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GEOLOGY OF THE GOLVERNEUR QUADRANGLE

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new deposits formed of any importance, and those already existing were little modified during the interval.

Consequently the occurrence of Potsdam has little or no bearing upon the existence of mineral deposits in the underlying Precambrian. There is the same likelihood of finding them under the sandstone as in the exposed formations, other things being equal.

List of Minerals and Mineral Localities

Preliminary to the description of the deposits of economic importance, brief mention will be made of the various minerals which have been noted as native to the district and of their local occurrence. The list of mineral species for the district embraces a large number that have no special value industrially, as in fact the useful minerals generally constitute only a small proportion of those actually known. The vicinity of Gouverneur has provided a great array of minerals in the way of crystallized and uncommon physical forms, and not a little that has served as type material for purposes of scientific description or illustration, so that an enumeration of the individual species with information of their occurrence may prove serviceable to the student and collector.

In the compilation of the mineral occurrences information has been drawn to some extent from published sources, notably Dana's Manual which is valuable principally for the data about the early discoveries, from the reports of the First Geological Survey of New York State and particularly those by Emmons and Beck, and from Whitlock's New York Mineral Localities.¹ The last-named work is the most complete in its references to the mineral occurrences of the district that has appeared up to the present time. The information thus made available has been supplemented by observations in the district by the writer in the course of a field experience that extends through a period of many years.

Although attention is restricted generally to those occurrences within the limits of the map, a few localities of particular interest that are found in the bordering areas will be included, for which Gouverneur would naturally be used as a base by any one intending to visit such places.

Actinolite. This variety of amphibole occurs in characteristic development of thin bladed and fibrous crystals in the walls of the talc mines in the town of Edwards. It has the same methods of occurrence as tremolite, the common parent mineral of the talc, and

¹ N. Y. State Mus. Bul. 70, 1903.

differs in appearance only in its greenish color which is traceable to the small content of iron in ferrous form. The crystals occur in felted or matted intergrowths, as actinolite schist. The country rock is limestone, but porphyritic granite appears nearby.

Albite. Soda feldspar is present in some of the pegmatite bodies, as one of the essential constituents. It is associated usually with microcline and may be intergrown with it as perthite. One of the localities where both varieties are found in large crystals or masses is at the quarry now being worked for pottery spar on the road between Richville station and East De Kalb, 3 miles northeast of the former place.

Amphibole. The members of this mineral family are mentioned under their specific names, as far as they are recognized. (*See actinolite and tremolite.*) Various aluminous amphiboles are represented, of which the exact composition and type has not been determined. One of the common forms is of greenish color in prismatic shapes, to be classed probably with the variety pargasite. It is found in the limestones, often associated with tremolite and diopside. Localities are the Calvin Mitchel farm in East De Kalb, the zinc mines at Edwards and the vicinity of Talcville. Darker green or black amphibole is an important ingredient of the gneisses; one of the gneissic rocks developed on the borders of the Edwards limestone belt consists largely of this mineral and is described in the first part of the report under the name "amphibolite." It is believed to be derived from gabbro, in which case the amphibole is probably derived from an aluminous pyroxene. Black or green amphibole is also an accompaniment of some of the Grenville schists.

Apatite. Crystals of apatite, greenish or reddish in color, small to fairly large in size, occur in the crystalline limestones, notably in the marble quarries north and south of Gouverneur. The quarries just southwest of the town have supplied examples of the usual six-sided prisms, terminated by the unit pyramid, 4 to 6 inches long. Beck¹ records a crystal nearly a foot long and weighing 18 pounds from the Robinson farm, town of Hammond, which is outside the limits of the map. This locality is perhaps the same as that listed by Whitlock as near DeLong's mills.

Asbestos. Fibrous tremolite, or brittle asbestos, is not uncommon in the walls of the talc mines, one or both of which may be constituted of tremolite schist. It is also to be seen in other limestone areas, as a development of the normal tremolite. The flexible

¹ Mineralogy of New York, 1842, p. 282.

asbestos, or chrysotile, is an occasional accompaniment of the massive serpentine disseminated through the Edwards limestone. The occurrences are of no commercial interest.

Barite. In the zinc ores of the Edwards district barite is generally present in the form of small crystals or grains (intergrown with the calcite. In the ore-forming process it has been partly replaced by the sulphide minerals. The presence of barite is not easily detected in the examination of the ore although it shows readily on crushing and separation as practised at the mill of the Northern Ore Company, which reports the presence of 1 to 3 per cent of barite in the run-of-mine product. Large crystals are reported to occur at Osborn lake, in the western part of De Kalb township.

Biotite. This occurs widely in the granites, pegmatites and gneisses of the district as an essential component. Large plates are obtainable in the coarse-grained rocks. It has no commercial value for electrical purposes owing to the iron content and is too nearly opaque to be useful for stove mica.

Calcite. Although abundant in the limestones and marbles of the district, good crystallized specimens are not common. The noted localities, of which there are many in western St Lawrence county, are all off the Gouverneur sheet; the Rossie and Hammond lead mines which are reached in a short drive from Gouverneur, have provided great quantities of crystallized material, some clear and almost of optical grade. Descriptions of these will be found in Whitlock's *Calcites of New York*.¹

Chalcopyrite. This is an occasional ingredient of the pyrite deposits, but never an important one.

Datolite. The only occurrence that has been noted is on the Calvin Mitchel farm, in the town of De Kalb, mentioned in the following paragraph. It is rather uncommon at that place.

Diopside. Green pyroxene belonging to the diopside species is prevalent as small disseminated crystals or aggregates in the limestones, particularly those of the Edwards district. It is the parent mineral of the serpentine, characteristic of much of the limestone, and in thin section is observed to occur as nuclear particles surrounded by serpentine.

Transparent, well-formed crystals of gem quality occur on the Calvin Mitchel place, 3 miles northeast of Richville Station, town of East De Kalb. The prismatic crystals measure as much as 2 or 3 inches in length by an inch across, with single terminations. They

¹ N. Y. State Museum Memoir 13, 1910

A band of very rich garnet rock, about 2 miles north of Gouverneur on the road to Peabody bridge, has been the object of some mining activity. About 1902 the Gouverneur Garnet and Lead Mining Company started operations in the locality with the purpose of producing garnet for abrasive uses. The garnet is of pinkish color and probably almandite; it occurs in round particles that average not over one-quarter of an inch diameter but are very plentifully distributed so as to constitute fully one-fourth of the entire rock mass. The other ingredients are bright green and the combination of color makes the rock a striking one when seen in fresh specimens. It is no doubt a development of the Grenville gneisses and resembles very much one of the Grenville rocks commonly associated with the graphite beds of the eastern Adirondacks. The rock is richer in garnet than that available in most places for quarrying, but the mineral is rather too fine to serve the purpose of an abrasive, after it has been submitted to the necessary reduction required for its separation. The quarry has not been worked for a number of years.

Graphite. This mineral is quite common in the sedimentary schists of the Grenville series, in which it is disseminated in small scales or flakes through the body of the schists, constituting perhaps 2 or 3 per cent of the mass. The schist belts of the Edwards-Sylvia lake district and of the Gouverneur pyrite belt exemplify this method of occurrence. It is also occasionally to be seen in the crystalline limestones or marbles. So far as is known, there are no deposits within the quadrangle that seem to merit attention from an economic standpoint; only one or two graphite deposits in St Lawrence county have been worked to any extent, the principal operations centering on an occurrence of graphite schist near Popes Mills, town of Hammond, which yields a crystalline product of finer grain than the eastern Adirondack graphite. The product from this mine has been sold for paint purposes.

Greenockite. The zinc ores from the Edwards district have been observed in a few instances to have a coating of a greenish-yellow earthy substance that reacts for cadmium and has been identified as the sulphide greenockite. It is found on the weathered joint surfaces as a bloom, the result doubtless of partial decomposition of the sphalerite which itself contains little more than a trace of cadmium. The presence of the mineral was first observed by the writer in the ores from the mine of the Northern Ore Company. Good specimens were later collected from the Rhodes prop-

erty near Talcville. No other occurrences of this mineral seem to have been recorded in the State.

Hematite. Deposits of red hematite are associated with the Grenville schists and limestones and have been the object of mining in years past. In some instances they are simply the gossan or weathered outcrop of the pyrite and pyrite-sphalerite ores; this seems to be true of the ore localities in the vicinity of Fullerville and Sylvia lake which once were worked for the supply of the Fullerville furnace. About a mile east of Fullerville, in the sand terrace which here is underlain by limestone, is an old shaft that has afforded some soft earthy and hard hematite, with more or less white quartz admixed with it. Another locality is the zinc prospect on the Dominion Company's property, just east of Sylvia lake. A soft earthy hematite was mined here some 30 years ago, the principal opening being a pit on the outcrop of a lens or shoot of the ore which in depth became charged with the sulphides of iron and zinc and thus unsuitable for smelting. Later exploration showed that the change progressed with depth, so that practically unaltered sulphides were taken in the prospect shaft at a depth of 100 feet or a little more. The occurrence of hematite within the limestone belt, may serve to indicate the presence of sulphides.

Other deposits of hematite occur in the Grenville schists, as at Ore Bed school, in the southern part of DeKalb township, and near Fowler. The schists in which it is found are pyritic, but the ore itself is free of sulphur and not apparently directly related to the pyrite. The occurrences are of little economic importance in themselves, although they illustrate a type which has played a considerable rôle in the iron industry of this section. The mines of the Antwerp district are found in association with pyritic Grenville schists and along the contact of the schists and crystalline limestone, the ore being a replacement of these rocks formed through the agency of underground circulations. The principal mines are situated along a belt that begins just north of Antwerp village and extends northeast, parallel with the R. W. & O. railroad, to near the Rossie-Gouverneur town line; they include the Dickson, Old Sterling, Morgan, Keene, Caledonia and Clarke mines, from which altogether a large quantity of ore has been mined.

Limonite. Bog iron ore abounds in many parts of St Lawrence county, where the sluggish streams and swampy areas favor its accumulation. The towns of Gouverneur, Fowler, Canton, and Brasher have yielded furnace material in some quantity during the

time when local smelting operations were in progress 40 or 50 years ago. Limonite of spongy nature occurs as gossan on the outcrops of some of the zinc deposits of Edwards, notably the White property of the Northern Ore Company.

Magnetite. This mineral is an ingredient of the crystalline silicate rocks, particularly the granite and schists, but it is not known to occur in workable amount anywhere in the quadrangle. The large deposits of Benson Mines are off the limits of the map to the southeast of Edwards.

Microcline. This is an important mineral in the porphyritic granite and its pegmatite offshots. It is often intergrown with albite in perthitic arrangement, and is the principal feldspar in the quarries near Bigelow, which are described separately in this report.

Muscovite. Although this occurs in granite and to a minor extent in the pegmatites, it is not of economic importance.

Oligoclase. Occurrences of this mineral are noted in association with some of the granite and pegmatite, in the same manner as microcline, but in smaller amounts.

Pyrolusite. Good specimens of fernlike crystals of pyrolusite are found as an incrustation of the talc schist in the Edwards district. No. 2½ mine, Talleville, yields abundant specimens.

Pyrite. The occurrence of this important mineral is described separately. It is widespread in certain quartz schists of the Grenville.

Phlogopite. This occurs in small scaly crystals rather commonly in the limestone of Gouverneur and other sections, and, in larger sheets as a contact mineral associated with other secondary silicates like amphibole, wernerite, diopside and titanite. Sheets measuring 6 inches or more across were observed by the writer on the waste dumps of No. 2½ talc mine at Talleville.

Pyrrhotite. This accompanies pyrite in some of the deposits found in the Grenville schists. It is more particularly abundant in the deposits outside of the Gouverneur quadrangle and notably those at Pyrites, south of Canton, and at the Laidlaw prospects, near Oxbow, southwest of Gouverneur. It may carry a little nickel.

Quartz. Various forms occur in great abundance. It is found crystallized in vugs and fissures, and particularly in the Grenville quartz schists which constitute the wall rocks of the pyrite deposits. Handsome crystals have been taken from the mines of the St Lawrence Pyrites Company at Stellaville, near Hermon, just off the Gouverneur sheet. The crystals are simple combinations of the unit

prism and pyramid. Massive quartz, white or vitreous, occurs very widely in veins that intersect all of the rocks and are most common around the borders of the porphyritic granite. The quartz has the characters of magmatic quartz; it appears in practically pure bodies and in combination with feldspar as pegmatites of varied composition. The occurrence of quartz in the Grenville limestone where it produces banded and ribbed structures is described in the earlier part of this report. The limestone on the borders of Sylvia lake especially abounds in quartz which stands out as white hummocks and reefs above the surface.

Chert and jasper are occasionally in evidence around the zinc deposits of the Edwards district. A considerable body of chert occurs on the limestone ridge that is mined by the Northern Ore Company, just north of Edwards.

Serpentine. This mineral abounds in the Edwards limestone belt as nodules and bunches enclosed by the carbonates. Most of the serpentine, as shown by Smyth,¹ is pseudomorphic after diopside, whereas talc, the other important secondary mineral in the limestone, is derived from tremolite. A peculiar whitish serpentine, seemingly of low iron content, is found in a quarry in the limestone area near Peabody bridge, north of Gouverneur. According to local accounts, the mineral was thought to be talc and some of it was ground and sold for the same purposes for which talc is employed. It is noticeably harder than talc and has rather an oily luster.

Sphalerite. Occurrences are noted in the lead veins of Rossie and Macomb as an accompaniment of galena, pyrite and chalcopryrite. In the Edwards district it is associated with pyrite and occurs in replacement bodies in the Grenville limestones. These are described elsewhere under their own title.

Talc. One of the important economic minerals of the Gouverneur district is talc. It is reserved for special description.

Titanite. Fair-sized recognizable crystals of titanite are found in some of the limestone-granite contacts, as near the Gouverneur marble quarries south of the village and in the vicinity of No. 2½ talc mine, Talville. It is associated with diopside, tremolite, wernerite and tourmaline.

Tourmaline. This is quite common in white, brown and black crystals, as a sporadic ingredient of the limestones where it has been

¹ Genesis of the Zinc Ores of the Edwards District, St Lawrence County, N. Y. N. Y. State Mus. Bul. 201, 1918, p. 17-18.

Plate 13



Folding and banding of impure Grenville limestone, Edwards.

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¹ Genesis of the Zinc Ores of the Edwards District, St Lawrence County, N. Y. N. Y. State Mus. Bul. 201, 1918, p. 17-18.

formed by contact action with the porphyritic granite. Perhaps the best known occurrence of this type, from which have come most of the museum specimens that bear the locality name Gouverneur, is on the Reese farm, 2 miles southwest of Richville, on the Rock Island School road. It is described in some detail by Cushing on page 20. Good crystals of brown color are also to be had from the Rylestone marble quarry, southwest of Gouverneur. The black variety is a common accompaniment of the pegmatite bodies, all over the district, so widely scattered that specific mention of the localities seems unnecessary. As a constituent of the Grenville gneisses it occurs in various colors and locally may form 50 per cent of the entire rock mass. (See page 24.)

Tremolite. This member of the amphibole group is abundantly developed along the borders of some limestone areas, particularly the Edwards-Sylvia lake belt where great bodies of nearly pure tremolite in the form of crystalline aggregates appear along the contact and for some distance toward the interior of the belt. It is usually white in color and developed in long blades or needles without crystal terminations. The crystals are so interlaced that they make a very tough rock, although in the mass the latter appears to be of schistose structure. Bands of the tremolite may be traced for long distances parallel with the strike of the limestone. All of the talc mines are situated along these bands, with the tremolite forming one or both walls of the deposit.

The pink or purplish form of tremolite, called hexagonite, is a handsome mineral which occurs in the walls of the mines at Talcville, particularly on the southwestern end, and in the mines near Sylvia lake. Large masses of it are still available in the rock dumps of the old United States Talc Company's mine.

Vesuvianite. The only locality so far recorded for this mineral within the map limits, is 1 mile south of Gouverneur, probably one of the marble quarries. The locality is mentioned by Whitlock.¹

Wad. This mineral is found in association with bog limonite in some of the Edwards and Gouverneur occurrences.

Wernerite. Sporadic occurrences of wernerite as a contact mineral are reported in the Grenville limestones. It is observed at Talcville and in the Gouverneur marble quarries.

¹ New York Mineral Localities. N. Y. State Mus. Bul. 70, 1903, p. 78.