Acquiring Michigan Upper Peninsula Geological Samples and Well Records for use in Potential Critical Mineral Research, Student Education, and K-12 Outreach at Western Michigan University

Field Trip Report

August 1-6, 2019

Department of Geological and Environmental Sciences
Michigan Geological Survey
Michigan Geological Repository for Research and Education
Western Michigan University

Edited by Peter J. Voice

Field Trip Participants: William B. Harrison, Peter J. Voice, Jennifer L. Trout and Linda K. Harrison

Field trip objectives:

- Document and sample geological formations for use in research about potential critical mineral host rocks
- Digitize geological well records and obtain research theses archived at the Upper Peninsula geological repository in Harvey, Michigan, for use in critical minerals research and WMU student education
- Collect samples for use in WMU student education and CoreKids, our K-12 outreach program

Introduction

This field trip, conducted by William B. Harrison, Peter J. Voice, Jennifer L. Trout and Linda K. Harrison, was organized primarily to obtain samples and create digital well records from Upper Peninsula geological formations that may host critical minerals. Those materials are essential to research being conducted by Western Michigan University (WMU) at the Department of Geological and Environmental Sciences, through the Michigan Geological Repository for Research and Education (MGRRE) and the Michigan Geological Survey (MGS).

That research is funded by a grant from the United States Geological Survey (USGS), National Geological and Geophysical Data Preservation Program (NGGDPP). William Harrison, MGRRE director, leads this research project and is joined by department faculty member Peter J. Voice, who also serves as director of CoreKids, our K-12 outreach program. Michigan Geological Survey director, John A. Yellich, and department faculty member, Joyashish Thakurta, together with MGRRE geologist, Jennifer L. Trout, complete the research team.

The team is searching Michigan for 35 minerals and rare earth elements—defined by the Department of the Interior as critical to America's economy and security—because the United States currently imports 90-100% of these materials (Fig. 1). They are finding geologic data about these minerals in published and unpublished reports, reviewing and preparing geologic maps, and compiling resource lists.

Finding these materials in Michigan could mean creating more jobs and providing raw materials that so much of America's economy and security depend upon.

In addition to searching for critical mineral data and samples, participants collected samples for use in WMU student education and the CoreKids outreach program. Samples will be available for examination and testing by WMU students. They will also be added to a display about economic minerals at MGRRE. We will use the samples to prepare mineral cards for distribution at CoreKids events.

This field trip was carried out through funding from grants directed by Dr. Harrison and by contributions from the participants themselves.

Appendices, prepared by Peter J. Voice, provide additional information and references.

Photographs were contributed by Linda K. Harrison unless otherwise noted.

Stop locations and activities

August 1

Stop 1 near Palmer, Michigan

- M 35, South of Palmer, MI, near Warner Falls. Described and sampled Goodrich Quartzite.
- Near Tilden and Empire Mines, attempted to sample Negaunee Iron Formation, but were unable to access the formation due to collapse of abandoned mine shafts (Fig. 2).

Stop 2 near Negaunee, Michigan

- CR 480 0.5 miles East of Negaunee, Michigan, examined and sampled a Siamo Slate outcrop.
- Outcrop off Farrer Street, near intersection with Michigan Street, just outside Negaunee, examined and sampled Negaunee Iron Formation (chlorite-grade and diabase Fig. 3)

Stop 3 Between Negaunee and Big Bay, Michigan

- Along CR 510, north of CR 502, examined several roadside outcrops of high-grade gneisses north of the McClure Storage Basin (Fig. 4).

August 2

Stop 1 Republic Mine

- Took part in mineral field trip to the Republic Mine near Republic, MI, hosted by the Ishpeming Rock and Mineral Club. The club provided access to this site which is otherwise not open to visitors. Collected numerous samples of sillimanite-grade Negaunee Iron Formation to distribute through the CoreKids program and for use in WMU student education (Fig. 5 and 6).

August 3

Stop 1 Ishpeming

- Visited vendors at Ishpeming Rock and Mineral Club to purchase specimens for use in preparing mineral cards to distribute at CoreKids events.

Stop 2 Cliffs Shaft Mining Museum on Euclid Street between Lakeshore Drive and Spruce Street

- At this former iron mine site, now a heritage museum, purchased banded iron ore specimens for MGRRE economic minerals exhibition.

- Participated in museum mine tour to take photographs to use in CoreKids program to show how iron was mined historically in Michigan. (Fig. 7).

Stop 3 East of L'Anse, Michigan, off Arvon Road, 3-4 miles east of Skanee Road, at Slate River and nearby slate outcrops near Avon Slate Quarries

- Photographed slate outcropping in Slate River (Fig. 8).
- Collected slate from small outcrops. High water level made Arvon Slate Quarry inaccessible (Fig. 9).

August 4

Stop 1 Ishpeming, MI

- Took part in mineral field trip to the Lindberg Quarry near Harvey, hosted by the Ishpeming Rock and Mineral Club. Collected many samples of Kona dolomite, particularly those with stromatolitic layering, for use in CoreKids outreach (Fig.10 and 11). These are particularly interesting for WMU students and for the CoreKids program.

August 5

Stop 1 Ishpeming, MI

- Took part in mineral field trip to Michigan Gold Mine Shaft #7 tailings, near Ishpeming, hosted by the Ishpeming Rock and Mineral Club. The club provided access to this site which is otherwise not open to visitors. Collected samples of the host rocks (porphyritic igneous rock cross-cut by gabbroic intrusion). Gold mined here was associated with quartz veins emplaced during the intrusion of the gabbroic dike (Fig 12). Samples will be used by WMU students and included in an exhibit for the CoreKids program.

Stop 2, Harvey Michigan, Upper Michigan EGLE Repository

- Scanned previously unscanned well records from Upper Peninsula bore holes and searched research theses. Compared on-site records with previously scanned records. We are grateful for those scanned records, provided by

Melanie Humphrey, Marquette district office and repository manager, and Ray Vugrinovich, Permits and Bonding Unit geologist, of the Michigan Department of Environment, Great Lakes, and Energy (EGLE). By comparing the archived paper records to those previously scanned, we scanned only the remaining unscanned paper records and created file names reflecting locations and included a unique identifier. The team also scanned assays and other geochemical analyses, technical reports, wireline logs and other documents associated with these wells. We saved scanned well files in PDF format, later identifying all records by the same naming protocol (Fig. 13). These documents provide essential data for the critical mineral research project.

August 6

Stop 1, Harvey Michigan, Upper Michigan EGLE Repository

- Continued to scan well records from Upper Peninsula wells and searched for research theses.
- Photographed file cabinets and storage cabinets showing extensive mining records from Hannah Mining Company and mine maps with cross sections previously archived by the Michigan Geological Survey (Fig. 14 and 15). If further funding is made available next year, those maps and cross sections will provide data for mapping potential bands of critical mineral host rocks.

Appendix A

Paper copies of theses and dissertations about Michigan geology were lent to the participants by Michigan EGLE district office and repository manager Melanie Humphrey. She archives these reports at the Upper Peninsula repository. Peter Voice is currently converting these to digital format. These documents provide further research data about potential critical mineral host rocks.

Several of these theses were previously unknown to the field trip participants and likely would not have been brought to light without Melanie Humphrey's knowledge. We gratefully acknowledge her help in offering us these documents, which include:

BLEWETT, W.L. (1984) Ice stagnation landforms in Eastern Upper Michigan: A Reinterpretation of the Munising Moraine. Unpublished MA Thesis, Western Illinois University, Macomb, IL.

BROJANIGO, A. (1984) Keweenaw Fault: Structures and Sedimentology, Unpublished MS Thesis, Michigan Technological University, Houghton, MI.

BURNS, G.K. (1975) Middle Precambrian Black Slates of the Baraga Basin, Baraga County, Michigan. Unpublished MS Thesis, Bowling Green State University, Bowling Green, OH.

DENNING, R.M. (1949) The Petrology of the Jacobsville Sandstone, Lake Superior, Unpublished MS Thesis, Michigan College of Mining and Technology, Houghton, MI.

ECKERT, K.B. (1982) The Sandstone Architecture of the Lake Superior Region. Unpublished PhD Dissertation, Michigan State University, East Lansing, MI. [Interestingly – this one actually was published as a book in 2000.]

EHLERS, G.M. (1930) Stratigraphy of the Niagaran Series of the Northern Peninsula of Michigan, Unpublished PhD Dissertation, University of Michigan, Ann Arbor, MI.

HARRISON, J.E. (1984) Mineralogy and Petrology of the Vulcan Iron Formation and Related Rocks, Felch District, Dickinson County, Michigan. Unpublished MS Thesis, Bowling Green State University, Bowling Green, OH.

HORNER, W.J. (1958) Paleocurrent Studies of the Middle and Upper Keweenawan Conglomerates of Michigan, Unpublished MS Thesis, University of Kansas, Lawrence, KS.

HUGHES, J.D. (1963) Physiography of a Six-Quadrangle Area in the Keweenaw Peninsula North of Portage Lake, Unpublished PhD Dissertation, Northwestern University, Evanston, IL.

KARPIAK, S.T., JR. (1979) Copper Mining in the Porcupine Mountains: An Interpretive Program. Unpublished MS Thesis, Michigan Technological University, Houghton, MI.

MAHARIDGE, A.D. (1986) The Structural and Tectonic History of a Portion of the Felch Trough, Central Dickinson County. Unpublished MS Thesis, Bowling Green State University, Bowling Green, OH.

MCMAHON, D.A. (1990) The source rock potential of the Nonesuch Formation, White Pine District, Michigan. Unpublished MS Thesis, University of Toledo, Toledo, OH.

MORRIS, W.J. (1977) Geochemistry and Origin of the Yellow Dog Plains Peridotite, Marquette County, Northern Michigan. Unpublished MS Thesis, Michigan State University, East Lansing, MI.

PENNINGTON, R.L. (1986) Magnetic Survey of a portion of the Felch District, Central Dickinson County, Michigan. Unpublished MS thesis, Bowling Green State University, Bowling Green, OH.

REGIS, R.S. (1989) The relationship between water-well yield and bedrock geology in the central portion of Marquette County. Unpublished MA Thesis, Indiana State University, Terre Haute, IN.

SANTANGELO, M.A. (1987) Magnetic Survey over the Section 32-35 Area of the Felch District, Central Dickinson County, Michigan. Unpublished MS thesis, Bowling Green State University, Bowling Green, OH.

SHEPECK, A.W. (1985) Characterization of the Ore Host Rock and Hydrothermal System at the Ropes Gold Mine, Ishpeming, Michigan, Unpublished MS Thesis, Michigan Technological University, Houghton, MI.

SUNDEEN, S.P. (1968) The Petrology of a Magnetite-Rich Portion of the Negaunee Iron Formation in the Southeast Part of the Marquette Range, Michigan, Unpublished PhD Dissertation, The University of Wisconsin - Madison, Madison, WI.

Appendix B

Peter J. Voice is compiling a spreadsheet of scanned records of well reports, assays and other geochemical analyses, technical reports, wireline logs and other documents associated with wells from the Upper Peninsula, with an emphasis on those wells with associated cores and or cuttings archived at the Harvey repository or at MGRRE. To date, he has organized approximately 1,100 well files into this user-friendly database, organized by geographic location.

Figures

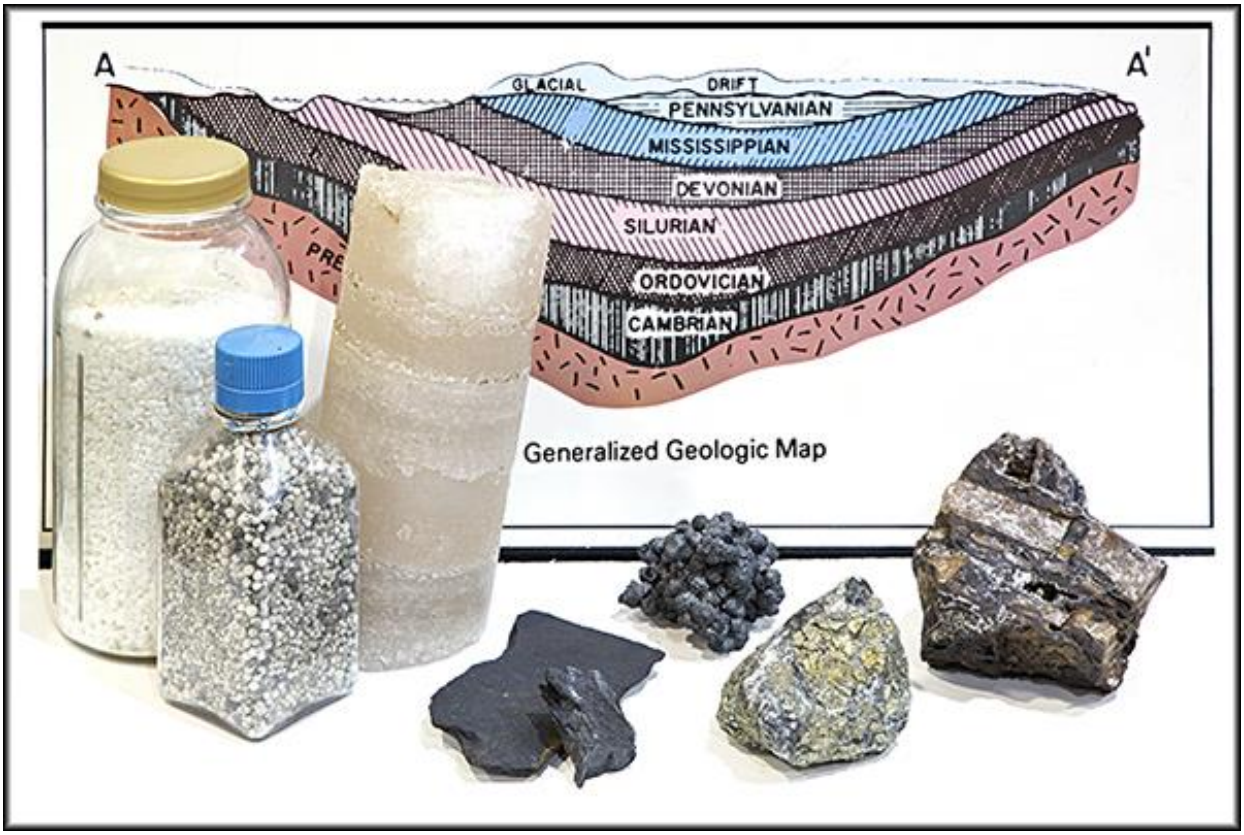

Figure 1. Examples of Michigan Critical Minerals: potash (left, lighter colors) graphite (center front) manganese-bearing iron formation (two specimens on right)

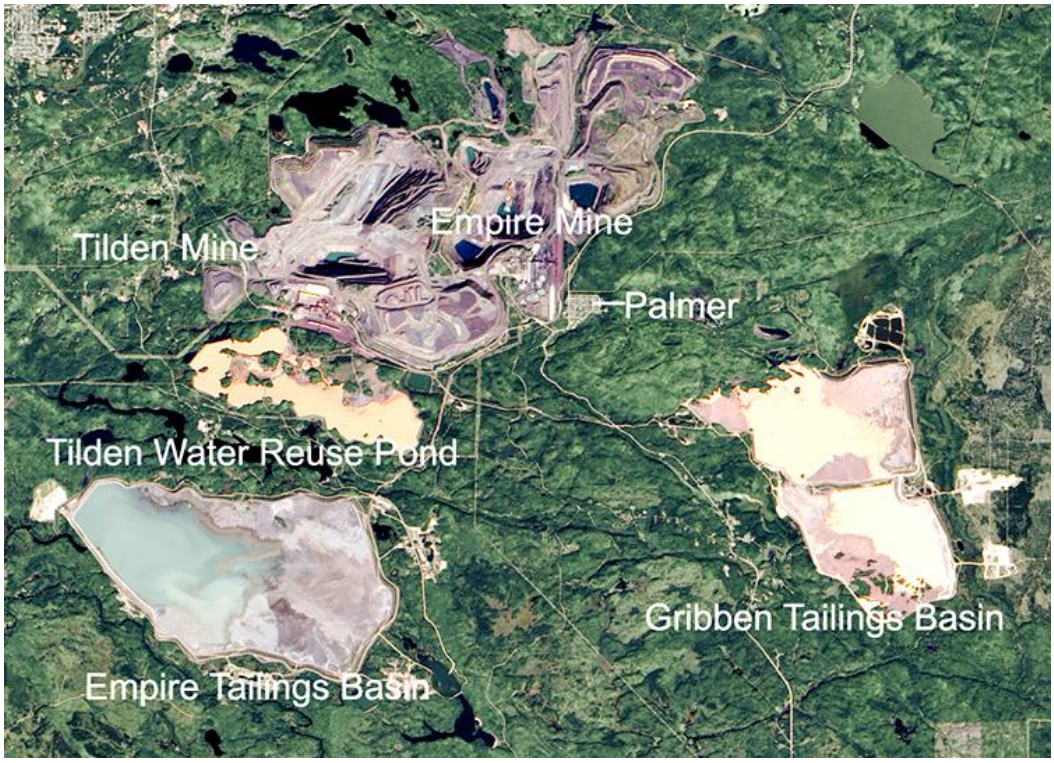

Figure 2. Tilden and Empire Mines –*Photo Courtesy of NASA*

Figure 3. Peter J. Voice at Farrer Street Negaunee Iron Formation outcrop

Figure 4. Outcrop of high-grade gneiss along CR 510

Figure 5. Collecting at the Republic Mine with the Ishpeming Rock and Mineral Club

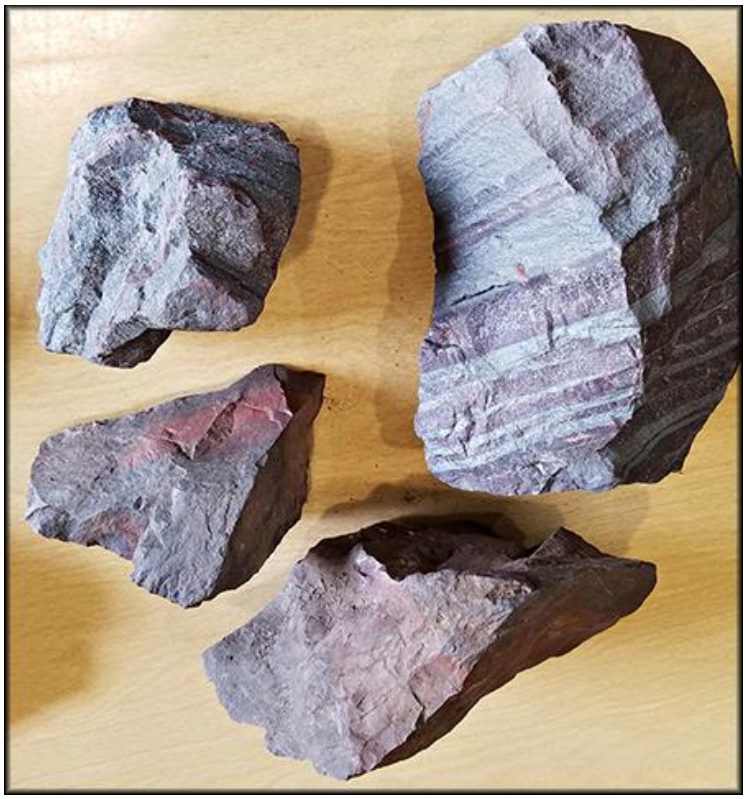

Figure 6. Banded Iron Ore collected at Republic Mine (Negaunee Iron Formation)

Figure 7. Cliffs Shaft Mining Museum, Ishpeming

Figure 8. Slate outcrop in Slate River Falls

Figure 9. Slate collected near Arvon Slate Quarry (Michigamme Formation)

Figure 10. Collecting at Lindberg Quarry, with the Ishpeming Rock and Mineral Club
–Photo Courtesy of Peter J. Voice

Figure 11. Kona dolomite collected at Lindberg Quarry, Ishpeming

Figure 12. Samples collected at Michigan Gold Mine #7 tailings

Figure 13. Scanning paper well records at Harvey repository (Jennifer L. Trout, left, William Harrison, center, and Peter J. Voice, right)

Figure 14. Cabinets with mine maps and cross sections at Harvey repository

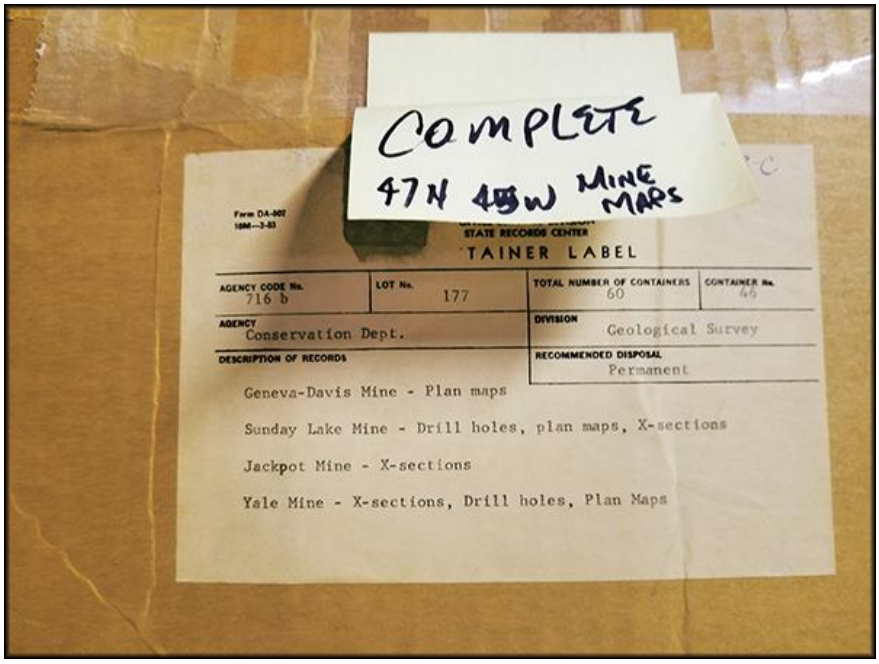

Figure 15. Example of box containing mining records at Harvey repository