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Digital Representation of Exposures of Precambrian Bedrock in Parts of Dickinson and Iron Counties, Michigan, and Florence and Marinette Counties, Wisconsin

By W.F. Cannon, Ruth Schulte, and Damon Bickerstaff

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The U.S. Geological Survey (USGS) conducted a program of bedrock geologic mapping in much of the central and western Upper Peninsula of Michigan from the 1940s until the late 1990s. Geologic studies in this region are hampered by a scarcity of bedrock exposures because of a nearly continuous blanket of unconsolidated sediments resulting from glaciation of the region during the Pleistocene ice ages. The USGS mapping, done largely at a scale of 1:24,000, routinely recorded the location and extent of exposed bedrock to provide both an indication of where direct observations were made and a guide for future investigations to expedite location of observable rock exposures. The locations of outcrops were generally shown as colored or patterned overlays on printed geologic maps. Although those maps have been scanned and are available as Portable Document Format (PDF) files, no further digital portrayal of the outcrops had been done. We have conducted a prototype study of digitizing and improving locational accuracy of the outcrop locations in parts of Dickinson County, Michigan, to form a data layer that can be used with other data layers in geographic information system (GIS) applications. Outcrops shown on five map sheets from two USGS professional papers (fig. 1) were digitized by methods described below. Those digitized data can be downloaded from Cannon and others (2017; https://doi.org/10.5066/F7SJ1JH0).

Although the original mapping was done by skilled field geologists, the methods of location and compilation were crude by modern standards. Much of the area was mapped by conducting parallel traverses spaced about 100 meters apart. Locations of exposures were determined largely by "pace and compass" techniques (walking straight lines determined by hand-held compass and counting paces). Distinctive physiographic features visible on topographic maps and aerial photographs were used to further aid in locating outcrops. Gently rolling to nearly flat topography and frequent dense forest understory and swamps were impediments to accuracy. Field locations were transferred to base maps by manual drafting. Part of the area (Professional Paper 310) was mapped before topographic maps were available. Outcrops were drawn on aerial photographs in the field and transferred manually to a planimetric base that was not geographically well rectified. The published maps that were shown on that base were found to have considerable inaccuracy.

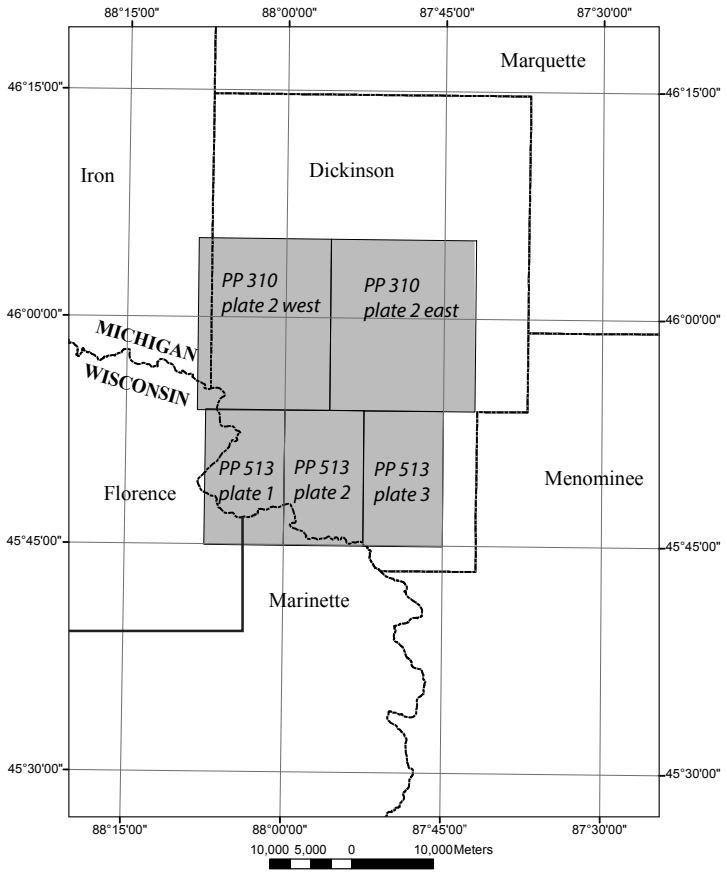

Figure 1. Index map of Dickinson County, Michigan, and surrounding counties in Michigan and Wisconsin showing the location of five map sheets from which outcrop locations were digitized. The map sheets are parts of U.S. Geological Survey Professional Papers (PPs) 310 (James and others, 1961) and 513 (Bayley and others, 1966).

The data presented in Cannon and others (2017) and discussed here show adjusted locations of outcrops to conform to a newly available light detection and ranging (lidar) image of Dickinson County, Michigan (U.S. Geological Survey, 2016; https://coast.noaa.gov/htdata/lidar1_z/geoid12a/data/4808/). The image, which shows the topography in detail, allows a reliable interpretation of the true location of outcrops based on experience in bedrock mapping in the region. Outcrops typically are found high on steep slopes, on small isolated knobs projecting above plains, and along lakeshores or major streams. We have found that individual outcrops, and commonly clusters of outcrops, can be moved from their locations as digitized from printed maps to positions much more likely to have bedrock exposures as indicated by lidar data (see figure 2 for an example). The location of outcrops relative to roads, rail lines, streams, and other reliably portrayed features from the original maps also have been used in the adjustments. Adjustments of as much as several hundred meters have been made in extreme cases, but typically were considerably less. Adjustments were larger in the older data from Professional Paper 310. Data from Professional Paper 513 required less or no adjustment, probably because topographic maps were used as a base for compilation. We feel that the locations of outcrops in our current dataset are accurate to within a few tens of meters in most cases. Professional Paper 310 showed outcrops in a small part of Iron County, Michigan, and Professional Paper 513 also included outcrop locations in small parts of Florence and Marinette Counties, Wisconsin. These outcrops were included within the dataset without any additional locational adjustments because lidar coverage was not available for those areas.

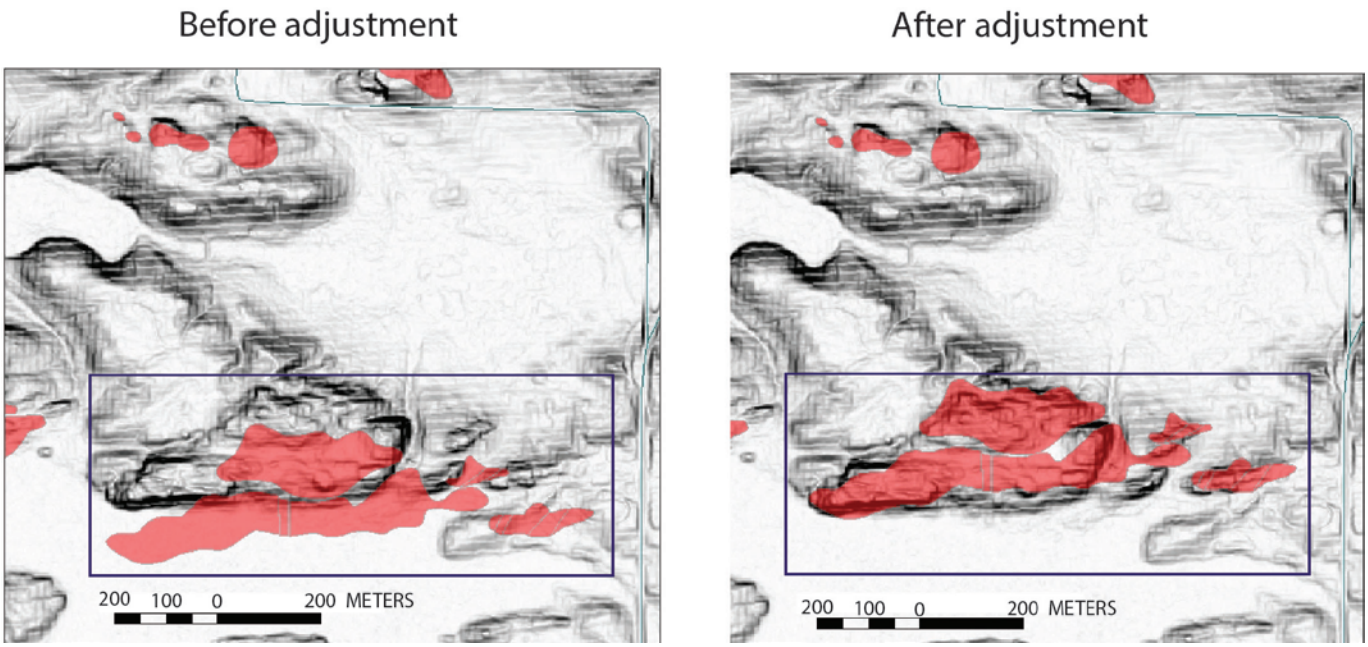

Figure 2. Images showing an example of the adjustment of the location of outcrops. On the left, a group of outcrops from plate 2 east of Professional Paper 310 (James and others, 1961), within the rectangle, are located as digitized from the printed geologic map and shown with respect to the lidar data. On the right, the same group of outcrops adjusted to their more likely location, derived by moving the group, as a unit, to a topographic position where outcrops are much more likely to be found. Lidar image is from U.S. Geological Survey, 2016 (https://coast.noaa.gov/htdata/lidar1_z/geoid12a/data/4808/).

The maps in Professional Paper 310 presented complete coverage for areas underlain by Paleoproterozoic rocks, the principal interest for that study, but were incomplete for areas of Archean rocks that were of secondary interest. Judging from the topography as shown by lidar data, there are surely considerably more exposures of Archean rocks than were included on the original maps and our digital files. Professional Paper 513 included more complete coverage of both Paleoproterozoic and Archean rocks and there were relatively few areas of incomplete outcrop data in the study area.

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