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GEOLOGY OF THE GRAND PORTAGE AREA, COOK COUNTY, MINNESOTA

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CERAMIC EXPERIMENTS AT THE STATE TEACHERS COLLEGE, MANKATO, MINNESOTA

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Pottery has always been one of the most responsive forms of human expressions. The plasticity and ease with which the soft clay takes shape under the potter's hand suggest something of the very changing nature of life itself. Man's civilization may be measured in his pottery, a fact which history bears out through all the ages. With this idea in mind, considerable experimentation in ceramic materials has been carried on at the Mankato State Teachers College.

The poor quality of the Mankato brick is one of the specific things which prompted our work in this field. In general locally-made Mankato brick is low grade and has a latent tendency to shell off and crack under pressure. These Mankato bricks are inferior because they were not fired properly. We have noted, however, one example of good local brick in Mankato. A house was constructed of brick made in the yard in which it stands. The bricks in this house were fired properly, and though the house is over 80 years old, it is still in good structural condition with the bricks essentially as sound as the day the house was built.

The repeated Pleistocene glaciation of the Minnesota River Valley have brought about a complex stratification of alluvial and glacial deposits. The particular deposits which were the basis of the experimental work are clay beds associated with Keewatin glaciers.

The first of these deposits is a transported Cretaceous clay called "Porcite" which was brought in by an early Keewatin glacier. It is thoroughly mixed with fine sand and different size fragments of sandstone, and varies in color from white to cream in the exposure. The bed varies in depth, the average being five feet, and has a lateral extent of over one mile. This clay is so sticky that considerable effort is needed to remove it from the sampling shovel. Except for the fact that the sand particles are a detriment to its workability, the clay could be used just as it occurs, because the plasticity is so great as to nullify the weakening effect of the contained sand grains. Firing natural sample blocks of this clay shows that it has the same compact character both before and after firing that the cleaned clay possesses.

The second layer under consideration, which we named "Alite," is of similar character to the white clay, except that it is freer from foreign particles. It has a firey red color in the "vein." Upon drying it turns to a very light pink and fires to an orange pink at 1800° F. The fired product is porous. This deposit is very limited, filling a pocket about 100 feet wide with a depth of about two feet.

A greenish clay which we refer to as "Drabite" may occur at various levels, two of which have been found in the Mankato area. These beds, however, are but a foot thick although they extend horizontally about two miles. The clay is of unusual purity, no cleaning being necessary. Its color after firing ranges from a light brown to an olive drab according to the temperature. The clay is porcelain in character, vitrifying and forming dense waterproof ware when fired to 2100° F. The product is very hard and resistant to shock.

A gray clay, which we call "Erinite" because it fires green, is interpreted as a part of the glacial debris left by a receding glacier. It is more of a curiosity than a commercial prospect since the deposit, as far as observed, is only two feet thick and approximately 100 feet in length. However, there is a strong possibility that it continues much farther than it has been actually traced. There is only a small percentage of foreign material in this gray clay. It is hard and rock-like and vitrifies very easily when fired, forming a shiny self-glaze which can be used as a slip glaze to cover ware made of common clay.

Next, two layers of clay, which though differing in natural color, fire to the same final product are considered to be post-glacial water deposits. They lie immediately above a limonitic layer.

The first of these, called "Annite," is black as it occurs in nature, and is thick, and although it has been traced for only two miles, there is a possibility that it extends nearly the entire length of the Minnesota River Valley. The color range is from light red to dark chocolate, depending on the firing temperature. It vitrifies at cone two or 2100° F. and forms a true terra-cotta "skin" on the surface. This makes it a very desirable material for tile, as the vitrified surface is extremely hard, and resistant to wear. As a pottery clay, it has its limitations, such as the proportion of water to clay in a mixture that will work well must be so exact as to make it practically impossible to obtain or to retain the correct proportion. It, moreover, has a tendency to crack in the drying process, and will not take a glaze because it vitrifies.

The second of these water-laid deposits is a brown to rust colored clay which we named "Schwartzite." It occurs immediately above the "Annite" layer, and like it averages 12 feet thick and extends for at least two miles along the valley. It fires similarly. It has, however, less tendency to check and molds more easily into tile and other articles than does the "Annite." A phase of this clay is dark brown which fires red.

A brick was made of each clay, and tested for compressional strength. The standard for engineering brick is 300 tons per square foot, for face brick 120 tons per square foot, and for common brick 60 tons per square foot. The Mankato clays have always withstood pressure considerably above their respective limits. The lowest pressure taken by the bricks was 220 tons per square foot for the "Alite" clay. The greatest pressure was by the "Drabite" which took 7,000 tons per square foot, with "Annite" a close second with 6,500 tons per square foot.

Another excellent quality of the Mankato clay is the very low percentage of shrinkage. The largest shrinkage was shown by "Porcite" which had a 5 per cent lineal shrinkage, with "Drabite" a close second with 4 per cent. The lowest shrinkage of the clay tested was "Schwartzite" with a 1.2 per cent lineal shrinkage.

An important factor in any tile or brick clay is the calcium and magnesium content. Limestone pebbles in a clay will cause the face of the brick or tile to pit and pop out, ruining its appearance and also decreasing its strength. The reason for this is that in the process of burning the brick or tile the calcium or magnesium carbonates is calcined much as is done in the manufacture of lime. In the same manner as lime slaking with the addition of water, the calcined pebbles of limestone in the brick slake, steam, and expand breaking the brick or tile.

We have analysed all of the clays for calcium and magnesium content according to the procedure outlined in Scott's Analysis. The results of the determination show the clays in a favorable light. The "Annite" clay has a combined percentage of calcium and magnesium of 2.44 per cent, the "Schwartzite" combined percentage of 1.18 per cent, while the "Porcite" has a higher percentage of calcium and magnesium, amounting to 4.59 per cent. The combined per cent of calcium and magnesium in the "Alite" clay is 7.10 per cent. From this it is concluded that the Mankato clays are free enough from calcium and magnesium pebbles to render them useable for all clay products with a minimum danger of pitting or rupture.

The results of the experimental work done at Mankato State Teachers College reveal interesting commercial possibilities for the clays. It was found that the clays can be made into many desired products. The fired articles can be glazed. In addition, they will withstand any pressure to which they may ordinarily be subjected. There is little loss from internal rupture. In short, the clays in the Minnesota River Valley in the vicinity of Mankato are a suitable basis for the establishment of a high-grade ceramic industry.

GEOLOGIC MODEL CONSTRUCTION

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