CLAY PARTINGS IN GYPSUM DEPOSITS IN SOUTHWESTERN INDIANA[1]

by

JACK L. HARRISON

Indiana Geological Survey, Bloomington, Indiana

AND

JOHN B. DROSTE

Geology Department, Indiana University, Bloomington, Indiana

ABSTRACT

Gypsum deposits of Mississippian age in southwestern Indiana contain several argillaceous partings. A study of these partings was made to find out what clay minerals are present in such an evaporite association.

The most abundant minerals in the clay partings are dolomite, gypsum, quartz, illite, chlorite and mixed-layer illite–montmorillonite. No kaolinite was found in any of the samples.

INTRODUCTION

The last few years have seen the development of the gypsum industry in Indiana, and currently the National Gypsum Company and the United States Gypsum Company are removing evaporite ore by underground mining in the vicinity of Shoals, Martin County, Indiana (Fig. 1).

The evaporite strata are present as lenticular bodies up to 25 ft thick and are composed of interbedded gypsum, anhydrite and dolomitic limestone (Bundy, 1956) in the lower part of the St. Louis limestone (Mississippian, Meramec). The thickness of rocks containing the evaporites ranges from 130 to 200 ft, and averages about 150 ft in Martin County. Fig. 2 shows the generalized stratigraphic section of the lower St. Louis limestone in southwestern Indiana.

The evaporites were deposited in intrasilled basins and the evaporite cycle of marine, penesaline and marine conditions producing these beds resulted from tectonic and environmental causes (McGregor, 1954). Pinsak (1957) suggested that Silurian reefs probably influenced development of the evaporite basin in that differential compaction of the sediments deposited above these reefs gave rise to more or less positive topographic features on the sea floor during Mississippian time.

Bundy (1956) suggested that the present evaporite minerals have developed in three stages : (a) precipitation of gypsum, (b) burial and diagenesis resulting in conversion of gypsum to anhydrite, and (c) removal of overburden and exposure of the secondary anhydrite to a new equilibrium condition permitting the reconversion of anhydrite to gypsum.

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CLAY PARTINGS

The argillaceous material selected for this study was obtained in the National Gypsum Company and the United States Gypsum Company mines from the middle of the lower part of the St. Louis limestone (Fig. 2). These evaporite beds range in thickness from 8 to 20 ft. A grayish-orange very fine-grained dolomite bed about 1–2 ft thick is present in the middle of the ore bed in the National Gypsum Company mine. This dolomite layer is not present in the corresponding ore bed in the United States Gypsum Company mine.

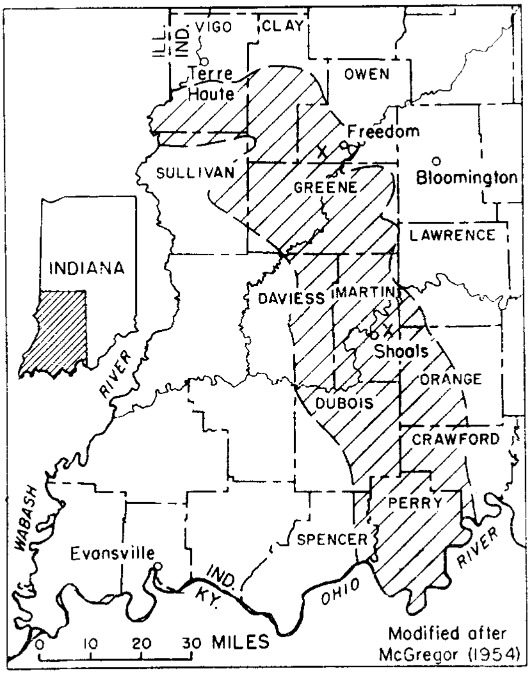

FIGURE 1.—Map showing areal extent of evaporite unit.

Dense, dark finely crystalline dolomite and dolomitic limestone are found above and below the ore bed in both mines.

The clay partings are in the upper 1 ft of the gypsum bed and directly below the overlying dolomite. The partings are dark green, olive and dark gray, and range in thickness from a fraction of an inch to 2.5 in. Most of the argillaceous material is found in a breccia composed of argillaceous fragments, but some layers of clay can be traced several feet or more. Well developed diversely oriented slickensides are common. The thin clastic layers may have been deposited in rather widespread units, but the pressure and volume changes that accompanied the transition of gypsum to anhydrite and back to gypsum have destroyed all evidence of the number and uniformity of these clay laminae. Many selenite veins ranging in thickness from a fraction of an inch to several inches cross-cut the entire gypsum layer.

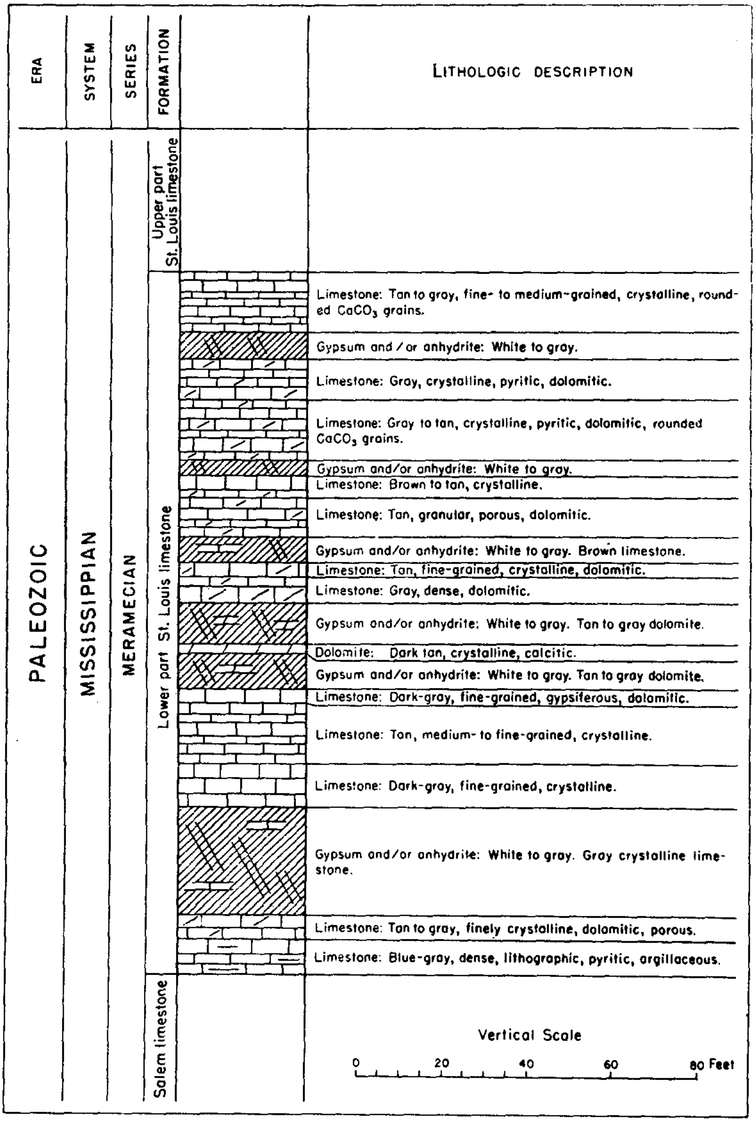

FIGURE 2.—Stratigraphic column showing position of evaporite unit in the lower part of the St. Louis limestone.

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Mineralogy

The texture and mineralogic composition of the clay partings are quite variable. Examination by petrographic microscope, x-ray diffraction and DTA shows that the minerals are gypsum, dolomite, calcite, quartz, illite, chlorite and a mixed-layer clay mineral.

Dolomite.—Dolomite is present in almost all samples and ranges in abundance from 0 percent to about 50 percent. Most of the dolomite grains are of silt size and in a few samples the fraction finer than 5μ contains more than 40 percent dolomite. Thin sections of the clay partings show abundant dolomite grains in the medium and fine silt range as well as a few fine sand size dolomite euhedra. Texturally, the clay partings consist of a very fine-grained matrix in which relatively large dolomite euhedra are dispersed.

Gypsum.—The number of gypsum crystals making up an integral part of the clay partings is not large. Locally, uniformly dispersed silt-sized gypsum grains may make up about 10 percent of the clay layer. The amount of gypsum indicated by x-ray and DTA is misleading for it is difficult to separate particles that do not contain some secondary gypsum crystals and selenite veins. No anhydrite was found in the upper 1 ft of the evaporite bed.

Quartz.—Quartz is present in all samples studied and ranges in abundance from about 15–30 percent. The quartz grains are almost entirely within the silt sizes and equally dispersed throughout this size range.

Illite.—Illite is the dominant clay mineral present in all samples. The mineral is well crystallized and makes up more than 60 percent of the clay sized minerals.

Chlorite.—Chlorite is present in all samples and does not amount to more than about 30 percent of the clay-sized material of any sample. In some samples the 001 reflections of chlorite are unaffected by heating to 450°C while in others these reflections are modified by thermal treatment, indicating that the organization of this mineral is better in some samples than in others.

Mixed-layer material.—As much as 10 percent mixed-layer mineral is found in the clay partings. A small diffuse band appears in some of the x-ray diffraction traces of the untreated samples on the low-angle side of the illite peak between 11 Å and 13 Å. The band disappears upon heating the clay to 450°C and the 10 Å peak increases in intensity. The band also disappears upon ethylene glycol treatment and a weak diffuse band appears between 15 Å and 16 Å. This evidence indicates that the mineral is probably a random mixing of illite and montmorillonite.

DISCUSSION

This study is a part of a larger investigation of the argillaceous rocks of Mississippian age in Indiana and adjoining states in the Illinois Basin. Preliminary results from the examination of several hundred samples of Mississippian argillites indicate several generalities.

Mississippian rocks in Indiana are divided into four series (from oldest to youngest): (1) Kinderhook, (2) Osage, (3) Meramec and (4) Chester. The

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shale and limestone beds that compose the Kinderhook attain a maximum thickness of 20 ft. The Osage rocks are almost entirely deltaic and include sandstone, siltstone and shale, as well as a small amount of limestone; maximum thickness of the series is 845 ft. The Meramec series is a succession of dolomitic, cherty, gypsiferous limestone beds that contain some intercalated shale. The Meramec has a maximum thickness of 525 ft. The Chester rocks are a succession of interbedded limestone, shale and sandstone, and the sequence has a maximum thickness of 550 ft.

Illite and chlorite are found in all rocks of Mississippian age in Indiana. Kaolinite is found in rocks of Osage and Chester age and is the dominant clay mineral in many Chester formations. As yet kaolinite has not been detected in the cherty and gypsiferous dolomite and limestone beds of Meramec age except at the very top.

Many workers have indicated that kaolinite may not form in a basic environment, particularly where concentration of Ca^{2+} is high. Others suggest that the clay minerals found in sedimentary rocks reflect the clay mineral composition of the source rocks. The absence of kaolinite in the carbonates of Meramec age may indicate either that kaolinite, if deposited, did not remain after deposition in the high-Ca^{2+} environment or that kaolinite was not present in detritus derived from the source rocks. In Indiana, the Silurian Waldron shale, which is an argillaceous dolomite in places and a dolomitic argillite in others, contains significant amounts of kaolinite. Thus, it appears possible for kaolinite to exist in an environment that has abundant Ca^{2+} and Mg^{2+}.

From the general history of the rocks of southwestern Indiana, it appears that all the clastics in the Mississippian rocks came from the same general source area, but this does not mean that the source area contributed the same clay mineral assemblage throughout Mississippian time. The clay minerals in the gypsum beds are thought to reflect the sediment contributed by the source area to a greater extent than they do the environment of deposition.

Some of the dolomite, particularly the exceedingly fine-grained dolomite found in the clay partings in the gypsum, may be primary dolomite. The influx of the fine-grained clastic material which produced the clay laminae may have disturbed the equilibrium just enough to precipitate dolomite rather than gypsum. Alderman and Skinner (1957) report that primary dolomite is forming in South Australia at the present time in an environment that probably is similar to that of early St. Louis time in Indiana.

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