

by William I. Rose^{1*}, Erika C. Vye¹, Carol A. Stein², David H. Malone³, John P. Craddock⁴, and Seth A. Stein⁵

Jacobsville Sandstone: a candidate for nomination for “Global Heritage Stone Resource” from Michigan, USA

¹ Department of Geological Engineering and Sciences, Michigan Technological University, Houghton, MI 49931, USA; *Corresponding author, E-mail: raman@mtu.edu

² Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL 60607, USA

³ Department of Geology and Geography, Illinois State University, Normal, IL 61790, USA

⁴ Department of Geology, Macalester College, St. Paul, MN 55105, USA

⁵ Department of Earth and Planetary Sciences, Northwestern University, Evanston, IL 60208, USA

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Information mainly collected decades ago, during and following its quarrying years, is here reviewed for the Jacobsville Sandstone, a well-known red bed sandstone of Neoproterozoic age from Upper Michigan, USA. This formation is here proposed as a suitable “Global Heritage Stone Resource”. The Jacobsville is an excellent example of a heritage stone as it was used extensively all over Eastern North America from 1880 to 1920 in hundreds of prominent buildings in major cities and many small towns, including the famous Waldorf Astoria Hotel in New York City. It was extensively mined from several quarry sites near Jacobsville, Michigan in Michigan’s Keweenaw Peninsula. The location is part of a significant geoheritage location, where native copper has also been mined for thousands of years.

Introduction

The purpose of this paper is to review scattered information about an important formation and to propose Jacobsville Sandstone of Michigan USA as a Global Heritage Stone Resource. This is a newly established international designation (www.globalheritagestone.com). Here we discuss the geoheritage of this well-known building stone from the United States.

The Jacobsville Sandstone is part of the Keweenaw Supergroup, a rift-filling sequence that marked a continental hotspot and rift forming event. It is found around the southern edge of Lake Superior, where there are many cliff exposures (Figs. 1 and 2). Establishment of GHSR is explained by Cooper et al. (2013) and here we provide information essential to a GHSR nomination. The information here comes mainly from reviewed information from geological work done decades ago (e.g., Hamblin, 1958; Lane and Seaman, 1907; Kalliokoski, 1982), during times of active quarrying and thereafter and then reviewed by geological studies with regional foci larger than a single formation (Door and

Eschman, 1970; Cannon and Nichol, 2001; Heinrich, 2001; Ojakangas and Dickus, 2002). Recent work on the formation has been focussed on age dating (Malone et al., 2016) and rifting geophysics (Stein et al., 2015).

Jacobsville Sandstone

The most important quarry locations of the Jacobsville are near the town of Jacobsville, hence the name, which is 12 miles (19 km) SE of Houghton, Michigan (46.9783N; 88.4142W).

This location is an area of cliff shorelines, where desirable sandstone layers could be found and easily transported by water to industrial areas and cities where the stone was highly prized and widely used in prominent buildings. Large scale quarrying developed (Fig. 3) and employed many from the immigrant populations from Europe that came to the Keweenaw to work in copper mines in the same area as part of North America’s early metal mining. Copper mining started in 1845 and continued until the 1960s, while sandstone mining began about 1880 and lasted through to about 1920.

Use of Jacobsville Sandstone was conspicuous in the Eastern US, including important buildings in Chicago, St Louis, Cincinnati, Cleveland and New York City. The best known building which used the Jacobsville was the Astoria Hotel, one of the city’s most famous buildings (Fig. 4). This elegant hotel operated from about 1897 to 1929, when it was abandoned and demolished for a much larger building, now called Waldorf-Astoria Hotel. Jacobsville buildings have mostly endured the century and a half history at other sites (Fig. 5), and an extensive list of them, along with their architectural significance is the subject of an important book by Eckert (2000), which covers the diverse architectural context of its use. Jacobsville Sandstone was fashionable for hotels, churches and commercial buildings for about 30 years, beginning in about 1883. It was also in high demand as a building stone across the Eastern US. The rock outcrop was mined selectively of thick homogeneous layers which were cut into large building blocks with a red colour. In addition to its handsome colour, the stone had the advantages of being readily

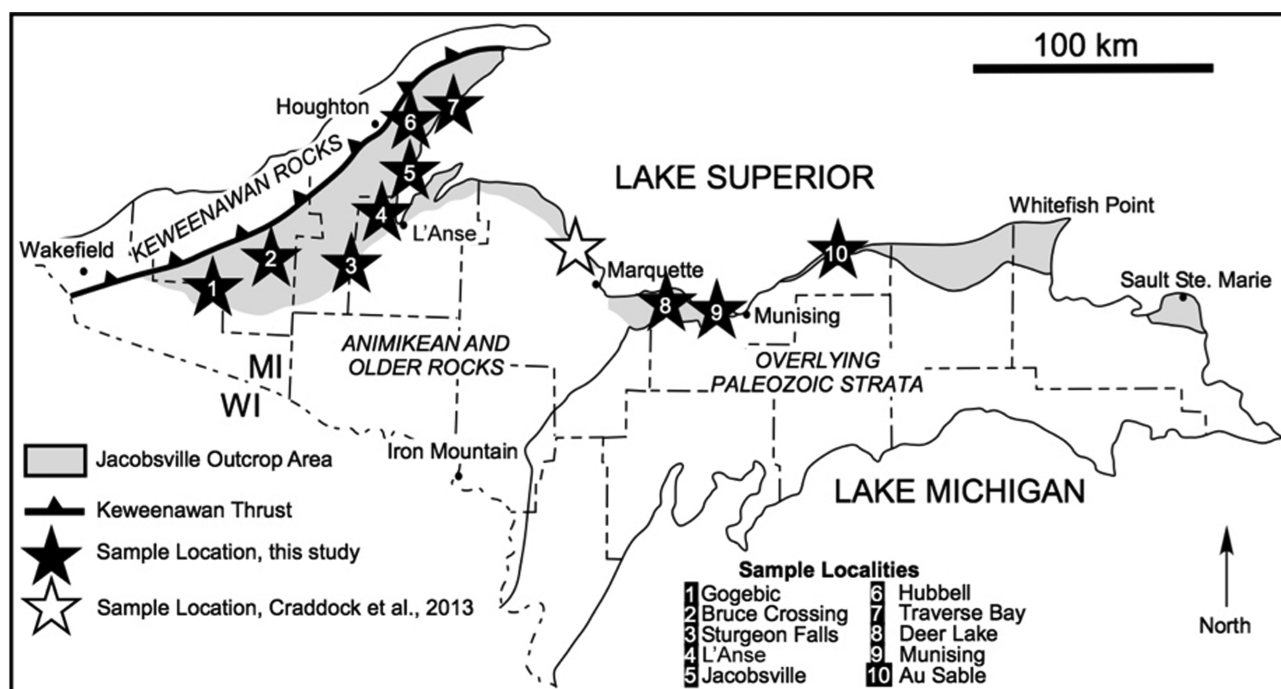


Figure 1. Jacobsville Sandstone distribution is along the south shore of Lake Superior in Michigan's Upper Peninsula. Figure from Malone et al. (2016). Shaded region shows Jacobsville outcrop areas. Stars mark sites where zircon ages were obtained by Malone et al. (2016). Star 5 shows type location of Jacobsville.

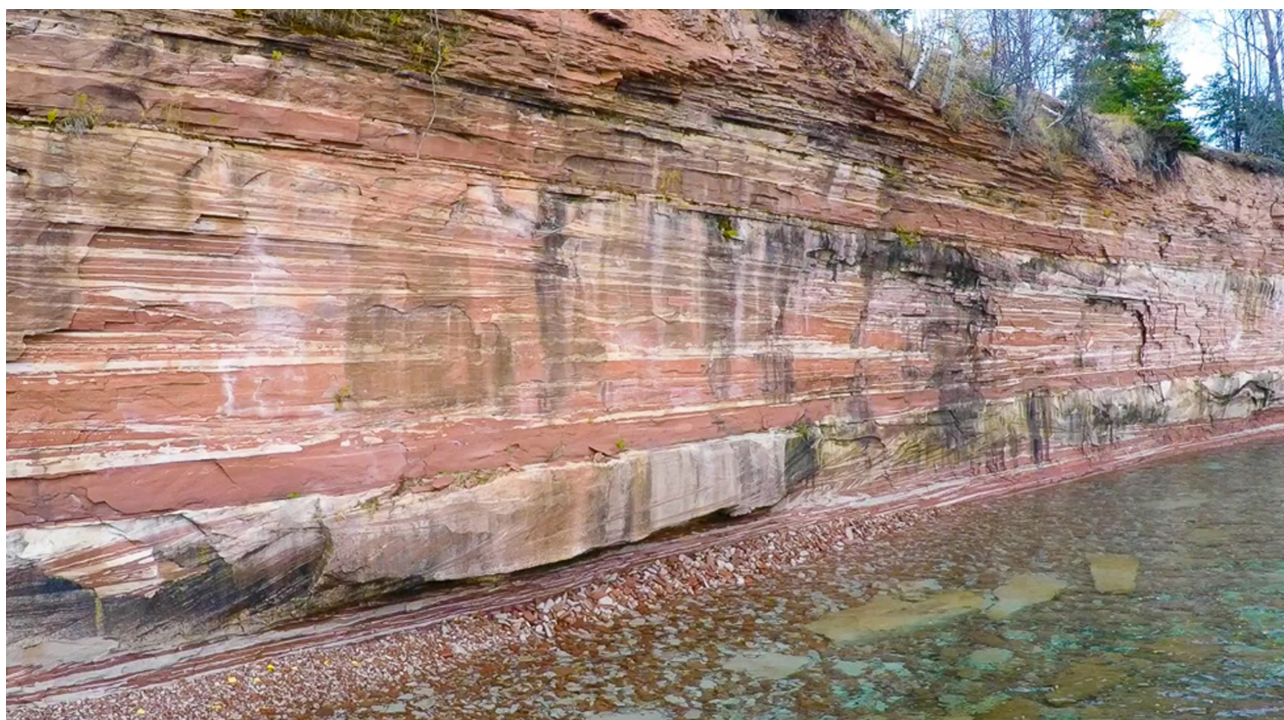


Figure 2. Cross bedded Jacobsville Sandstone, exposed in Lake Superior shoreline cliff, 1 Mile N of Jacobsville, Michigan (Steve Brimm photo).

workable, surface-hardening rapidly upon exposure to air, and being fire-resistant (Heinrich, 2001, Fig. 6).

Formal Name

Jacobsville Sandstone (Lane and Seaman, 1907; Hamblin, 1958)

Commercial Designations

Redstone refers to Jacobsville quarried near Jacobsville, which is more reddish in colour. Brownstone refers to a reddish brown facies which was less extensively quarried at sites east of Jacobsville.



Figure 3. *Jacobsville Quarry near Portage Entry, in operation, about 1895 (MTU Neg 03965, Michigan Technological University Archives and Copper Country Historical Collections, Houghton, Michigan Michigan Technological University Archives).*



Figure 4. *The Astoria Hotel, Park Avenue, New York, part of the world famous Waldorf-Astoria Hotel, built of Jacobsville Sandstone from the Portage Entry Quarry and operated from 1897–1929 (Public Domain image, 1916, Cooper Collection of US Hotel History).*

Related Dimension Stones

The Jacobsville likely correlates with similar red bed units in nearby regions, such as northern Wisconsin, where there is a very



Figure 5. *St. Paul the Apostle Church (originally St. Joseph's Austrian Church), Oak Street, Calumet, Michigan built with Jacobsville Sandstone from the Portage Entry Quarry in 1908 (Public Domain Photo from Wikipedia Commons).*



Figure 6. Detail (~20 × 40 cm) of carved Jacobsville Redstone, Sheldon Block, Houghton, Michigan.

similar formation, the Bayfield Group, exposed around Ashland and the Apostle Islands and Hinkley Sandstone and Fond du Lac Formation in Northern Minnesota (Fig. 7).

Place of Origin

The type locality for the formation is the town of Jacobsville (46.9783N; 88.4142W), which had a population of several thousand people during the quarry activity, but now has fewer than 50 permanent residents.

Area of Occurrence

The formation is found along the southern shore of Lake Superior (Fig. 2).

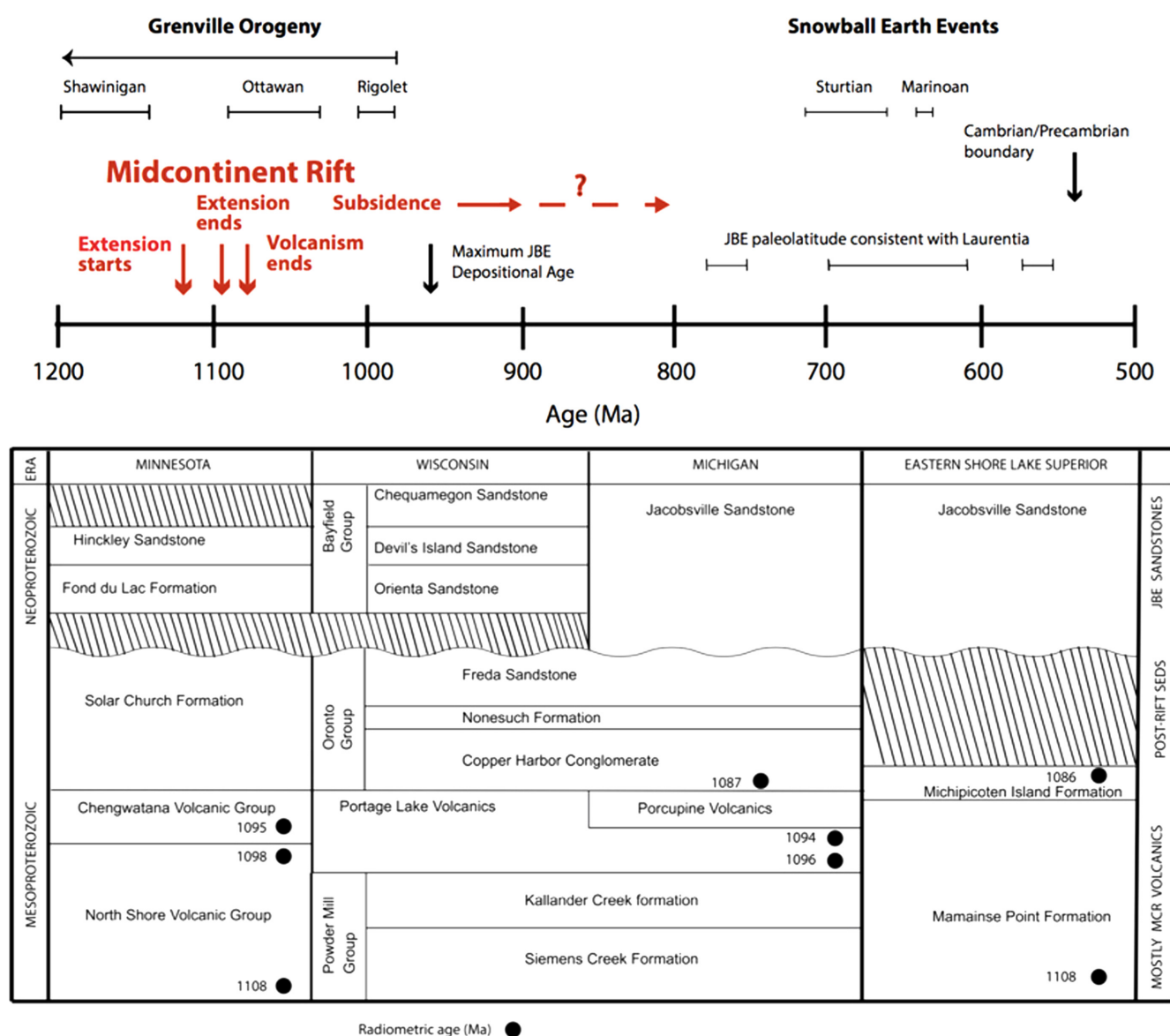


Figure 7. Schematic timing and stratigraphy of mid-continent rift and younger sediments for the Lake Superior region after Ojakangas and Dickas (2002). Solid circles are radiometric ages of the volcanic rocks. Upper Keweenawan sandstones have different names across the Lake Superior region, including Jacobsville and Bayfield. We propose that these sandstones are Neoproterozoic (Craddock et al., 2013; Stein et al., 2015; Malone et al., 2016).

Principal Location of Quarries

There are approximately 10 quarries within 2 miles (3 km) of Jacobsville. Only 5 were active for more than a few years. Most quarrying occurred from 1885–1910, operations mostly ceased by 1923. There are no active quarries at the date of this writing (2016) although there is some industrial interest in renewed supplies.

Three Quarries near Jacobsville are best known:

1. Portage Entry Quarry (46.9806N; 88.4107W): Operated by the Wolf and Jacobs Company beginning in 1883. Largest and most extensive Quarry in the area, and by 1891 had acquired all the other quarries and changed its name to Portage Entry Quarries Company.

2. Craig Quarry (46.9968N; 88.4193W): Earliest Quarry started by George Craig, N of Jacobsville.

3. Stone Quarry Lake (47.0034; 88.3950W): The Kerber-Jacobs Quarry, also the Excelsior Redstone Company, NE of Jacobsville near Red Rock 1891–96.

Heritage Issues: Importance of GHSR Designation

Fashionable building stone of much of Eastern North America, 1885–1920 (Eckert, 2001). The extensive geoheritage of the region is the focus of an elaborate website (<http://www.geo.mtu.edu/KeweenawGeoheritage>). Designation of the Jacobsville as a Global Heritage Stone would support geoconservation efforts within the Keweenaw. Since quarrying has ceased these sites have been overgrown and are often overlooked. Highlighting the significance of these places and increasing access offers an opportunity to teach locals and visitors about a unique period in Earth's history. It also further connects people to an important element of Keweenaw geoheritage often eclipsed by the history of copper mining.

Petrographic Name

Subarkose to quartz sub-lithic arenite, with some beds of arkose and quartzite (Kalliokoski, 1982) and minor siltstone, shale and conglomerate. Grain size mainly between 30 and 100 mesh (0.15–0.6 mm diameter).

Chemical Composition (Heinrich, 2001)

98.76% Silica; 0.72% Alumina, 0.33% Potash.

Colour

Mainly red, but also some brown and white.

Natural Variability (Summarized by Heinrich, 2001)

The main recognized colour varieties were the redstone (uniformly red) and the variegated (red streaked and mottled with white: Fig. 2). In 1910 the former sold for \$31.80 per m³ delivered at any lake port, the latter for only \$26.50 per m³. One variety known as “Marquette



Figure 8. Red Jacket firehouse in Calumet (built in 1898–99) – National Register of Historic Places. Use through Creative Commons by Andrew Jameson.

stone” had a brown and purplish colour and was regarded as the handsomest stone quarried, but supplies were limited.

Suitability

In addition to being intensively employed locally in the Northern Peninsula (especially in Marquette and Houghton-Hancock) for churches, public buildings, breweries, and residences, the stone enjoyed a wide geographic market. It was shipped as far west as Kansas City, south to St Louis and New Orleans and east to Cleveland, New York and Philadelphia. Duluth, Chicago and Buffalo were the lake ports utilized for inland distribution. The Jacobsville Redstone, more widely used, was available as dimension stone in sizes up to 30 inches thick. In addition to its use as ordinary building stone, surfaces of the blocks could be carved readily into intricate relief designs (Figs. 6 and 8).

Geological Age and Setting

Jacobsville Sandstone is a fluvial deposit marked by conspicuous river channels and variegated red/white colors (Kalliokoski, 1982; Fig. 2). These rocks sit on top of the mid-continent rift igneous rocks and its post-rift sediments. The rift formed ~1100 Ma and is a ~3000 km long “U” shaped feature in North America, centered on the Lake Superior area (Cannon and Nicholson, 2001; Stein et al., 2015). The Jacobsville are the youngest of the area’s Precambrian rocks, but the exact age is unknown. Its maximum age, of 959 ± 18 Ma, is constrained by detrital zircons dated with U-Pb methods (Malone et al., 2016) but it is older than ~542 Ma. Intensive efforts in zircon dating are now active and may refine age uncertainties.

Stratigraphy

This formation is mainly flat lying, contrasting with the Oronto Group (Fig. 6), a series of progressively maturing rift-filling sediments which overlie the Portage Lake Volcanics, and are tilted toward the rift axis (Cannon and Nicholson, 2001). There are no surface exposures between the Oronto and the Jacobsville, but drill holes have bridged the contact in two wildcat holes (Ojakangas and Dickas, 2002).

The top of the Jacobsville is marked by a nonconformity with a Cambrian formation, the Munising Sandstone (Hamblin, 1958; Heinrich, 2001). Near the Keweenaw Fault the Jacobsville is markedly deformed, demonstrating that this great thrust fault had significant movement during an extended period from at least 960 to 1060 Ma. As the Jacobsville must be younger than its youngest included sand grain, some and perhaps significant displacement along the Keweenaw fault must have occurred after 959 Ma. As the Grenville Orogeny had concluded by this time, some movement along the thrust occurred perhaps as late as Paleozoic time. The Jacobsville has been considered to be the youngest of the post-rift rocks but its age is at least ~200 million years younger than the Oronto Group. The Jacobsville could be several hundred million years younger, perhaps forming soon after a Snowball Earth event, so it is unlikely to be related to post-rift subsidence (Malone et al., 2016).

Physical Properties (Heinrich, 2001)

Mean Water Absorption: 6.18%
 Specific Gravity: 2.63–2.69 g/cm³
 Mean Compressive Strength: 12060 psi (83.15 MPa)
 Tensile Strength: 440 psi (3.03 MPa)
 Modulus of Rupture: 919 psi (6.34 MPa)
 Permeability: 8.11 md
 Hardness (scleroscopic): 33
 Mean Porosity: 13.8%

Vulnerability and Maintenance of Supply

There is currently no active quarrying of Jacobsville Sandstone. There is demand for the rock to repair damaged parts of the large numbers of Jacobsville buildings and in the last year there is business starting about reopening quarries.

Current Activity/Outreach

The natural beauty and allure of the Jacobsville cliffs have made them a popular selection for a series of summer geoheritage tours developed for the Keweenaw. The tours afford participants an opportunity to observe the cliffs by boat and land and to visit quarry sites and Jacobsville town. These are led by local residents who share stories of the historical significance of the stone as well as experts who share state of the art scientific information about how the region was formed. There have also been numerous public museum exhibits highlighting the redbeds in local history and natural history museums.

Historic Use and Geographic Area of Utilization

With the development of North America's first great metal mining district, beginning in the 1840s, predating the California Gold Rush and continuing for many decades, Michigan's Copper Country became a major industrial and immigration focus. Many new buildings were needed. Quarries were developed and Great Lake Shipping lanes were used for stone transport to much of Eastern North America. The sandstone was fashionable for public buildings for a few decades (1885–1915), perhaps especially reflecting hazards of wood constructions following the famous Chicago fire of 1871. It was used mainly for building blocks.

Buildings

Many hundreds of buildings in the Lake Superior area (Upper Michigan, Wisconsin and Minnesota) and 115 buildings listed in Eastern US, most built 1885–1900 (complete listing in Eckert, 2000, which publishes many photographs and full descriptions including architectural information). Many buildings are with 100% Jacobsville walls. Some have Jacobsville bases and decorative Jacobsville trimming.

Some prominent examples (*National Register of Historic Places):

New Orleans:

Cotton Exchange 1883

Chicago:

Masonic Temple, 1892

Minneapolis:

Northwestern Guaranty Loan 1890

Public Library 1889

Upper Peninsula, Michigan:

John Munro and Mary Beecher Longyear House, Marquette 1890

*US Customs House, Marquette 1888–9

*Upper Peninsula Branch Prison, Marquette 1885–9

*Red Jacket Fire Station, Calumet 1898–99 (Fig. 7)

*St Joseph's Austrian Church, Calumet 1902–4

*Red Jacket Town Hall and Opera House, Calumet 1899–1900

*St Ignatius Loyola Church, Houghton, 1898–1902

*Town Hall and Fire station, Hancock, 1899.

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David H. Malone is University Professor of Geology at Illinois State University. His specialties are structural and sedimentary geology. In particular he has studied the Heart Mountain Slide in Wyoming, and has engaged in provenance analysis of rocks that range in age from Precambrian to Quaternary.

John P. Craddock is a Professor of Geology at Macalester College in St Paul, MN. His research interests include using microstructural techniques to analyze rock fabrics and interpret geologic structures. He has employed U-Th zircon age-dating techniques to sedimentary units.

Seth A. Stein is William Deering Professor in the Department of Earth and Planetary Sciences at Northwestern University, Evanston, IL. His research focuses on investigating plate boundary processes and deformation within the lithosphere using a range of techniques including space-based geodesy, seismology, and marine geophysics.



William I. Rose is a research professor at Michigan Technological University, where he has been for 45 years. He is a volcanologist with experience in active eruptions, volcanic ash and aviation hazards, remote sensing, Central American volcanoes and their natural hazards and Geoheritage.



Erika C. Vye is a Ph D candidate at Michigan Tech with degrees from Dalhousie University in Nova Scotia and University College, Dublin and professional geoscience experiences in India, Germany and New Zealand. Her Ph D research has involved Earth Science Education, Place-based education and Geoheritage.



Carol A. Stein is a Professor in the Department of Earth and Environmental Sciences at the University of Illinois at Chicago. Her research covers a range of topics in plate tectonics dealing with the thermal and mechanical evolution of the lithosphere.