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MINERAL COLLECTING AT PENFIELD QUARRY

BY

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ABSTRACT

Penfield Quarry, Penfield, N.Y., is in the dense gray Lockport Dolomite and is operated by Dolomite Products as a source of material for road construction. A large variety of nicely crystallized minerals occur in solution vugs as well as cavities associated with corals in the upper portions of the formation. Some of the finest specimens to come from this locality are variously colored fluorite cubes, very clear gypsum, reddish brown sphalerite crystals, celestite crystals, and vugs lined with dolomite and calcite crystals. The origin of these minerals is a subject that can lead to lively discussions.

Lockport Dolomite

The Lockport Dolomite is a hard, dense, fine grained dolomitic limestone of Middle Silurian age. It is quarried and crushed by the Dolomite Products Company for use in road construction. Its resistance to erosion has led to the formation of an escarpment that is a rather prominent feature running west from Rochester to Niagara Falls where it forms the crest of the falls. From there it runs west through Ontario and Michigan. In places it is argillaceous. It is also very petroliferous and has a strong odor of crude oil when broken. Black encrustations and blobs of natural asphaltum are abundant. At Rochester the Lockport Dolomite has a total thickness of approximately 180 feet. Fossil corals are commonly found in some layers but are not easily removed from their matrix. Solution has produced cavities and stylolites which in turn have served as hosts for much of the mineralization.

Mineralization

In spite of numerous outcrops and extensive quarrying of the Lockport Dolomite, there are only certain localities that offer the variety of minerals and well developed crystals found at the Penfield Quarry. The best known of these are the Royalton Stone Quarry east of Gasport on route 31, Frontier Quarry southwest of Lockport, the piles of rubble taken from the Barge Canal excavation at the east edge of the Monroe County Airport and just west of Lockport, and the Walworth Quarry east of Rochester. The minerals described below occur as crystals and encrustations lining the inner surfaces of the solution vugs, fissures, and corals found in the Lockport Dolomite. One reason that the mineral specimens from these localities have been very popular among collectors is the fact that they have formed as crystals growing rather freely into solutions that filled these spaces. The sequence of crystallization among the minerals has resulted in particularly interesting relationships. For instance, calcite crystals are commonly found on top of the dolomite crystals whereas dolomite crystals are commonly found embedded in clear gypsum. The availability and quality of the minerals at the Penfield Quarry vary considerably with time as the quarry workings traverse certain zones.

Anhydrite $CaSO_4$ Orthorhombic mmm

Light blue masses often found completely filling vugs and enveloping other minerals, commonly mixed with fine grained white gypsum. These masses are often found to be somewhat foliated. The gypsum may be an alteration of the anhydrite.

Aragonite $CaCO_3$ Orthorhombic mmm

Sometimes found as white crusts.

Barite $BaSO_4$ Orthorhombic mmm

Distinguished from the more common celestite with certainty only by flame tests or X-ray diffraction. It has an occurrence similar to that of celestite.

Calcite $CaCO_3$ Trigonal $\bar{3}$ 2/m

Scalenohedral crystals (dog tooth) are sometimes found as large as 15 centimeters; more commonly 2-5 centimeters. Also occurs as beautiful micro-crystals of rhombohedral habit and unusual clarity associated with marcasite on the dolomite. Scalenohedral crystals commonly occur on the dolomite oriented in such a way as to permit firmly attached doubly terminated specimens. Best large specimens are found in dolomite-lined vugs with little else present.

Celestite $SrSO_4$ Orthorhombic mmm

Light blue to white to colorless, translucent to transparent, elongate crystals. A light blue color is fairly indicative of celestite. The colorless crystals may be barite. Often found enveloped by gypsum; beautiful specimens with celestite penetrating transparent gypsum can be found. Crystal size from millimeters to approximately 0.3 meters.

Dolomite $CaMg(CO_3)_2$ Trigonal $\bar{3}$

Nice translucent white rhombohedral crystals with curved faces lining cavities are a certain find for anyone visiting Penfield Quarry. Crystals are commonly 0.5 - 1 centimeter in size and situated so as to show faces. Smaller colorless transparent rhombohedrons may also be observed with a lens and distinguished from calcite by acid.

Fluorite CaF_2 Isometric m3m

The most prized specimens from Penfield Quarry are those with free-standing fluorite cubes. They range in size from less than a millimeter to approximately 10 centimeters on a side, though most are in the 1 - 2 centimeter range. Color ranges from colorless to yellow to green to blue to purple making these especially attractive specimens. Many of the examples exhibit especially fine banding which can be seen in three dimensions within the crystals. The best crystals are found free-standing in vugs lined with white dolomite crystals which make the fluorite colors stand out vividly.

Galena PbS Isometric m3m

Rare. Occurs imbedded in the gray dolomite rock, more rarely as free standing cubes in cavities.

Gypsum $CaSO_4 \cdot 2H_2O$ Monoclinic 2/m

Occurs as fine grained white masses as well as the selenite variety of unusual clarity. Some selenite masses are as large as 0.3 meter in length. Occasionally crystal faces can be found. Selenite commonly envelops other crystals, notably celestite and dolomite producing quite nice specimens. Both varieties of gypsum commonly fill entire cavities.

Marcasite FeS_2 Orthorhombic mmm

Small cockscomb masses and singly or doubly terminated crystals usually less than 3 millimeters in length. Most are tarnished to a brilliant iridescent blue; some are pale bronze-yellow. Usually found on dolomite crystals and sometimes imbedded in gypsum.

Pyrite FeS_2 Isometric $2/m\ \bar{3}$

Small cubes and pyritohedrons less than 2 millimeters. Other forms may be present as well. Usually brass-yellow, sometimes tarnished iridescent blue. Usually found on dolomite crystals with little else near except marcasite and colorless rhombs of calcite.

Quartz SiO_2 Trigonal 32

Skeletal masses of drusy micro-crystals. Distinguishable in hand specimens from similar masses of dolomite by sparkle and from similar masses of calcite by acid test. Hardness is not applicable because the individual crystals are of the order of tenths of a millimeter. With a hand lens and a careful eye, identification based on crystal forms is possible in some cases. All three minerals may occur together.

Sphalerite (ZnFe)S Isometric $\bar{4}3m$

Variable in color from light yellow to red to dark brown depending on iron content. Occurs as veinlets in the dolomite rock and as curved, thick, fan-shaped crystals that are free-standing in the vugs. The crystals are often a centimeter or more across.

Strontianite $SrCO_3$ Orthorhombic mmm

Sometimes found associated with celestite.

Sulphur S Orthorhombic mmm

Occurs rarely as surface coatings and masses and as micro-crystals.

Origin of the Mineralization

The mineralization in the Lockport Dolomite has all of the characteristics of the Mississippi Valley type of deposit. Ohle (1959) describes these:

1. Absence of outcrops of igneous rocks that are potential sources of the ore solutions,

2. Simple mineralogy,

3. Low precious metal content,

4. Occurrence in limestone or dolomite,

5. Bedded replacements and veins,

6. Location in passive structural regions (regions that have not undergone strong mountain building activity),

7. Relation to positive structures (these include such features as gentle uplifts and arches),

8. Evidence of solution activity.

There are many deposits in this country and around the world that have these characteristics and are classified as the Mississippi type. Of these, the one that is perhaps most like the mineralization in the Lockport Dolomite is the Tri-State district (Oklahoma, Missouri, Kansas). Specimens from the Tri-State district consist of well crystallized dolomite, sphalerite, galena, marcasite, pyrite, calcite, and drusy quartz filling solution cavities and associated with corals in dolomitized limestone. Many of the relationships are the same. For instance, well formed crystals of sphalerite, marcasite, pyrite, galena and calcite occur on dolomite crystals.

There has been very little work concerning the origin of the mineralization in the Lockport Dolomite. However, there have been extensive studies done on the other Mississippi Valley deposits, especially those in the Tri-State district. These have led to a controversy that still continues today. Ohle (1959) gives the following proposed origins:

1. Original deposition

2. Original scattered deposition with modification by regional metamorphism

3. Original scattered deposition with modification by circulating ground water moving up

4. Original scattered deposition with modification by circulating ground water moving down

5. Deposition from fluids of igneous derivation with hydrothermal or gas transport either with volatile aid or simply as metallic vapor.

He dismisses the first because it could not account for veins and beds of galena and sphalerite inches thick. He dismisses the second explanation because it would call for deposits in the Precambrian rocks that were the source of the lead and zinc. No such potential source has been found in the exposed Precambrian rocks. He questions 3 and 4 on the grounds that in southeast Missouri faulting has cut up the areas in such a way as to reduce the size of the potential metal "gathering ground". He questions just how efficient ground water can be in leaching metals from limestone. Observations of present-day leaching indicate that it is quite limited. He also questions the mechanisms that cause precipitation. Organic matter has been suggested but there are deposits where no organic matter is found. Another objection to ground water emplacement is the depth of some of the deposits, 1500 feet in Missouri, 2000 feet in Tennessee, 5000 feet in Kansas.

In spite of these objections, the ground water hypothesis cannot be rejected. Deep circulating ground water could become quite warm and have many of the characteristics of hydrothermal mineralizing solutions of igneous derivation. The fifth hypothesis, mineralization by hydrothermal solutions of igneous origin, can explain such features as variation in mineral composition from area to area and pressure motivation for circulation. If these deposits do have such an origin, they should be classified as epithermal or telethermal since they exist at such large distances from any known igneous source for the minerals. A puzzling aspect of a hydrothermal origin is the extensive areas that have virtually identical mineralization, in some cases hundreds of miles across. This implies either a large area of igneous activity at depth that is able to produce solutions of remarkably uniform composition over a large area or it requires extensive circulation in the sedimentary rocks themselves.

Bastin and Behre (1939) and Bateman (1955) give evidence for a hydrothermal origin of the Tri-State deposits:

1. Bubble inclusions in sphalerite and galena contain 12 to 25 grams of NaCl per 100 cc of water as compared with an average of 3.5 grams per 100 cc in sea water. This seems inconsistent with concentration of the minerals by fresh ground water if the trapped inclusions represent the mineralizing solutions.

2. The bubble inclusions have been used to determine that the temperature of crystallization was 115° to 135°C. In this determination it is assumed that the mineralizing solution was trapped in the bubble as the crystal formed and that the liquid completely filled the bubble. As the crystal cooled the volume of the liquid decreased and its capacity for keeping gases in solution decreased, thus gas separated from the liquid inside the bubble inclusion. The process can presumably be reversed simply by heating the crystal and watching the gas disappear. This was done by observing crystals of sphalerite on a hot stage under a microscope. When the gas disappeared, it was assumed to be at the temperature at which the crystal formed. The temperatures determined by this method are considerably in excess of the temperatures that would result from deep burial in a region having a normal geothermal gradient.

3. The presence of the mineral enargite has been interpreted to indicate a hydrothermal origin.

More recently there have been studies by Hagni and Grawe (1964) on mineral paragenesis in Tri-State ores from which they conclude that the deposits are due to ground water circulation and by Erickson (1965) of bubble inclusions in calcite from which he concludes that his results are consistent with either a hydrothermal origin or a ground water origin.

Platt (1949) investigated the mineralization in the Lockport Dolomite. He favored an origin by ground water concentration of indigenous minerals. He cites as evidence the presence of impervious shales above and below the Lockport and the absence of mineralization in formations above and below the Lockport. He also made spectrographic analyses that showed both lead and zinc present throughout the dolomite in concentrations that could serve as a source for the galena and sphalerite.

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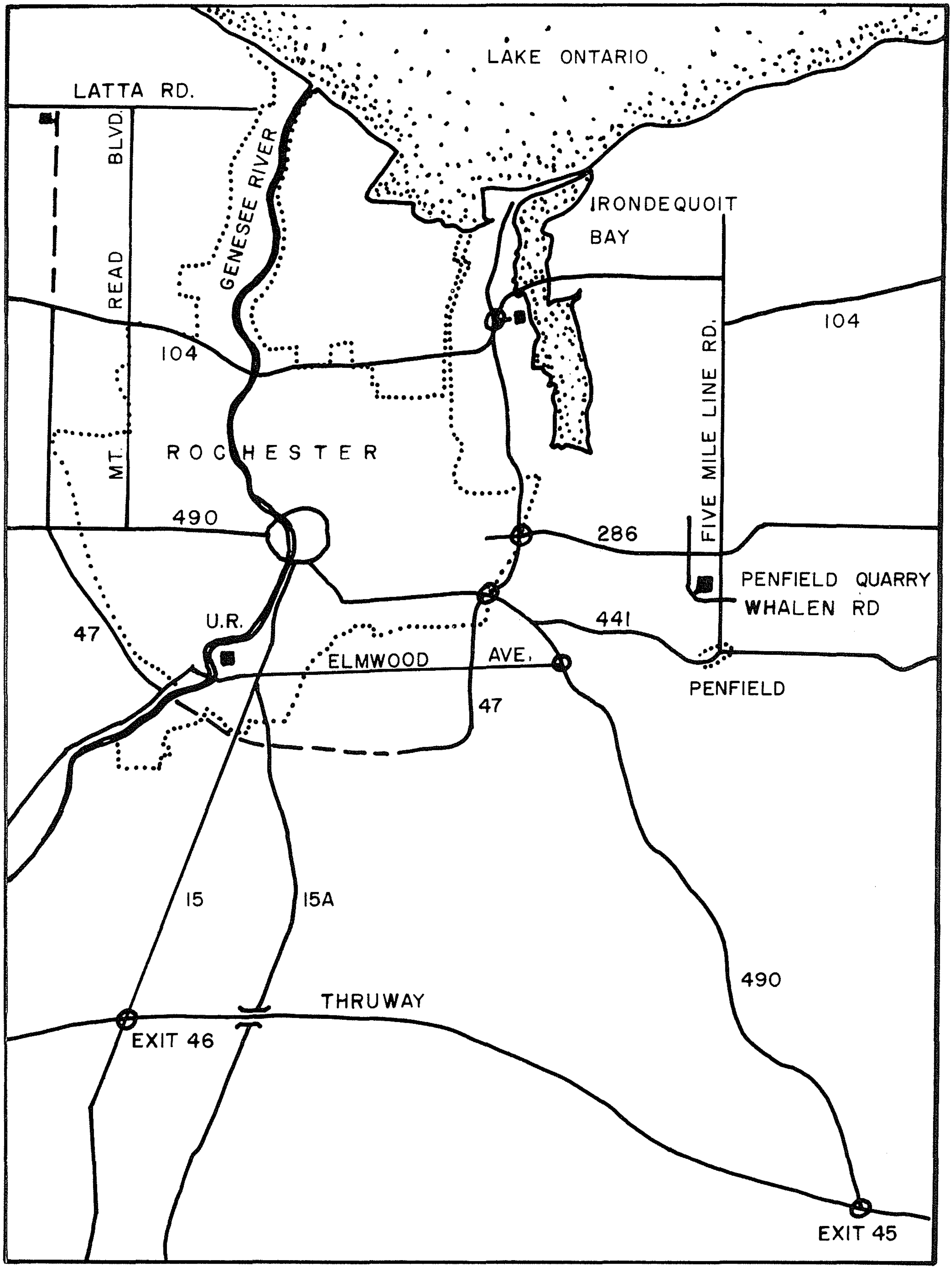
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