THE OHIO JOURNAL OF SCIENCE

Vol. XXII MARCH, 1922 No. 5

# SOME SUB-SURFACE ROCK CHANNELS AND CAVITIES FILLED WITH GLACIAL MATERIAL.

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## DESCRIPTION OF DEPOSITS.

At Silica, in Lucas County, Ohio, about ten miles west of Toledo, is a large quarry which shows a face about twenty feet in height and about one-fourth of a mile long, extending N-S. and facing east. The strata exposed are in the upper part of the Lucas dolomite and they dip westward at an angle of about five degrees.

Along the south part of this quarry face at about 15 feet beneath the top there was exposed in 1921 a zone of light drab dolomite, three to four feet thick, containing a number of cavities that are lined and partially filled with large crystals of calcite of the dog-tooth form. These spaces, or former spaces now partly filled, commonly appear as lense-shaped in the quarry face and are one to three feet long and six to twelve inches high.

Associated with the dolomite and calcite of this zone there is a considerable quantity of fine grained silt clay. Most of it is greenish or greenish-blue in color, but brown and other dark shades exist. Most of it is laminated, but some is compact without laminæ. It is very tough and when wet sticks to the hammer and tears like putty. When dry it is very hard and breaks with a direct even fracture. Most of this clay is without grit. At many places the clay rests against and fits around the projecting dog-tooth calcite crystals. It was found also in sharp lateral contact with the dolomite and even filling

small irregularities in the roofs of the former cavities. The clay exists in masses two to three feet across and in such quantity that in wet weather it causes considerable trouble in the crushing plant, because it clogs in the crushing burrs and prevents the rock from dropping into them. The larger masses are dumped to one side by the steam shovel and not loaded on the cars.

At several places sand is associated with the clay and at a few places there is gravel containing pebbles and cobbles, some of the latter being four to six inches through. The most common rock among the pebbles and cobbles is the Monroe dolomite, but basalts, granitoids and foreign sedimentaries exist. Some of the pebbles are well rounded and some are subangular. All of this material is relatively fresh. Most of the quarry face was a confused mass of blasted stone, but where the form of the clay deposits could be determined it was found that if gravel and sand exist they are at the bottom and at most places are overlaid by the clay. A few cases of very fine sand interbedded with clay exist. Surfaces of projecting dog-tooth calcite crystals are buried in the sand, which can be cleaned away from around the crystals.

One deposit in a tunnel in the rock gives such clear evidence as to deserve special notice. The rock channel is three feet six inches high and two feet wide at the widest part, and is cut across at an angle by the quarry wall. In the bottom is coarse gravel containing some cobbles up to six inches in diameter. Above the gravel is about two feet of compact, tough clay, blue in color, except for six inches at the top, which is oxidized and yellow. Above the clay is an open space about one foot high. The channel extends obliquely into the quarry wall and at a distance of about five feet it broadens out into a space four to five feet across, with about two feet above the filling of clay. Farther in, the channel narrows and the roof comes down until at a distance of about 20 feet from the quarry face there appears to be only four to six inches of space above the filling.

## ORIGIN OF DEPOSITS.

As to the origin of the clay deposits, it is evident that they did not originate by weathering in place, but have been introduced in some way. The characteristics of the clay suggest

slack-water silt deposits such as are in many cases associated with glacial deposits. The composition and shape of the pebbles and cobbles and the amount of wear show that the gravel is glacial material. How did it come to its present position fifteen feet below the surface and apparently enclosed in the dolomite? The stone above is compact, bedded dolomite without any known natural opening through it. Numerous drill holes have been sunk for blasting the stone and some of these show on the quarry face, but the silt clay is very different from the calcareous slime derived by wash from the drillings and the packing used in the drill holes is distinct from the sand and gravel filling.

The characteristics of abundant calcite, cavities more or less filled with calcite, and the enclosed silt and gravel deposits, are present along the quarry face for more than a hundred yards; that is, these are characteristics of a zone. The strata here dip west into the quarry wall at an angle of about five degrees and if this zone is projected upward it would meet the level of the general rock surface about forty-five yards east of the present quarry wall. In fact, such a position of outcrop is shown at the south wall of the quarry. The cavernous character of this zone continued to the outcrop and it was by these openings that the glacial material entered. The first material carried down and deposited was sand and gravel with cobbles. The coarser material was deposited only in or near the more open channels like the one described above. Some of the sand was carried into the smaller crystal-lined cavities and deposited around the crystals.

The deposition of the clay followed that of the sand and gravel. Much of it is laminated and the material is very fine grained, indicating deposition from relatively quiet water which apparently filled all the cavities of the zone. The deposition continued until the cavities were completely filled, even to the placing of laminated clay in small irregularities in the roofs of the cavities. At other places the cavity filling was only partial or absent entirely.

The ground water level of the region at the present time is about 15 feet beneath the surface and it is evident that these cavities go deeper than this, and in another quarry this same zone contains much calcite filling, although few open spaces, at a depth of 45 feet. It is not known to what depth the

introduced glacial deposits extend, but their presence at 15 feet below the surface and the calcite filling at greater depth show that the region was higher and the ground water surface deeper at the time of the formation of the cavernous zone and probably at the time when the gravels were carried down the passages on a general five degree gradient. The clay on the other hand gives evidence that the channels were filled with water at the time of the clay deposition. This indicates a higher water table, or deposition at the time that the region lay beneath Lake Maumee and its successors. The general similarity of these clays to the clay deposits of the old lake bottom adds support to this latter interpretation. As the waters of the lake bottom at this place were agitated, the fine silt settled down into the water of the channels beneath, which were more or less connected with the lake, and in these channels and the connected rock cavities the clay deposition took place.

Two miles north of Silica a quarry, exposing the same horizons as at Silica, shows this same cavernous zone with crystal lined cavities. A fine grained clay was observed in the cavities at eight feet below the rock surface and a workman reported that they had found some very tough and sticky clay in the cavities of this zone at 15 feet below the rock surface. This clay is undoubtedly of the same type and origin as that at Silica.

Considerable masses of tough, fine grained clay were seen associated with the loose blocks of stone on the quarry faces at the Holland quarry, seven miles south of Silica and at the France Stone Company quarry, one mile south of Monroe, Michigan. The clay was much like that seen at Silica, but in neither of these places could it be so definitely connected with a glacial origin.