DL-3
PRELIMINARY GEOLOGIC DATA DIAMOND-DRILLING FOR GEOLOGIC INFORMATION IN THE MIDDLE PRECAMBRIAN BASINS IN THE WESTERN PORTION OF NORTHERN MICHIGAN

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Figure 1. Cross section showing gross structure at DL-3. 2

INTRODUCTION

This report presents more geologic data than appear in the Engineering Report for DL-1, issued in Grand Junction. More geologic information also will follow in a final report on all holes. In that report thin sections and chemical analyses will be reported along with correlations from hole location.

LOCATION (Lat. 46°44'9" N., Long. 87°54'17" W.)

Drill location 3 is on the flat, sandy Yellow Dog Plains in the NW¼ NW¼ section 14, T.50N., R.29W., Marquette County, Michigan, generally north of swamps related to the Yellow Dog River, near a monument with an altitude of 1,449.47 feet, 801.39 feet east and 448.12 feet south of the northwest corner of section 14. This site is reached by driving three miles on Marquette County Highway 510 generally southwestward from its intersection with Highway 550 (southeast from Big Bay), and thence eleven miles southwestward on the Triple-A Road to a trail which is followed 1.3 miles southward. The latter trail passes through an old, abandoned lumber camp.

SITE SELECTION

The site was selected by the Michigan Geological Survey because U. S. Geological Survey gravity surveys by John Klasner suggested that in this immediate area the East Baraga (structural) Basin attains its maximum stratigraphic section of the Michigamme Formation, estimated by Klasner to be of the order of magnitude of 3,000 feet thick. As complete as possible a stratigraphic section of the formation was desired, hence this location was chosen, in terms of availability of State land.

GEOLOGY

SALIENT GEOLOGIC FEATURES DETERMINED BY DRILLING

Notable observations include the following:

1) Sand overburden with few boulders extends to a depth of 163 feet.

2) The orientation of the hole departed from the Intended vertical, by Increasing degrees to a maximum of 44° from the vertical at the terminal depth of 1634 feet. All deviations occurred within a range of bearings between due N. and N.21°E., determined by Sperry-Sun single-shot camera. The deviation is considered to be an attempt on the part of the bit to penetrate the conspicuous slaty cleavage perpendicularly.

3) A study of the above deviations and the perpendicularity of the cleavage to the core at some depths shows that the average strike of the slaty cleavage is N.79°W. Dip of slaty cleavage ranges between 40°SW, and 55°SW.

4) Using the rather consistent regionally southwestward-dipping slaty cleavage as a guide, the bedding appears in the cores to have essentially the same strike as the cleavage, N.80°W., so that this portion of the East Baraga Basin must be almost non-plunging, i. e., its fold axis locally must be essentially horizontal.

5) Bedding In the cores clips from 20°NE. (not overturned) to 60°5W. (overturned), and therefore the site lies on the southwestern limb of the syncline.

6) The commonly observed approach of many of the bedding planes to perpendicularity with the slaty cleavage indicates the nearness of the site to the axis of the syncline.

7) The Michigamme Formation consists principally of carbon-rich black and gray straight-bedded or contorted slate with thin siliceous bands containing euhedral pyrite cubes and Irregular masses. Some pyrite also occurs ±½"-long sheets, parallel to the slaty cleavage.

8) Vein quartz, generally accompanied by pyrite (and other sulfides in some cases) occurs in ubiquitous cross-cutting veinlets.

9) Pyrite occurs at all depth ranges in the hole.

10) Epigenetic chalcopyrite occurs at 343 feet, 805 feet, and between 965-1123 feet. The showing at 805 feet occurs along the footwall of a sheared, brecciated graphitic fault zone which dips 55°SW., parallel to the slaty cleavage, and hence parallel to the axial plane of the syncline.

11) Epigenetic, magnetic pyrrhotite occurs sporadically at depths between 965-1168 feet and 1235-1634 feet.

12) Carbonate veinlets occur at 585-637, 850, 1195, 1197, 1152, 1270, 1444, 1504, 1551-1556, and 1621 feet.

13) Mainly chlorite layers with some pyrite occur at 315-317, 418, 909, 1119, and 1123 feet. Most of these have conformable tops and unconformable bottoms, and appear to be metamorphosed or propylitized andesitic tuffs, probably correlated with the Clarksburg Volcanics.

14) White talcous material (talc or pyrophyllite) indicates slippage between 236-240 feet. Thin veinlets of similar material occur at 255 feet. Alteration of chlorite could cause this material to form, for example a) 3 clinochlore + 23 quartz = 5 talc + 4 water + 3 pyrophyllite, or b) 3 clinochlore + 17 quartz = 5 talc + 1 water + 3 dickite.

15) Graphite gouge indicating slippage occurs at 647, 803-805, and 1252 feet. At 647 feet shear planes, cleavage, and bedding all dip 40°SW. At 803-805 feet the fault is parallel to slaty cleavage, dipping 55°SW. At 1252 feet the fault dips 55°SW, parallel to slaty cleavage.

16) An apparently east-west-striking vertical Keweenawan diabase dike four feet thick occurs at depths from 1545-1551 feet. This is well illustrated in all the geophysical logs.

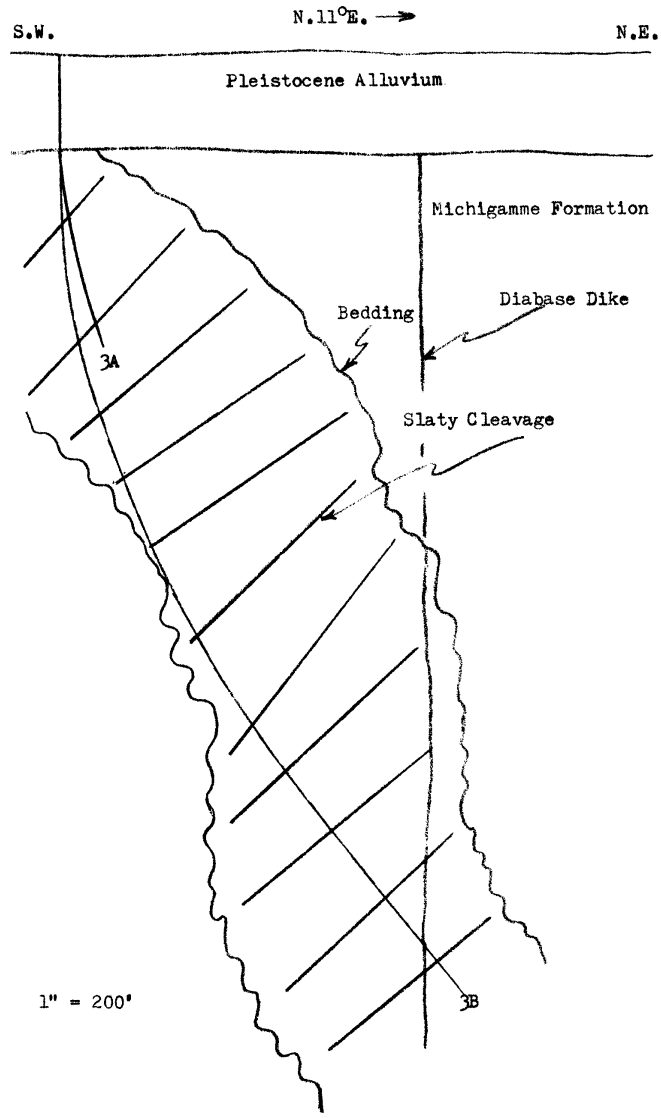

Figure 1.--Cross section showing gross structure at DL-3.

17) Scintillometer measurements of the core by Jack W. Avery reveal that with a background of 60 c.p.s., most of the core registers between 70-100 c.p.s. The two sole exceptions are as follows: Readings between 95-105 c.p.s. occur between 710-730 feet; readings between 65-75 c.p.s. occur between 1160-1170 feet. Highly radioactive zones are lacking.

18) Ammonium molybdate tests of acidized core (1:1 conc. HCl) at 2½-feet-intervals by William T. Swenor, technician, indicate that no obvious phosphorite occurs in the drilled sequence at DL-3. All tests were negative.

19) Errors in the calibration of depths involved in the geophysical logging of the hole by Birdwell caused a maximum discrepancy of 10 feet between the actual depths and the designations on the Birdwell logs, so

that 1644 on the geophysical logs, at the bottom of the hole, corresponds to an actual depth of 1634 feet. A given Birdwell depth, y', can be converted to a true depth, y, by multiplying the former by 1634/1644 = .9939; y = 0.9939y'.

20) Figure 1, on the preceding page, is a cross section of the gross structure observed in drilling. From this it can be seen that the same 400 feet of strata were being sampled twice, and were about to be sampled for the third time. Therefore, I requested that the hole should be terminated for geological reasons, as there was little hope that the base of the Michigamme Formation with possible phosphorite and iron-formation would be attained within the capacity of this rig, with NQ core required to allow a wide enough bore to permit all the geophysical logging anticipated, with this orientation of bedding, and with this deviation of the hole from the intended vertical.

21) Further, a geometric projection based upon the dips of bedding in the core and upon dips recorded on the perimeter of the East Baraga Basin suggests that the syncline must here be much steeper and deeper than anticipated by geophysics. Such a projection indicates a thickness of the Michigamme Formation more than 5000 feet, and possibly as much as 6000 feet, rather than the 3000 feet suggested by the gravity survey. This error in the geophysical depth estimate by Klasner probably relates to a much higher than expected greenstone/granite ratio of the concealed Early Precambrian, age W, rocks, and therefore relates to a much higher than anticipated density for such rocks.

22) Other rock densities also are much more than anticipated. The Birdwell bulk density log shows that the Michigamme Formation ranges in density between 2.75 and 3.08 g/cm^3, with an average value of 2.90 g/cm^3, probably as a consequence of all the sulfides in the rock. The diabase dike, at a Birdwell depth of 1552-1559 feet, displays a density peak off scale, more than 3.55 g/cm^3.

23) The gamma ray log shows that the overburden and the diabase dike are less radioactive than the Michigamme Formations. The most radioactive section of the latter occurs between Birdwell depths of 905-1017 feet.

24) The neutron log suggests extra hydrogen, presumably water, along the outer contact of the diabase dike, at Birdwell depths of 1554 and 1560 feet. Inasmuch as the bulk density log shows no significant decrease in density at these points, water-filled fractures are not suspected. Instead, it is presumed that the diabase magma assimilated water from a wet Michigamme Formation to yield hydrous minerals in its chilled zone.

25) Jack Van Alstine suggests that the self-potential and resistivity peaks centered around Birdwell depths of 1157, 129y, 1430, 1606, and 1618 feet are related to a diminution of graphite content in the Michigamme Formation. The peak centered around Birdwell depth of 1557 feet is related to the diabase dike. Apparently the self potential and resistivity logging could not distinguish the ubiquitous pyrite in the Michigamme Formation from the pyrrhotite and chalcopyrite.

COMPLETE DRILL LOGS

Inasmuch as many valuable details are included in Jack W. Avery's on-site logs, these are being reproduced in their entirety, for the benefit of the public. It should be noted that drilling was interrupted at 495 feet because deviation from the vertical of 16° was considered excessive for that depth. This segment of drilling was named DL-3A. After being cemented, the hole was re-entered and redrilled with less deviation. The latter drilling was named DL-3B. Early core obtained in this re drilling is oriented by the portion of cement, and by Sperry-Sun camera measurements. This orienting technique may have further application elsewhere, in other drilling campaigns.

RECOMMENDATIONS FOR FURTHER EXPLORATION

While no ore grades or tonnages were penetrated by the drill, sufficient showings of chalcopyrite suggest that the area deserves further exploration for copper. Propylitization of andesite tuffs fortifies this conclusion. Presumably these effects relate to Keweenawan hydrothermal activity. It is suggested that the area should be covered by an integrated geophysical survey to search for appropriate drill targets. One difficulty that may be encountered is the widespread graphite and pyrite conductors which will tend to mask chalcopyrite mineralization. The co-occurrence of pyrrhotite and chalcopyrite suggests that magnetic surveys of high resolution may aid in the location of targets. The correlation of some chalcopyrite occurrences with minor faulting parallel to slaty cleavage (which is parallel to the axial planes of folds) suggests that such axial planes may be more favorable for mineraligation. The intersections of such southwestwardly-dipping axial planes with the east-west-striking vertical fractures parallel to the Keweenawan diabase dikes may yield potential gently-plunging linear ore shoots that should plunge gently westward.

If drilling is necessary, hammer drilling probably would maintain much straighter holes in the Michigamme Formation, and such drilling combined with geophysical logging should suffice for exploration. However, the chalcopyrite down the hole was not obvious on the self-potential and resistivity logs. Perhaps a real ore deposit would be revealed by such, logging. David W. Snider suggests that IP and pulse EM logs should correct this deficiency.

Routine geochemical prospecting is not considered to be suitable unless accompanied by an extensive study of Pleistocene sedimentation.