University of Wisconsin-Extension

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A SUMMARY OF GEOLOGY AND MINERAL AND WATER RESOURCES OF ROCK COUNTY

by

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A Summary of Geology and Mineral and Water Resources of Rock County

by Perry G. Olcott

Physiography

Rock County is nearly equally divided between the Eastern Ridges and Lowlands Province and the Western Upland Province (fig. 1) as described by Martin (1916). The Western Upland Province is characterized by deep valleys and high ridges formed in bedrock with a thin soil or glacial drift veneer. The Eastern Ridges and Lowland Province is characterized by low relief and gentle slopes with thick glacial dirft cover over bedrock.

Prominent topographic features in Rock County are the flat outwash plains extending southeasterly across the north central part of the county and southward along the Rock River and the hilly morainal area in the northern part of the county.

Geology

Rock County is underlain by a thick section of sedimentary rocks of Cambrian and Ordovician age that consist largely of sandstone, a lesser amount of dolomite (a magnesium-rich limestone), and some shale. Overlying the sedimentary rocks are glacial deposits and alluvium consisting predominantly of till and outwash. The geologic map of Wisconsin (fig. 2)

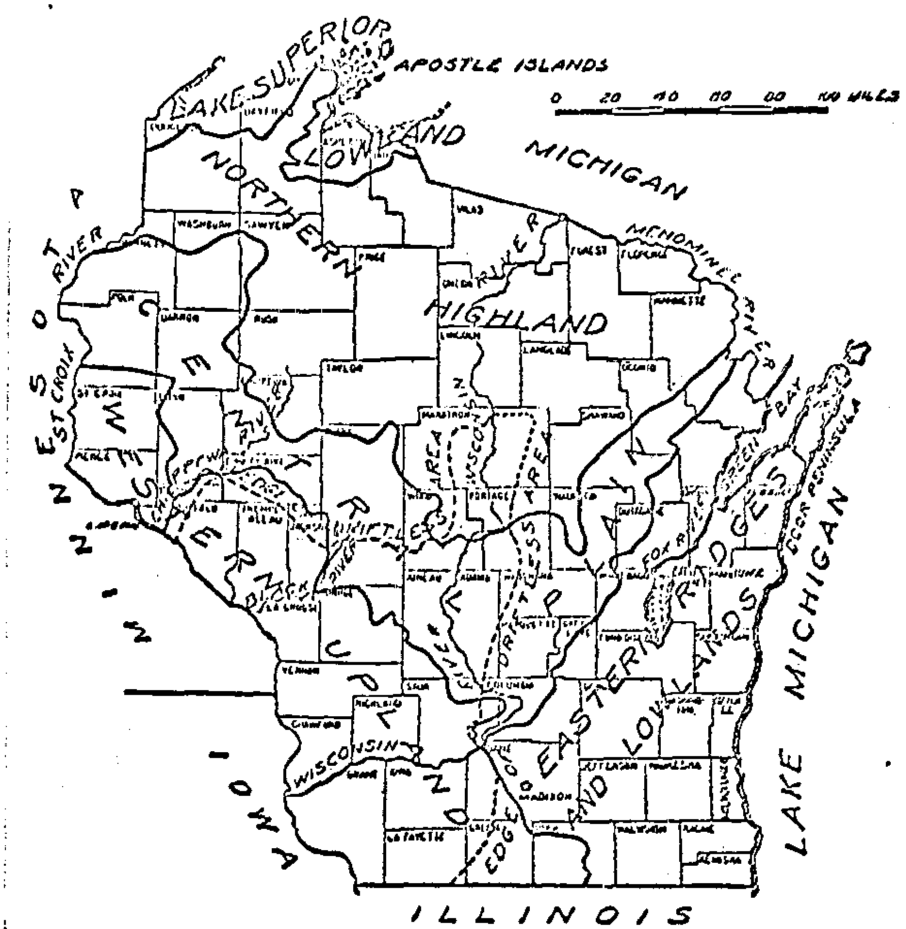


Figure 1. Physiographic provinces of Wisconsin. (After Martin, 1916)

shows the bedrock geology of Rock County and its relationship to the geology of Wisconsin. Similarly, the map of Wisconsin glacial deposits (fig. 3) outlines the glacial geology of the county and its relationship to surrounding areas. Table 1 is a summary of the lithology, maximum thickness, and water-bearing characteristics of the geologic units of Rock County.

Sandstones of late Cambrian age overlie crystalline rocks of Precambrian age throughout the county. Both the crystalline rock surface and the sedimentary rocks dip southeastward and the rocks of Cambrian age thicken in the direction of dip from about 950 feet in the northwestern corner to over 1300 feet in the southeastern corner of the county.

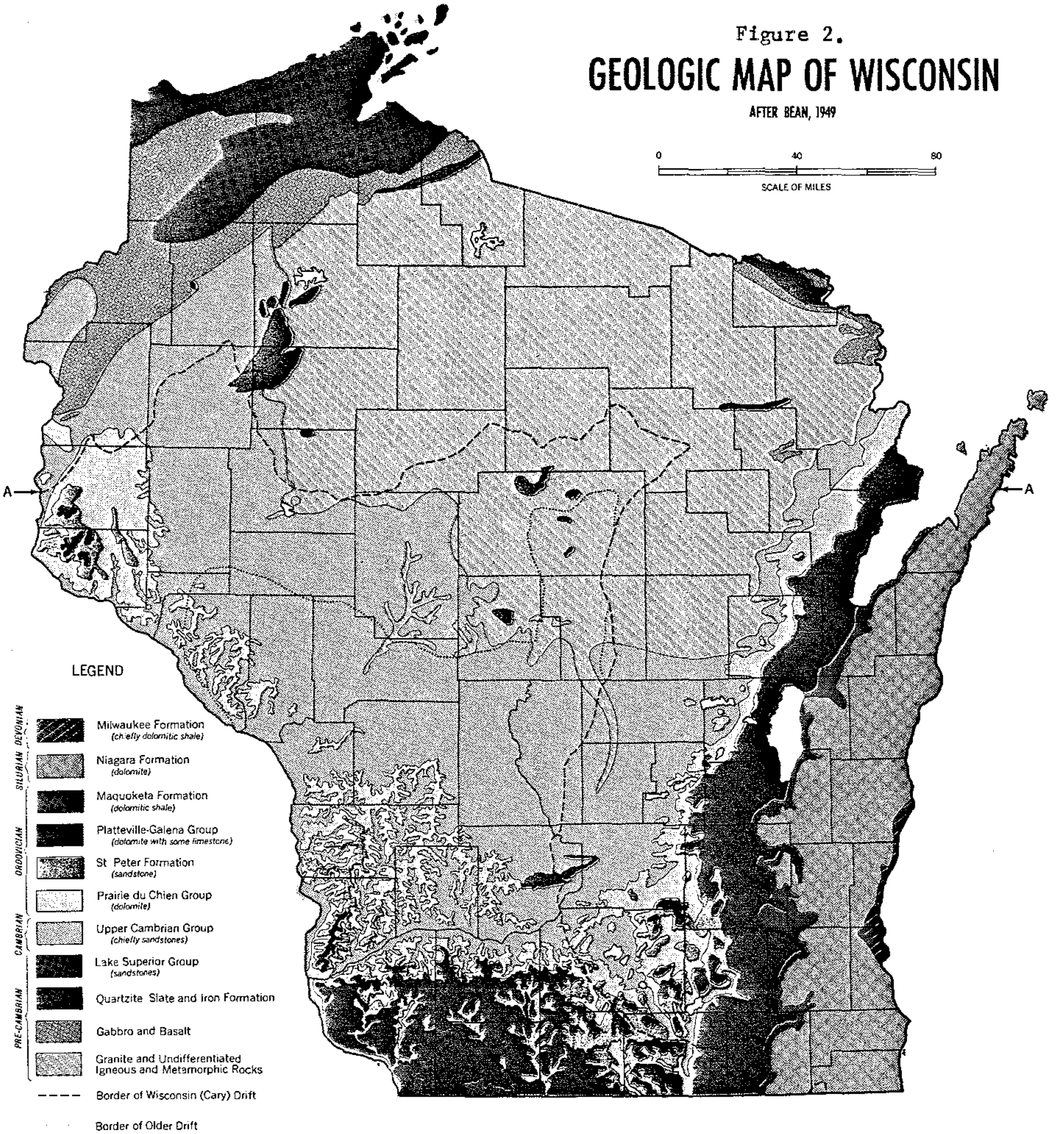
Rock formations of Cambrian age are, in ascending order, the Mt. Simon Sandstone, Eau Claire Sandstone, Galesville Sandstone, Franconia Sandstone, and Trempealeau Formation. In the Rock River and Sugar River valleys these rocks of Cambrian age underlie unconsolidated glacial deposits. Elsewhere they are overlain by rocks of Ordovician age.

Rock formations of Ordovician age include in ascending order the Prairie du Chien Group (dolomite), the St. Peter Sandstone, and the Platteville-Galena unit (dolomite). The Prairie du Chien Group and St. Peter Sandstone are exposed at the bedrock surface in the major river valleys and in much of the western part of the county. Bedrock east of the Rock River valley and ridge tops west of the valley are formed by the Platteville-Galena unit. The Prairie du Chien Group was greatly thinned by erosion before deposition of the St. Peter Sandstone. Because it was laid down on this uneven erosion surface, the St. Peter varies considerably

Figure 2.

GEOLOGIC MAP OF WISCONSIN

AFTER BEAN, 1949



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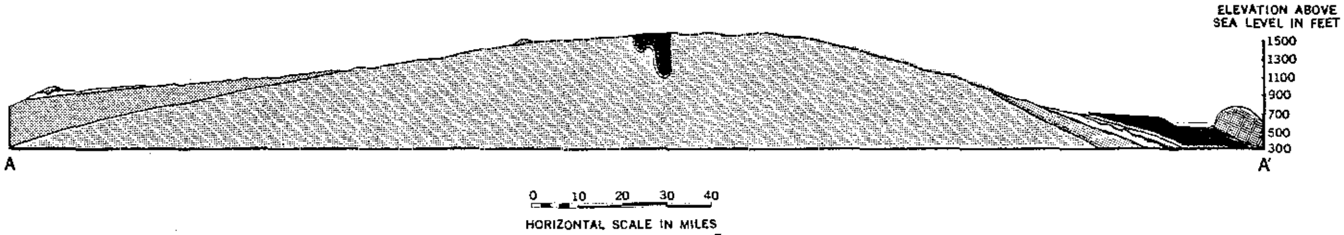


SHORT GEOLOGIC HISTORY OF WISCONSIN

The bedrock of Wisconsin is separated into two major divisions: (1) older, predominantly crystalline rocks of the Precambrian Era, which were extensively deformed after their deposition by movements of the Earth's crust; and (2) younger flat-lying sedimentary rocks of the Paleozoic.

The Precambrian Era lasted from the time the earth cooled, over 4,000 million years ago, until the Paleozoic Era which began about 500 million years ago. During this vast period of 3,500 million years sediments, some of which were rich in iron and which now form our iron ores, were deposited in ancient oceans, volcanoes spewed forth ash and lava, mountains were built and destroyed, and the rocks of the upper crust were invaded by molten rocks of deep-seated origin. Only a fragmentary record of these events remains but, as tree stumps attest the former presence of forests, the rocky roots tell the geologist of the former presence of mountains.

At the close of the Precambrian Era most of Wisconsin had been eroded to a rather flat plain upon which stood hills of more resistant rocks as those now exposed in the Baraboo bluffs. There were still outpourings of basaltic lava in the north and a trough formed in the vicinity of Lake Superior in which great thicknesses of sandstone were deposited.

The Paleozoic Era began with the Cambrian Period, the rocks of which indicate that Wisconsin was twice submerged beneath the sea. Rivers draining the land carried sediments which were deposited in the sea to form sandstones and shales. Animals and plants living in the sea deposited calcium carbonate and built reefs to form rocks which are now dolomite—a magnesium-rich limestone. These same processes continued into the Ordovician Period during which, as indicated by the rocks, Wisconsin was submerged three more times. Deposits built up in the sea when the land was submerged were partially or completely eroded at times when they were subsequently elevated above sea level. During the close of the Ordovician Period, and in the succeeding Silurian and Devonian periods, Wisconsin is believed to have remained submerged.

There are no rocks outcropping in Wisconsin that are younger than Devonian. Absence of this part of the rock record makes interpretation of post-Devonian geologic history in Wisconsin a matter of conjecture. Available evidence from neighboring areas, where younger rocks are present, indicates that towards the close of the Paleozoic Era, perhaps some 250 million years ago, a period of gentle uplift began which has continued to the present. During this time the land surface was carved by rain, wind and running water.

The final scene took place during the last million years when glaciers invaded Wisconsin from the north and sculptured the land surface. They smoothed the hill tops, filled the valleys and left a deposit of glacial debris over all except the southwest quarter of the State where we may now still see the land as it might have looked a million years ago.

Prepared by U. of W. Geological and Natural History Survey, 1963.

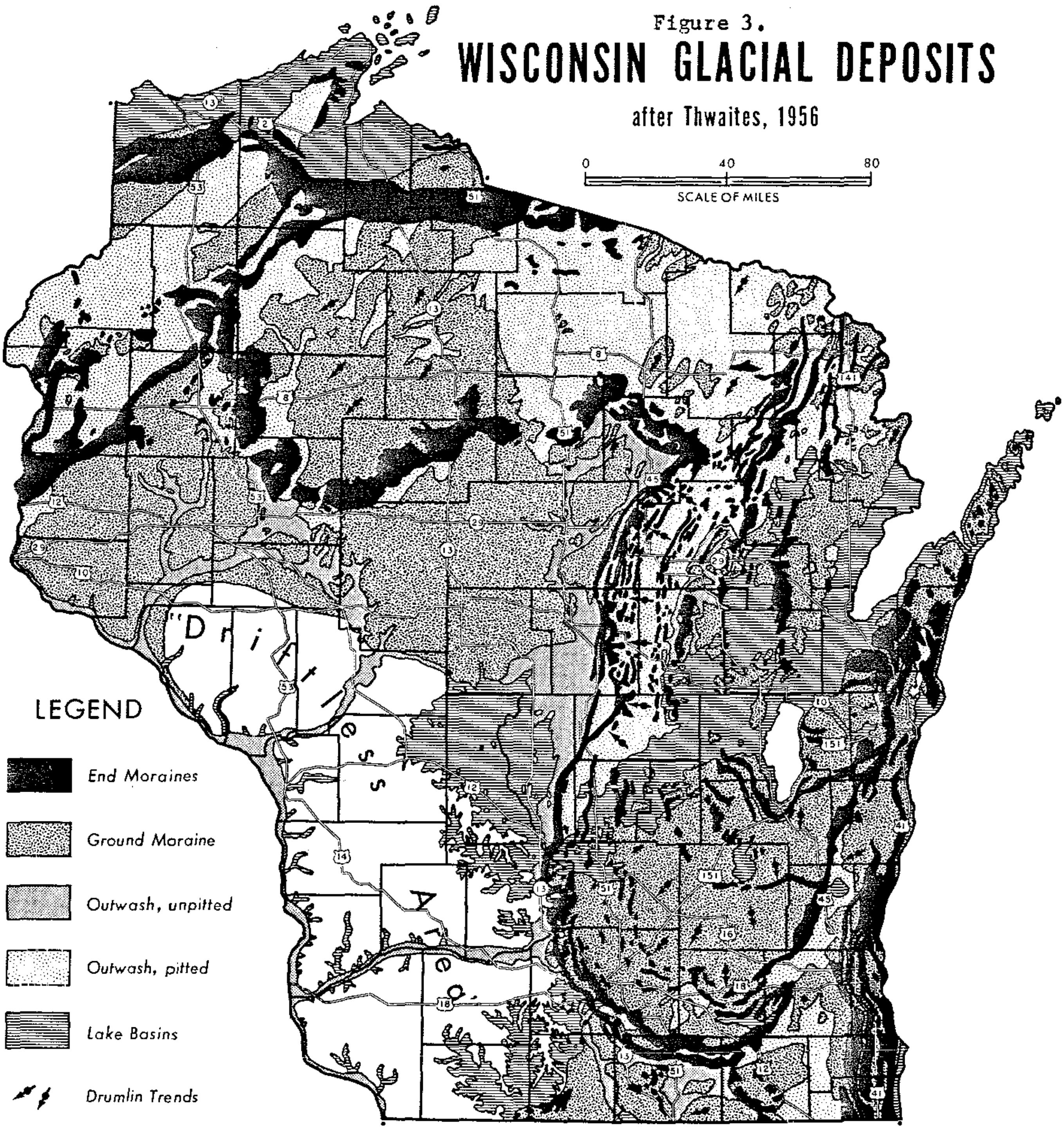
Table 1. Lithologic and water-bearing characteristics of geologic units in Rock County. (After LeRoux, 1963)

System	Geologic unit	Maximum thickness (ft)	Description	Water-bearing characteristics
Quaternary	Recent alluvium		Silt, sand, peat, and marl.	Not determined. Probably too thin to yield significant quantities of water to wells.
	—— Unconformity ——			
	Pleistocene deposits	382	Till and outwash, gray to brown; consists of clay, silt, sand, gravel, and boulders.	Outwash sand and gravel in the Rock River valley yields large amounts of water. Other bodies of sand and gravel yield moderate amounts of water to properly developed wells.
	—— Unconformity ——			
Ordovician	Platteville, Decorah, and Galena formations, undifferentiated.	288	Dolomite, light-gray to blue-gray, yellowish-gray, sandy, fractured at top, fine- to medium-grained sandstone at base; and green shale.	Yield sufficient water for domestic and stock use from fractures and solution openings. Principal source of supply for wells east of the buried Rock River valley.
	St. Peter sandstone.	185	Sandstone, yellowish-gray to white, fine- to medium-grained; white chert and chert conglomerate; and red shale.	Yields sufficient water for domestic, stock, and small industrial supplies. Principal source of ground water west of the buried Rock River valley. Usually left uncased to contribute water to wells tapping rocks of Cambrian age.
	—— Unconformity ——			
	Prairie du Chien group.	60	Dolomite, yellowish-brown to gray; and white and gray chert.	Not determined.
Cambrian	Trempealeau formation Franconia sandstone Galesville sandstone } Dresbach group Eau Claire sandstone } Dresbach group Mount Simon sandstone } Dresbach group	960	Sandstone, white, gray, red, fine- to very coarse-grained, dolomitic; siltstone, shale; and dolomite.	Yield large amounts of water to deep wells throughout the county. Lower part usually more permeable.
	—— Unconformity ——			
Precambrian	Crystalline rocks	?	Not penetrated by wells in Rock County.	Not determined. May yield some water from possible weathered and creviced zone.

Figure 3.

WISCONSIN GLACIAL DEPOSITS

after Thwaites, 1956



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SHORT HISTORY OF THE ICE AGE IN WISCONSIN

The Pleistocene Epoch or "Ice Age" began about 1,000,000 years ago which, in terms of geologic time, is a very short time ago. There were four separate glacial advances in the Pleistocene each followed by an inter-glacial period when the ice receded. The fourth glacial stage is called the Wisconsin Stage because it was in this State that it was first studied in detail.

The glaciers were formed by the continuous accumulation of snow. The snow turned into ice which reached a maximum thickness of almost two miles. The ice sheet spread over Canada and part of it flowed in a general southerly direction toward Wisconsin and neighboring states.

The front of the advancing ice sheet had many tongues or "lobes" whose direction and rate of movement were controlled by the topography of the land surface over which they flowed and by the rates of ice accumulation in the different areas from which they were fed.

The ice sheet transported a great amount of rock debris called "drift". Some of this was deposited under the ice to form "ground moraine" and some was piled up at the margins of the ice lobes to form "end moraines". "Drumlins" are elongated mounds of drift which were molded by the ice passing over them and hence indicate the direction of ice movement.

The pattern of end moraines, in red, shows the position that was occupied by four major ice lobes. One lobe advanced down the basin of Lake Michigan, another down Green Bay, a third down Lake Superior and over the northern peninsula of Michigan and yet a fourth entered the state from the northwest corner. The well-known "Kettle Moraine" was formed between the Lake Michigan and Green Bay lobes. As the ice melted the drift was reworked by the running water. Large amounts of sand and gravel were deposited to form "outwash plains"; pits were formed in the outwash where buried blocks of ice melted and many of these are now occupied by lakes.

The action of the ice profoundly modified the landscape, smoothing off the crests of hills and filling the valleys with drift. In some places it changed the course of rivers forcing them to cut new channels such as that of the Wisconsin River at the Dells; elsewhere it dammed the valleys to create lakes such as those of the Madison area.

During recent years there have been intensive studies made of the polar ice caps, and methods have been developed for dating glacial events from the radioactivity of the carbon in wood, bones, etc. which are found in many of the deposits. The results of these studies are causing many previously accepted concepts to be changed or challenged.

We once thought that there were rather extensive glacial deposits older than Wisconsin age in the State, but age determinations do not support this. It was also thought that the ice left Wisconsin some 20,000 years ago but a forest at Two Creeks in Manitowoc County was buried under an advancing ice tongue only 11,000 years ago. Evidence is accumulating to indicate that ice may have occupied the so-called "Driftless Area" of the southwestern part of the State which hitherto has been held to be unglaciated.

Most scientists now believe that the cause of the Pleistocene "Ice Age" was due to variations in the solar energy reaching the earth, but how these may have occurred is still a matter of conjecture. We are still in the Ice Age and it is anybody's guess whether future millenia will see the melting of the ice caps and the slow drowning of our coastal cities, or the regrowth and once more the inexorable advance of the glaciers.

Prepared by the University of Wisconsin Geological & Natural History Survey, August 1964

in thickness. The Prairie du Chien is thin at Edgerton, Janesville, Brodhead, Footville and Milton. Elsewhere it is absent and the St. Peter Sandstone rests directly on sandstones of Cambrian age.

Unconsolidated glacial deposits overlie bedrock throughout the county (fig. 3) and represent at least two stages of glaciation. Approximately the northern one third of the county is covered by terminal and recessional moraines of the Wisconsinan Stage of glaciation. Extensive outwash deposits associated with this terminal moraine extend southeasterly across the county south of the moraine and southward along the Rock River valley. The remainder of the county is covered largely by ground moraine of an earlier episode of Wisconsinan Stage glaciation.

The terminal and recessional moraines in the northern part of the county consist largely of unsorted and unstratified clay, silt, sand, gravel, and boulders and the deposit is relatively thick. The older ground moraine is of a similar composition but generally is thin, highly weathered, and somewhat eroded. Outwash consists largely of silt, sand, and sand and gravel with some cobbles and boulders and is well sorted and stratified. Outwash deposits in the Rock River valley, which is underlain by a deep preglacial valley cut in the bedrock surface, have a reported thickness over 300 feet.

Mineral Resources

The principal mineral production from Rock County includes only sand and gravel and crushed and broken limestone (Olson, 1966). Reported production of sand and gravel, representing 86 percent of the county mineral value and a 49 percent increase over the previous year, was 2.4 million tons in 1966. Fifty-six percent of this sand and gravel was used for building, 25 percent for road construction, and 19 percent for railroad ballast, molding sand, and fill. The principal production came from deposits of glacial outwash near Janesville, Edgerton, Beloit, and Shopiere and from the St. Peter Sandstone near Hanover.

Crushed and broken limestone production in the county was about 406,000 tons in 1966. The stone was used for concrete aggregate, road construction, aglime, and riprap. Principal production was from quarries in the Platteville Formation and Galena Dolomite located near Footville, Beloit, Milton, Clinton, Janesville, Evansville, and Allens Grove.

Rock County has large reserves of sand and gravel from the extensive outwash deposits (fig. 3) in the county. Large reserves of limestone are available from ridge tops located west of the Rock River and from about the eastern one third of the county where overburden is thin (fig. 2).

Surface Water

Rock County is partly in the Rock River basin and partly in the Sugar River and Coon Creek basins. The Rock River flows southward through the central part of the county with a gradient of about 1.4 feet per mile. The northwestern part of the county is drained by the Yahara River which flows southeastward to join the Rock about four miles south of Edgerton. The Rock is joined by Marsh Creek north of Janesville which flows generally eastward. The western and southwestern parts of the county are drained by the Sugar River and Coon Creek which flow southeasterly into Illinois to join the Pecatonica River which in turn empties into the Rock.

Turtle Creek drains the southeastern part of the county flowing westward and southward to join the Rock just south of the Illinois border. The upper part of Turtle Creek and the Rock and Sugar rivers are all discharge areas for ground water which makes up a considerable part of their flow. The lower part of Turtle Creek loses water to the ground water body as it enters the flat outwash deposits in the Rock River valley.

Three U. S. Geological Survey stream gaging stations are located in Rock County on the Rock River at Afton, Turtle Creek near Clinton and the Sugar River near Brodhead. Table 2 summarizes data from the gaging stations.

Table 2 Stream Gaging Stations in Rock County

	Period of record	Area of drainage basin	Average discharge	Maximum flow	Minimum flow
Rock River at Afton	1914-66	3,300 sq.mi.	1,715 cfs	13,000 cfs	22 cfs
Turtle Creek near Clinton	1939-66	186 sq.mi.	103 cfs	6,560 cfs	8 cfs
Sugar River near Brodhead	1914-66	527 sq.mi.	335 cfs	14,800 cfs	35 cfs

Industrial cooling and recreation on the lakes and streams are probably the principal uses of surface water in Rock County. Surface water is not used for municipal or industrial supply except for cooling.

Chemical quality of streams in Rock County generally is adequate for most uses and reflects the chemical quality of ground water which makes up much of the stream flow. Selected chemical analyses are shown in Table 3. Chemical quality of streams will vary with discharge; greatest mineralization will occur during low flow conditions when stream flow is largely ground water discharge and mineralization will be least with high flow conditions when much of the streamflow is from surface runoff. Analyses in Table 3 all reflect low flow conditions.

Table 3 Selected Chemical Analyses of Streams in Rock County

(all values except pH and flow in parts per million; analyses by U. S. Geological Survey)

	Rock River at Afton	Turtle Creek near Clinton	Marsh Creek near Janesville	Yahara River near Fulton
Silica (SiO_2)	10	9.5	15	14
Iron (Fe)	.16	.13	.2	.17
Manganese (Mn)	.0	.05	.0	.02
Calcium (Ca)	56	71	99	56
Magnesium (Mg)	38	39	39	29
Sodium (Na)	27	10	3.0	24
Potassium (K)	3.3	1.5	.9	3.8
Bicarbonate (HCO_3)	316	341	301	264
Sulfate (SO_4)	39	43	128	36
Chloride (Cl)	37	20	7.0	34
Fluoride (F)	.6	.4	.2	.4
Nitrate (NO_3)	.2	13	4.9	8.6
Phosphorus as PO_4	---	---	.02	3.5
Dissolved Solids	376	368	461	348
Hardness as $CaCO_3$	296	338	408	259
Noncarbonate	36	58	157	42
pH	7.1	7.9	8.2	7.8
Estimated flow, cfs	452	38	38	---
Date	Oct 27, 1966	Oct 27, 1966	Nov 13, 1967	Nov.15, 1967

Hydrogeology

Ground water availability depends chiefly on the character and thickness of water-bearing rocks. Although bedrock formations are of moderate permeability in Rock County, high capacity wells can be easily developed because of the great saturated thickness of rocks of Cambrian and Ordovician age. Wells penetrating the sandstones of Cambrian age and the St. Peter Sandstone generally will yield up to 1000 gpm (gallons per minute) or more in most areas of the county.

The best water yielding units of the bedrock formations appear to be the Mt. Simon Sandstone, Galesville Sandstone, and the St. Peter Sandstone. The Franconia Sandstone, Eau Claire Sandstone, and Trempealeau Formation yield moderate to small amounts of water to wells penetrating the more productive units. The Platteville-Galena unit generally yields only small quantities of water to wells but it is important as an aquifer for domestic wells particularly east of the Rock River. The St. Peter Sandstone is an important source of water for domestic wells west of the Rock River valley. The Prairie du Chien Group is not considered an aquifer in Rock County. Water-bearing characteristics of geologic units are outlined in Table 1.

Thick and highly permeable outwash deposits consisting of generally well sorted and stratified sand and sand and gravel fill a preglacial bedrock valley system to a depth of more than 300 feet in its deepest part and up to two miles in width. This valley system generally underlies the present Rock River and its tributaries. Yields of more than 5000 gpm with only seven feet of drawdown have been obtained from wells penetrating

Municipal pumpage in the Rock River basin for 1957 and 1966 are summarized in Table 4. Figures for total pumpage in the basin are not available. The totals in Table 4 show pumpage has increased about 37 percent in the Rock River basin in the nine years between 1957 and 1966. Pumpage in the county for uses other than municipal supply undoubtedly has also increased during the 1957-66 period but probably not as much as municipal pumpage. Present water use represents only a small part of the water that can be withdrawn perennially from the ground water reservoir (LeRoux, 1963).

Quality of Ground Water

Ground water in Rock County is generally a hard calcium magnesium bicarbonate type which is slightly alkaline. Although differences occur, water from the several water bearing units in the county are similar in chemical quality. Iron in the water is excessive in places, but generally it is not a problem.

A summary of chemical constituents in ground waters of the county is shown in Table 5.

Table 5 Summary of chemical constituents of ground water in Rock County, Wis.

(In parts per million, except pH)

	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Hardness as $CaCO_3$	pH
Average	12	0.6	60	34	6.9	343	14	6.4	310	317	7.5
Maximum	18	5.4	73	40	15	460	52	17	422	386	7.8
Median	9.8	.2	60	34	6.3	345	9.4	6.0	304	310	7.4
Minimum	8.4	.0	49	26	.0	277	.0	1.2	230	260	7.2
Number of analyses	10	33	30	30	30	44	44	44	42	37	27

Summary

Rock County is nearly equally divided between the Western Upland and Eastern Ridges and Lowland Provinces as defined by Martin (1916). Prominent topographic features are the Rock River valley and associated flat lying plains and a hilly area in the northern part of the county.

A thick section of sedimentary rocks of Cambrian and Ordovician age, predominantly sandstones, underlie extensive Pleistocene outwash plains, older ground moraine, and terminal and recessional moraines. Sedimentary rocks range from about 950 feet to 1300 feet in thickness. Glacial drift thickness is over 300 feet in the Rock River valley.

Mineral resources of the county include sand and gravel and crushed and broken limestone. Production of sand and gravel and limestone in 1966 was 2.4 million tons and 406,000 tons, respectively. Extensive reserves remain in the county.

Rock County is drained by the Rock River and its tributaries and the Sugar River and Coon Creek. Three U. S. Geological Survey gaging stations in the county show an average (for period of record) discharge of 1,715 cfs (cubic feet per second) for the Rock River at Afton; 103 cfs for Turtle Creek near Clinton; and 335 cfs for the Sugar River near Brodhead. Chemical quality of streams generally is adequate for most uses and reflects the quality of ground water. For the most part there is no withdrawal use of surface water in the county.

Extremely large quantities of ground water can be obtained from thick outwash deposits in the Rock River valley in Rock County. Yields in excess

of 5,000 gpm with little drawdown can be expected from properly constructed wells in the deepest part of the buried valley. Yields of 1000 gpm or more can be obtained from sandstones of Cambrian and Ordovician age throughout most of the county. Adequate supplies of ground water for domestic and stock use also are available from the Platteville-Galena unit, the St. Peter Sandstone, or sand and gravel layers in unconsolidated Pleistocene deposits.

About 23 mgd was pumped from wells in 1957 in the county and 90 percent of this water was withdrawn in the Rock River basin. This pumpage represents only a small part of the water that can be withdrawn perennially from the ground water reservoir. Average municipal pumpage in the Rock River basin increased about 37 percent between 1957 and 1966 from 11.34 mgd to 15.57 mgd.

Ground water in the county generally is a hard calcium magnesium bicarbonate type that is slightly alkaline and is adequate for most uses.

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