Latah County are shown in this report to be better than these minimum requirements. Available Al₂O₃ and Fe₂O₃ is defined by Skinner and Kelly (26) as the amount that can be extracted from clay by leaching with hot 20 per cent sulfuric acid after drying at 130° C. to remove free moisture and calcining at 700° C. for one hour. The clays which show an alumina content a little below the minimum requirement may, in some cases, be commercially upgraded by air flotation methods.

Among the processes for extraction of alumina from clays, Popoff(27) outlines the following hydrometallurgical methods:

**Ammonium Sulfate Method**

The clay is baked with a slight excess of ammonium sulfate to form anhydrous ammonium alum from the alumina in the clay, ammonia being liberated. The ammonium alum is dissolved out with water and crystallized from solution. Purified crystals of alum are converted to aluminum hydroxide by treating with the liberated ammonia, ammonium sulfate being recovered in this step. Aluminum hydroxide is calcined to form pure alumina for the aluminum smelter.

**Potassium Sulfate Method**

A mixture of clay and alunite is dehydrated and leached with dilute sulfuric acid to form potassium alum. The potassium alum recovered from the solution is heated in an autoclave to produce basic alum. The basic alum is calcined and alumina is separated by leaching with water.

**Sulfite Method**

In this process calcined clay is leached with sulfurous acid to form a basic aluminum sulfite which is precipitated by heating to remove sulfur dioxide. Thermal decomposition of the precipitate yields alumina and sulfur dioxide.

**Combined Sulfate-Sulfite Method**

The clay is calcined and leached with sulfurous acid. The residue is treated with sulfuric acid. The leaching efficiency is higher than the straight sulfite leach. Both leach liquors are mixed in certain proportions and the alumina is precipitated as basic aluminum sulfate by expulsion of the sulfur dioxide.

Additional research has been continued in recent years and refinements or combinations of some of these methods may have increased their efficiency to the point where a practical plant operation is feasible.


Scheid, V. E., Clay resources of Latah County, Idaho: Univ. of Idaho thesis, 1940.


