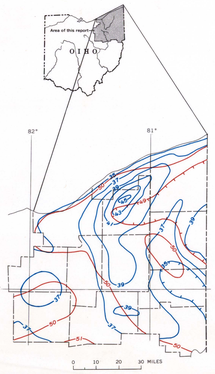
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

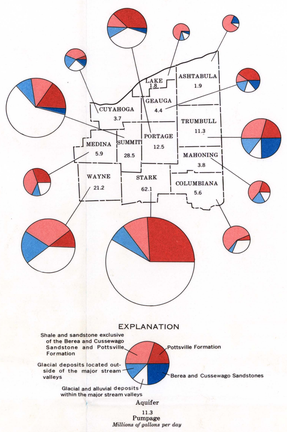
PREPARED IN COOPERATION WITH THE
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

HYDROLOGIC INVESTIGATIONS
ATLAS HA-494 (SHEET 1 OF 2)

PHYSICAL SETTING AND GEOLOGIC FRAMEWORK



MAP SHOWING AVERAGE ANNUAL PRECIPITATION AND MEAN ANNUAL TEMPERATURE



GRAPHS SHOWING SOURCE AND QUANTITY OF GROUND WATER USED

INTRODUCTION

Northeastern Ohio is one of the most highly industrialized and fastest growing areas in the United States. One of the primary problems this region faces 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 of ground water and its availability from three important sandstone aquifers. These aquifers are the Sharon, the Connoquenessing Sandstone, and the Homewood Sandstone Members of the Pottsville Formation. Rau (1969) described the hydrology of the Berea and Cussewago Sandstones of Mississippian age that are stratigraphically the lowest of the consolidated rock aquifers in northeastern Ohio. Overlying these lower units, and separated from them by several tens of feet of relatively unproductive shales, are the sandstone aquifers of the Pottsville Formation of Pennsylvanian age. The Pottsville aquifers, together with the Berea and Cussewago Sandstones, represent the most important bedrock sources of ground water in northeastern Ohio.

Published and unpublished data used in this report were obtained from reports and files of the Ohio Department of Natural Resources, Division of Water, and the U.S. Geological Survey.

PHYSICAL SETTING

Most of the study area is within the glaciated part of the Appalachian Plateaus province. The sections shown on the physiographic map are modified after Fenneman (1938). The northwestern part, bordering the outcrop area of the Pottsville Formation, is in the till plains and lake plains sections of the Central Lowland province. A small area in the southern part is in the unglaciated Appalachian Plateaus province. The land surface in northeastern Ohio, about 573 feet above mean sea level at Lake Erie, rises southward to an altitude of 1,360 feet in Geauga County, and declines gradually to an altitude of about 1,000 feet before rising again to a maximum altitude of 1,447 feet in Columbiana County near the south edge of the study area. Local relief in the glaciated part of the region is greatest near Lake Erie, in the vicinity of the northeast trending Portage escarpment (physiographic map). Farther south the glaciated terrane in northeastern Ohio is generally flat, and local relief is less than 200 feet. Beyond the south limit of glaciation the topography is more rugged. In Columbiana County near the Ohio River, local relief may exceed 500 feet. The preglacial topography that was developed on the Pottsville Formation, before it was overridden by the continental ice sheets, was probably similar to the thoroughly dissected terrane south of the glacial border. The many isolated remnants of the Pottsville Formation shown on the areal distribution map are evidence of extensive dissection of the upland surface by former stream systems, which were obliterated or extensively modified by glaciers (Rau, 1970).

Climatic data for northeastern Ohio are summarized in the figure above which shows the average annual precipitation and mean annual temperature, based on the 1931–60 period of record (U.S. Weather Bureau, 1964). Lake Erie has a moderating effect on temperature and the Portage escarpment has a pronounced effect on precipitation. A small area in northern Geauga County, for example, receives as much as 10 inches more precipitation than do areas to the southeast less than 30 miles away, and is thus an important area for recharge.

RECHARGE

Recharge to the Pottsville Formation aquifers is by precipitation percolating directly into the bedrock and by infiltration in favorable areas where the formation is traversed by streams. Except in their upper reaches several of the major streams flow in valleys cut below the base of the Pottsville Formation. However, many of the outlying remnants of the Pottsville are above the major streams and recharge is mostly by precipitation.

In Portage and Geauga Counties where precipitation is relatively abundant, conditions for recharge are especially favorable. The Sharon Member (conglomerate unit) is open textured and becomes an excellent reservoir for precipitation that percolates through the permeable glacial drift. However, limited distribution of the Sharon Member and its location above the major streams reduces the regional significance of recharge both by precipitation and by induced infiltration from streams.

Infiltration from the Tuscarawas River in Summit and Stark Counties could be detrimental to the ground-water resources because of chlorides that enter the stream system by seepage from waste settling basins in Summit County (Smith and White, 1953, p. 52).

A combination of hydrologic and geologic conditions favorable for ground-water development occurs in relatively flat areas traversed by streams where permeable saturated gravels are in contact with the Pottsville. These conditions occur locally in the vicinity of Mogadore Reservoir in Portage County, in Berlin Reservoir in Stark, Portage, and Mahoning Counties, and in Lake Milton and Meander Reservoir in Mahoning County, all of which areas are underlain by the Sharon Member or Connoquenessing Sandstone Member.

The availability of ground water from the Pottsville Formation becomes progressively less in the southern part of the study area where the sandstones are more deeply buried, more tightly cemented and with hydraulic conductivities reduced. The depth-to-aquifer maps indicate the areas in which the aquifer units are deeply buried and recharge is minimal.

GROUND-WATER CONTRIBUTION TO STREAMFLOW

A summary of streamflow data for several streams in northeast Ohio is given in the following table (Cross, 1968). Except for the Muskingum River basin each station's drainage area comprises at least four-fifths of the respective basin. (See map showing stream discharge.)

River basin and station	Drainage area (sq mi)	Adjusted mean discharge[a] (cfs per sq mi)	Discharge equaled or exceeded 90 percent of time[a] (cfs per sq mi)	(cfs)
Rocky River near Berea.*	267	0.906	0.028	7.50
Cuyahoga River at Independence.*	707	1.141	.216	153
Chagrin River at Willoughby.[b]	246	1.260	.133	32.8
Grand River near Madison.	581	1.112	.017	9.90
Mahoning River at Lowellville.*	1,073	.932	[c].267	[c]287
Little Beaver Creek near East Liverpool.	496	1.050	.089	44.0
Sandy Creek at Waynesburg.	253	1.036	.121	30.5
Tuscarawas River at Massillon.*	518	.788	[d].181	[d]94.0
Sugar Creek above Beach City Dam.	160	.806	.058	9.20

*Flow regulated.
[a]From records adjusted to period 1931–60 unless otherwise noted.
[b]Diversion added to record.
[c]For period 1944–65.
[d]For period 1940–65.

The 90 percent flow, in cubic feet per second per square mile, is a good indicator of the base-flow characteristics of the geologic formations in the basin. Relatively high base flow for some streams in the region results from permeable glacial deposits. Locally, however, discharges from sandstones of the Berea Sandstone and Pottsville Formation contribute significantly to the flow of streams, such as in Geauga County where these units crop out along the Chagrin River.

In Summit County numerous springs issue at the base of the Sharon Member (conglomerate unit) where it crops out as ledges (Smith and White, 1953). These springs contribute to base flow which, however, is largely sustained in this area by ground-water discharge from permeable outwash in buried valleys, kames, and terraces.

High base flow in the Mahoning River basin results chiefly from ground-water inflow to tributary basins in Trumbull and Portage Counties (Cross and others, 1952). Part of this discharge is from the Berea and Cussewago Sandstones (Rau, 1969) and part may also come from sandstones of the Connoquenessing and Sharon Members that constitute the bedrock in much of the area. In the upper Mahoning River basin to the south, which is underlain by shales, thin sandstones and coal-bearing strata of the upper part of the upper part of the Pottsville and lower part of the Allegheny Formations, ground-water discharge from the bedrocks has little effect on streamflow (Cross and Hedges, 1959, p. 33).

In the Beaver Creek basin much of the Pottsville Formation is below the level of surface streams. Farther west in Stark County the Pottsville Formation is partly above stream level; nevertheless most of the dry-weather flow to streams is from the abundant outwash deposits in most of the stream valleys. The relatively low base flow in Sugar Creek shows that neither the glacial deposits nor the Pottsville rocks contribute significantly to streamflow.

WATER USE

Ground water is an important resource in most parts of northeastern Ohio, and is the chief source of municipal and industrial water supply in Stark, Portage, Geauga, and Wayne Counties. The aquifers of the Pottsville Formation yield more than 60 mgd (million gallons per day) or about 38 percent of the total ground-water supply in northeastern Ohio. The Sharon Member is the most productive of the three Pottsville aquifers and is the best bedrock source of water in much of northeastern Ohio.

CONSOLIDATED ROCK AQUIFERS

The areal distribution map shows the extent of the Pottsville aquifers and of other consolidated rock units of hydrologic significance in northeastern Ohio. The Sharon Member occurs at the surface or beneath a thin covering of glacial drift in most of Portage County, in the central part of the study area, and in scattered localities in adjacent and nearby counties. The outcrop area of the Connoquenessing and Homewood Sandstone Members borders that of the Sharon Member on the south, forming a southwest trending band, 5 to 10 miles wide, that crosses the study area in the vicinity of Canton and Youngstown. The bedrock units in southeastern Stark, southern Mahoning, and Columbiana Counties, are chiefly shales and shaly sandstones of the Allegheny and Conemaugh Formations of Pennsylvanian age, which are important only locally as aquifers. The Berea Sandstone of Mississippian age, described by Rau (1969) is the principal bedrock aquifer north of the area underlain by the Sharon Member. The extreme northwestern part of the area, bordering Lake Erie, is underlain by shales of Devonian age which are a poor source of ground water. The meager ground-water supplies in this area are generally obtained from shallow wells tapping weathered zones in the bedrock, or from unconsolidated glacial deposits.

POTTSVILLE FORMATION

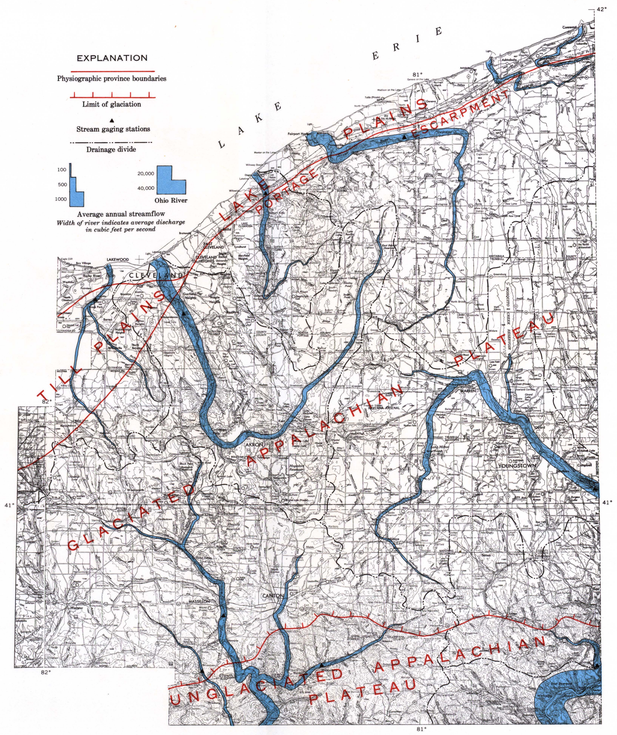
The Pottsville Formation is the oldest and stratigraphically lowest of four formations which make up the Pennsylvanian System in Ohio. In ascending order, the Allegheny, Conemaugh, and Monongahela Formations overlie the Pottsville. Extending northward from southern Ohio, the Pottsville Formation is exposed in a relatively narrow belt along the eroded west edge of the area underlain by Pennsylvanian rocks. In northeastern Ohio, the Pottsville underlies a broad area, of which most is covered by glacial drift.

The U.S. Geological Survey lists the members of the Pottsville Formation in northeastern Ohio, in descending order, as follows:

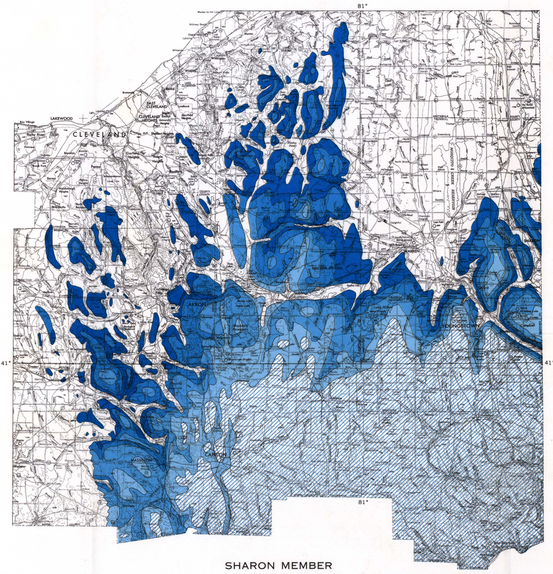
Homewood Sandstone Member
Mercer Member
Connoquenessing Sandstone Member
Sharon Member
Shale unit
Conglomerate unit

The lithologic and hydrologic characteristics of the Pottsville units are summarized in the columnar section. The figure compares the generalized Pottsville section in Portage County of Winslow and White (1966), with that in Stark County as reported by Delong and White (1963). The gross structural and stratigraphic relations of the Pottsville units with the other principal stratigraphic units in the region are shown on the geologic section. Although the vertical scale of the diagram is greatly exaggerated, some idea of thickness variations within the Pottsville is apparent.

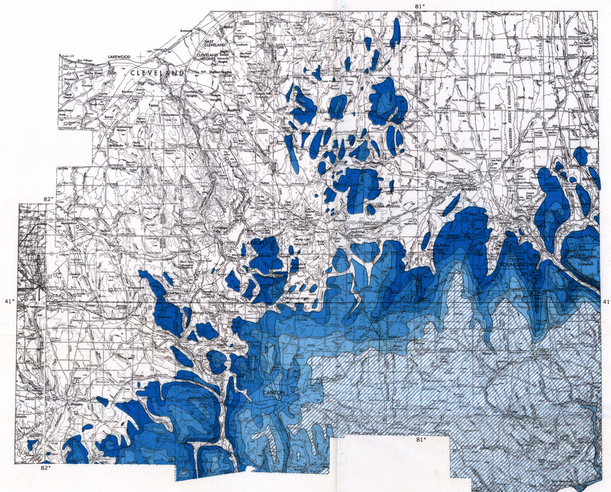
In most of northeastern Ohio, post-Mississippian-pre-Pottsville erosion generally removed the Mississippian formations. The basal units of the Pottsville Formation disconformably overlie the Cuyahoga Group. In Wayne County, the eroded Mississippian surface has a local relief of more than 250 feet (Multer, 1967). Coarser sediments of the Sharon Member of the Pottsville are limited to the eastern part of Wayne County, where they were laid down in the deeper valleys of the eroded Mississippian surface. Traced toward central Ohio, the Sharon Member becomes progressively thinner or pinches out entirely; the Connoquenessing Sandstone Member and the Mercer Member become the basal units of the Pottsville Formation in central Ohio.



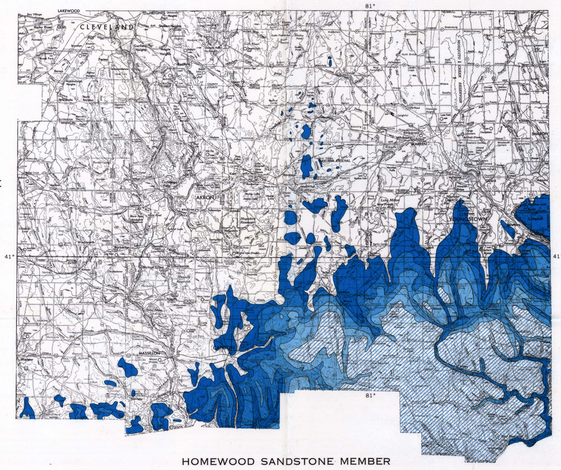
PHYSIOGRAPHIC MAP SHOWING MAJOR DRAINAGE BASINS AND AVERAGE DISCHARGE OF PRINCIPAL RIVERS



SHARON MEMBER



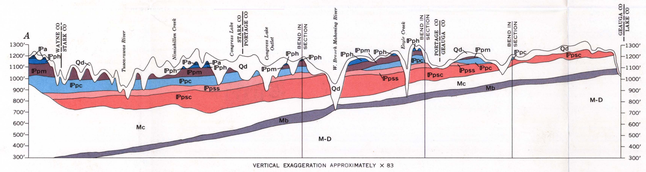
CONNOQUENESSING SANDSTONE MEMBER



HOMEWOOD SANDSTONE MEMBER

EXPLANATION
Approximate depth to top of aquifer below land surface, in feet
Less than 50
50 to 100
100 to 150
150 to 200
More than 200
Aquifers not present

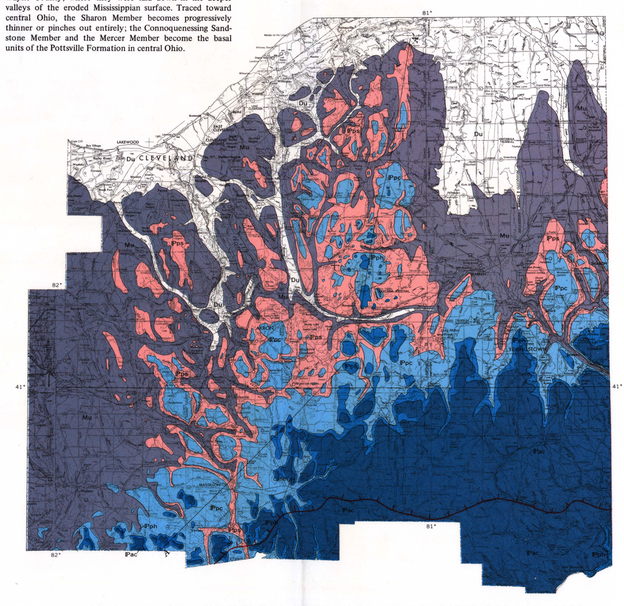
MAPS SHOWING APPROXIMATE DEPTH OF THE POTTSVILLE AQUIFERS



GENERALIZED GEOLOGIC SECTION

EXPLANATION

Qd	Glacial deposits	QUATERNARY
Pa	Allegheny Formation	PENNSYLVANIAN
Pph	Homewood Sandstone Member	
Ppm	Mercer Member	
Ppc	Connoquenessing Sandstone Member	
Ppss	Sharon Member, shale unit	
Pssc	Sharon Member, conglomeratic unit	
Mc	Cuyahoga Group	MISSISSIPPIAN
Mb	Berea Sandstone	
M-D	Pre-Berea rocks undifferentiated	MISSISSIPPIAN AND DEVONIAN



MAP SHOWING AREAL DISTRIBUTION OF PRINCIPAL CONSOLIDATED-ROCK AQUIFERS

EXPLANATION

Pc — Allegheny and Conemaugh Formations, undifferentiated
Variable sequences of shale, sandstone, underclay, coal and thin limestone. Yields to wells are generally meager, although, locally, the sandstones are important for domestic supplies

Pph — Homewood Sandstone Member
Locally important for domestic supplies. Lateral graduation to shale limits yields to wells. Most of outcrop area shown is covered with glacial drift

Ppc — Connoquenessing Sandstone Member
Important source for domestic and municipal supplies over a wide area. Outcrop area shown includes remnants of overlying Mercer Member. Most of area is covered with glacial drift

Ppss — Sharon Member
Conglomerate unit, although patchy in distribution, is among the best bedrock source of water in the region. Outcrop area shown is covered with glacial drift

Pottsville Formation — PENNSYLVANIAN

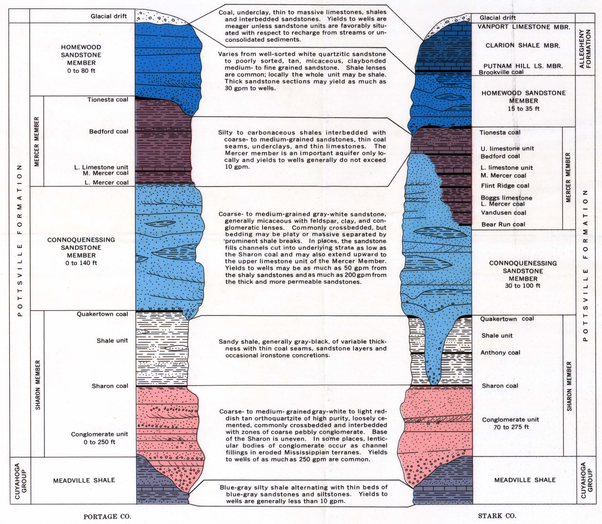
Mu — Mississippian rocks, undifferentiated
Outcrop area covered with glacial drift. Bedrock aquifers in most of area are sandstone and shaly sandstones of the Cuyahoga Group. Berea and Cussewago Sandstones are important aquifers in the northern third of the area

Du — Devonian rocks, undifferentiated
Mostly shales having little water. Small yields available in weathered or fractured sections that are overlain by glacial gravels and sands

Contact
Limit of glaciation

Geology modified after Rau, J. L., 1969; Rau, J. L., 1970; Winslow, A. G. and White, G. W., 1966; Smith, R. C. and White, G. W., 1953; Delong, R. M., and White, G. W., 1963; and Multer, H. G., 1967

SCALE 1:500 000
10 0 10 20 30 MILES
10 0 10 20 30 KILOMETERS
DATUM IS MEAN SEA LEVEL



REPRESENTATIVE GENERALIZED SECTIONS

Base from U.S. Geological Survey, 1:250,000;
Canton, Cleveland, and Marion, 1950, and Toledo, 1956

HYDROGEOLOGY OF THE POTTSVILLE FORMATION IN NORTHEASTERN OHIO

By
Alan C. Sedam

1973

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For sale by U.S. Geological Survey, price $1.75 per set