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PRELIMINARY REPORT ON THE EASTERN PART OF THE NORTHWESTERN ADIRONDACK MAGNETITE DISTRICT, NEW YORK

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Introduction

The Geological Survey, United States Department of the Interior, during the field season of 1943, started geologic mapping of parts of the Stark and Cranberry Lake quadrangles that lie within the eastern half of the northwestern Adirondack magnetite district. The work is not complete, but, in view of the current interest in this area and the pressure for the development of additional iron ore deposits in the Eastern States, a preliminary geologic map based on the work so far done has been issued and this text has been prepared to accompany it.

Most of the known magnetite deposits of the northwestern Adirondacks lie within a circle that has a radius of about 12½ miles and an area of about 500 square miles. This area is shown on the Stark, Russell, Oswegatchie, and Cranberry Lake quadrangles of the U. S. Geological Survey. Geologic maps of the Russell and Oswegatchie quadrangles have already been published by the New York State Museum (Albany, N. Y.).

It has been known for over a century that magnetite deposits occur in the pre-Cambrian rocks of the northwest Adirondacks. Three of these deposits—at the Benson, Clifton, and Jayville mines—were mined for short periods in the past. Two of them, the Benson and the Clifton, have recently been again brought into production, and renewed attention has thus been directed to the district.

Much of the area in which the bedrock geology seems favorable to the occurrence of magnetite bodies is covered by a veneer of deposits from the Pleistocene glaciers and their melt-waters. The authors do not know of any magnetite body that has been located in the Adirondacks during the last fifty years by discovery of outcropping ore. Owing, however, to their highly magnetic nature, some concealed deposits of magnetite can be located by means of the dip needle, and it is by systematic magnetic surveys that new ore bodies are most likely to be found. But in order that magnetic methods may be applied without waste of effort, geology should first do all it can to outline the areas in which bodies of magnetite are likely to occur.

Regional geology of the northwest Adirondacks

Favorable areas for prospecting can be roughly blocked out by considering some features of the regional geology that are shown on the accompanying sketch map (fig. 1). The area represented in that map includes parts of two physiographic provinces--the St. Lawrence Lowlands and the Adirondacks. The St. Lawrence Lowlands are bounded on the northwest by the St. Lawrence River, and on the southeast by a line running west of Parishville and through Natural Bridge, Harrisville, Russell, and Colton. In these lowlands about 70 percent of the rock consists of Grenville metasediments, including limestone, quartzite, gneiss, and migmatite. Only about 30 percent of the area is occupied by igneous intrusives.

Southeast of the St. Lawrence Lowland lies the core of the Adirondacks. There igneous intrusives--chiefly granite, syenite, gabbro, and anorthosite--predominate, and belts of Grenville metasediments occupy only about 20 percent of the surface. A major feature of the part of the core in the northwest Adirondack magnetite region is a belt of old granite gneiss with coarse phacoidal structure--made up, that is, of almond-shaped bodies. This gneiss constitutes a large complex anticlinorium, which plunges beneath the surface at the south and extends northeastward far beyond the limits of the area. This core of old phacoidal granite is flanked on each side and at the south end by a younger granite, intruded into Grenville metasediments and enclosing belts of them that have been dismembered and distorted in the process of intrusion. The magma that formed this younger granite is thought to have also yielded the solutions that introduced large quantities of iron combined in sulfides and in magnetite.

The iron-rich mineral deposits in the northwest Adirondacks lie in three northeasterly-trending belts of markedly different geologic character.

At the northwest, within the St. Lawrence Lowland, where Grenville rocks predominate, there is a belt about 40 miles long and three to four miles wide, passing through or near to Pyrites, Hermon, Gouverneur, and Antwerp, in which there are numerous deposits of pyrite and pyrrhotite, which partially replace Grenville feldsphatic-quartzose gneisses. These deposits contain about 20 percent of iron in the form of iron sulfides, and it is mainly for their sulfur content that they have been extensively worked in the past, at the Pyrites, Stella, and Cole mines.

The middle belt, passing through Parishville, Russell, Degrasse, Fine, and Jayville, lies between the old phacoidal granite gneiss on the east and the St. Lawrence Lowlands Grenville belt to the northwest. In this belt there are magnetite prospects, but as yet no large commercial deposit has been developed.

In the third belt, east and southeast of the belt of old phacoidal granite gneiss and parallel to it, three magnetite deposits are being worked commercially in the Clifton, Parish, and Benson mines. This belt also contains a promising but undeveloped magnetite deposit, known as the Ross.

The mineralogic differences between these three belts indicate that the belts represent horizons that, at the time of mineralization, were increasingly deeper and hotter from northwest to southeast. In the St. Lawrence-Grenville belt, at the northwest, the iron is combined as sulfide; in the middle belt there is much magnetite but that which is known is not in large deposits, and in the southeastern belt there are large magnetite deposits that are being mined. It thus appears that commercial iron deposits, consisting of magnetite rather than iron sulfides, are most likely to be found in relatively thin layers of Grenville metasediments, enclosed in the broad belt of younger granite, rather than in the St. Lawrence Lowlands, where Grenville metasediments predominate, and the granite is subordinate. Still farther to the south and southeast, deep within the interior of the Adirondacks, only a few deposits of nontitaniferous magnetite have been found. As workable deposits of magnetite have certainly been looked for in this area, failure to find more of them seems to indicate the possibility that, because of something unfavorable in the geology, few of them have been formed.

Geologic history

The oldest rocks in the area are the Grenville metasediments, which are the metamorphosed and partly granitized equivalents of shale, sandstone, graywacke, calcareous shale and sandstone, and limestone. These sedimentary rocks were first intruded by sheets and lenses of gabbro, now thought to be represented in large part by amphibolites, and then by widespread intrusion of thick sheets of more siliceous magmas, which make up a series ranging from dark pyroxene-rich syenite, through green quartz syenite, to very coarse hornblende granite (now phacoidal granite gneiss). This complex of sedimentary beds and intrusive sheets was subjected to orogenic stresses and strongly deformed and folded. Next followed the intrusion of the younger granitic magma. The younger granite of the Stark and Cranberry Lake quadrangles is but a small part of a huge mass at least a hundred miles long. In part this granite cuts across the structure of the older rocks; but much of it is conformable with the older structures and forms sheets, lenses, and phacolithic masses in the Grenville metasediments. During and subsequent to the emplacement and consolidation of this younger granite magma, much of the granite itself, as well as the older rocks, was subjected to renewed deformation. The younger granite therefore usually has a gneissoid or gneissic structure. The latest period of intrusion is represented by a diabase dike which cuts the granite about a mile east of Newbridge.

CCC Grenville belt

The geologic sketch map of the northwestern Adirondacks (fig. 1) shows a long tongue of the old phacoidal granite gneiss, partly surrounded on the flanks and south nose by younger granite, which in turn is partly surrounded by Grenville metasediments. On the northwest flank of the anticline the metasediments are broken into many isolated lenses. As the eastern limb of the irregular U-shaped belt of Grenville metasediments lies in the townships of Clifton, Clare, and Colton, it may be called the CCC Grenville belt. It lies almost wholly within the Stark and Cranberry Lake quadrangles.

The Grenville metasediments are extremely varied in character. They comprise medium-grained quartzite, which is in part fairly pure but mostly feldspathic or pyroxenic or both; biotitic gneiss, which is similar in composition to granite but more strongly foliated and much darker in color because of abundant biotite; sillimanite-biotite schist intercalated with the biotitic gneiss and locally grading into pink sillimanitic gneiss of granitic composition; beds of amphibolite consisting of hornblende and plagioclase with more or less pyroxene; pyroxene skarn, here commonly a granular aggregate of pyroxene, usually associated with a little sulfide, believed to have been formed by metasomatic replacement of limestone; coarsely crystalline limestone, usually containing disseminated silicates; and migmatities, which consist of any of the preceding rocks except limestone, with injections of granite pegmatite along the foliation planes. Some of the rocks mapped as Grenville metasediments are probably granite with some biotite, garnet, or sillimanite derived from incorporated metasediments, and the Grenville metasediments have in part been substantially modified by granitization.

The quartzitic rocks appear to predominate, especially the feldspathic and pyroxenic facies. The biotitic gneisses are locally garnetiferous. They are well exposed on the outer borders of the Parish and Granshue synclines, described below. Sillimanite granite was especially noted in boulders, some of them at the old road crossing of the Oswegatchie River northwest of Dillon Pond, in the Cranberry Lake quadrangle, and some of them in the drift on the hills shown just north of the "e" in the name "Pleasant Lake Brook" on the Stark quadrangle. The pyroxene skarn is locally in intercalated beds with other types of metasedimentary rock or included in the granite. Limestone has been found at only two localities, one on the north side of Marble Mountain, in the Cranberry Lake quadrangle, and the other about 3/4 mile southwest of Deerlick Rapids, in the Stark quadrangle. Granite pegmatite is usually injected in subordinate amount along the foliation planes of all of the rocks except limestone.

The belts mapped as Grenville metasediments include minor intrusive sheets and lenses of granite that are not distinguished on the map.

Structure

The geologic structure of the region is very complex. The simplest cross section that it seemed possible to draw is the one across the central part of the Stark quadrangle (see sec. A-B-C). At the extreme northwest, beyond the North Branch of the Grass River, this section crosses a belt of Grenville metasediments, which lie on the north limb of a great anticlinorial core of the old phacoidal granite gneiss, from which they are locally separated by sheets of the younger granite. Along the southeast limb of the gneiss is a sheet of younger granite, and southeast of this is the east limb of the Grenville belt. The Grenville rocks are here split into two belts by an anticlinal mass of the younger granite, the anticlinal structure of which is best shown at the south end, near Spruce Mountain. At the north the granite has a uniform nearly vertical dip. The anticline of younger granite is flanked on both sides by synclinal belts of

Grenville metasediments, which are isoclinally folded and in general nearly vertical. The western belt of Grenville rocks may be called the Parish syncline and the eastern one the Granshue syncline. The latter is well defined between Tunkethandle Hill and Ormsbee Pond, but its possible extension to the south is largely covered with glacial deposits. East of the Granshue syncline is another mass of granite, folded into an anticline, the axis of which nearly coincides with Webb Creek. This anticline, in turn, is flanked on the east by a broad synclinal structure in granite that incloses layers of amphibolite. The amphibolite in these layers is thought to be metamorphosed gabbro, although the layers of amphibolite enclosed in the granite of the west limb of the Webb Creek anticline are thought to represent metamorphosed Grenville beds.

The belt of Grenville metasediments in the Cranberry Lake quadrangle is so disturbed by intrusive bodies of younger granite that its structure has not been deciphered.

The linear structure in the rocks of the northern third of the Cranberry Lake quadrangle, wherever it has been observed, uniformly strikes and pitches southeast to east-southeast. The phacoidal granite gneiss in the western part of the Stark quadrangle has a marked linear structure, which strikes and pitches northeast to east-northeast. These two structures, though oriented at such large angles to each other, apparently conform in general with the strike of the folds in the respective areas. Two quite different structural trends thus merge in this region, and the resulting structural relations are highly complicated.

Magnetite deposits

Practically all of the known magnetite deposits in the northwest Adirondack magnetite district are directly associated with Grenville metasedimentary layers or are enclosed in granite contaminated with garnet, biotite, sillimanite, pyroxene, and other minerals derived from the Grenville metasediments. The magnetite deposits are therefore interpreted as resulting from partial to complete replacement of the Grenville rock by mineralizing solutions, which are thought to have originated in the magma that yielded the great masses of younger granite. The ore bodies, at the Parish and Benson mines, for example, lie within belts of Grenville metasediments. The Ross deposit replaces a thin tabular layer of Grenville metasedimentary rock that is enclosed in granite but lies close to the border of a major belt of metasediments. The Clifton and Jayville deposits both replace tabular layers of Grenville metasedimentary rock that are wholly enclosed in granite and far from any exposed major belt dominated by Grenville metasediments. The Benson mines and Parish magnetite deposits replace feldspathic-quartzose gneisses of the Grenville series, and the Clifton and Ross deposits replace pyroxene skarn—a granular aggregate of pyroxene derived from limestone layers in the Grenville. In general, the micaceous feldspathic and quartzose gneisses containing pyroxene and garnet and the pyroxenic skarn layers of the Grenville series appear to have been the most favorable host rocks; they evidently were more easily replaced than the dominantly siliceous quartzites.

Possibilities for new discoveries

Nearly all of the magnetite deposits in the Adirondacks that are known today were also known a century ago. As D. H. Newland*/ has well said, "The favorable ground for development was sought out by the early prospectors who seem to have penetrated into the most remote parts in the search and to have made good use of the dip needle and compass by which the location of highly magnetic bodies like these is a comparatively easy matter." He adds, "it is probable that future exploration will result in the addition of new deposits to the list; but it can hardly be expected that the discoveries will compare in importance with those already made."

If new deposits are found in the future, it is likely again to be by means of systematic dip-needle surveys. The magnetic work should be concentrated in areas that, on the basis of our knowledge of the local geology and of the mode of occurrence of the known magnetite deposits, appear to be specially favorable. Some apparently favorable areas in the Stark and Cranberry Lake quadrangles are as follows:

(1) The entire CCC belt of Grenville metasediments (GvM on map) is well worthy of systematic prospecting, in view of its containing known magnetite deposits (Benson mines, Clifton, Parish, Ross), of the known presence of several other zones of magnetic anomalies, of the nature of its geology, and of the relations of the local geology to the regional geology.

(2) On the west flank of the CCC belt of Grenville metasediments there is a zone of granite with numerous included tabular layers of Grenville metasediment, (GrGv on map), which is deemed worthy of systematic prospecting.

(3) Farther to the west, on the east flank of the anticlinal core of old phacoidal granite gneiss, is a belt of relatively uniform granite. This belt contains the Clifton ore body, and although the number of included layers of Grenville metasediment is very much smaller than in belt 2, such layers as are present may contain magnetite deposits; this belt is also worth prospecting.

(4) The margins of granite masses adjacent to belts of Grenville metasediments constitute favorable areas for prospecting. The borders of the granite lenses within the Grenville metasediments on the Cranberry Lake quadrangle, and the adjacent zone of granite around the Granshue syncline of metasediments, would belong in this category. Locally, zones of the granite itself may be substantially impregnated with magnetite, especially where the granite forms relatively thin lenses or sheets within the Grenville.

No magnetite deposits are known to occur in areas underlain by large masses of uniform granite, by granite associated with subordinate amphibolite, or by amphibolite with subordinate granite, where no evidence has been found

*/ Newland, D. H., Geology of the Adirondack Magnetic Iron Ores, N. Y. State Mus. Bull. 119, p. 24, 1908.

that Grenville metasediments ever were present. The chances of finding commercial magnetite deposits would obviously be less in such areas than in the belts above listed as favorable. Local magnetic anomalies have been reported, however, in these areas, and it is therefore not beyond the bounds of possibility that these areas may contain minable deposits. Nevertheless it would seem wise to concentrate exploration first on the belts for which the evidence is more positively favorable.

No magnetite deposit has been reported in the area underlain by the old phacoidal granite gneiss, in the Russell, Stark, Nicholville, or Childwold quadrangles. This belt is therefore considered to be poor prospecting ground. The Jayville deposit, however, in the Oswegatchie quadrangle, occurs in phacoidal granite gneiss near its contact with the younger granite. If other magnetite deposits occur in this gneiss, they would probably be near its borders, where included layers of Grenville metasediments, mineralized and replaced by solutions from the younger granite magma, would be most likely to occur.

The belts of syenite and quartz syenite are likewise considered to be poor prospecting ground, and, furthermore, any iron-rich segregations in them are likely to be relatively high in titanium.

A substantial percentage of the magnetite deposits indicated by newly discovered magnetic anomalies may be expected to be non-commercial. Drilling of the ground showing the stronger and more persistent anomalies will be necessary to prove the existence of workable ore bodies.

Parts of the belts on the Stark and Cranberry Lake quadrangles suggested as relatively favorable have already been systematically surveyed for magnetic anomalies by the local operating companies, but much more work of this kind remains to be done.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP

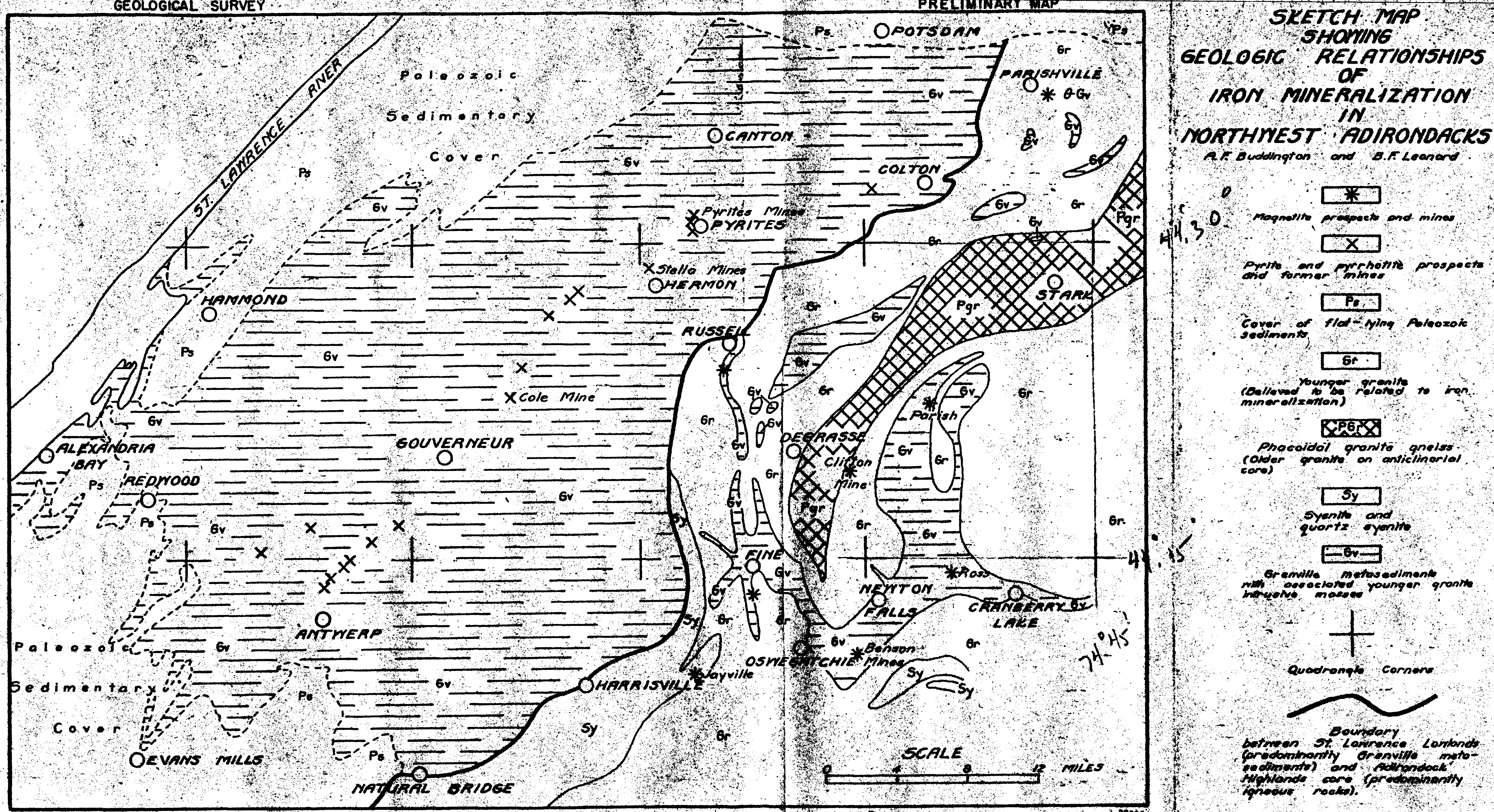

Figure 1.

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