

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS
GEOPHYSICAL SURVEYS OF AN AREA SOUTHWEST OF
INDUS, KOOCHICHING COUNTY, MINNESOTA

By M. K. Vadis and D. G. Meineke
D. G. Meineke, Supervisor of Minerals Exploration

1978

PROJECT 146
SHEET 1 of 7

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INTRODUCTION

Early mineral prospecting in Koochiching County identified massive sulfide (pyrite-pyrrothite) mineralization in the survey area. Figure 1 shows some of the test pits and a shaft in this area. Outcroppings of Lower Precambrian felsic-intermediate metavolcanic rocks are found mainly on the southwest side of a Middle Precambrian diabase dike which runs NW-SE (Figure 1). The general strike of these rocks is N40°E with a dip of 60°-70° to the northwest (Listerud, 1976; Ojakangas, Meineke and Listerud, 1977).

As part of a program to test the application of basal till exploration geochemistry in this region in 1972, the Minerals Division conducted geophysical surveys to locate extensions of outcropping sulfides beneath the glacial till. Based on electromagnetic and magnetic surveys, sites were selected for basal till sampling. Drill core samples were also obtained below the basal till. These core samples contained semi-massive pyrite and pyrrothite (Meineke, Gilgosh and Vadis, 1976; Meineke, Vadis and Gilgosh, 1976).

Further geophysical surveys were conducted in this area during 1977, the subject of this report, with the objective of obtaining data on the orientation of the rocks and conductors in this area. The outcrops of Lower Precambrian rock are restricted to a narrow band mainly on the down-ice side (southwest side) of the diabase dike and, therefore, provide little information on the overall structure of the area. The geophysical surveys were done in conjunction with a thesis study by L. W. Gladen (in preparation) at the University of Minnesota - Duluth.

The Minerals Division ran horizontal shootback EM (Crone CEM), fixed transmitter vertical loop (Crone VEM) and broadside vertical loop EM (Crone CEM), and magnetics (Geometrics Unimag) for these geophysical surveys. The resulting data is presented on the following maps:

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One conductor lies immediately northeast of the diabase dike and was drilled by IH-10 (Map 4). The IH-10 drill hole intersected semi-massive sulfide. The 1830Hz profile and the 390Hz profile do not follow each other exactly. The 1830Hz profile indicates an east-west trend for the conductor axis. The 390Hz profile indicates a N75°E trend for this conductor. This conductor was detected on three lines by horizontal shootback (Map 1) and two lines by fixed transmitter vertical loop EM (Map 4).

Another identified conductor exists on the northeast side of the diabase dike in the SW of section 9 (Map 4). The vertical loop data from this area indicates a slightly north of due west trend of the conductor axis. The possibility exists of there being one or two conductors several hundred feet to the north of this identified conductor in section 9. The horizontal shootback EM (Map 1) indicates a multiple conductor zone, but this was not confirmed by vertical loop EM.

The third conductor traced by fixed transmitter vertical loop lies southwest of the diabase dike in section 17 (Maps 5 and 6). This conductor was intersected by drill hole IH-12 and contained semi-massive sulfide. The transmitter was set up at the test pit east of IH-12 (Map 6). VLF-EM scouting from this test pit indicates a conductor which trends west, then southwest from the test pit (Meineke, Vadis, and Gilgosh, 1976). The 1830Hz profile is used to determine strike trend of the conductive zone due to the semi-massive nature of the sulfides. The vertical loop survey may indicate that the conductor trends due west from the test pit for a distance of approximately 300 feet, then breaks to a trend of S50°W (Map 6). The EM anomalies in this area are not well defined and the interpretation given is, therefore, tenuous. It appears that multiple conductors, as indicated by the broadside survey on Map 5, are complicating the interpretation.

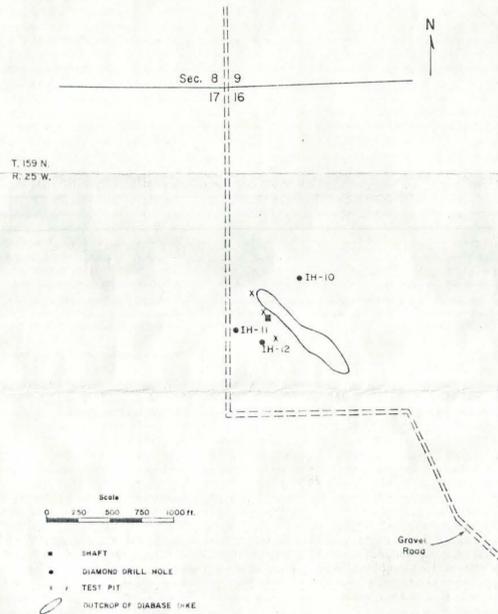


FIGURE 1 - Indus Test Pit Area

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MAGNETIC RESULTS

Two of the three main conductors have an associated magnetic anomaly (Map 2). The magnetic response from the area indicates the conductive zones have a near vertical to a steep north dip. The conductor immediately northeast of the diabase dike has a steeper dip than the conductor on the southwest side of the dike. The magnetics rapidly flatten several hundred feet north of the test pit area. The conductor which lies in section 9 has no associated magnetic response.

A major magnetic anomaly associated with magnetic iron formation lies slightly south of the test pit area and trends northeast to southwest (Map 3). Outcroppings of iron formation are shown on Map 3. The magnetics from the eastern portion of Map 3 indicate two peaks over the area of the iron formation. This may be the result of two iron formation horizons. However, the diabase dike crosses the line of traverse in approximately the same area where the magnetics decrease (between the two peaks) so the relatively low magnetic response of the diabase dike may produce the two peaks of the magnetic anomaly. Also, the dike appears to be intruded into a pre-existing fault zone. Therefore, the two peak anomalies may result from a lateral shift of the iron formation along the fault. Further work is required to determine which of these cases exist. The general trend of the magnetic iron formation may be established and is approximately N40°-50°E.

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- Map 1 - Horizontal shootback EM
- Map 2 - Magnetics
- Map 3 - Magnetics
- Map 4 - Fixed transmitter vertical loop EM
- Map 5 - Fixed transmitter vertical loop and broadside vertical loop EM
- Map 6 - Fixed transmitter vertical loop EM

EM RESULTS

The horizontal shootback EM indicates several conductors in the area (Map 1). Most of the major conductors lie in the area of the test pits and shaft. The EM conductors from near the shaft and test pits appear to be at a relatively shallow depth and have a near vertical to steep north dip. The main conductors are the ones which exist in the area of where IH-12 was drilled, the one where IH-10 was drilled, and a conductor which is north of the shaft - test pit area in sections 8 and 9, T. 159N., R. 25W. There are several other EM responses which appear to be of relatively minor amplitude and importance to indicating conductive zones or localized geological structure.

The vertical loop fixed transmitter data from Maps 4, 5 and 6 indicate that fairly continuous conductors appear to exist to the northeast and southwest of the diabase dike. There are three main conductors which are intersected and respond to the horizontal shootback in the area. These three conductors also respond to the fixed transmitter vertical loop EM. Two frequencies were run on the fixed transmitter vertical loop system: 390Hz and 1830Hz. The two frequency responses do not produce the same data plot. This is probably due to the semi-massive nature of the sulfides. For structural purposes, the 1830Hz profile will be used.

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REFERENCES

- Listerud, W. H., 1976, Sulfides in the Birchdale-Indus Area, Koochiching County, Minnesota: Minnesota Department of Natural Resources, Division of Minerals, Minerals Exploration Section, Report 26, 21 pages.
- Meineke, D. G., Gilgosh, M. A. and Vadis, M. K., 1976, Exploration Geochemistry of Quaternary Deposits in Northwestern Koochiching County, Minnesota: Minnesota Department of Natural Resources, Division of Minerals, Minerals Exploration Section, Report 36-7, 69 pages.
- Meineke, D. G., Vadis, M. K. and Gilgosh, M. A., 1976, Geophysical Surveys Conducted in Northwestern Koochiching County, Minnesota: Minnesota Department of Natural Resources, Division of Minerals, Minerals Exploration Section, Report 36-8, 10 pages.
- Ojakangas, R. W., Meineke, D. G. and Listerud, W. H., 1977, Geology, Sulfide Mineralization and Geochemistry of the Birchdale-Indus Area, Koochiching County, Northwestern Minnesota: Minnesota Geological Survey, Report of Investigations 17, 78 pages with bedrock geologic plate.

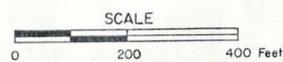
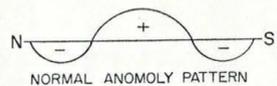
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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
 DIVISION OF MINERALS
 HORIZONTAL SHOOTBACK ELECTROMAGNETIC
 SURVEY OF AN AREA SOUTHWEST OF INDUS,
 KOOCHICHING COUNTY, MINNESOTA

By M.K. Vadis and D.G. Meineke
 D.G. Meineke, Supervisor of Minerals Exploration

CRONE CEM SYSTEM

- 300' Tx-Rx SEPARATION
- x 390 Hz (DIP ANGLE)
- OUT OF PHASE COMPONENT
- 1" = 10° RESULTANT DIP ANGLE
- 1" = 10% OUT OF PHASE

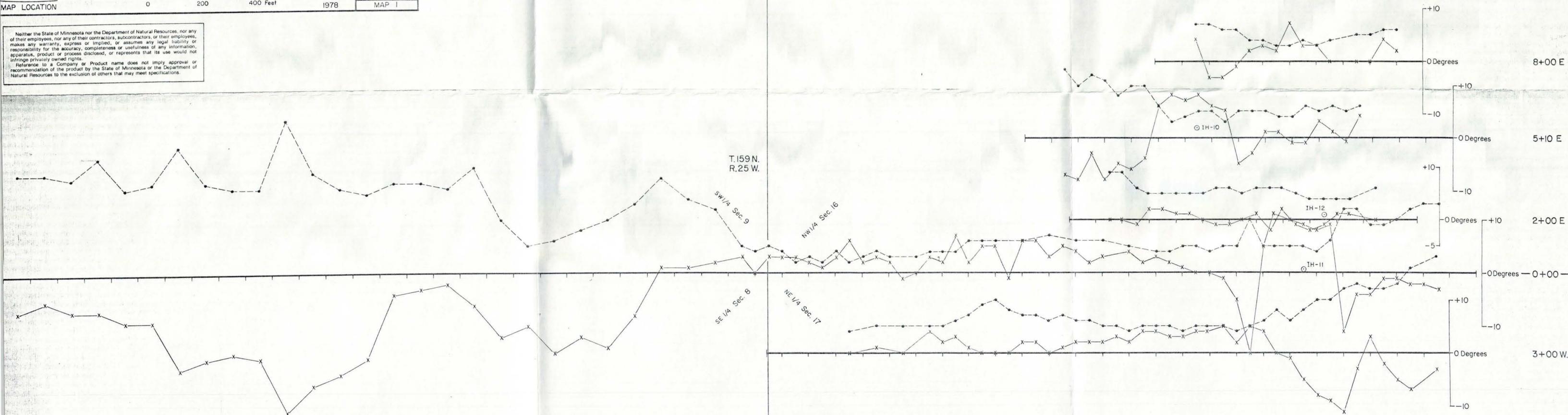


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 PROJECT 146
 MAP 1

1978

MAP LOCATION

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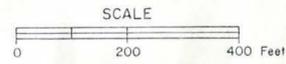
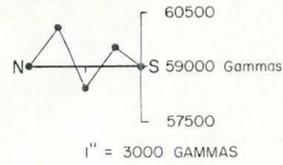


MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

MAGNETIC SURVEY OF AN AREA SOUTHWEST
OF INDUS, KOOCHICHING COUNTY, MINNESOTA

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GEOMETRICS UNIMAG PROTON MAGNETOMETER



1978

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MAP 2



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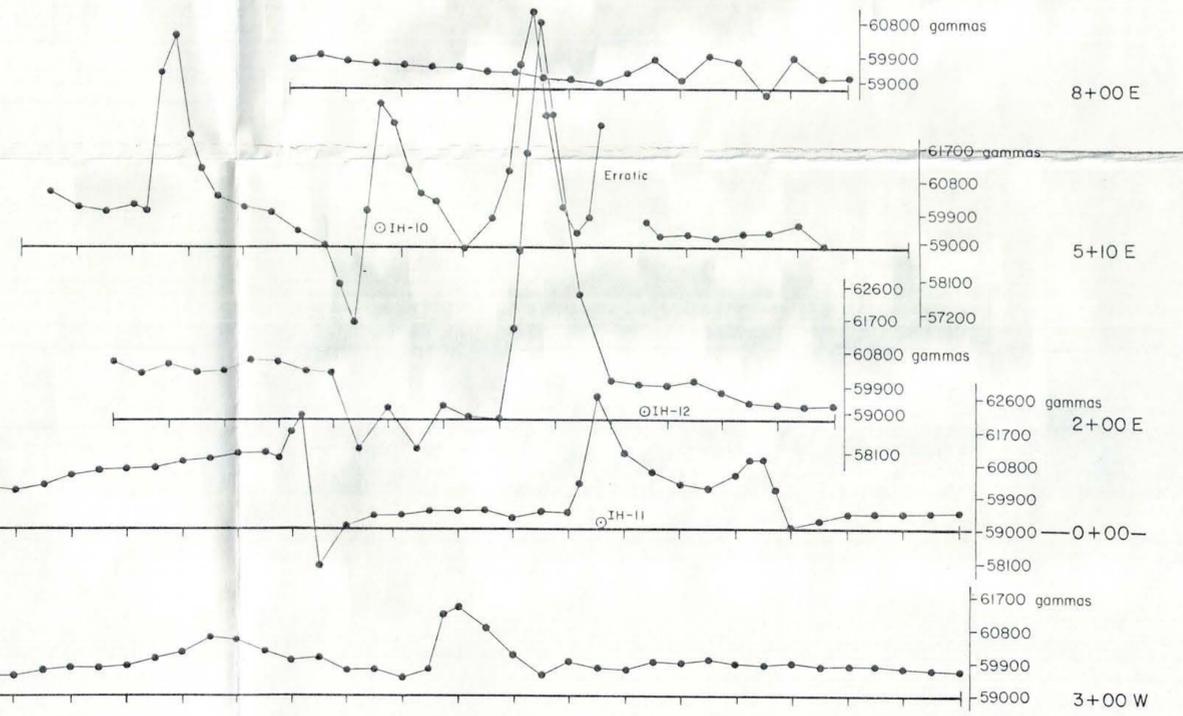
T. 159 N.
R. 25 W.

SW 1/4 Sec. 9

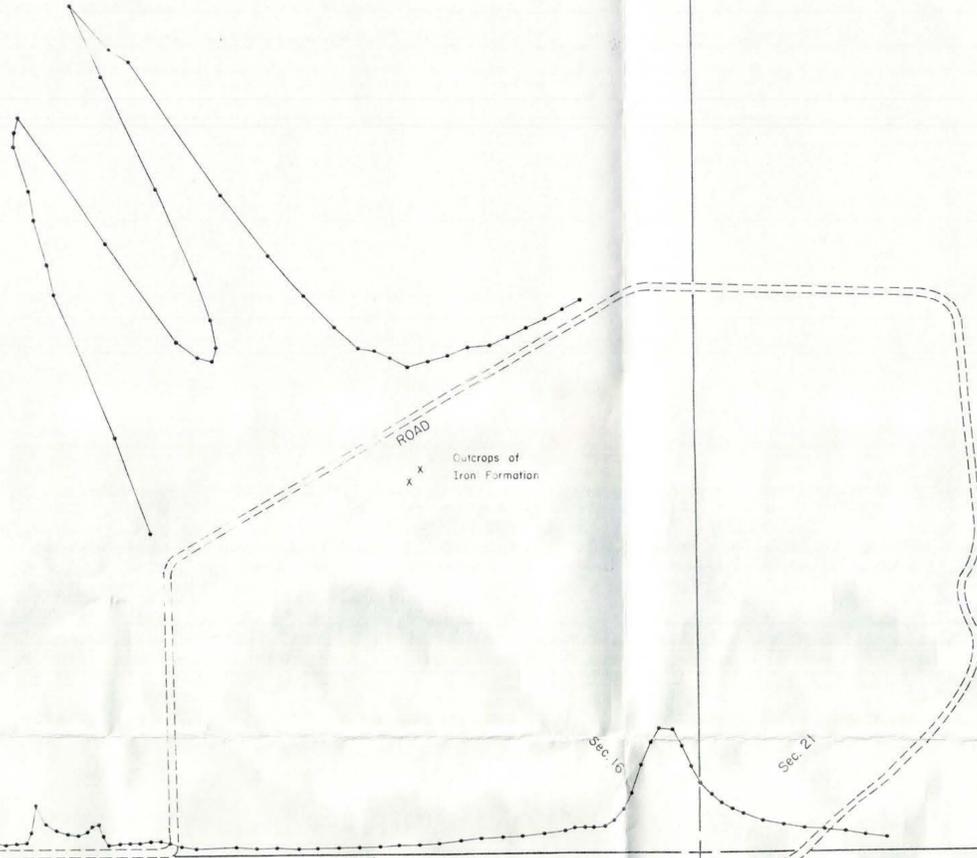
NW 1/4 Sec. 16

SE 1/4 Sec. 18

NE 1/4 Sec. 17



T.159 N.
R.25 W.

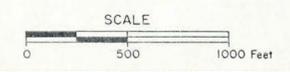
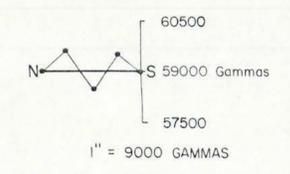
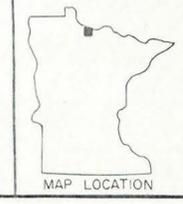


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GEOMETRICS UNIMAG PROTON MAGNETOMETER



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MAP 3

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS

FIXED TRANSMITTER VERTICAL LOOP EM SURVEY OF
AN AREA SOUTHWEST OF INDUS,
KOOCHICHING COUNTY, MINNESOTA

By M.K. Vadis and D.G. Meineke
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CRONE VEM SYSTEM

RIGHT WAY CROSS-OVER



1" = 10°

1830 Hz

390 Hz

TREND OF CONDUCTOR AXIS



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MAP 5

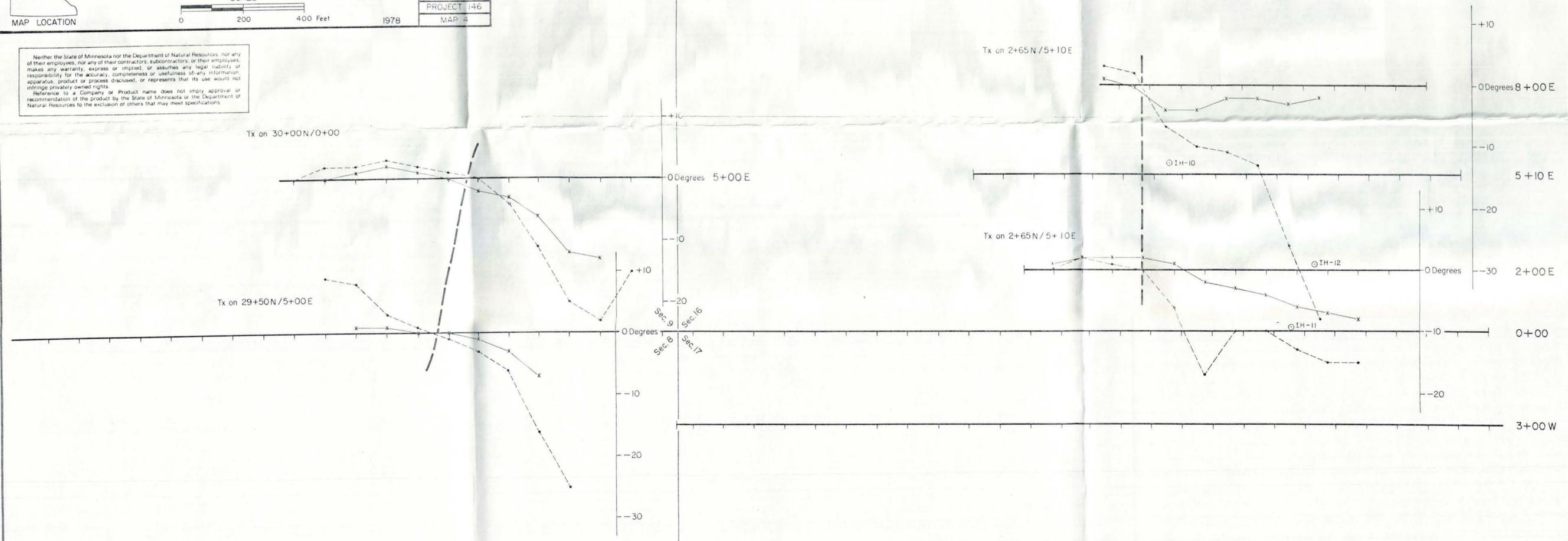


MAP LOCATION

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T. 159 N.
R. 25 W.

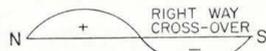


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FIXED TRANSMITTER & BROADSIDE VERTICAL LOOP EM
SURVEY OF AN AREA SOUTHWEST OF INDUS,
KOOCHICHING COUNTY, MINNESOTA

By M.K. Vadis and D.G. Meineke
D.G. Meineke, Supervisor of Minerals Exploration

CRONE VEM SYSTEM



1" = 10°

1830 Hz

390 Hz

CRONE CEM SYSTEM

BROADSIDE V-LOOP 390 Hz

SCALE



MAP LOCATION

SHEET 6 of 7
PROJECT 146
MAP 5



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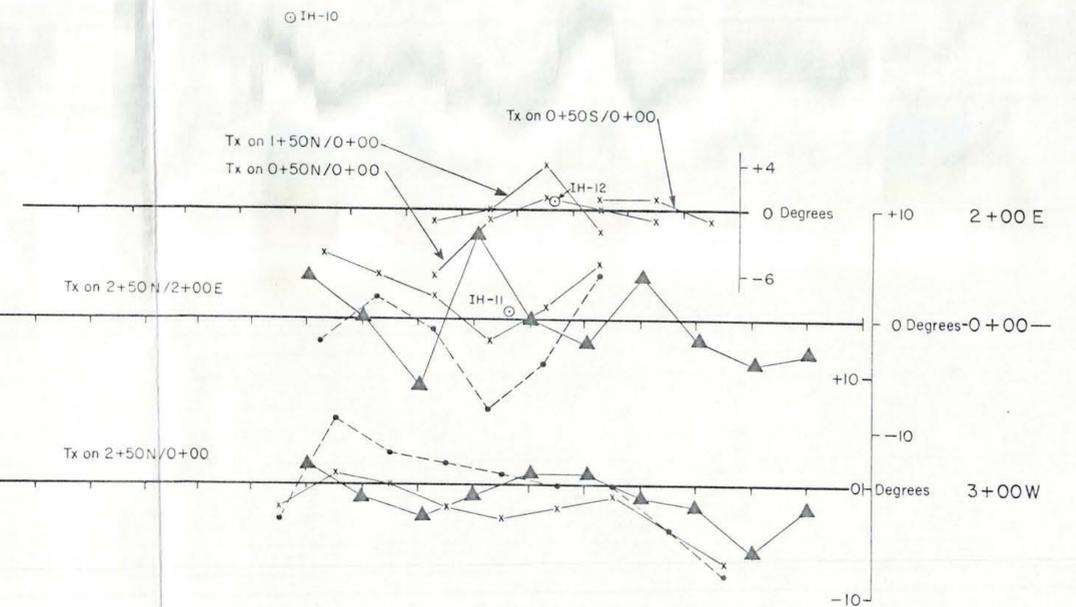
T.159N.
R.25W.

SW 1/4 Sec. 9

NW 1/4 Sec. 16

SE 1/4 Sec. 8

NE 1/4 Sec. 17



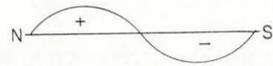
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FIXED TRANSMITTER VERTICAL LOOP EM SURVEY OF
 AN AREA SOUTHWEST OF INDUS,
 KOOCHICHING COUNTY, MINNESOTA

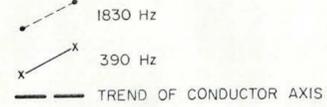
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CRONE VEM SYSTEM

RIGHT WAY CROSS-OVER



1" = 10°



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 MAP 6



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T.159 N.
 R.25 W.

SW 1/4 Sec. 9

NW 1/4 Sec. 16

SE 1/4 Sec. 8

NE 1/4 Sec. 17

Tx at west end of Test Pit

⊙ IH-10

▲ Tx

