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REVIEW OF THE GEOLOGY OF THE JULIAN LAKE DEPOSIT

April 1963

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INTRODUCTION

The trench stripping project undertaken in November 1962 exposed the iron formation across over 2200 feet of the Julian Lake deposit and provided, for the first time, a virtually complete exposure across the ore body. Mapping and study of this exposure showed that there are six basic mineralogic varieties of the iron formation and that they occur in at least 76 distinct bands across the trench area.

These varieties, the secondary features and the multiple banding were recognized during the 1959 geologic study, but the lack of complete exposure and other aspects of the study allowed only the mapping of the large stratigraphic units within the deposit. As a result, the 1959 geologic map emphasizes the stratigraphic interpretation and does not readily convey the nature of the mineralogy of the deposit.

The Julian Deposit - Geology Plan II, the cross sections and this report are the result of a re-interpretation of the 1959 data in terms of the evidence exposed in the trench area. This interpretation is of limited value, however, because the whole deposit should be re-examined and studied to properly correlate outcrop and drill hole evidence with the trench area exposure. However, the need for a re-interpretation of the deposit has justified the preparation of the new map and sections.

This report should be considered as a summary amendment report, covering only the re-interpretation of the deposit. Details concerning the 1959 work and the trench project will be found in separate reports. A more specific geologic study and report should be deferred until further field work and drilling have been accomplished.

MINERALOGY

The revised mineralogic classification of the Julian Lake iron formation is given below. It is slightly different from that developed in 1959 in that the six basic varieties occur as rock forming stratigraphic units which may be modified by secondary mineralogic features.

A distinction is made between specular hematite and granular hematite. This appears to be the basic mineralogic feature responsible for the occurrence of most of the different bands. The evidence strongly indicates that the shinney, platey specular hematite is the metamorphic ferric oxide mineral and the dull, granular hematite is martite; that is, hematite derived from ferric-ferrous metamorphic magnetite by the post metamorphic oxidizing environment which accompanied the leaching of the deposit. This secondary oxidizing-leaching event is responsible for the variable friability of the deposit and the irregular distribution and amounts of the secondary iron and manganese minerals.

Basic Mineralogic Varieties

Quartz-Specular Hematite (Silicates). This material consists of foliated quartz-specular hematite with variable amounts of a white to cream colored material dispersed through the rock. This cream colored material is apparently the altered remains of a silicate mineral which has been leached out. The unweathered crystals have not yet been found in the Julian deposit, but similarly occurring material in the Wapussakatoo Mountains contains anthopolite. Its distinctive appearance may, in part, also be due to intense shearing.

Quartz-Specular Hematite. This material consists of massive to foliated quartz-specular hematite. It is generally quite free of alteration products but is often leached and friable.

Quartz-Specular Granular Hematite. This variety is usually hard, massive, fine grained and limonitic. It consists of quartz and granular hematite which is probably martite, representing an oxidized quartz-magnetite.

Ferruginous Quartzite. This variety is actually lean iron formation, consisting of quartz with small amounts of granular hematite, limonite, and goethite. It is brownish, light colored and generally friable.

Manganiferous Variety. The manganiferous bearing material occurs in two forms: hard, fine grained, manganiferous, cherty hematite and/or specular hematite; and soft, earthy, manganese oxides, mostly pyrolusite. The hard, cherty variety occurs in discreet layers while the secondary pyrolusite may have permeated into other rock types.

Modifying Mineralogic Varieties

Sericite Seams. Soft, clay-like sericite and mica representing altered, late stage metamorphic injections or pegmatites.

Introduced Material. Vein-like or impregnations of sponge textured, red-brown material containing goethite, hematite, sometimes with large plates of hematite and magnetite (now martite) octahedrons and with or without quartz. This material apparently was mobile during the late stages of metamorphism and it settled in fractures and other porous parts of the deposit, particularly towards the south side.

Secondary Iron Oxides. Red, earthy hematite and/or yellow-brown limonite is common throughout the deposit in degrees varying from a slight discoloration of the rock to a sandy "soft ore" replacement. It preferentially occurs with the specular-granular and granular varieties.

Siliceous Goethite. A brown, hard, porous material consisting of silica and goethite, not greatly unlike a gossan. Believed to represent completely altered silicate and/or carbonate bands.

Fine Grained. Aphanite, very fine grained, hard material consisting of a chert-hematite mixture, occurs in thin bands and appears to have some association with the manganiferous bands.

The particular combination and relative proportions of the basic mineralogic varieties of the iron formation occurring across a band of mapable width serve to identify a stratigraphic unit.

STRATIGRAPHIC UNITS

The rock stratigraphic units mapped across the trench change so rapidly and with such irregularity that if there is any systematic variation of the 76 bands it is not readily apparent. However, there are a few features about the distribution of varieties which do form a basis of stratigraphic classification which can be recognized in other parts of the deposit.

The trench internal 9+80 to 12+90 contains several occurrences of ferruginous quartzite. Other occurrences are known to the east, west and in holes 2 and 8. While any one ferruginous quartzite lens is likely to pinch out, it seems apparent that the zone containing the ferruginous quartzite bands is a continuous zone and can be considered as a distinct stratigraphic unit. A few other occurrences of ferruginous quartzite are known, but it appears that they are most likely isolated lenses of lean material.

The quartz-specular silicate variety appears to occur in substantial quantities only near the outer edge of the deposit and is a separate stratigraphic unit. It appears to occur twice along part of the north side of the deposit, whether there are two distinctly separate bands or one interfingered with other material is not known.

The map and sections accompanying this report have been drawn using the above mentioned recognizable units as the principal basis of corelation. The variety designations assigned to the numerous outcrops and drill hole intervals are those assigned in 1959. The small si... of many of the outcrops may present a false impression of the actual predominating variety in the outcrop area. Thus the whole deposit should be re-mapped and several new exposure areas made in order to properly map the deposit.

The great number of individual bands and their distribution suggests that rapid mineralogic variety changes can be expected along strike and down dip. This expectency is a natural consequence of the shallow water sedimentary environment, where facies changes would naturally occur. Evidence for this can be seen in that only about 30 feet of quartz-granular variety separates quartz-specular from quartz-specular silicate near station 19+60 in the trench area whereas along the bench to the east at least 300 feet of quartz-specular granular hematite with a band of fine grained variety separates these same two units.

The increase in the width of the deposit from around 1600 feet on the west to 2400 feet and greater in the eastern and central parts is probably due to a combination of stratigraphic and structural thickening of the iron formation.

STRUCTURE

The interpretation of the features observed in the 1959 program indicated that the deposit was basically an overturned syncline modified by later cross folding. This interpretation was based largely upon a fairly symmetrical sequence of large scale variations on either side of the ferruginous quartzite along the bench exposure on the east side of the deposit and other supporting evidence.

The evidence from the trench area, however, indicates a more non-symmetrical sequence, both in varieties and space. If one looks for strati-graphic units symmetrically located on either side of the ferruginous quartz-ite member they cannot be found unless changes in variety are allowed.

The quartz-specular unit at 7+60 to 8+70 should, on the basis of miner-alogy, corelate with the unit at 17+35 to 19+48, but such a corelation greatly distorts the space relationships and completely eliminates the northern expression of the iron formation found from 2+00 to 7+60. An alternative to this and other objections would corelate the quartz-specular unit (7+60 to 8+70) with a band of mixed quartz-specular and quartz-specular granular found at 13+65 to 14+55 and the quartz-specular from 17+35 to 19+48 would have to change to all quartz-granular at 3+80 to 4+70 on the south side of the syncline to arrive at any interpretation that is spatially nearly balanced. This is the corelation made in constructing the cross sections used for the deposit as a syncline.

However, the fact of the matter is that the evidence can readily be interpreted on a non-synclinal basis, in which case the deposit would have to be the outcrop expression of a dipping body of iron formation over a thousand feet thick and of great depth extent. Such a thickness would be twice the general thickness for the Wabush area.

Under either the synclinal or regular outcrop interpretation, the actual dip of the south half of the deposit is still open because of the fact that the south dipping foliation is probably completely independent of the actual dip of the body.

A recent study of the ground and aerial magnetic evidence shows that 90% of the magnetic anomaly is due to magnetite bearing material lying below elevation 1000 assuming that there is no permanent magnetism in the deposit. The non-symmetrical anomaly, if it is caused by iron formation and not by other magnetic rocks north of the deposit, further indicates that the iron formation below elevation 1000 should dip to the north at about 30 degrees. There is no magnetic evidence for a southerly dipping body.

Some of the principal lines of evidence pertaining to the basic structural problem are presented below.

Synclinal Interpretation

A) Favorable:

1) The occurrence of muscovite schist-quartzite on both sides of the deposit.

2) Possible corelations of equivalent stratigraphic units within the deposit, some large mineralogic changes allowed.

3) Observed evidence, at least locally, of near vertical to north dipping stratigraphy along south side of deposit.

B) Non-favorable:

1) The trench area exposure is clearly non-symmetrical in space and in mineralogy.

2) Magnetic evidence suggesting depths to the top of magnetic part of the I. F. which are about equal to the projected bottom of the syncline.

Regular Outcrop Interpretation

A) Favorable:

1) Non-symmetrical trench area exposure.

2) Magnetic evidence of depth and extent.

B) Non-favorable:

1) Micaceous and quartzose occurrences on the north side of deposit; such occurrences are not uncommon in the upper parts of the I. F., however.

2) Some reasonable corelations, such as the silicate and manganiferous horizons.

As the evidence is about equally divided between the two interpretations, it is concluded that more work will be required to demonstrate the nature of the basic structure.

The cross sections prepared to accompany the map and this report have been drawn using the synclinal interpretation, not because the physical evidence on hand does support such an interpretation as a reasonable minimum for the depth extent of the deposit, thus providing as sound a basis for planning future work as is possible at this stage of knowledge about the deposit.

CONCLUSIONS

The mineralogy of the Julian Lake deposit is fairly simple, in that there are only six mineralogic varieties of the iron formation and four of these have either specular hematite or martite as an essential component. The distribution of these varieties indicates, however, a complex stratigraphic sequence characterized by bands only a few feet thick and as yet undetermined lateral extent. There are only a few stratigraphic units which may be used for corelation within the deposit.

The stratigraphic evidence may be interpreted to indicate that the basic structure of the deposit is a syncline, or it may as equally well be interpreted to indicate the normal outcrop of the iron formation. As a consequence of these two interpretations, the depth extent of the deposit has yet to be determined.

There probably will be little change in the general character of the deposit along strike and similar ore can be expected both east and west of the trench exposure area to well beyond the lake shore; the only things which will change are the depths of water and overburden cover.

It is not possible to quantitatively estimate the amount of leaching within the deposit. However, there is abundent evidence, in the form of secondary iron oxides, friability and porosity, that secondary oxidation and leaching of the iron formation has occurred in virtually all of the deposit so far explored. This condition is most likely to continue indefinitely along strike and probably to depths of 900 to 1000 feet. The distribution of secondary limonite and hematite clearly shows that they are directly associated with the presence of granular hematite.

RECOMMENDATIONS

An improved geologic understanding of the deposit can be obtained through re-mapping of the deposit at a scale of 100 feet per inch or larger. Such a program, to be really worth while, should also include the opening up of two more exposures across the deposit, one on the east bench and the other on the west bench, as well as a few more short exposures in critical areas on the deposit.

Further diamond drilling of the deposit is clearly required for reserve-grade information. From a geologic point of view the hole interval should be not greater than 500 feet to insure proper corelation, but this could probably be accomplished with a 500 foot interval alternating with a 1000 foot interval on sections 500 feet apart.

In that the indicated minimum depth extent of the deposit under the synclinal interpretation is deeper than the practical depth of drilling for reserve purposes, evidence regarding the actual depth extent will have to be based upon interpretation of the stratigraphy-structure evidence obtained in the shallow holes. Such interpretation would necessarily be only qualitative. The interpretation can be changed to quantitative by a gravity survey of the deposit. Such a survey would indicate the depth and shape of the high density mass responsible for the gravity anomaly and would be a valuable guide in planning deep drill holes. A few such holes to confirm and refine the gravity model should suffice to virtually prove the presence of probable ore reserves at depth.

One of the problems which might be inherent in the ore body is the distribution of grade, recovery and other metallurgical characteristics of the ore. The evidence at hand indicates that the grade of certain mineralogic varieties seems to be about 5 percentage points different from the 35-36% iron average.

After the various stratigraphic units are recognized and defined in

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space, the drill core and outcrop samples should be metallurgically tested to determine the geology-metallurgy relationship for each important stratigraphic unit or 50 foot thickness. The location in space of the various metallurgical types of ore could then be predicted from the geologic interpretation.

Thus, predicted ore quality control information for the mine could be no better than the data it is based upon (drill core) and the accuracy of interpretation of the geology (stratigraphy-structure). For these reasons it would seem imperative to obtain as nearly as is possible 100 percent core recovery in future drilling and also to insure that drill holes are spaced sufficiently close that there is no margin for error in the geologic interpretation.

The implication of the above line of reasoning is that sampling and metallurgical testing should ideally be postponed until the geology of the deposit has been clearly worked out, and further that bulk samples for pilot plant tests should be obtained after completion of the ore quality evaluation stage.

In order that this suggested procedure not unduly delay the Julian project, it is recommended that drilling of the deposit be commenced as soon as possible.