OVER THE EDGE: MAPPING QUATERNARY GEOLOGY DEPOSITS BEYOND THE GLACIAL MARGIN

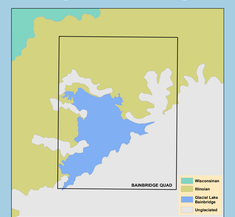
PAVEY, Richard R. (Richard.Pavey@dnr.state.oh.us)
Ohio Department of Natural Resources, Division of Geological Survey,
2045 Morse Road, Columbus, OH 43229

ABSTRACT

With the assistance of LiDAR data, surficial geology mapping work under the auspices of the Great Lakes Geologic Mapping Coalition has led to the development of new mapping capabilities. Recent mapping studies conducted by the Ohio Geological Survey included using LiDAR data and ArcGIS software to develop methods for mapping glacial geology in three dimensions as well as setting a new standard for detailed mapping of karst features. Availability of LiDAR data also makes it possible to map the landscape in greater detail, including the results of Quaternary weathering processes that produced deposits in unglaciated territory. With the use of the slope derivative from LiDAR data, much can be delineated that was not previously observable. Current surficial mapping at the glacial margin in the Rainsboro and Bainbridge 1:24,000 quadrangles required definition of new mapping units for Ohio due to observations associated with LiDAR data coverage. Thick colluvial deposits are evident in the chaotic slope data at the base of otherwise smoothly sloped bedrock hills. Landslide scarps, chutes, and toe slope deposits are quite evident and can be mapped also. Although printed 1:24,000 topographic maps still have many uses, LiDAR data provides a new set of analytical tools rapidly is becoming the primary choice for creating base maps for detailed surficial mapping.

Location of the Bainbridge 1:24,000 Quadrangle

Glacial regions in the Bainbridge area



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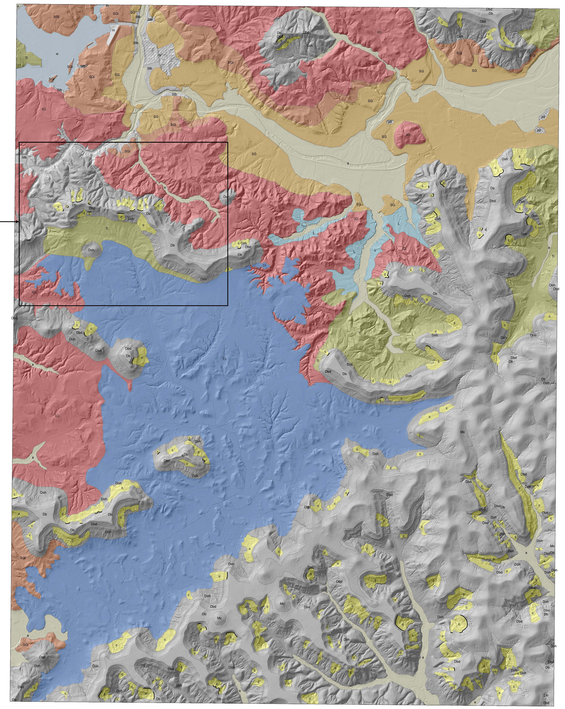
Surficial Geology of the Bainbridge, OH Quadrangle

Richard R. Pavey
2015

Area of detailed figures to the right



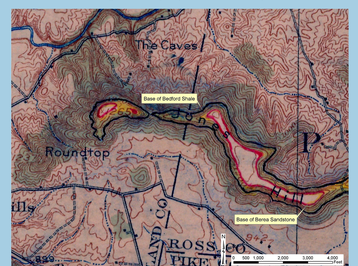
Surface Lithologies

- w — Water. Large modern lakes and reservoirs.
- m — Made land. Large cut-and-fill areas.
- gp — Sand-and-gravel pit.
- q — Quarry.
- a — Alluvium, Holocene-age. Found within floodplains of modern streams.
- c — Thick colluvium and landslide debris. Holocene and Pleistocene(?).
- L — Clay and silt, Wisconsinan-age. Massive to laminated; may contain thin, interbedded, fine sand and minor gravel. Deposited in lakebeds at the ice margin.
- SG — Sand and gravel, Wisconsinan-age. Stratified sand and gravel with thin, discontinuous layers of silt and clay. Deposited as valley trains and outwash plains.
- CI — Clay and silt, Illinoian-age. Massive to laminated; may contain thin, interbedded, fine sand and minor gravel, deeply weathered, leached, and dissected. Deposited in lakebeds at the ice margin.
- SGI — Sand and gravel, Illinoian-age. Similar to SG above, but more deeply weathered, leached, and dissected.
- IG — Ice-contact deposits, Illinoian-age. Highly variable deposits of poorly sorted gravel and sand; silt, clay, and till lenses common; may be partially covered or surrounded by till. Deposited directly from stagnant ice as kame or esker landforms; deeply weathered, leached, and dissected.
- Tl — Loam till, Illinoian-age. Deeply weathered, leached, and dissected. Overlain by up to 4 feet of loess where not eroded. Till may contain silt, sand, and gravel lenses. Deposited directly from ice.
- Mc — Cuyahoga Formation, Mississippian-age. Sandstone, siltstone, and shale; thin to massive bedding; mainly shades of gray, olive, brown, and yellow.
- Db — Berea Sandstone, Devonian-age. Gray to shades of brown; medium grained to silty.
- Dbd — Bedford Shale, Devonian-age. Gray, red, and brown; silty to clayey; locally abundant siltstone and sandstone interbeds.
- Doh — Ohio Shale, Devonian-age. Mostly black; carbonaceous; calcareous concretions common in lower portion.
- Sto — Tymochtee, Greenfield, and Peebles Dolomites, and Lilley and Bisher Formations, undivided, Silurian-age. Thin to thick, interbedded dolomites and shales.
- Significant landslide scarp

N

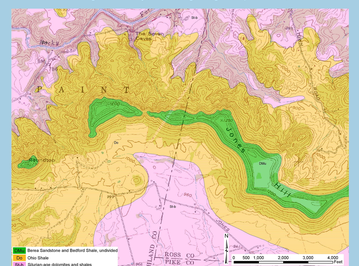
0 0.25 0.5 1 1.5 2 Miles

Ohio Geological Survey unpublished field map, 1919



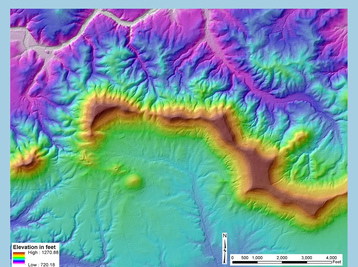
In 1919, Raymond Lamborn of the Ohio Geological Survey conducted field mapping in the Bainbridge area. He mapped the contact between the Berea Sandstone and the Bedford Shale (red lines) and the contact between the Bedford Shale and the Ohio Shale (black lines).

Ohio Geological Survey bedrock geologic map of Ohio, 2006



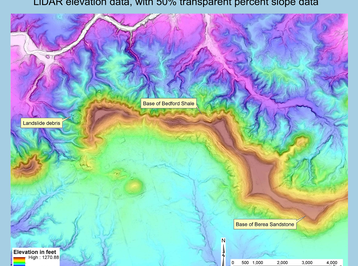
During the 1990s, Ohio Geological Survey geologists performed reconnaissance mapping of the area, using only the 1960s-era topographic maps and limited field work. They were unable to map the Berea Sandstone, an important economic resource, separately from the Bedford Shale and thus combined these units (Slucher and others, 2006).

LiDAR elevation data, with 50% transparent hillshade data



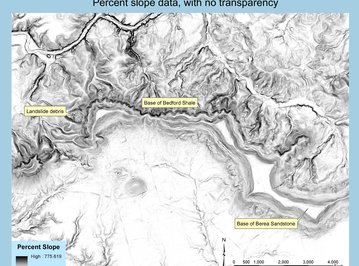
Modern LiDAR elevation data provides a much more accurate topographic base than older topographic maps. Elevation is symbolized from red (highest) to white (lowest). The shading is hillshade data, the most commonly used LiDAR derivative dataset. As a 50% transparent overlay to elevations, it provides a three-dimensional look at the landscape. However, hillshade is not very useful analytically.

LiDAR elevation data, with 50% transparent percent slope data



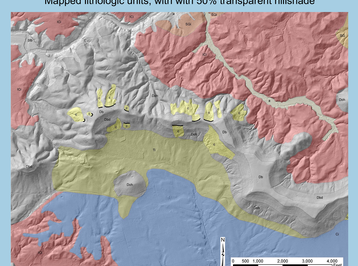
The LiDAR derivative dataset used here is percent slope as calculated from cell-to-cell elevation clanges. Lighter shading represents less slope and darker shading represents steeper slope. As a 50% transparent elevation overlay, it is more useful analytically. The geomorphic uniformity of most thinly mantled bedrock slopes becomes evident but is interrupted in places by steep scarps and downhill areas of chaotic slope.

Percent slope data, with no transparency



Using the slope derivative with no transparency, geologists can observe and map the slope break at the base of the Berea Sandstone and a prominent bench at the base of the Bedford Shale, as well as numerous steep landslide scarps and their downslope deposits. The toe slope of landslide debris is often quite steep.

Mapped lithologic units, with with 50% transparent hillshade



On the Bainbridge quadrangle, the Berea Sandstone and the Bedford and Ohio Shales are mapped as separate units, along with undifferentiated Silurian dolomites and shales and numerous glacial and post-glacial map units. The 50% transparent hillshade overlay provides a traditional look to the final map. The 176 mapped landslides in the Bainbridge quadrangle represent the introduction of a new Quaternary mapping capability that can be applied to detailed mapping beyond the extent of Pleistocene glaciation. (See main map at far left for legend.)

Reference Cited

Slucher, E.R., Swinford, E.M., Larsen, G.E., Schumacher, G.A., Shrake, D.L., Rice, C.L., Caudill, M.R., and Rea, R.G., with GIS production and cartography by Powers, D.M., 2006, Bedrock geologic map of Ohio: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Map BG-1, scale 1:500,000.