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Comparison of Geology and Magnetism of a Portion of the Thunder Bay and Rainy River Districts

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COMPARISON OF GEOLOGY AND MAGNETISM OF A PORTION OF THE THUNDER BAY AND RAINY RIVER DISTRICTS

by
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ILLUSTRATIONS

COMPARISON OF GEOLOGY AND MAGNETISM OF A PORTION OF THE THUNDER BAY AND RAINY RIVER DISTRICTS

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ABSTRACT

The portion of the Thunder Bay and Rainy River Districts covered in this report is an area of greatly varying magnetic susceptibility. Comparison of the geology and magnetic susceptibility by use of transparent overlays displays various features not previously shown on conventional geologic maps.

Two subparallel magnetic highs trending at essentially right angles to the regional trends are strongly suggestive of dikes of basic rock. Small isolated highs in the western portion of the map are interpreted to be stocks of highly magnetic rock. The magnetic anomaly crossing batholithic granite indicates a continuation of Keewatin strata though not mapped. Likely locations of gold, nickel and iron concentrations are exhibited.

INTRODUCTION

Geological interpretation of aeromagnetic maps is becoming increasingly important in determining rock types and structure not observable in outcrops. Probable areas of mineral concentration are often clearly delineated on magnetic maps even though completely covered by overburden. The Ontario Department of mines has published a large number of maps showing magnetic intensities and this report is based on a sequence of twenty-four of these maps (1961).

Location

The area studied in this paper is located in southern Ontario. It is bounded on the south by the United States-Canadian border, on the north by 49°15' longitude, on the east by 92°00' and on the west by 92°30' latitude (fig. 1).

Purpose

The purpose of this report is to compare the geology of a portion of Ontario province as shown on conventional geologic maps with features that are revealed on magnetic maps. An attempt is made to interpret the geology and make the necessary additions or revisions which the magnetic anomalies suggest. Also, by comparing the magnetic suscepti-

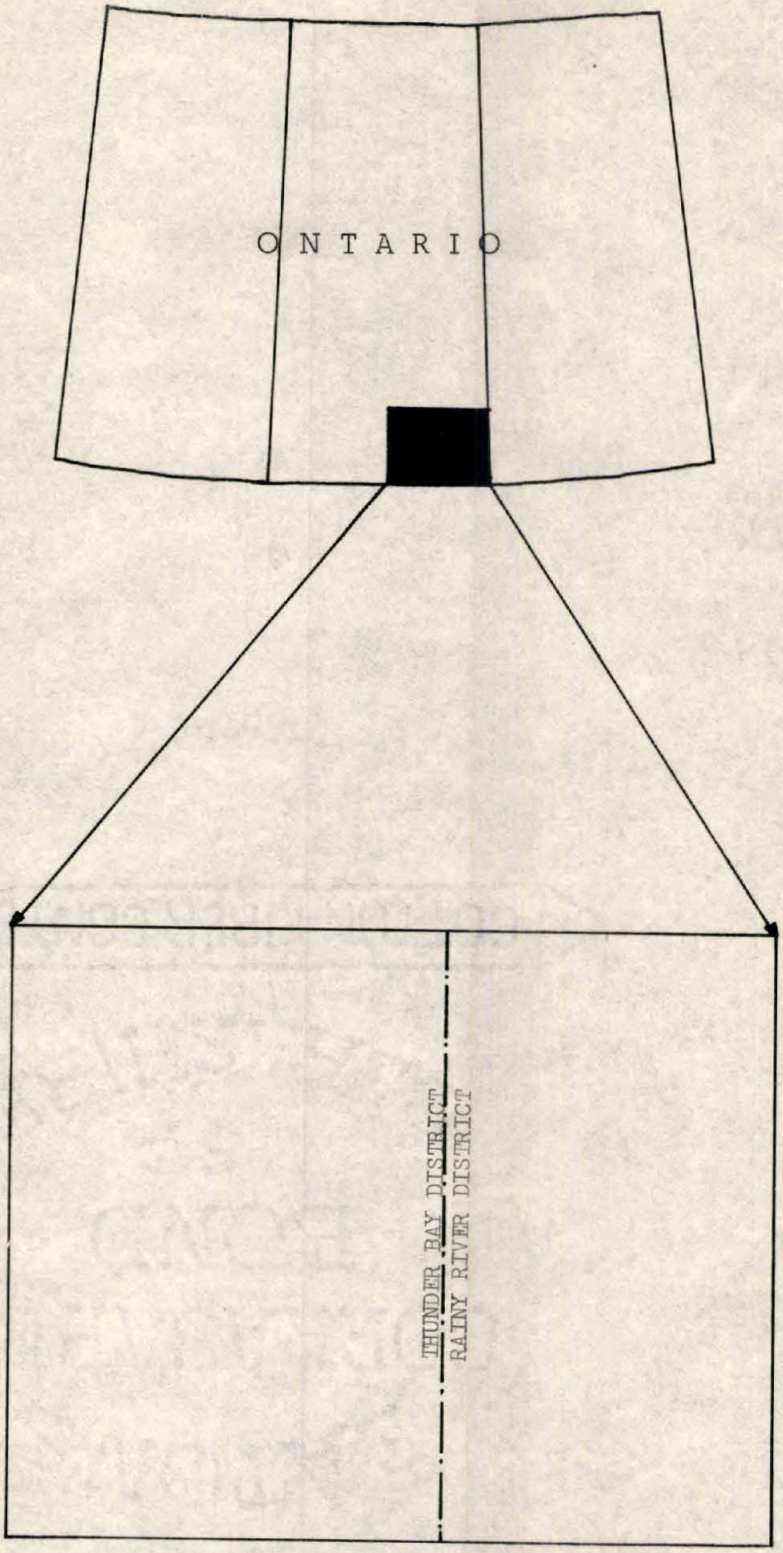

Fig. 1: Index map of a portion of the Thunder Bay and Rainy River districts.

bility in areas of producing mines an attempt is made to locate other probable areas of economically important deposits or at least of mineral concentrations.

Acknowledgments

The writer wishes to thank Fred Ballard, a graduate student, for his instructions and aid in the "art" of developing and enlarging pictures. Secondly, the writer expresses his especially sincere appreciation and thanks to Mr. Gillett for the help and conversations from which some order came to the seeming chaos.

METHODS

Pictures were taken of twenty-four aeromagnetic maps covering the area mentioned above. A composite was then made by pasting the photos in the proper sequence on poster board. An overlay was made from the composite in which the magnetic anomalies were shaded. These shaded areas do not give absolute values of the magnetic susceptibility but rather outline areas of high magnetic relief. To delineate exactly the areas of equal magnetic susceptibility would be extremely time consuming and would probably not be desirable as it would tend to mask the anomalies.

A geologic map was also compiled by use of three geologic maps, each of which covered a portion of the studied area. The desired scale was obtained by using a vertical sketchmaster. This map was put on

semi-transparent vellum and colored lightly so as to serve as an overlay.

A third vellum overlay shows the changes of the geology as ascertained by comparing the geologic map with the magnetic map. Also possible ore and mineral deposits, or at least concentrations of minerals are noted.

GENERAL TOPOGRAPHY

According to Tanton (1938, 1939, 1940) the region is, for the most part, a succession of hummocky hills and ridges. In the south-southeast part there are rather high tablelands which slope slightly to the southwest and which end abruptly on the northwest as steep-sided cliffs. The relief in this area is as much as 500 feet above the lakes. The relief decreases progressively to the north and in the extreme northern part of the region it is less than 100 feet. The elevation generally is between 1,190 and 2,000 feet above sea level. Glacial drift is thin and patchy in the southern portion where the relief is greater and this drift covers only the intervening lower areas between the hills and ridges. Moving north the drift thickens considerably as the relief becomes less and finally the drift-covered lowlands predominate.

In the southern one-half of the area lakes and ponds are extremely numerous due to the scarcity of drift and the irregularity of the rock surface. These lakes are connected by short, fast flowing streams in

which rapids and falls are common. To the north as the drift cover thickens, muskeg becomes more extensive, lakes less numerous and streams more gently flowing.

INTERPRETATIONS

Geologic features

Each addition or revision of the geology as the Revisions of Geology map is presented below by number. These numbers correspond to those on the map.

(1a-c) The very distinct, narrow linear magnetic high trending northwest-southeast is interpreted to be a diabase dike. This conclusion is based on the fact that diabase crops out at its southern extremity (latitude $48^{o}45'$--$40^{o}00'$ and longitude $90^{o}00'$--$90^{o}30'$) and on conversation with Mr. Gillett who states that this pattern is characteristic of these dikes in the area of Ontario which he studied.

(2a-c) This rather spotty linear magnetic high is also anomalous in its almost due north-south trend which is essentially at right angles to the regional magnetic and geologic trends. There seems to be two possible explanations for this anomaly. A) this is a dike as (1) or B) this anomaly is due to some downfolding or faulting at right angles to the regional structure which causes the Keewatin sedimentary rocks, which characteristically exhibit highs in this map area, to be protected from erosion and therefore is still present in spotty patches. Explanation (A) is not substantiated by any outcrops and this anomaly does not exhibit the

straightness shown by the anomaly in (1). That this anomalous magnetic high may be due to the presence of Keewatin, though not distinguished by Tanton (1938), is supported by the presence of these sedimentary rocks with the same general trend to the northwest and southeast. Explanation (B) could possibly be proved or disproved by field inspection to determine whether these sediments are present or not.

(3a-d) Iron formations in the Keewatin as mapped on the geologic map are almost always associated with high magnetic intensity as shown by the overlays. Many highs do not have iron formations differentiated on the geologic map and again field inspection may reveal iron concentrations in these areas.

(4) Subsequent to mapping of this area by Tanton a large iron deposit has been discovered (Stockwell, 1957). This ore body has been divided into two parts by a fault of large displacement. The eastern portion nearly corresponds to a magnetic high but the western portion does not display an anomaly.

(5) On the geologic map this feature is shown as malagnite and/or nephiline syenite. The anomaly is approximately the same size and shape but is offset to the southeast. This would seem to suggest that this is a stock of basic rock which plunges steeply to the southeast.

(6a-f) These several isolated highs in the Couchiching may be unexposed stocks similar to that described in (5).

(7) This magnetic high, which is a continuation of the highs approximately delineating the Keewatin strata to the east and west seems to indicate a possibility of continuation of the Keewatin though not differentiated by Tanton (1938).

Mineral Occurrences

(8) Gold: The magnetic high discussed in (2) above would be a likely prospect for gold occurrence since there are deposits along an extension of the anomalous trend to the north.

(9a-c) Iron: Additional iron formations would probably be located by inspecting the magnetic highs in the Keewatin rock. It should be noted, however, that part of the Steep Rock deposits described by Stockwell (1952) have no magnetic high associated.

(10a-b) Nickel: Nickel deposits which occur at the contact of the small Windigokan bodies with gabbroic affinities and the Couchiching sedimentary rocks are usually marked by magnetic highs. Inspection of other small highs in the Couchiching would possibly prove to be similar occurrences with associated nickel.

Regional Structure

Although there is evidence that the Keewatin overlies the Couchiching this relationship is not conclusive (Tanton, 1938). In attempting to determine the regional structure it is assumed that the Keewatin is younger than the Couchiching and interpretations are based on this assumption.

The regional trend is almost due easterly. Windigokan strata crops out approximately along 48°45' latitude in the western third of the map. These Windigokan rocks are surrounded by Keewatin which, in turn are surrounded by Couchiching. This sequence of young rock in the middle with progressively older rocks to the outside defines a syncline. A magnetic high approximates the extent of the Keewatin in the western part of the map but to the east this high shifts progressively farther south into the Couchiching. This suggests that the Keewatin is overlain by Couchiching as the overturned limb of the syncline. Immediately south of the syncline, is a large anticline which plunges to the west. Also to the west the fold appears to be less "tight" as evidenced by the broad expanse of Couchiching. At the U. S. - Canadian border between 91°00' and 91°30' longitude another syncline is evident. To the northeast there appears to be an offset of the synclinal axis. This is perhaps caused by a large fault but evidence of this is inconclusive. The evidence supporting the possibility of a fault includes the shift in the synclinal axis, the coincidence in trend between the postulated fault and the magnetic anomaly discussed in (2), the linear band of erosional remnants of Keewatin strata north of the magnetic high and the abrupt southerly turn of the U. S. - Canadian border which follows the course of several south flowing rivers. All these features are in almost perfect alignment. One important contradiction to the theory of a fault is the continuation of an easterly trending magnetic high across the postulated fault zone.

CONCLUSION

The results of this report, though limited, have served to clarify and add to the geology of the region. Evidence of two dikes have been found (1, 2), the discontinuity of the mapped iron formations has been proven and several other areas of probable iron concentrations have been found (3, 9). Anomalies in the Couchiching in the western third of the map suggest the presence of several stocks (5, 6a-f). The continuation of the magnetic high across rock mapped as granite suggests the possibility that further field inspection would show this to be Keewatin rock.

Inspection has shown several likely locations of mineral occurrences. Gold may occur along the magnetic anomaly described in (2). Windigokan rock and associated nickel at positions of small magnetic highs in the Couchiching, and iron in the highs in the Keewatin rock.

The magnetic map was not greatly helpful in interpreting the regional structure. Anomalies along $48^{o}15'$ suggest reversal of stratigraphic position and the anomalous trend described in (2) aids in the theory of a fault. The regional structure as can be ascertained from the maps consists of a series of synclines and anticlines which plunge to the west. There is also inconclusive evidence of a fault at right angles to the regional trend.

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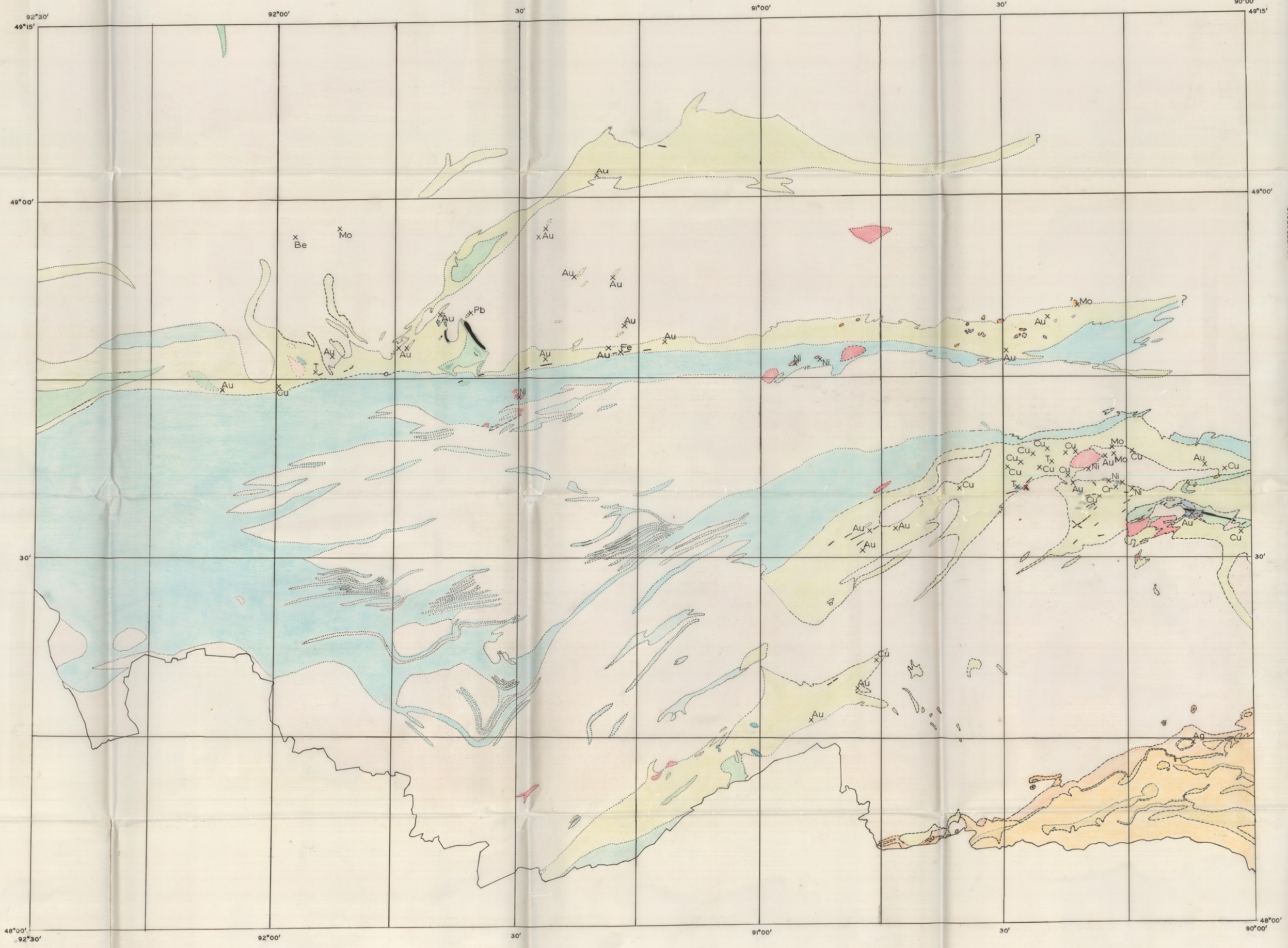
PLATE I



LEGEND

PROTEROZOIC

KEWEENAWAN

Diabase

ANIMIKIE

ROVE FORMATION: sholy sediments

GUNFLINT FORMATION: iron formation and sholy sediments
KAKABEKA FORMATION: conglomerate

POST-WINDIGOKAN

Granite, granite-gneiss: Saganaga granite

Granodiorite, diorite, hornblende gabbro, anorthosite

Hornblende porphyrite

Peridotite, serpentine

ARCHEAN

WINDIGOKAN

Andesitic lava, pyroclastics

Conglomerate, arkose, greywacke, slate, iron formation

KEEWATIN

Greenstone, pyroclastics, slate, greywacke, iron formation, schists, meta-diorite, amphibolite

COUCHICHING

Mica schist, gneiss; slate, greywacke, impure quartzite

Iron formation

Geological boundary (defined, appoximate, assumed) .....

Mineral occurrence ..... ×

International boundary .....

MINERAL OCCURRENCES

Ag	silver
Au	gold
Cr	chromium
Cu	copper
Mo	molybdenum
Ni	nickel
T	talc
Be	beryllium
Fe	iron

Modified from: Tanton, T. L.: 1938, 1939, & 1940.

GEOLOGIC MAP

OF A PORTION OF THE

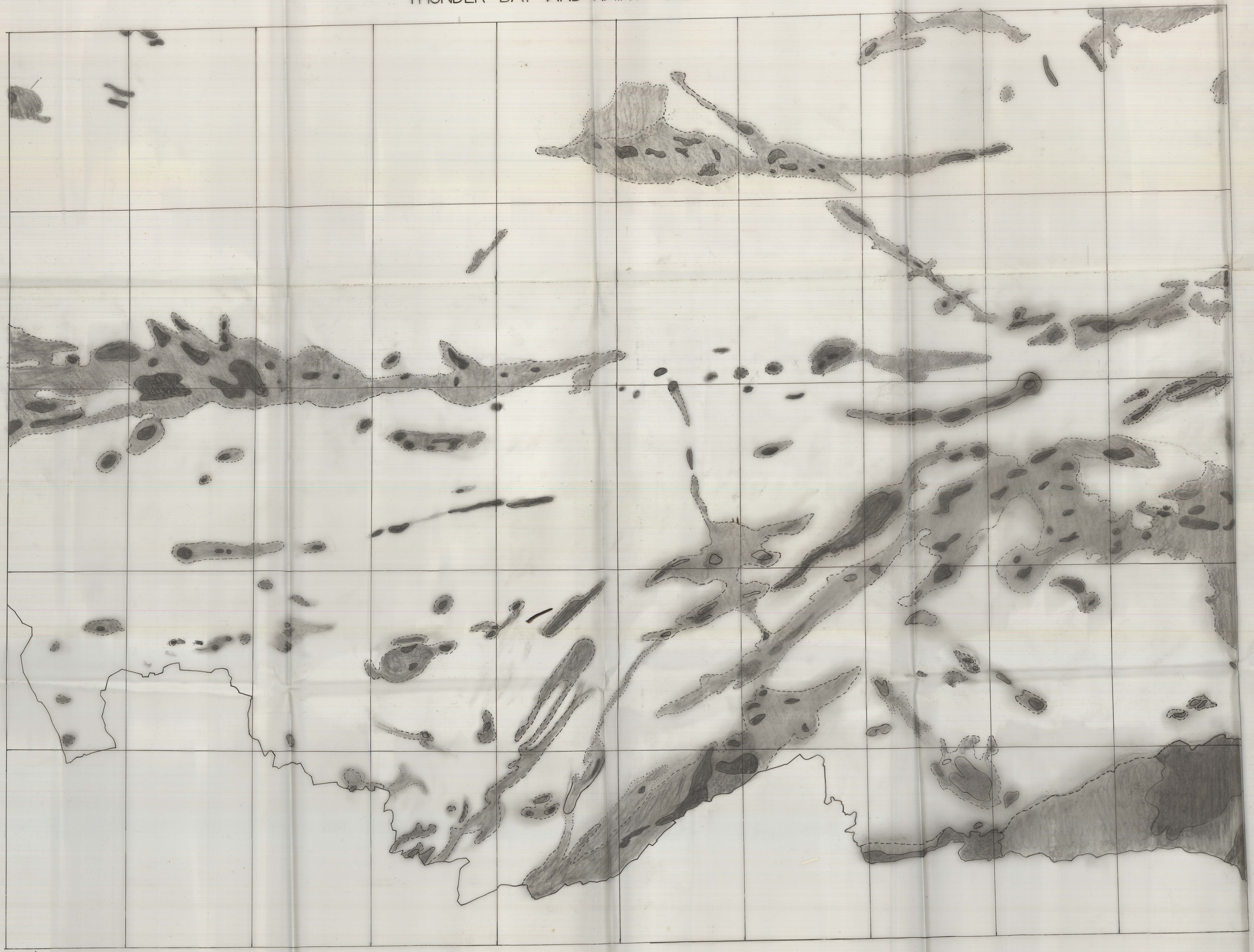
THUNDER BAY AND RAINY RIVER DISTRICTS

MILES
4 0 4 8 12

MAGNETIC ANOMALY MAP

OF A PORTION OF THE

THUNDER BAY AND RAINY RIVER DISTRICTS



LEGEND

(1a-c) Diabase dike

(2a-c) Diabase dike and/or patchy remnants of Keewatin sediments

(3a-d) Patchy and discontinuous iron formations

(4) Economic iron ore deposit

(5) Steeply dipping, granite capped stock of basic rock

(6a-h) Basic intrusives

(7) Continuation of Keewatin across granite

(8a-c) Possible location of gold deposits

(9a-c) Possible location of iron formations

(10a,b) Possible locations of Windigokan and associated nickel

Interpretations

Anticline showing direction of plunge and axial plane

Overturned anticline

Syncline showing direction of plunge and axial plane

Overturned syncline

Strike and dip direction of beds

Strike and dip direction of overturned beds

REVISIONS TO

GEOLOGIC MAP

OF A PORTION OF THE

THUNDER BAY AND RAINY RIVER DISTRICTS