GEOPHYSICAL SURVEYS CONDUCTED IN NORTHWESTERN KOOCHICHING COUNTY, MINNESOTA

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GEOPHYSICAL SURVEYS CONDUCTED IN NORTHWESTERN KOOCHICHING COUNTY, MINNESOTA

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I. INTRODUCTION

Much of northwestern Koochiching and northeastern Lake of the Woods counties are underlain by felsic to mafic Lower Precambrian metavolcanic rocks (Ojakangas, 1972). Early prospecting was conducted in this area, but intensive exploration for volcanogenic massive sulfide deposits did not commence until 1967 and has continued in varying degrees to the present. This exploration has not resulted in the discovery of a mineable deposit, but significant amounts of zinc were drilled in Section 16, T159N, R27W. Also, showings of copper and zinc have been encountered in several other localities throughout the area.

The Division of Minerals of the Minnesota Department of Natural Resources has the responsibility for the administration of the approximate ten million acres of state controlled mineral lands. This responsibility includes the administration of state mineral leases. To date, over 40,000 acres of state controlled mineral lands have been leased in the area shown on Figure 1. These leases were issued to four companies. All of these leases are now terminated.

It is also the responsibility of the Division of Minerals to assess the mineral potential of state controlled mineral lands. By 1972, the mining company exploration had diminished considerably in this area, but the Division of Minerals considered the geologic environment favorable for the occurrence of economic sulfide deposits.

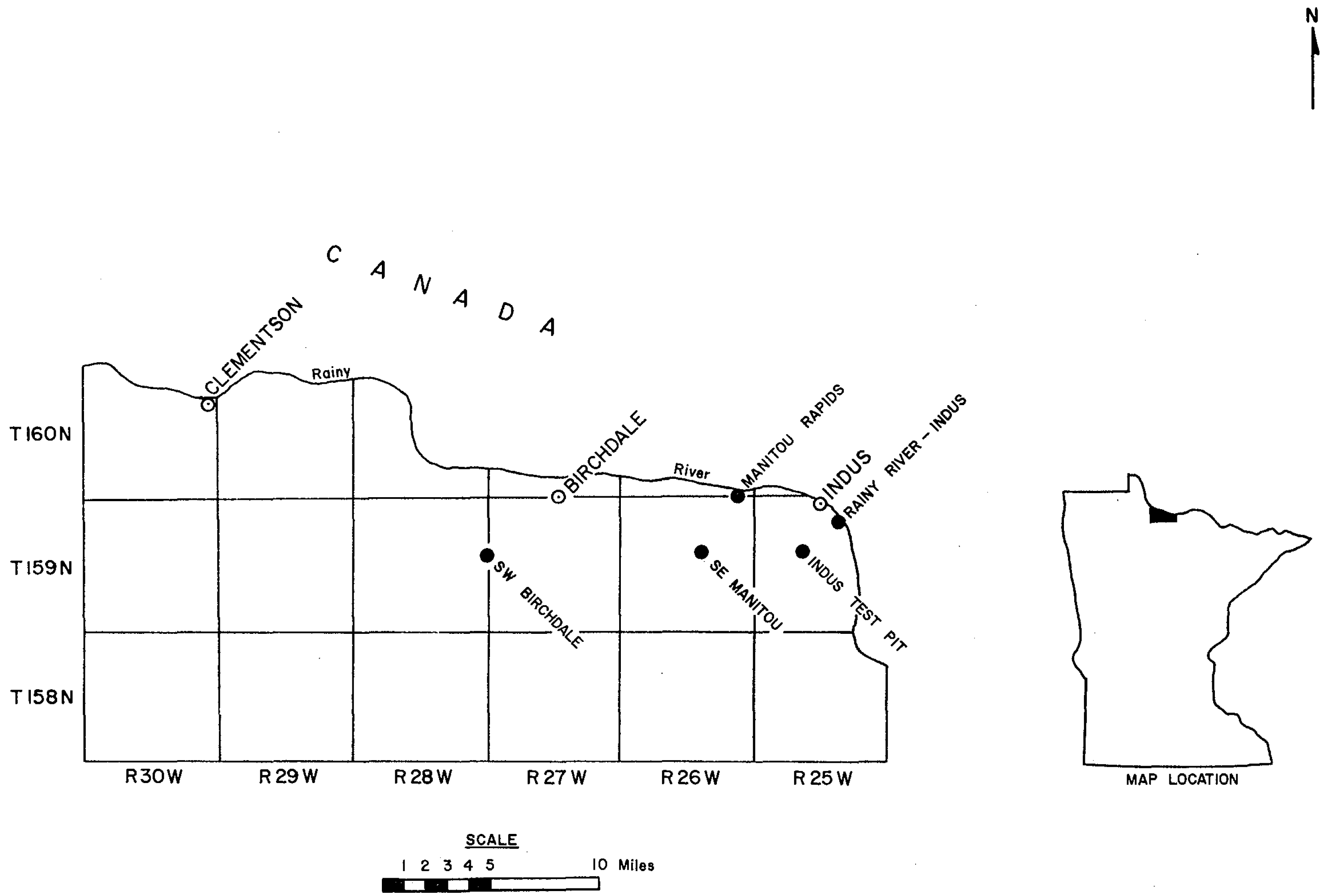

FIGURE 1: Northwest Koochiching County, Minnesota
Showing Areas of Geophysical Surveys

As a result, it was decided to conduct surveys to evaluate the mineral potential of state controlled mineral lands in this region.

The mining companies had conducted airborne electromagnetic and magnetic surveys. They followed up these surveys with ground geophysics and drilled some of the most promising conductors. Due to the extensive geophysical surveys that had been done, the Division of Minerals decided to attempt to utilize the chemical properties of the Quaternary deposits of the region as a means of generally delineating potential areas, in combination with existing geologic and geophysical data. The geochemical surveys have been described by Meineke, Gilgosch and Vadis (1976). Concurrent with these surveys, R. W. Ojakangas was mapping the Precambrian geology of this area for the Minnesota Geological Survey. The geophysical surveys conducted by the Division of Minerals, described in this report, were mainly conducted to aid the geochemical surveys and to locate drill sites for geologic control which would assist R. W. Ojakangas in his geologic interpretation of the area.

Geophysical surveys were conducted in the five areas shown on Figure 1. These surveys included electromagnetic, resistivity, induced polarization and magnetic methods. The results of these surveys are presented in this report in written form. A considerable number of maps and graphs have been prepared from these surveys which are available for examination at the Division of Minerals, Minnesota Department of Natural Resources, Hibbing, Minnesota. In addition, geophysical and other exploration data from terminated State of Minnesota mineral leases is also available for examination at the Division of Minerals.

II. DESCRIPTION OF SURVEYS

A. Indus Test Pit

The location of the Indus Test Pit is shown on Figure 1. The geology of this area has been described by Listerud (1976). Massive, semi-massive and disseminated pyrite and pyrrhotite occurs in felsic to intermediate metavolcanic, pyroclastic, and volcaniclastic rocks on the southwest side of a northwest-southeast trending diabase dike (Listerud, 1976). The outcrop of the diabase dike in the area of the test pits is shown on Figure 2. The shaft and test pits shown on Figure 2 are located over the sulfide zone.

A major magnetic anomaly associated with magnetite iron-formation extends for many miles northeast and southwest of the Indus Test Pit area. According to Ojakangas (1972), this magnetic anomaly lies stratigraphically above the Indus Test Pit area. This anomaly was approximately located during our surveys. The axis of this anomaly is shown on Figure 2.

An extensive geochemical orientation survey was conducted in this area (Meineke, Gilgosch and Vadis, 1976). Geophysical surveys were done in order to define the sulfide zones for the geochemical survey. Additional surveys have also been conducted over the sulfide zones to test various geophysical equipment and methods. These methods include: refraction-seismic, magnetic, resistivity, time domain induced polarization, and VLF, in-phase/quadrature horizontal loop and dip angle horizontal loop (Crone CEM) electromagnetic methods.

These geophysical surveys located several conductors. Three vertical holes were drilled over these conductors to obtain split

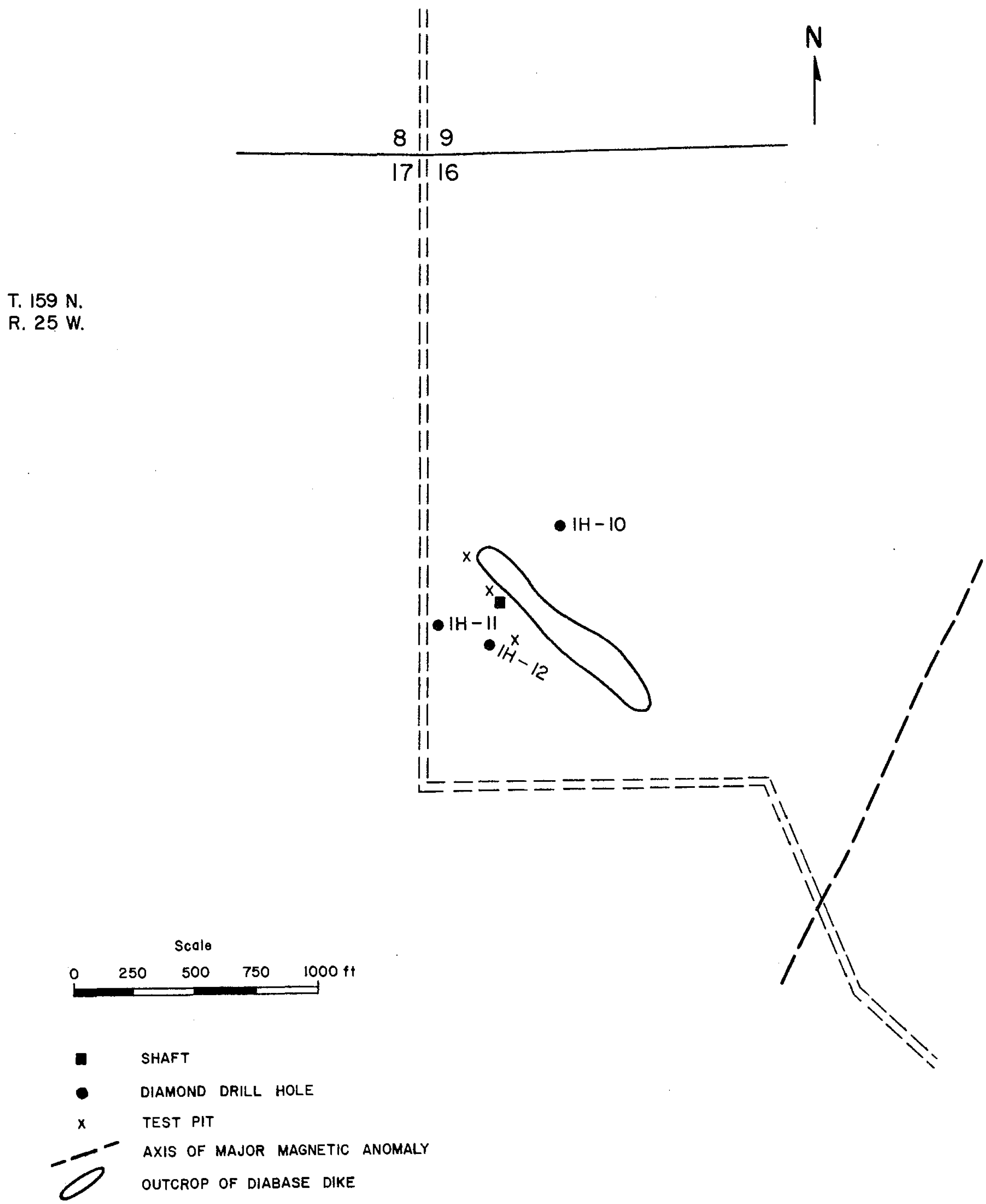

FIGURE 2: Indus Test Pit Area

tube till samples. When the split tube sampling reached bedrock, several feet of bedrock was cored to obtain geologic control for the geochemical surveys.

A wide VLF conductor, without magnetic response, extends southwest from the southernmost test pit shown on Figure 2. Semi-massive to massive sulfide occurs in this pit. IH-12 was drilled over this conductor encountering up to 20% pyrite-pyrrhotite.

From the vicinity of the test pit immediately north of the shaft, a VLF conductor extends across hole IH-11 to the southwest (strike N63° E). This conductor was also located by dip angle horizontal loop. Near the shaft a 10,000 gamma magnetic anomaly is coincident with the conductor. A 3,000 gamma anomaly occurs over IH-11. This magnetic anomaly indicates a steep south dip. Hole IH-11 intersected up to 5% pyrite-pyrrhotite, but it is a shallow hole and probably was not drilled deep enough or in the right location to intersect the conductor.

The general strike as measured in outcrop on the southwest side of the dike is N40°E (Listerud, 1976). As previously described, the conductors on the southwest side of the dike generally follow this strike. Outcrops of volcanic rock are not known to occur on the northeast side of the dike; however, geophysical surveys indicate a northwesterly strike.

From IH-10, which yielded up to 70% pyrite-pyrrhotite, a VLF conductor extends to the northwest across the north-south road shown on Figure 2. The strike of this conductor ranges from N53°W to N74°W. At IH-10, the conductor was also located with dip angle horizontal loop, which indicated a south dip, and horizontal loop (in-phase/quadrature). In the IH-10 area, this conductor has a coincident 5,000 gamma magnetic anomaly. A time-domain induced polarization survey gave a low resistivity and anomalous chargeability over IH-10.

About 150 feet south of IH-10 another VLF conductor, which dips south, approximately parallels the conductor in the last paragraph. At 350 feet west of IH-10, this conductor also is indicated by a weak dip angle horizontal loop response with a coincident 1,000 gamma magnetic anomaly.

Four hundred feet north of IH-10 a resistivity low with anomalous chargeability was detected.

Near the common corners of sections 8, 9, 16 and 17 on Figure 2, several VLF conductors were located along the road. The magnetics in this area was very flat.

B. Manitou Rapids

Listerud (1976) has described test pits with massive pods and disseminations of pyrite-pyrrhotite with traces of chalcopyrite in this area (Section 36, T160N, R26W), see Figure 1. A VLF conductor with a coincident 1,500 to 6,000 gamma magnetic anomaly was located which extends from the test pits to the west.

C. SW Birchdale

In this area, see Figure 1, a copper anomaly was located by geochemical surveys (Meineke, Gilgosch and Vadis, 1976). As part of the geochemical follow-up in this area, VLF and magnetic surveys were conducted. Several VLF conductors were located along the west side of Section 18. These conductors, however, were not detected by dip angle horizontal loop. The magnetics were very flat.

D. SE Manitou

In this area, see Figure 1, a zinc anomaly was located by geochemical surveys (Meineke, Gilgosch and Vadis, 1976). As part of the geochemical follow-up in this area, VLF and magnetic surveys were conducted. Conductors were located which generally followed a linear topographic depression. This depression has approximately the same bearing (N50°E) as the geologic strike. The conductors had 100 to 800 gamma associated magnetic anomalies.

E. Rainy River-Indus

At the Indus Test Pit, as previously described, the sulfides lie stratigraphically above the major regional magnetic anomaly related to the magnetite facies iron-formation. In combination with the geologic studies of this region by Ojakangas, the Minerals Division examined the Rainy River-Indus area, see Figure 1, to determine if sulfide also existed north of the magnetic anomaly. The Rainy River-Indus area is two miles northeast of the Indus Test Pit.

The magnetic anomaly was easily located. It produced a 7,000 to 20,000 gamma anomaly, the higher value occurring at lower elevations along the Rainy River. Based on inflections of the magnetic profile, the apparent thickness of the rock units producing the anomaly is approximately 900 feet with a vertical to steep dip south. The strike based on two magnetic lines spaced 600 feet apart was N89°E.

VLF electromagnetic surveys were conducted to determine if conductors occurred near the magnetic anomaly. Three conductors were located 400 to 900 feet north of the crest of the magnetic anomaly. These conductors are located on the extreme northern flank of the anomaly.

A vertical hole was drilled to test one of the conductors. Eight feet of 5% to 10% pyrite, with extensive disseminated pyrite, was intersected in volcanic rock.

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