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Geology of an area near Randville, Michigan

by

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Extension of Work

The work conducted in the Randville, Mich. area during the summer of 1946 was a continuation of that begun in 1945, and the same methods were used.[1] From secs. 5 and 7, T. 41 N., R. 30 W., Dickinson County, mapping was extended into the adjoining secs. 6 and 8, then eastward into secs. 3 and 4, and secs. 33, 34, and 35, T. 42 N., R. 30 W., all in Dickinson County, and westward into secs. 11 and 12, T. 41 N., R. 31 W., Iron County (fig. 1). Both iron-formation and quartzite were mapped almost continuously throughout this entire distance, the iron-formation chiefly from magnetic data, the quartzite from numerous outcrops and magnetic data.

1/ Lamey, Carl A., Geology of an area southwest of Randville, Dickinson County, Michigan: U. S. Geol. Survey open file report, released April 19, 1946.

Exposures mapped

Exposures mapped during 1946 include numerous outcrops of quartzite, one small but apparently critical outcrop of mica-garnet-grunerite schist in sec. 35, a number of exposures of Randville dolomite in secs. 34 and 35, some outcrops of dioritic rock cutting quartzite in sec. 8 and cutting mica-garnet-grunerite schist in sec. 35, and several exposures of granite pegmatite and of granite gneiss. The granite pegmatite cuts quartzite in sec. 33 and dolomite in sec. 35 (see pl. 1).

Age relations

Age relations are still obscure, but the following table gives those that are most likely from present evidence:

<u>Table showing probable age relations</u>

PRE-CAMBRIAN	Post-Huronian	Granite pegmatite and diorite; possibly some granite gneiss.
	Middle Huronian	Iron-formation Mica-garnet-grunerite schist; possibly equivalent to the Siamo slate of the Marquette district or the Brier slate member of the Vulcan iron-formation of the Menominee district.)
	- - - - - - - - - Unconformity - - - - - - - - -	
	Lower Huronian	Randville dolomite Sturgeon quartzite
	- - - - - - - - - Unconformity - - - - - - - - -	
	Pre-Huronian	Part of the granite gneiss

The table does not include a thin-bedded, micaceous and quartzitic slate that appears to be in fault contact with the iron-formation in sec. 5. Its presence is known only from the dumps of two shafts and a test pit, and its age relations could not be determined.

Iron-formation.— The iron-formation was early designated the "Groveland formation" and placed in the Lower Huronian,[2] but was later named the "Vulcan formation" and placed in the Upper Huronian,[3] and more recently placed in the Middle Huronian.[4] It appears likely that it properly belongs in the Middle Huronian.

Mica-garnet-grunerite schist.— The small outcrop of mica-garnet-grunerite schist in sec. 35 probably grades upward into the iron-formation, as magnetic values increase rapidly to the northward and the magnetic crest is reached 150 feet north of this outcrop. Bedding preserved in the schist dips northward, and magnetic anomalies

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2/ Smyth, Henry L., The Felch Mountain Range: U. S. Geol. Survey Mon. 36, p. 415 and pl. 46, 1899.

3/ Van Hise, C. R., and Leith, C. K., The geology of the Lake Superior region: U. S. Geol. Survey Mon. 52, pp. 302 and 306, 1911.

4/ Leith, C. K., Lund, R. J., and Leith, Andrew, Pre-Cambrian rocks of the Lake Superior region: U. S. Geol. Survey Prof. Paper 184, p. 4 and chart opposite p. 10, 1935.

indicate that the iron-formation dips northward also. Hence the schist probably underlies and grades into the iron-formation unless both are overturned, in which case the top would be to the south and the schist would lie above the iron-formation. As stated in the report released in 1946,[5] the schist probably is a metamorphosed, ferruginous and calcareous slate. Three such units are known in the general Michigan iron area: (1) the Bijiki iron-formation of the Michigamme slate, above the iron-formation; (2) the Siamo slate of the Marquette district, beneath the iron-formation; and (3) the Brier slate member of the Menominee district, between the Curry and the Traders iron-formation members of the Vulcan iron-formation. It seems likely that the schist represents a formation similar to one of these, but that it underlies the iron-formation and is of Middle Huronian age.

A schist in the Felch Mountain district, stated to underlie the iron-formation, was early designated the Mansfield schist and assigned to the Lower Huronian,[6] but was later designated the Felch schist and first assigned to the Upper Huronian [7] and later to the Lower and Middle Huronian.[7] The Felch schist was stated to be known from drill

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5/ Lamey, Carl A., op. cit.

6/ Smyth, Henry L., op. cit., p. 411 and pl. 49.

7/ Van Hise, C. R., and Leith, C. K., op. cit., pp. 302 and 306; Leith, C. K., Lund, R. J., and Leith, Andrew, op. cit., p. 4 and chart opposite p. 10.

records only, whereas the Mansfield schist was named from outcrops near the Mansfield mine, which were thought to correlate with sub-surface schists of the Felch Mountain district. The mica-garnet-grunerite schist mapped by the writer may correlate with the Felch schist or the Mansfield schist, if they are the same. The early map of the Felch Mountain district[8] shows that the Mansfield schist is known from test pits bottomed in rock, from drill holes, and from outcrops. Several test pits are shown in sec. 34, T. 42 N., R. 30 W., about three-quarters of a mile west of the small outcrop of schist mapped by the writer in sec. 35; outcrops are shown in the eastern part of sec. 35 and the western part of sec. 36; and drill holes, test pits, and outcrops in sec. 31, T. 42 N., R. 29 W., north of the Groveland mine, a little more than 2 miles east of the outcrop in sec. 35 (see fig. 1). If the Felch schist is known from drill holes only, there seems to be some doubt about its correlation with the Mansfield schist. Only additional work to the eastward, and study of all out-crops and other available data, will establish the relations between the mica-garnet-grunerite schist mapped by the writer and the Felch or Mansfield schist.

Randville dolomite and Sturgeon quartzite.— The age of the Randville dolomite and the Sturgeon quartzite has been stated as

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8/ Smyth, Henry L., op. cit., pl. 46.

Lower Huronian since the publication of the early report by Smyth.[9] There seems to be little reason to doubt this interpretation, although present mapping shows nothing from which the age relations can be determined.

Granite gneiss.— The major part of the granitic rock in this area was designated Archean in early reports,[10] but it was recognized that younger granitic dikes cut the Sturgeon quartzite, the Randville dolomite, and the iron-formation.[11] Moreover, larger masses of younger granite were mapped in secs. 19, 20, 29, and 30, T. 42 N., R. 31 W.,[12] about 3 miles northwest of the western end of the present mapped area. These outcrops are now chiefly submerged by Peavy Pond (fig. 1). The writer has suggested that this younger granite may be more extensive than was originally thought, and may have caused much of the metamorphism of the Huronian formations.[13] The problem in the

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9/ Smyth, Henry L., op. cit., pp. 383-385, 398, 406, and pl. 46.

10/ Smyth, Henry L., op. cit., pp. 385-386 and pl. 46.

11/ Smyth, Henry L., op. cit., p. 426.

12/ Clements, J. M., The Crystal Falls iron-bearing district: U. S. Geol. Survey Mon. 36, p. 190 and pl. 3, 1899.

13/ Lamey, Carl A., Granite intrusions in the Huronian formations of northern Michigan: Jour. Geology, vol. 39, pp. 289-292, 1931; The intrusive relations of the Republic granite: Jour. Geology, vol. 41, pp. 490-491, 1933; Some metamorphic effects of the Republic granite: Jour. Geology, vol. 42, pp. 256-258, 1934.

present area is to determine what part of the granite gneiss, if any, is post-Huronian and what part of it is pre-Huronian. The mere fact that it is gneiss, as contrasted with the granite pegmatite dikes, is not sufficient basis for stating that all of it is older, since granite gneiss may be formed from sediments by granite intrusion; Clements described gneisses so formed in the area to the northwest of the western end of the mapped area.14/

Some evidence tending to clarify the age of part of the granite gneiss was presented recently by Pettijohn. He described exposures in the Browning Creek area of sec. 20, T. 41 N., R. 30 W., about 1-1/2 mile south of the area mapped by the writer (see fig. 1), and concluded that the gneiss is Archean, because (1) the structure of the gneiss is beveled by the Sturgeon quartzite, and (2) one exposure shows a basal conglomerate phase of the quartzite, which rests upon gneiss.15/ The Sturgeon quartzite mapped by Pettijohn very likely is a continuation of the Sturgeon quartzite mapped by the writer as far as the south line of sec. 7. The last outcrop shown by Pettijohn is near the south quarter corner of sec. 17, and is thus about a mile south and nearly a mile east of the last outcrop mapped by the writer (fig. 1). The structure of the quartzite in both areas is the same, overturned with the top to the west. The mile difference in

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14/ Clements, J. M., op. cit., pp. 194-198.

15/ Pettijohn, F. J., Basal Huronian conglomerates of Menominee and Calumet districts, Michigan: Jour. Geology, vol. 51, pp. 394-397, 1943.

east-west direction between the two exposures could easily result from a fault or a change in strike. The last strike observed by the writer was northwest, and this strike, if continued southeast, would go far toward connecting the two quartzite exposures. Moreover, Pettijohn shows faults which would offset the quartzite in the proper direction to account for the lack of continuity. Hence it seems likely that the gneiss mapped by Pettijohn may be part of the same gneiss mapped by the writer in sec. 8 (pl. 1). In sec. 8 the foliation of the gneiss in the few outcrops mapped appears to be essentially the same as the strike of the quartzite, but the mapping done was not extensive enough to verify this point.

It appears likely that granitic rocks of both pre- and post-Huronian age are present in the general Randville area, but the distribution of each type is not certain.

Magnetic anomalies

Both the high magnetic anomalies that mark the position of the iron-formation, and the somewhat lower anomalies that mark the position of the sugary quartzite that contains magnetite octahedrons, show clearly on the magnetic map (pl. 2). Several other moderately high anomalies are present in sec. 8 south of the known area of Sturgeon quartzite. No information is available regarding the cause of the latter anomalies. They could mark other magnetic belts in the lower part of the quartzite; they could represent structural repetitions of the sugary quartzite to the north, caused either by folding or faulting; or they could represent some sedimentary formation lying beneath the Sturgeon quartzite, although no such formation has ever been described. There seems to be a slight but not marked discordance in the trend of these anomalies and the ones produced by the sugary quartzite.

It is of interest to note that the anomalies produced by the iron-formation vary in strength along the crest. Some of the lower anomalies are accompanied by overlapping and offset crests, indicating faulting. In one such case (secs. 33, 34), additional work is necessary to determine the shape of the closure of the contours,[16] as this may be significant in determining the direction of the fault. Present information points to a considerable overlap of the crests of the higher anomalies and indicates that the fault has a general northeast trend, a little more northerly than the strike of the iron-formation. Several other low anomalies along the crest show no displacement, and these may result from deeper burial of the iron-formation, a lesser degree of metamorphism, a smaller amount of iron present, or oxidation and development of hematite, which would yield very much lower anomalies than magnetite.

16/ Field work was done without the usual assistance , so magnetic traverses here were limited to the roads and the railroad grade, which normally would have been sufficient. When observations were plotted, after leaving the field, it was discovered that the area along the section line between secs. 33 and 34 is critical.

A belt of low anomalies is persistent throughout the entire distance from sec. 8 to sec. 35, and lies between the quartzite and the iron-formation. Since there are no outcrops along this belt, its significance is not clear. If the Randville dolomite is present north of the quartzite, it might yield low anomalies. So far there has been no possibility of testing the anomalies the dolomite would yield, because all outcrops of that rock in the mapped area appear to have been thrust over the iron-formation, and only high anomalies are obtained on those outcrops. The low anomalies could be caused by deep burial of the rocks, and this in turn might suggest a fault along which there had been pre-glacial or glacial erosion and later glacial filling.

Structure

The structural relations are still imperfectly known, but the additional outcrops and magnetic anomalies mapped during the summer clarify some relations.

Magnetic anomalies indicate that the iron-formation is dipping northward, probably rather steeply, as the width of the magnetic bands generally is less on the south than on the north side of the magnetic crest. Further, anomalies indicate at least three faults that displace the iron-formation. Two of these trend nearly east (see pl. 1). The third fault probably trends in about the same direction, as indicated by the apparent overlap of the magnetic crest in secs. 33 and 34. However, some additional work must be done to verify this trend or establish a different one.

Magnetic anomalies, combined with the distribution of the Randville dolomite, suggest that a thrust fault has brought the dolomite over the iron-formation in secs. 34 and 35, the thrusting being from the north. This is indicated by the high anomalies that are obtained on the dolomite outcrops, a condition that is almost duplicated in the Menominee district, where vertical drill holes passed through dolomite and breccia into underlying iron-formation,[17] showing that the dolomite had been thrust southward over the iron-formation.

The structural relations of the Sturgeon quartzite along the southern part of the area are not clear. The quartzite dips south persistently, whereas the dolomite and the iron-formation generally dip north or are vertical. The quartzite, however, is overturned, and the top is to the north and northwest. Moreover, the quartzite and the iron-formation diverge markedly toward the western part of the area. These facts could be explained by a great thickening westward of the rocks that lie between the quartzite and the iron-formation, or they could be explained by a fault, probably a thrust. If a thrust fault is present, it may well be that the central part of the

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17/ Dutton, Carl E., and Lamey, Carl A., Geology of the Menominee Range, Dickinson County: Michigan Geological Survey Division, Department of Conservation, progress reports No. 5, 1939, No. 6, 1941, and No. 8, 1942.

mapped area is part of a closely folded syncline, and that the syncline is flanked to the north by a thrust fault which has brought up Randville dolomite and perhaps some older formations, and on the south by a thrust fault which has brought up Sturgeon quartzite. This is merely a suggestion, which might serve as a working hypothesis to be tested by additional work. This hypothesis is indicated not only by the westward divergence of the iron-formation and the quartzite, and by overturning of the quartzite, but also by smaller faults that cut the iron-formation but appear not to displace the quartzite.

Evidence regarding relations between various faults and the time of granite pegmatite intrusion is not clear. At the easternmost dolomite quarry, in sec. 35, the similar or like degree of metamorphism of the dolomite, iron-formation, and mica-garnet-grunerite schist, suggests to the writer that the dolomite was thrust over the iron-formation prior to the intrusion of the granite pegmatite. The basis for this suggestion rests in the belief that the metamorphism was produced by the granite pegmatite intrusion on a much larger scale than is indicated by the dikes cutting the dolomite at the quarry, and that the age of this more extensive intrusion is the same as the age of the pegmatite dikes, but erosion has not yet uncovered the larger pegmatite mass along its contact with the dolomite. It is recognized that the pegmatite could have intruded the dolomite, and that later the dolomite and pegmatite could have been thrust into their present position, but when one considers the extremely high degree of magnetism in the immediately adjacent iron-formation to the south of these dikes, where a maximum of 85° was obtained, there is a strong suggestion of intrusion following rather than preceding thrust faulting. Moreover, the trend of the pegmatite dikes indicates that they were intruded in part along fracture zones that seem to have the same general trend as faults that cut the iron-formation at the Groveland pit farther east, where, also, there is a pegmatite dike cutting the iron-formation and following the same trend as the faults. Both the dikes and the faults cut sharply across the bedding, whereas the thrust fault in secs. 34 and 35, near Randville, appears to cut across the bedding at only a slight angle. From these facts, which need further study, it appears to the writer that the thrust faulting may have preceded the pegmatite intrusion, and that the cross faulting was later, and either slightly prior to or essentially contemporaneous with the pegmatite intrusion.

Possible distribution of ore

It seems apparent that the distribution of ore must be related to the geologic history of the region, and only by considering that history can a proper conception of the probable distribution be gained. The chief items that appear to deserve attention in the immediate area, aside from the actual method of concentration, are (1) the influence of folding, faulting, and rock character; (2) the influence of metamorphism and igneous intrusion; and (3) the relation existing between these factors and the time of ore concentration.

Throughout the Michigan area both folds and faults appear to have been important factors in bringing about concentration of ore where impervious rock was adjacent to and beneath iron-formation. Some folding and faulting preceded the principal ore concentration and were in part responsible for it, but some folding and faulting followed the principal concentration. These relations are illustrated in the Iron River, Crystal Falls, and Menominee ranges. However, another relation appears to be illustrated also in those ranges and in the Felch Mountain district. In general, although folding is prevalent in the entire area, the iron-formation contains chiefly hematite in the Iron River and Crystal Falls areas, both hematite and magnetite in the Menominee district, and chiefly magnetite in the Felch Mountain range. Moreover, the magnetism, which is comparatively feeble in the Iron River district, increases progressively through the Crystal Falls area and into the Felch Mountain range, where it reaches a maximum. The magnetism in the Menominee district is variable, but generally higher than in the Iron River and Crystal Falls areas. This general increase in magnetism from one range to another is accompanied by a change from hematite and limonite to magnetite in the iron-formation, the appearance of grunerite and other silicates in the ferruginous rocks, of silicates in the dolomite, tourmaline in some of the schists, and an increasing number of granite pegmatite dikes. That is, increase in magnetism is accompanied by contact metamorphism, which was superimposed on previous metamorphism produced during folding.

The Felch Mountain range, the one that shows the highest magnetism, has been relatively unproductive. This could be a direct result of the highly magnetic character of the iron-formation. Whether it is or is not might depend on whether the time of principal ore concentration in the region was before or after the formation of the magnetite.

If ore concentration was later than the development of the magnetite, the areas where the iron-formation is highly magnetic might be poor ore areas because of the mineralogical stability and structural competence of the iron-formation, which would not then readily yield to secondary concentration by ground water. Hence in the magnetite areas there might be only minor concentration limited to post-magnetite faults where the iron-formation had been much shattered and perhaps some secondary concentration had been possible. These areas would show relatively low magnetic anomalies along the crest of the iron-formation anomalies. Other areas of low anomalies along the cfest might result from places which had escaped much metamorphism, where little magnetite might have formed, and where consequently ore might have concentrated if structural conditions were favorable.

If the main period of concentration was before the development of magnetite, the change to magnetite should make no difference in the position of the ore bodies except insofar as they might have been somewhat enriched by a second period of concentration along faults. Hence it would seem that the places of high magnetism along the crest of the iron-formation anomalies might indicate ore concentration. This would be true only if (1) the degree of metamorphism were the same throughout the entire iron-formation; (2) the depth of burial was the same throughout; (3) there was no post-magnetite faulting which shattered the iron-formation, reduced magnetism, and perhaps permitted some secondary concentration with the development of hematite and consequent lowering of magnetism.

Within that part of the Felch Mountain district now mapped by the writer, early exploratory work was done in one of the areas of high magnetism (pls. 1 and 2), but there appears to have been no exploratory work done in the areas of low magnetism along the crest of the iron-formation anomalies. Two of these areas might be suggested for possible consideration if any exploratory drilling were contemplated. One of these is the break in the iron-formation at the boundary of secs. 5 and 6, T. 41 N., R. 30 W., and the other is in sec. 12, T. 41 N., R. 30 W. The area at the boundary of secs. 5 and 6 is small, and moreover it is farm land. The area in sec. 12 is much larger, part of it is moderately open woods, and it is relatively near a good road.

Recommendations for future work

Magnetic anomalies toward the western end of the mapped area indicate that the trend of the iron-formation is turning southward. Hence it is thought that magnetic work should be continued to the south and west through secs. 11, 10, 15, and 14, T. 41 N., R. 31 W. (fig.1). Early magnetic maps made by the Michigan Geological Survey, although not in detail, show a slight magnetic crest passing through parts of those sections. Furthermore, at least one outcrop of magnetite is shown in sec. 17, farther west, although numerous outcrops of graywacke intervene between it and the end of the magnetic anomalies in sec. 12 of the accompanying map (pl. 1) and a fault may separate the two areas.

Other Michigan Geological Survey maps show several areas of high magnetic anomalies to the north and west, in secs. 2, 34, 35, and 23 (fig. 1). Hence it appears that magnetic work should be extended in that direction also, to determine whether there is a connection between the iron-formation there and that shown on plate 1.

Mapping should be extended eastward, also, beyond the Groveland pit, because of the outcrops there. These outcrops, together with the detailed magnetic anomalies that would be obtained, are likely to furnish important structural information, as well as information regarding the formation of the Groveland ore body. Since the formation of any ore body must be closely related to the geologic history, it is desirable to widen the strip mapped eastward, so as to include at least an eighth of a mile of the granitic areas. It is only in this way that the structural and age relations can be determined.

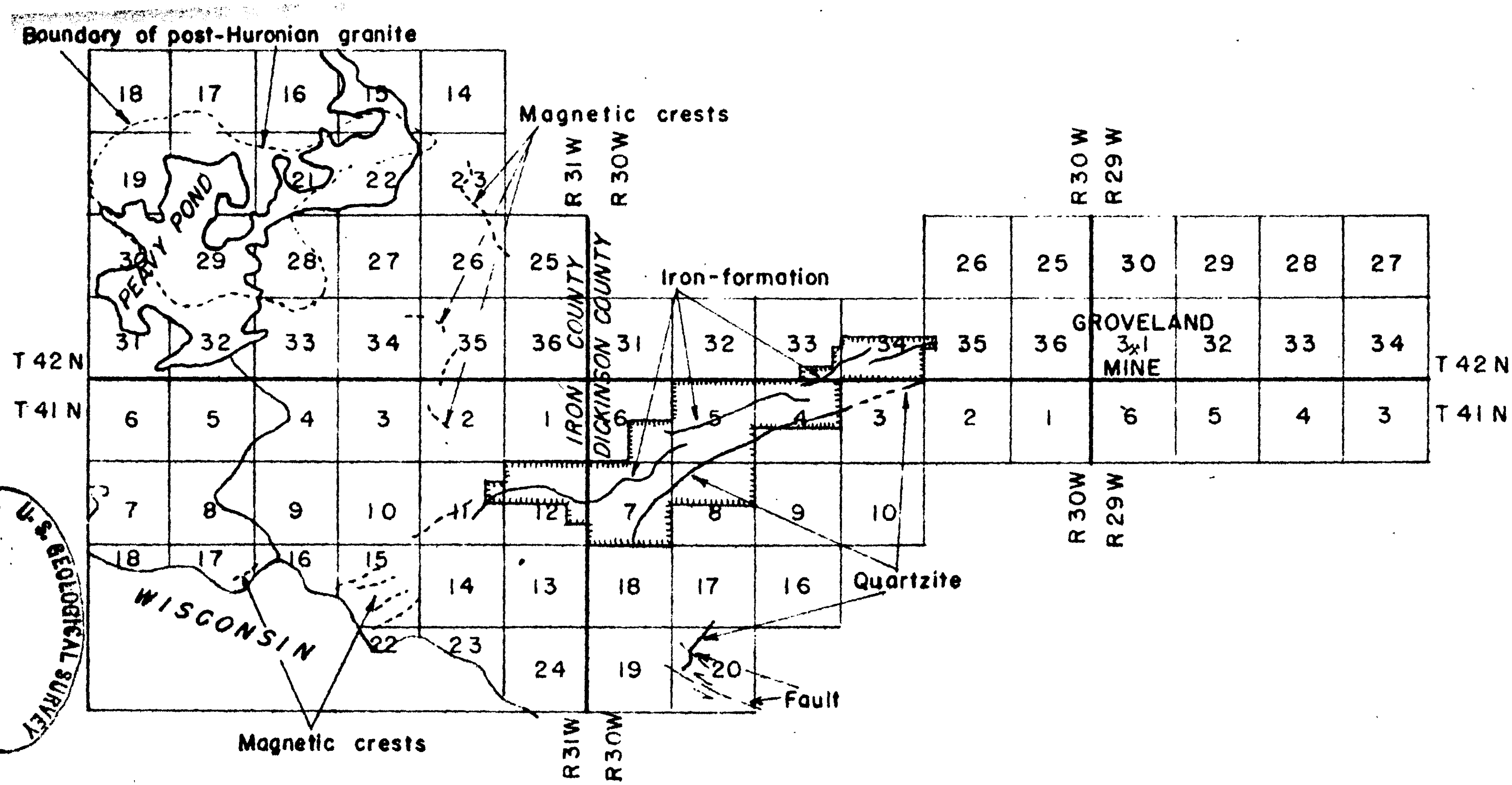

Figure I. Sketch showing the area mapped in Iron and Dickinson Counties, Michigan, and its relation to surrounding areas.
Mapped area indicated by hachures.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED WITH THE COOPERATION OF THE
GEOLOGICAL SURVEY DIVISION, MICHIGAN DEPARTMENT OF CONSERVATION

47-26

STRATEGIC MINERALS INVESTIGATIONS
PRELIMINARY MAP PLATE 1


PRELIMINARY MAGNETIC MAP
OF A PART OF
THE FELCH MOUNTAIN IRON DISTRICT
NEAR RANDVILLE, MICHIGAN
By: G.A. Lamey July—September, 1945
July—August, 1946
G.E. Siple July—August, 1945
A.F. Trites August—September, 1945
Scale
1000 0 1000 2000 feet
Contour intervals
Above 20° = 10°
Below 20° = 2°
EXPLANATION
Magnetic contour
Magnetic crest
Magnetic depression
Magnetic trough
Above 60°
50°—60°
40°—50°
30°—40°
20°—30°
18°—20°
16°—18°
14°—16°
12°—14°
MAGNETIC NORTH
TRUE NORTH
RANDVILLE
Highway M 69
Highway M 95
C.M. St. P. & R.
County road 607
LOST LAKE
IRON COUNTY
DICKINSON COUNTY
T 42 N
T 41 N
R 31 W
R 30 W
32
33
34
35
6
4
3
2
11
12
8
14
13
18