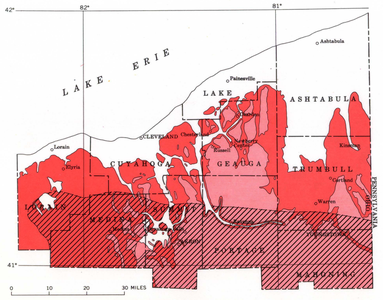
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

HYDROLOGIC INVESTIGATIONS
ATLAS HA-341 (SHEET 1 OF 2)

PHYSICAL SETTING AND GEOLOGICAL FRAMEWORK



EXPLANATION

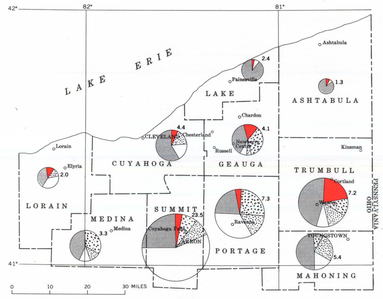
Area where the Berea Sandstone and locally the Cussewago Sandstone are the only major bedrock sources of water. The average yield of the Berea Sandstone in the area is 14 gallons per minute

Area where aquifers such as the conglomerate of the Sharon Member that occur above the Berea are present. Where these are thick and permeable, the Berea is a secondary source of water

Shales, mainly of Devonian age, having little water. Moderate yields may be obtained where shales are fractured and overlain by glacial sand and gravel

Dashed line shows approximate position of fresh water—salt water interface for the Berea and Cussewago Sandstones. Ruled area shows where these aquifers contain salt water. Water quality criteria for other aquifer systems are not considered in this figure

MAP SHOWING PRINCIPAL BEDROCK SOURCES OF WATER



EXPLANATION

AQUIFER

Shale and sandstone exclusive of the Berea and Cussewago Sandstone and Sharon Member

Berea and Cussewago Sandstones

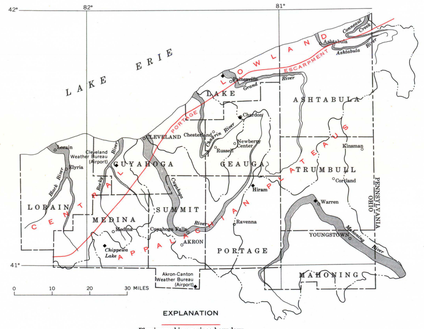
7.2—PUMPAGE (millions of gallons per day)

Sharon Member of Pottsville Fm.

Glacial and alluvial deposits within the major stream valleys

Glacial deposits located outside of the major stream valleys

MAP SHOWING THE SOURCE AND QUANTITY OF GROUND WATER USED



EXPLANATION

Physiographic province boundary

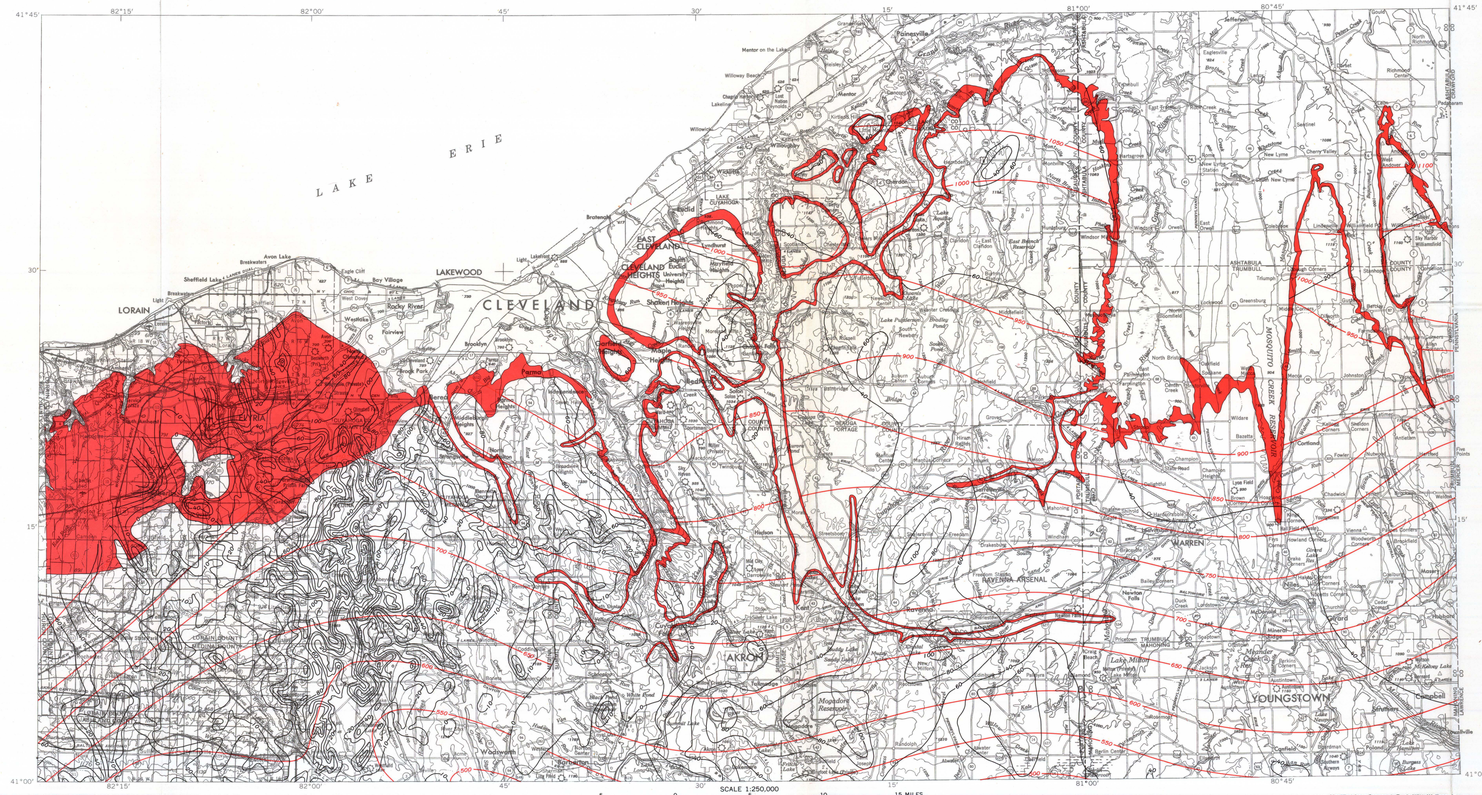
Weather Stations

Drainage divide

100
500
1500
20,000

Width of river indicates average discharge, in cubic feet per second

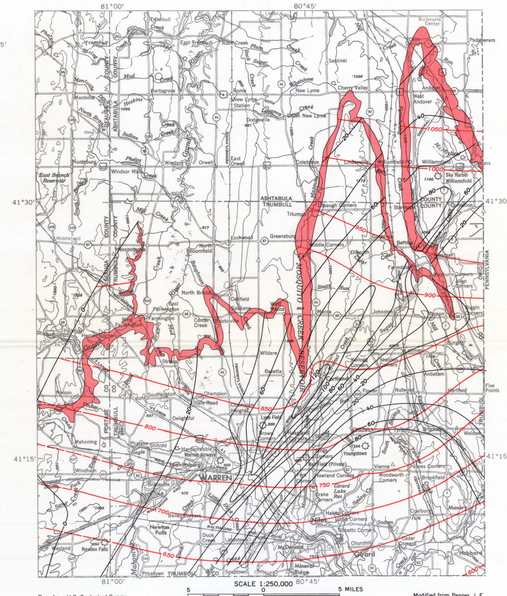
MAP SHOWING PHYSIOGRAPHIC DIVISIONS, LOCATION OF WEATHER STATIONS, MAJOR DRAINAGE BASINS AND AVERAGE DISCHARGE OF THE PRINCIPAL RIVERS



Base from U.S. Geological Survey Cleveland, 1956–66 and Toledo, 1956

MAP SHOWING THE THICKNESS AND STRUCTURE OF THE BEREA SANDSTONE

EXPLANATION SHOWN AT RIGHT



Base from U.S. Geological Survey Cleveland, 1956–66

Modified from Pepper, J. F., de Witt, Wallace, Jr., and Demarest, D. F.

MAP SHOWING THE THICKNESS AND STRUCTURE OF THE CUSSEWAGO SANDSTONE

EXPLANATION

Berea Sandstone

Cussewago Sandstone Bedrock exposures

Contact

850 Structure Contour
Dashed where approximate. Shows altitude of the top of the Berea Sandstone or Cussewago Sandstone. Contour interval 50 feet.

800 Line of equal thickness of Berea Sandstone or Cussewago Sandstone
Intervals 10 and 20 feet

INTRODUCTION

Northeastern Ohio is one of the most highly industrialized and fastest growing areas in the United States. One of the primary problems northeastern Ohio will face is the development of adequate quantities of ground water. Ground water is available in most of the area, but only in limited quantity in many places. Effective use of ground water has been hampered by the lack of technical knowledge of the regional characteristics—geologic and hydrologic—of each aquifer. It is the purpose of this atlas to present geologic and hydrologic data governing the occurrence and availability of ground water in two of the more important sources—the Berea and Cussewago Sandstones.

Published and unpublished data used in this report were obtained from reports and files of the Ohio Department of Natural Resources, Division of Water and the U.S. Geological Survey, Water Resources Division. The author gratefully acknowledges the assistance of A. C. Sedam in helping compile the maps and illustrations in this report.

WATER USE

Throughout northeastern Ohio ground water is pumped from several aquifers of which the Berea and Cussewago Sandstones, both of Mississippian age, are two of the most important. The Berea Sandstone is a source of potable water in Lorain, Cuyahoga, Summit, Portage, Geauga, Lake, Ashtabula, and Trumbull Counties. The Cussewago Sandstone, which is more restricted in areal distribution, yields potable water in Ashtabula and Trumbull Counties and in small parts of Geauga and Portage Counties. In some localities the Berea and Cussewago are the only important bedrock sources of fresh water (Source of water map). Although the total pumpage from other bedrock sources is greater (Water use map), the Berea and Cussewago Sandstones, excluding the conglomerate of the Sharon Member of the Pottsville Formation, consistantly yield more water to individual wells.

PHYSICAL SETTING

Most of northeastern Ohio is within the Appalachian Plateau Province (Physiographic map) and ranges in altitude between 573 feet (the mean level of Lake Erie) and 1,200 feet above mean sea level. The terrane generally is rather flat, and local relief rarely exceeds 200 feet. Principal rivers draining the area of investigation are shown on the physiographic map.

Prior to and during the Pleistocene age the streams dissected the relatively flat-lying rocks, producing deep valleys which are partially filled with glacial deposits (Geologic section). Some of these valleys no longer contain streams because of the derangement of the stream systems by the glaciers.

Storm systems moving through the Great Lakes region toward the St. Lawrence River valley provide northeastern Ohio with abundant precipitation more or less evenly distributed throughout the year. Temperature and precipitation data for several localities are given in the table.

In northeastern Ohio, owing to the effect of the Portage Escarpment—a topographically high terrane feature which crosses the area diagonally (Physiographic map) in a northeastern direction—more precipitation occurs on the upland surface than on the lowland bordering Lake Erie. Consequently, the annual precipitation in the outcrop area of the Berea Sandstone south of the Portage Escarpment averages about 1 to 6 inches more than the precipitation on the lakeshore lowland. Hence, southern Cuyahoga, Lake, and Ashtabula Counties and northern Geauga County, by virtue of receiving more recharge, are more favorably situated for ground-water development than areas farther north.

GEOLOGICAL FRAMEWORK

Berea Sandstone.—The Berea Sandstone, of Mississippian age, named from a 50-foot high sandstone cliff near Berea, Ohio (Newbury, 1870, p. 22), is overlain by the Orangeville Shale or, locally, by the Sunbury Shale, and rests disconformably on the Bedford Shale (Weller and others, 1948). The sequence is well exposed at Stebbins Gulch in Geauga County and near Wick in Ashtabula County (Stratigraphic section).

Studies of the geometry, lithology, fossils, and primary structure of the Berea Sandstone indicate that it was formed by a river system spreading sand and silt along the seaward margin of a broad delta extending from Norwalk, Ohio, on the west to northwestern Pennsylvania on the east. This delta was slowly built into a shallow sea by streams originating in Canada. Sand was spread as far south as Kentucky and West Virginia. Much of the sand was deposited in sinuous channels and occurs locally as thick masses or stringers of sandstone, interbedded with shale.

The Berea Sandstone is coarse- to medium-grained in the western counties. Locally containing pebbles, it is cemented with clay. East of Cleveland thin, intercalated shale stringers are common and the dominant grain size is silt. In Lorain and western Cuyahoga Counties the sandstone is more massive, relatively clean and well sorted, and free of intercalated beds of shale.

The map showing areal extent, thickness, and outcrop area of the Berea Sandstone indicates that the thickness of the sandstone ranges from a few feet near the edge of the outcrop area to more than 235 feet at South Amherst, Lorain County. The average thickness, where the sandstone was deposited in channels, is 50 feet, but large lateral variations in thickness may occur in short distances. The thickest of the channel sandstones occur along the outcrop belt in the northern part of the area in western Cuyahoga County, where they range in thickness from 100 to 125 feet (Pepper, de Witt, and Demarest, 1954, p. 32). Thinner channel deposits occur along the outcrop belt between the Cuyahoga and Chagrin Rivers.

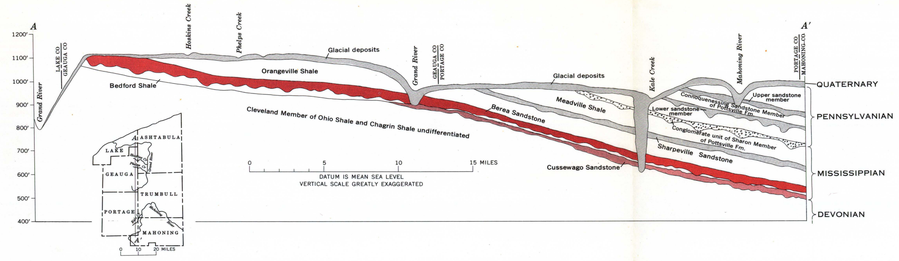
In most areas the thickness of the Berea Sandstone is an important factor in determining the yield of wells; generally, the thicker the unit the more water it will yield. In Lorain County, however, the Berea Sandstone locally is more than 100 feet thick, yet yields to wells are relatively low. Other geologic and hydrologic factors, including the degree of cementation and amount of saturation, evidently are more important in some areas than thickness in determining the yield of wells.

Cussewago Sandstone.—In the eastern part of the area, in Trumbull and Ashtabula Counties, logs of wells drilled through the Berea Sandstone commonly show 20 to 30 feet of underlying Bedford Shale beneath which is a soft, greenish-yellow to greenish-brown, quartz sandstone. This is the Cussewago Sandstone, which was first described by White (1881, p. 94–96) at its type locality in the valley of Cussewago Creek in western Crawford County, Pennsylvania. White included the sandstone in a sequence which he termed the Cussewago Limestone, Shale, and Sandstone. DeWitt (1946) restricted the name to the sandstone unit, and his designation is followed here. The age of the Cussewago Sandstone is early Kinderhookian, and it is the oldest rock unit of the Mississippian System in northeast Ohio. Drillers in Trumbull and Ashtabula Counties refer to this unit as the "white sand."

Locally, in south-central Trumbull County, the Berea Sandstone lies directly on the Cussewago Sandstone, which disconformably overlies the Cleveland Member of the Ohio Shale or the Chagrin Shale (Riceville Shale of Pennsylvania) of Devonian age.

The Cussewago Sandstone is coarser grained than the typical Berea of the eastern area; the predominant mineral is quartz and the bonding materials are iron oxide and clay. It may contain pebbles of chert and igneous rock and, locally, may be interbedded with siltstone and shale. The sandstone is clean and well sorted in Ohio, but becomes poorly sorted and contains more clay in Pennsylvania. Locally, the Cussewago Sandstone is so soft as to be almost unconsolidated. Hence, it has a tendency to cave from the sides of well holes.

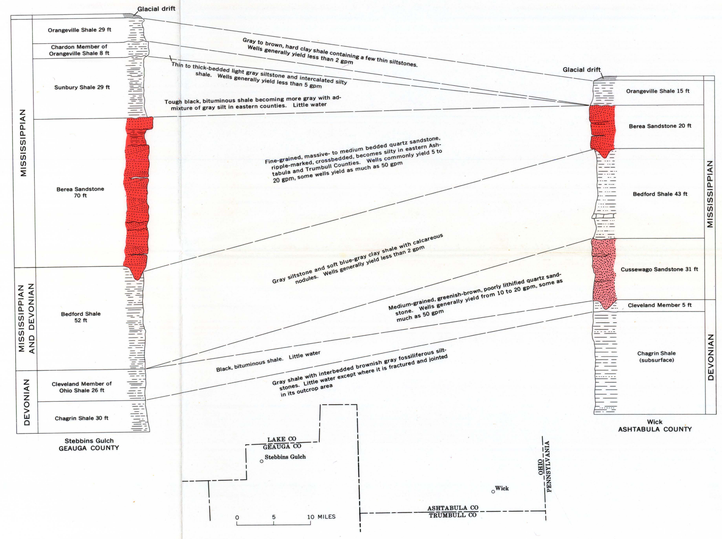
The Cussewago Sandstone represents the fanlike delta of a system of rivers which flowed into western Pennsylvania and northeastern Ohio from the east and southeast. Near its edge, in Pennsylvania, the Cussewago Sandstone ranges between 9 and 35 feet in thickness. In central Trumbull County where the sandstone was deposited either in a major northeast-trending channel, or as a bar, it is much thicker(Thickness and structure map of Cussewago sandstone). For example, about 2 miles south of Cortland it is more than 129 feet thick, as reported in the log of a well.



GENERALIZED GEOLOGIC SECTION BETWEEN EASTERN LAKE COUNTY AND SOUTHWESTERN MAHONING COUNTY

SUMMARY OF WEATHER DATA REPORTED BY STATIONS

Station	Location		Altitude (feet)	Mean annual temperature (° F)	Number of years of record	Average annual precipitation (inches)	Number of years of record
Cleveland WB-AP	41°24′	81°51′	787	50.9	31	36.42	23
Chippewa Lake	41°05′	81°54′	1,040	49.6	64	36.82	81
Akron-Canton WB-AP	40°55′	81°26′	1,209	49.5	12	37.11	12
Hiram	41°19′	81°09′	1,260	48.7	73	38.60	79
Warren	41°15′	80°51′	900	50.0	68	37.42	73
Chardon	41°35′	81°12′	1,260	49.2	15	45.98	15
Painesville	41°45′	81°15′	600	50.1	11	37.04	11



STRATIGRAPHIC RELATIONS AND GENERAL LITHOLOGIC CHARACTER OF SECTIONS MEASURED AT STEBBINS GULCH, GEAUGA COUNTY, AND AT WICK IN ASHTABULA COUNTY

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HYDROGEOLOGY OF THE BEREA AND CUSSEWAGO SANDSTONES IN NORTHEASTERN OHIO

By
Jon L. Rau

1969

For sale by U.S. Geological Survey, price $1.00 per set