FIRE CLAYS IN NORTHERN IDAHO.

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Location and Accessibility.—During the past three years there have been several important discoveries of high grade fire clay in Latah County, Idaho. Latah County is in the northwest part of the State, adjoining Whitman County, Washington. The clay deposits occur near Moscow, the County seat, and site of the University of Idaho. The deposits lie in close proximity to the Lewiston branch of the Northern Pacific Railway, and at the property of the Moscow Fire Brick and Clay Products Co., near Moscow, a railroad spur is being built to the clay pits to permit of the loading of the clay direct from the pit to the cars.

Geology of the Clay Deposits.—The geological occurrence of the clay deposits is interesting and some rather unusual features are exhibited. The fire clay is of the residual type, and has been derived from the weathering and decomposition of granite and associated pegmatite dikes. In addition to these fire clays there are other residual clays derived from the decomposition of basalt, which occurs over a large area in this region as a capping on top of the granite. The clays derived from the decomposition of the basalt are red, yellow or brown in color. Because of the higher percentage of iron and other fluxing impurities, they have little value for refractory purposes, but are excellent for the manufacture of brick, tile and other structural clay products. The fire clays are usually white or cream colored, and are white burning.

The general geology of this section of Idaho is comparatively simple. The rocks in the vicinity of Moscow consist of granite, quartzite, and basalt. The quartzite, which is the oldest rock, probably Algonkian in age, has been altered to a quartz schist in places. The granite occurs as a large intrusion into the quartzite and quartz schists and is probably of Cretaceous age. It forms the edge of the enormous granite batholith which, because of erosion, is now exposed at the surface over many square miles in the mountainous region to the east and southeast. The

quartzite and associated pre-Cambrian sediments have been mostly eroded from the region under discussion, but large areas are exposed to the northeast.

The basalt occurs as a flow, or series of flows, which originally covered the entire region of the Snake River plains in Idaho, Eastern Washington, and a large part of Eastern Oregon. This formation is known as the Columbia basalt and is probably of Miocene age. The lava flows originally reached well up on the foothills and lower western flanks of the mountains to the east of Moscow. Subsequent erosion has removed the basalt capping from many of the upper slopes of the foothills bordering the mountains and it is along the contact of this basalt cap-rock and the denuded granite that the fire clays and associated basaltic residual clays occur. Although there are large areas of granite, just east of this contact, from which the basalt has been completely removed, no important deposits of fire clay have been discovered as yet on these terrains.

The occurrence of the clay along the contact zone is probably due to the fact that on the granite side of the contact the hills rise to considerably higher elevations with rather steep slopes and the clay and decomposed granite is rapidly removed by erosion. Along the contact zone the slopes are more gentle and thus clay deposits of considerable thickness have accumulated. Another probable reason for the close association of the clay deposits and the zone of contact between granite and basalt suggested itself to the writer in examining one of the recently exposed clay banks near the town of Troy. At this locality the clay is overlain by a bed of volcanic tuff (consolidated volcanic ash), which, in turn, is partly overlain by basalt. At this place the tuff is exposed in immediate contact with the underlying residual fire clay which grades downward into partially decomposed granite. For a thickness of several feet beneath the tuff the clay is stained dark brown or yellow and contains numerous altered fragments of wood, showing plainly the existence here of an old weathered surface antedating the volcanic activity which resulted in the deposition of the ash. This evidence points to the conclusion that in some cases the residual clay was formed before the lava flows which now cover so much

of the region. Recent erosion of the lava capping has resulted in the exposure of the clay and decomposed granite and this in turn has been rapidly removed because of its relatively weaker resistance to erosion processes. The more rapid erosion of the areas of decomposed granite would tend to remove the clay except along the zone adjoining the contact, where the protecting capping of basalt, or tuff, has not been removed sufficiently long to result in the erosion of the clay. It is probable that much of the fire clay is Miocene or pre-Miocene in age, but as considerable decomposition of the granite has taken place since the erosion of the basalt, this has probably resulted in the formation of post-Miocene residual clay deposits.

The red, yellow, and brown clays which have been derived from the decomposition of the basalt are clearly of recent age. As would be expected, these generally occur at somewhat higher elevations than the white fire clays and in some cases are found directly overlying the fire clay. Recent erosion has resulted in the accumulation of secondary deposits of mixed sedimentary clays derived from the removal and mixing of the residual fire and basaltic clays.

The granite from which the fire clay in this locality has been derived is rich in feldspar, and generally contains only small amounts of hornblende, biotite or other ferro-magnesian minerals. In the vicinity of Moscow, the granite shows almost no mica and hornblende. Considerable white mica occurs in the granite at some places and there is also a segregation of the feldspars along narrow zones cutting through the granite in various directions. This has resulted in the occurrence of numerous narrow streaks of almost pure kaolin cutting the clay deposits. Narrow pegmatite dikes are also of rather frequent occurrence in the granite of this locality and this pegmatite has contributed additional amounts of kaolin to the fire clay. Because of the numerous segregations of the feldspar, white mica, or quartz constituents of the granite, the material resulting from the decomposition of the granite is often "spotty" in its occurrence. In places this material will consist almost entirely of sub-angular quartz sand. In other places, large amounts of partially de-

composed mica were noted, especially at the O. K. Olsen mine near Troy. In some places, where the proportion of feldspar in the original granite was high, deposits of good white fire clay have resulted from the weathering of the rock.

Extent of the Clay Deposits.—The size and shape of the clay deposits are variable. They range in thickness from a few feet to 40 or 50 feet, and the area of the deposits may vary from a fraction of an acre to 40 or 50 acres. This variation in size and shape is to be expected from the method of origin of the deposits, and from the character of the parent rock. In prospecting or developing these deposits, it is advisable to put down a large number of bore holes or test pits, arranged on some systematic plan, in order to obtain accurate data from which the extent of the deposit may be outlined.

Quality of the Clay.—The fire clay is of excellent quality and is well suited for the manufacture of fire brick. The best and purest deposits are those being worked at Moscow. Heating tests have shown that the clays have softening points ranging from that of Cone 30 to Cone 36. As the material comes from the pits, it develops only a moderate degree of plasticity and is of coarse texture, containing numerous angular grains of quartz embedded in white kaolin. There is sometimes present small amounts of white mica but in the Moscow deposits the quantity of mica in the clay is negligible. The kaolin is often rather dry and powdery, which makes the clay crumble easily, but when water is added and the material thoroughly mixed, the clay develops a surprising degree of plasticity. Up to the present time, no attempts have been made to utilize these clays for any purpose other than in the manufacture of fire brick and other refractory shapes. However, if the clay were washed, kaolin and silica of very good quality should result. The former might be utilized in the manufacture of pottery and other high-grade wares, and the white quartz, which is of unusual purity, might be of value in the manufacture of silica brick.

Development and Market.—The discovery of the fire clays of this locality is of recent date, but already two plants are in

operation manufacturing refractories. The plant of the Moscow Fire Brick and Clay Product Company at Moscow, Idaho, was placed in operation in 1917 and from the start this company has been operating continuously. Another plant is in operation at Troy, Idaho, about 10 miles east of Moscow. There are also brick plants at Mica and Freeman, in Spokane County, Washington, northwest of Latah County, Idaho. These Washington plants are operating on clays of similar origin to those here described. The market for fire brick and other refractories in the Northwest is very encouraging. The large smelters at Kellogg, Idaho; Northport, Washington; Tacoma, Washington, and in British Columbia, furnish a regular market for large quantities of refractories in addition to the amounts regularly used in the various industrial works at Spokane, Seattle, Tacoma, Portland, Vancouver, and other points in the Northwest.

It is not unlikely that a steel plant will be erected on the north Pacific coast in the near future, affording an additional market for fire clay and other refractory products. The Moscow Fire Brick and Clay Product Company is also utilizing deposits of the residual basaltic clay, which occurs on their property, in the manufacture of brick, tile and special shapes. Several varieties and colors of this type of clay occur in the Moscow deposit, and by their mixture with variable quantities of the fire clay, a wide range of red, buff, brown, and spotted brick and other products can be produced.

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