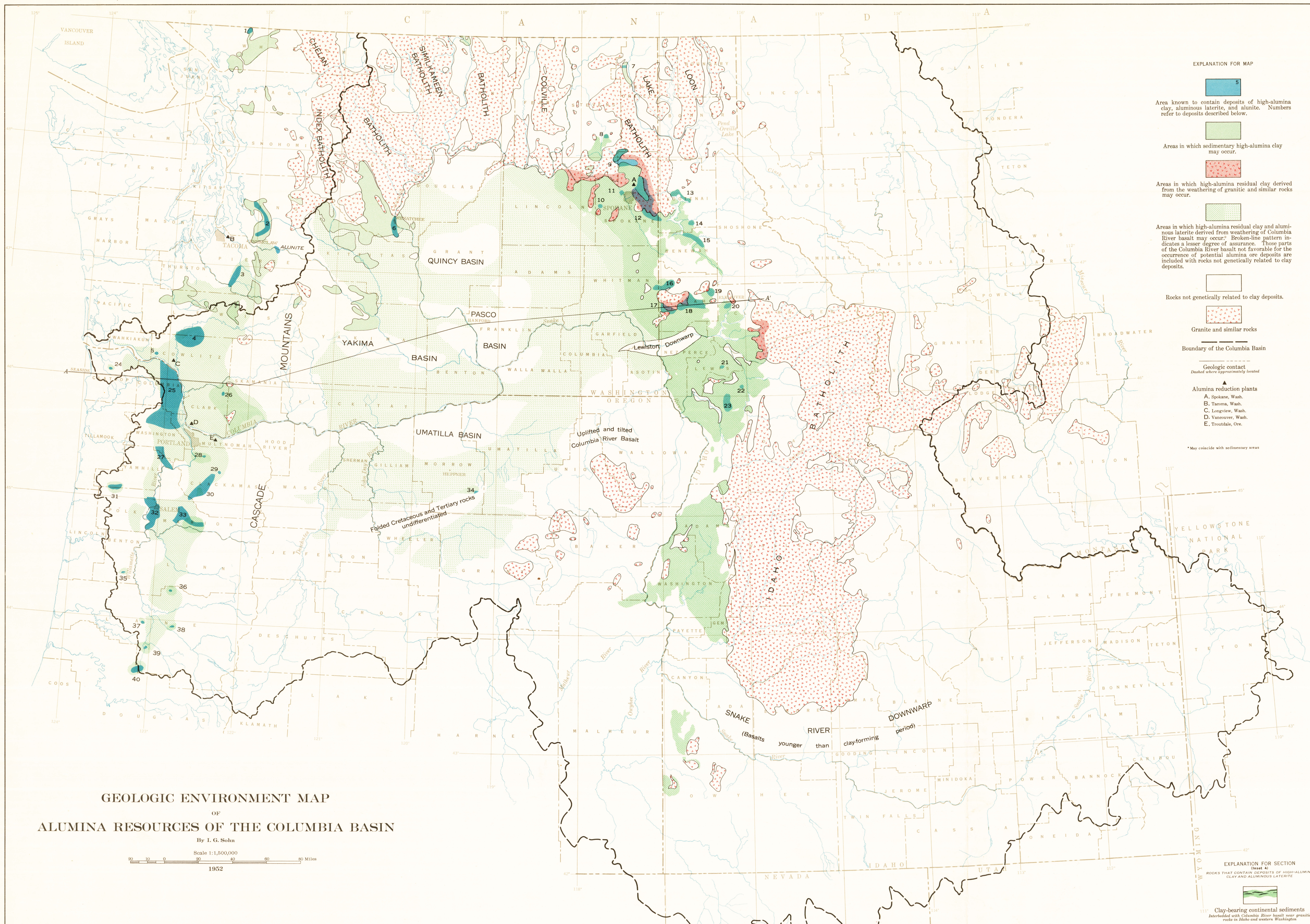
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

MINERAL INVESTIGATIONS
RESOURCE APPRAISALS MAP MR 1



GEOLOGIC ENVIRONMENT MAP OF ALUMINA RESOURCES OF THE COLUMBIA BASIN

By I. G. Sohn

Scale 1:1,500,000

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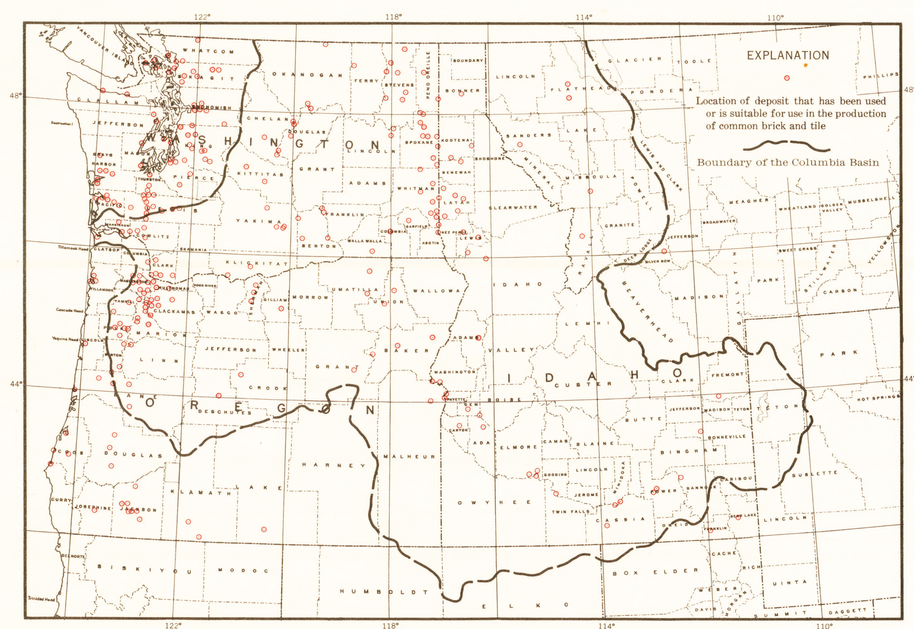
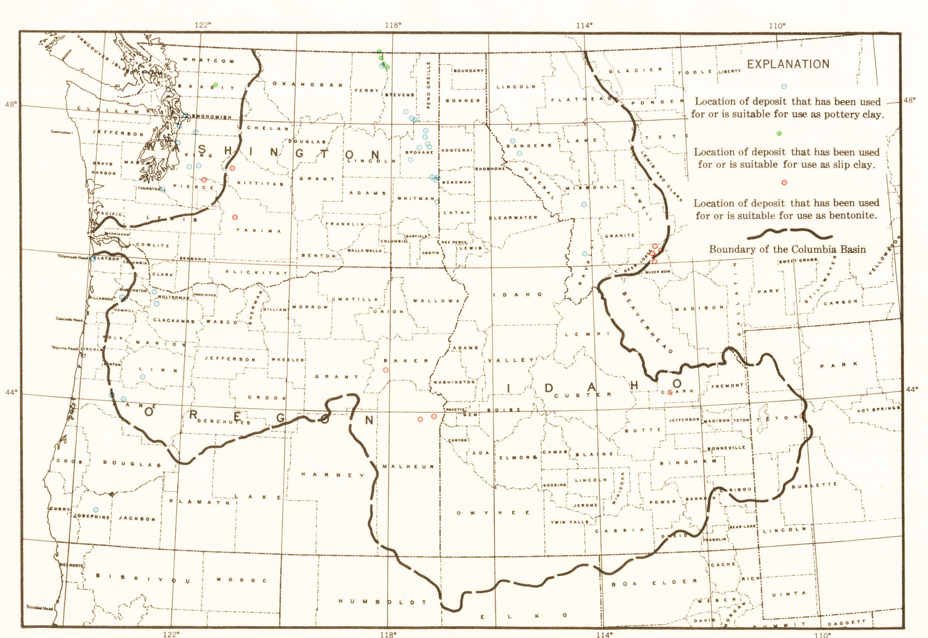
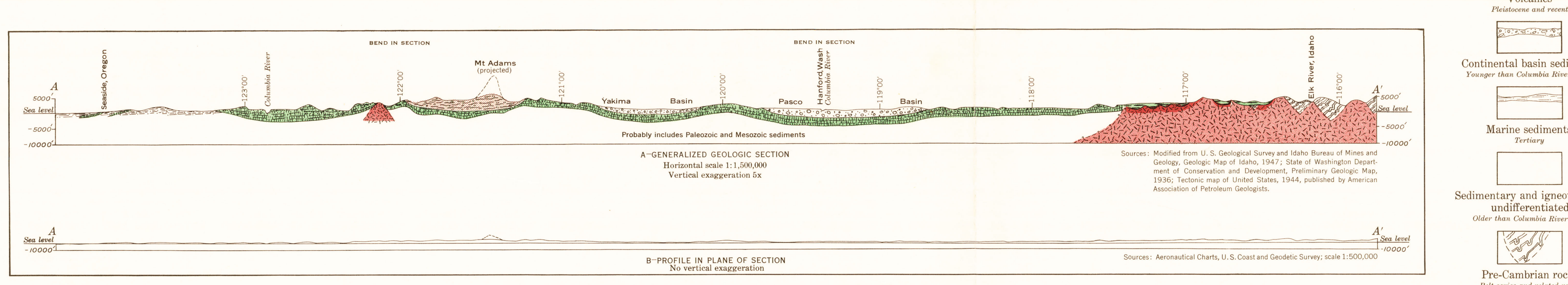


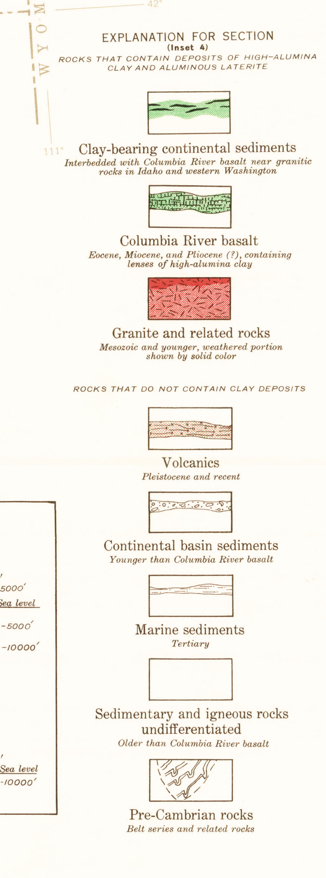
INSET 1. BRICK AND TILE CLAY DEPOSITS.

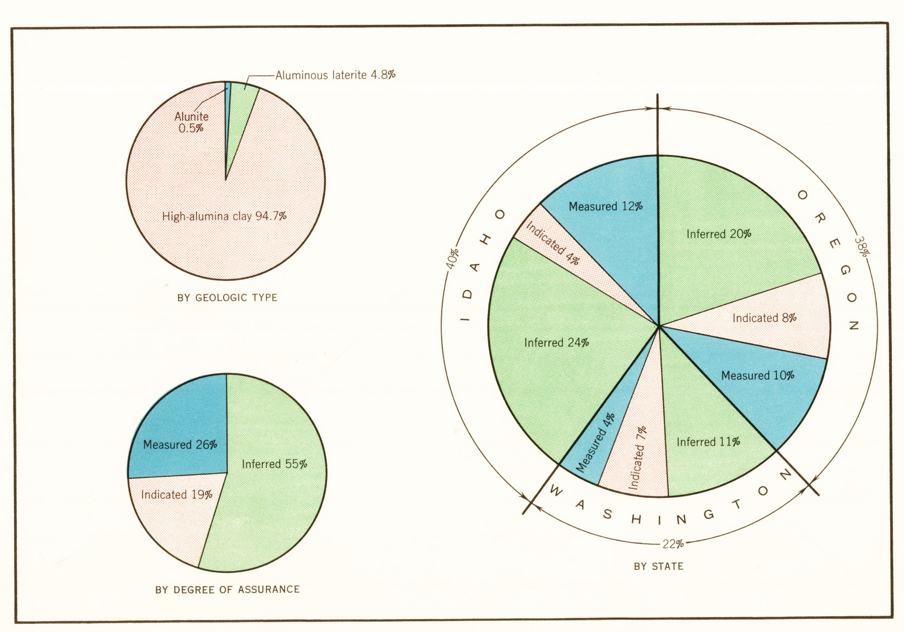


INSET 2. POTTERY CLAY, SLIP CLAY, AND BENTONITE DEPOSITS.

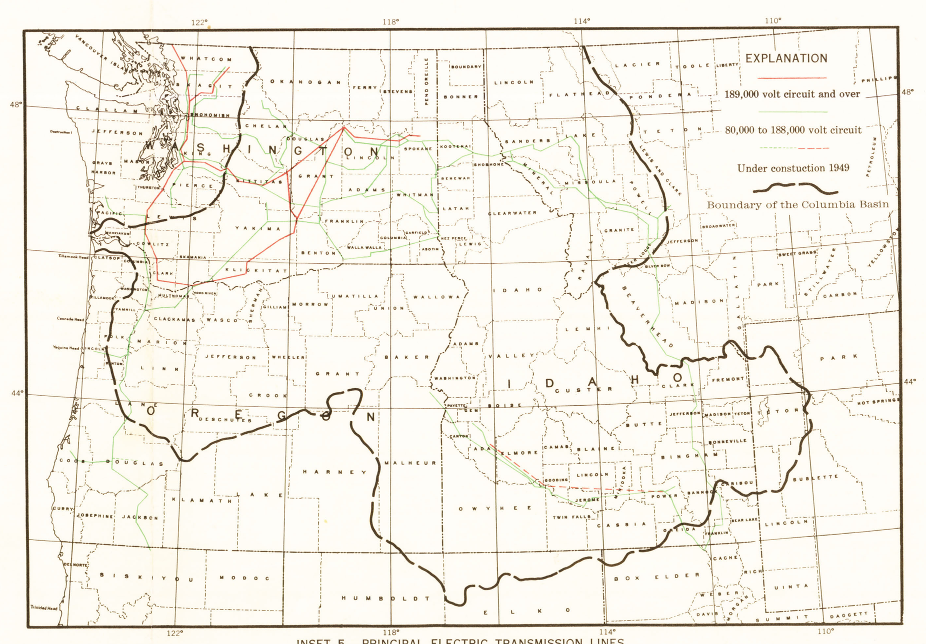


INSET 4. GEOLOGIC SECTION AND PROFILE ACROSS WASHINGTON, OREGON, AND IDAHO.





INSET 3. DISTRIBUTION OF POTENTIAL ALUMINA ORE RESERVES.



INSET 5. PRINCIPAL ELECTRIC TRANSMISSION LINES.
(Modified from Transmission Map No. 10, Federal Power Commission, 1948)

GEOLOGIC ENVIRONMENT OF ALUMINA RESOURCES OF THE COLUMBIA BASIN

By I. G. Sohn

INTRODUCTION

This map shows, according to available data, the known potential alumina resources of the Columbia Basin, and the discovery possibilities of additional deposits. Aluminum, one of the key metals of modern industry, is reduced by electrolysis from alumina (Al_2O_3). Many rocks contain alumina, but bauxite is the only present commercial source. Interest in sources other than bauxite was stimulated during World War II, because of the increased demand for aluminum and because of the difficulty of transporting foreign ores. As a consequence Federal and State agencies made detailed studies of known domestic deposits of potential sources, such as high-alumina clay, aluminous laterite (ferruginous bauxite), and alunite. Research in methods of recovering alumina from these potential ores was pursued by the U. S. Bureau of Mines and other laboratories and by 1945 had progressed to the pilot-plant stage for high-alumina clays and for alunite.

Considerable attention was given to the Columbia Basin, which contains many deposits of high-alumina clay and aluminous laterite; some alunite is present just outside the Basin proper but within the same economic province. The region has possibilities for the development of an aluminum industry based on these deposits because of the abundance of potential hydroelectric power.

Available geologic information (including geologic maps) is incomplete for much of the Columbia Basin; consequently this map has various degrees of reliability in different areas. The principal source of data has been the wartime field investigations of the U. S. Geological Survey, conducted under the general supervision of V. T. Allen; the writer was one of the group that worked in northern Idaho and eastern Washington. Other sources of data are the U. S. Bureau of Mines, the Idaho Bureau of Mines and Geology, the Oregon State Department of Geology and Mineral Industries, the Washington Division of Mines and Geology, other State and Federal organizations, trade journals, and technical publications.

Incidental data were compiled on brick clay, pottery clay, slip clay, and bentonite, and summarized in inset maps 1 and 2. More specific data on the related but distinctly separate commodities are given in U. S. Geological Survey Circular 158, Industrial clays of the Columbia Basin.

TYPES OF ALUMINOUS DEPOSITS

HIGH-ALUMINA CLAY

High-alumina clay is here defined as a clay in which the dominant mineral is kaolinite ($Al_2Si_2O_5(OH)_4$) and which contains at least 20 percent available alumina (Al_2O_3). "Available alumina" by definition is the percentage of alumina that is dissolved from one-half gram of clay dried at 130°C, by boiling in 35 ml of hot sulfuric acid solution (containing 20 percent by weight H_2SO_4) for one hour after the clay is dehydrated by calcining at 700°C. This is the definition established by the U. S. Bureau of Mines, whose analyses were used to calculate the alumina and iron content shown in table 2.

Three genetic types of high-alumina clay deposits are known in the Columbia Basin:

(1) Residual clay deposits derived by weathering of granodiorite and associated granitic rocks of the Idaho batholith and similar intrusions. This residual clay is low in alumina because it contains large amounts of residual quartz and mica. These minerals would have to be removed before the clay could be used for the production of alumina. The chemical composition of this type of clay is illustrated by analyses 1, 2, and 3 in table 1.

(2) Residual clay derived by weathering of the Columbia River basalt and related basalts. These may be divided into low-iron and high-iron clays, which grade into one another. The chemical compositions of low-iron and high-iron clays in the Columbia Basin are illustrated by analyses 4 and 5 in table 1.

(3) Sedimentary clay consisting of transported weathered products of both granitic and basaltic rocks. The clay occurs in beds a few inches to 8 feet or more thick associated with sand, gravel, and coal or lignite. The chemical composition of sedimentary clay is shown in analyses 6, 7, and 8 in table 1.

TABLE 1.- CHEMICAL ANALYSES OF POTENTIAL ALUMINA ORES IN THE COLUMBIA BASIN AND VICINITY, IN PERCENT

	1	2	3	4	5	6	7	8	9	10	11	12
Al_2O_3	20.5	22.51	13.80	31.1	22.8	39.30	27.41	33.09	34.7	20.5	32.9	21.4
Fe_2O_3	1.9	2.28	1.70	8.2	22.4	1.47	*3.37	2.39	33	1.55	1.80	1.30
SiO_2	68.3	68.57	77.00	41.2	38.2	40.80	55.64	51.36	9.5			
TiO_2			0.50	7.3	4.4	0.30			4.9			
CaO	0.38	0.23	0.93	1.0		0.87	0.58					
MgO	0.36		0.54	0.05		0.54	0.76	0.78				
Na_2O	0.32		1.42	0.4		1.30	Trace	0.08		1.20	0.89	1.94
K_2O	1.59		0.28	0.3			Trace			3.59	7.61	1.60
V_2O_5				0.05								
SO_3										16.8	29.9	13.6
P									0.2			
H_2O (110°C)	0.57	0.64				1.28		2.12				
Loss on ignition	7.2	6.61	**4.40	11.1		14.90	11.29	10.54				
Insoluble										48.6	17.5	57.1

* Includes FeO.

** Given as "volatile."

1. Residual clay derived by weathering of granite, colored tan by iron oxide, Johannsen pit (Benson deposit). Tullis, E. L., and Laney, B. F., Composition and origin of certain commercial clays in northern Idaho: Econ. Geology, vol. 28, no. 5, p. 493 (analysis 4), 1933.
2. Kaolinized quartz monzonite, gray type, northeast corner of Benson pit. Hodge, E. T., Market for Columbia River hydroelectric power using northwest minerals: War Dept., Corps of Engineers, U. S. Army, Office of Div. Engineer, North Pacific Div., Portland, Oregon, sec. 4, vol. 3, p. 643 (analysis 1), 1938.
3. Residual clay derived by weathering of granitic intrusive, Freeman clay deposit. Wilson, Hewitt, The clays and shales of Washington: Washington Univ. (Seattle) Eng. Exp. Sta. Bull. 18, p. 65, 1923.
4. Low-iron residual clay derived by weathering of Columbia River basalt, chemical analysis of weighted composite sample. Excelsior clay deposit, Spokane County, Washington. Analyzed by Seattle Laboratory, U. S. Bureau of Mines.
5. High-iron residual clay derived by weathering of Columbia River basalt, high-iron clay deposit, Latah County, Idaho. Weighted average of composite samples of 12 drill holes. Analyzed by Seattle Laboratory, U. S. Bureau of Mines.
6. Sedimentary marine clay, Kummer clay deposit, Puget group, Eocene. Wilson, Hewitt, ibid., p. 65, 1923.
7. Sedimentary continental clay, Swauk formation, Eocene, Wenatchee clay mine. Hodge, E. T., ibid., p. 697, 1938.
8. Sedimentary continental clay, Latah formation, Miocene. Clayton deposit, Stevens County, Washington. Shedd, Solon, The clays of the State of Washington: their geology, mineralogy, and technology: Washington State College, Pullman, Wash., pp. 320-321 (analysis 72), 1910.
9. Aluminous laterite, average chemical composition. Libbey, F. W., Lowry, W. D., and Mason, R. S., Ferruginous bauxite deposits in northwestern Oregon: Oregon Dept. Geol. and Min. Ind. Bull. 29, p. 1, 1945.

10, 11, 12. Alunite: sample 10 contained 43.5% alunite, 11 - 77.5%, and 12 - 35.2%. Thoenen, J. R., Alunite resources of the United States: U. S. Bur. Mines R. I. 3561, p. 35, 1941.

TABLE 2.- RESERVES OF POTENTIAL ALUMINA ORE IN THE COLUMBIA BASIN (IN MILLIONS OF SHORT TONS (DRY), ESTIMATES AS OF JUNE 1949)

	MEASURED					INDICATED					INFERRED					Total[1] Tons
	Tons	Percent Al_2O_3		Percent Fe_2O_3		Tons	Percent Al_2O_3		Percent Fe_2O_3		Tons	Percent Al_2O_3		Percent Fe_2O_3		
		Range	Average	Range	Average		Range	Average	Range	Average		Range	Average	Range	Average	
High-alumina clay	110	23-33	25	1.6-11.2	6	70	22-33	27	3-11	7	215	20-33		2-12[2]	7[2]	400
Aluminous laterite	--					5[3]		34.7		23.1	15[3]		34.7		23.1	20
Alunite	--	(See footnote 3)				2	20.5-32.9		1.3-1.55			No data				2
Total[1] Tons	110					75					230					450

[1]In round numbers.
[2]High-iron deposits of large aggregate tonnage not considered in arriving at Fe_2O_3 range and average, though included in tonnage and for Al_2O_3 average.
[3]Preliminary estimate for Oregon, U. S. Geological Survey, 1945. Subsequent exploration by private capital in Oregon and Washington proved greater tonnage, but figures are not available for publication.

ALUMINOUS LATERITE

Aluminous laterite is a residual weathering product of the Columbia River basalt and related basalts. The laterite is composed principally of gibbsite ($Al(OH)_3$) and hematite (Fe_2O_3), with lesser amounts of kaolinite, halloysite ($Al_2Si_2O_5(OH)_4$), and other minerals. The average chemical composition is shown in analysis 9 in table 1.

ALUNITE

Alunite is a hydrous sulfate of potassium and aluminum ($KAl_3(OH)_6(SO_4)_2$). It was used as a source of alumina in an experimental plant operated by Kalunite, Inc., for the Defense Plant Corporation at Salt Lake City, Utah, in 1943 and 1944. The chemical composition of three samples of alunite from a source near the Columbia Basin is shown in analyses 10, 11, and 12 in table 1.

DISTRIBUTION

The known deposits of residual clay derived by weathering of granitic rocks are located in eastern Washington and northwestern Idaho, where they have been exploited mainly for use as firebrick. All the granitic rocks in this region are of Mesozoic age and younger.

Deposits of residual clay, derived by weathering of the Columbia River basalt and related volcanic rocks, are located in two north-trending belts: one in eastern Washington and northwestern Idaho along the eastern margin of the Columbia Plateau and the other in Washington and Oregon west of the Cascade Mountains.

Deposits of sedimentary clay are distributed on the eastern, northern, and western margins of the Columbia Plateau. A deposit of sedimentary kaolinite southeast of Heppner, Oregon, indicates that the southern margin may also locally contain sedimentary high-alumina clay.

Aluminous laterite is known to occur in a belt having a maximum width of about 20 miles and extending northward from Polk and Marion Counties, at about the latitude of Salem, and through Yamhill, Washington, and Columbia Counties, Oregon, and across the Columbia River into Cowlitz County, Washington.

Alunite is known in only one area, which is 10 miles east of Enumclaw, in King and Pierce Counties, Washington. Although this area is outside the Columbia Basin, it is considered in this report because of its location within the same economic province.

RESERVES

Table 2 and inset 3 show the reserves of high-alumina clay, aluminous laterite, and alunite in the Columbia Basin, according to data available in June 1949. The reserves are estimated for alumina ore only and do not include the deposits developed for other uses. These estimates include material that contains 20 percent or more of "available alumina" as defined above. In the estimates for individual deposits, made by different persons, the standards differed with regard to the permissible available iron (Fe_2O_3) content determined in the same manner as "available alumina"; consequently the total tonnage figures may vary proportionately. Although normally high-alumina clay can be used in the ceramic industry, table 2 cannot be used to indicate reserves of fire clay for two reasons: one, because the residual clay derived from weathering of basalt is not suitable for ceramic use owing to excessive firing shrinkage caused possibly by admixed minerals of the montmorillonite group; and two, because some of the sedimentary clays contain too much iron for ceramic use. The totals shown in the table are compiled for the most part from estimates made by the U. S. Geological Survey for individual deposits.

The anomaly of a larger reserve in the measured category than in the indicated category is explainable by the fact that reserve data for all the deposits are a result of the Federal Government's Strategic Minerals Investigations of 1941-1945, in which the more promising deposits were drilled by the U. S. Bureau of Mines in enough detail for reserves to be classified as measured.

GEOLOGIC FACTORS INFLUENCING OCCURRENCES

HIGH-ALUMINA CLAY

Future discovery of deposits of high-alumina clay may be expected in areas that have geologic histories similar to those of known deposits. Such areas are shown on the map by appropriate symbols. The inclusion of any particular favorable area on the map is based on the supposition that the occurrence of potentially commercial deposits is controlled largely by the intersection of the present erosion surface with the clay-bearing formations. Only those clay beds that were protected from erosion by a thin cap of overlying material constitute actual and potential deposits. Some beds that were deposited over large areas have since been partly eroded. Other beds are now tilted or are overlain by very thick overburden. The geology of each genetic type is discussed below.

Residual clay derived from weathering of granitic rocks.--The distribution of granitic rocks is shown on the map. These rocks probably began to weather in early Tertiary time, as soon as they were exposed by erosion, and continued to weather through the Miocene epoch in areas where they were not covered by Columbia River basalt. The length of the weathering period and the depth of the weathering profile, which control the magnitude of the clay deposits, varied locally. Many areas that may contain large deposits of clay are now covered by a thick series of basalt flows and will never be of economic value because of excessive overburden (inset 4, geologic cross-section). Other deposits have been destroyed by subsequent erosion. The areas most favorable for the discovery of clay deposits are those where the topographic relief is moderate, not much higher in altitude than the 3,000-foot contour, and those that were not glaciated.

Residual clays derived by weathering of Columbia River basalt.--Residual clay derived from Columbia River basalt is the result of weathering in the period between the end of the Miocene epoch and the uplift of the region in the Pliocene epoch.

Near the end of the period during which the Columbia River basalt was being extruded, the entire area of the Columbia Plateau and the area west of the Cascade Mountains had a climate that was favorable for deep weathering. Local areas that are now underlain by basalt but that were in the past exposed for long periods developed deep weathering profiles with the resultant formation of thick residual clays and aluminous laterites. Renewed volcanism in these areas buried the weathered basalt beneath fresh basalt, or caused it to be buried by sediments that accumulated where fresh basalt dammed drainage basins. Recurrent periods of deep weathering resulted in more that one weathering profile in some areas.

It is inferred from the fact that high-alumina clay occurs both west of the Cascade Mountains and along the eastern margin of the Columbia Plateau that climatic, topographic, and drainage conditions were similar in the two areas at that time. Similar conditions probably existed over the entire area underlain by Columbia River basalt. This is confirmed by paleontologic evidence.[1] For this reason certain areas underlain by these basalts are shown on the map as possibly favorable for the occurrence of small local high-alumina clay deposits.

Areas underlain by Columbia River basalt regarded as unfavorable for residual clay include those where the weathered mantle has been eroded, those covered by younger lavas, and those in which great thicknesses of sediments have accumulated, such as the Quincy, Pasco, and Umatilla basins (inset 4, geologic cross section).

Sedimentary clay.--The high-alumina sedimentary clay beds in the eastern part of the Columbia Plateau are considered to be part of the Latah formation, which is a series of sedimentary rocks interbedded with the Columbia River basalt. Only those parts of the Latah formation that were deposited in lakes near granitic masses contain high-alumina clay, and therefore deposits of such clay in this formation may be expected only in belts of varying width along the margins of granitic rocks. The deposits may be contaminated by lenses of sand and gravel. Sediments which were deposited in lakes that did not receive detrital material from weathered granitic bodies consist mostly of diatomite and volcanic ash.

In the vicinity of Wenatchee, Washington, and westward in the Cascade Mountains, sedimentary clay and shale occur as lake, river, and possibly estuarine deposits. Some of these deposits have been developed for use as fire clay. Disconnected areas underlain by similar material are shown on the map as favorable for the discovery of additional deposits.

West of the Cascade Mountains some of the sedimentary clay of marine, lake, river, and volcanic origin were subsequently enriched by hydrothermal action.

Little is known about the kaolinite locality southeast of Heppner, Oregon; deposits of high-alumina clay may be present in the area shown on the map as "Folded Cretaceous and Tertiary rocks, undifferentiated."[2]

ALUMINOUS LATERITES

The areas in Oregon shown on the map as favorable for the discovery of high-alumina clay derived by weathering of Columbia River basalt are favorable also for the discovery of aluminous laterite deposits. The aluminous laterite was known in northwestern Oregon for a long time as "low-grade iron ore" and was assumed to be similar to bog iron ore, deposits of which are present in the same area. It was not investigated for its alumina possibilities until 1944, when the Oregon State Department of Geology and Mineral Industries demonstrated its potentialities as an ore of alumina.[3] The high-alumina clays that lie beneath these laterites were discovered when the deposits were drilled. The Aluminum Company of America (Alcoa) began in 1945 an extensive program of exploration to determine the size and tenor of these deposits.

The aluminous laterite deposits in Cowlitz County, Washington, are located in an area shown on the geologic map of Washington as underlain by the Astoria shale. These deposits originated from basalts that are interbedded with the middle Miocene Astoria shale, and only those areas underlain by this shale and known to contain interbedded basalts are shown on the accompanying map as favorable for the discovery of aluminous laterite.

The association of aluminous laterites with high-alumina clay derived by weathering of Columbia River basalt west of the Cascade Mountains implies a similar relationship along the eastern margin of the Columbia Plateau, although no aluminous laterites are now known in this eastern region.

ALUNITE

Alunite occurs in altered volcanic rocks belonging to the Keechelus andesite series of Miocene and Oligocene age. Most of the alunite occurs at the base of layers or masses of silicified volcanic rock and has been described as the result of hydrothermal replacement of preexisting volcanic rock.[4] The higher grades of alunitized rock are in small masses that occur in larger bodies of much lower grade material. The silicified rock with which the alunite is associated is widely distributed in the area, suggesting the possibility of discovering additional deposits. No other area of similar geologic history is known at present in or near the Columbia Basin.

POTENTIAL BYPRODUCTS

The high-alumina clays of the Columbia Basin locally contain titanium, iron and gallium, all of which are potentially recoverable. Titanium and iron have been reported in residual clay derived by weathering of Columbia River basalt (see table 1). Gallium is reported in the same clay in percentages ranging from 0.003 to 0.006; spectrographic analyses by the U. S. Geological Survey[5] of samples from northern Idaho show an average gallium content of 0.0045 percent for a thickness of 56 feet. The weighted averages of available Fe_2O_3 and Al_2O_3 for the same samples are 2.8 percent and 29.9 percent respectively. The Aluminum Company of America reported[6] in 1949 that it developed a commercial process for extracting gallium from bauxite containing only about one ounce of gallium per ton (0.003 percent).

SOURCES OF ENERGY

The production of alumina from aluminous ores requires substantial amounts of energy. Areas in the Columbia Basin and vicinity that contain coal are shown on a map published by the U. S. Geological Survey in 1942.[7] Natural gas in commercial quantities is not now available in the Columbia Basin, but the feasibility of piping gas into the area is being considered by private interests. Areas along the coast of Washington and Oregon are favorable for the occurrence of petroleum.[8]

The reduction of alumina to aluminum requires a great amount of electric energy; inset 5 showing the principal electric transmission lines in the Columbia Basin was compiled to indicate the accessibility of available power to the major aluminous deposits. This represents about 20 percent of the potential hydroelectric power in the Columbia Basin.[9]

[1]Chaney, R. W., The Dallas flora: Carnegie Inst. Washington Contrib. to Paleontology, Pub. 553, pp. 229, 305, 354-355, 373, 1944.
[2]Allen, V. T., Sedimentary and volcanic processes in the formation of high-alumina clay: Econ. Geology, vol. 41, no. 2, pp. 132-138, 1946.
[3]Libbey, F. W., Lowry, W. D., and Mason, R. S., Ferruginous bauxite deposits in northwestern Oregon: Econ. Geology, vol. 41, pp. 246-265, 1946.
[4]Callaghan, Eugene, Alunite deposits near Enumclaw, King and Pierce Counties, Washington: U. S. Geol. Survey unpublished report, 13 pp., 1940.
[5]Murata, J. K., analyst.
[6]Annual Report 1948, Aluminum Company of America, p. 7, 1949.
[7]Averitt, Paul, Coal fields of the United States: U. S. Geological Survey Mineral Resources Map, 1942, scale 1:2,500,000.
[8]Fowler, H. C., Miser, H. D., and White, A. C., Petroleum, in Mineral position of the United States, appendix to hearings on "Investigation of the factors affecting minerals, fuels, and reclamation projects:" United States Congress, Senate Subcommittee of the Committee on Public Lands, 80th Cong., 1st Sess., May 15, 16, and 20, chart XX, facing p. 280, 1947.
[9]The Columbia River: U. S. Department of Interior, Bureau of Reclamation, p. 323, 1947.

DEPOSITS OF HIGH-ALUMINA CLAY, ALUMINOUS LATERITE, AND ALUNITE.

Explanation of code letters and numbers

B - Residual clay derived by weathering of basalt.
G - Residual clay derived by weathering of granite and related rocks.
H - Hydrothermally altered material.
S - Sedimentary clay.
P - Producing or has produced clay.
N - No production, except for test samples.

(I) - Reserves in known clay area of (measured, indicated, or inferred) 10,000,000 tons or more.
(II) - Reserves in known clay or alunite area of 1,000,000 to 10,000,000 tons.
(III) - Reserves in known clay area of less than 1,000,000 tons.
(IV) - Reserve data for known clay area not available, but probably more than 1,000,000 tons.
(V) - Reserve data for known clay area not available, but probably less than 1,000,000 tons.

The clay areas are keyed to map locations by Arabic numerals.

Alunite area, King and Pierce Counties, Washington.

Enumclaw alunite area (II).

Enumclaw alunite deposit, T. 19 and 20 N., R. 8 E., H, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

High-alumina clay and aluminous laterite areas in Washington.

1. Sumas fire clay area (III).

Sumas fire clay deposit, sec. 12, T. 40 N., R. 4 E., S, P; Glover, 1941, pp. 308-319, 341, 352-353; Goodner, 1921; Hodge, 1938, pp. 769-777; Shedd, 1910, pp. 286-288; Wilson, 1923, pp. 65-67, 99-104, 119, 123-125.

2. King County clay area (I).

Harris high-alumina clay deposit, SE¼ sec. 32, T. 24 N., R. 6 E., S, P; Glover, 1941, p. 120; Hodge, 1938, pp. 761-769; Nichols, 1945, pp. 2, 15, 23.

Gladding McBean & Co. clay pit, NW¼ sec. 33, T. 24 N., R. 6 E., S, P; Glover, 1941, p. 120.

Squak Mountain clay locality, sec. 33, T. 24 N., R. 6 E., S, N; Nichols, 1945, p. 15.

Taylor fire clay mine, sec. 3, T. 22 N., R. 7 E., S, P; Glover, 1941, pp. 122-128, 337, 344-345; Hodge, 1938, pp. 777-784; Landes, 1902, pp. 174-177; Shedd, 1910, pp. 263-268, 318-319; Wilson, Hewitt, and Goodspeed, 1934, pp. 98-100.

Kangley high-alumina clay deposit, SE¼ sec. 26, T. 22 N., R. 7 E., S, N; Nichols, 1945, pp. 2, 11, 13, 27.

Durham high-alumina clay deposit, secs. 35 and 36, T. 22 N., R. 7 E., and secs. 1 and 2, T. 21 N., R. 7 E., S, N; Dorisy, 1935, p. 7; Glover, 1941, pp. 134, 337; Nichols, 1945, pp. 2, 12, 26.

Kanaskat high-alumina clay deposit, sec. 12, T. 21 N., R. 7 E., S, N; Nichols, 1945, pp. 2, 12, 26.

Black Diamond fire clay deposit, sec. 13, T. 21 N., R. 6 E., S?, N; Dorisy, 1935, p. 7.

Kummer high-alumina clay deposit, NE¼ sec. 26, T. 21 N., R. 6 E., S, P; Glover, 1941, pp. 126-133, 337, 344-345; Goodner, 1921; Hodge, 1938, pp. 749-761; Landes, 1902, pp. 174-175; Nichols, 1945, pp. 2, 4, 15; Shedd, 1910, pp. 255-263, 318-319; Wilson, 1923, pp. 62-65, 96-97, 102-104, 118-119, 123-125.

Blum high-alumina clay deposit, SW¼ sec. 31, T. 21 N., R. 7 E.; NE¼ sec. 36, T. 21 N., R. 6 E., S, N; Nichols, 1945, pp. 2, 13, 27.

3. Pierce County fire clay area (III).

Kapowsin clay locality, NW¼ sec. 7, T. 17 N., R. 5 E., B, N; Glover, 1941, pp. 213-214, 339; Wilson, 1923, pp. 121-125.

Far West Brick and Tile Co. pit, SE¼ sec. 25, T. 17 N., R. 4 E., B, P; Glover, 1941, pp. 208-213, 339, 348-349, facing p. 358; Hodge, 1938, pp. 796-797; Wilson, 1923, pp. 98, 102-104, 188-189.

La Grande clay pit, R.R. cut half a mile north of La Grande, B, P; Glover, 1941, pp. 206-207, 339, 348-349; Shedd, 1910, pp. 274-275; Wilson, 1923, pp. 84, 97-98, 102-104.

4. Cowlitz and Lewis Counties clay area (I).

Toledo lignite and clay deposit, sec. 15, T. 11 N., R. 1 E., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Buswell farm high-alumina clay deposit, NW¼ sec. 25, T. 11 N., R. 2 W., S?, P; Glover, 1941, pp. 170-174, 184-185, 338; Shedd, 1910, pp. 294-296; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson, 1923, pp. 100-104, 120-121, 123-125, 137, 146-148.

Taylor brothers clay locality, sec. 1, T. 10 N., R. 1 W., S?, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Cowlitz high-alumina clay deposit, T. 10 N., R. 1 and 2 W., S, P; Glover, 1941, pp. 81-83, 336, 342-343; Hodge, 1938, pp. 784-794; Nichols, 1943; Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 15, 17, 43-46.

Spirit Lake road ferruginous clay locality, sec. 14, T. 10 N., R. 1 E., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Washout Hill high-alumina clay locality, secs. 29, 30, T. 10 N., R. 1 E., S?, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

5. Cowlitz County aluminous laterite area (IV).

Cameron Creek deposit, SW¼ sec. 27, E½ sec. 28, NE¼ sec. 33, and W½ sec. 34, T. 9 N., R. 4 W., B, N; Valentine, 1949, p. 17.

Mill Creek deposit, E½ sec. 32, W½ sec. 33, T. 9 N., R. 4 W., N½ sec. 4, T. 8 N., R. 4 W., B, N; Valentine, 1949, p. 17.

6. Wenatchee high-alumina clay area (I).

McDonald mine deposit, center N½ sec. 26, T. 23 N., R. 20 E., S, P; U. S. Geological Survey unpublished reports, memoranda and field notes.

Wenatchee clay mine, sec. 23, T. 23 N., R. 20 E., S, P; Glover, 1941, pp. 85-87, 336; Hodge, 1938, pp. 693-706; U. S. Geological Survey unpublished reports, memoranda and field notes.

Dry Gulch high-alumina clay deposit, NW¼NE¼ sec. 21, T. 22 N., R. 20 E., S, N; Hodge, 1938, p. 693; Huntting, 1943, p. 50; U. S. Geological Survey unpublished reports, memoranda and field notes.

Squillchuck Creek high-alumina clay deposit, NW¼ sec. 27, T. 22 N., R. 20 E., S, P; Glover, 1941, pp. 62, 336, 342-343; Hodge, 1938, pp. 706-708; Huntting, 1943, p. 50; U. S. Geological Survey unpublished reports, memoranda and field notes; Valentine, 1949, p. 23.

Upper Stemilt Creek high-alumina clay deposit, NE¼SE¼ sec. 11, T. 21 N., R. 20 E., S, N; Huntting, 1943, p. 51; U. S. Geological Survey unpublished reports, memoranda and field notes.

7. Pend Oreille County clay area (IV?).

Pend Oreille County clay deposit, T. 62 N., R. 43 E., S, N; Hodge, 1938, p. 609.

8. Valley clay area (IV).

Valley high-alumina clay locality, N½ sec. 20, T. 31 N., R. 41 E., S?, N; Glover, 1941, pp. 293-294; Shedd, 1910, pp. 211-212, 320-321; Shedd, 1913, p. 126.

John Kulzer high-alumina clay locality, NE¼ sec. 3, T. 31 N., R. 41 E., B, N; Wilson, 1923, pp. 117, 123-125.

9. Clayton high-alumina clay area (IV).

D. C. Neafus clay mine, S½ sec. 34, T. 30 N., R. 42 E., S, P; Glover, 1941, pp. 290-291, 340, 350-351; Hodge, 1938, pp. 605-606; Wilson, 1923, pp. 116, 123-125.

Clayton clay deposit, sec. 19, T. 29 N., R. 42 E., S, P; Glover, 1941, pp. 282-287, 340, 350-351; Goodner, 1921; Shedd, 1910, pp. 199-207, 320-321; Wilson, 1923, pp. 65, 70-71, 96, 102-103.

Carpenter clay deposit, about 3 miles southwest of Clayton, S, P; U. S. Geological Survey unpublished reports, memoranda and field notes.

Deer Park high-alumina clay deposit at Deer Park, G, N; Shedd, 1910, pp. 196-197, 320-321.

Saltese Creek clay deposit, S½ sec. 4, T. 24 N., R. 45 E., S, G, N; Glover, 1941, p. 256.

Milan clay locality, north center sec. 2, T. 28 N., R. 43 E., S?, G, N; Glover, 1941, pp. 262-264, 340; Wilson, 1923, pp. 95-96, 102-104, 116, 123-125.

10. Medical Lake clay area (V?).

Medical Lake clay deposit, sec. 10, T. 24 N., R. 40 E., S, N; Glover, 1941, p. 253; Hodge, 1938, p. 607.

11. Five-mile Prairie clay area (IV).

Five-mile Prairie clay deposit, secs. 13, 14, 23, 24, T. 26 N., R. 42 E., S, N; Dorisy, 1935; Glover, 1941, p. 262; Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 36-37, 47, 52; U. S. Geological Survey unpublished reports, memoranda and field notes.

12. Spokane clay area (I).

Deadman Creek clay deposit, secs. 15, 26, 27, 28, 31, 32, T. 27 N., R. 44 E., S, P; Glover, 1941, pp. 258-260, 340, 350-351; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson, 1923, pp. 114-115, 123-125.

Oley M. Skattum clay locality, center S½ sec. 11, T. 26 N., R. 44 E., G, N; Glover, 1941, pp. 257, 340, 350-351; Wilson, 1923, pp. 114, 123-125.

Bigelow Gulch clay locality, sec. 25, T. 26 N., R. 43 E., S, N; Glover, 1941, p. 257.

Chester fire clay deposit, sec. 35, T. 25 N., R. 44 E., S, G, P; Glover, 1941, pp. 253-255, 340, 350-351, facing p. 358; Hodge, 1938, pp. 594-601; Shedd, 1910, pp. 175-181; Wilson, 1923, pp. 71-72, 91, 102-104, 106, 109-110.

Excelsior high-alumina clay deposit (Mica clay deposit), S½ T. 24 N., R. 44 E., S, B, G, P; Glover, 1941, pp. 244-252, 340, 348-349; Hodge, 1938, pp. 526-570; Scheid, 1945; Shedd, 1910, pp. 181-188; Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 38-40, 51, 53; Wilson, 1923, pp. 18, 94-95, 102-103.

Freeman fire clay deposit, sec. 1, T. 23 N., R. 44 E., G. P. Glover, 1941, pp. 241-244, 339, 348-351; Goodner, 1921; Hodge, 1938, pp. 570-590; Shedd, 1910, pp. 320-321; Wilson, 1923, pp. 61, 65, 67-69, 93-94, 102-103, 113-114, 123-125.

Ed Thompson clay pit, E½SW¼ sec. 5, T. 23 N., R. 45 E., S, P?; Hodge, 1938, p. 602.

Manito clay locality, NW¼ sec. 9, T. 23 N., R. 45 E., S, N; Glover, 1941, p. 239; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson and Goodspeed, 1934, pp. 57-58.

Mica Creek clay locality, sec. 3, T. 23 N., R. 45 E., or sec. 34, T. 24 N., R. 45 E., S?, G?, N; Hodge, 1938, p. 603.

Saxby clay locality, R. R. cut southeast of Saxby station, G, N; Glover, 1941, pp. 236, 238-239; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson, 1923, pp. 94, 102-104.

Lockwood Siding clay locality, sec. 8, T. 23 N., R. 45 E., S, N; Hodge, 1938, p. 602; Wilson, 1923, pp. 113, 123-125; Valentine, 1949, p. 24.

High-alumina clay areas in Idaho

13. Coeur d'Alene clay area (II).

Stockton clay deposit, secs. 9, 10, 15, 16, T. 50 N., R. 4 W., S, G, N; Skeels, 1920, p. 36; U. S. Geological Survey unpublished reports, memoranda and field notes.

Stanley Hill clay deposit, sec. 7, T. 50 N., R. 3 W., S, N; Skeels, 1920, pp. 33-35; U. S. Geological Survey unpublished reports, memoranda and field notes.

Fernam Hill clay deposit, secs. 8, 9, 16, 17, T. 50 N., R. 3 W., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Kid Island clay deposit, secs. 26, 35, T. 50 N., R. 4 W., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Blue Creek Bay clay deposit, sec. 36, T. 50 N., R. 3 W., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

14. Harrison clay area (IV).

Harrison clay deposit, about midway between the towns of Harrison and Cataldo, S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

15. St. Maries clay area (V).

Benewah Creek clay locality, secs. 10, 12, T. 46 N., R. 3 W., S, N; Skeels, 1920, pp. 25-27.

St. Maries clay locality, sec. 21, T. 46 N., R. 2 W., S, N; Skeels, 1920, p. 28.

Thorn Creek clay locality, sec. 7, T. 45 N., R. 1 W., S, N; Kirkham, 1926, p. 4; Kirkham and Johnson, 1929, p. 492.

16. Potlatch clay area (II).

Onway clay deposit, sec. 6, T. 41 N., R. 4 W., S, P; Glover, 1941, p. 326; Shedd, 1910, pp. 222-224; Skeels, 1920, pp. 55-56; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson and Goodspeed, 1934, pp. 95-96.

Old Brickner clay pit, sec. 25, T. 42 N., R. 5 W., S, P; U. S. Geological Survey unpublished reports, memoranda and field notes.

Potlatch Junction clay locality, W½ sec. 16, T. 41 N., R. 5 W., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Palouse, Washington clay pit, sec. 7, T. 16 N., R. 46 E., Whitman County, Washington, S, P; Glover, 1941, pp. 321-325, 341, 352-353; Shedd, 1910, pp. 222-225; Wilson, 1923, pp. 112-113, 123-125.

17. Moscow high-alumina and fire clay area (I).

Canfield-Rogers high-alumina clay deposit, T. 39 and 40 N., R. 5 W., S, B, G, P; Hodge, 1938, pp. 619-638; Tullis and Laney, 1933, p. 493; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson, 1923, p. 61; Wilson and Goodspeed, 1934, pp. 72-73, 81-91.

Joel fire clay deposit, NW¼ sec. 18, T. 39 N., R. 4 W., G, P; Hodge, 1938, pp. 615-619; Skeels, 1920, pp. 47-55; Wilson and Goodspeed, 1934, pp. 69-72.

18. Troy high-alumina and fire clay area (I).

Stanford clay deposit, secs. 5, 6, 7, T. 40 N., R. 2 W., secs. 1, 12, T. 40 N., R. 3 W., B, G, S, P; U. S. Geological Survey unpublished reports, memoranda and field notes.

Deary Station clay locality, SE¼ sec. 15, T. 40 N., R. 2 W., G, N; Scheid, 1940, pp. 66-67; Skeels, 1920, pp. 42-43; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson and Goodspeed, 1934, pp. 92-93.

Benson fire clay deposit, secs. 27, 28, 33, 34, T. 40 N., R. 3 W., G, B, P; Hodge, 1938, pp. 638-678; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson, 1923, p. 61; Wilson and Goodspeed, 1934, pp. 73-85.

Olson high-alumina clay deposit, T. 40 N., R. 2 W., B, S, N; Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 41-43, 51, 54-55; U. S. Geological Survey unpublished reports, memoranda and field notes.

Deary high-alumina clay deposit, secs. 27, 34, T. 40 N., R. 2 W., B, S, N; Scheid and Sohn, 1945.

McKeehan fire clay pit, SW¼ sec. 6, T. 39 N., R. 3 W., G?, S?, P; Scheid, 1940, pp. 44-45; Wilson and Goodspeed, 1934, pp. 85-86.

Troy clay locality, sec. 18, T. 39 N., R. 3 W., B, N; Scheid, 1940, pp. 45-47.

Park clay localities, sec. 8, T. 39 N., R. 1 W., sec. 6, T. 39 N., R. 1 E., G, S, N; Scheid, 1940, pp. 69-71.

19. Bovill clay area (I).

Bovill high-alumina clay deposit, secs. 25, 36, T. 41 N., R. 1 W., sec. 2, T. 40 N., R. 1 W., B, S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Clarkia clay locality, sec. 32, T. 42 N., R. 1 E., G, N; Tullis and Laney, 1933, p. 481; U. S. Geological Survey unpublished reports, memoranda and field notes.

20. Elk River clay area (I).

Elk River clay deposit, T. 39 N., R. 2 E., G, B, S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

21. Lewis County clay area (IV).

Lewis County clay deposit, sec. 6, T. 33 N., R. 2 E., S, P; Skeels, 1920, p. 59; U. S. Geological Survey unpublished reports, memoranda and field notes.

22. Stites clay area (V).

Stites clay deposit, sec. 36, T. 32 N., R. 3 E., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

23. Grangeville clay area (IV).

Fenn clay locality, SE¼NE¼ sec. 34, T. 31 N., R. 2 E., S or B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Camas Prairie clay deposit, SE¼ sec. 31, T. 30 N., R. 2 E., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Grangeville clay locality, NE¼NW¼ sec. 35, T. 30 N., R. 2 E., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Taylor G. Burton clay locality, SE¼SE¼ sec. 4, T. 29 N., R. 2 E., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

High-alumina clay and aluminous laterite areas in Oregon

24. Clatsop County clay area (V).

Clatsop County clay deposit, sec. 21, T. 7 N., R. 8 W., S, N; Hodge, 1938, pp. 842, 845-846.

25. Portland aluminous laterite area (I).

Yankton deposit, sec. 6, T. 4 N., R. 1 W.; sec. 1, T. 4 N., R. 2 W., B, N; Bell, 1945, pp. 7-9; Kelly, 1947, pp. 4, 6, 28-45, 49; Libbey, Lowry, and Mason, 1945, pp. 22, 47-50; U. S. Geological Survey unpublished reports, memoranda and field notes.

Alder Creek deposit, NW¼ sec. 16, T. 4 N., R. 2 W., B, N; Bell, 1945, pp. 9-11; Kelly, 1947, pp. 4, 6, 27; U. S. Geological Survey unpublished reports, memoranda and field notes.

Lambert farm locality, sec. 11, T. 4 N., R. 2 W., B, N; Bell, 1945, p. 12; Kelly, 1947, pp. 4, 7; Libbey, Lowry, and Mason, 1945, pp. 22, 47; U. S. Geological Survey unpublished reports, memoranda and field notes.

Kramer farm locality, SW¼ sec. 1, T. 4 N., R. 2 W., B, N; Bell, 1945, p. 12; Kelly, 1947, pp. 4, 7.

Cater Road deposit, E½ sec. 10, T. 4 N., R. 2 W., B, N; Bell, 1945, pp. 12-13; Kelly, 1947, pp. 4, 7, 46-48, 50-51; U. S. Geological Survey unpublished reports, memoranda and field notes.

Anderson Road locality, W½ sec. 35, T. 5 N., R. 2 W., B, N; Bell, 1945, p. 15; Kelly, 1947, pp. 4, 7; U. S. Geological Survey unpublished reports, memoranda and field notes.

Rainier locality, sec. 18, T. 7 N., R. 2 W., S, N; Bell, 1945, pp. 15-16; Kelly, 1947, pp. 4, 8; Libbey, Lowry, and Mason, 1945, pp. 22, 54-56; U. S. Geological Survey unpublished reports, memoranda and field notes.

Maple Hill locality, 1 mile southwest of Deer Island, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Smith Ridge locality, 2½ miles southwest of Deer Island, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Trenholm area I locality, sec. 20, T. 5 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 23, 53, 60; U. S. Geological Survey unpublished reports, memoranda and field notes.

Serafin locality, 1 mile west of Trenholm, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Trenholm area II locality, 1.3 miles east of Trenholm, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Happy Hollow School area I locality, 1 mile north of Happy Hollow School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Happy Hollow School area II locality, one-half mile northeast of Happy Hollow School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Happy Hollow School area III locality, 1 mile northeast of Happy Hollow School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Dark Creek Road locality, 3 miles northwest of Columbia City, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Maple Ridge locality, 2 miles northwest of Columbia City, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

John Gentry locality, SE¼ sec. 26, T. 5 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 52; U. S. Geological Survey unpublished reports, memoranda and field notes.

A. M. Mallory locality, one-half mile east of John Gentry's place, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Dowd School area I locality, 2½ miles west of Dowd School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Dowd School area II locality, 2 miles west of Yankton, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Anderson Road locality, 1 mile west of Yankton, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

W. F. Weis and T. C. Hudson locality, one-half mile southwest of Yankton, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Eber Brown aluminous laterite locality, about 2 miles west of St. Helens, B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 52; U. S. Geological Survey unpublished reports, memoranda and field notes.

Spitzenberg area I aluminous laterite and high-alumina clay locality, 1 mile east of Spitzenberg, B, N; Libbey, Lowry, and Mason, 1945, pp. 23, 62; U. S. Geological Survey unpublished reports, memoranda and field notes.

Spitzenberg area II aluminous laterite and high-alumina clay locality, 0.8 mile east of Spitzenberg, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Sly Creek locality, 1½ miles east of Spitzenberg, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Spur at end of Church Road locality, about 2 miles east of Spitzenberg, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Spitzenberg area III locality, about 1 mile southeast of Spitzenberg, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Oester Road locality, 3½ miles northwest of Scappoose, B, N; Libbey, Lowry, and Mason, 1945, pp. 23, 57; U. S. Geological Survey unpublished reports, memoranda and field notes.

Lange locality, about 2 miles northwest of Scappoose, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Colport Development Company locality, about 2½ miles northwest of Scappoose, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Apple Valley locality, 2½ miles northwest of Scappoose, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Section 34 locality, sec. 34, T. 7 N., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Fern Hill School locality, SW¼ sec. 30, T. 7 N., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Hendrickson and Hendrickson Extension deposits, NW¼ sec. 6, T. 2 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1944, pp. 10-13; Libbey, Lowry, and Mason, 1945, pp. 22, 29-32; Libbey, Lowry, and Mason, 1946, p. 258; U. S. Geological Survey unpublished reports, memoranda and field notes.

Hutchison-Nixon deposit, about 1 mile east of Hendrickson property, B, N; Libbey, Lowry, and Mason, 1944, pp. 15-17; Libbey, Lowry, and Mason, 1945, pp. 22, 32-43; Libbey, Lowry, and Mason, 1946, p. 257; U. S. Geological Survey unpublished reports, memoranda and field notes.

Nelson deposit, SW¼ sec. 32, T. 3 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1944, pp. 13-15; U. S. Geological Survey unpublished reports, memoranda and field notes.

J. W. Leitzel locality, sec. 3, T. 1 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 44-45; U. S. Geological Survey unpublished reports, memoranda and field notes.

Lazy "W" Ranch locality, sec. 30, T. 3 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1944, p. 19; Libbey, Lowry, and Mason, 1945, pp. 22, 28; U. S. Geological Survey unpublished reports, memoranda and field notes.

Gus Nelson locality, SE¼ sec. 25, T. 3 N., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 47; U. S. Geological Survey unpublished reports, memoranda and field notes.

C. E. Ferguson locality, NW¼NE¼ sec. 24, T. 3 N., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 46; U. S. Geological Survey unpublished reports, memoranda and field notes.

Becker locality, 4.6 miles north of Pleasant View School, B, N; Libbey, Lowry, and Mason, 1944, p. 19; U. S. Geological Survey unpublished reports, memoranda and field notes.

Martaw Creek locality, 2 miles west of Meacham School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Bald Mountain School road cut locality, 2½ miles southeast of Bald Mountain School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Prickett School locality, 1 mile northeast of Prickett School, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

H. Davies No. I locality, about 2 miles northeast of Banks, SE¼ sec. 19, T. 2 N., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 46-47; U. S. Geological Survey unpublished reports, memoranda and field notes.

H. Davies No. II locality, 1½ miles northeast of Banks, NE¼ sec. 19, T. 2 N., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 47; U. S. Geological Survey unpublished reports, memoranda and field data.

Pearl Smith locality, 0.2 mile southwest of Pleasant View School, B, N; Libbey, Lowry, and Mason, 1944, p. 19; Libbey, Lowry, and Mason, 1945, pp. 22-32; U. S. Geological Survey unpublished reports, memoranda and field notes.

Northeast corner section 12 locality, northeast corner of sec. 12, T. 2 N., R. 3 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Parmele locality, SE¼ sec. 5, T. 2 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1944, p. 21; U. S. Geological Survey unpublished reports, memoranda and field notes.

East Fork and McKay Creek locality, sec. 18, T. 2 N., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Moreland Road locality, northwest corner of sec. 21, T. 2 N., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

W. O. Jacobs locality, W½ sec. 30, T. 2 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 44; U. S. Geological Survey unpublished reports, memoranda and field notes.

Cathey Farm high-alumina clay locality, sec. 34, T. 2 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1944, p. 19; Libbey, Lowry, and Mason, 1945, pp. 22, 44; U. S. Geological Survey unpublished reports, memoranda and field notes.

G. F. Berger locality, NW¼ sec. 2, T. 1 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 45; U. S. Geological Survey unpublished reports, memoranda and field notes.

Mrs. A. Anderson and Edw. Anderson locality, NW¼ sec. 27, T. 2 N., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 22, 45; U. S. Geological Survey unpublished reports, memoranda and field notes.

Pumpkin Ridge locality, SE¼ sec. 34, T. 3 N., R. 3 W., B, N; Libbey, Lowry, and Mason, 1944, p. 15; U. S. Geological Survey unpublished reports, memoranda and field notes.

W. E. Davis locality, 1½ miles northwest of Banks, B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Albright high-alumina clay locality, sec. 3, T. 2 N., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Sig Fransen fire clay deposit, NE¼ sec. 33, T. 8 N., R. 3 W., B?, S, P; Hodge, 1938, pp. 839-841; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson and Treasher, 1938, pp. 21-33, 84-88.

26. Fly Creek clay area (V).

Fly Creek clay deposit, sec. 16, T. 5 N., R. 4 E., S?, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

27. Laurel clay area (V).

Chehalem Mountain locality I, SE¼ sec. 30, T. 2 S., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 23, 64; U. S. Geological Survey unpublished reports, memoranda and field notes.

Chehalem Mountain locality II, SE¼ sec. 34, T. 2 S., R. 2 W., B, N; Libbey, Lowry, and Mason, 1945, pp. 23, 64; U. S. Geological Survey unpublished reports, memoranda and field notes.

Parrett Mountain locality, SW¼ sec. 13, T. 3 S., R. 2 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Red Hills of Dundee locality, sec. 3, T. 4 S., R. 3 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

28. Carver clay area (V).

Carver clay deposit, sec. 24, T. 2 S., R. 2 E., S, P; Hodge, 1938, pp. 848-849.

29. Estacada high-silica aluminous laterite area (IV?).

Estacada high-silica aluminous laterite deposit, secs. 3 and 4, T. 4 S., R. 4 E., B, N; Anonymous, 1948.

30. Molalla high-alumina clay area (I).

Colton clay locality, T. 4 S., R. 3 E., B?, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Molalla clay deposit, secs. 15, 22, 27, 28, T. 5 S., R. 2 E., B, S, P; Hodge, 1938, pp. 849, 853; Nichols, 1944; Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 24-28, 47-48; Wilcox, 1935, pp. 17-19; Wilson and Treasher, 1938, pp. 39-48, 84-88.

Joseph Zahar and Guy Dibble clay deposit, sec. 1, T. 6 S., R. 2 E., S, P; Hodge, 1938, pp. 851-853; Wilson and Treasher, 1938, pp. 46-48, 84-86, 89.

Scotts Mills clay locality, NE¼ sec. 23, T. 6 S., R. 1 E., B?, S?, N; Hodge, 1938, pp. 866-867; Wilson and Treasher, 1938, pp. 62-63, 84.

31. Willamina fire clay area (IV).

Grand Ronde clay deposit, SE¼ sec. 5, T. 6 S., R. 7 W., S, P; Hodge, 1938, p. 837; Wilson and Treasher, 1938, pp. 7, 38.

Willamina clay deposit, sec. 36, T. 5 S., R. 7 W., S, P; Hodge, 1938, pp. 818-837, 848; Wilson and Treasher, 1938, pp. 34-38, 84, 88.

32. Salem aluminous laterite and high-alumina clay area (IV).

Macleay high-alumina clay locality, SE¼NE¼ sec. 3, T. 8 S., R. 2 W., B, N; Hodge, 1938, p. 866; Wilson and Treasher, 1938, pp. 62, 84, 91.

Buena Vista clay deposit, W½ sec. 23, T. 9 S., R. 4 W., S, N; Hodge, 1938, p. 856; Wilson and Treasher, 1938, pp. 63, 85.

Aluminous laterite locality, SW¼NE¼ sec. 12, T. 7 S., R. 3 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Wallace Hill aluminous laterite locality, NW¼SE¼ sec. 8, T. 7 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 75.

Chaplin Hill aluminous laterite locality, SW¼ sec. 17, T. 7 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 75.

Mountain View School aluminous laterite locality, SE¼ or SW cor. sec. 16, T. 7 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 75.

Roadcut aluminous laterite locality, SE¼SW¼ sec. 17, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 76.

Prospect Hill aluminous laterite locality, SW¼ sec. 19, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 76.

Roadcut gibbsite locality, center sec. 30, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 76.

Rosedale School aluminous laterite and high-alumina clay locality, NW¼ sec. 28, T. 8 S., R. 3 W., B, N; Libbey, 1945, pp. 76-77.

Gibbsite float locality, SW¼SW¼ sec. 22, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 78.

Sunnyside School aluminous laterite and high-alumina clay locality, center sec. 26, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 78.

Roadcut aluminous laterite and high-alumina clay locality, NE¼SW¼ sec. 28, T. 8 S., R. 3 W., B, S, N; Libbey, Lowry, and Mason, 1945, pp. 77-78.

Jackson Hill aluminous laterite and high-alumina clay locality, sec. 35, T. 8 S., R. 3 W., B, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Roadcut aluminous laterite and high-alumina clay locality, secs. 35, 36, T. 8 S., R. 3 W., B, N; Libbey, Lowry, and Mason, 1945, p. 79.

33. Mehama high-alumina clay area (IV).

Mehama high-alumina clay deposit, sec. 1, T. 9 S., R. 2 E., secs. 6, 7, 9, 23, T. 9 S., R. 3 E., B, S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

Silverton clay localities, T. 7 and 8 S., R. 1 W., B, N; Hodge, 1938, pp. 864-865, 867; Wilson and Treasher, 1938, pp. 60-61, 84, 91.

Silver Creek Falls clay locality, SW¼SW¼ sec. 3, T. 8 S., R. 1 E., B, N; Wilson and Treasher, 1938, pp. 59-60, 84, 90.

Sublimity clay deposits, secs. 18, 19, 21, T. 8 S., R. 1 E., S, P; Hodge, 1938, pp. 862-864, 867; Wilson and Treasher, 1938, pp. 49-59, 61, 84-86, 89, 91.

34. Southeast of Heppner kaolinite area (V).

Deposit southeast of Heppner, S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

35. Bellefountain fire clay area (III).

Bellefountain fire clay deposit, SW¼ sec. 2, T. 14 S., R. 6 W., S, N; Chelikowsky, 1935, p. 382; Hodge, 1938, pp. 853-855; Wilcox, 1935, pp. 25-26, 38; Wilson and Treasher, 1938, pp. 63-64, 91.

36. Mable fire clay area (IV).

Mable fire clay deposit, SW¼ sec. 15, NW¼ sec. 22, T. 15 S., R. 1 W., S?, N; Chelikowsky, 1935, p. 382; Hodge, 1938, p. 884; Wilson and Treasher, 1938, pp. 66-67.

37. Spencer Butte clay area (IV?).

Spencer Butte clay deposit, sec. 30, T. 18 S., R. 3 W., S, N; U. S. Geological Survey unpublished reports, memoranda and field notes.

38. Winberry fire clay area (IV?).

Winberry fire clay deposit, sec. 31, T. 18 S., R. 1 E., S?, B?, N; Hodge, 1938, pp. 886-887; Wilson and Treasher, 1938, pp. 67-68.

39. Putman high-alumina clay area (II).

Putman high-alumina clay deposit, sec. 3, T. 21 S., R. 3 W., S, H. N; U. S. Geological Survey unpublished reports, memoranda and field notes.

40. Hobart Butte clay area (I).

Hobart Butte clay deposit, T. 22 and 23 S., R. 3 W., S, H, P; Bell, 1945, pp. 25-33; Hodge, 1938, pp. 873-883, 887; Iverson and Coughlin, 1945, p. 81; Loofbourow, 1943, Skinner and Kelly, 1948, pp. 183-184; Skinner and Kelly, 1949, pp. 23, 30-35, 49-51; U. S. Geological Survey unpublished reports, memoranda and field notes; Wilson and Treasher, 1938, pp. 84-85, 92.

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