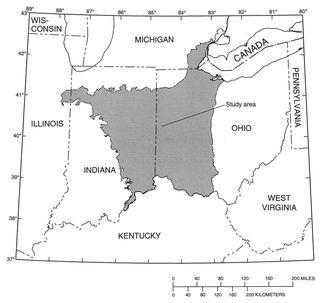


Figure 1. Map showing the location of the Midwestern Basins and Arches Regional Aquifer System Analysis study area in parts of Indiana, Ohio, Michigan, and Illinois

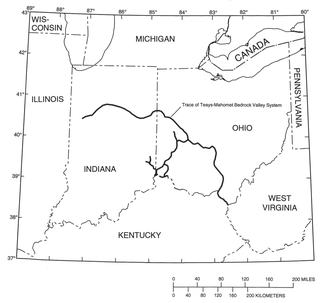
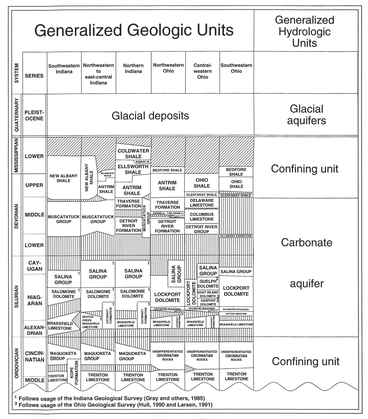


Figure 2. Map showing the generalized location of the Teays-Mahomet Bedrock Valley System (Modified from Goldthwait, 1991)



[1] Follows usage of the Indiana Geological Survey (Gray and others, 1985)
[2] Follows usage of the Ohio Geological Survey (Hull, 1990 and Larsen, 1991)

Figure 3. Chart showing time- and rock-stratigraphic framwork, nomenclature, and geohydrologic units

Bedrock-Surface Altitude in the Midwestern Basins and Arches Region of Indiana, Ohio, Michigan, and Illinois

By Danny W. Bunner, Jr.

INTRODUCTION

The Midwestern Basins and Arches Regional Aquifer-Systems Analysis (RASA) is one of 28 projects that were identified by Congress in 1978, after a period of severe drought, to be studied by the U.S. Geological Survey (Sun, 1984). The Midwestern Basins and Arches RASA study area in parts of Indiana, Ohio, Michigan, and Illinois is defined by either the limestone-shale contact of rocks of Devonian age or by the contact of the land with surface-water bodies (fig. 1).

The compilation of a bedrock-surface-altitude map was considered a necessary element of the Midwestern Basins and Arches RASA project. A compilation of existing data in map form would be important to a variety of earth scientists because it would represent the first time that the altitude of the bedrock surface is presented in a cohesive manner for this region. Such a map could be used to help define the geohydrologic framework of the Midwestern Basins and Arches RASA study area, to provide input for a regional ground-water-flow model, and to assist other large-scale hydrogeologic studies.

This map shows the altitude and configuration of the bedrock surface within the Midwestern Basins and Arches RASA study area in parts of Indiana, Ohio, Michigan, and Illinois. The data used to create the map were gathered largely from sources that were compiled after 1980. A variable contour interval was selected to improve the readability and utility of the map, particularly in areas of high bedrock-surface relief, such as in some southern parts of the study area. The variable contour intervals used were 100 ft in the glaciated areas and 200 ft in unglaciated areas and in areas of significant bedrock-surface relief.

Approach

All available bedrock-surface-altitude maps, wells, and borehole data describing the study area were compiled, digitized and entered into a Geographic Information System (GIS). (Sources of available data are listed in "Selected References.") In areas where bedrock-surface altitudes had never been estimated, water-well-log data, (compiled from the Ohio Department of Natural Resources, Division of Water, in conjunction with the Ohio Geological Survey) were plotted on topographic maps and were contoured.

The individual maps and data were compiled and appended into one large map that is based on an Albers Equal-Area projection. Contours were constructed and labeled to prepare the final map by consideration of geologic and topographic features that were common to adjoining individual maps. Selected contours were then removed in order to present the data clearly at a scale of 1:750,000.

Acknowledgments

The author acknowledges E. Mac Swinford, Glenn E. Larsen, and C. Scott Brockman of the Ohio Geological Survey and Felix Nathan and Lon Rudesell of the University of Toledo for assistance in locating and obtaining the maps and data necessary for the compilation of this report. The author also thanks the Indiana Geological Survey for providing the stable-base map of the bedrock surface of Indiana for digitizing.

REGIONAL GEOLOGIC SETTING

The regional geologic units in the Midwestern Basins and Arches RASA study area consist of interbedded shales and carbonates of Ordovician age, carbonate rocks of Silurian and Devonian age, and shales of Devonian and Mississippian age (fig. 3). The Ordovician shales, which crop out in southwestern Ohio and southeastern Indiana, are considered to be the basal confining unit of the carbonate aquifer and underlie the rest of the Midwestern Basins and Arches RASA study area. Silurian and Devonian carbonate rocks that consist primarily of limestones and dolomites overlie the Ordovician shales in the Midwestern Basins and Arches RASA study area and are considered to be the bedrock aquifer in this study.

The confining unit that lies above the carbonate aquifers is made up of Middle and Upper Devonian and Lower Mississippian shales. The New Albany Shales; the Antrim Shales; the Olentangy and Ohio Shales; the Ellsworth Shales; the Sunbury Shales; and the Bedford, Ohio, and Coldwater Shales make up most of the confining unit. These units have been eroded from a large part of the study area, but, where present, they function as a confining layer above the Silurian and Devonian carbonate aquifer (fig. 3).

The regional carbonate aquifer consists of Silurian and Devonian limestones and dolomites. The rocks that make up the aquifer in Indiana and northwestern Illinois can be grouped into four major stratigraphic units: Brassfield Limestone or Sexton Creek Limestones and the Cataract Formation, the Salamonie Dolomite, the Salina Group, and the Detroit River and Traverse Formations or the Muscatatuck Group. The stratigraphic units in Ohio and southern Michigan are more specifically categorized than those in Indiana. Therefore, in western Ohio and southern Michigan, the rocks that make up the regional aquifer are grouped into 10 stratigraphic units: Brassfield Limeston or Cataract Formation, the Dayton Limestone, the Rochester Shale equivalent, the Lockport Dolomite or Lockport Group, the Salina Formation, the Hillsboro Sandstone, the Detroit River Group, the Columbus Limestone, the Delaware Limestone, and the Traverse Formation (fig. 3).

The basal confining unit of the Silurian and Devonian carbonate aquifer consists of the Upper Ordovician rocks, known collectively as the Maquoketa Group, and the undifferentiated Cincinnatian rocks. These units crop out in southeastern Indiana and southwestern Ohio and are not considered to be an aquifer (fig. 3).

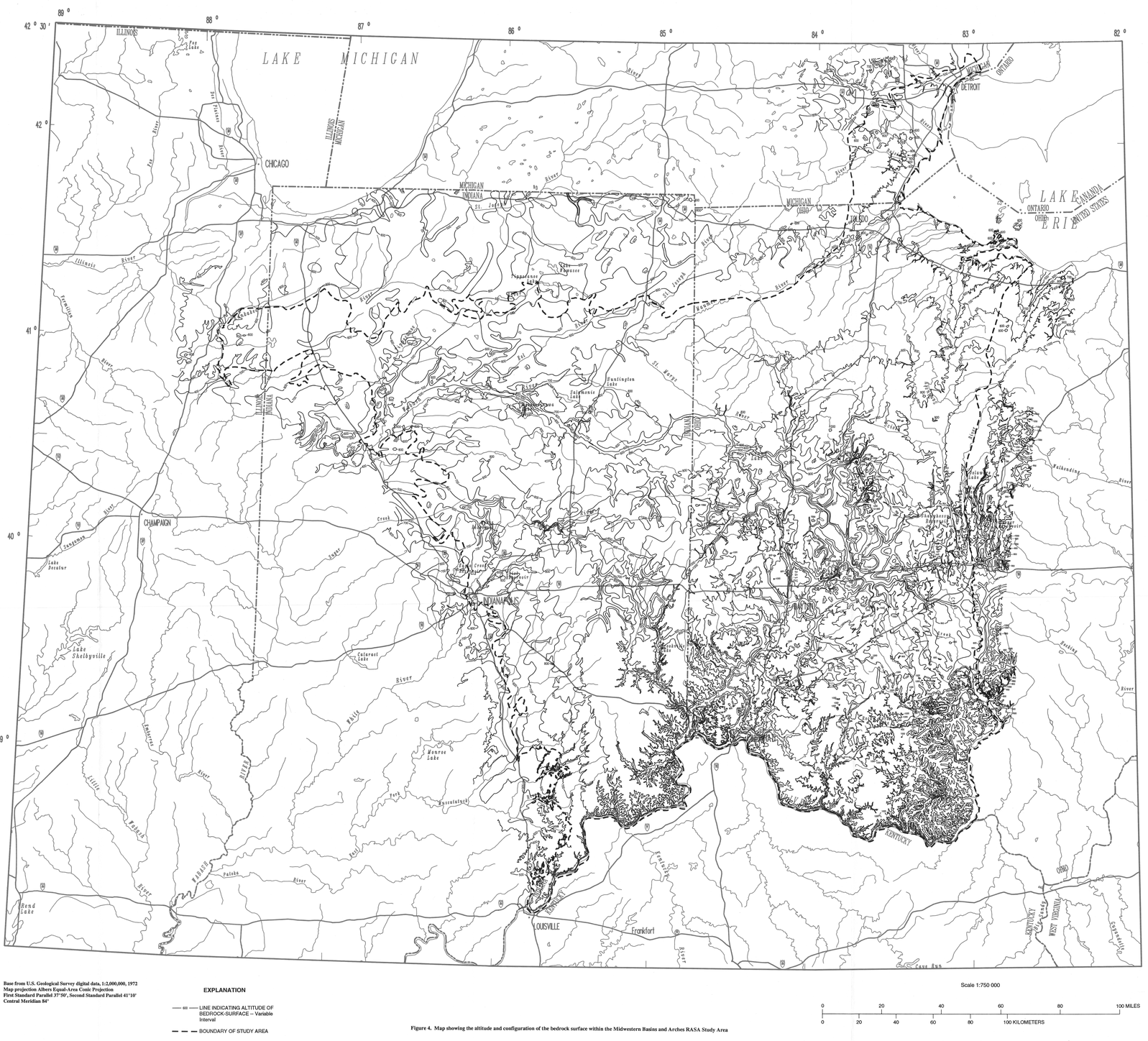
The Silurian and Devonian carbonate rocks are not as easily eroded by fluvial action as are the Ordovician, Devonian, and Mississippian shales. In areas where the carbonates crop out, the bedrock topography is predominantly flat. Where the carbonate rocks (which are generally massively bedded) crop out, few signs of erosion are evident. The Ordovician, Devonian, and Mississippian shales are more fissile, thinly bedded, and susceptible to mechanical erosion than are the carbonates. These physical characteristics of the shales allow for an increased rate of erosion that created steep stream valleys within the outcrop area of the shales. Areas of great relief on the bedrock surface tend to be near stream valleys in areas where the Ordovician, Devonian, or Mississippian shales crop out in Ohio and Indiana.

A major contributor to the features of the bedrock surface is the preglaical Teays River system. The Teays River system flowed into the Midwestern Basins and Arches RASA study area from near the point where the Scioto River enters the Ohio River. The rennant Teays course runs northward from the Ohio River, cuts northwestward just south of Columbus toward Indiana, and crosses the Ohio-Indiana State line in an east-west orientation (Goldthwait, 1991). The Teays flowed westward across Indiana in a sinuous channel and out of the study area, toward Illinois, from the west-central part of Indiana (Bleuer, 1991; Gray, 1991). The many tributaries to the Teays System helped to shape and define the current drainage systems (fig. 2). The Great Miami and the Little Miami Rivers flow within channels of Teays tributaries. The Ohio and Scioto Rivers flow within sections of the original Teays Valley (Goldthwait, 1991).

BEDROCK-SURFACE ALTITUDE

The altitude of the bedrock-surface in the Midwestern Basins and Arches RASA study area ranges from approximately 400 to 1,400 ft above sea level. A bedrock high of about 1,400 ft above sea level is southeast of Indian Lake in west-central Ohio. This location is also the highest point within the Midwestern Basins and Arches RASA study area. Several other bedrock highs of about 1,300 ft above sea level are present in central Ohio approximately 50 mi south of Columbus and 45 mi north of Columbus (fig. 4).

Bedrock lows primarily underlie stream valleys of Holocene age or are within buried glacial valleys. The lowest altitudes, about 400 ft above sea level, are present in the Ordovician, Devonian, or Mississippian shales in Ohio and Indiana; in terms of physiography, these lows are located within the Wabash River Valley in Indiana, the Kankakee River Valley in Illinois, and along the main stem of the Ohio River. The bedrock lows within the Great Miami River system in Ohio can be associated with the ancient Teays River system. Bedrock lows of about 500 ft above sea level are present along the Lake Erie shoreline and along channels of the Teays-Mahomet bedrock valley system that contained the ancient Teays River system. A major feature of the Teays-Mahomet Bedrock Valley system is the erosion through the Silurian and Devonian carbonate rocks to the Ordovician shales. This buried-valley system completely dissects the carbonate aquifer in west-central Ohio and partially dissects the carbonate aquifer in east-central Indiana.



Base from U.S. Geological Survey digital data, 1:2,000,000, 1972
Map projection Albers Equal-Area Conic Projection
First Standard Parallel 37°50', Second Standard Parallel 41°10'
Central Meridian 84°

EXPLANATION
— 600 — LINE INDICATING ALTITUDE OF BEDROCK-SURFACE -- Variable Interval
— — — BOUNDARY OF STUDY AREA

Figure 4. Map showing the altitude and configuration of the bedrock surface within the Midwestern Basins and Arches RASA Study Area

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BEDROCK-SURFACE ALTITUDE IN THE MIDWESTERN BASINS AND ARCHES REGION OF INDIANA, OHIO, MICHIGAN, AND ILLINOIS

By
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1993