Geologic map of the North Freedom 7.5-minute quadrangle, Sauk County, Wisconsin

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INTRODUCTION AND SCOPE

The North Freedom quadrangle is located on the South Range of the Baraboo Hills. Most of the quadrangle falls within the unglaciated Driftless Area of Wisconsin. The Baraboo Hills are recognized for their ecologic and geologic significance, with superb exposure of Precambrian and Paleozoic rocks and Quaternary sediments.

This map builds on past work by subdividing and mapping members of the Baraboo Quartzite. Offset of Baraboo Quartzite members provides evidence for the newly identified South Range fault. The map differs from previous maps in assigning several quartzite outcrops along the axis of the Baraboo syncline to the Dake Quartzite, a quartzite near the top of the Precambrian section, rather than invoking fault repetition of the Baraboo Quartzite.

The North Freedom quadrangle is underlain by Paleoproterozoic granite, quartzite, slate, iron formation, and dolostone. These units were metamorphosed to lower greenschist facies and folded into the Baraboo syncline. Deformation also resulted in several smaller-scale folds superposed on the gently north-dipping southern limb of the Baraboo syncline. During the early Paleozoic, the resistant quartzite formed monadnocks that were eventually buried by sandstone and dolostone. Exhumation has re-exposed parts of the Proterozoic section and much of the lower Paleozoic section. During the Quaternary, the terminal moraine of the Green Bay Lobe of the Laurentide Ice Sheet reached the eastern side of the quadrangle. A large proglacial lake formed west of the terminal moraine, depositing the lake sediments that cover much of the northern half of the quadrangle. The ice sheet also produced outwash deposits along the western margin of the moraine.

Mapping focused on the Precambrian section. Henry (1975) divided the Paleoproterozoic Baraboo Quartzite into three informal members. As part of this mapping effort, the three members were verified, and a fourth quartzite and metapelite member was identified. Paleozoic units were mapped in reconnaissance. Where Paleozoic units lack good exposure, the different topographic expressions of the units, as described in Clayton and Attig (1990), were used to map contacts. Quaternary units and contacts were compiled and slightly modified from mapping by Clayton and Attig (1990).

STRATIGRAPHY

The total thickness of exposed Baraboo Quartzite near Sauk Hill and Devil's Lake was estimated by Weidman (1904) to be approximately 1,460 m based on an average dip of 15 degrees. Our mapping along Sauk Hill and immediately east in the Baraboo quadrangle yields an average dip of 19.5 degrees, which increases the estimated thickness of exposed quartzite to around 1,900 m. Modifying Henry (1975), the Baraboo Quartzite is subdivided into four members that are mappable at 1:24,000-scale: The lower conglomerate and quartzite member (Xblc) is overlain across a sharp contact by the lower quartzite member (Xblq), which is overlain across a gradational contact by the upper conglomerate and quartzite member (Xbuc), which in turn is gradational with the overlying upper quartzite and metapelite member (Xbqp).

The Dake Quartzite problem

The stratigraphy at the top of the Precambrian section in the Baraboo Range has been debated for decades. Leith (1935) examined drill core and drill records and named and described the Dake Quartzite as a quartzite unit that unconformably overlies the Freedom Formation in the core of the Baraboo syncline. In his unpublished master's thesis, Schmidt (1951) interprets a fault south of the town of North Freedom based on his stratigraphic pick of the base Freedom Formation. Evidence for the fault comes from only two drill logs (see base Freedom Formation depth-structure map, Schmidt, 1951). He argues that the location of the fault suggests the quartzite outcrops at North Freedom represent Baraboo Quartzite faulted into the core of the Baraboo syncline. Stewart and others (2018, table 1) document stratigraphic picks for these same drill records, as well as additional records not included in Schmidt (1951), and find no evidence for offset of the Freedom Formation south of North Freedom. Additionally, some drill records not used by Schmidt (1951) directly conflict with his depth-structure maps (for example, core 12_HF_2 NW SW in Stewart and others, 2018). These basic problems, combined with the very simple structural interpretation of Leith (1935), led Stewart and others (2018) to discard Schmidt's (1951) fault block model. No evidence for structural repetition has been presented for any other proposed Dake Quartzite outcrop. On this basis, Stewart and others (2018) included the Dake Quartzite as a younger quartzite that unconformably overlies the Freedom Formation.

STRUCTURE

Folds

Baraboo syncline

The Baraboo syncline is the dominant structure in the North Freedom quadrangle. The north limb of the syncline is characterized by steeply south-dipping to overturned north-dipping bedding, while the south limb of the syncline is characterized by several kilometer-scale folds superposed on a gently north-dipping limb. The axial trace of the Baraboo syncline is buried beneath Paleozoic and Quaternary rocks and sediment throughout the quadrangle. Aeromagnetic anomaly data and historic core data (Stewart and others, 2018) were used to estimate the axial trace of the fold.

Quartzite pressure solution cleavage is well developed in the Baraboo Quartzite, particularly near the axis of the syncline. Cleavage typically strikes east-northeast and dips steeply to the north. Lineations in the vicinity of the fold hinge in the North Freedom and adjoining quadrangles are generally subhorizontal and parallel to the fold axis. The cleavage is interpreted to be an axial planar cleavage, and the subhorizontal lineations to reflect a component of axis parallel extension during folding (for example, Czeck and Ormand, 2007).

The Baraboo syncline likely formed as a fault propagation fold. The sharp bend in the axis of the syncline in the northern portion of the North Freedom quadrangle, evident in aeromagnetic data (Stewart and others, 2018) may indicate a buried lateral ramp or that the two sections of the syncline formed as separate fault propagation folds from two different faults.

Otter Creek syncline

The Otter Creek syncline was first identified and named by Dalziel and Dott (1970). The fold lies on the gently north-dipping, south limb of the Baraboo syncline. The fold axis near Baxter's Hollow plunges 3 degrees at 067 (NE) based on a cylindrical best fit of bedding orientations. The Otter Creek syncline is a kilometer-scale, open fold with an interlimb angle of approximately 115 degrees. The amplitude of the Otter Creek syncline decays west of Baxter's Hollow such that by the western portion of section 31 (T11N, R6E) the syncline has turned into a series of mesoscale (meters to tens of meters) anticlines and synclines, and the overall contact between the lower conglomerate and quartzite (Xblc) and lower quartzite (Xblq) is essentially flat.

Skillet Creek anticline

The Skillet Creek anticline was first identified and named by Dalziel and Dott (1970), though part of the anticline also appears in the mapping of Leith (1941). The calculated fold axis of the anticline plunges 6 degrees at 068 (NE). The fold brings the basal lower conglomerate and quartzite member (Xblc) to the surface in the core of the fold (NE¼ section 29, T11N, R6E). The stratigraphic section youngs along the axial trace of the fold to the northeast, consistent with the calculated plunge on the fold axis. The lower conglomerate and quartzite member (Xblc) disappears along the fold axis to the southwest, suggesting that the fold may be doubly plunging (as mapped). Alternatively, a small fault near the middle of section 29 (T11N, R6E) could bring the lower quartzite member (Xblq) down on the west. Quartzite near the anticline axis has well-developed axial planar cleavage. The fold is truncated by the South Range fault on the west, and presumably continues at depth within the footwall of the South Range fault for some distance before decaying in amplitude. The interlimb angle is approximately 120 degrees.

Pine Creek syncline

The Pine Creek syncline was mapped by Weidman (1904), Leith (1941), and Dalziel and Dott (1970). The fold axis plunges approximately 6 degrees towards 045 (NE), consistent with the map pattern defined by the contact between the lower quartzite member (Xblq) and the upper conglomerate and quartzite member (Xbuc), which indicates a shallowly plunging syncline. The interlimb angle is approximately 115 degrees. Along most of its length, the axial trace of the fold is buried beneath Parfreys Glen Formation conglomerate and sandstone (O€pg) and Quaternary alluvium (Qa).

Happy Hill anticline

The Happy Hill anticline was mapped by Weidman (1904), Leith (1941), and Dalziel and Dott (1970). The calculated fold axis plunges approximately 4 degrees at 046 (NE). The fold is believed to continue to the northeast in the subsurface for several kilometers. The calculated northeast plunge is consistent with overall map patterns showing the stratigraphic section youngs along the axis to the northeast, though a slightly steeper average plunge of roughly 8 degrees is needed to account for the entire Baraboo section before reaching the buried Seeley Slate contact. Fold limbs commonly contain smaller mesoscale parasitic folds (tens of meters).

Faults

North Freedom fault

The North Freedom fault is a northeast striking, up-on-the-northwest fault present entirely in the subsurface in the North Freedom quadrangle. The fault is probably a reverse fault. The North Freedom fault was first mapped by Schmidt (1951) and later by Dalziel and Dott (1970), but both maps incorrectly placed the eastern extent of the fault too far to the south (for a complete review, see supplemental text in Stewart and others, 2018).

Evidence for the fault exists west of the North Freedom quadrangle where the fault passes through the West Range of the Baraboo Hills (Rock Springs 7.5-minute quadrangle, see supplemental text, in Stewart and others, 2018). Here, the upper conglomerate and quartzite member of the Baraboo Quartzite (Xblc) is faulted over the upper quartzite and metapelite member (Xbqp). Slip on the fault is difficult to estimate due to the uncertainty in fault dip, but we believe it to be several hundred meters. At Diamond Hill in the Rock Springs 7.5-minute quadrangle west of North Freedom, Dalziel and Dott (1970) estimated a displacement of at least 365 m.

South Range fault

The South Range fault has not been previously described in the literature, but a fault in a similar location was included in the compilation map of Schmidt (1951). No other known maps of the area include the fault (Weidman, 1904; Leith, 1935; Leith, 1941; Dalziel and Dott, 1970; Clayton and Attig, 1990). The South Range fault strikes approximately N60E for most of its length, but its strike curls to the north-northeast near the southern edge of the quadrangle. The dip direction and dip angle are uncertain due to minimal topographic relief and uncertainty in the exact location of the fault core within a relatively wide damage zone. The fault is tentatively interpreted as a northwest-dipping reverse fault that places the lower conglomerate and quartzite member (Xblc) over the lower quartzite member (Xblq). Evidence for a northwest dip on the fault is restricted to the presence of a fault termination fold in sections 20 and 21 (T11N, R6E), where bedding and the contact between the lower quartzite member (Xblq) and the upper conglomerate and quartzite member (Xbuc) strike anomalously northwest–southeast, and bedding dips to the northeast. This fold geometry is inconsistent with normal motion on the South Range fault, but could develop near the tip line of a reverse fault.

The damage zone of the fault is best exposed immediately south of the North Freedom quadrangle in the Sauk Prairie 7.5-minute quadrangle (NE ¼, SE ¼, section 2). Within the North Freedom quadrangle, the damage zone is exposed in the SE ¼, NE ¼ section 36 (T11N, R5E). The damage zone is marked by intense fracturing, silicification, and abundant quartz veins, some of which show minor displacement along small fractures. Bedding orientations near the fault are highly variable, likely due to distributed slip and accompanying block rotations within the damage zone.

Slip on the South Range fault is estimated to be 180 m based on cross section A–A'. Most of the slip is thought to be Proterozoic in age, postdating deposition of the Baraboo Quartzite. However, to the south in the Sauk Prairie 7.5-minute quadrangle, the fault underlies the Denzer syncline, a structure that folds the Early Ordovician Oneota Formation and underlying units. The correspondence between the fault and fold suggests the Denzer syncline is a fault propagation fold and that the South Range fault was reactivated along parts of its strike during the Paleozoic. A prominent Ordovician wave-cut scarp and terrace running along the northern portion of sections 1 and 2 in the extreme southwest corner of the North Freedom quadrangle is not displaced by the fault. The terrace postdates the deposition of the Early Ordovician Oneota Formation, but formed prior to deposition of the Sinnipee Group in the Middle Ordovician when the South Range was buried by sediment (Clayton and Attig, 1990). The coincidence of the South Range fault and Denzer syncline together with the observation that the wave-cut terraces are not displaced, suggest that the South Range fault was reactivated sometime during the Early to Middle Ordovician.

REFERENCES

Clayton, L., and Attig, J.W., 1990, Geology of Sauk County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 67, 68 p., 2 pls., scale 1:100,000.

Czeck, D., and Ormand, C.J., 2007, Geometry and folding history of the Baraboo Syncline: Implications for the Mazatzal Orogeny in the north-central U.S.: Precambrian Research, v. 157, p. 203–213.

Dalziel, I.W.D., and Dott, R.H., Jr., 1970, Geology of the Baraboo District, Wisconsin: A description and field guide incorporating structural analysis of the Precambrian rocks and sedimentologic studies of the Paleozoic strata: Wisconsin Geological and Natural History Survey Information Circular 14, 164 p., 7 pls., scale 1:62,500.

Henry, D.M., 1975, Sedimentology and stratigraphy of the Baraboo Quartzite of south-central Wisconsin: Madison, University of Wisconsin, M.S. thesis, 90 p.

Leith, A., 1935, The Precambrian of the Lake Superior region, the Baraboo District, and other isolated areas in the Upper Mississippi Valley, *in* Trowbridge, A.C., ed., Guide Book: Kansas Geological Society Ninth Annual Field Conference, p. 320–332.

Leith, C.J., 1941, Structural features of the quartzite in an area in the Baraboo south range: Madison, University of Wisconsin, M.A. thesis, 54 p.

Lundqvist, J., Clayton, L., and Mickelson, D.M., 1993, Deposition of the Late Wisconsin Johnstown moraine, south-central Wisconsin: Quaternary International, v. 18, p. 53–59.

Marshak, S., Wilkerson, M.S., and DeFrates, J., 2016, Structural geology of the Baraboo District: An introduction, *in* Davis, R.A., Jr., Dott, R.H., Jr., and Dalziel, I.W.D., eds., Geology of the Baraboo, Wisconsin, Area: Geological Society of America Field Guide, v. 43, p. 13–36.

Medaris, L.G., Jr., Singer, B.S., Dott, R.H., Jr., Naymark, A., Johnson, C.M., and Schott, R.C., 2003, Late Paleoproterozoic climate, tectonics, and metamorphism in the southern Lake Superior region and Proto-North America: Evidence from Baraboo interval quartzites: The Journal of Geology, v. 111, no. 3, p. 243–257.

Schmidt, R.G., 1951, The subsurface geology of Freedom Township in the Baraboo iron-bearing district of Wisconsin: Madison, University of Wisconsin, M.S. thesis, 40 p.

Stewart, E.D., Stewart, E.K., Walker, A., and Zambito, J.J., IV, 2018, Revisiting the Paleoproterozoic Baraboo interval in southern Wisconsin: Evidence for syn-depositional tectonism along the south-central margin of Laurentia: Precambrian Research, v. 314, p. 221–239.

Van Wyck, N., 1995, Oxygen and carbon isotopic constraints on the development of eclogites, Holsnøy, Norway and major and trace element, common Pb, Sm-Nd, and zircon geochronology constraints on petrogenesis and tectonic setting of pre- and early Proterozoic rocks in Wisconsin: Madison, University of Wisconsin, Ph.D. dissertation, 280 p.

Weidman, S., 1904, The Baraboo iron-bearing district of Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 13, 190 p.

BASEMAP

Vector map base from U.S. Geological Survey, The National Map digital data, US TOPO map series, 2016–17; Wisconsin Department of Natural Resources, 2016; and Open Streetmap, 2018. Hillshade derived from 5 ft-resolution lidar DEM, Sauk County, 2011 (available through WisconsinView.org).

Highway 12 southwest of Baraboo (SW section 10, T11N, R6E) was rerouted in 2017. Road symbols have been updated to reflect this change; topographic contours and lidar hillshade represent the land surface prior to reconstruction.

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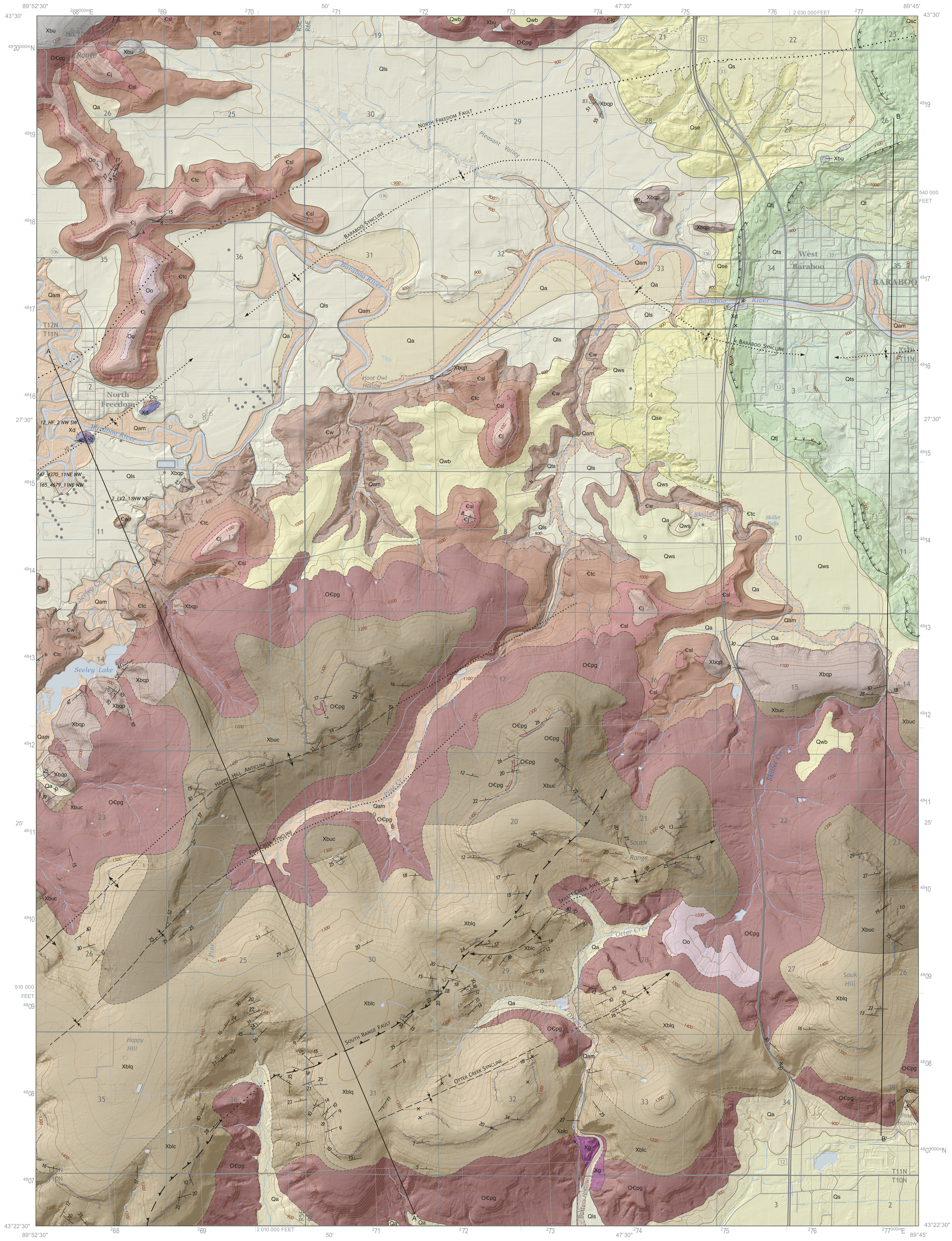
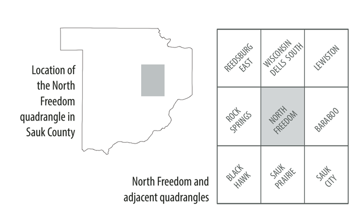
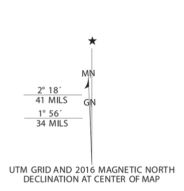
Symbols

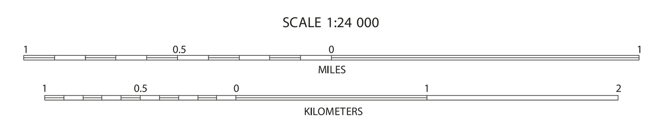
- Contact; dashed where approximate
- Fault; dashed where approximate, dotted where concealed
- Anticline; dashed where approximate, dotted where concealed
- Syncline; dashed where approximate, dotted where concealed
- Wave-cut scarp (Ordovician)
- Moraine
- A—A' Line of cross section
- Elevation contour; interval 20 ft
- Strike and dip of bedding
- Strike and dip of cleavage
- Bearing and plunge of lineation
- Overturned bedding
- Outcrop
- Drill core hole
- Drill core hole with log
- Well or drill hole in cross-section view
- Fault in cross-section view







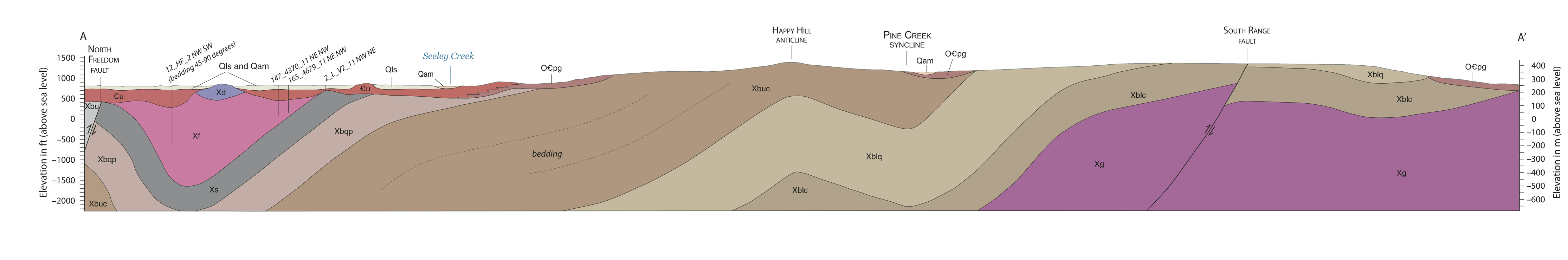
SCALE 1:24 000



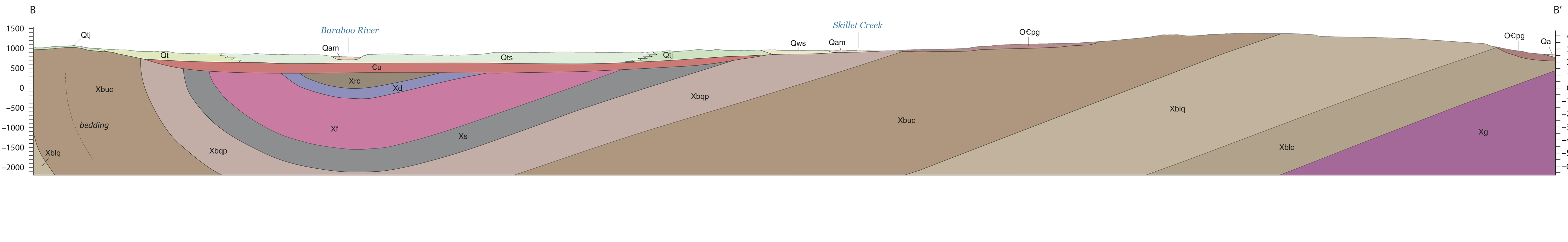
Universal Transverse Mercator Projection, Zone 16N
North American Datum of 1983 (NAD83)
Contours from U.S. Geological Survey, The National Map digital data; interval is 20 ft

Mapped and compiled by
Eric D. Stewart and Esther K. Stewart, 2016–2017
Geodatabase and cartography by K.C. Roushar

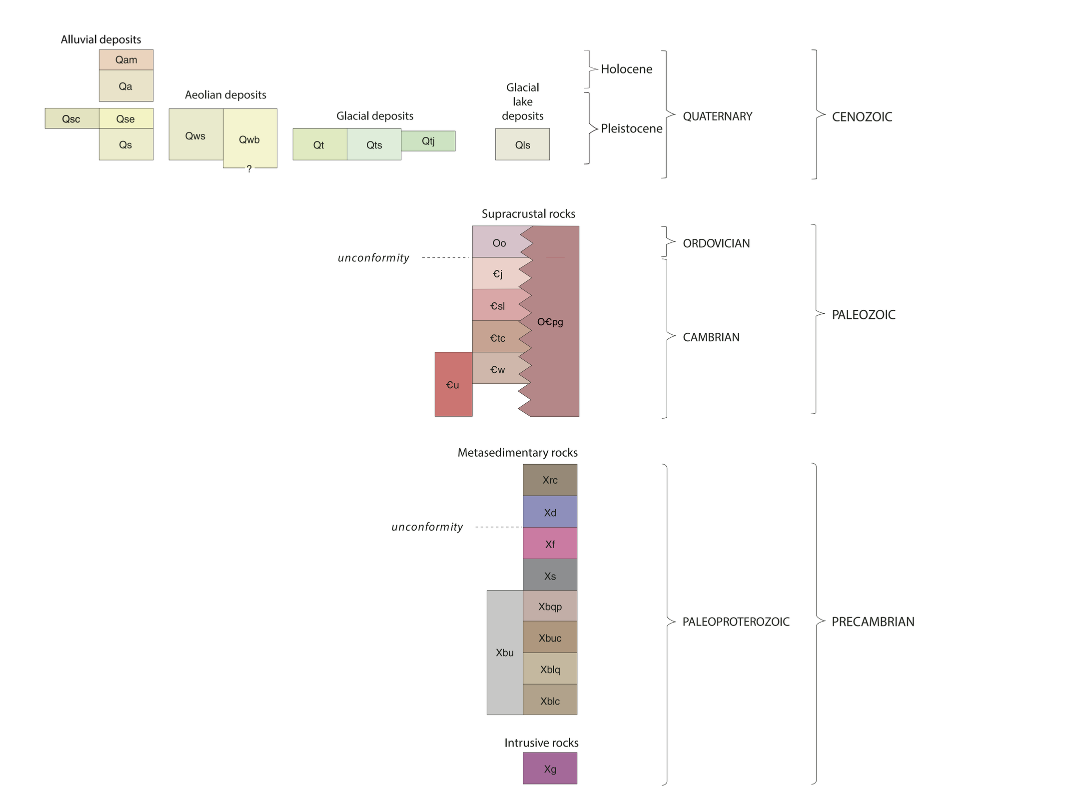
The map and cross sections are interpretations of the data available at the time of preparation. Every reasonable effort has been made to ensure that this interpretation conforms to sound scientific and cartographic principles; however, the map should not be used to guide site-specific decisions without verification. Proper use of the map is the sole responsibility of the user.



No vertical exaggeration of cross sections



CORRELATION OF MAP UNITS



MAP UNITS

QUATERNARY

Alluvium

Qa, Qam — **Qa** Pre-modern fine-grained sand, silt, and mud overbank stream deposits in modern drainages. Holocene to latest Pleistocene in age. **Qam** Modern fine-grained sand, silt, and mud overbank stream deposits.

Meltwater stream sediment

Qs, Qse, Qsc — **Qs** Gravel and sand deposited as stream sediment on an outwash plain adjacent to the Johnstown moraine. Gravel is common near the contact with the moraine and fines to sand to the west. **Qse** A geomorphic unit representing incision into meltwater stream sediment, largely as a result of the draining of the west Baraboo basin during latest Pleistocene glacial retreat. **Qsc** Similar to Qs but with hummocky topography due to deposition on stagnant ice. Locally, thin till may drape older sand deposits and till may project through a thin surface layer of sand (Clayton and Attig, 1990).

Lake sediment

Qls — Sandy offshore lake sediment. Sands were derived from adjacent Cambrian sandstones and conglomerates flanking the Baraboo Hills. Lake sediment in the northern half of the quadrangle was deposited in the west Baraboo basin, an arm of the larger glacial Lake Wisconsin. Lake sediment in the extreme southern edge of the quadrangle along Otter Creek was deposited in the smaller late Pleistocene Stones Pocket Lake (see Clayton and Attig, 1990).

Glacial sediment

Qt, Qts, Qtj — **Qt** Poorly sorted clay, silt, sand, and gravel with less abundant cobbles and boulders. Gravel is commonly composed of dolomite clasts (Clayton and Attig, 1990). Boulders are often composed of Baraboo Quartzite or Precambrian intrusive rocks derived from the Wisconsin Dome. The till is derived from the Green Bay Lobe of the Laurentide Ice Sheet. **Qts** Similar to Qt but includes areas of offshore lake sediment similar to Qls. **Qtj** Till of the Johnstown moraine, composed of a basal boulder gravel, overlain by layered sandy till, and capped by a thin layer of boulder gravel (Lundqvist and others, 1993).

Windblown silt

Qws, Qwb — **Qws** Windblown silt overlying outwash stream sediment; at least 1.5 m thick. Deposited during the latter stages of the most recent glaciation (Clayton and Attig, 1990). **Qwb** Similar to Qws but overlying and blanketing pre-Pleistocene bedrock. May include older silt than present in Qws.

ORDOVICIAN

Oneota Formation

Oo — Gray dolostone and chert. Poorly exposed in the North Freedom quadrangle. Only the base of the unit is exposed, generally as float. The base contains brecciated chert, dolostone, and sometime oolites. Iron-staining is common. The exposed portion of the unit does not exceed 40 feet in the quadrangle.

Parfreys Glen Formation

O€pg — Pink to tan conglomerate and tan to brown, fine- to medium-grained quartz arenite. Conglomerate beds contain clasts of Baraboo Quartzite in a clean sandstone matrix. Clasts typically range in size from cobbles to pebbles. Locally, boulders as large as 1 m in diameter occur. Conglomerate is present in medium- to massively bedded tabular sets, as well as at the base of upward fining, decimeter- to meter-thick lenticular beds capped with sandstone. Quartz arenite intervals are present as both medium- to massively bedded tabular sets as well as the caps of decimeter- to meter-scale lenticular beds. Planar and trough cross-bedding is common in sandstone bedsets. Pebbles of Baraboo Quartzite are present draping cross-bed foresets or floating within sandstone beds. The thickness of the unit is unclear, as it drapes underlying Precambrian basement topography. The unit is equivalent to the Cambrian Elk Mound Group through at least the Ordovician Oneota Formation.

CAMBRIAN

Jordan Formation

€j — Generally tan to gray to white, fine- to coarse-grained, well-rounded, well- to moderately sorted quartz arenite. Trough cross-beds and low-angle cross-beds are common within medium to thin bedded tabular bedsets. Hummocky cross-stratification, planar laminations, clay partings, and *Skolithos* trace fossils are locally present. The unit tends to form cliffs (Clayton and Attig, 1990). Approximately 20 m thick.

St. Lawrence Formation

€sl — Tan, very fine- to fine-grained carbonate-cemented sandstone. The unit is very poorly exposed in the North Freedom quadrangle but tends to form flat benches above the Tunnel City Group and below the cliff-forming Jordan Formation (Clayton and Attig, 1990). Approximately 12 m thick.

Tunnel City Group

€tc — Tan to brown, generally fine-grained sandstone with lesser medium-grained sandstone. Typically well to moderately rounded and moderately sorted. Carbonate-cemented sandstone with common trace glauconite grains is interbedded with clean quartz arenite in tabular bedsets tens of centimeters thick. This unit is locally cemented with hematite. Minor detrital feldspar has been reported (Clayton and Attig, 1990). Cross-bedding is common throughout. The unit outcrops poorly and is characterized by low-gradient, gently undulating slopes (Clayton and Attig, 1990). It is approximately 30 m thick.

Wonewoc Formation

€w, €u — **€w** Tan to white, fine- to coarse-grained quartz arenite. Sand is generally well rounded and moderately to well sorted. Bedsets range from tens of centimeters to over a meter in thickness and are planar tabular or lenticular. Cross-bedding is common. Generally, the Wonewoc Formation is coarser-grained than the overlying Tunnel City Group and tends to form steep cliff faces. The base of the unit is not exposed in the North Freedom quadrangle, but in the Baraboo Hills region its thickness is around 30 m (Dalziel and Dott, 1970). **€u** Undivided Cambrian sandstone of the Elk Mound Group. Cross section only.

PALEOPROTEROZOIC (<1710 Ma)

Rowley Creek Slate

Xrc — Cross section only. Reported to be a gray slate composed dominantly of sericite, quartz, and chlorite (Leith, 1935). At least 45 m thick.

Dake Quartzite

Xd — The Dake Quartzite is a gray to purple, fine- to coarse-grained, moderately to poorly sorted quartzite and pebble conglomerate with lesser fine-grained, well-sorted quartzite and phyllite interbeds. Clasts range in size up to 2 cm, and are mostly quartz with less abundant jasper and slate. Quartz is the dominant matrix constituent in conglomeratic intervals. Quartzite beds range from 5 to 50 cm thick and are organized into both lenticular and broadly tabular bedsets that are separated by thin (up to 5 cm thick) phyllite or sandy phyllite interbeds. Sedimentary structures include trough cross-beds and angular, centimeter-scale, red mud chip rip-up clasts that tend to be locally concentrated along bedding surfaces. The unit is approximately 65 m thick.

Freedom Formation

Xf — Cross section only. The Freedom Formation is known only from drill core. It is composed of a lower, gray to white to red iron-rich member and an upper, white to gray dolomite-rich member. The lower member is composed of interlaminated chert, silicate minerals, and iron-oxides including magnetite and hematite and lesser interbedded dolomite. Weidman (1904) reports mudcracks in the lower member from the Illinois mine, one of three sites in the interior of the syncline mined for iron ore in the early 1900s. The upper member is composed primarily of dolomite, often massively bedded. The top of the formation is cut by an angular unconformity that separates the unit from the overlying Dake Quartzite. It is estimated to be at least 480 m thick near North Freedom (Stewart and others, 2018) and becomes progressively thinner to the east.

Seeley Slate

Xs — Cross section only. The Seeley Slate is a chemically mature, gray to black slate. Near the top of the unit, fine-grained sand beds are common. Bedding is thick to massive at the base of the unit and grades to thin and laminated near the top. Sedimentary structures, including ripples, scours, and graded beds, are common at the top of the unit. Granule-sized clasts are present throughout the slate. Dalziel and Dott (1970) estimate a thickness of 110 m, while Weidman (1904) estimates a thickness of 150–300 m.

Baraboo Quartzite

Upper quartzite and metapelite member

Xbqp — Pink to purple, dominantly fine- to medium-grained quartzite with subordinate interbedded, dark gray metapelite and sandy metapelite. Quartzite is composed of clean quartz sand and local, isolated quartz pebbles. Quartzite is organized into tabular and broadly lenticular beds tens of centimeters to 1 m thick. Trough cross-bedding is common, and thin (about 20 cm) tabular, fine-grained quartzite bedsets are locally planar laminated. Metapelite beds are commonly 10–20 cm thick and may reach several meters in thickness (for example, Marshak and others, 2016). Spectacular chevron folds are common locally in metapelite horizons. Minimum thickness of 230 m.

Upper conglomerate and quartzite member

Xbuc — Pink to purple, fine- to medium-grained quartzite with local pebble beds up to 20 cm thick. Quartzite is composed of compositionally mature quartz sand. Pebbles in conglomerate beds are composed of well-rounded monocrystalline quartz and polycrystalline quartz, and lesser, subrounded to subangular jasper, red rhyolite, and gray slate or chert. Pebbles are generally 1 cm in length or less. The base of the member is characterized by a marked increase in approximately 3-cm-thick pebble beds. The overall abundance of pebble conglomerate is minor, and conglomerate abundance is less than what is present in the lower conglomerate and quartzite member (Xblc). Distinctive, high-angle planar-tabular to low-angle trough cross-bed sets generally several centimeters to tens of centimeters-thick and truncated by reactivation surfaces are common and diagnostic of this unit. Pebble conglomerate beds commonly overlie reactivation surfaces. This unit is equivalent to the upper member described by Henry (1975), and is estimated to be approximately 975 m in thickness.

Lower quartzite member

Xblq — Generally pink to purple, fine- to medium-grained, compositionally mature quartzite. Pebble lags one pebble thick are rarely present across the unit. Overall, the unit is significantly finer-grained than the underlying conglomerate unit. Isolated pebble clasts reaching 2 cm in diameter are present in the upper half of the member and are not associated with continuous conglomeratic beds. Trough cross-beds and planar cross-beds are commonly organized into wedge-shaped bedsets tens of centimeters thick. Locally, larger trough cross-beds (10–30 cm thick), characterized by upward fining (from coarse- to medium-grained quartz) foresets, are organized into stacked, lenticular bedsets bounded by high-angle scour surfaces. These crossbeds are associated with a distinctive horizon at least 15 m thick comprising thin (millimeters thick) phyllitic beds and laminations present near the base of the member. The fine-grained beds are commonly deformed into spectacular chevron folds (see supplemental field trip stop H, in Dalziel and Dott, 1970). This unit is equivalent to the middle member described by Henry (1975). It has an estimated thickness of 520 m.

Lower conglomerate and quartzite member

Xblc — Pink to purple, pebble conglomerate to fine-grained quartzite. Fine- to coarse-grained quartzite beds are composed of nearly pure quartz sand. The composition of pebbles in conglomerate beds is dominated by well-rounded monocrystalline and polycrystalline quartz, with subordinate, subrounded to subangular red jasper and rhyolite and angular gray slate or chert. Conglomerate beds are clast supported with a matrix composed of quartz sand. Individual pebbles in conglomerate beds are generally 1 cm in length or less. Pebble beds are most abundant near the base of the unit, where beds commonly reach 20 cm in thickness. Pebbles become less prevalent up section. The top of the unit contains sporadic 3 cm thick pebble beds. Cross-bedding is common in both quartzite and conglomerate beds and is locally organized into wedge-shaped bedsets tens of centimeters thick. This unit is equivalent to the lower member described by Henry (1975). Its thickness varies across the Baraboo Range, but is estimated to be approximately 250 m near Baxter's Hollow and thins to the east. This member and overlying units were deposited sometime after 1710 Ma, based on U-Pb ages of detrital zircons sampled from near the basal contact (Medaris and others, 2003).

Undivided

Xbu — Undivided Baraboo Quartzite, used where outcrops are sparse and the location within the Baraboo section is unknown.

Baxter's Hollow granite

Xg — Gray to red, fine- to medium-grained biotite granite. Sericite alteration of feldspar is common. Miarolitic cavities with quartz crystals are locally observed. The age of the granite is 1746±11 Ma (Van Wyck, 1995). The Baxter's Hollow granite unconformably underlies the Baraboo Quartzite.

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