New Map of the Surficial Geology of the Lorain and Put-in-Bay 30 x 60 Minute Quadrangles, Ohio

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ABSTRACT

A map depicting the surficial geology of the Lorain and Put-in-Bay 30 x 60 minute (1:100,000-scale) quadrangles has been produced by the Ohio Department of Natural Resources, Division of Geological Survey. Existing surficial maps at various scales document the uppermost surficial lithology of the area. The new map depicts underlying lithologies from the surface down to bedrock for use in geotechnical studies, land-use planning, and mineral exploration. To produce the new map, surficial deposits were mapped at 1:24,000 scale to create thirty-six 7.5-minute quadrangles, which were compiled digitally using GIS technology and converted into a full-color, print-on-demand, 1:100,000-scale, surficial-geology map. The map includes all or portions of Erie, Huron, Lorain, Lucas, Sandusky, and Seneca Counties in north-central Ohio. Data sources include field mapping, county soil surveys, Ohio Department of Transportation and Ohio Environmental Protection Agency boring logs, engineering logs, ODNR water-well logs, theses, and published and unpublished geologic and hydrogeologic reports. Map polygons were attributed using a stack-unit designator that indicates the thickness and stratigraphic sequence of major material units (i.e., till, gravel, sand, silt, and clay), from the surface down to and including the uppermost bedrock unit. Several regional material trends are apparent on the map, including large areas of lacustrine clay and silt landward of Lake Erie, the prominence of shallow bedrock that parallels the Lake Erie shoreline, a deltaic sequence deposited during higher levels of water of ancestral Lake Erie, the locally widespread and thick organic and marl deposits, and the expanse of Wisconsinan-age till that mantles the surface in most of the quadrangles. The text explains how to read the map, provides lithologic descriptions of mapped glacial and bedrock units, and offers other explanatory information. A GIS geodatabase contains spatial information on each polygon and data attributes of the stack units, all of which can be queried on the basis of material types and thicknesses for rapid generation of derivative maps. Potential queries for derivative maps might include isolating clay and silt deposits for the identification of potential geohazards, identifying sand and gravel deposits for aggregate exploration, or depicting areas of thick glacial till for the identification of potentially favorable solid-waste disposal sites. Mapping was partially funded by the U.S. Geological Survey, National Cooperative Geological Mapping Program, STATEMAP component. Digital compilation was made possible by funding from the Central Great Lakes Geologic Mapping Coalition.

INTRODUCTION

In 1997, the Ohio Department of Natural Resources (ODNR), Division of Geological Survey (OGS) began work on a long-range goal to produce reconnaissance-style three-dimensional surficial-geology maps for all of Ohio. The plan to attain this goal focuses on completing surficial mapping of major urban areas and highly populated corridors first in order that a majority of Ohio's 11.4 million citizens (2003 Census estimate) can benefit from modern surficial-geologic maps for land-use planning, resource exploration, hydrogeologic investigations, and geohazard identification. Less populated glaciated portions of Ohio will then be mapped followed by all of unglaciated Ohio. To date, this effort has resulted in the completion of three-dimensional surficial geology maps for 45% of the state's land area (354 of 788 7.5-minute quadrangles).

Existing Maps

Prior to recent mapping efforts, glacial-geology maps of Ohio were generalized, two-dimensional, geomorphically oriented products such as the 1:500,000-scale *Quaternary geology of Ohio* (Pavey and others, 1999) (Figure 1) and other published/open-file glacial-geology maps (generally at 1:62,500-scale) for 27 counties in north-

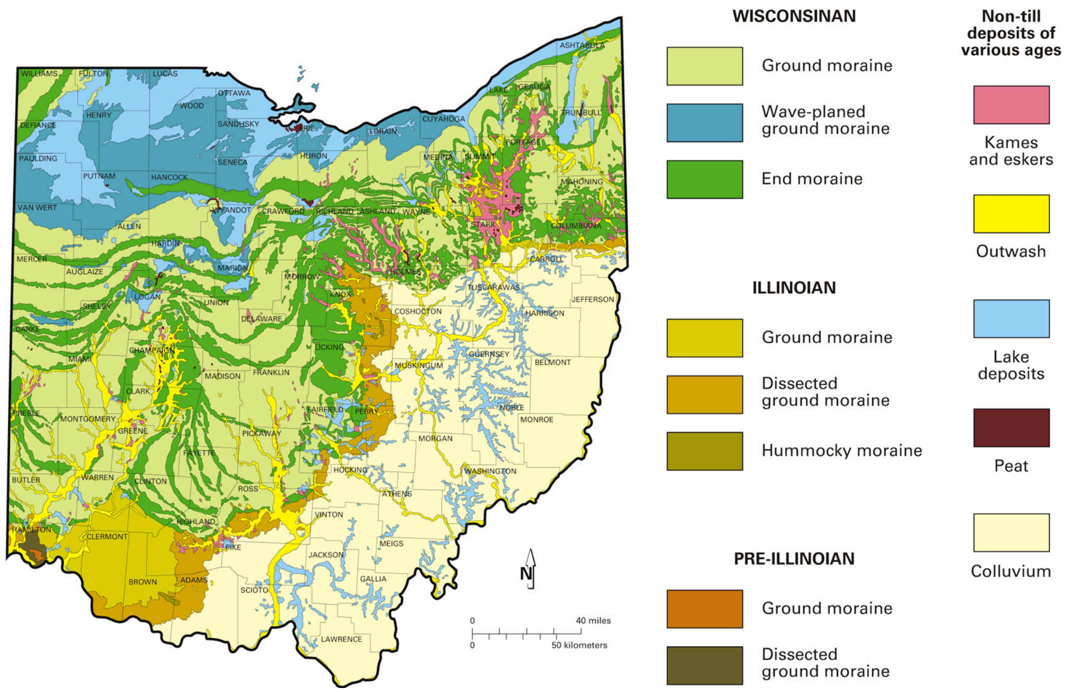

Figure 1. Map showing the glacial deposits of Ohio.

eastern, central, and southwestern Ohio (Figure 2). These older maps were constructed using a combination of field investigations, geomorphic analysis, and existing soils maps. Describing the entire surficial lithologic interval from surface down to top of bedrock was not attempted in this map set, as only the topmost unit was defined. However, existing glacial maps were used as a basis for selecting boundaries of the uppermost units during the remapping effort. While such maps can provide general information on the distribution of materials deposited by Pleistocene glacial and postglacial events, the maps are wholly inadequate for the characterization and assessment of unconsolidated materials at depth. The new surficial mapping effort adds the third-dimension component of variable lithologies at depth and their thicknesses.

New Glacial Mapping Program

In 1996, OGS conducted a survey of surficial-geology map users in Ohio to determine the kinds of map information they require for their needs. The majority of respondents to the survey questionnaire indicated a strong need for comprehensive, three-dimensional, surficial-geology maps that depict all deposits and their thicknesses down to and including the uppermost bedrock unit. In recognition of this need for more comprehensive surficial-geology data, OGS implemented a program to produce reconnaissance-style, three-dimensional, surficial-geology maps at 1:100,000 scale for the entire state. The mapping effort is based on a three-dimensional mapping method first implemented by the Illinois State Geological Survey (e.g., Berg and Kempton, 1988). The Illinois surficial mapping model used established glacial stratigraphic names (abbreviated) that are “stacked” as stratigraphic units would appear within the polygon they are defining. Ohio’s surficial mapping effort modified the stack-unit concept to reflect lithologies of materials rather than glacial stratigraphic names and introduced additional constraints on unit thickness, allowing each area to be mapped down to the bedrock surface.

To date, reconnaissance-style, 1:100,000-scale surficial-geology maps have been completed for fifteen of the thirty-four 30 x 60 minute quadrangle areas of the state. An estimated 8.9 million Ohio citizens now have three-dimensional surficial mapping for various societal needs, including mineral-resource exploration, land-use planning, geohazard identification, and environmental protection. A database that contains the surficial-unit lithology, thickness, and distribution information on thousands of polygons shown on the map can be queried to produce derivative maps that identify geology of societal interest such as mineral resources or geohazards.

The new mapping program is largely funded by a tax on the mineral industries of Ohio, including oil and gas, with additional funding by the U.S. Geological Survey (USGS) STATEMAP program, the Central Great Lakes Geologic Mapping Coalition, and the U.S. Environmental Protection Agency Nonpoint-Source Pollution Program.

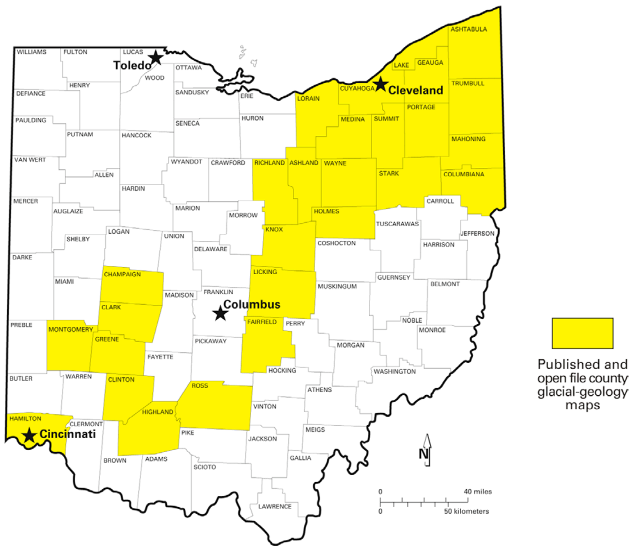

Figure 2. Map showing counties for which glacial-geology maps are available as published or open-file reports from the Ohio Department of Natural Resources, Division of Geological Survey or as part of Division of Water bulletins.

Purpose and Justification

Three-dimensional mapping of Ohio's glacial geology in urbanized or rapidly urbanizing areas (Figure 3) is a high priority for OGS. To date, OGS has completed 1:100,000-scale three-dimensional surficial-geology maps for the Akron, Canton, Cincinnati, Cleveland, Columbus, Dayton, Lancaster, Springfield, Toledo, and Youngstown metropolitan areas. These maps have been used by

1. private sand and gravel explorationists,
2. the Ohio EPA for waste-facility siting analysis and contaminated-site evaluations,
3. regional planning commissions for land-use planning,
4. colleges and universities as teaching tools,
5. private geotechnical firms for site evaluations, and
6. the Ohio Department of Transportation (ODOT) for shallow subsurface evaluations.

Major metropolitan areas and their surrounding interstate highway corridors (especially in glaciated areas of the state) are experiencing major economic development and related population growth. Land-use planning and industrial development in these corridors will benefit greatly from the three-dimensional mapping this overall effort will provide. OGS's long-range plan for surficial mapping in Ohio is to complete statewide mapping of the densely populated major metropolitan areas where most Ohioans live and work; surficial mapping of densely populated areas in glaciated Ohio is complete or in progress. When this phase of mapping is complete, the OGS mapping effort will focus on rapidly developing interstate highway corridors in glaciated portions of northern and western Ohio, such as the Interstate-71 corridor in northern Ohio, and the Interstate-75 corridor in western Ohio. After completion of the major portions of glaciated Ohio, mapping efforts will focus on the largely unglaciated terrain of southeastern Ohio, where thick deposits of outwash and landslide-prone glacio-lacustrine sediments occupy large portions of former and present-day river valleys.

METHODS

Construction of the Lorain/Put-in-Bay Map

OGS has compiled a map that shows the three-dimensional framework of the surficial geology, from the surface down to and including the uppermost bedrock unit, for the Lorain/Put-in-Bay 30 X 60 minute quadrangles (Pavey and others, 2005) located in north-central Ohio (Figure 4). Geologists at the OGS developed an easy-to-read format, described below, that depicts 1) the type of deposit, 2) the thickness range of the deposit, 3) the vertical sequence of deposits in the map area, and 4) the bedrock lying beneath the deposit.

Map Format Guidelines

- Map colors depict the uppermost continuous unit and are intended to assist users in visualizing the surface geology of the area (e.g., greens = till, reds and oranges = sand and/or gravel, blues and purples = silt and clay).
- Polygons or map-unit-areas define boundaries of the vertical sequence indicated by stack-unit descriptions that are composed of letters, numbers, and modifiers.
- Letters, numbers, and modifiers are arranged in stacks to depict the vertical sequence of lithologic units for a polygon. Simple abbreviations are used for ease of reading.
    - Letter abbreviations indicate lithology (e.g., SG = sand and gravel, T = till, L = silt).
    - Numbers indicate average thickness in tens of feet (e.g., 2 = 20 ft thick, + or - 50%).
    - Modifiers indicate aerial extent. A minus {-} sign following a number indicates the maximum thickness for that unit in areas like buried valleys or ridges. Parentheses () indicate that a unit has a patchy or discontinuous distribution in that map-unit area.

Data used to create the map were collected from numerous sources. The concentration of surficial data is greatest near the surface and decreases with depth. U.S.

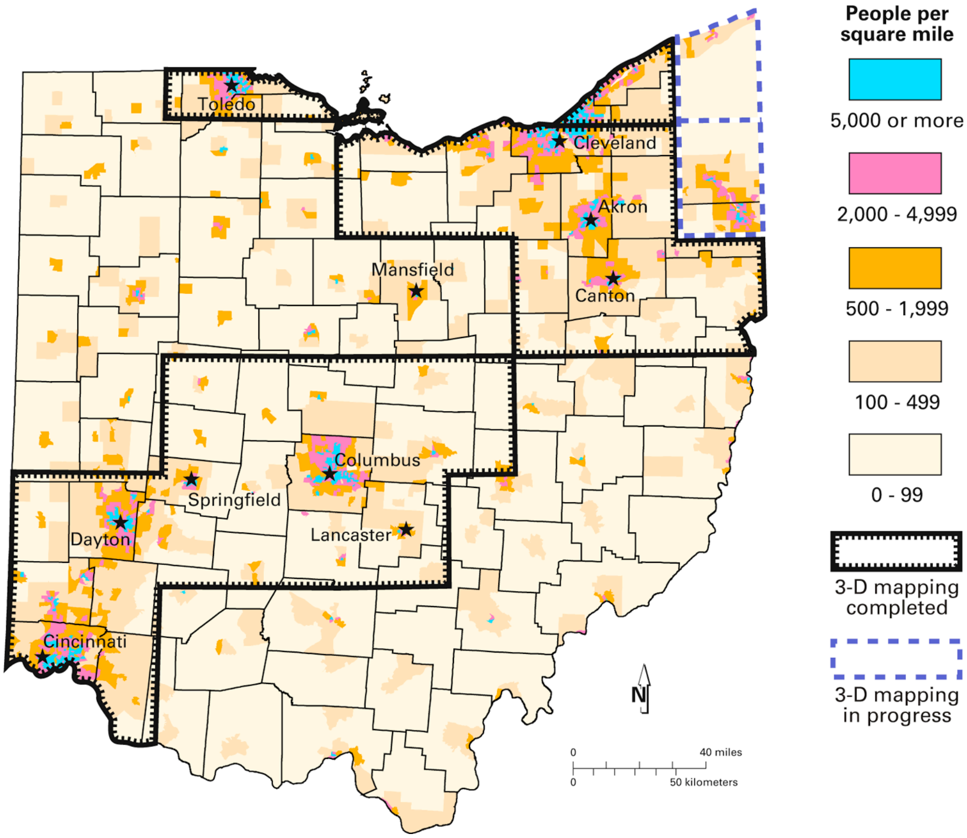

Figure 3. Map showing the population of Ohio by census tract and the outlines of areas with completed three-dimensional surficial mapping. Sources: the U.S. Bureau of the Census and the Ohio Department of Development.

Department of Agriculture, Soil Conservation Service maps, which describe the top 5 ft of surficial materials, provided an initial guide to map-unit area delineation. These areas were modified through interpretation of local geomorphic settings and other data that indicated a change in the type of deposit at depth, such as ODNR water-well logs, ODOT and Ohio EPA test-boring logs, engineering-boring logs, theses, and published and unpublished geologic reports, maps, field notes, and seismic-refraction profiles. These data also provided the basis for lithologic unit descriptions, which summarize, as accurately as possible, recognized associations of genetically related materials. The total thickness of surficial deposits was calculated by subtracting from land-surface elevation the bedrock elevation found on OGS open-file bedrock-topography maps, which are available for each 7.5-minute quadrangle in the map area. The bedrock units were summarized from OGS bedrock-geology maps, which are also available for each 7.5-minute quadrangle. Land-surface topography shown on the base map was prepared largely from data derived from the U.S. Geological Survey's National Elevation Dataset.

The polygon and stack-unit information were hand-drawn at a scale of 1:24,000 on Mylar overlays registered to 1:24,000-scale 7.5-minute quadrangles. These Mylar maps were scanned, the line work was captured, and polygons were created. Stack-unit information that identifies the surficial geology from surface down to and including bedrock for each polygon was input into a geodatabase. Several iterations of quality control took place to ensure that line work between quadrangles and stack-unit assignments were edge matched. The color map consisting of polygons and stack-unit indicators was generated and included base map information and shaded elevation for the final map product. Other map elements include an explanation of how to read the map along with a schematic cross-section, detailed lithologic unit descriptions, references of sources used, a location map of the quadrangle, an index map that shows mapping responsibility, and a map color key.

RESULTS

Several regional surficial-material and bedrock-geology trends appear on the map. Large areas of lacustrine clay and silt deposited during higher levels of ancestral Lake Erie were mapped; they dominate the surface materials landward of Lake Erie in the central and western

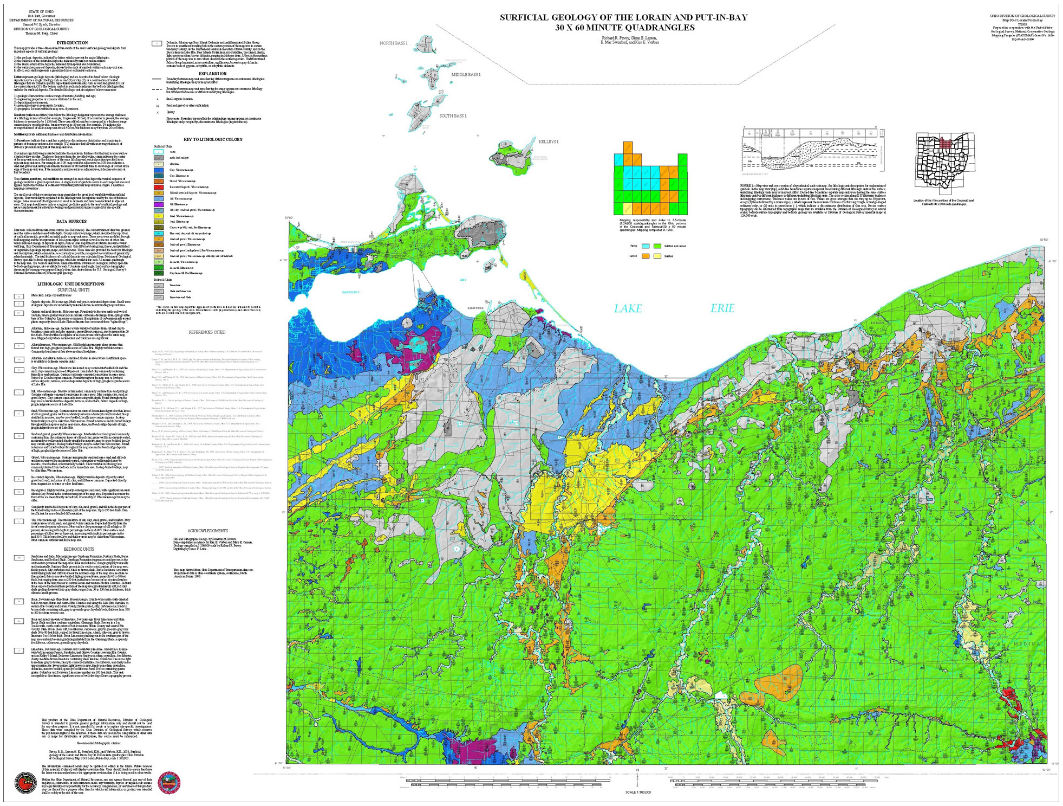

Figure 4. Surficial geology map of the Lorain and Put-in-Bay 30 x 60 minute quadrangles located in north central Ohio to be published as a full-color, print-on-demand paper map and released on CD-ROM disk and as a web-based interactive map.

portions of the map. Shallow bedrock parallels portions of the Lake Erie shoreline and ranges from economic deposits of limestone in the west to shale and economic deposits of sandstone in the east. A deltaic sequence of sand and silt deposited during higher levels of water of ancestral Lake Erie covers a large area in the central portion of the map. Locally widespread and thick organic and marl deposits, formed from the precipitation of calcium carbonate from local springs, were mapped in the northwestern portion of the map. Wisconsinan-age till, present as ridge and ground moraine deposits up to 120 ft thick, mantles most of the southern portion of the map.

Map Products

The final Lorain and Put-in-Bay 30 x 60 minute map will be released to the public in three formats: 1) a full-color paper format, print-on-demand, 1:100,000-scale, surficial-geology map; 2) a digital format on CD-ROM disk, which includes database files, base-map files, metadata files, and a PDF file of the original map; and 3) an Internet Map System product on the OGS website (http://ohiodnr.com).

Derivitive Map Products

The Lorain/Put-in-Bay 30 X 60 minute map is a digital product that can be manipulated to isolate various geologic components. Polygons and stack-unit information are in ArcGIS geodatabase file format and can be sorted by lithology and thickness to create derivative maps for a variety of uses. Figure 5 is a derivative product showing polygons that contain layers of sand, sand and gravel, or gravel with a thickness greater than 20 ft. Mineral companies could use this style of map to delineate areas that contain economic deposits of natural aggregate (sand and gravel) for potential exploration. Water-well drillers could use this map to delineate areas of thick, coarse sand and gravel deposits that may contain an abundant water supply.

Other derivative map products can be extracted from the digital data to suit many purposes. Examples include derivative maps that show areas of thick till, for potential placement of a solid-waste disposal facility, or areas of surface silt, clay, or organic materials that could indicate construction geohazards such as landslides and unstable near-surface materials.

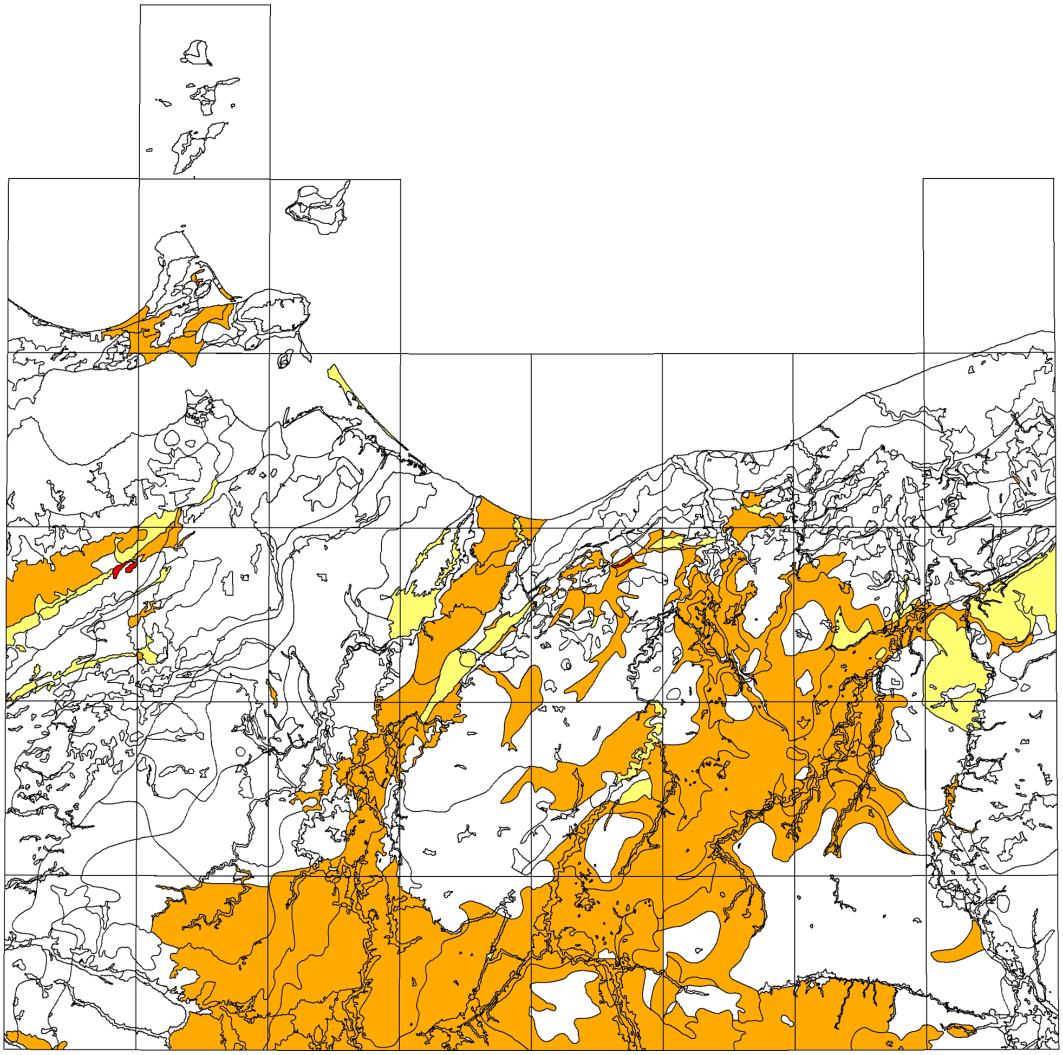

Figure 5. Digitally derived map (extracted from the original stack-unit information) showing areas that have sand, sand and gravel, or gravel with a thickness greater than 20 ft in the Lorain and Put-in-Bay 30 x 60 minute quadrangles.

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