Geologic and magnetic data of the Sholdeis-Doane and Red Rock explorations, Iron County, Michigan

by

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Prepared with the cooperation of the Geological Survey Division

Michigan Department of Conservation

This report and accompanying illustrations are preliminary and have not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

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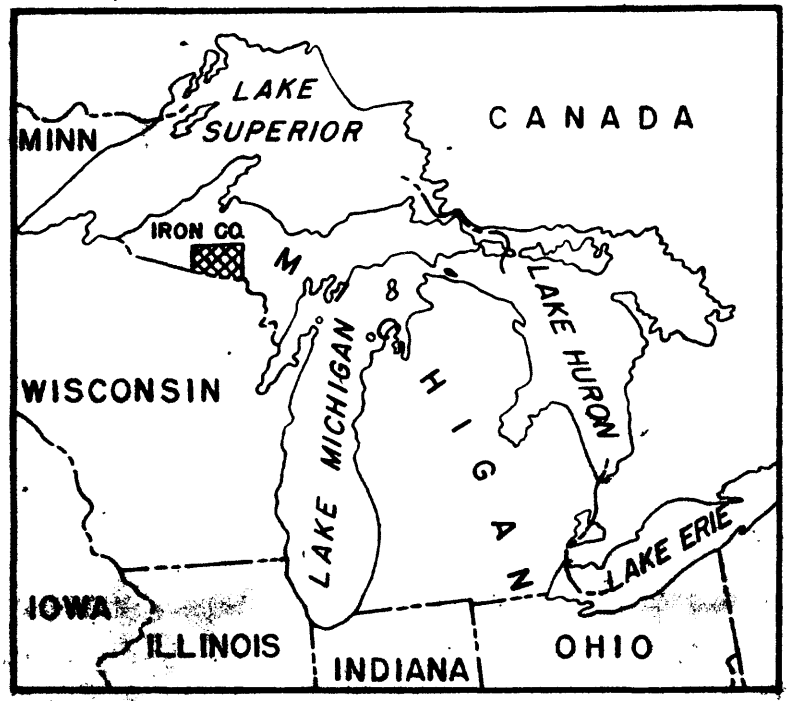
INTRODUCTION

Purpose and scope of report

In conjunction with geologic studies being made in some of the iron districts of Michigan by the U. S. Geological Survey in cooperation with the Geological Survey Division of the Michigan Department of Conservation, approximately 5,000 square miles of the central part of the Northern Peninsula has been surveyed with the airborne magnetometer. Some of the aeromagnetic data, together with tentative geologic interpretations of the aeromagnetic anomalies, have been published in preliminary reports (Balsley, et al., 1949; Wier, et al., report in preparation).

In preparing a similar report on part of the remaining aeromagnetically surveyed area, field studies have been made in the northeastern part of Iron County in an effort to determine the relationship of certain aeromagnetic anomalies to the geology of the "Amasa Oval" (fig. 1).

Much of the information derived from this work cannot conveniently be included in a report on the aeromagnetics; so in order to make it available, the data are being presented in an open file report.



INDEX MAP SHOWING LOCATION OF IRON COUNTY, MICHIGAN

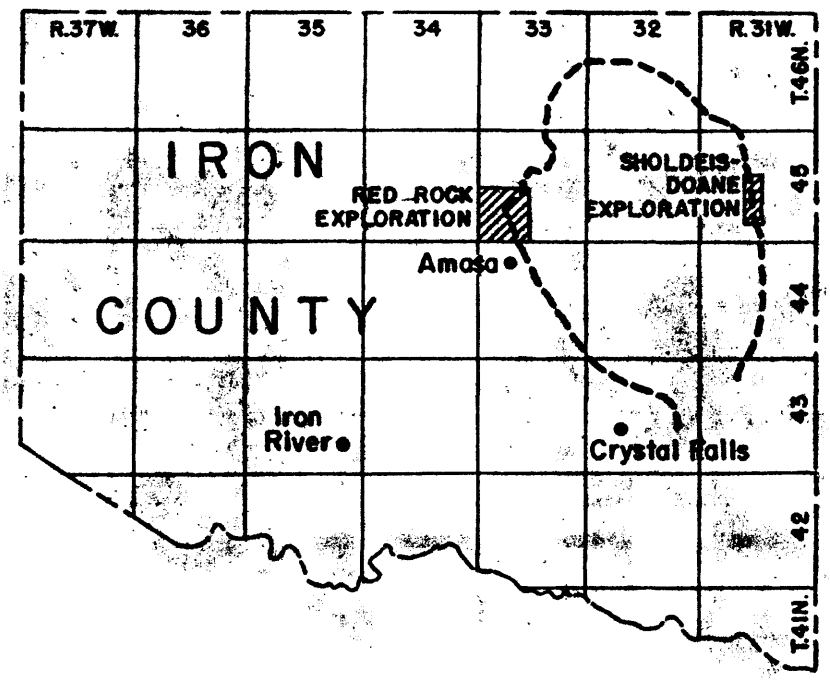


Figure 1. Index map showing location of Sholdeis-Doane and Red Rock areas. Dashed line shows approximate location of iron-formation around "Amasa" oval.

The "Amasa Oval", as shown on published geologic maps (Barrett, et al., 1929; Leith, et al., 1935; Martin, 1936), is a dome-like, truncated anticlinal structure covering an area of almost 200 square miles. It is almost completely outlined by magnetic anomalies. Detailed ground magnetometer and geologic work has been done in two local areas, one on the east flank of the oval in the vicinity of the Sholdeis and Doane explorations in secs. 21 and 16, T. 45 N., R. 31 W., and the other on the west flank of the oval in the vicinity of the Red Rock or Channing exploration in sec. 20, T. 45 N., R. 33 W.

Acknowledgments

The authors were ably assisted by John Bokman in making a plane-table map of part of secs. 20 and 21, T. 45 N., R. 33 W., and in making the magnetometer survey in that area. They are indebted to personnel of the U. S. Geological Survey and of the Geological Survey Division of the Michigan Department of Conservation for helpful discussion, and especially so to H. L. James of the former organization for help in examining drill core and rock exposures. Information concerning the explorations was obtained from the files of various mining companies, including the North Range Mining Co., the Pickands Mather & Co., and the M. A. Hanna Co. The cooperation received from the officials of these companies is gratefully acknowledged.

AREA NEAR THE SHOLDEIS AND DOANE EXPLORATIONS

Location

The area considered here includes parts of secs. 16, 21, and 28, T. 45 N., R. 31 W. The Sholdeis exploration consists of several test pits and trenches immediately adjacent to an exposure of magnetic iron-formation in the $SE\frac{1}{4}NE\frac{1}{4}$ sec. 21. The Doane exploration is in the northern part of the $SE\frac{1}{4}$ sec. 16 about one mile to the north of the Sholdeis; it consists of several test pits.

Field procedure

Starting at the southeast corner of sec. 21, the section and quarter lines necessary for mapping control were determined with sun-dial compass and steel tape. Rock exposures and test pits were located by pace and sundial compass traverses. The geologic data of the outcrop area are shown on plate 1.

Magnetometer traverses were made in an east-west direction across the mapped area. The traverses were spaced 300 to 600 feet apart, and magnetometer determinations were made at intervals of approximately 100 feet. An Askania vertical component magnetometer with a sensitivity of about 40 gammas per scale division was used. The gamma values are believed accurate to within 25 gammas. The magnetic data are shown on plate 2.

Geology

The area is underlain by rocks of Huronian age and is mostly covered with glacial drift. Rock outcrops are confined chiefly to the vicinity of the Fence River in secs. 21 and 28. Although outcrops are fairly numerous, the contacts between the several formations are not exposed.

The generalized stratigraphic sequence, from oldest to youngest, is as follows: dolomite, metavolcanics with some interbedded metasediments, and iron-formation. All the rocks are moderately metamorphosed. They have been described by Clements and Smythe (1899) as the Randville dolomite, the Hemlock formation, and the Groveland iron-formation.

Structurally the area is part of the eastern flank of the "Amasa Oval". The strike of the exposed rocks ranges from about north to N. 30° W.; the dip is 30° to 50° east. This eastward-dipping monoclinal structure does not appear to be folded, except on a minor scale, and the stratigraphic units form a belted pattern with the oldest rocks on the west.

Dolomite (Randville formation).—Within the area mapped the outcrops of dolomite are confined chiefly to the NW¼ sec. 28, but some extend northward into the southwest corner of sec. 21. Dolomite is also exposed on the ridge along the east side of the Fence River near the west quarter corner of sec. 21 (not shown on the maps). In the NW¼ sec. 28 the dolomite crops out in two general areas separated by a swamp. The western outcrop area is chiefly in the NW¼NW¼, along and adjacent to the river; the eastern outcrop area is in the NE¼NW¼, south of the river.

The dolomite of the western group of outcrops is mostly massive and gray to buff. The grain size is variable; some of the rock is very fine grained, whereas other parts are coarsely crystalline. In the westernmost outcrop south of the river, part of the dolomite is very fine grained, almost lithographic in texture. A thin, intraformational breccia zone contains fragments that range in size from 2 or 3 millimeters to more than a centimeter in their longest dimension. In this same general outcrop, the dolomite stratigraphically above the fine-grained material is thin banded and contorted. Much of the dolomite, especially in the central outcrops of this western group, contains tremolite. Features similar to algal structures are present in one outcrop.

The eastern group of outcrops forms two sub-parallel ridges in the NE¼NW¼ sec. 28. The western ridge trends northwestward along the east edge of a swamp for a distance of about 400 feet. In places the dolomite contains abundant sand grains, and cross bedding can be seen in one exposure (see pl. 1); the cross bedding indicates that the tops are to the east. The eastern ridge trends southward from the river for a quarter of a mile. The dolomite in the northern outcrops is fine grained to lithographic, and in places it is tremolitized. The dolomite in the southern outcrops is coarse grained and contains a narrow band of thin-bedded, slaty dolomite. No clastic quartz was found in this eastern belt of outcrops.

Basic dikes, now metadiabase, intrude the dolomite in the area adjacent to the river. Where the contacts could be observed, a narrow zone of dolomite adjacent to the dike has been altered to a silicate, probably actinolite.

Assuming that structural complications are not present, the minimum thickness of the dolomite is about 1,600 feet.

Metavolcanics with interbedded metasediments (Hemlock formation).— Overlying the dolomite to the east is the Hemlock formation, which in this area consists of metavolcanics with interbedded metasediments. The total thickness is about 1,500 feet. These rocks have been described by Smythe as chiefly biotite schists, biotite-hornblende schists, and sericite schists lacking in any sedimentary features. They are considered by him to be a "series of old lava flows, varying in composition from basic to acid" (Clements and Smythe, 1899, p. 446).

Most of the rock exposed is dark, massive, and fine to medium grained. Parallel alignment of the dark minerals gives the rock a gneissic or schistose appearance. Quartz, feldspar(?), biotite, muscovite, and chlorite are the major constituents. Small garnets are occasionally seen, and fine-grained magnetite is locally abundant. In some of the outcrops, the rock contains lenticles of quartz that may represent original vesicules.

The rock that makes up the large outcrop 300 feet south of the center of the SE¼ sec. 21 probably originally was a tuff. The rock is light colored, banded, and fine to medium grained; it contains dark fragments as much as 6 inches in length as well as small opalescent quartz "eyes" and augen-shaped fragments of pink feldspar. Similar rock is present in minor quantity elsewhere in the outcrop area.

Some of the rock contains clastic quartz grains and is almost certainly sedimentary in origin. The rock is dark and massive, and commonly grades into micaceous schist that also is of probable sedimentary origin. Such rock is exposed on the west side of the large outcrop that lies 500 feet east of the north quarter corner of sec. 28, and along the west and east sides of the large outcrop that lies to the southeast, across the river.

A dark crystalline rock with abundant needle-like crystals of hornblende makes up the small outcrop 500 feet southeast of the north quarter corner of sec. 28, and similar material is locally found elsewhere.

Iron-formation.--The exposure of iron-formation in the SE¼NE¼ sec. 21 is the only known outcrop of this rock along the east side of the "Amasa Oval" north of the Michigamme Mountain area. The exposed iron-formation is mostly a dark fine-grained thin-banded rock consisting chiefly of quartz, magnetite, hornblende, and epidote. Locally the beds are very contorted. The thin-bedded material grades stratigraphically upward into massive garnet and grunerite schist.

Test pits a short distance north and west of the outcrop reveal fine-grained, bluish-black, almost vitreous quartzite that contains magnetite and scattered opalescent quartz grains. Blue specular hematite is common in the quartzite, and in a few specimens it makes up the greater part of the rock. Similar specimens of iron-formation are present on the test pit dumps of the Doane exploration in the north central part of the SE¼ of sec. 16. The high magnetite content of parts of the iron-formation causes a strong magnetic anomaly that clearly reveals the continuity and trend of the formation in this area.

Three holes are reported to have been drilled in the vicinity of the Sholdeis exploration, but no information about the rock encountered could be found.

Magnetic anomalies

A strong anomaly is clearly traced from the outcrop of iron-formation in the SE¼NE¼ sec. 21 to the north and south margins of the area surveyed with the magnetometer. Dip needle data indicate that this magnetic anomaly continues southward to the Michigamme Mountain area and northward into sec. 32, T. 46 N., R. 31 W. Two crests appear on the anomaly in the vicinity of the Doane exploration. The eastern crest is a direct continuation of the crest that centers over the iron-formation outcrop near the Sholdeis exploration. The western crest lies over the test pits and dies out or merges with the eastern crest a short distance to the south. The geologic significance of this double crested part of the anomaly is not known, but there is little doubt that the entire anomaly is caused by the iron-formation.

The magnetic pattern in the metavolcanic belt is more complex, but two distinct although rather discontinuous anomalies are disclosed. In the outcrop area the stronger anomaly is near the base, and the weaker anomaly is near the middle of the metavolcanic series. To the south the anomalies appear to converge; to the north the magnetic trends are more obscure, partly because the magnetometer information is not as complete.

The crest of the stronger anomaly lies over a small, low outcrop 1,200 feet south and 700 feet east of the north quarter corner of sec. 28. Hand specimens of rock from this outcrop are strongly magnetic._/ The rock is sericite-biotite-quartz schist with interbedded zones that contain more than the usual amount of magnetite. The crest of the weaker anomaly approximately coincides with outcrops of sericite-biotite-quartz schist in the SE¼ sec. 21. Specimens of this rock are moderately magnetic.

Some specimens from many of the other outcrops of this metavolvanic-metasedimentary series contain enough magnetite to be slightly magnetic. Apparently these slightly magnetic zones are quite local and irregular, as they do not cause well-defined anomalies.

An abrupt decrease of magnetic values effectively marks the contact between the Hemlock formation and the non-magnetic Randville dolomite. Magnetometer readings over the area of dolomite outcrops are uniformly low. No magnetic horizons were detected although some of the basic dikes, which intrude the dolomite, are slightly magnetic and give rise to small local anomalies.

_/ A measure of the magnetic property of a rock may be obtained by observing the effect of bringing specimens of the rock close to a magnetometer.

AREA NEAR THE RED ROCK OR CHANNING EXPLORATION

Location

The Red Rock or Channing exploration is located in the SE¼ sec. 20, T. 45 N., R. 33 W. The exploration consists of test pits, diamond drill holes, and underground mine workings. The mine workings extend to a depth of slightly more than 300 feet and consist of limited development on three levels. Production records are not available, but miners who worked there report that several carloads of ore were shipped. Ferruginous chert crops out in the north central part of the SE¼ sec. 20, and greenstone is exposed near the southeast corner of sec. 20 and throughout much of sec. 21.

Field procedure and extent of area mapped

A plane-table map (pl. 3) on which outcrops, test pits, the mine shaft, and roads were located, was made of the SE¼ sec. 20 and the southwestern part of sec. 21 at the scale of 200 feet to the inch. All the known outcrops, material on mine and test pit dumps, and available drill core and exploration records were examined.

A detailed magnetometer survey was made in this area. The magnetic data are shown on plate 4. Magnetic contours in the northwestern part of sec. 21 are taken from a magnetometer survey of that area made by the North Range Mining Co. A less detailed magnetometer survey covered parts of secs. 19, 20, 29, 30, 31, and 32 (pl. 5).

The magnetic work was done mostly with an Askania and partly with a Wolfson vertical component magnetometer. Both instruments were used with a sensitivity of approximately 40 gammas per scale division. The gamma values shown on plates 4 and 5 are believed accurate to within 25 gammas.

Geology

The area shown on the maps is underlain by volcanic and sedimentary rocks of Huronian age and is largely covered with glacial drift. Greenstone volcanics of the Hemlock formation are the oldest rocks and are overlain to the west by younger sediments including an iron-formation. Structurally the area is part of the west side of the "Amasa Oval". In this area the general westward-dipping monoclinal structure of the oval is complicated by cross folds. The rocks are less metamorphosed than those in the vicinity of the Sholdeis and Doane explorations on the east side of the "Amasa Oval". Outcrops are confined chiefly to sec. 21, and with the exception of banded chert in the SE¼ sec. 20 and vein quartz in the SE¼ sec. 30, they are of greenstone.

Although the outcrops and explorations in the SE¼ sec. 20 provide much geologic information, many details of the geology are not clear. The geology on plate 3 agrees fairly well with the available information, but additional exploration data may require modification of the geologic interpretation shown on the map. Faults may complicate the structure, but to what extent is not known.

Volcanic greenstones (Hemlock formation).--The greenstone in this area is the upper part of a thick greenstone series that continues eastward for several miles. The greenstone outcrops are predominantly chloritized agglomerates and tuffs, although some of the more massive, fine-grained parts may be basic flows. Some parts of the greenstone are very magnetic and cause strong magnetic anomalies.

Drill core was available from one hole, in the NE¼SE¼ sec. 20, that passed through the lower part of the iron-formation and into the upper part of the greenstone. The core shows that a massive, buff-colored, leached-appearing rock lies immediately beneath the iron-formation. This rock grades stratigraphically downward into banded ferruginous slates and siltstones, which in turn are underlain by greenstone. The greenstone cut in the drill hole is massive, fine grained, and vesicular in places. Some parts of the greenstone and siltstone are moderately to strongly magnetic. The buff colored rock is found in nearby test pits at what seems to be the same stratigraphic horizon. It is possibly an altered flow or tuff.

Apparently the upper part of the greenstone contains some interbedded sediments which appear to be stratigraphically below the greenstone found in the drill core inasmuch as massive siltstone, slate, and dark quartzose graywacke, together with greenstone, are found in test pits in the E½SE¼ sec. 20. The contact with the overlying iron-formation, as seen in the drill core, appears to be gradational.

Iron-formation.---The iron-formation in the area of the Red Rock exploration consists of three fairly distinct units. These are, from oldest to youngest: (1) slaty iron-formation (2) chert breccia, and (3) dense, banded, slightly ferruginous chert. All the rocks are oxidized.

As seen in drill core, the lower part of the slaty iron-formation is banded hematitic slate with graywacke layers. This rock grades upward into slaty iron-formation with thin bands of hematite and some poorly banded ferruginous chert. In places the slaty iron-formation contains much clastic quartz and resembles the quartzite at the base of the Traders member of the Vulcan iron-formation of the Menominee range. The drill hole information shows that the iron-formation is 400 to 600 feet thick in places. This thickness may be due in part to thickening on folds.

The chert breccia consists chiefly of chert fragments in a ferruginous matrix. Much of this breccia is strongly sheared. Clastic quartz grains are present, and in places the chert breccia resembles a conglomerate.

The banded chert is a massive rock that consists mostly of dense, light-colored chert with thin bands of jasper and rare bands of hard, blue hematite. This chert is well exposed in several outcrops in the north central part of the SE$\frac{1}{4}$ sec. 20.

The chert breccia ("conglomerate") has been interpreted by some geologists as indicating a major unconformity at the base of the Upper Huronian, but the evidence for such an unconformity is not very convincing within the area examined. Except for a lower iron content, the banded chert above the breccia is very much like some of the rock below the breccia. An extraordinary coincidence is required for the strata above and below the postulated stratigraphic break to be so similar. Moreover, a chemical sediment such as chert is not normally found immediately above an unconformity.

Pieces of magnetic iron-formation are present on the dump of a large test pit about 400 feet northeast of the southwest corner of sec. 28 (pl. 5). Much of this rock is of unoxidized, thin-banded, slaty iron-formation. One specimen contains a 4-inch layer of oolitic hematite bordered on both sides by a 2-inch layer of magnetitic hematite. "Chert", "ferruginous chert", "ferruginous slate", and "gray slate" are reported from drilling several hundred feet west of this test pit.

Slates.--Thin-banded, fissile, red, green, and gray slates are reported from several drill holes and are found on the dump of one test pit in the NW¼SE¼ sec. 20. These varicolored slates apparently lie stratigraphically above the banded chert.

Magnetic anomalies

In vicinity of Red Rock exploration.--The major magnetic anomalies are confined to the area of greenstone, and many of the most prominent ones lie over the outcrops. Individual anomalies differ in trend and intensity, but a general northeast-southwest trend is clearly revealed by the magnetic data. The somewhat complex and erratic magnetic pattern is characteristic of greenstone areas in this part of Michigan. It probably reflects original variations in lithology and continuity of the original volcanic rocks. The broken magnetic trends may be in part the result of faults, but clearly defined fault displacements of the anomalies are not apparent. In general, the magnetic data suggests folding rather than faulting in this area.

In the SE¼ sec. 20, magnetic highs occur close to the contact between the greenstone and iron-formation. Because of their location, these anomalies are probably caused more by the greenstone and interbedded sediments than by the iron-formation, although drill core specimens of both rocks are moderately magnetic. To the northeast, in the NW¼ sec. 21, the major anomalies appear well within the greenstone area at a considerable distance from the probable contact with the iron-formation. If the iron-formation is present in this area, it and the adjacent underlying greenstone are not very magnetic.

A small local anomaly in the NW¼SE¼ sec. 20 is within the area mapped as ferruginous chert but is possibly chert breccia. Its cause is not known as both the banded and brecciated chert are nearly non-magnetic.

Area south and east of Red Rock exploration.--The anomalies extend southward into sec. 29 (pl. 5), and the one associated with the iron-formation footwall becomes stronger and more linear. With the exception of a short gap--or low saddle--near the center of sec. 29, this anomaly is clearly defined as it trends southeastward through the SE¼ sec. 29 and then southward through sec. 33. The anomaly lies directly over the test pit which encountered magnetic iron-formation near the southwest corner of sec. 28. Here it appears to be caused more by the iron-formation than by the footwall material or the adjacent greenstone material.

At the Hemlock mine in sec. 4, T. 44 N., R. 33 W., presumably along this same magnetic line, Clements (Clements and Smyth, 1899, p. 157) determined that the anomaly was caused by magnetic slate in the footwall of the iron-formation. The anomaly continues roughly along the footwall of the iron-formation throughout the mining area southeast of the Hemlock mine.

The broad anomaly in the southwest part of the surveyed area (secs. 30, 31, and 32) is the eastern end of the Ponozzo Lake aeromagnetic anomaly described in an earlier publication (Balsley, et al., 1949). Analysis of the magnetic data indicates that the rocks causing the anomaly are at a depth of 2,000 to 3,000 feet in secs. 30 and 31. The anomaly appears to define an east-trending anticlinal fold on which the magnetite-bearing strata are brought relatively nearer the surface. The bulge shown in the magnetic pattern in the E½ sec. 29 is probably the reflection of this anticlinal cross structure on the flank of the "Amasa Oval". Although the rocks responsible for the Ponozzo Lake anomaly are not known to be exposed or explored, they almost certainly are a continuation of the magnetic rocks that are present along the western side of the "Amasa Oval".

RESULTS

Major aeromagnetic anomalies are correlated with the geology in both of the areas studied.

In the vicinity of the Sholdeis-Doane explorations in T. 45 N., R. 31 W., magnetic anomalies are caused by an iron-formation and by parts of an underlying metavolcanic-metasedimentary series. The iron-formation is strongly magnetic, and its continuation beyond the area of outcrop can be determined accurately by magnetic methods. The relatively simple geologic structure in this area is reflected in the magnetic data.

In the vicinity of the Red Rock exploration in T. 45 N., R. 33 W., magnetic anomalies are caused in part by an iron-formation, chiefly the lower portion, and in part by magnetic layers within an underlying volcanic greenstone mass. The magnetic data clearly outline the general structural trend in this area, although the anomaly associated with the iron-formation is not very distinctive or continuous. The east- and west-trending Ponozzo Lake aeromagnetic anomaly is correlated with reasonable assurance to the magnetic rocks of the west side of the "Amasa Oval". The rocks causing this anomaly appear deeply buried in secs. 29, 30, and 31, but they are probably at bedrock surface to the west along the trend of the anomaly (Balsley, et al., 1949).

Published geologic maps show a fault displacement of the magnetic rocks in the SE¼ sec. 20 and in the SE¼ sec. 29. Presumably these faults were based on dip needle data, but the more detailed magnetometer data indicate that the magnetic rocks are folded rather than faulted in these two places.

References

Balsley, J. R., James, H. L., and Wier, K. L., 1949, Aeromagnetic survey of parts of Baraga, Houghton, and Iron Counties, Michigan, with preliminary geologic interpretation: U. S. Geol. Survey Geophysical Investigations Rept.

Barrett, L. P., Pardee, F. G., and Osgood, W., 1929, Geologic Map of Iron County: Geol. Survey Div., Michigan Dept. of Cons.

Clements, J. M., and Smythe, H. L., 1899, The Crystal Falls iron-bearing district of Michigan: U. S. Geol. Survey Mon. 36.

Leith, C. K., Lund, R. J., and Leith, A., 1935, Pre-Cambrian rocks of the Lake Superior region: U. S. Geol. Survey Prof. Paper 184.

Martin, Helen M., 1936, Geologic map of the northern Peninsula of Michigan: Geol. Survey Div., Michigan Dept. of Cons., Pub. 39, Geol. series 33.

Wier, K. L., Balsley, J. R., and Pratt, W. P., Aeromagnetic survey of Dickinson County, Michigan: U. S. Geol. Survey Prelim. Rept. (in preparation).