NRRI/TR-2009/33

COMPILE AND MAKE DIGITAL THE LITHOLOGIES FOR ALL NRRI DRILL LOGS, WITH EMPHASIS ON THE DULUTH COMPLEX DRILL HOLES
(An addendum to an earlier NRRI database)

By

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and
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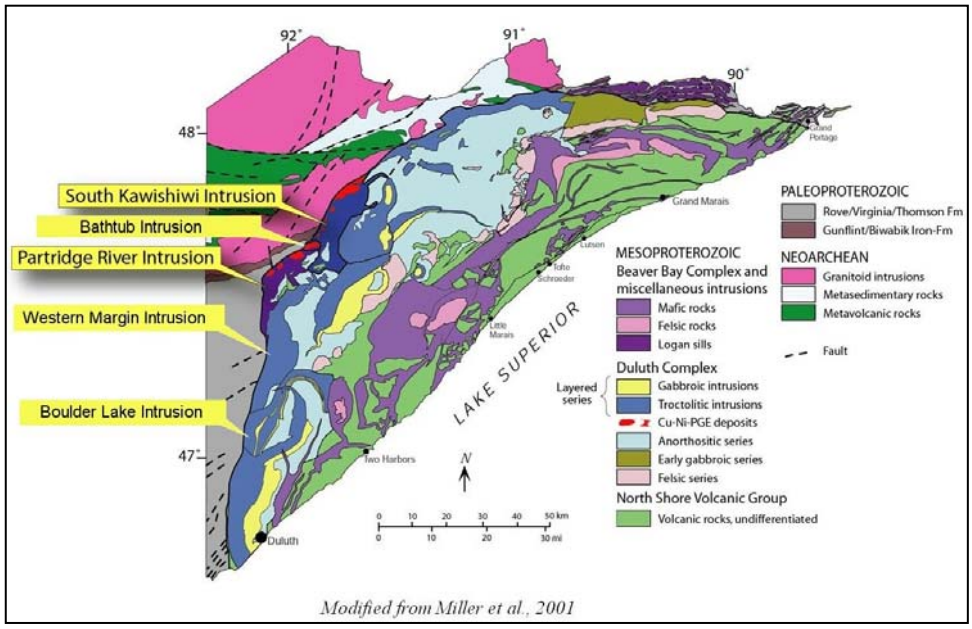

Modified from Miller et al., 2001

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Cover Photo Caption
Location of the most intensively drilled intrusions of the Duluth Complex (modified from Miller et al., 2001).

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ABSTRACT

This report and associated databases are updates on many of the holes that have been recently logged by the Natural Resources Research Institute (NRRI) in the Keweenawan Duluth Complex, the Paleoproterozoic Biwabik Iron Formation of the Mesabi Iron Range, and the Archean Deer Lake Complex of northeastern Itasca County, Minnesota.

The main emphasis of this project was to update some of the databases that were presented in an earlier NRRI report (Patelke, 2003) with regard to lithologies in Duluth Complex drill holes that were logged by the NRRI since 2003 (and discussed in Severson and Hauck, 2008). To date, all of the publically available drill holes (except for around 30 drill holes) have now been logged in the Duluth Complex by the NRRI. These 30 holes are all that are missing from either the databases in this report or the databases in Patelke (2003). It is strongly suggested that the databases herein be combined, at the user's discretion, with corresponding databases in Patelke (2003) in order to make an all- encompassing database for lithologies for all NRRI logged drill holes in the Duluth Complex.

A secondary goal of this project was to present a header file database for all the holes that were recently drilled in the Duluth Complex (post-2003). Most of these holes are not yet publically available, but data regarding drill hole locations can be gleaned from abandonment files. Combining Duluth Complex header files in this report with the similar header file in Patelke (2003) could provide an all-encompassing database of locations for all of the holes drilled to date in the Duluth Complex (pre-2010 data). This combining of the data is left to the user's discretion.

Lastly, additional goals of this project (time permitting) were to present lithologic databases for all holes logged by the NRRI in the Mesabi Iron Range and, to a much lesser extent, holes logged by the NRRI in the Deer Lake Complex. The database for the Mesabi Iron Range contains information for almost 300 drill holes (over 5,947 lines of lithologic data) in regard to the lithologic picks pertaining to informal members and submembers of the iron-formation. The data in this file is about 80% complete in that not all of the iron-formation submembers are presented for holes drilled at the Keetac Taconite mine or in the Coleraine, MN, area (the latter holes are discussed in Zanko et al., 2003).

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INTRODUCTION

Background

The primary goal of this project was to update some of the databases that were originally presented in Patelke (2003). One of Patelke's (2003) databases was a digital compilation of rock types/lithologies intersected in all of the exploratory holes that were drilled in the Mesoproterozoic Duluth Complex during 1955-2003. This compilation included the lithologic picks for drill holes that had been logged by personnel of the Natural Resources Research Institute (NRRI) during 1990-2003, as well as lithologic picks from core that had not been logged by the NRRI, but major lithologies could still be determined from existing exploration company drill logs. Since 2003, an additional 295 holes were logged in the Complex – primarily from holes in the Mesaba and Dunka Pit Cu-Ni deposits. The geology intersected in these holes was recently summarized in Severson and Hauck (2008). In addition to these Duluth Complex drill holes, numerous holes have also been logged by NRRI personnel in the Paleoproterozoic Biwabik Iron Formation on the Mesabi Iron Range, and in the Archean Deer Lake Complex (Itasca County, MN), during 2002-2008. Data compilations of the lithologies intersected in both of these groups of holes are also included in this report. A report detailing the stratigraphy of the Biwabik Iron Formation is presented in Severson et al. (2009). While there is no recent report pertaining to the geology of the Deer Lake Complex, its geology is summarized on a geologic map completed by Severson and Jirsa (2005).

Data pertaining to lithologic rock types present in drill holes that have been logged by the NRRI, but are <u>not yet included</u> in this report, include:

- 43 holes drilled by Teck American at their Mesaba deposit in the Duluth Complex (also includes data for holes logged by Teck American);
- 6 holes drilled by Encampment Resources at the South Filson Creek deposit of the Duluth Complex;
- Detailed submember lithologies, in the Biwabik Iron Formation, for 27 holes in the Coleraine, MN, area.
- Detailed submember lithologies, in the Biwabik Iron Formation, for 62 holes drilled by Keetac in the Keewatin, MN, area; and
- Detailed submember lithologies, in the Biwabik Iron Formation, for 11 holes drilled in miscellaneous areas of the Mesabi Iron Range.

During 2003-2009, considerable exploratory drilling took place in the Duluth Complex and reached a peak during 2008-2009. A second goal of this project was to provide an update on all of those recently-drilled holes (711 drill holes and wedges) in the form of a header file that lists the various drill hole locations, and other pertinent data, as determined from abandonment reports that are submitted to the State Health Department and the Minnesota Department of Natural Resources.

Seven databases are herein submitted with this report (on the CD in the back pocket) and include the following:

1. *Duluth-Complex-Header-File.xls* = locations of all holes drilled in the Duluth Complex since 2003 along with subsidiary data pertaining to length of hole, direction and inclination of hole, collar elevation, intrusion in which the hole is located, depth to footwall, etc. (most of data compiled from drill hole abandonment reports);
2. *Mesaba-Deposit-logs.xls* = lithology of 126 holes (including six wedged holes) at the Mesaba Cu-Ni deposit (formerly known as the Babbitt or MinnAMAX deposit) that were logged by the NRRI during 2005-2008. Also included are

lithologies for 23 holes in the Water Hen and Longnose deposits;

3. *Dunka-Pit-Deposit-logs.xls* = lithology of 47 holes from the Dunka Pit Cu-Ni deposit, one hole from the Serpentine deposit, and 23 holes from the South Filson Creek deposit that were logged by the NRRI during 2007-2008;
4. *Mesabi-Range-Header-File.xls* = locations of all holes logged by the NRRI on the Mesabi Iron Range along with subsidiary data pertaining to length of hole, and where the core is now stored;
5. *Mesabi-Range-logs.xls* = lithology for 289 drill holes logged by the NRRI from the Mesabi Iron Range during 2002-2008;
6. *Deer-Lake-Complex-Header-File.xls* = locations of holes (all logged by the NRRI personnel) in the Archean intrusive Deer Lake Complex along with subsidiary data pertaining to length of hole, direction and inclination of hole, etc; and
7. *Deer-Lake-Complex-logs.xls* = lithology of geologic units intersected in 15 drill holes from the Deer Lake Complex.

USER ASSUMPTIONS

There are some important overriding assumptions that must be kept in mind when using the data presented in this report that are:

1. The user should have some familiarity with Duluth Complex geology and geography, and we have assumed they have read the following:
   a) Minnesota Geological Survey Report of Investigations 58 (Miller et al., 2002) pertaining to the geology and exploration history of the Duluth Complex;
   b) Reports on the geology of the Partridge River intrusion of the Duluth Complex (Severson and Hauck, 1990) and discussions pertaining to the geology of the NorthMet Cu-Ni deposit (Dunka Road deposit – Geerts, 1991; 1994), Wyman Creek and Wetlegs Cu-Ni deposits (Severson and Hauck, 1997), and the Longnose, Longear, and Section 17 Fe-Ti deposits (Severson, 1995; Severson and Hauck, 1997);
   c) Reports on the geology of the Mesaba Cu-Ni deposit within the Bathtub and Partridge River intrusions (Severson and Hauck, 2008), and to a lesser extent, earlier reports by: Severson (1991), Severson and Barnes (1991), Severson et al. (1994, 1996);
   d) Reports on the geology of the South Kawishiwi intrusion (Severson, 1994);
   e) Reports on the geology of the Western Margin and Boulder Lake intrusions of the Duluth Complex (Severson, 1995 – referred to as the South Complex area); and
   f) A review on the PGE mineralization in the Duluth Complex (Severson and Hauck, 2003);
2. The user should have some familiarity with the stratigraphy of the Biwabik Iron Formation and the geography of the Mesabi Iron Range, as is defined in Severson et al. (2009);
3. The user should have some familiarity with the geologic map units present in the Deer Lake Complex of Itasca County as defined by Severson and Jirsa (2005);
4. The digital data included in this report are not substitutes for the original drill logs, and the logs often describe more features than can ever be digitally recorded – **Note** that scans of these same drill logs can be found at the NRRI's website at www.nrri.umn.edu.egg/;
5. The original drill logs, both in the Duluth Complex and along the Mesabi Iron Range, were used to create well

over 200 cross-sections in attempts to understand the overall geology and how geologic units correlate in the third dimension. The coding used in the databases of this report is based on those cross-sectional interpretations;

6. The data were formatted in Microsoft Excel spreadsheets, using filters to help standardize the data, and the data should be easily converted to formats used by mine modeling programs (Gemcom, MedSystem, DataMine, Vulcan, etc.);
7. Attempts were made to limit the amount of rock type entries in the databases of this report (versus Patelke, 2003) through the use of Microsoft Excel filters and subsidiary additional columns. However, even this limited list of rock types could be further shortened by future users that are well versed in the rock types present at the various deposits and mines; and
8. The various databases of this report have been broken down into specific areas, e.g. Mesaba deposit, Dunka Pit deposit, Mesabi Iron Range, and Deer Lake Complex, and **the user should combine some of these data** with previous data in the spreadsheets of Patelke (2003) as they see fit.

FUNDING

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ACKNOWLEDGMENTS

There is virtually nothing original in this work except that the databases serve as quick summaries that list the rock type lithologies, and other pertinent data, in several hundred drill holes. This project, and the project of Patelke (2003), builds on discussions that are presented in numerous previous reports, and on the observations and lithologic descriptions presented in multiple drill logs recorded by: Mark Severson, Steven Hauck, Steve Geerts, Larry Zanko, John Heine, Richard Patelke, and Marsha Meinders Patelke, with lesser amounts of logging by James Strommer and Mary Jo Kuhns. Most of the drill holes are stored in the core library of the Minnesota Department of Natural Resources (DNR) – Lands and Minerals Division in Hibbing, MN, and the DNR must be thanked for having the presence of mind for securing the drill core and any data that is associated with those holes.

EXPLANATION OF DATA FORMATS FOR DULUTH COMPLEX INFORMATION

Introduction

This section contains a summary of listings for each of the databases submitted with this report pertaining to information regarding the Duluth Complex. All of the databases of this report use the same format as established by Patelke (2003), and thus they can and **should be** combined with the databases of Patelke (2003) as the user sees fit. A breakdown of the information in each of the columns in the various databases is discussed below.

Format for Locations of Recent Drill Holes in the Duluth Complex – Header File

The database *Duluth-Complex-Header-File.xls* contains information, from abandonment reports, for all holes drilled in the Duluth Complex after 2003. The data columns in this file, as described below, are presented in the same order as in Patelke (2003 – *HEADER.xls* file) so that this file can be easily combined with the 2003 version. Note that some of the columns associated with the databases of this report do not contain any information, but are retained for "place-keeping" purposes relative to the *HEADER.xls* file of Patelke (2003).

HOLE-ID = hole numbers for core holes drilled at the following deposits and areas (see poster NRRI-2009-09 for locations of the deposits – included on the CD in the back pocket of this report):

- Nokomis and Maturi Extension deposits in the South Kawishiwi intrusion of the Duluth Complex – includes 221 holes and uncontrolled wedges (MEX-designations with W's denoting wedges) that were drilled by Duluth Metals Ltd;
- Birch Lake deposit in the South Kawishiwi intrusion of the Duluth Complex – includes 128 holes and uncontrolled wedges (BL-designations with W's denoting wedges) that were drilled by Franconia Minerals Corp.;
- NorthMet deposit in the Partridge River intrusion of the Duluth Complex – includes 171 holes (05- and 07-designations) that were drilled by PolyMet Mining Corp.;
- Mesaba deposit in the Bathtub intrusion of the Duluth Complex – includes 64 drill holes (MB-designations; 66 actual locations that include two abandoned hole locations) and 71 short holes (MBB1-, MBB2-, and MBB3-designations) that were drilled at very close-spacings in three sites prior to selecting (and eventually collecting) a bulk sample for metallurgical tests – all holes were drilled by Teck American Inc.;
- South Filson Creek deposit in the South Kawishiwi intrusion of the Duluth Complex – includes 37 holes (SFC-, S2- and FD-designations) drilled by Encampment Resources LLC;
- Dunka Pit deposit in the South Kawishiwi intrusion of the Duluth Complex – includes three holes (D02- and D06-designations) drilled by Franconia Minerals Corp.;
- Skibo deposit in the Partridge River intrusion of the Duluth Complex – includes four holes (SK09-designations) drilled by Encampment Resources LLC;
- Siphon Fault area in the Partridge River intrusion of the Duluth Complex – includes two holes (SP09-01 and SP09-02) drilled by Encampment Resources, LLC;

- Sonju Lake intrusion of the Beaver Bay Complex – includes three holes (SL02- designations) drilled by Franconia Minerals Corp.; and
- Scattered reconnaissance holes – includes four holes (FL-02-1, P-03-1, P-03-2, and FCV-02-1) drilled by Franconia Minerals Corp.

INTRUSION = listing of the informal intrusion name in which the drill hole was located (see Fig 1):

- BLI – Boulder Lake intrusion;
- BTI – Bathtub intrusion;
- PRI – Partridge River intrusion;
- SKI – South Kawishiwi intrusion; and
- SLI – Sonju Lake intrusion.

XLSFILE = this column would list which file contains assay data for a particular hole, but since these data are not yet available, there is no such listing. Therefore, the column is left blank for place-keeping purposes.

EASTSP27 = east coordinates in State Plane NAD27 (in feet) for the drill collar location.

NORTHSP27 = north coordinates in State Plane NAD27 (in feet) for the drill collar location.

COL-EL = elevation (in feet above sea level) at the collar for each drill hole. It is extremely important to **note** that the uncontrolled **wedges,** which branch outward from an initial drill hole at depth, are also listed in this column as exhibiting the same collar elevation as the collar elevation for the initial hole. The actual depth from which the wedge was started is listed in the OVB-THICK column. For example, drill hole MEX-075M in the *Duluth-Complex-Header-File.xls* has a collar elevation of 1,470 feet above sea level; whereas, a wedged portion of this same hole, designated drill hole MEX-075M-W1, was started at a depth of 1,569 feet (data listed in the OVB-THICK column) from the top of MEX-075M. See also the LITH-COMM column for specifics on where the wedges started in the initial hole.

LENGTH = total length, or depth, of each drill hole (in feet).

AZIMUTH = direction in which each hole was drilled (0-360°).

DIP = inclination of the hole at the collar location (in degrees; wherein, -90° is a vertical hole).

EASTSP83 = east coordinates in State Plane NAD83 (in feet) for the drill collar location.

NORTHSP83 = north coordinates in State Plane NAD83 (in feet) for the drill collar location.

COL-EL-MET = elevation (in meters above sea level) at the collar for each drill hole.

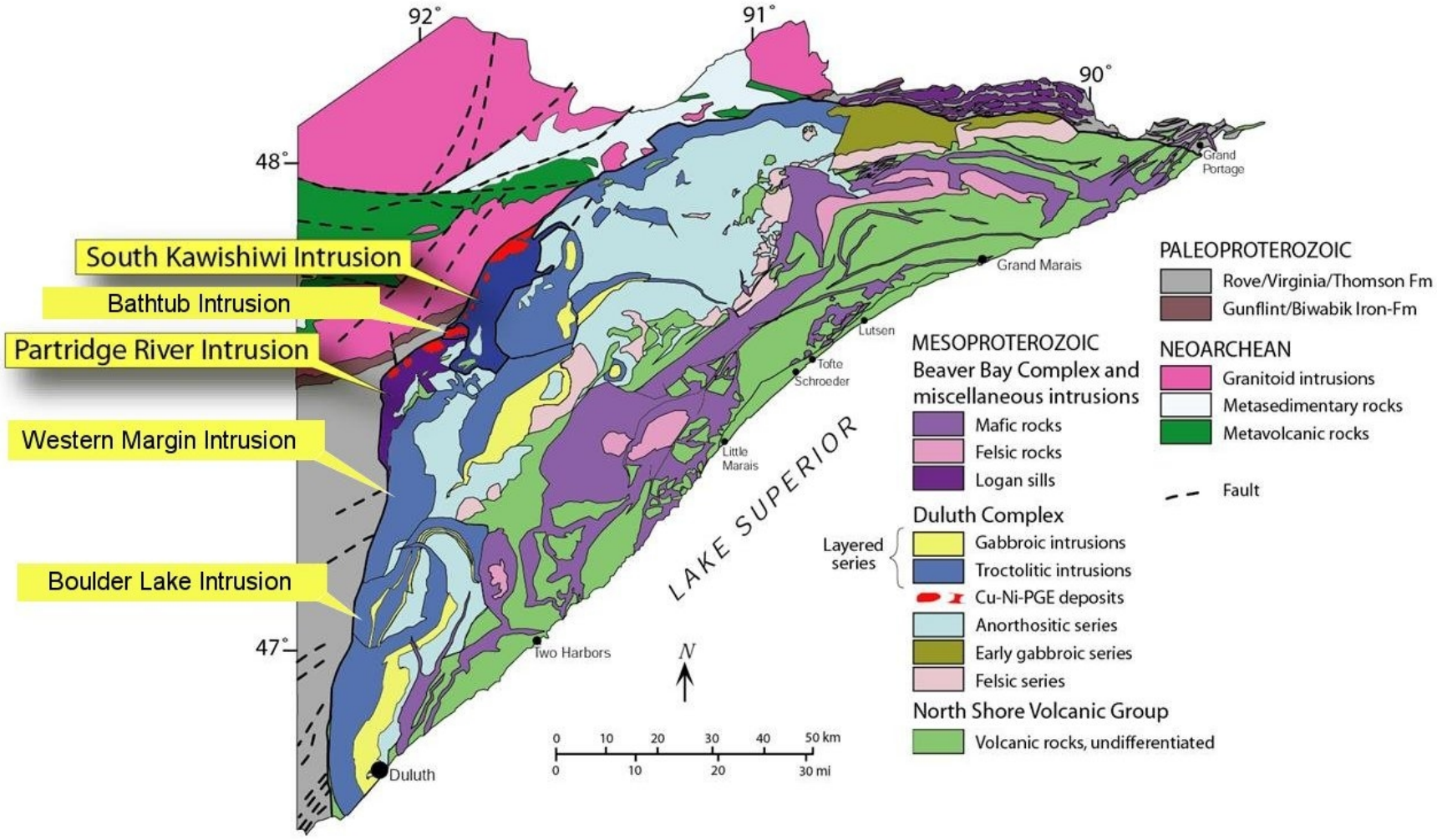
EASTUTM27 = east UTM-NAD27 coordinate (in meters) for the drill collar location.

NORTHUTM27 = north UTM-NAD27 coordinate (in meters) for the drill collar location.

EASTUTM83 = east UTM-NAD83 coordinate (in meters) for the drill collar location.

NORTHUTM83 = north UTM-NAD83 coordinate (in meters) for the drill collar location.

TOTDEPMETR = total depth of hole in meters.



Modified from Miller et al., 2001

Figure 1. Location of the most intensively drilled intrusions of the Duluth Complex.

OVB-THICK = thickness of overburden in top of hole (in feet). Note that the value listed for wedged holes is NOT the depth of overburden; rather, it is the depth down the initial hole from which the wedge was started.

FWDEPTH = depth (in feet) to footwall, e.g., basal contact of Duluth Complex with the underlying: Virginia Formation, Biwabik Iron Formation, or granitic rocks of the Giants Range Batholith. Note that the designation of NDE indicates that the drill hole, or wedge, was **N**ot drilled **D**eep **E**nough to intersect the basal contact.

CORE-RC = hole was either cored (all of the holes in this database) or consists of cuttings from reverse circulation drilling.

COUNTY = county in which the hole was drilled (either St. Louis or Lake County).

DATE-DRILL = date that the drill hole was completed.

DEPOSIT = name of deposit in which the drill hole is located as follows:

- NorthMet (formerly known as Dunka Road);
- Mesaba (formerly known as Babbitt or MinnAMAX);
- Nokomis (northwestern portion known as Maturi Extension);
- Birch Lake;
- South Filson Creek;
- Skibo; and
- Dunka Pit.

FORTY = partial list of forty acre subdivisions.

GEOLOGIST = lists the geologist responsible for logging the drill hole:

- MJS – Mark J. Severson (NRRI);
- SAH – Steven A. Hauck (NRRI);
- TDJ – Tim D. Jefferson (Teck);
- MLT – Michael L. Takaichi (Teck);
- AKA – Ashley K. Anderson (Teck);
- MJR – Matt J. Reiderer (Teck); and
- ABANLOG – data from abandonment report.

GRIDCOMP = lists the company responsible for the original grid (not listed for this report, but retained for place-keeping purposes).

GRIDEAST = grid east location on original company grid (only listed in this report for holes at the Mesaba deposit).

GRIDNORTH = grid north location on original company grid (only listed in this report for holes at the Mesaba deposit).

INITIAL? = designates whether the hole was an initial surface hole or an uncontrolled wedge drilled at depth.

LESSEE = lists the company that had the hole drilled.

QUAD = lists the USGS 7.5 minute quadrangle in which the hole is located.

RANGE = lists the Public Land Survey Range (all are Range West).

SECTION = lists the Public Land Survey Section.

SUR-UNDG = designates whether the hole was a surface or underground hole.

TOWNSHIP = lists the Public Land Survey Township (all are Township North).

VERT-ANG = designates whether the hole was vertical or angled at the collar.

NRRI-SECT = lists the particular NRRI cross-section that shows this drill hole (only applies to holes in the Mesaba deposit).

COMP-SECT = company cross-section on which this hole is displayed (none are available, but this column is included for place-keeping purposes).

BEST-REF = best reference regarding drill hole information (mostly from abandonment reports submitted to the Minnesota Department of Health with copies submitted to the Lands and Minerals Division of the Minnesota Department of Natural Resources).

HEAD-COMM = comments related to data in the header file for this hole (none are listed, but column retained for place-keeping purposes).

LITH-COMM = comments related to data in the lithology file for this hole (wedges are indicated as being drilled from a specific initial hole at a specified depth in this column).

ASSAY-COMM = comments related to data in the assay file for this hole (none are listed but column retained for place-keeping purposes).

SURV-COMM = comments related to down hole survey information (none are listed, but column retained for place-keeping purposes).

SOURCEFILE = NRRI record keeping entry that lists the various sources, such as:

- ABAN LOG-DNR GIS FILE – both the paper copy of the abandonment log, and shape files generated by Rick Ruhanen of the DNR (after obtaining a location with a hand-held GPS unit), where used to determine the hole location;
- ABANDONMENT LOG – the paper copy of the abandonment log on file at the DNR was used for the location;
- DNRABAN.MDB – a previously prepared database, generated by Rick Ruhanen of the DNR by using the paper abandonment copies on file at the DNR, was used for hole locations;
- DNRABAN.MDB, ABANLOG – includes the above category and information listed on the paper abandonment copy on file at the DNR (most of the holes in the *Duluth-Complex-Header-File.xls* were obtained in this category) ;
- DNRABAN.MDB, ABANLOG-DDHLOG – above category supplemented with information included on the detailed company drill logs; and
- TECK; DNRABAN.MDB; ABANLOG – drill hole location from company drill logs by Teck American. Paper copies of the abandonment reports at the DNR, and data from DNRABAN.MDB database.

Format for Lithologies in Drill Holes at the Mesaba Deposit

The database *Mesaba-Deposit-logs.xls* contains information, from NRRI and some Teck American logs, for holes logged in the Mesaba deposit after 2003. Additional holes included in this file include:

- 2 holes located well south of the NorthMet deposit (BA-3 and BA-5);
- 10 holes from the Water Hen deposit; and
- 10 holes from the Longnose deposit.

The data columns in this file, as described below, are presented in roughly the same order as in Patelke (2003 – *west-lith.xls*), **but** some of the columns in this report are new (indicated in red) and they should be created in the *west-lith.xls* of Patelke (2003) before the two are combined.

It is also extremely to remember that most of the holes in the *Mesaba-Deposit-logs.xls* are also in the *west-lith.xls* of Patelke (2003). However, the lithologies in *west-lith.xls* are based on earlier company

drill logs, and these should be replaced by the more recently determined lithologies (by the NRRI) in the *Mesaba-Deposit-logs.xls* file at the user's discretion.

HOLE-ID = lists the drill hole number.

FROM = start of interval relative to collar (in feet).

TO = end of interval relative to collar (in feet).

INTERVAL = interval length (in feet) measured along drill core.

ROCKTYPE = logged rock type using Figures 2 and 3 to classify the type and abbreviated as follows:

- AGT = augite troctolite;
- AGT W/MT = augite troctolite with melatroctolite (often further modified by "texture" column);
- AGT W/ORT = augite troctolite with olivine-rich troctolite (often further modified by "texture" column);
- AN = anorthosite;
- ANG = anorthositic gabbro;
- ANT = anorthositic troctolite;
- ANT W/MT = anorthositic troctolite with melatroctolite;
- ANT W/ORT = anorthositic troctolite with olivine-rich troctolite;
- BIF = Biwabik Iron Formation/ undivided with submember names as follows:
  - BIFA = Biwabik Iron Formation/A submember (chert and marble);
  - BIFB = Biwabik Iron Formation/B submember (chert and diopside);
  - BIFC = Biwabik Iron Formation/C submember (thin-bedded and magnetic); and
  - BIFD = Biwabik Iron Formation/D submember (thick- and thin-bedded).
- BOX MISSING = box of drill core was lost in transit/no longer preserved;
- BRECCIATED = self-explanatory;
- BSLT = basaltic hornfels inclusion (presumably correlative with the North Shore Volcanic Group);
- DIKE-BSLT = fine-grained, black, near-vertical, basaltic dike;
- FAULT = fault zone consisting of brecciated, busted-up, gouge-like core zones (often with poor recovery zones);
- FELD PER = feldspathic peridotite;
- GAB = gabbro;
- GAB NOR = gabbronorite;
- GAN = gabbroic anorthosite;
- GRANITE-BLDR? = possible boulder, or vein, at top of hole (only used once);
- GRAPHITE MASS = massive graphite (>70% graphite);
- GRAPHITE SEMI-MASS = semi-massive graphite;
- HAMMER = top of hole drilled by reverse-circulation (no core, but cuttings);
- HNFL = hornfels undivided (inclusion of metamorphosed Virginia Formation in the Duluth Complex);
- HNFL BDD = bedded hornfels;
- HNFL BDD PO = hornfels with conspicuous pyrrhotite laminae;
- HNFL CALC-SIL = hornfels with abundant white/bedded calc-silicate zones and beds;
- HNFL CORD = massive hornfels that consists dominantly of cordierite;
- HNFL DISRUPT = hornfels with disrupted bedding and partial melt veinlets, e.g., metatexite;
- HNFL GRAPH ARG = graphite-bearing hornfels with disseminated pyrrhotite (similar chemically to the HNFL BDD PO);
- HNFL HYBRID = unique hornfels with unexplained texture and mineralogy;
- HNFL MIXED = hornfels with highly interbedded rock types;

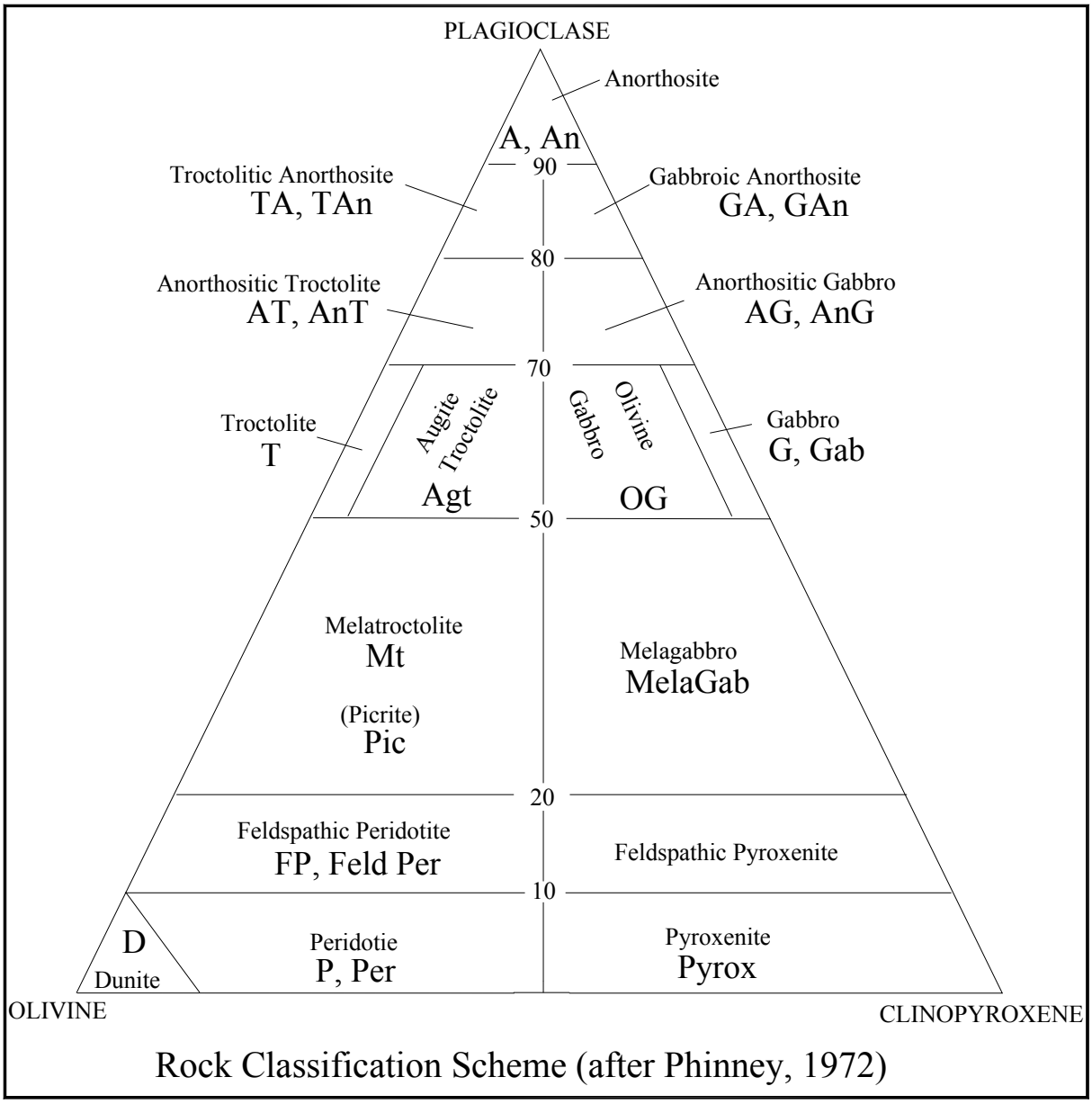


Figure 2. Rock classification scheme of Phinney (1972), based on modal percentages of minerals present; used during logging of drill holes in the Duluth Complex (both old and new abbreviations are listed for each rock type).

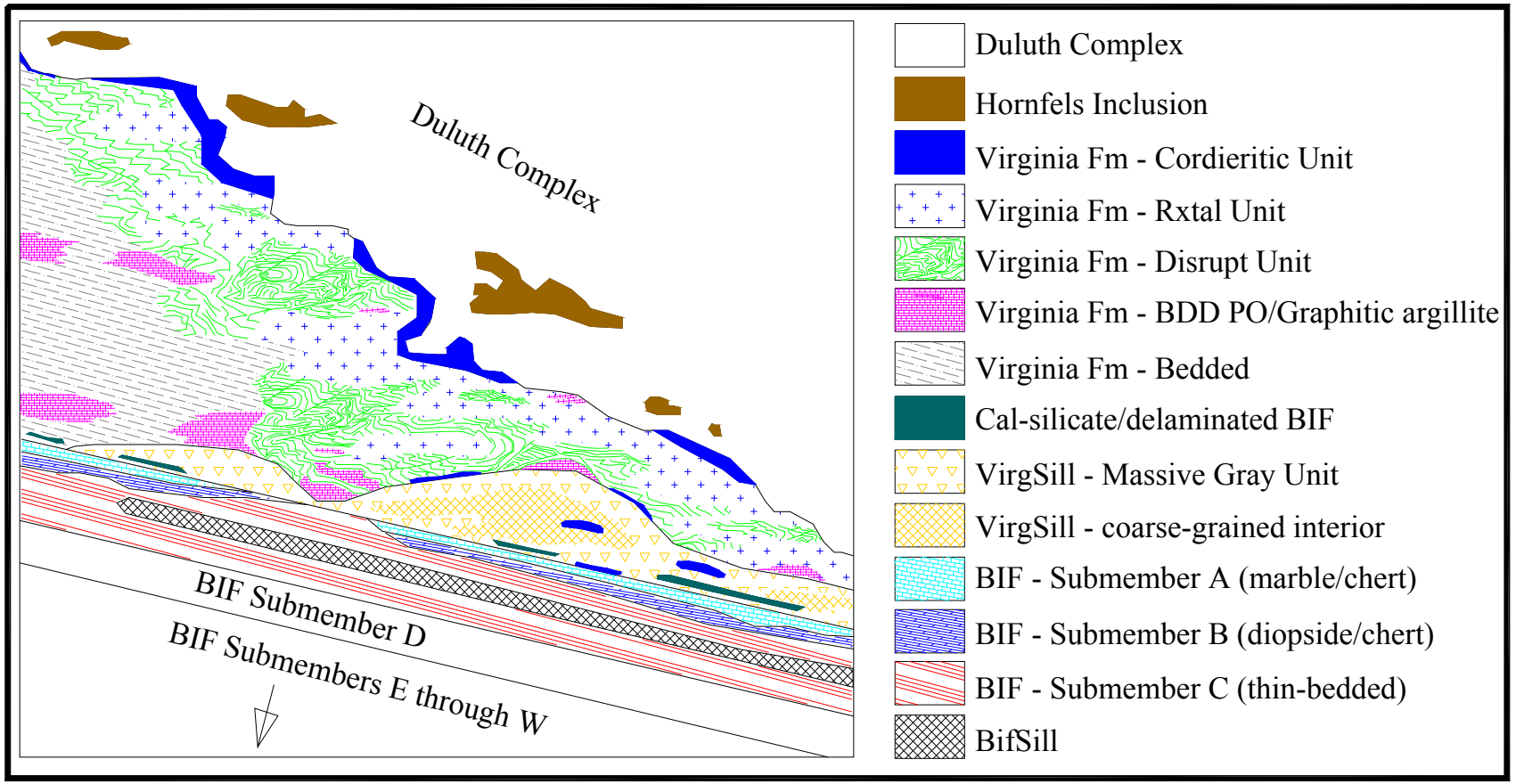


Figure 3. **S**chematic diagram showing the general relationships of the metamorphosed footwall rocks beneath the Duluth Complex at the Mesaba, NorthMet, Wetlegs, and Serpentine deposits. A complete description of the informally named metamorphic rock units displayed in this figure is presented in Severson and Hauck (2008).

- HNFL RXTAL = hornfels consisting of a totally-recrystallized, massive, biotite-rich rock type, e.g., diatexite;
- HYBRID = unique intrusive rock (often contaminated by footwall rocks) with unexplained texture and mineralogy;
- MASS CHL = massive chlorite zones (could be highly serpentinized ultramafics, fault zones, or strongly chloritized footwall rocks);
- MASS SULF = massive sulfide (>70% sulfides);
- MELANOR = melanorite;
- MT = melatroctolite;
- MT W/Cr-TITANOMGT = melatrocto-lite with fine-grained dots of chromium titanomagnetite (used once in the more recently logged holes, but is also present in several of holes that the NRRI logged prior to 2003), e.g., base of Unit IV of the Partridge River intrusion;
- NO CORE = zones with no core preserved (or sampled in its entirety), or used as a place-keeper for holes that did not intersect the basal contact, but were probably terminated close to the basal contact based on projections in cross-sectional relationships;
- NOR = norite;
- NOR & HNFL = ranges from hornfels-with-norite to norite-with-hornfels;
- NOR LENSE = thin norite lense situated in the footwall rocks well below the basal contact of the Duluth Complex (thus considered part of the footwall on the cross-sections);
- OG = olivine gabbro;
- OPXENITE = orthopyroxenite;
- ORT = olivine-rich troctolite (50-55% olivine);
- OUI – OX PYROX = late Oxide-bearing Ultramafic Intrusive body of oxide pyroxenite;
- OVB = glacial overburden (not cored);
- PEG = pegmatitic or pegmatoidal (see TEXTURE column);
- PEG AG = pegmatitic anorthositic gabbro;
- PEG AGT = pegmatitic augite troctolite;
- PEG AN = pegmatitic anorthosite;
- PEG ANG = pegmatitic anorthositic gabbro;
- PEG ANT = pegmatitic anorthositic troctolite;
- PEG FELD PER = pegmatitic feldspathic peridotite;
- PEG GAB = pegmatitic gabbro;
- PEG GAN = pegmatitic gabbroic anorthosite;
- PEG MG = pegmatitic melagabbro;
- PEG MT = pegmatitic melatroctolite;
- PEG OG = pegmatitic olivine gabbro;
- PEG T = pegmatitic troctolite;
- PEG TAN = pegmatitic troctolitic anorthosite;
- PER = peridotite;
- PYROX = pyroxenite (usually clinopyroxenite);
- SMS = semi-massive sulfide (40-70% sulfides);
- T = troctolite;
- T W/MT = troctolite with melatroctolite (often further modified by “texture” column);
- T W/ORT = troctolite with olivine-rich troctolite (often further modified by “texture” column);
- TAN = troctolitic anorthosite;
- VEIN-CALCITE = vein composed mostly of calcite (rare);
- VEIN-GRAN = granitoidal veins of varying compositions;
- VEIN-HNBLDITE = vein composed mostly of hornblende;
- VEIN-QTZ = vein composed mostly of quartz;
- VEIN-SYENITE = quartz-poor, pink, syenite vein;
- VF = footwall Virginia Formation/ undivided;
- VF BDD = Virginia Formation with preserved bedding;

- VF BDD PO = Virginia Formation with conspicuous pyrrhotite laminae;
- VF CALC-SIL = Virginia Formation consisting mostly of calc-silicate beds and pods;
- VF CORD = massive, cordierite-rich Virginia Formation;
- VF DISRUPT = Virginia Formation with highly disrupted bedding and partial melt veins, e.g., metatexite;
- VF GRAPH ARG = graphite-bearing Virginia Formation with disseminated pyrrhotite (chemically similar to the BDD PO unit);
- VF MIXED = Virginia Formation with highly intermixed rock types and textures;
- VF RXTAL = recrystallized Virginia Formation with decussate biotite, e.g., diatexite;
- VIRGSILL/INTERIOR = pre-Duluth Complex sill at the base of the Virginia Formation that contains medium-grained olivine and/or hornblende – usually found in the center of the VIRGSILL/MG UNIT; and
- VIRGSILL/MG UNIT = pre-Duluth Complex sill at the base of the Virginia Formation that is massive and often confused with hornfelsed Virginia Formation.

TEXTURE (**note**: new column that is not found in the databases of Patelke, 2003) = macroscopic texture applied to both intrusive rocks (Duluth Complex and Giants Range Batholith) and sedimentary rocks (Virginia Formation and Biwabik Iron Formation):

- BDD = well bedded sedimentary rock present as either inclusions in the Duluth Complex or as footwall rocks below the Duluth Complex;
- BLOCKY = usually applied to CORD HNFL, wherein cordierite also occurs as coarse-grained blocky poikiloblasts;
- BROADLY HETEROGENEOUS = modal percentages and/or grain size variations in the intrusive rocks that constantly exhibit changes in intervals that range from 5-20 feet thick;
- CHLLED = fine-grained, chilled margins on the edges of near vertical basaltic dikes, and at the basal contact where noritic rocks of the Duluth Complex are in contact with footwall rocks;
- DELAMINATED = used to denote thin curtain-like lenses of the Biwabik Iron Formation wholly contained within the VIRGSILL unit (see Fig. 3). These lenses appear to have been delaminated away from the top of the iron-formation as the VIRGSILL was emplaced along bedding planes;
- DISRUPT = texture applied to the sedimentary footwall rocks and inclusions (mostly applied to the Virginia Formation) that exhibit chaotic and disrupted bedding planes with partial melt veinlets, e.g., metatexite;
- FOLIATED = self-explanatory;
- HETEROGENEOUS = modal percentages and/or grain size variations in intrusive rocks that constantly exhibit changes in very short interval lengths, e.g., less than five feet thick;
- HOMOGENEOUS = there are relatively no modal percentages and/or grain size variations in the intrusive rocks;
- MASSIVE = featureless, fine-grained, hornfelsed, sedimentary rock (usually applied to HNFL CORD or VF CORD – see above);
- MIXED = applied to intervals wherein sedimentary hornfels and norite are intricately mixed;
- MODAL BDD = intrusive rock wherein modal concentrations of cumulus minerals define beds or bands; usually applied to:
  - melatroctolite;
  - peridotite;

  - olivine-rich troctolite;
  - augite troctolite with melatroctolite bands (and vice-versa);
  - anorthositic troctolite with melatroctolite bands; and
  - troctolite with either melatroctolite and olivine-rich troctolite bands (and vice-versa);
- MYRM = myrmeketic texture seen in granophyre veins and lenses;
- NO CORE = usually applied to situations wherein a select group of holes were not drilled deep enough to encounter the footwall rocks, but the basal contact can be approximated via cross-sectional relationships (used mostly as a place-holder); in a few instances, either no core was recovered during drilling, or the drill core has been misplaced, and therefore, not available to be logged by the NRRI;
- NOT SERP = applies to ultramafic rocks wherein no serpentinization foliation is readily evident;
- OPHITIC = applies to situations wherein intercumulus augite completely or partially encloses cumulus plagioclase and/or olivine (not often specifically used during logging as it is almost synonymous and very commonly associated with augite troctolite and gabbro);
- OXIDE = preface for oxide-rich rocks, e.g., oxide gabbro;
- PATCHES = used in a similar fashion as MODAL BDD, but in this case, both troctolitic and ultramafic rocks alternate in an irregular pattern that is not suggestive of beds or bands;
- PEGMATITIC = coarse-grained intrusive rock wherein plagioclase and augite crystals are commonly over 3 cm long;
- PEGMATOIDAL = coarse-grained intrusive rock wherein plagioclase and augite crystals are commonly 1-3 cm long;
- PLAG FOLIATION = subparallel alignment of plagioclase laths in one plane;
- POIK, OPHITIC = rock that exhibits both a poikilitic and ophitic texture;
- POIKILITIC = applies to situations wherein intercumulus olivine completely or partially encloses cumulus plagioclase (usually applied to Unit III of the Partridge River intrusion);
- PORPHYRITIC = intrusive rock that contains large phenocrysts of plagioclase (only applied to norite in the database);
- RUBBLE = descriptive term for fault zones wherein the core recovery is poor and consists mostly of chlorite-replaced core pieces and green-colored, chloritic clays;
- RXTAL = applied to hornfelsed, sedimentary, footwall rocks and inclusions that have undergone a high degree of partial melting, and thus, exhibit a totally-recrystallized, massive, biotite-rich rock type, e.g., diatexite;
- SCHISTOSE = self-explanatory and mostly applied to the sedimentary footwall rocks and inclusions;
- SERP = ultramafic rocks that display a high degree of serpentinization with a moderate- to well-developed secondary foliation;
- SLICKENSIDED = mostly applied to faults and massive chlorite zones (even within the Virginia Formation) that exhibit common slickensides;
- SPECKLED = dark-colored, hornfelsed basalt with light-colored specks (most likely vesicles);
- VESICULAR = hornfelsed basalt with vesicle-like features;
- WEAKLY HETEROGENEOUS = modal percentages and/or grain size variations in intrusive rocks that exhibit weak and/or localized changes; and
- WK SERP = ultramafic rock that displays a weak degree of serpentinization.

BDD TO CORE AXIS (**note**: new column that is not found in the databases of Patelke,

2003) = planar features that are measured relative to the core axis (in degrees) such as:

- bedding in sedimentary rocks;
- foliation in sedimentary rocks (particularly the BDD PO and GRAPH ARG units as either inclusions or footwall rocks below the basal contact);
- modally-bedded intrusive rocks;
- plagioclase foliation; and
- serpentinization foliation in ultramafic rocks.

SPLIT CORE (**note**: new column that is not found in the databases of Patelke, 2003) = denotes drill core intervals that have been split or sawn in half (Y for yes); ¼ cored (1/4 designation), or not split (N for no).

SULFIDE-BEARING (**note**: new column that is not found in the databases of Patelke, 2003) = denotes whether a specific rock type is sulfide-bearing as follows:

- N = not sulfide-bearing;
- Y = is sulfide-bearing (generally >1% visually estimated sulfides);
- TR = visually estimated sulfides present in amounts that range from trace (scattered occurrences) to ≤1%;
- RARE = visually estimated sulfides are present in rare amounts (widely-scattered occurrences);
- MS = massive sulfide (>70% visually estimated sulfides);
- SMS = semi-massive sulfide (40-70% visually estimated sulfides);
- (SMS) = semi-massive sulfides patches are locally present throughout an interval; and
- NR = not recorded on the drill log (this is usually applied to very short intervals (<5 feet thick), but there are exceptions).

INTRUSION (**note**: new column that is not found in the databases of Patelke, 2003) = abbreviation for the intrusion in which the specified rock type is contained (or overlain by in the case of the footwall rocks). This designation is most importantly applied to the Mesaba deposit where the holes were drilled on a grid system that spanned three intrusive bodies that include the: Partridge River intrusion (PRI), Bathtub intrusion (BTI – most of the holes); or South Kawishiwi intrusion (SKI – least of the holes); in some cases, a single hole intersected more than one intrusion at depth.

UNIT = Igneous unit designations as depicted in Figures 4, 5, and 6 and discussed in detail in Severson and Hauck, 1990; Severson 1994; and Severson and Hauck, 2008. Units that are not shown on these figures that deserve special mention are as follows:

- Units I through VIII of the Partridge River intrusion (PRI) are designated by numbers 1 through 8;
- 4-a = designates a unique augite-rich augite troctolite near the base of Unit IV in the Local Boy area of the Mesaba deposit;
- ALT +/- PIC = denotes an ultramafic zone that serves as an alternative choice for the ±PIC unit of the BTI;
- Base 4 = denotes a thick package of ultramafic rocks interbedded with troctolitic rocks at the base of Unit IV of the PRI;
- DELAMINATED BIF = denotes instances where the VIRGSILL, at the base of the Virginia Formation, contains curtain-like lenses of the Biwabik Iron Formation (specifically submembers A and B) that were delaminated from the top of the iron-formation when the VIRGSILL was emplaced along bedding planes;
- NA = applied to reverse-circulation drilled top portion of two drill holes, wherein only cuttings are available for inspection (and not looked at by the NRRI);

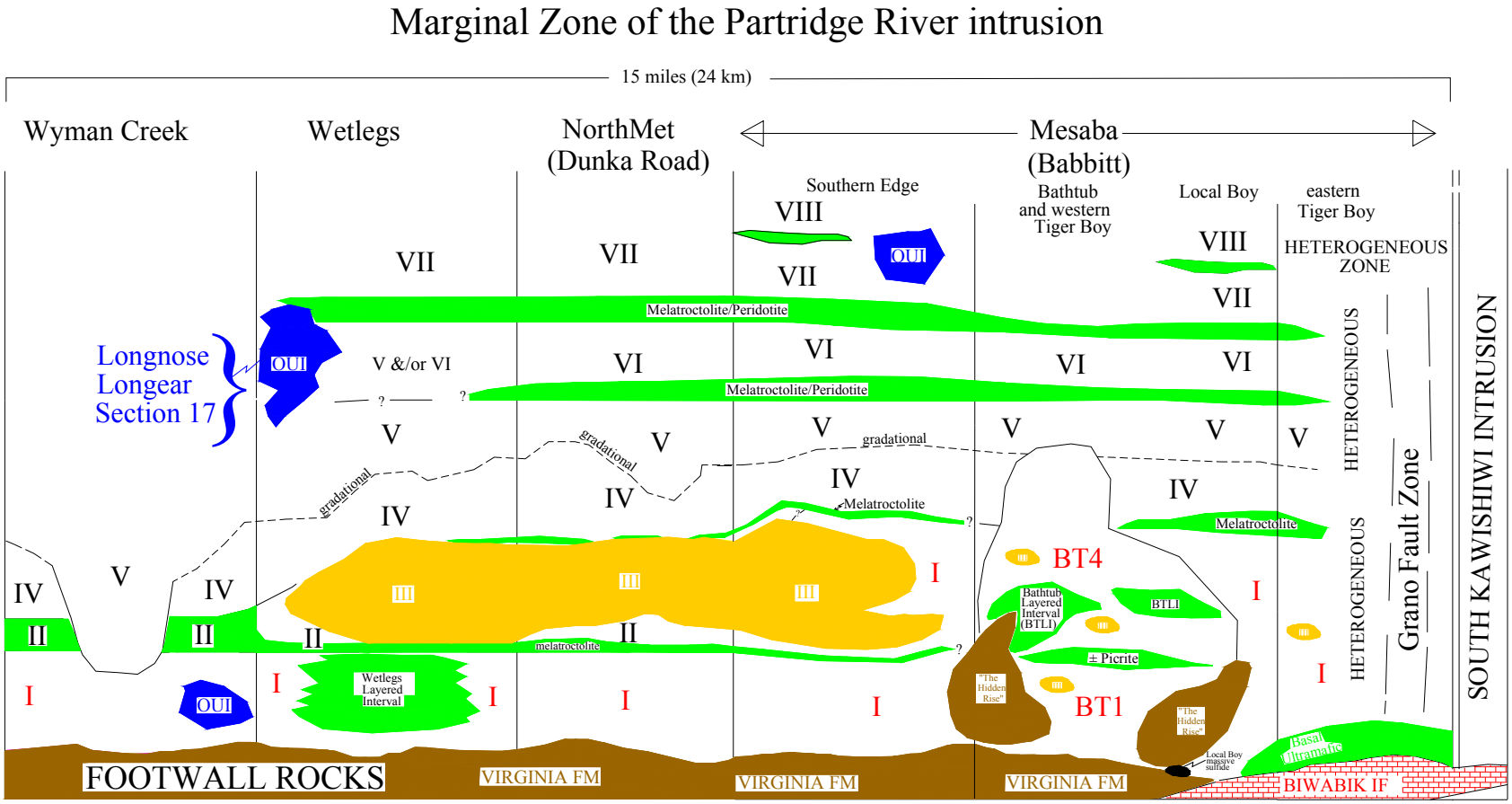


Figure 4. Generalized stratigraphy of the basal zone of the Partridge River intrusion (from Severson and Hauck, 2008). Roman numerals (I through VIII) denote igneous units in the Partridge River intrusion; BT1 and BT4 denote igneous units in the Bathtub intrusion, and OUI denotes Oxide-bearing Ultramafic Intrusions.

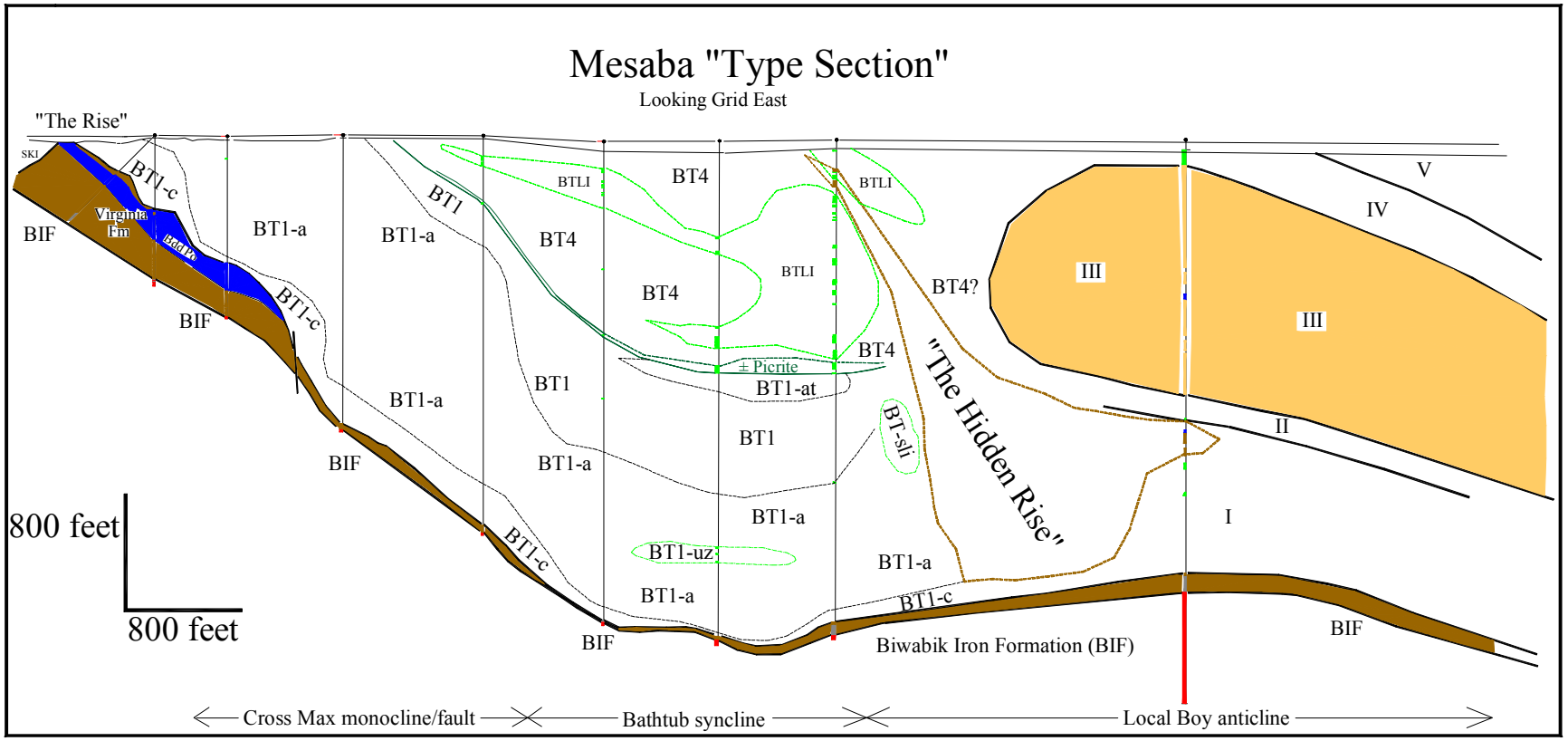


Figure 5. Schematic "type-section" cross-section, looking east, through the Mesaba deposit that crudely displays the spatial distribution of most of the igneous units in the Bathtub intrusion (from Severson and Hauck, 2008). Note that not all of the PRI units are shown on the right side of the figure.

SW NE

Marginal Zone of the South Kawishiwi intrusion

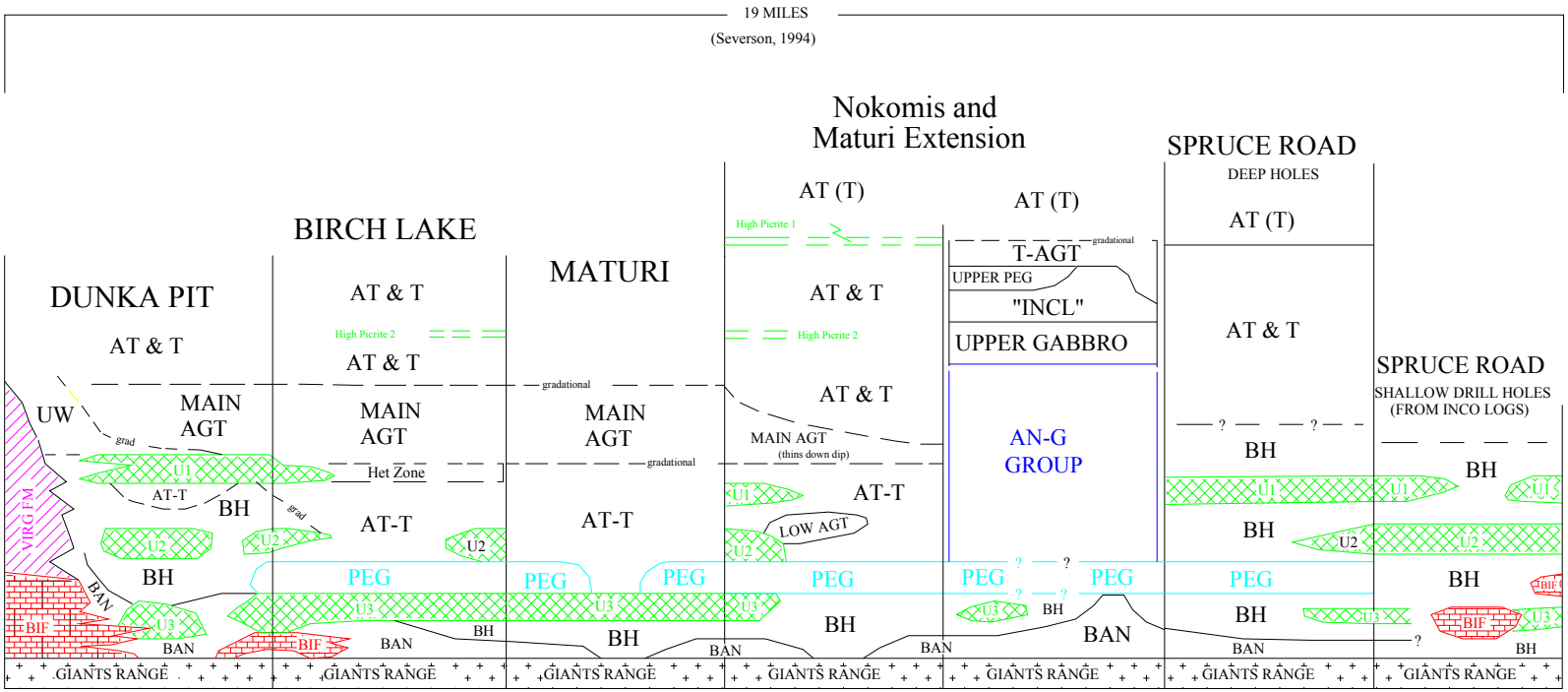


Figure 6. Generalized stratigraphy of the basal zone of the South Kawishiwi intrusion (modified from Severson, 1994; and included in Miller and Severson, 2002). The lowermost igneous units are: BAN = Basal Augite Troctolite and Norite; BH = Basal Heterogeneous; U3 = Ultramafic 3; PEG = Pegmatitic unit of Foose (1984); U2 = Ultramafic 2; U1 = Ultramafic 1; AT-T = Anorthositic Troctolite to Troctolite; UW = Updip Wedge; Main AGT = Main Augite Troctolite.

- NO CORE = mostly applied as place-keepers for holes were the basal contact was never reached (but is probably close to the bottom of the hole), and the basal contact can be projected by cross-sectional relationships;
- Not correlated = drill hole logged, but many of the nearby holes have yet to be logged by the NRRI (about 20 holes in the extreme eastern portion of the Mesaba deposit), and thus, no correlative units have yet been established;
- OUI = Oxide-bearing Ultramafic Intrusion;
- OVB = glacial overburden (not cored);
- POCKET PIC = package of interlayered ultramafic and troctolitic rocks that are locally present in a small portion of the Mesaba deposit (see Severson and Hauck, 2008); and
- VF = Virginia Formation.

EXP-RTYPE = expanded rock type description taken almost verbatim from the description in the drill log. This column has not been specifically condensed (what-you-see-is-what-you-get); however, some of the descriptions have been standardized for filtering purposes.

ALTERATION/FRACTURING (**note**: new column that is not found in the databases of Patelke, 2003) = description taken almost verbatim from the drill log using many of the abbreviations as listed in the above categories. Additional abbreviations that are not described above, but can be found in this column, are as follows:

- OLIV→IDDINGSITE/HEM = olivine is altered to either red iddingsite and/or hematite adjacent to subhorizontal chlorite-filled joints;
- URAL = uralitized (deuteric alteration) intrusive rock containing interstitial hornblende, actinolite, and chlorite with minor calcite;
- SAUSS = saussuritized plagioclase; and
- Cl- = drill core exhibits chlorine-rich drops and precipitations that form on the core surface via a deliquescent/ hydroscopic process (see Hauck et al., 1997 for a more detailed description of these features). This category can be used to quickly find zones where the drops are common in specific drill holes.

COMMENT (**note**: new column that is not found in the databases of Patelke, 2003) = additional comments taken verbatim from the drill logs. Specific abbreviations that are unique to this column and can be used to filter out specific occurrences are as follows:

- Cl- = see above;
- CU-RICH SULF = denotes zones where chalcopyrite or talnakhite are the dominant sulfide types;
- GRAPHITE = denotes graphite-bearing and massive graphite zones;
- SHOULD HAVE BEEN SAMPLED = denotes zones with significant amounts of sulfides that were never split and sampled;
- SILLIMANITE = denotes where the BDD PO unit of the Virginia Formation contains macroscopic sillimanite needles; and
- WITH CS-GRN SULFIDES = denotes zones with coarse-grained sulfides (this is unique to several groups of holes at the Mesaba deposit, and generally occurs near the base of the Bathtub intrusion).

CON-RTYPE = consolidated rock type, for sorting purposes using filters, as follows:

- ANORTHOSITIC = consolidated category for the various anorthositic rocks such as: AN, TAN, and GAN;
- BASALT HORNFELS = hornfels basalt inclusions presumably correlative with the North Shore Volcanic Group;
- BIWABIK IRON FORMATION = consolidated rock type for the various submembers of the iron-formation;

- DIKE;
- FAULT;
- GABBROIC = consolidated category for the various gabbroic rocks such as: GAB, OG, and ANG;
- GRAPHITE = graphite-bearing rocks (including massive graphite);
- HAMMER = reverse circulation holes (chips only/no core);
- HYBRID = intrusive rocks with either a strange collection of minerals (not typical troctolitic or gabbroic rocks) and/or a strange collection of alteration minerals;
- MASS CHL = massive chlorite;
- MASS SULF = massive sulfide;
- NO CORE = denotes intervals where the core is no longer available;
- NORITIC = consolidated category for the various noritic rocks such as: GAB NOR, MELANOR, NOR, NOR&HNFL, and NOR LENSE;
- OVB = glacial overburden;
- PROJECTED (NO CORE) = used as a place-keeper to denote an intrusive rock interval in instances where the basal contact was not intersected, but was probably close to the bottom of the hole based on projections from cross-sectional relationships;
- SEDIMENTARY HORNFELS = consolidated category for all of the various HNFL types;
- SEMI-MASS SULF;
- TROCTOLITIC = consolidated rock type for various troctolitic rocks such as: T, AGT, and ANT;
- ULTRAMAFIC = consolidated rock type for various ultramafic rocks, such as: MT, ORT, FELD PER, and PER;
- VEIN = consolidated rock type for the various types of cross-cutting veins; and
- VIRGINIA FORMATION = consolidated rock type for the various forms of Virginia Formation that are present in the footwall below the Duluth Complex.

FW-MARKER = marks the interval as occurring either:

- COMPLEX = in the Duluth Complex;
- COMPLEX UNDER = used in instances wherein a thick lense of intrusive rock is situated beneath a thick package of footwall rocks. This situation generally occurs in localized areas. One example occurs along the northern edge of the Mesaba deposit where inclined holes were drilled through the BTI, then through the footwall Virginia Formation (= "The Rise" on Fig. 5), and were terminated in the SKI on the other side of "The Rise." Another example occurs at Dunka Pit where vertical holes were drilled through the SKI, then encountered a thick package of the Biwabik Iron Formation, and then encountered another package of the SKI before terminating in the Giants Range Batholith;
- FOOTWALL = in the footwall rocks beneath the Duluth Complex; and
- OVB = in the glacial overburden.

FW-FROM = interval "from" measured upward or downward from the drill hole footwall penetration point (values are in positive feet for intervals above the basal contact and in negative feet for intervals below the basal contact).

FW-TO = interval "to" measured upward or downward from the drill hole footwall penetration point (values are in positive feet for intervals above the basal contact and in negative feet for intervals below the basal contact).

DESURVFROMX = three-dimension easting (or "X") location at the beginning of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in

this report, but it is retained for place-keeping purposes.

DESURVFROMY = three-dimension northern (or "Y") location at the beginning of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in this report, but it is retained for place-keeping purposes.

DESURVFROMZ = three-dimension elevation (or "Z") position at the beginning of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in this report, but it is retained for place-keeping purposes.

DESURVTOX = three-dimension easting (or "X") location at the end of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in this report, but it is retained for place-keeping purposes.

DESURVTOY = three-dimension northing (or "Y") location at the end of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in this report, but it is retained for place-keeping purposes

DESURVTOZ = three-dimension elevation (or "Z") position at the end of a particular interval as determined from down hole surveys (in feet). This column was calculated in Gemcom by Patelke in 2003; however, the NRRI no longer has a license to use this program (nor the experience), and the column is left blank in this report, but it is retained for place-keeping purposes

GEOLOGIST = geologist responsible for editing the drill hole, as in the *Duluth-Complex-Header-File.xls* file, with the following additions:

- ERIE = information from an Erie Mining Company log for drill core that is no longer preserved; and
- PROJECTED = used as a place-keeper in cases where the drill hole was terminated before reaching the basal contact, but was probably close based on projections in cross-sectional relationships.

DEPOSIT = name of the deposit or area.

NRRI-SECT = NRRI cross-section that shows this drill hole (only applies to holes in the Mesaba and Dunka Pit deposits).

SOURCEFILE = blank column, but retained for place-keeping purposes.

COMP-SECT = company cross-section on which this hole is displayed (none are available, but this column is included for place-keeping purposes).

XLSFILE = cross-reference to where the corresponding Cu-Ni assay data for the hole can be found in Patelke (2003):

- WEST = Cu-Ni assay data can be found in the *CuNi-west.xls* file; and
- EAST = Cu-Ni assay data can be found in the *CuNi-east.xls* file.

FORMAT FOR LITHOLOGIES IN DRILL HOLES AT THE DUNKA PIT DEPOSIT

The database *Dunka-Pit-Deposit-logs.xls* contains information, from NRRI logs, for all holes logged in the Dunka Pit deposit after 2003. The data columns in this file are presented in roughly the same order as in Patelke (2003 – *east-lith.xls*), **but** some of the columns in this report are new (indicated in red), and they should be created in the *east-lith.xls* of Patelke (2003) before the two are combined.

It is also extremely important to remember that all of the holes in the *Dunka-Pit-Deposit-logs.xls* are also in the *east-lith.xls* of Patekle (2003). However, the lithologies in *east-lith.xls* are based on earlier company drill logs, and these should be replaced by the more recently determined lithologies (by the NRRI) in the *Dunka-Pit-Deposit-logs.xls* file.

A detailed description of each of the columns in the *Dunka-Pit-Deposit-logs.xls* file would be almost identical to the descriptions presented above for the *Mesaba-Deposit-logs.xls* file; however, because there are local differences in the footwall rocks that are present at Dunka Pit, there are some differences in the *Dunka-Pit-Deposit-logs.xls* file that are listed below.

ROCKTYPE = logged rock type (with additions as follows):

- "NOR" = partially melted granitic rocks of the Archean Giants Range Batholith that exhibit a "washed-out" and poorly-foliated appearance consisting of saussuritized plagioclase and orthopyroxene with only minor amounts of quartz and amphibole,
- AGT W/BIF = augite troctolite with inclusions of Biwabik Iron Formation,
- AGT W/GRAN = augite troctolite with granitic inclusions of the Giants Range Batholith,
- Additional Biwabik Iron Formation submembers (see Gundersen and Schwartz, 1962 for descriptions) such as:
  - BIF E;
  - BIF F;
  - BIF G (often with coarse-grained garnet crystals);
  - BIF H;
  - BIF I (algal/conglomerate horizon);
  - BIF INCL = iron-formation inclusion that cannot be correlated with a specific submember;
  - BIF K;
  - BIF K';
  - BIF M;
  - BIF O;
  - BIF P;
  - BIF Pd;
  - BIF Q (Intermediate Slate horizon); and
  - BIF R;
- BIFSILL = pre-Duluth Complex sill in about the middle of the BIF C submember;
- DIOR = diorite associated with the Giants Range Batholith;
- GRANITE = granite associated with the Giants Range Batholith;
- GRANODIOR = granodiorite associated with the Giants Range Batholith;
- MG = melagabbro;
- MONZ = monzonite associated with the Giants Range Batholith;
- NOR & BIF = mixed norite and iron-formation inclusions or iron-formation with abundant norite lenses;
- QTZ MONZ = quartz monzonite associated with the Giants Range Batholith; and
- QTZITE = Pokegama Formation (mostly quartzite).

TEXTURE (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

BDD TO CORE AXIS (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

SPLIT CORE (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

SULFIDE-BEARING (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

INTRUSION (**note**: new column that is not found in the databases of Patelke, 2003) = only SKI is entered in this column in this particular spreadsheet.

UNIT = Igneous unit designations as depicted in Figure 6 and discussed in detail in Severson (1994). Units that are not shown on Figure 6 that deserve special mention are as follows:

- BAN UNDER = denotes a unique situation wherein a thick package of intrusive rock (usually augite troctolite and norite) are positioned between the Biwabik Iron Formation (also present as a thick package) and the Giants Range Batholith;
- BIF INCL = inclusion of Biwabik Iron Formation/undivided;
- BIFSILL = pre-Duluth Complex sill situated about in the middle of the BIF C submember;
- GRAN = denotes granitic rocks of the Giants Range Batholith;
- LENSE = denotes situations where a thin lense of augite troctolite is positioned in the footwall rocks well below the basal contact of the Duluth Complex (thus the lense is considered to be part of the footwall on the cross-sections);
- NICKEL LAKE MACRODIKE = large, subvertical, pegmatitic, dike-like feature mapped by Dr. Paul Weiblen in the Gabbro Lake Quadrangle (Green et al., 1966), and more recently by Peterson et al. (2006), and thought to be the feeder dike for portions of the SKI and the Bald Eagle intrusion (Miller et al., 2002) – only one hole (NM-2) was drilled into this dike;
- NOPEMING? = denotes inclusions of white, quartz-rich sandstone that are presumably correlative with either the Nopeming Formation or interflow sandstones in the North Shore Volcanic Group; and
- POKEG = denotes Pokegama Formation that underlies the Biwabik Iron Formation.

EXP-RTYPE = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

ALTERATION/FRACTURING (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

COMMENT (**note**: new column that is not found in the databases of Patelke, 2003) = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

CON-RTYPE = consolidated rock type, for sorting purposes using filters, with the following additions relative to the *Mesaba-Deposit-logs.xls* file:

- GRANITIC = consolidated category for all of the various granitic rock types that constitute the Archean Giants Range Batholith; and
- POKEGAMA FORMATION = consolidated category for the various sedimentary rock types that are present within the Paleoproterozoic Pokegama Formation.

FW-MARKER [**and the remaining columns in this spreadsheet**] = no changes, and thus, the same as listed for the *Mesaba-Deposit-logs.xls* file.

EXPLANATION OF DATA FORMATS FOR MESABI IRON RANGE INFORMATION

Introduction

This section contains a summary of listings for each of the databases submitted with this report pertaining to information regarding the Mesabi Iron Range. These data are presented in a different format than the databases of Patelke (2003) and should not be combined with the 2003 data. Breakdowns of the columns in the two spreadsheets regarding the Mesabi Iron Range that are submitted with this report (on the CD in the back pocket) are presented below.

Format for Locations of Drill Holes that were Logged by the NRRI in the Mesabi Iron Range – Header File

The database *Mesabi-Range-Header-File.xls* contains location information, and other pertinent data, pertaining to drill holes logged by the NRRI in the Mesabi Iron Range from 2002-2008. Holes that were logged, and displayed on Figure 7, extend in an area from west of Coleraine, MN, to Hoyt Lakes, MN. The materials that are listed in the various data columns for this file are described below.

HOLE = hole numbers for core holes that were logged by the NRRI from several locations across the Mesabi Iron Range.

E (SP-27-ft) = east coordinates in State Plane NAD27 (in feet) for the drill collar location.

N (SP-27-ft) = north coordinates in State Plane NAD27 (in feet) for the drill collar location.

ELEV. (ft) = elevation (in feet above sea level) at the collar for each drill hole.

ELEVATION DATE-FROM = lists the source for the drill collar elevation.

ASSOC MINE/AREA = listing of the general area in which the drill hole is located (see also Fig. 8) such as:

- Cliffs-Erie Site (former LTV mine on the eastern end of the Mesabi Iron Range);
- Hibtac Mine located near Hibbing, MN;
- Keetac Mine located near Keewatin, MN;
- McKinley Extension Mine (Pits #1 and #2) located between McKinley and Biwabik, MN (also referred to as the East Reserve Mine);
- Minntac Mine (East and West pits) located near Mt. Iron, MN;
- Minorca Mine (the mine is closed, but the ArcelorMittal taconite processing plant is still located at the site) located to the north of Virginia, MN;
- Ox Tac – Coleraine (MN) is a site that has potential to contain millions of tons of oxidized taconite (Zanko et al., 2003), but as yet has seen no development;
- Regional holes are holes drilled to the south of existing taconite mines by various state agencies and mining companies (see Fig. 7 for locations); and
- Utac Mine (United Taconite) located near Eveleth, MN.

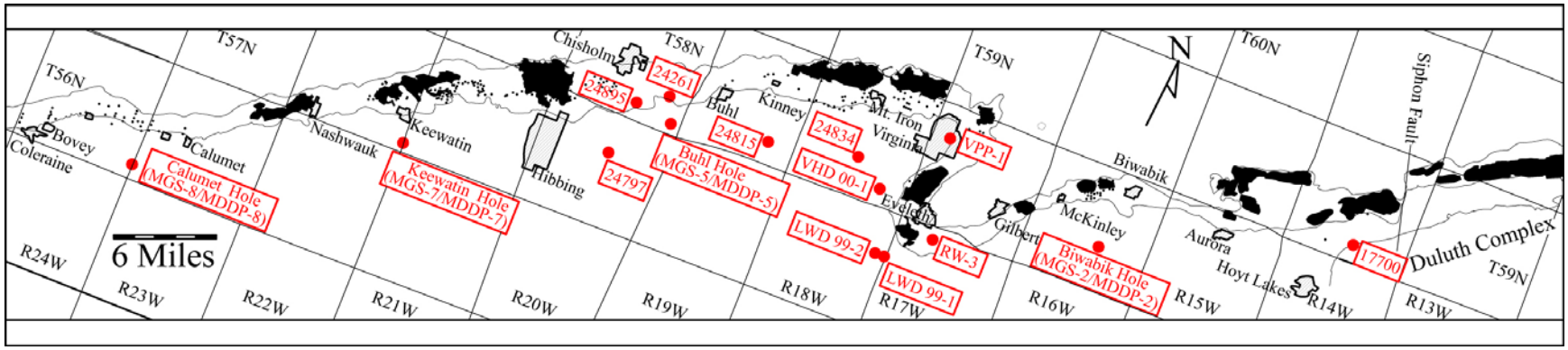


Figure 7. Location map of logged drill holes in the Mesabi Iron Range that are considered to be regional in nature (in red), in addition to holes logged at each of the mine areas (small unlabeled black dots). All of the red holes shown in this figure, except for 24261 and 24895, are stored at the Minnesota Department of Natural Resources core storage facilities in Hibbing, MN, and are available to the public. Figure from Severson et al. (2009).

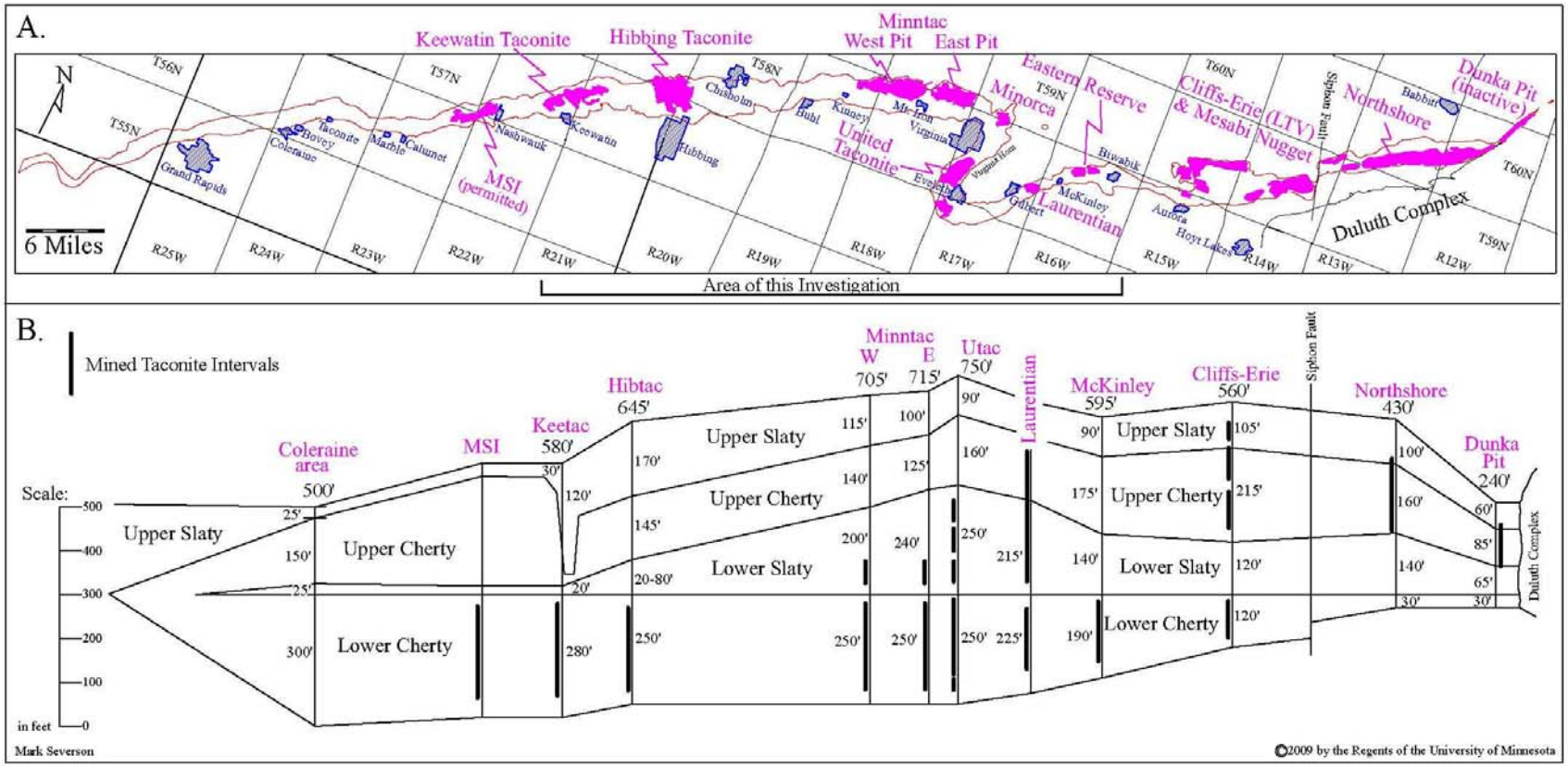


Figure 8 (from Severson et al., 2009). **A.** Map of Mesabi Iron Range with aerial distribution of taconite pits (magenta) and cities (blue). Trend of Biwabik Iron Formation is shown in red. MSI (Minnesota Steel and Iron) on the western Iron Range is now owned by Essar Steel Minnesota LLC. **B.** Longitudinal section of the Biwabik Iron Formation showing: average thickness of the iron-formation at each taconite operation (along with the thickness of the various members at each operation), and mined taconite intervals represented by black bars.

SEC = lists the Public Land Survey Section.

TOWNSHIP (N) = lists the Public Land Survey Township (all are Township North).

RANGE (W) = lists the Public Land Survey Range (all are Range West).

QUAD = lists the USGS 7.5 minute quadrangle in which the hole is located.

HOLE DEPTH = total depth of each drill hole (in feet).

CORE STORAGE = lists location where the core is now stored as follows:

- Coleraine = RGGS private core storage facilities at the Coleraine Minerals Research Lab of the NRRI in Coleraine, MN;
- Consumed = core is no longer preserved, and the drill hole was logged before it was consumed for ore grade testing purposes (magnetic Fe, Silica, phosphorous, etc.);
- DNR-Hibbing = public core storage of the Department of Natural Resources, Division of Land and Minerals, in Hibbing, MN;
- Lerch Bros.-Hibbing = private core storage of Hibtac (Cliffs NR) in one of the buildings now occupied by Lerch Brothers Inc. (an analytical lab) in Hibbing, MN;
- Minntac = private core storage facilities of United States Steel Corp. in the concentrator building (floors 3 and 6) at their taconite processing plant near Mt. Iron, MN; and
- Utac = private core storage facilities of United Taconite (Cliffs NR) at their Thunderbird North Mine near Eveleth, MN.

[**Note that** all of the holes in this spreadsheet are vertical (-90°), and thus, no AZIMUTH and DIP columns are needed as in other files. Note also that all of the taconite mines use a State Plane (NAD-27) system, and thus, no other location coordinates, e.g., UTM system, are listed in the spreadsheet.]

Format for Lithologies in Drill Holes of the Mesabi Iron Range that were Logged by the NRRI

The database *Mesabi-Range-logs.xls* contains rock type and lithologic information pertaining to the Biwabik Iron Formation for all of the holes logged by the NRRI in the Mesabi Iron Range of northeastern Minnesota. Descriptions of the types of data that are listed in each of the columns of this spreadsheet are discussed below.

HOLE-ID = lists the drill hole number.

FROM = start of interval relative to collar (in feet).

TO = end of interval relative to collar (in feet).

THICKNESS = interval length (in feet) measured along drill core.

DATA CHECK = arithmetic formula column to double check that the sum of all of the thickness values is equal to the total depth of the hole.

MEMBER (modified by NRRI) = The Biwabik Iron Formation (Paleoproterozoic, approximately 1878 Ma; Fralick, et al., 2002) is typically broken down into four informal members (Wolff, 1917) that are termed (from the base up):

- LOWER CHERTY;
- LOWER SLATY;
- UPPER CHERTY; and
- UPPER SLATY.

The slaty members are typically thin-bedded (<1 cm thick beds), were deposited in deep water below wave base, and originally consisted of fine-grained chemical muds. The cherty members are typically thicker-bedded (> 3 cm thick beds), were deposited in shallower water, and consist of reworked granules (intraclasts) derived from the slaty members and transported shoreward by currents. The above four informal member designations are listed in this column, and in some cases, the NRRI determination of where a particular member begins and ends may differ from a similar determination made by a mining company (in fact even the mining companies do not always make the same determination) – the listing in this column is made by the NRRI. This dichotomy in member designations is most pronounced at the Lower Slaty/Upper Cherty contact due to the presence of large, laterally-discontinuous, channel-like bodies of cherty iron-formation, often referred to as "Interbedded Cherts" or IBCs, that are situated in the Lower Slaty member in the Virginia Horn area (see discussions in Severson et al., 2009). Also included in this column are designations for:

- ARCHEAN = Archean basement rocks (~2.75 Ga) that typically consist of either granitic rocks of the Giants Range Batholith or mafic flows that are possibly correlative with the Ely Greenstone member;
- COLERAINE FM = Cretaceous conglomerate that contains iron-formation clasts (often strongly oxidized, and thus, locally mined as direct ore bodies) in addition to other clast types;
- CRETACEOUS CLAYS = clay-rich materials at the top of the ledge rock that probably developed by deep weathering and/or deposition during the Cretaceous;
- DECOMPOSED ROCK = strongly weathered rock of unknown affinity (this term is only used in two holes);
- DIKE = subvertical dike of unknown age (only noted in two holes in the McKinley Extension area);
- INTERBEDDED CHERT = channel-like bodies of cherty materials (IBCs) in the Lower Slaty member in the Virginia Horn area;
- LOWER SLATY/LOWER CHERTY = only used once to denote that the Lower Slaty/Lower Cherty contact could not be determined as several 10s of feet of core were missing from the contact zone;
- NO CORE = denotes areas where core was not preserved (or never found);
- OVERBURDEN = unconsolidated glacial materials that were rarely cored;
- POKEGAMA = Paleoproterozoic Pokegama Formation beneath the Biwabik Iron Formation;
- STOCKPILE = denotes drill holes that were collared in old direct ore-related stockpiles (difficult to drill through with poor core recoveries); and
- VIRGINIA FM = Paleoproterozoic Virginia Formation that overlies the Biwabik Iron Formation.

MINING CO. SUBMEMBERS BY NRRI = The mining companies of the Mesabi Iron Range typically further subdivide the iron-formation into several submembers based on numerous characteristics including ore and waste zones. However, each of the mines uses a different system/designation in their subdivisions, and their particular submember nomenclatures are not easily used by adjacent mines. One of the goals of Severson et al. (2009) was to reinterpret each mine's submembers into a system that links all of the dichotomous submember terminologies. Each submember at each of the mines is summarized in the correlation charts of Figures 9 through 12 (from Severson et al., 2009). The various sub-members, from each of the specific mines that are listed in this column, can be found in those figures. Note that the items listed in

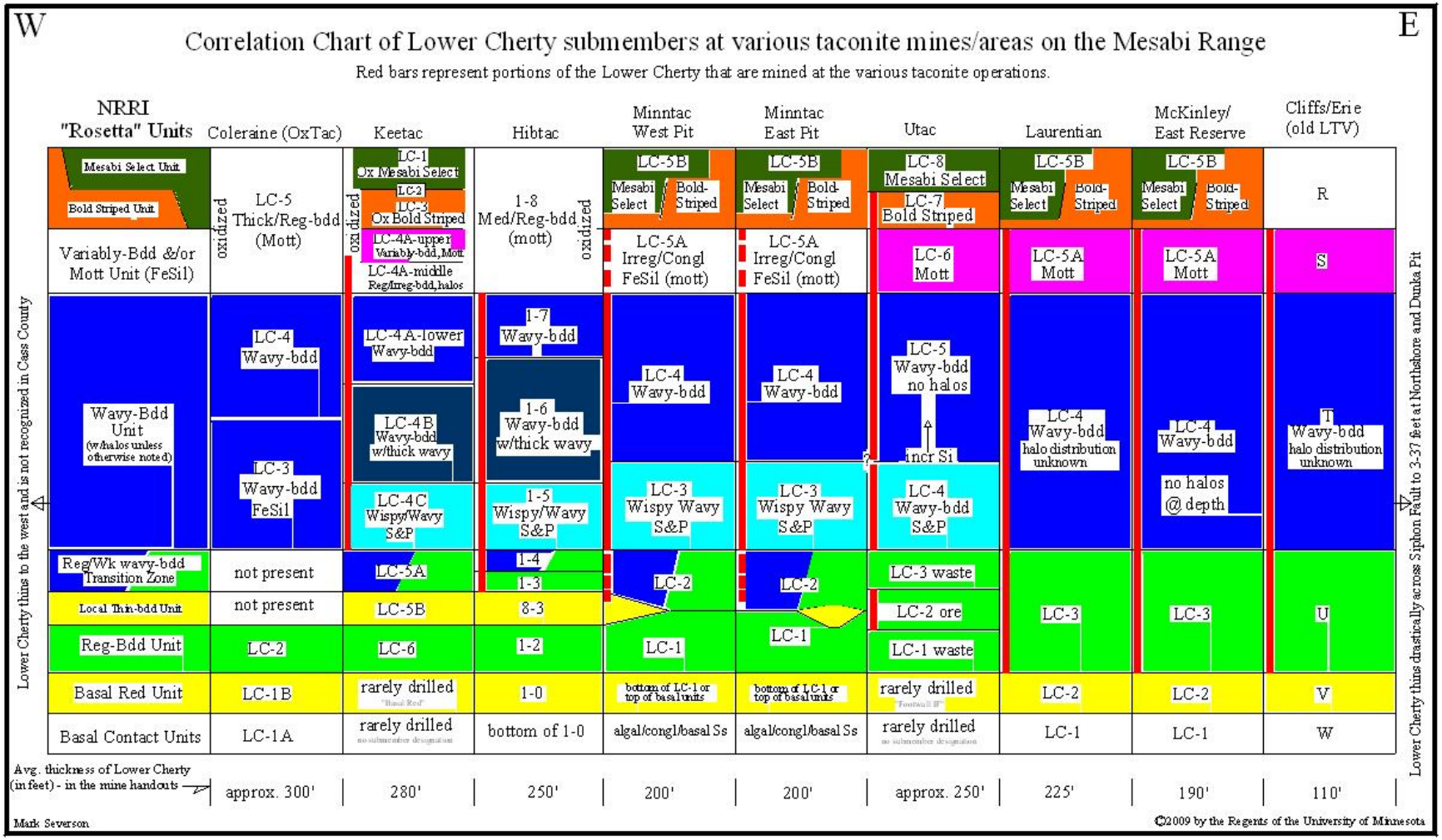


Figure 9. Correlation chart of Lower Cherty submembers at the various taconite mines/areas along the Mesabi Iron Range. Red bars represent portions of the Lower Cherty that are mined at the various taconite operations. No scale implied; from Severson et al. (2009).

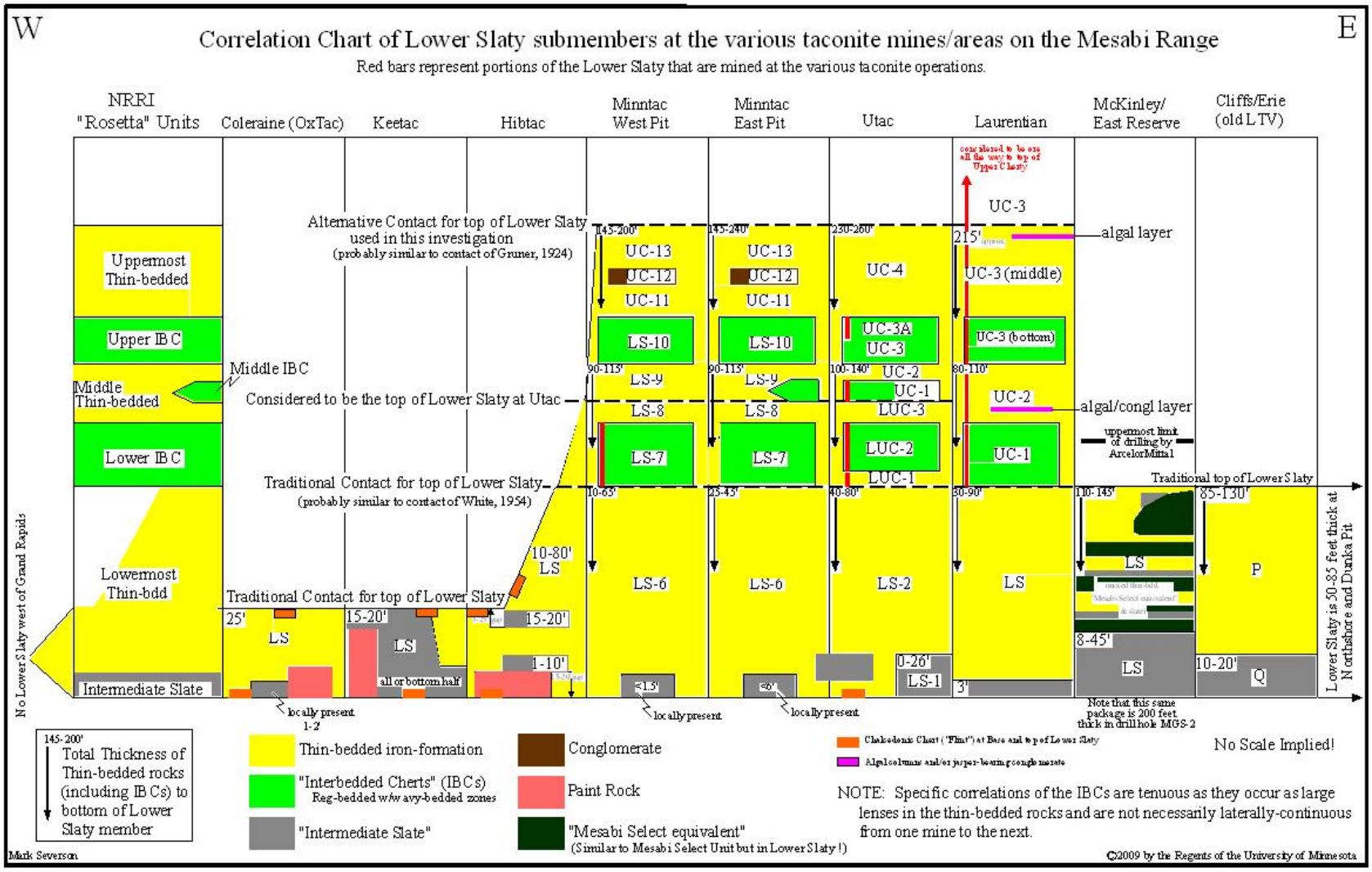


Figure 10. Correlation chart of Lower Slaty submembers at the various taconite mines/areas along the Mesabi Iron Range (from Severson et al., 2009). Red bars represent portions of the Lower Slaty member that are mined at the various taconite operations. No scale implied. Note the three optional contacts for the top of the Lower Slaty. The upper "alternative contact" is used by the NRRI. See Severson et al. (2009) for a detailed discussion of the Lower Slaty member, the various submembers, the nature of the Interbedded Cherts (IBCs), and the nature of the upper contact zone.

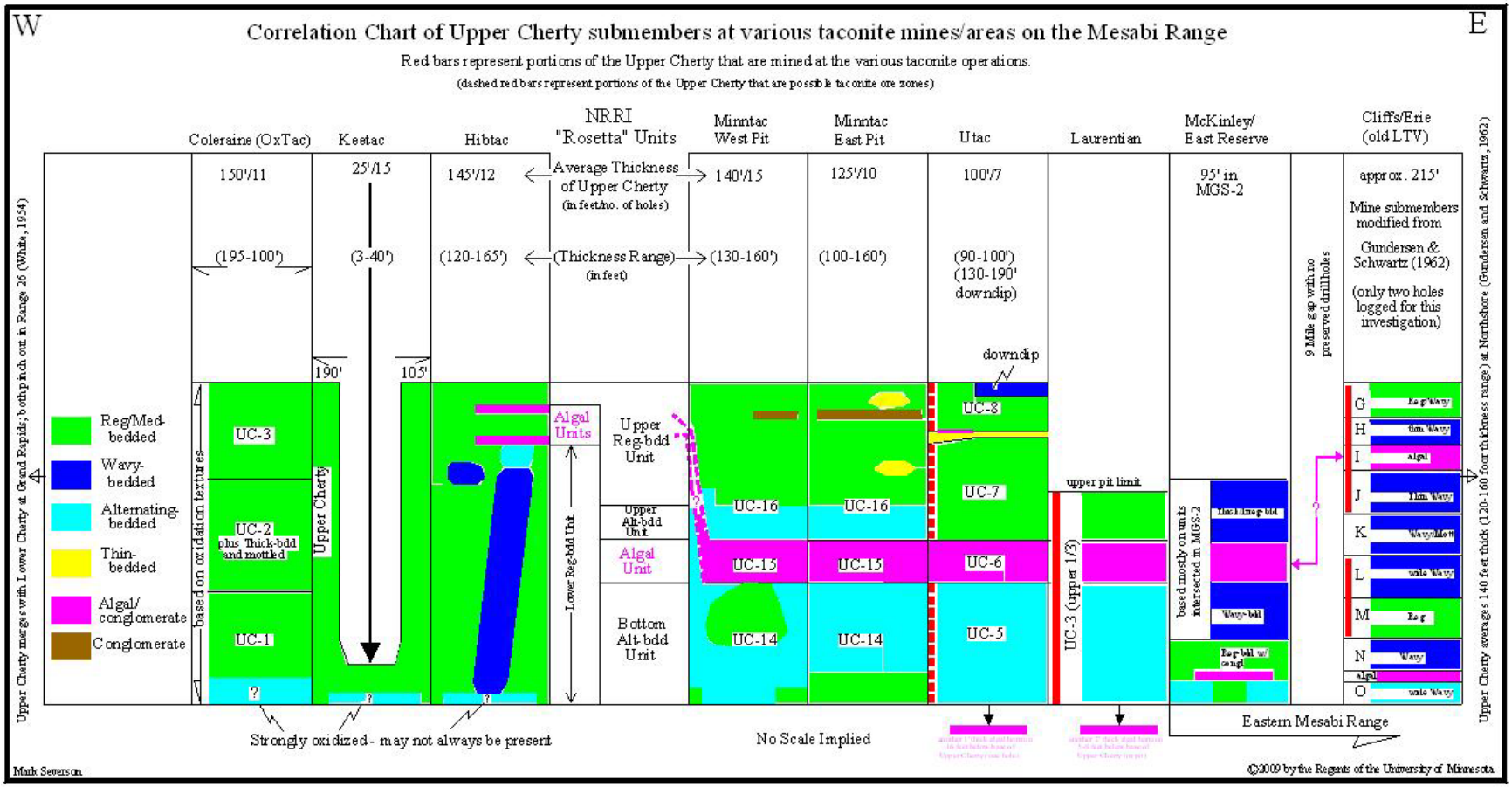


Figure 11. Correlation chart of Upper Cherty submembers at various taconite mines/areas along the Mesabi Iron Range (from Severson et al., 2009). Red bars represent portions of the Upper Cherty that are mined as taconite ore. Note that the Upper Cherty thins drastically in the central portion of the Keetac area in a valley-like morphology. Note also the distinct change in bedding types that constitute the Upper Cherty in the eastern Mesabi Iron Range and the two possible algal units.

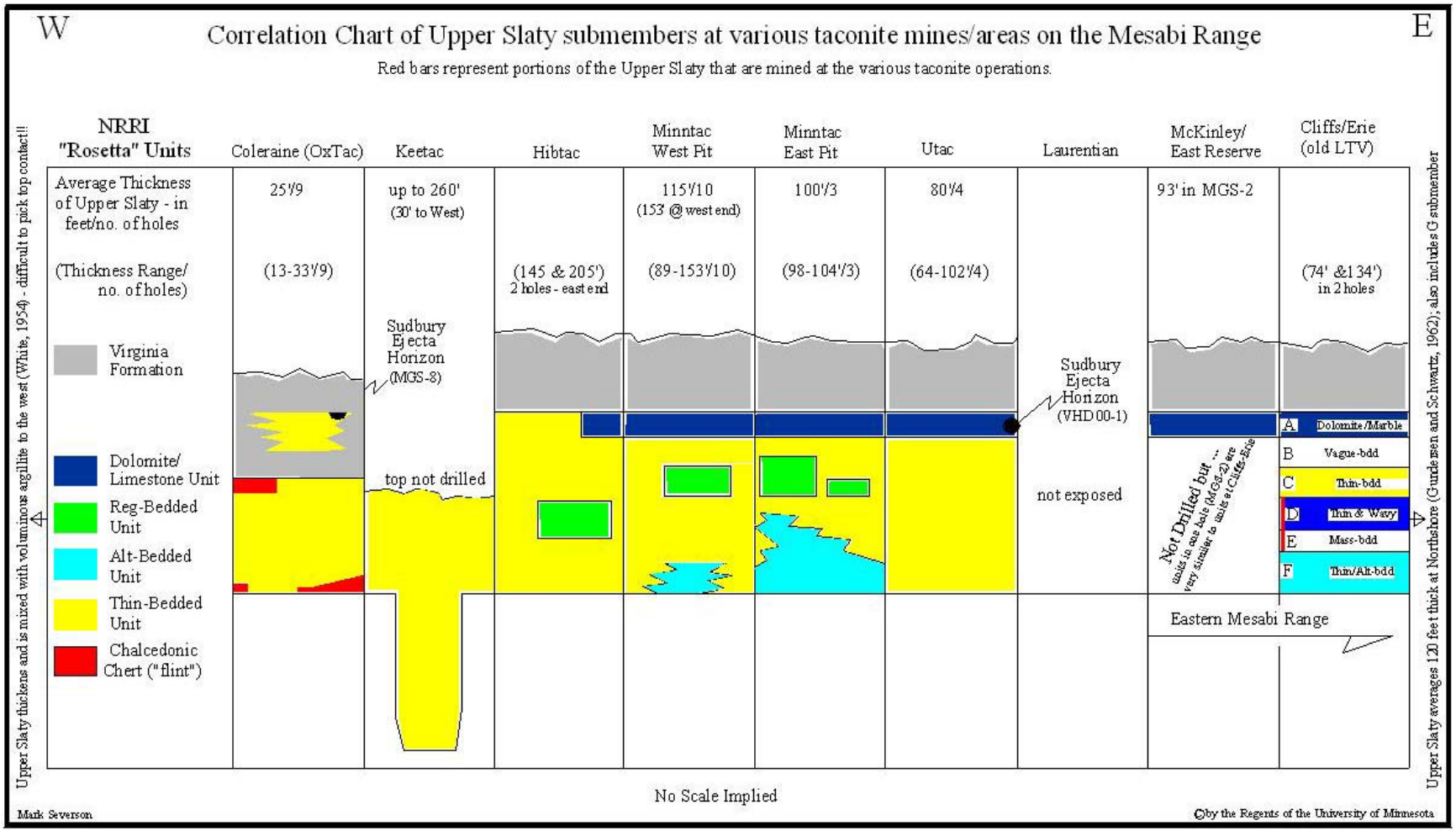


Figure 12. Correlation chart of Upper Slaty units and submembers at the various taconite mines/areas along the Mesabi Iron Range (from Severson et al., 2009). Red bars represent portions of the Upper Slaty that are mined as taconite ore. Note that the Upper Slaty exhibits drastic changes in thickness across the Mesabi Iron Range.

this column are lithologic picks determined by the NRRI and not necessarily mining company lithologic picks (although both are often close choices).

Aside from the submember designations that are included in this column, and portrayed in Figures 9 through 12, additional items in this column include the following:

- Sometimes two submember designations are listed in this column, e.g., LC5A/1-7. This situation occurs for holes that are spatially located between two mines, and thus, the submember designations for both mines were used while logging the core;
- In a few instances, the submember designation is followed by a "W" as in the case of LC4W or 1-5W. In these instances, the unit represents a silicate taconite body and a potential waste rock unit (thus, the W is tacked on the end of the designation). The determination of the unit as being a potential waste unit was made solely by the NRRI and was based on the relative magnetism that the rock displayed – **NO ore grade results** were used in making this determination as the data were not made publically available. For a more complete description of these silicate taconite bodies, which are channel-like bodies situated in ore horizons, see discussions in Severson et al. (2009);
- ARCHEAN = footwall Archean rocks;
- DIKE = subvertical dike of unknown age;
- FAULT = fault zone;
- IBC = Interbedded Chert body in the Lower Slaty member;
- LC = Lower Cherty/undivided;
- LS = Lower Slaty/undivided;
- POKEG = Pokegama Formation;
- SLTST = denotes a fine-grained, hematitic siltstone unit with very fine-grained detrital quartz grains near the base of the iron-formation (could be correlated with either the Biwabik Iron Formation or Pokegama Formation);
- UC = Upper Cherty/undivided;
- US = Upper Slaty/undivided; and
- VF = Virginia Formation.

NRRI "ROSETTA" UNITS = This column contains NRRI-named, all-encompassing "Rosetta Stone" units that tie together all of the various submembers as named by the different mining companies. These "Rosetta" unit names are also portrayed in the correlation charts of Figures 9 through 12, and the names are summarized in Figure 13. This column is probably the most important column in this database as it makes it easier to quickly recognize where the unit is positioned in the stratigraphy of the Biwabik Iron Formation instead of using the barrage of names as used by the mining companies. For example, the Reg-Bdd Unit of the Lower Cherty member ("Rosetta" unit) is equivalent to the LC-2, LC-6, 1-2, LC-1, LC-1/LC-2/LC-3, and U submember at the various mines (see Figure 9). Not only is it difficult to remember this barrage of names, but it is also difficult to remember which name applies to which mine. Thus the NRRI came up with a "Rosetta" unit name that is all-encompassing and based on the dominant bedding feature(s) of the unit.

BEDDING TYPES/GENERALIZED UNITS = this column lists the dominant bedding type(s) displayed by an interval of the Biwabik Iron Formation as described by Severson et al. (2009) and portrayed in Figure 14. Note that in some cases, the bedding form exhibits a wide range of types, and thus, several bedding-related names are applied to an interval. For example, if the bedding types range from wavy-bedded to regular-bedded with superimposed pink ankerite mottles the resultant designation in this column would be listed as WAVY/REG/MOTTLED.

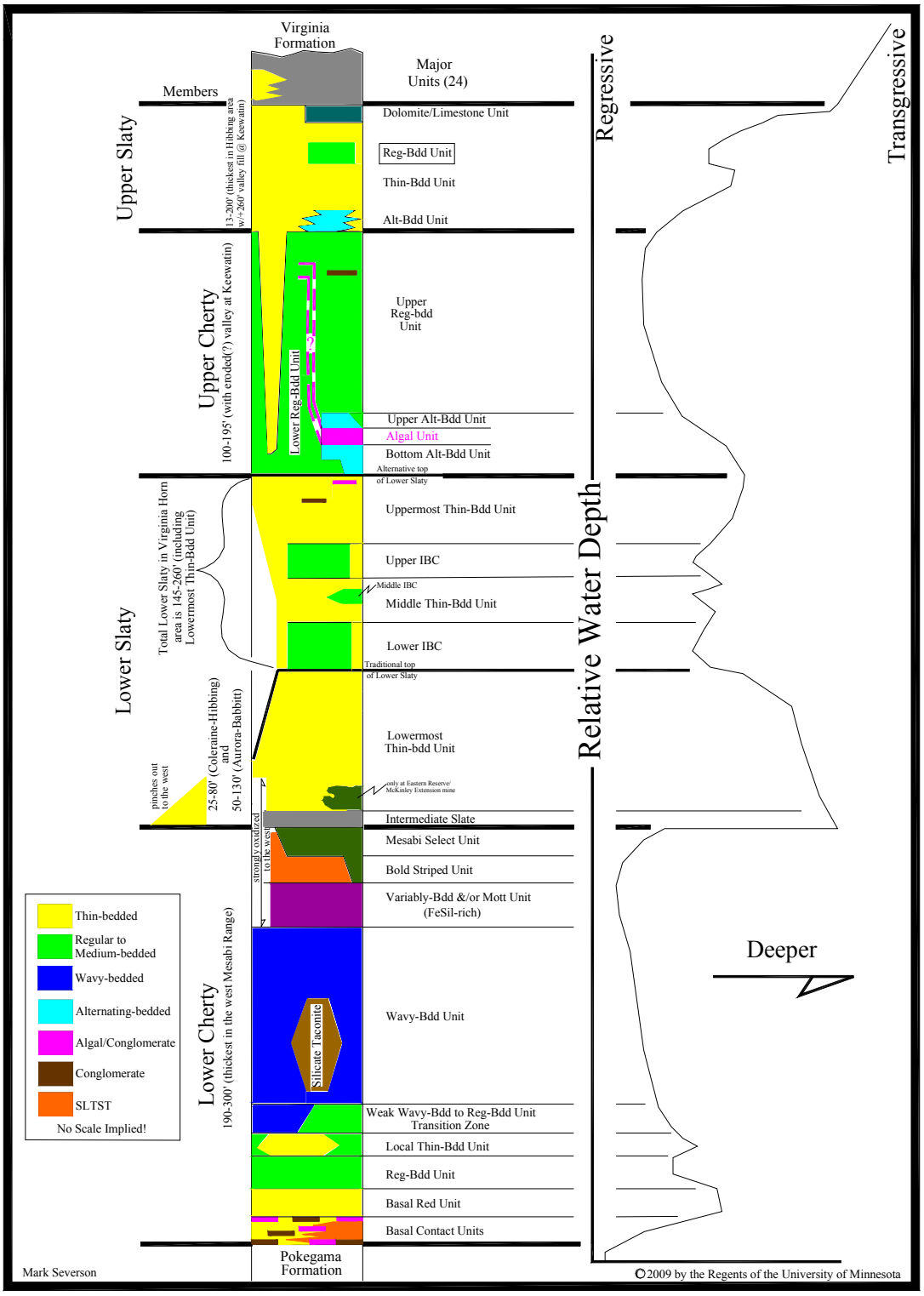


Figure 13. Summary of all of the 25 "Rosetta" units in the Biwabik Iron Formation that have been identified and described in Severson et al. (2009). Most of these units have corresponding submember designations at each of the taconite mines that can be seen in Figures 9, 10, 11, and 12.

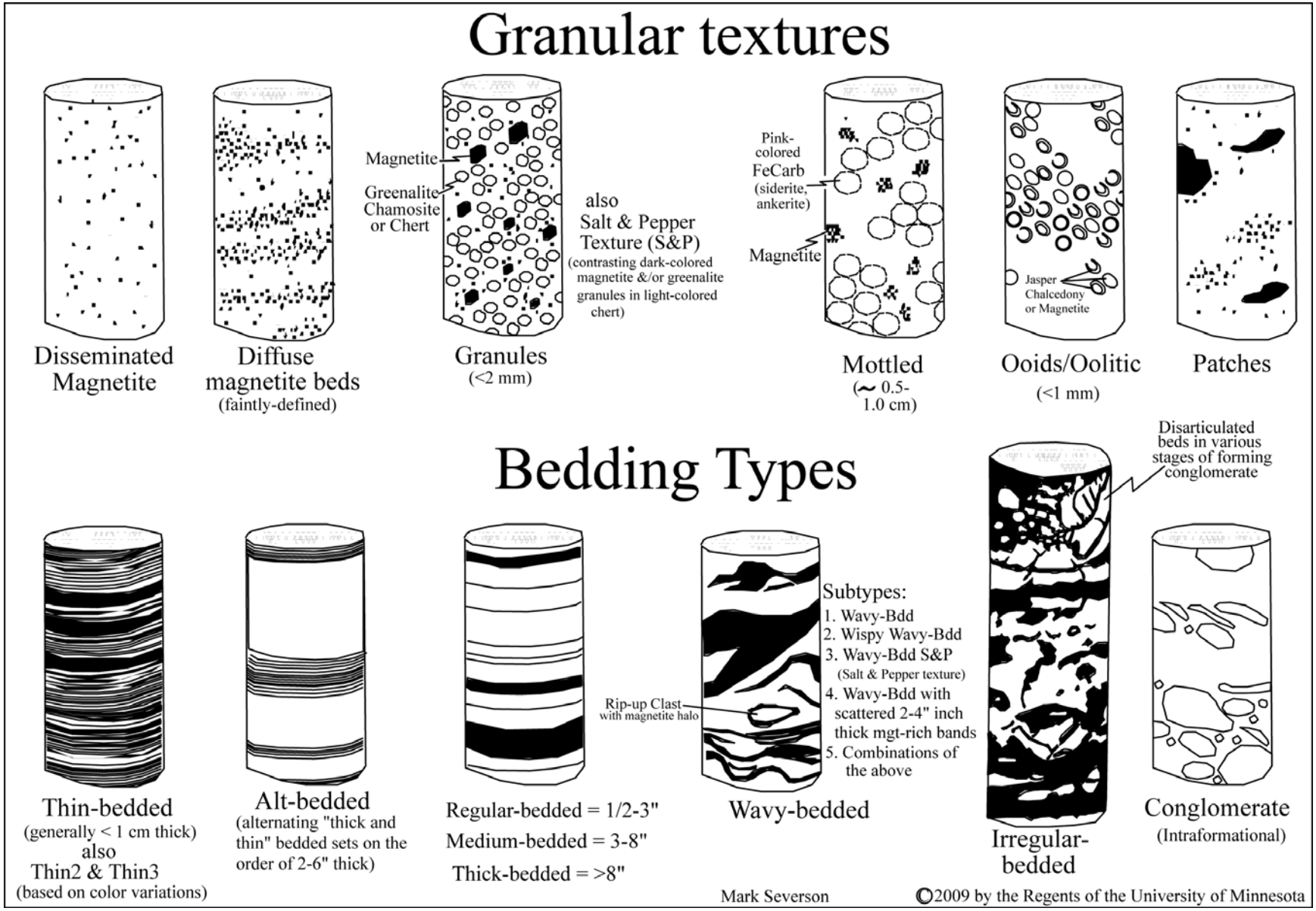


Figure 14. Template of textural and bedding characteristics of the Biwabik Iron Formation used during logging of drill core (from Severson et al., 2009).

MAGNETISM = this column lists the range of magnetism for an interval based on the relative attraction displayed by a hand-held, swivel magnet when held in close proximity to the drill core as follows:

- non-magnetic (or nil magnetism) – no movement of the magnet toward the core was discernable;
- weakly magnetic – the magnet slowly moved toward, and silently touched, the drill core;
- moderately magnetic – the magnet moved toward the core and attached to it with an audible sound; and
- strongly magnetic – the magnet rapidly moved toward the core with a loud "clunk" and stayed attached as the magnet was pulled away from the core.

[**Note** that there is more detail pertaining to the relative magnetism of an interval that is recorded in the drill logs than could ever be entered into this database without the use of three times the amount of entries that are already present].

CROSS-SECTION = lists the cross-sections, presented as plates in Severson, et al. (2009), in which a particular drill hole is displayed.

GEOLOGIST = geologist that logged the drill core, or where subsidiary data was obtained, as follows:

- MJS = Mark J. Severson;
- JJH = John J. Heine;
- MMP = Marsha Meinders Patelke;
- LMZ = Larry M. Zanko;
- ST = Seth Trobec (a summer intern at the Coleraine Research Lab. of the NRRI);
- J&L LOG = data from Jones and Laughlin Mining Company records for drill core that is no longer preserved; and
- USS LOG = data from a United States Steel Corp. drill log for core that is no longer preserved.

ASSOCIATED MINE/QUAD NAME = this column lists the mine that the drill hole is positioned within or adjacent to. Wherever drill holes are positioned well outside of current pit limits, the name of the 7.5 minute quadrangle is listed.

THIN-BDD COLORS = lists the color, or range of colors, for thin-bedded zones within a given interval.

CHERT COLORS = lists the color, or range of colors, for granular cherty zones within a given interval.

TEXTURE = lists secondary features that are associated with a specific bedding type. For example, if the interval is wavy-bedded and contains magnetite halos around rip-up intraformational clasts, then WAVY is entered into the BEDDING TYPES/ GENERALIZED UNITS column and HALO is entered into the TEXTURE column.

NOTES = contains additional information, in some cases, a repeat of what is in many of the previous columns, that was taken almost verbatim from the drill logs.

EXPLANATION OF DATA FORMATS FOR THE DEER LAKE COMPLEX INFORMATION

Introduction

This section contains a summary of listings for each of the databases submitted with this report pertaining to information regarding the Deer Lake Complex (Archean) in Itasca County, MN. These data are presented in a different format than the databases of Patelke (2003) and should not be combined with the 2003 data. A breakdown of the columns in the two spreadsheets that are submitted with this report (on the CD in the back pocket) are presented below.

Format for Locations of Drill Holes that were Logged by the NRRI in the Deer Lake Complex – Header File

The database *Deer-Lake-Complex-Header-File.xls* contains location information, and other pertinent data, pertaining to holes logged by the NRRI in the Deer Lake Complex. The drill holes were originally logged by Mark Severson in 1986 during his employment with Santa Fe Pacific Mining Company. His original logs were modified in 2005 during mapping and sampling of the Deer Lake Complex to evaluate its platinum-group element potential. This project was done in conjunction with the Minnesota Geological Survey and a 1:24,000 geologic map was published in 2005 (Severson and Jirsa, 2005; a copy of this map, listed as *m165-deer-lake-comp.pdf*, is included on the CD in the back pocket of this report). The locations of 15 holes that were drilled into the Deer Lake Complex by United States Steel Corp. and the Hanna Mining Company are portrayed on a reproduction of this same map (also on the CD, listed as *m165-Deer-Lake-drill-holes.pfd*, in the back pocket of this report).

A breakdown of the items entered into each of the columns in the *Deer-Lake-Complex-Header-File.xls* file follows.

HOLE-ID = drill hole number.

INTRUSION = name of intrusion (all are in the Deer Lake Complex).

COL-EL = collar elevation (in feet).

LENGTH = total depth of the drill hole (in feet).

AZIMUTH = direction of the drill hole at the collar (0-360º).

DIP = inclination of the drill hole at the collar (all of the holes are inclined).

EASTUTM83 = east coordinates in UTM system NAD83 (in meters) for the drill collar location.

NORTHUTM83 = north coordinates in UTM system NAD83 (in meters) for the drill collar location.

COL-EL-METR = collar elevation (in meters).

TOTDEPMETR = total depth of the hole (in meters).

OVB-THICK = thickness of glacial overburden.

COUNTY = county in which the drill hole is located (all are in Itasca County).

DATE-DRILL = approximate date of when the hole was drilled.

DEPOSIT = all are in, or peripheral to, the Deer Lake Complex.

FORTY = partial list of forty acre subdivision.

GEOLOGIST = name of geologist that logged the hole (MJS – Mark J. Severson).

LESSEE = name of exploration company that had the hole drilled.

QUAD = lists the USGS 7.5 minute quadrangle in which the hole is located.

SECTION = lists the Public Land Survey Section.

TOWNSHIP = lists the Public Land Survey Township (all are Township North).

RANGE = lists the Public Land Survey Range (all are Range West).

Format for Lithologies in Drill Holes in the Deer Lake Complex that were Logged by the NRRI

The database *Deer-Lake-Complex-logs.xls* contains rock type and lithologic information pertaining to the Deer Lake Complex of northeastern Itasca County, Minnesota. Descriptions of the types of data that are listed in each of the columns of this spreadsheet are discussed below.

HOLE-ID = drill hole number.

FROM = beginning of a specific interval (in feet).

TO = end of a specific interval (in feet).

INTERVAL = length of a specific interval (in feet).

ROCKTYPE = rock type designation (also see descriptions in the attached geologic map) as follows:

- ARGILLITE;
- CHERT;
- CHILLED ZONE – very fine-grained rocks usually at the base (sometimes at the top) of a particular sill. There are many intrusive sills that collectively comprise the Deer Lake Complex and not all of the sills exhibit well chilled margins. Some chilled margins are also on the outer edges of vertical, northwest-trending dikes of the Kenora-Kabetogama dike swarm;
- CLINOPYROXENITE;
- DACITIC TUFF;
- FAULT ZONE;
- FELSIC TUFF;
- GRAPHITIC ARGILLITE;
- GRAYWACKE;
- GREENSTONE;
- HORNBLENDE GABBRO;
- KENORA-KABETOGAMA DIKE – northwest-trending Paleoproterozoic dike swarm;
- MAFIC TUFF;
- MELAGABBRO;
- MIXED ZONE;
- OVERBURDEN;
- PERIDOTITE;
- PORPHYRITIC GABBRO;
- SHEAR ZONE; and
- TUFF.

TEXTURE = lists the textures displayed by the rock in drill core such as:

- HETEROGENEOUS;
- HOMOGENEOUS;
- INTERBEDDED – applies to inter-bedded metasediments;
- MASSIVE – applies to massive beds of graywacke;
- OVB - glacial overburden; and
- PORPHYRITIC.

BDD TO CORE AXIS = angle of bedding in the metasediments measured relative to the core axis (in degrees – where bedding at right angles to the core axis would be 90°). Note that these numbers are not true bedding trends as all of the holes are inclined (which is not taken into account in this spreadsheet).

SPLIT CORE = designates intervals (in feet) where the drill core has been split and sampled.

SULFIDE-BEARING = denotes whether a specific rock type is sulfide-bearing as follows:

- N = not sulfide-bearing;
- Y = is sulfide-bearing (generally >1% visually estimated sulfides);
- TR = visually estimated sulfides present in amounts that range from trace (scattered occurrences) to ≤1%; and
- RARE = visually estimated sulfides are present in rare amounts (widely-scattered occurrences);

CON-RTYPE = consolidated rock type, for sorting purposes using filters, as follows:

- DLC - consolidated category for the various intrusive rocks of the Deer Lake Complex;
- K-K - consolidated category for the northwest-trending Kenora-Kabetogama dike swarm;
- MAFIC - consolidated category for the various types of mafic flows/greenstone including minor amounts of interbedded metasediments;
- OVB - unconsolidated glacial overburden; and
- SED - consolidated category for the various types of metasediments, including minor amounts of tuffaceous rock.

MAP UNIT = lists specific geologic map units from Map M-165 (Severson and Jirsa, 2005) that correspond to each of the various intervals in the spreadsheet as follows:

- Adc – chilled margin rock (mostly applies to the chilled margins on the edges of some of the many sills that comprise the Deer Lake Complex);
- Adg – porphyritic gabbro (similar to the Adh unit, but contains 10-15% orthopyroxene phenocrysts that are variably altered to tremolite);
- Adh – amphibole-rich gabbro;
- Adm – melagabbro;
- Adn – porphyritic melagabbro (similar to the Adm unit, but contains 15-20% orthopyroxene phenocrysts);
- Adp – peridotite;
- Adv – ultramafic to mafic volcanic rocks that vary geochemically from high-Mg tholeiitic basalt to basaltic komatiite;
- Adx – clinopyroxenite;
- Ajs – metasedimentary rocks of the Joy Lake Sequence; and
- Pd – Kenora-Kabetogama dike swarm.

TOPPING DIRECTION = the topping direction is either listed as being uphole or downhole and is determined by either graded beds in the metasediments, gradational relationships displayed by ultramafic rocks that grade upward into mafic rocks within the Deer Lake Complex, or the placement of chilled margins at the top or base of the various sills of the Deer Lake Complex.

ALTERATION/FRACTURING = lists the type of alteration, weathering, and types of fracture coatings noted in the drill log.

EXP-RTYPE = expanded rock type description taken almost verbatim from the description in the drill log.

CONCLUSIONS AND RECOMMENDATIONS

A considerable amount of effort went into compiling all of the information in the databases that are provided with this report. Over 21,500 lines of entries are provided in the databases that cover:

1. *Duluth-Complex-Header-File.xls* = header file for locations of holes that were drilled in the Duluth Complex post-2003 – these data are exactly in the same format as the *HEADER.xls* file of Patelke (2003), and the two files should be combined to give an all inclusive list of every hole ever drilled in the Duluth Complex;
2. *Mesaba-Deposit-logs.xls* = lithologies for 129 drill holes at the Mesaba (formerly Babbitt or Minnamax) deposit plus a few other areas in the Partridge River Intrusion – after a few columns are added to the *west-lith.xls* database of Patelke (2003), these two files should be combined to give an almost complete listing of all of the holes at this deposit (repeat holes should probably be eliminated from the west-lith.xls because they were based on 1970s vintage company drill logs);
3. *Dunka-Pit-Deposit-logs.xls* = lithologies for 47 drill holes at the Dunka Pit deposit – after a few columns are added to the *east-lith.xls* database of Patelke (2003), these two files should be combined to give a complete listing of all of the holes at this deposit (repeat holes should probably be eliminated from the west-lith.xls because they were based on 1970s vintage company drill logs);
4. *Mesabi-Range-Header-Files.xls* = header file for locations of holes in the Mesabi Iron Range that have been logged by the NRRI to better define the stratigraphy of the Biwabik Iron Formation – this database bears no semblance to the databases of Patelke (2003) and should be treated separately;
5. *Mesabi-Range-logs.xls* = lithologies for 289 holes drilled into the Biwabik Iron Formation that were logged by the NRRI – this file should be treated "as is" and not combined with any known database.
6. *Deer-Lake-Complex-Header-File.xls* = a stand-alone database pertaining to 15 holes drilled in the Archean Deer Lake Complex of Itasca County, MN; and
7. *Deer-Lake-Complex-logs.xls* = another stand-alone database pertaining to the lithologies of 15 holes drilled into the Deer Lake Complex that can be correlated with units in the geologic map of Severson and Jirsa (2005).

The report that accompanies these databases is subsidiary to those databases and only serves to help explain what items are included in which of the columns. There are no conclusions generated in this report other than explanatory notes.

Due to time and money constraints this project was curtailed before all of the lithologies from holes (logged by the NRRI in the Duluth Complex) could be completed. There are still several items that could be finished to further update the databases in this report and those in Patelke (2003) that include:

- Add the remainder of lithologies for Teck American drill holes to the *Mesaba-Deposit-logs.xls* (drill holes MB07-22 to MB08-64);
- Refine the unit designations in the *west-lith.xls* of Patelke (2003) – recent work by Severson and Hauck (2008) indicates that most of the deposit is contained within the Bathtub intrusion rather than the Partridge River intrusion, and the unit designations in Patelke (2003) need to reflect this more recent interpretation; and
- Continue to add the iron-formation submember units to the holes not yet finished in *Mesabi-Range-logs.xl*s file.

(This mostly applies to holes logged from the Coleraine and Keewatin, MN, areas).

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APPENDIX A:
Listing of Excel spreadsheets that are included on the CD in the back pocket of this report.

1. *Duluth-Complex-Header-File.xls* = header file for locations of holes that were drilled in the Duluth Complex post-2003;
2. *Mesaba-Deposit-logs.xls* = lithologies for 106 drill holes at the Mesaba (formerly Babbitt) deposit;
3. *Dunka-Pit-Deposit-logs.xls* = lithologies for 47 drill holes at the Dunka Pit deposit;
4. *Mesabi-Range-Header-File.xls* = header file for locations of holes in the Mesabi Iron Range that have been logged by the NRRI;
5. *Mesabi-Range-logs.xls* = lithologies for 87 holes drilled into the Biwabik Iron Formation that were logged by the NRRI;
6. *Deer-Lake-Complex-Header-File.xls* = header file pertaining to 15 holes drilled in the Archean Deer Lake Complex; and
7. *Deer-Lake-Complex-logs.xls* = lithologies for 15 holes drilled into the Deer Lake Complex.

APPENDIX B:
Listing of posters and geologic maps that are included on the CD in the back pocket of this report.

1. *NRRI-2009-08.pdf* = map of : Copper-Nickel and Iron-Titanium deposits of the Partridge River, South Kawishiwi, and Bathtub intrusions, Duluth Complex, NE Minnesota (Severson, 2009);
2. *m165-deer-lake-comp.pdf* = geologic map of the Deer Lake Complex published by the Minnesota Geological Survey (Severson and Jirsa, 2005); and
3. *m165-Deer-Lake-drill-holes.pdf* = above listed geologic map with highlighted drill hole locations.