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Contents

Illustrations

A magnetic anomaly near Bear Lake, Houghton County, Michigan

by

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Introduction

A large magnetic anomaly of unknown origin occurs about 1½ miles east of Bear Lake, Houghton County, Michigan, in secs. 24 and 25, T. 56 N., R. 34 W. The occurrence is isolated in an area of very weakly magnetic rocks and has special geologic interest because it is adjacent to a non-magnetic rhyolite porphyry body that is stratigraphically higher than any other known igneous rock in the Keweenawan series.

An aeromagnetic survey of the Michigan copper district by the Geophysics Branch of the U. S. Geological Survey in 1948 first revealed the anomaly (Fig. 1). The anomalous area has been more fully outlined by a dip-needle survey, and briefly discusses the geology of the area and possible significance of the anomaly.

Geology

The area surrounding the anomaly is underlain by rocks of the very thick Keweenawan series, which dip gently northwest toward Lake Superior. The formations recognized _/ in the vicinity of the

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_/ Lane, A. C., The Keweenaw series of Michigan: Michigan Geol. and Biol. Survey Pub. 6, vol. 1, pp. 26-41, 1911.

Butler, B. S., and Burbank, W. S., et al, The copper deposits of Michigan: U. S. Geological Survey, Prof. Paper 144, pp. 16-25, 1929.

anomaly include, in stratigraphic order: a thick group of copper-bearing lava flows, the Copper Harbor conglomerate, the Nonesuch shale, and the Freda sandstone. Post-glacial lake sands and clays mantle the Keweenawan formations and form a nearly level, partly swampy surface over the anomaly.

With the exception of the rhyolite porphyry described below and perhaps the rock responsible for the local magnetic anomaly described in this report, all of the area shown in Figure 2 is probably underlain by northwestward-dipping Freda sandstone. The sandstone is not exposed in the map area, but the outcrops at Freda, Michigan _/

_/ Lane, op. cit., p. 40.

(about 10 miles southwest of Bear Lake), are dominantly red arkosic sandstone with some interbedded red and green shale, and minor beds of grit and pebble conglomerate.

The only local bedrock exposures are two small rhyolite porphyry outcrops _/ (points "A" and "B" on Fig. 2). In 1917-1918

_/ Butler and Burbank, op. cit., p. 47.

this rhyolite porphyry was explored by six diamond drill holes and a forty-foot shaft _/. The locations of the shaft and of the three

_/ Weed, W. H., The mines handbook, vol. 14, p. 785, 1920.

diamond-drill-hole collars found during the survey are shown in Figure 2.

The local, isolated occurrence of rhyolite porphyry in a sandstone area suggests that the rock is intrusive, but no definite conclusions about its structure can be made from the available data.

The rock in both the surface exposures and the shaft dump is a typically flow-banded, essentially non-magnetic rhyolite porphyry that ranges from red to pinkish gray. Alkalic feldspar predominates in the rock and is accompanied by accessory biotite, hornblende, quartz, apatite, and iron oxides. The coarser-ground facies have a fine granitic texture (about 0.4 mm grains), while the finer-grained facies consist of an aggregate of grains (about 0.02 mm diameter) in a glassy matrix, with some phenocrysts of apatite and orthoclase.

A few rhyolite specimens collected at the shaft dump and from abandoned diamond-drill-core chips show a little green copper stain in joints and calcite seams. The exceedingly fine-grained original copper mineral, where megascopically visible, appears to be native copper.

Measurement of the magnetic anomaly

The aeromagnetic survey revealed, but did not fully outline the anomaly which was crossed by only one flight-line, number 87 (see Fig. 1). The ground survey with a Lake Superior model dip needle was made to complete the mapping of the anomaly.

Three survey lines, originating at point "C" (see Fig. 2) on a watercourse near several old prospect pits, and radiating (1) irregularly northwest (down the watercourse, (2) due east, and (3) nearly due south, were run with stations spaced every 25 feet. The values for these points were fairly close to one another over

considerable distances so the readings along other lines were taken only every 50 feet. Minor irregularities in the magnetic contours were smoothed by averaging three readings taken at successive 50-foot intervals along the traverse lines.

Spot values outside the anomaly area are averages of the reading at the point indicated on the map and four readings taken at symmetrically spaced intervals 50 feet from the point.

An extreme anomaly, about 40 feet in diameter, occurs about 100 feet east of the outcrop at point "B". At the center of this area (too small to be shown on the map) the dip-needle deflection was 21 degrees.

Significance of the magnetic anomaly

Either of two minerals, magnetite or pyrrhotite, may cause the anomaly discussed here. Neither the Freda sandstone nor the rhyolite porphyry is known to contain either mineral in quantity. Local concentrations of magnetite or pyrrhotite might be contained in another igneous rock associated with the rhyolite, or in an adjacent contact-metamorphosed sandstone. There is nothing to indicate which type of concentration, if either, is present.

No other igneous body has been found intruding the Freda formation, so that the effect of contact metamorphism on this sandstone can not be gauged.

However, at Mount Bohemia (about 30 miles northeast in Keweenaw County) there is a complex igneous intrusive consisting of two rock types cutting the Keweenawan series a/. The intrusive rocks would be

a/ Hubbard, L. L., Keweenaw Point with particular reference to the felsites and their associated rocks: Michigan Geol. Survey, vol. 6, pt. 2, 155 pp., maps 1898.

Wright, F. E., The intrusive rocks of Mount Bohemia, Mich.: Michigan Geol. Survey Rept. for 1908, pp. 355-402, 1909.

classified according to the Johannsen system by their analyses b/ as

b/ Wright, op. cit., pp. 368-373.

Broderick, T. M., Differentiation in lavas of the Michigan Keweenawan: Bull. Michigan Coll. Min. and Technology, vol. 8, p. 536, 1935.

an aplite and a syenodiorite. The syenodiorite contains an unusually large amount (10.9%) c/ of magnetite, and a vein along the

c/ Broderick, ibid.

contact of the two facies bears minor amounts of pyrrhotite in association with other iron and copper sulfides d/. A somewhat

d/ Wright, op. cit., p. 392.

similar occurrence of either mineral may cause the magnetic anomaly near Bear Lake.

Whether the rock causing this magnetic anomaly bears any minerals of economic value is not known. Rhyolite seen on the dump at the old shaft shows only a few insignificant traces of copper, but as shown on Figure 2, the drill holes and shaft were not sunk

in the area of the magnetic anomaly. Magnetite (Fe_3O_4), which most commonly causes magnetic anomalies, is an ore of iron, but is minable only when present in fairly high concentrations and large quantities.

A rough analysis was made _/ of the dip needle survey assuming

_/ Balsley, J. R., personal communication.

a sensitivity of 200 gammas per degree. Estimated depths to the source of the anomalies are on the order of 100 feet. The observed anomalies could be produced by a few masses of 10,000 to 15,000 tons each consisting of 60% magnetite (by weight). If it is assumed that the sources are dike like, extending to great depth, the computed susceptibility compares to that of diabase.

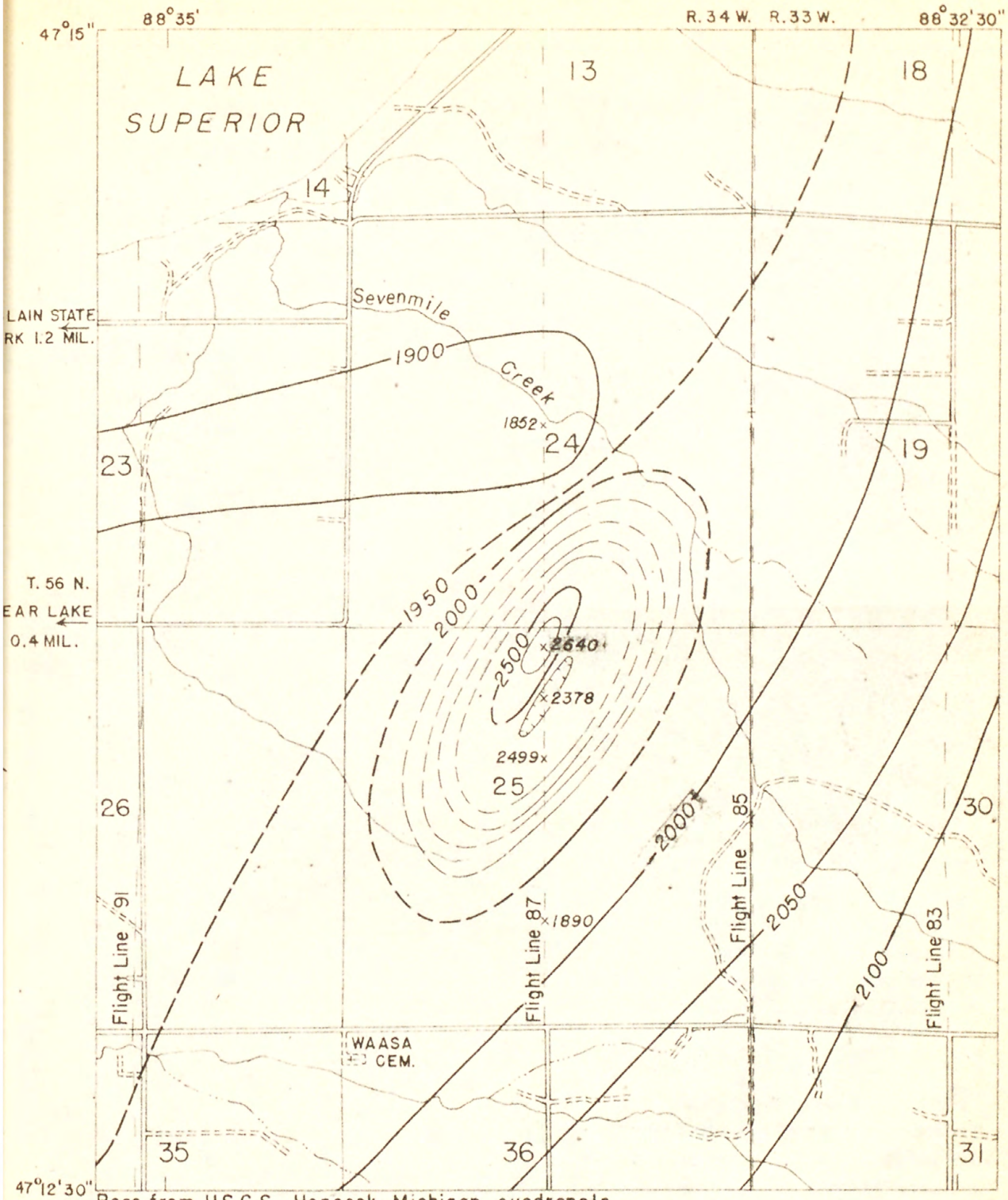
Pyrrhotite (FeS), which may also cause magnetic anomalies, is in itself of little economic value, but is commonly associated with copper- and nickel-bearing minerals.

Further exploration

Diamond drilling would be the most satisfactory method of further investigating this area of magnetic anomaly. The diamond-drill core would allow positive identification of the magnetic material, as well as yield a measure of the form and extent of its occurrence. Trenching would be unsatisfactory unless the magnetic material happens to occur right at the bedrock surface. Electrical, gravimetric, seismic, and more-refined magnetic surveys might all add to the indirect knowledge of the physical characteristics of the anomalous material, and perhaps indicate its depth below surface.

Summary

The magnetic anomaly near Bear Lake, about one-half mile in diameter is spatially, and probably genetically, closely related to the adjacent rhyolite porphyry. It may be caused either by magnetic igneous rock associated with the non-magnetic rhyolite porphyry, or by contact-metamorphic effects of the felsite or other intrusive rock on the surrounding Freda sandstone. Copper, iron, or nickel minerals might be included in the magnetically anomalous rock, but no evidence, now available, indicates their presence or absence.



Base from U.S.G.S. Hancock, Michigan, quadrangle

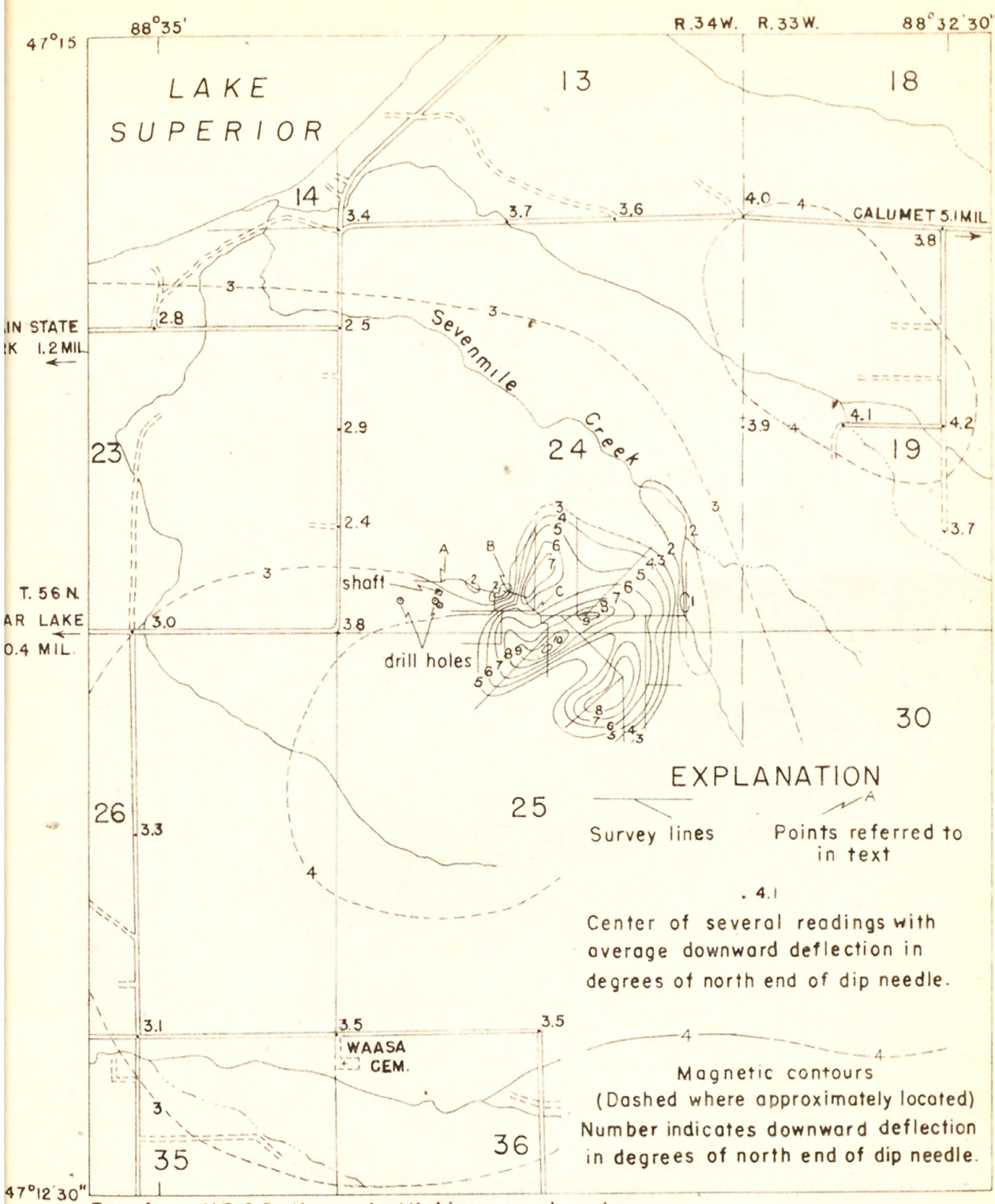
AEROMAGNETIC MAP OF AN ANOMALY NEAR BEAR LAKE HOUGHTON COUNTY, MICHIGAN

Magnetic contours from aeromagnetic profiles by the U. S. Geological Survey.
Contour interval 100 gammas, locally supplemented by dashed half-interval contours.
Arbitrary magnetic datum.

1000 0 1000 2000 3000 4000 5000 FEET

s map is preliminary and has not
ited or reviewed for conformity
S. Geological Survey standards

FIGURE 1



Base from U.S.G.S Hancock, Michigan, quadrangle

DIP-NEEDLE SURVEY OF A MAGNETIC ANOMALY NEAR BEAR LAKE, HOUGHTON COUNTY, MICHIGAN

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FIGURE 2