

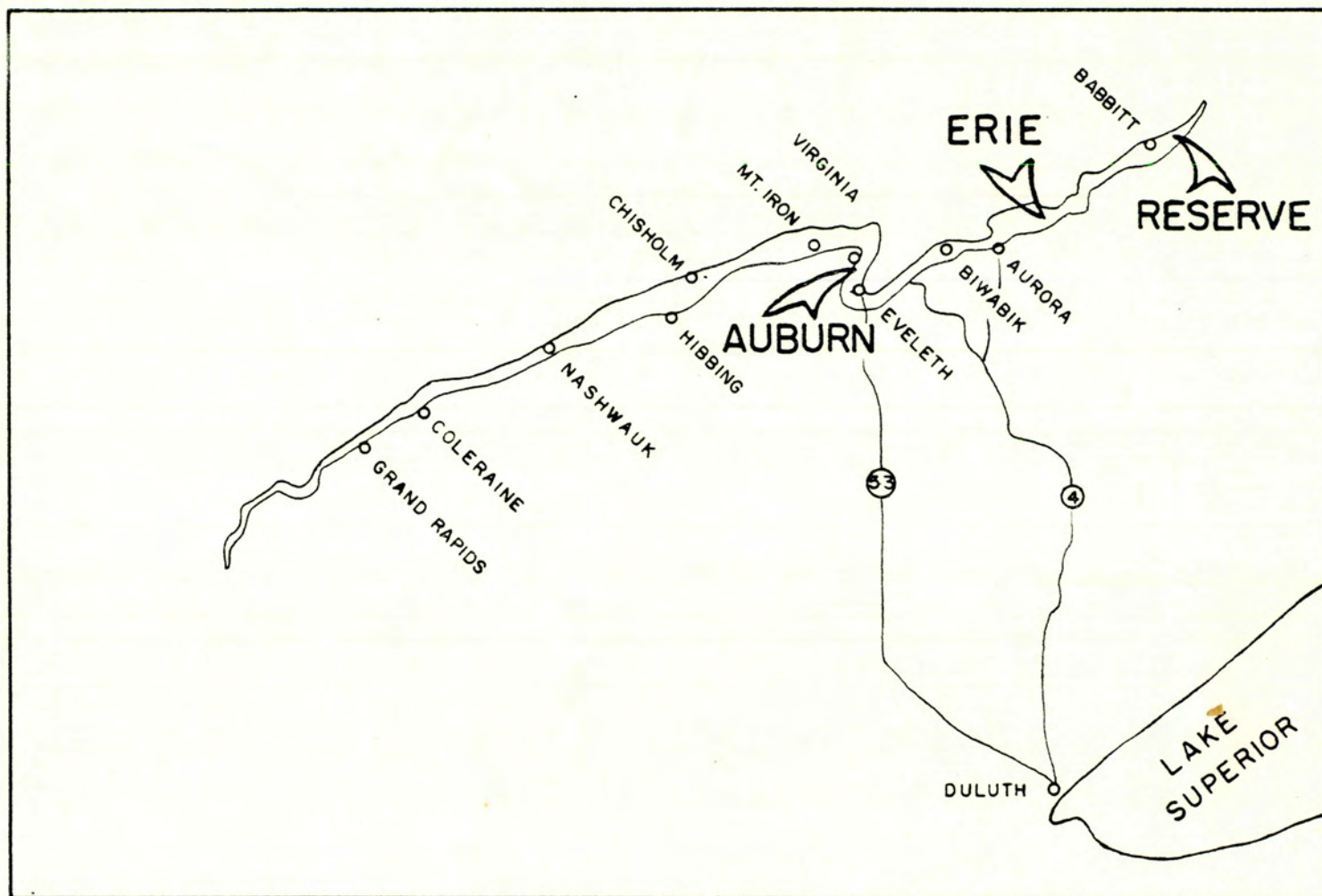
Itinerary  
for  
Lake Superior Geology Institute  
Field Trip

"Stratigraphy of the Biwabik Iron Formation"

Sponsored by the Lake Superior Geology Club

Duluth, Minnesota

May 4, 1963



INDEX MAP  
OF THE  
MESABI DISTRICT, MINNESOTA

## FOREWORD

Gentle reader, take heed, the field trip which you are about to take is not a polished affair with textbook illustrations and trip leaders able to give glib explanations for everything you are going to see. In keeping with the general objectives for which the Lake Superior Geology Institute was organized, that is, to present preliminary results of investigation in new areas of geologic interest, the leaders of this trip plan to show you their approach to subdividing the Biwabik iron formation beyond the basic fourfold subdivision first proposed by J. F. Wolff in 1917. That the problem of further subdivision is difficult can be accepted since such authorities as Gruner, Grout and Broderick, White, Schwartz and Gunderson have all come up with systems that many individuals can use but which do not appear to be generally acceptable to all workers in the field. In such a situation we may expect considerable discussion and disagreement with any system proposed. Perhaps in the anticipated clash of opinions the truth may emerge, but don't count on it. In any event the trip should be instructive to both you and the leaders, and perhaps even entertaining to the philosophers among you contemplating the state of geologic knowledge concerning this, the grandfather of all iron formations.

A secondary but highly interesting part of this trip will be the opportunity to observe the changes which take place in unoxidized iron formation from the Eveleth area eastward almost to the contact of the Duluth Gabbro. This aspect of the trip should be of particular interest to students of metamorphism and those less concerned with the local problems of iron formation stratigraphy. While controversy exists even in this area, the individualists among you won't have to accept any of our leaders' statements since the rocks themselves will be available for identification and collection.

Due to the unexpectedly large number of people participating in this trip, we are anticipating some difficulty in maintaining our schedule of arrivals and departures from each stop. Please return to the buses promptly after the horn blows. If you are left in the pit don't panic, apply for unemployment compensation.

The field trip will start at 7:30 A.M. at Hotel Duluth and proceed directly to the Auburn Mine property outside of Virginia. Upon completion of the one stop at Auburn, the buses will take us to the Erie property and proceed through four stops in various parts of the pit. Two stops are planned in the Reserve property to complete the program for the day. The buses will return to Duluth via Aurora and deposit passengers at the beginning point. Passengers wishing to remain on the Range should make private arrangements for transportation from the Reserve property or possibly from Aurora. It is anticipated that we will finish the trip around 6:00 P.M.

Lunch will be served at the third stop in the Erie pit and rest stops are planned on entering the Erie property and leaving the Reserve property. Please read, consider and observe the regulations on the following page to which we have agreed in order that we can gain entrance to the various properties.

\* \* \* \*

REGULATIONS:

Through the courtesy of the Oliver Iron Mining Division, United States Steel Corporation, Pickands Mather & Co., and the Reserve Mining Company, we have been granted permission to enter, inspect and collect small specimens on their respective properties. In return for this privilege, we have agreed to abide by the following regulations which apply not only to visitors but also to all company personnel.

1. Safety hats and goggles will be worn at all times while in the various pits. You will be issued such equipment at the first stop. This equipment is charged out to the Lake Superior Geology Club and we will have to pay for it if it is not returned at the end of the trip.

2. Picture taking of equipment is discouraged in all active pits and all pictures forbidden on the Reserve property. Arrangements will be made to check cameras at the entrance to the Reserve property. Please do not try to outwit these regulations for the fun of it. You may make it difficult for future geologists to enter these interesting areas.

3. Please use caution when approaching rock walls. The talus slopes are notoriously unstable footing and rock slides from the walls above are not uncommon in the spring. While the purists among you will want to remove specimens from the living rock, let us remind you that with taconite, it's going to take a lot of hammering. We have a long, tough day ahead of us, so save your strength. This also applies to potential mountain goats climbing up rock faces. You may endanger yourself and other people as well as delay the trip, so stay off high faces.

4. Please use discretion when hammering on rocks near other people. Taconite is tough and hard. Sharp chips have a tendency to fly in all directions at high speed. The safety goggles supplied you are not just a bureaucratic detail. Use them at all times and make sure they are on people near you before you test your arm on Minnesota taconite. It is reported to have an average crushing strength of 55,000 pounds per square inch.

Eastern Biwabik Stratigraphy  
from  
Gunderson and Schwartz  
Minnesota Geological Survey Bulletin 43

| Members<br>(Main Mesabi)<br>(Wolff, 1917) |                  | Members<br>(Eastern Mesabi)<br>(Gout-Broderick, 1919) |                                                                                                                                                                                                                                                                                                                  | Members<br>(Eastern Mesabi)<br>(approx thick, feet)<br>(Gundersen, 1958) |  | GENERALIZED COLUMNAR SECTION OF THE BIWABIK IRON-FORMATION<br>IN THE EASTERN MESABI DISTRICT, MINNESOTA            |  |
|-------------------------------------------|------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------|--|
|                                           |                  |                                                       |                                                                                                                                                                                                                                                                                                                  |                                                                          |  | Description of Submembers<br>(Notations (east) and (west) refer to areas near the eastern and western drill holes) |  |
| UPPER SLATY                               | Aub <sub>6</sub> | A (5)                                                 | calcite marble; minor diopside, wollastonite, idocrase, andradite and quartz                                                                                                                                                                                                                                     |                                                                          |  |                                                                                                                    |  |
|                                           |                  | B (16)                                                | layered (diopside) chert taconite locally with hornblende, hedenbergite and some cummingtonite and actinolite                                                                                                                                                                                                    |                                                                          |  |                                                                                                                    |  |
|                                           | Aub <sub>5</sub> | C (42)                                                | laminated (ferrohypersthene-magnetite) quartz taconite with hedenbergite and fayalite (east) and laminated (cummingtonite-magnetite) chert taconite (west)                                                                                                                                                       |                                                                          |  |                                                                                                                    |  |
|                                           |                  | D (7)                                                 | wavy laminated (actinolite-magnetite) chert taconite locally with cumming-<br>tonite and minor hedenbergite                                                                                                                                                                                                      |                                                                          |  |                                                                                                                    |  |
|                                           |                  | E (6)                                                 | quartz taconite with abundant granule structures and locally with quartz-<br>filled septaria structures; minor magnetite, cummingtonite and actinolite                                                                                                                                                           |                                                                          |  |                                                                                                                    |  |
|                                           |                  | F (20)                                                | shaly bedded (cummingtonite-magnetite) quartz taconite with minor andradite<br>and hedenbergite (east); locally abundant cummingtonite (west)                                                                                                                                                                    |                                                                          |  |                                                                                                                    |  |
|                                           |                  | G (25)                                                | quartz taconite (east) and mottled (andradite) quartz taconite (west) with<br>abundant magnetite-bearing granules throughout                                                                                                                                                                                     |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       | wavy layered (actinolite-magnetite) quartz taconite with minor hedenbergite;<br>locally with fayalite (east) and cummingtonite (west)                                                                                                                                                                            |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       | algal (magnetite) quartz taconite with abundant magnetite-rich granules and<br>pebbles; conglomeratic fabric throughout; minor hematite                                                                                                                                                                          |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       | granule (magnetite) quartz taconite with abundant magnetite-rich pebbles near<br>top and thickly layered (magnetite) quartz taconite near bottom                                                                                                                                                                 |                                                                          |  |                                                                                                                    |  |
| UPPER CHERTY                              | Aub <sub>4</sub> | K (35)                                                | wavy layered (silicate-magnetite) quartz taconite with abundant magnetite-<br>rich granules and pebbles; silicates are actinolite and ferrohypersthene (east)<br>and cummingtonite (west)                                                                                                                        |                                                                          |  |                                                                                                                    |  |
|                                           |                  | L (30)                                                | wavy layered (silicate-magnetite) silicate-quartz taconite with abundant mag-<br>netite-rich granules near bottom; silicates with magnetite are ferrohypersthene<br>and hornblende (east) and cummingtonite and actinolite (west); silicates with<br>quartz are ferrohypersthene (east) and cummingtonite (west) |                                                                          |  |                                                                                                                    |  |
|                                           |                  | M (20)                                                | layered (magnetite) fayalite-quartz taconite with ferrohypersthene (east) and<br>layered (magnetite) cummingtonite-quartz taconite (west)                                                                                                                                                                        |                                                                          |  |                                                                                                                    |  |
|                                           |                  | N (4)                                                 | fayalite-quartz taconite with ferrohypersthene (east) and cummingtonite-quartz<br>taconite (west); minor magnetite                                                                                                                                                                                               |                                                                          |  |                                                                                                                    |  |
|                                           |                  | O (17)                                                | bedded granule (magnetite) quartz-fayalite taconite with some ferrohypersthene<br>and minor cummingtonite (east) to quartz-cummingtonite taconite with mag-<br>netite-bearing granules (west)                                                                                                                    |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       | shaly quartz-fayalite taconite to fayalite taconite (east) and shaly quartz-<br>cummingtonite taconite to cummingtonite taconite (west); minor magnetite                                                                                                                                                         |                                                                          |  |                                                                                                                    |  |
|                                           |                  | P (60)                                                | argillaceous graphite-silicate-quartz taconite with abundant ferrohypersthene and<br>minor fayalite, biotite, almandine and pyrrhotite (east) and traces of pyrite, pyr-<br>rhotite and cummingtonite (west)                                                                                                     |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       | layered (magnetite) fayalite-quartz taconite with minor cummingtonite                                                                                                                                                                                                                                            |                                                                          |  |                                                                                                                    |  |
| LOWER SLATY                               | Aub <sub>3</sub> |                                                       | layered (magnetite) quartz taconite with minor cummingtonite throughout, and<br>hedenbergite and some fayalite (east)                                                                                                                                                                                            |                                                                          |  |                                                                                                                    |  |
|                                           |                  | Q (26)                                                | granule (magnetite) quartz taconite with minor cummingtonite throughout, and<br>minor fayalite (east)                                                                                                                                                                                                            |                                                                          |  |                                                                                                                    |  |
| LOWER CHERTY                              | Aub <sub>1</sub> | R (11)                                                | layered and granule (magnetite) cummingtonite-quartz taconite with hedenbergite<br>locally, and some fayalite (east)                                                                                                                                                                                             |                                                                          |  |                                                                                                                    |  |
|                                           |                  | S (8)                                                 |                                                                                                                                                                                                                                                                                                                  |                                                                          |  |                                                                                                                    |  |
|                                           |                  | T (5)                                                 |                                                                                                                                                                                                                                                                                                                  |                                                                          |  |                                                                                                                    |  |
|                                           |                  | U (10)                                                | quartz taconite with minor hedenbergite and cummingtonite; clastic quartz pebble<br>zone locally at base                                                                                                                                                                                                         |                                                                          |  |                                                                                                                    |  |
|                                           |                  | V (3)                                                 |                                                                                                                                                                                                                                                                                                                  |                                                                          |  |                                                                                                                    |  |
|                                           |                  |                                                       |                                                                                                                                                                                                                                                                                                                  |                                                                          |  |                                                                                                                    |  |

FIGURE 5. — Generalized columnar section of the Biwabik iron-formation.

SW-SW  
28-58-17

SE-SW  
17-58-17

NW-NW  
20-58-17

SW-NW  
20-58-17

SE-NW  
20-58-17

NE-NW  
20-58-17

UPPER  
LOWER  
CHERTY  
SLATY

LOWER  
LOWER  
SLATY  
CHERTY

QUARTZITE

GEOLOGIC MAP OF  
AUBURN MINE  
SCALE 1"=400'

N

DIP

LEGEND

- GEOLOGIC CONTACTS (APPROXIMATE)
- ~~~~~ OVERBURDEN
- ~~~~~ CREST OF BANK
- ~~~~~ TOE OF BANK

# STRATIGRAPHIC SEQUENCE IN THE BIWABIK IRON FORMATION

## AUBURN MINE

| <u>UPPER CHERTY MEMBER</u>                                                                                                                                                 | <u>Thickness<br/>in feet<sup>1</sup></u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 16. <sup>2</sup> Jaspery, conglomeratic and algal chert (G and S submember I)                                                                                              | 10 (est.)                                |
| Covered interval                                                                                                                                                           | 10 (est.)                                |
| 15. Nodular hematitic chert beds interbedded with laminated hematite-silicate-magnetite beds                                                                               | 48 +?                                    |
| 14. Laminated hematite-silicate-magnetite beds with subordinate jaspery chert beds and lenses                                                                              | 31                                       |
| 13. Jaspery, conglomeratic chert beds interbedded with subordinate laminated hematite-silicate-magnetite beds                                                              | 28                                       |
| 12. Cherty taconite with thin irregular magnetite beds, magnetite mottles and disseminated magnetite                                                                       | 16<br><hr/> 143                          |
| <u>LOWER SLATY MEMBER<sup>3</sup></u>                                                                                                                                      |                                          |
| 11. Laminated silicate magnetite taconite with subordinate silicate chert lenses                                                                                           | 101                                      |
| 10. Laminated non-magnetic silicate taconite, fissile in part. 6' of fissile "intermediate slate" at bottom (G and S submember Q)                                          | 37<br><hr/> 138                          |
| <u>LOWER CHERTY MEMBER</u>                                                                                                                                                 |                                          |
| 9. Cherty taconite with irregular magnetite beds. Upper 10' has dark-colored silicate rich beds instead of magnetite beds, making base of lower slaty somewhat indefinite. | 37                                       |
| 8. Mottled silicate-magnetite chert with chert "pebbles" and abundant coarse granules.                                                                                     | 11                                       |
| 7. Cherty taconite with thick (1"±) magnetite beds and mottles                                                                                                             | 84                                       |
| 6. Mottled cherty taconite with thin, very irregular magnetite beds.                                                                                                       | 14                                       |
| 5. Thick jaspery chert beds interbedded with varying proportions of thin, regular laminated magnetite-hematite-silicate-carbonate beds.                                    | 66                                       |

LOWER CHERTY MEMBER (Cont'd)Thickness  
in feet<sup>1</sup>

4. Thick hematitic chert beds with subordinate laminated zones. Some clastic sand grains near bottom. Much carbonate.
3. Jaspery, conglomeratic and algal chert with subordinate laminated zones. Sand grains common.
2. Massive chloritic (or hematitic) sandstone
1. Jaspery, conglomeratic and algal chert

8

4

8

4

236

Total thickness exposed

517POKEGAMA QUARTZITE

Base not exposed

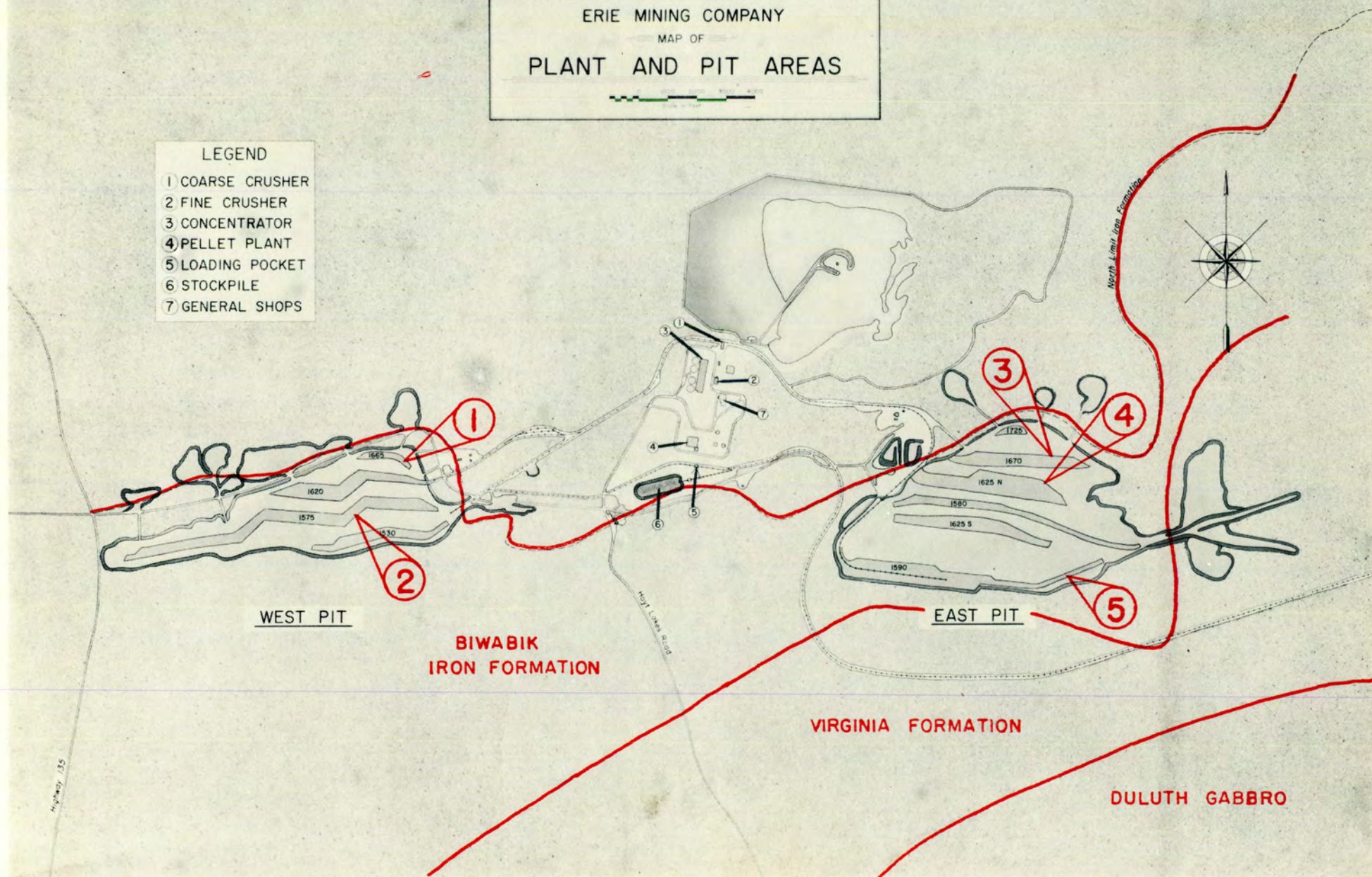
1. Units 15 and 16 measured on bank between truck road and railroad near entrance to pit. Units 1 - 5 measured on SW bank, at SE end of pit. Remainder measured above railroad.
2. Unit numbers correspond to numbers painted on the walls of the Auburn Mine and are not intended to be a new stratigraphic system.
3. The lower slaty-upper cherty contact is not well-marked and disagreement exists as to its position.

ERIE MINING COMPANY  
MAP OF  
PLANT AND PIT AREAS



LEGEND

- ① COARSE CRUSHER
- ② FINE CRUSHER
- ③ CONCENTRATOR
- ④ PELLET PLANT
- ⑤ LOADING POCKET
- ⑥ STOCKPILE
- ⑦ GENERAL SHOPS



## STOPS AT ERIE PITS

Stop 1. At this stop, we have the base of the iron formation in the West Pit. The Fokegama quartzite and the basal algal layer and conglomerate can be found in the road. The alternating chert and argillaceous layers of submember V are exposed in the outcrop.

The bank at the south edge of the pit is the Lower Slaty material P&Q. Therefore, the width of the pit here is the entire Lower Cherty member.

Stop 2. This stop shows the upper part of the Lower Cherty ore horizon. The lean submember R can be seen along the top of the bank. It is greenish in color and contains much minnesotaite and greenalite.

Directly below this is the wavy bedded submember R. This is more noticeable toward the west, (containing abundant granular jasper).

The mottled submember S is below this layer. This submember occupies most of the lower part of the bank. It also contains much jasper as well as the conspicuous pink to red carbonate mottles.

Stop 3. At the east end of the cut, we find the even bedded (U) and the alternating massive and slaty submember (V). The massive layers consist almost entirely of medium grained green silicates. Some granular jasper and flinty black chert occurs. Minor amounts of sulfides are present.

Proceeding westward, we encounter the lower wavy bedded submember (T) and the mottled submember (S). Here the mottles consist of fine grained silicates instead of the carbonates seen in Stop 2.

Stop 4. This stop is in the upper part of the Lower Cherty member and shows submembers R & S. It correlates with Stop 2. The effects of the gabbro to the southeast are quite apparent. At the extreme east end there are abundant sulfides and very coarse grained dark green silicates. Proceeding westward along the cut the grain size decreases and buff colored silicates (ferrocummingtonite) begin to appear. The cut immediately to the south is in the Lower Slaty horizon (P). This submember is much harder than elsewhere and shows recrystallization. Small garnets occur at the extreme east end.

Stop 5. At this stop, units D through K can be observed. Representative blocks of each subunit are marked. Locally abundant coarse grained silicates and some sulfides occur. A few blocks show portions of jet-pierced holes. Some septaria are evident.

# STRATIGRAPHY OF THE BIWABIK IRON FORMATION AT THE ERIE MINING CO.

## Probable Correlation to Gunderson

- A. Calcite - marble layer. (3 - 16)
- B. Lean quartz and silicate as irregular zones and layers. (10 - 35)
- Upper C. & D. Laminated zones of magnetite and silicate interlayered with thinner  
Slaty chert layers. (30 - 50)
- E. Massive granular chert with disseminated magnetite and occasional magnetite-silicate layers. Septaria. (5 - 10)
- F. Similar to C. & D. but the chert contains much disseminated magnetite and granular jasper. (25 - 35) *Highal*
- 
- G. Massive with much disseminated granular magnetite and jasper. Locally concentrated into irregular granular layering. Conspicuous carbonate or silicate mottles. (15 - 20)
- H. Similar to above except more abundant granular layering. Layering becomes more laminated toward bottom. (10)
- I. Algal structures and conglomerates. (3 - 10)
- J. Granular. Similar to G. & H. but more abundant disseminated granular magnetite. Carbonate - silicate mottles are very conspicuous. (5 - 15)
- Upper K. Thin, irregular and discontinuous magnetite layers having distinct  
Cherty boundaries separated by thicker massive layers of lean chert-silicate. The diabase sill is within this unit. (28 - 48)
- L. Moderately thick layers of laminated magnetite and silicate separated by equally thick layers of chert with much disseminated magnetite. (30 - 40)
- M. Thin, well defined magnetite layers similar to K. with more magnetite occurring as granular layers and disseminated magnetite (20 - 45)
- N. Not recognized.
- O. Alternating laminated magnetite - silicate zones and chert layers. Similar to L., but with increasing disseminated granular magnetite in the chert toward the bottom. Conglomerate near base. (15 - 35)

Probable Correlation  
to Gunderson

- 
- Lower Slaty    P.    Massive granular silicate unit with vague layering. (75 - 90)
- Q.    Black, moderately laminated argillite. (5-45)    = *Intermed. slate*
- 
- R.    Upper unit is massive with granular silicates in a chert - silicate matrix. Lower unit is similar to above with scattered thin layers of magnetite and disseminated granules. (20 - 35)
- S.    Irregular zones and mottles of dense and granular magnetite. Much disseminated magnetite in the massive chert. Abundant carbonate or silicate mottles. (15 - 35)
- Lower Cherty    T.    Thin irregular layers and granular concentrations of magnetite within thicker massive chert layers. Occasional mottles. (20 - 35)
- U.    Magnetite occurs in even bedded laminated zones with silicate and argillite and/or as even bedded concentrations of granules in the chert. (15 - 30)
- V.    Thick laminated zones of hematite, magnetite, silicate and argillite alternating with massive granular chert layers. Conglomerate, algal and/or slate usually occur at the base of this member. (6 - 30)

RESERVE MINING COMPANY  
BABBITT, MINNESOTA

LAKE SUPERIOR INSTITUTE OF GEOLOGY  
FIELD TRIP MAY 4, 1963

GENERAL:

RESERVE MINING COMPANY POLICY DOES NOT PERMIT POSSESSION OF CAMERAS ON THE PROPERTY. PLEASE CHECK YOUR CAMERA WITH PLANT PROTECTION AT THE MAIN GATE.

STOP 1:

PLEASE AVOID STANDING TOO CLOSE TO THE NORTH AND SOUTH WALLS. LARGE TACONITE CHUNKS ON TOP OF THE WALLS MAKE CLOSE INSPECTION OF THE WALLS HAZARDOUS. IN ADDITION PLEASE AVOID CLIMBING ON THE MUCKPILES AS THERE IS A POSSIBILITY OF DISLODGING CHUNKS OF TACONITE.

APPROXIMATELY 85 FEET OF UPPER CHERTY AND 35 FEET OF UPPER SLATY ARE REPRESENTED FROM THE BASE OF THE NORTH WALL TO THE TOP OF THE SOUTH WALL. THE STRATA GENERALLY DIP  $8^{\circ}$ - $10^{\circ}$  SOUTH.

THE DULUTH GABBRO LIES A FEW HUNDRED FEET TO THE SOUTH IN THIS AREA. CONSEQUENTLY THIS REGION EXHIBITS A HIGHER DEGREE OF METAMORPHISM THAN STOP NO. 2 WHICH IS ABOUT 3 MILES TO THE WEST.

MAGNETITE AND QUARTZ ARE THE PREDOMINANT MINERALS. HOWEVER, COARSE GRAINS OF HEDENBERGITE, FAYALITE, ACTINOLITE, FERROHYPERSTHENE AND HORNBLende ARE COMMON. SHINY BLACK HISINGERITE CAN BE SEEN IN THE NORTH WALL. IT IS ONE OF THE LAST SILICATES TO FORM IN THE BIVABIK IRON FORMATION AND CUTS THROUGH ALL PREVIOUS MINERAL ASSEMBLAGES.

GUNDERSEN AND SCHWARTZ ATTRIBUTE THE FORMATION OF MEDIUM TO COARSE GRAINED HEDENBERGITE, FERROHYPERSTHENE, HORNBLende AND CUMMINGTONITE TO THE INJECTION OF MANY PEGMATITE VEINS. TWO TYPES OF VEINS ARE EVIDENT IN THIS AREA. THE ACIDIC VEINS ARE ESSENTIALLY COMPOSED OF QUARTZ AND PINK ALKALI FELDSPAR. THE MAFIC VEINS CONSIST CHIEFLY OF HORNBLende.

STOP 2:

WE ARE ABOUT 3 MILES TO THE WEST OF STOP NO. 1. A MONOCLINAL FOLD IS EVIDENT IN THE NORTHEAST WALL.

GENERALLY FINER GRAIN SIZE IS PREVALENT IN THIS AREA. IN ADDITION TO QUARTZ AND MAGNETITE, CUMMINGTONITE, ACTINOLITE AND ANDRADITE ARE COMMON MINERALS.

OTHER FEATURES TO NOTE IN THIS AREA ARE THE ALGAL ZONE AND A SMALL DIABASE DIKE WHICH TRENDS SE-NW. A LARGER DIABASE DIKE ABOUT 35 FEET WIDE OCCURS APPROXIMATELY 6,600 FEET WEST ALONG THE PIT CENTER LINE FROM THE EAST END OF THE PIT. THIS DIKE ALSO TRENDS SE-NW.