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Geology Along the Illinois Waterway—A Basis for Environmental Planning

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CONTENTS

TABLES

ILLUSTRATIONS

PLATES
(in attached pocket)

Surficial Geology of the Area Bordering the Illinois Waterway

GEOLOGY ALONG THE ILLINOIS WATERWAY–A BASIS FOR ENVIRONMENTAL PLANNING

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ABSTRACT

The Illinois Waterway, which follows the Chicago, Des Plaines, and Illinois Rivers and connects Lake Michigan with the Mississippi River near St. Louis, is one of the busiest of the Inland Waterways. An intensive commercial development has extended down the Waterway area from Chicago to La Salle, and a large industrial area has also developed around Peoria. The seven surficial geology maps with this report show the distribution of the earth materials that are exposed or that occur at a shallow depth in the valley floor bordering the Waterway and in the uplands for about a mile back from the valley bluffs. The materials mapped include the bedrock formations—limestone, dolomite, sandstone, and shale of the Ordovician, Silurian, Devonian, and Mississippian Systems and several types of rocks, including coal, of the Pennsylvanian System. The unconsolidated rocks mapped include glacial till; glacial outwash deposits of gravel, sand, silt, and clay; mixed silt, clay, sand, and pebbles of river and stream alluvium, slopewash, and alluvial fans; silt, clay, and sand of lake sediments; sand in dunes; and peat and muck deposits of swamps. Wind-blown silt (loess) is shown on small inset maps. The geologic relations of the map units, the character, properties, and uses of the units, the geologic development of the area, and sources of additional information are summarized in the text. The geologic data are basic for environmental planning, for engineering projects, for the selection of industrial, residential, and recreational areas, and for the development of the mineral resources.

INTRODUCTION

The Illinois Waterway connects Lake Michigan at Chicago with the Mississippi River Waterway near St. Louis. In the nearly 40 years it has been open, use of the Waterway has grown to the point where enlargement of its capacity has been planned. At a time when the areas bordering the Waterway anticipate a growing population, an expanding industry, and improved supervision of the environment, knowledge of the earth materials that directly underlie the ground surface is a basic part of the perspective needed to solve present problems and to plan effectively for the future. The surficial geology maps that accompany this report summarize studies of the geology of the region that extend over many years.

The Waterway area contains many kinds of earth materials, and the continuing economic development of the area must be concerned with their properties, variations, and availability. For more than 100 years the geological formations have supplied the raw materials for a large mineral industry. The properties of the rocks are of vital concern in engineering geology problems — evaluating building sites and excavations for many purposes and determining use of the land surface. Furthermore, the surficial earth materials are in a dynamic environment. In varying degrees they are undergoing changes produced by gravity, rainfall, winds, streams and rivers, freezing and thawing, ground water, growth of vegetation, and the activities of animals, particularly man.

The upper Illinois Valley has been an area of intensive industrial development for many years. For example, from a single viewpoint at the east end of Buffalo Rock, west of Ottawa, one can see transportation facilities by waterway, railroads, highways, and air; coal strip mines; shale and clay pits that have produced raw materials for brick, tile, and refractories; pits from which silica sand is produced for glass making, abrasives, molding sand, and many other uses; and pits producing sand and gravel for concrete aggregate, road metal, and other uses. Large power lines and coal and oil barges on the Waterway can be seen bringing energy from distant areas. The long-abandoned Illinois and Michigan Canal along the bluff north of Buffalo Rock, opened in 1848 after years of construction through the wilderness, is a reminder of changes brought about in only 125 years.

GEOLOGY IN PLANNING LAND USE

The planned enlargement of the Illinois Waterway and the anticipated decline in pollution of the river will improve the Waterway area for commercial, residential, and recreational uses. Perhaps the intensive development of the part of the Illinois Valley above La Salle foretells the future of other parts.

In the upper part of the valley, some mineral deposits have been exhausted, others are nearing the end of their productiveness, and many others have been covered by buildings or removed from potential development by proximity to residential areas. Some of the more obvious resources in these areas are now largely held by operating industries.

In the areas along the Waterway that are still undeveloped, long-range planning is needed to assure efficient land use. Some areas with mineral resources that at present cannot be economically developed will be needed in the future, and unless they are preserved from industrial and residential construction, it will eventually be necessary to transport materials from distant areas at much greater expense.

The mining of surficial rocks for building materials, coal, or other materials needs be only a temporary stage in the efficient use of land. After excavation of these materials, the land can have many uses — it can be restored to agriculture, used for recreational areas, or used for building sites. Some excavations may be used for waste disposal before being converted to other uses.

Whether land is used as a source of minerals, as a site for residential or industrial construction, for agriculture, for recreational areas, or for underground storage, pipelines, or tunnels, the properties of the earth materials that underlie the surface are a primary consideration. The properties that must be evaluated include surface stability, load-bearing capacity, and ease of excavation. The disposition of excavated materials and the possibility of pollution of land, air, and water are important considerations. Drainage properties, the effects of draining on existing water bodies, and the possibilities of pollution of useful aquifers are significant factors in most land uses. These properties vary greatly with the nature and location of the surficial rocks, which are shown on plates 1-7.

This report is intended to assist the user in interpreting the geologic features shown on the accompanying maps and to give supplementary information that could not be included on the maps. It is based largely on field studies supervised by J. E. Lamar in 1929 and 1930 — below Peoria by Towner B. Root (1935) and above Peoria by H. B. Willman (1931). The original mapping on 15-minute topographic quadrangle maps is on open file at the State Geological Survey. The maps have been extensively revised. Mr. Lamar and others of the Survey staff provided helpful suggestions in the preparation of the report.

THE ILLINOIS WATERWAY

The Illinois Waterway extends for 327 miles from Lake Michigan at Chicago to the Mississippi River at Grafton, Illinois, which is just 20 miles above the mouth of the Missouri River at St. Louis, Missouri. On leaving Lake Michigan, the Waterway follows the south branch of the Chicago River, but in a few miles it crosses a low divide and enters a channel excavated entirely in bedrock in the floor of the Des Plaines Valley. This is the Chicago Sanitary and Ship Canal, which extends to a dam at Lockport. A branch, the Calumet Sag Channel, extends from the Lake Calumet industrial district and Lake Michigan on the south side of Chicago to the main canal at Sag Bridge. From just below Lockport to the mouth of the Kankakee River, above the Dresden Island Dam, the Waterway is also the Des Plaines River. Below the mouth of the Kankakee River the Waterway is the Illinois River, except at Marseilles, where the Waterway bypasses a rapids in the river by a canal about two miles long.

The Illinois Waterway, which opened in 1933, provides a 9-foot minimum depth channel by means of seven dams and locks and intermittent dredging. Five of the dams maintain nearly contiguous pools in the 95 miles from Lake Michigan to Starved Rock. In this segment the water level drops about 135 feet—from 580 to 445 feet in elevation above sea level. However, it drops only 25 feet—from 445 to 420 feet in elevation—in the 230 miles from Starved Rock to the Mississippi River. This segment has only two dams, one at Peoria and one at La Grange 10 miles below Beardstown; however, the lower few miles of the Waterway is in the pool above the Alton Dam on the Mississippi River. The Illinois River below Starved Rock has one of the lowest gradients of major rivers, only 1.3 inches per mile. This results in part from its being largely a low-gradient segment of the Ancient Mississippi River and in part from the later damming of the Illinois River by the late Wisconsinan glacial outwash that aggraded the Mississippi Valley. Although it has a low gradient, the Illinois River does not meander, and the most direct course from its mouth to Starved Rock on the Illinois Valley bottomland is only 200 miles. As the airline distance is 185 miles and as the upper segment also has a comparably straight course to Lake Michigan, the Illinois Waterway provides exceptionally direct transportation from the Great Lakes to the Mississippi Valley and the Gulf of Mexico.

The Illinois Waterway is one of the busiest of the Inland Waterways. The traffic in 1969 totaled 31,896,334 tons (U.S. Army Corps of Engineers, 1970), an increase of 28 percent since 1960 and more than 6 times the volume handled in 1945. This is the traffic between Grafton and Lockport and does not include the port of Chicago. Movement of this freight in 1969 required nearly 4,000 towboat or tugboat trips and about 20,000 barge and tanker trips each way. Traffic up the Waterway carries more than twice the tonnage of the traffic down the Waterway.

The commodities shipped on the Waterway are roughly one-fourth each of farm products, coal, petroleum and petroleum products, and all others—largely nonmetallic minerals, chemicals, and metal products (Birdzell, 1967). The Corps of Engineers classified the 1969 traffic under 74 items. The items of more than 1,000,000 tons were as follows:

	Short tons	Percent
Coal	7,664,320	24.0
Corn	7,002,694	21.9
Sand, gravel, and crushed rock	2,360,360	7.4
Gasoline	1,937,397	6.1
Residual fuel oil	1,498,206	4.7
Soybeans	1,256,094	3.9
Basic chemicals and products	1,173,304	3.7
Distillate fuel oil	1,010,274	3.2

Other minerals and mineral products include:

Building cement	417,558	1.3
Lime	169,113	0.5
Building stone	73,257	0.2
Clay	2,705	
Structural clay products	244	

The crude and processed minerals account for just under half (47 percent) of the tonnage carried on the Waterway.

GEOLOGIC MAPS

The seven geologic maps accompanying this report (plates 1-7 in separate packet) show the extent of the various types of earth materials that are exposed or that directly underlie the land surface in the Illinois Valley bottomlands, the bluffs, and the uplands for approximately one mile back from the bluffs. The area mapped extends from Joliet to just south of Kampsville. The area from Joliet to Lake Michigan is omitted because it is already intensively developed, its surficial geology has been mapped in detail by Bretz (1943, 1955) and Fisher (1925), and the geology has been summarized recently by Willman (1971). The lower end of the Waterway also is not included in this study, because the geology has been mapped and described in detail by Rubey (1952) and the complex geology of that area, shown on color maps in that report, cannot be presented as effectively on the black and white maps used in this report.

The available 15-minute topographic quadrangle maps (scale approximately 1 inch equals 1 mile) and the 7 1/2-minute maps (scale approximately 2 5/8 inches equals 1 mile) are shown in figure 1. Aerial photographs of the area bordering the Waterway below the Big Bend at Depue are shown in a report by the Illinois State Division of Waterways (1969).

The Waterway area is divided into seven separately mapped districts (fig. 1), in which the geology is shown on a scale of approximately 1 inch equals 1 mile (plates 1-7). The geology is, in part, compiled, revised, and adapted to the needs of this report from maps previously published on the same scale, as indicated on the maps of each district, but all, except those for parts of the Havana and Beardstown Districts, are at present out of print. Maps of somewhat more than half of the Waterway area have not been published previously on this scale.

USE OF MAPS

The maps show the types of earth material that are exposed or that directly underlie the soil, as determined from examination of roadcuts, stream cutbanks, ditches, quarries, pits, and other excavations. Mapping the boundaries of units between such exposures is based largely on the fact that most units have a characteristic topography, but records of test borings and wells were also used and hand-auger holes were bored in some critical areas. In most places, the boundaries are as accurate as the scale of the map permits, but in some places they represent only the best estimate that can be made from surface observation and may be much less accurate. In evaluating potential economic resources and foundation sites and other engineering structures, test drilling or pitting and sample testing are required to confirm the positions of boundaries and variations in thickness, character, and quality.

The map units were chosen primarily to differentiate the various earth materials present, and the legends of the maps are arranged to relate units of similar character, regardless of geologic age. Because geological formations are differentiated on the basis of rock character, many of the map units are also formations; but some are subdivisions of formations, and others, where the formations are too thin to be mapped separately, are combinations of formations. Thirty-three units are differentiated on the maps by patterns and also by identifying letter symbols. Six other features are shown by symbols alone. To avoid local congestion, the capital Q for Quaternary System, commonly used on geologic maps as the initial letter of symbols for unconsolidated deposits, is omitted. In general, this omission also serves to separate the unconsolidated units from the bedrock units, where the initial capital of the symbol shows the system, or age, of the units. However, in crowded areas and in very small exposures, a single lower-case letter is used for bedrock units, as shown in the legends.

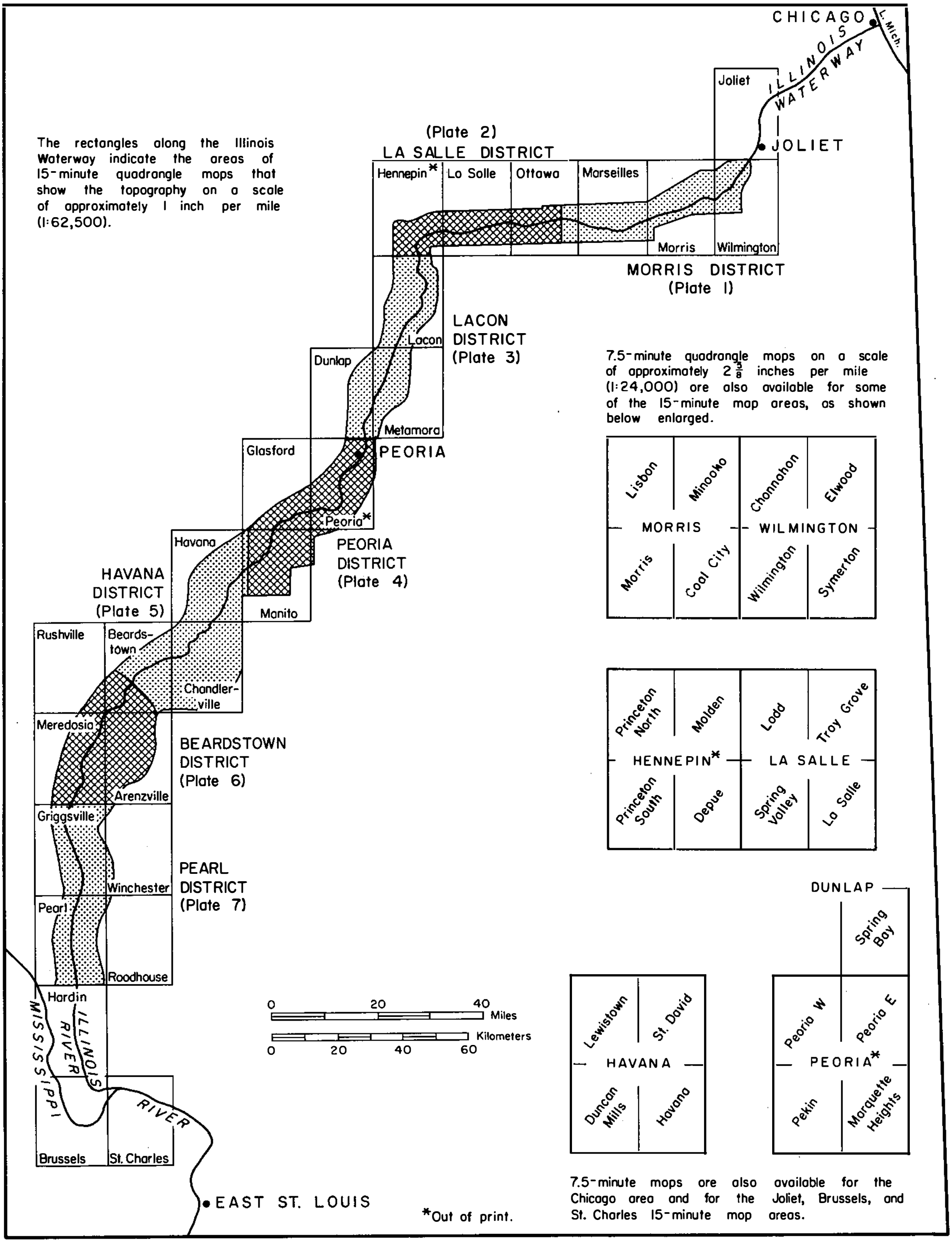


Fig. 1 - Index map showing the seven districts of the Illinois Waterway mapped on plates 1-7 and available quadrangle topographic maps.

The general arrangement of the legends by materials does not indicate the relationship between bordering units, because it does not show relative ages of the rock units. It does not show whether the units are laterally gradational into each other or whether one extends below the other. The age relations of the unconsolidated units are shown in figure 2 and those of the bedrock units in figure 3; these relations are described in a following section.

Some areas of bedrock have a thin and discontinuous cover of unconsolidated materials, generally sand and gravel, and are mapped as bedrock. Others, with an essentially continuous thin cover, are mapped separately. Because of the importance of indicating the presence of shallow bedrock, small bedrock exposures are of necessity generally mapped much larger than they actually are.

In the area below the Big Bend of the Illinois Valley at Hennepin, and particularly below Peoria, the bluffs and uplands have a cover of loess — wind-blown silt — that is thick enough to conceal the underlying rocks in most places. The loess is not mapped separately, but the general thickness is shown in inset maps with each district map. The loess thickness is highly varied in local detail. Except in the bluffs, the loess thickness is based on auger borings in relatively flat upland areas. Because of the rough topography on which the loess was deposited, the loess has been overthickened along many valleys by slumping and slopewash or entirely eroded by present streams. The bluff loess has been eroded in places where the Illinois River has flowed against the bluff.

The thickness indicated for a unit in the legends applies to the areas where the unit is overlain by the next younger formation and shows the typical thickness of the unit, or the general range for a unit that varies notably. It does not indicate the thickness exposed, which in many places may be only a few feet. For example, only a foot or two of limestone of the Galena Group is exposed in the small outcrops along Aux Sable Creek in the Morris District, but drilling at these exposures would encounter about 250 feet of the limestone and dolomite of the Galena and Platteville Groups. Within a district the thickness of some units, particularly the unconsolidated rocks, varies widely because of irregular deposition or erosion. When a range in thickness is given for a deposit or formation, for example, 50 to 100 feet, it indicates a general variation in thickness, but in places greater or lesser thicknesses may be present.

The symbols for quarries, mines, and pits do not necessarily indicate currently active operations, which are shown in figure 6. In many cases, one symbol may represent several closely spaced operations. Many small sand and gravel pits could not be shown on this scale.

The descriptions of particle sizes of the materials are based on a modified Wentworth (1922) classification, as shown in table 1. The term "granules," applied to grains 2 to 4 mm in size in the Wentworth classification, is rarely used, and this size material is included in the very coarse sand. In some recent studies, this size material is included with the pebbles rather than with the sand. In commercial use, however, material smaller than a No. 4 screen, which has an opening of 4.76 mm (.187 inch), is commonly called sand, and this usage is followed in this report.

When thin-bedded or laminated, claystones and some siltstones are called shale, the term being used especially for consolidated rocks that contain large proportions of both silt and clay.

The descriptions of particle size are based largely on field estimates of size, but some are based on laboratory analyses. The natural sediments are

AGE		ROCK UNITS			
SYSTEM	SERIES	FORMATION	MATERIALS	THICK.* (ft)	SYMBOLS (pls. 1-7)
PENNSYLVANIAN	MISSOURIAN	Bond Formation	shale, limestone, clay, coal	90	Pc, c
	DESMOINESIAN	Modesto Formation	shale, sandstone, limestone, clay, coal	180	Pc, c
		Carbondale Formation	shale, sandstone, coal, clay, limestone	225	Pc, c
		Spoon Formation	sandstone, shale, clay, coal, limestone	0-50	Ps, s
	ATOKAN	Abbott Formation	sandstone, clay, shale	0-30	Pc, Pcg
MISSISSIPPIAN	VALMEYERAN	St. Louis Limestone	limestone	0-60	Msl, L
		Salem Limestone	limestone, shale	50	Msw, w
		Warsaw Shale	shale, limestone	50	Msw, w
		Keokuk Limestone	limestone	100	Mo, b
		Burlington Limestone	limestone	90	Mo, b
		Meppen Limestone	limestone, dolomite	6-18	Mo, b
	KINDERHOOKIAN	Chouteau Limestone	limestone	5-20	Mk, k
		Hannibal Shale	shale, siltstone	80	Mk, k
		Glen Park Limestone	limestone, oolite	5-6	Mk, k
DEVONIAN	UPPER	Louisiana Limestone	limestone	2-3	Mk, k
		Saverton Shale	shale, gray	1	Mk, k
		Grassy Creek Shale	shale, black	0-50	Mk, k
		Sweetland Creek Shale	shale, gray	0-1	Mk, k
		Sylamore Sandstone	sandstone	0-½	Mk, k
SILURIAN	NIAGARAN	Joliet Dolomite	dolomite	50	Se
	ALEXANDRIAN	Kankakee Dolomite	dolomite	40	Se
		Edgewood Dolomite	dolomite	10-100	Se
ORDOVICIAN	CINCINNATIAN	Brainard Shale	shale, limestone, siltstone	20-90	Ob, Omg
		Fort Atkinson Limestone	limestone, dolomite, shale	40	Of, Omg
		Scales Shale	shale, limestone	75	Omg
	CHAMPLAINIAN	Galena Group	dolomite, limestone	150	Op, Opg
		Platteville Group	limestone, dolomite	100	Op, Opg
		St. Peter Sandstone	sandstone	150	Osp, Ospg
	CANADIAN	Shakopee Dolomite	dolomite, sandstone, shale	250	Os, Osg

*Typical thickness where overlain by next younger formation.

Fig. 2 - Bedrock formations along the Illinois Waterway, their dominant materials, and the symbols of those mapped on plates 1-7.

AGE				ROCK UNITS				
SYSTEM	SERIES	STAGE	SUBSTAGE	FORMATIONS				
QUATERNARY	PLEISTOCENE	HOLOCENE		Cahokia Alluvium al, alg, af	Grayslake Peat p	Parkland Sand sw	Peyton Colluvium sp	Sparland Formation*
QUATERNARY	PLEISTOCENE	WISCONSINAN	VALDERAN					
QUATERNARY	PLEISTOCENE	WISCONSINAN	TWOCREEKAN					
QUATERNARY	PLEISTOCENE	WISCONSINAN	WOODFORDIAN	Peoria Loess*	Richland Loess* / Morton Loess*	Wedron Formation tl	Henry Formation gh, gl, sh, sl	Equality Formation gd, sd, st
QUATERNARY	PLEISTOCENE	WISCONSINAN	FARMDALIAN	Robein Silt*		Peddicord Formation*		
QUATERNARY	PLEISTOCENE	WISCONSINAN	ALTONIAN	Roxana Silt*				
QUATERNARY	PLEISTOCENE	SANGAMONIAN				Glasford Formation tl		
QUATERNARY	PLEISTOCENE	ILLINOIAN		Loveland Silt*	Teneriffe Silt* / Petersburg Silt*	Glasford Formation tl		Pearl Formation sds
QUATERNARY	PLEISTOCENE	YARMOUTHIAN		Banner Formation*				
QUATERNARY	PLEISTOCENE	KANSAN		Banner Formation*				
QUATERNARY	PLEISTOCENE	AFTONIAN		Enion Formation*				
QUATERNARY	PLEISTOCENE	NEBRASKAN		Enion Formation*				
TERTIARY	PLIOCENE—PLEISTOCENE			Grover Gravel*				

*Not mapped separately on plates 1-7.

Fig. 3 - Pleistocene (Glacial and Recent) formations along the Illinois Waterway, their relative ages, and the symbols of those mapped on plates 1-7.

TABLE 1 - CLASSIFICATION OF ROCKS BY PARTICLE SIZE

Milli-meters	Inches	Pieces	Aggregates	
			Unconsolidated	Consolidated
		Boulder	Boulder gravel	Boulder conglomerate
256	10			
		Cobble	Cobble gravel	Cobble conglomerate
64	2.5			
		Coarse pebble	Coarse gravel	Coarse conglomerate
40	1.5			
		Medium pebble	Medium gravel	Medium conglomerate
20	0.75			
		Fine pebble	Fine gravel	Fine conglomerate
4	0.158			
		Very coarse sand grain	Very coarse sand	Very coarse-grained sandstone
1	0.0394			
		Coarse sand grain	Coarse sand	Coarse-grained sandstone
0.5	0.0197			
		Medium sand grain	Medium sand	Medium-grained sandstone
0.25	0.0099			
		Fine sand grain	Fine sand	Fine-grained sandstone
0.125	0.0049			
		Very fine sand grain	Very fine sand	Very fine-grained sandstone
0.0625	0.0024			
		Silt particle	Silt	Siltstone
0.0039	0.00015			
		Clay particle	Clay	Claystone

never entirely of one classification size; the gravels, for example, invariably contain at least some sand, silt, and clay. The materials, therefore, are described according to the dominant size, and if other sizes are abundant, the dominant size is modified by descriptive adjectives, such as "pebbly," "sandy," "silty," or "clayey." The terms "fine," "medium," and "coarse" refer to the dominant size of the sand grains in the sand or sandstone or of the pebbles in a gravel or conglomerate.

An exception is in the nomenclature of gravel. Sieve tests show that a large number of deposits called gravel, and worked commercially as gravel, contain 50 to 75 percent sand. Therefore, disregarding small percentages of silt and clay, the term "gravel" applies to deposits containing more than 25 percent pebbles and larger pieces. The term "sandy gravel" is used for those deposits containing 25 to 50 percent pebbles and larger pieces and 50 to 75 percent sand. Deposits containing less than 25 percent pebbles are called pebbly sand. If silt exceeds 10 percent and clay 5 percent, the terms "silty" or "clayey," or both, are added.

GEOLOGIC DEVELOPMENT OF THE WATERWAY AREA

The principal events in the geologic history of Illinois that account for the character and the surface distribution of the rocks that occur along the Illinois Waterway are briefly summarized as follows:

(1) The consolidated sedimentary rocks, the bedrock formations, were deposited during the Cambrian, Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian Periods of the Paleozoic Era (fig. 2). Some 4,000 to 5,000 feet of rocks, largely dolomite, sandstone, limestone, and shale, were deposited in embayments of the sea that repeatedly covered the interior region of the continent (Willman and others, 1967; Buschbach, 1971).

(2) The Illinois Basin, the northern part of which is crossed by the Illinois Waterway, subsided intermittently during the Paleozic Era. More localized deformation produced the Kankakee Arch in the Joliet to Chicago area, the Sandwich Fault Zone in the Morris District, the La Salle Anticline in the La Salle District, and the Lincoln Fold and Cap au Grès Faulted Flexure across the southern end of the Waterway, south of the Pearl District (Willman and others, 1967; Bristol and Buschbach, 1971; Atherton, 1971). Near Glasford in the Peoria District, a sharp dome with a core of highly brecciated rocks is believed to have been formed by impact of a meteorite during Ordovician time (Buschbach and Ryan, 1963).

(3) A long interval of erosion during the Mesozoic and early Cenozoic Eras produced a surface with low relief across the tilted rock formations. All except the Cambrian formations were exposed, the youngest in the central, deeper part of the syncline just west of the La Salle Anticline, and the oldest on the margins of the Illinois Basin at the ends of the Waterway and along the anticlinal structures (fig. 4).

(4) At the beginning of the Pleistocene Epoch, or the Glacial period, as it is commonly called, the rivers and streams were not deeply entrenched in the bedrock (Willman and Frye, 1970). The Nebraskan and Kansan glaciers (fig. 3) diverted many of the rivers to new positions, where they entrenched themselves into the bedrock, the Ancient Mississippi and some of its tributaries as much as 300 feet. The Illinoian and the early Wisconsinan glaciers repeatedly moved over the area, intensely scouring and significantly lowering the general bedrock surface. Below Peoria the present Illinois River occupies the valley of the Ancient Mississippi River. Above Peoria the Illinois River became established in its present position during Woodfordian glaciation and, augmented repeatedly by glacial meltwater, eroded the present valley deeply into bedrock in the areas from near La Salle to Marseilles and less deeply from there to Lemont. By this time the distribution of the bedrock formations at the bedrock surface was essentially that indicated in figure 4, which shows the general setting of the Waterway in relation to adjacent areas.

(5) During the early glacial stages a Nebraskan glacier from the northwest invaded western Illinois, probably reaching the Illinois Valley near Havana, and later the Kansan glaciers from both the northeast and the northwest covered much of the Waterway area. The glacial drift deposited by these early glaciers was intensely eroded and is generally preserved only in the deeper valleys. These deposits are not differentiated from the younger drifts on the district maps.

(6) All of the Waterway area near the lower end of the Illinois Valley, except an unglaciated area in Calhoun County and a relatively small area in Jersey County (fig. 5), was covered by the Illinoian glacier that advanced from the northeast — the Lake Michigan glacial lobe. As the area below Peoria was not covered by later glaciers, the drift directly below the surface cover of loess in that area is Illinoian in age (fig. 5). The Illinoian drift is largely in the upland areas because later, Wisconsinan glacial rivers eroded away much of the

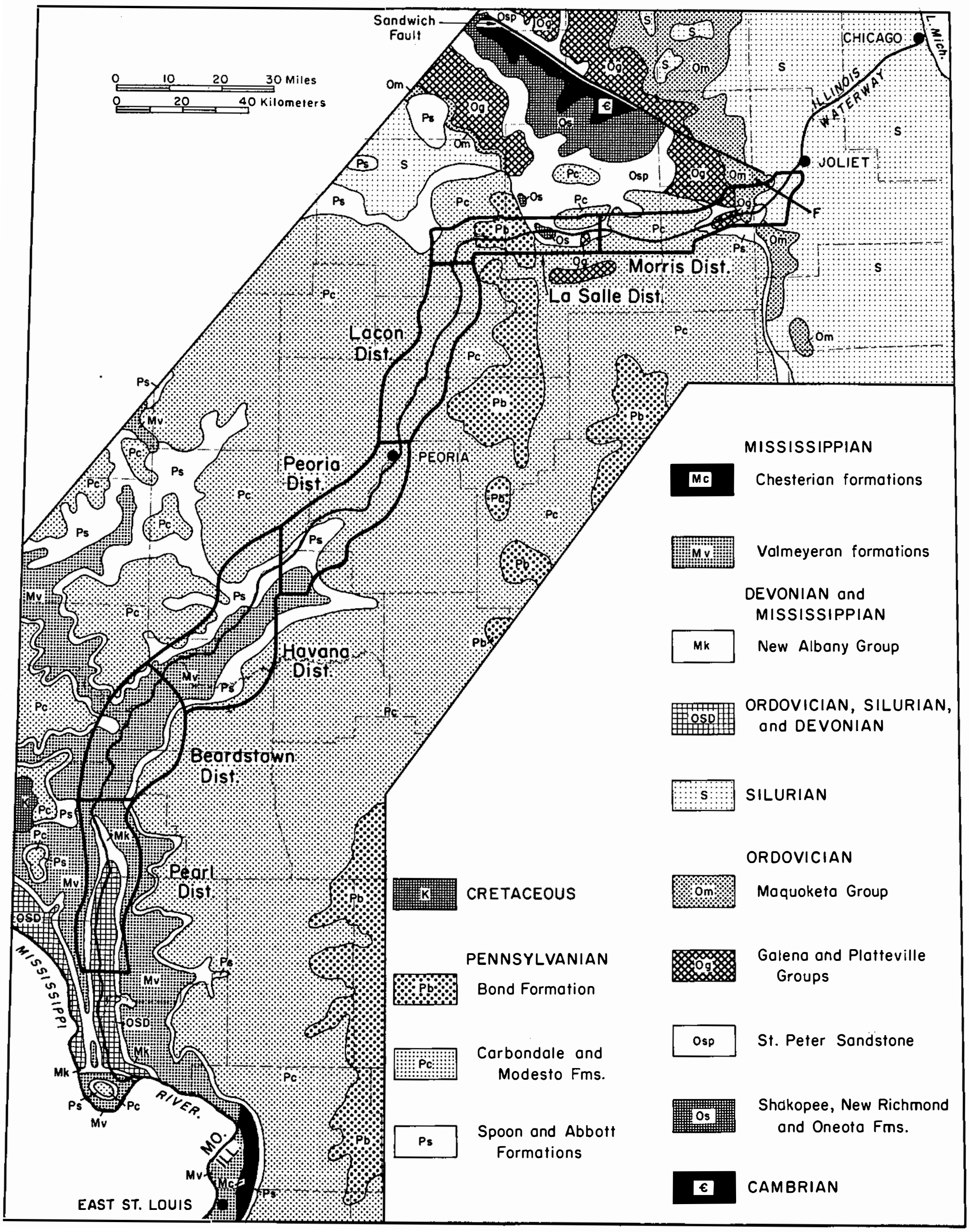


Fig. 4 - Distribution of bedrock formations as it would appear if all the overlying unconsolidated materials were removed.

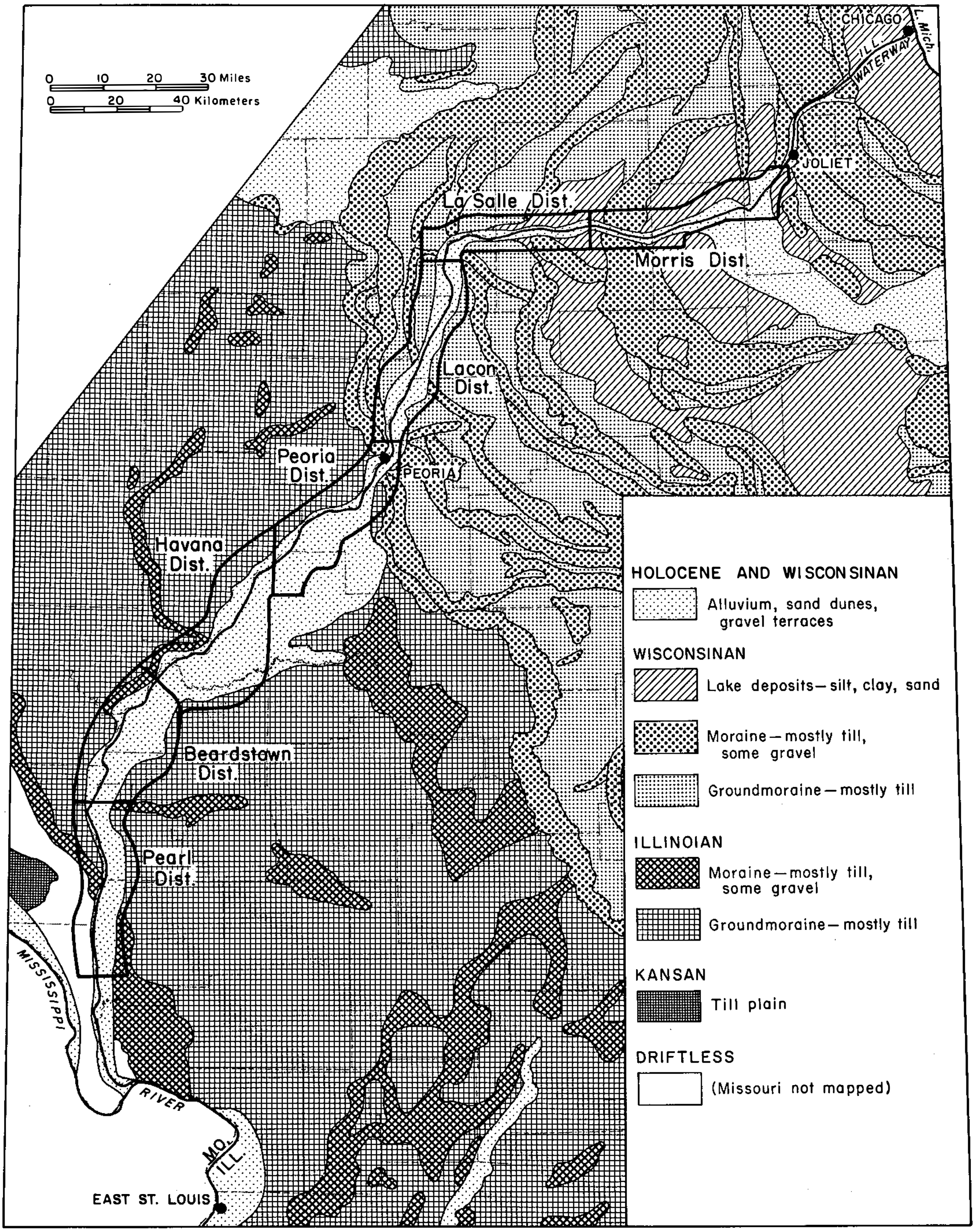


Fig. 5 - Glacial geology map showing the distribution of the major units of the unconsolidated deposits along the Illinois Waterway.

drift in the Illinois Valley. Remnants of Illinoian outwash occur along tributary valleys and may be locally present in areas of the Illinois Valley protected from later floods. A few feet of wind-blown silt (loess) was blown from Illinoian outwash onto the uplands. Beneath the Illinoian drift, this deposit is only locally preserved, in the Petersburg Silt. It is more widely preserved as the Loveland Silt in the unglaciated area south of Pearl in the Pearl District.

(7) During Wisconsinan time Woodfordian glaciers advanced southwestward from the Lake Michigan area and covered the Waterway area as far as Peoria. They overrode the Illinoian drift that had been deeply weathered during Sangamonian time and had been covered by earlier Wisconsinan silts of Altonian, Farmdalian, and early Woodfordian age. The earlier Wisconsinan deposits are widely preserved in the outermost 20 to 30 miles of the area covered by the Woodfordian glacier, but in the area farther east, where the ice probably was much thicker, these deposits and the older drifts are almost entirely eroded and the Wisconsinan drift rests directly on bedrock. Illinoian drift is preserved at only a few places east of Ottawa, these in deep valleys, and none has been definitely identified along the Waterway east of the Marseilles Morainic System in the Morris District.

(8) The Wisconsinan glacier reached its maximum extent along the Waterway at Peoria about 20,000 radiocarbon years ago. It had reached the Big Bend at Hennepin, where it diverted the Mississippi River westward, approximately 1,000 years earlier. During the general retreat of the ice front, relatively cool climatic cycles caused repeated readvances. During the intervals when the ice front was relatively stationary, because it was changing from advance to retreat, successive moraines were built. The pulsating ice front deposited about 20 moraines across the valley. A few were later eroded from the Waterway area (fig. 5). Between 14,000 and 13,500 years ago, the ice front retreated from Illinois into the Lake Michigan Basin.

(9) During Wisconsinan glaciation the major deposits of loess were formed. Winds alternately from east and west, but dominantly from the northwest, picked up silt from the bottomlands of the Illinois Valley that were being aggraded by meltwater from the glaciers and deposited it on the adjacent bluffs and uplands. On the bluffs southeast of the broad bottomlands in the Havana area, loess accumulated to nearly 100 feet in thickness, but elsewhere it generally is not so thick. It thins rapidly on the uplands back from the bluffs. The Roxana Silt, the lower part of the loess, was deposited during Altonian glaciation. The Farmdale Soil and the Robein Silt were formed on it during the Farmdalian retreat of the glacier. The overlying, thicker Peoria Loess was deposited during Woodfordian glaciation. As the Woodfordian ice withdrew from its maximum extent at Peoria, loess continued to be deposited. The Richland Loess, deposited on top of the Woodfordian drift, is much thinner than the Peoria, and it thins to only a foot or two in the upland area bordering the Waterway east of Morris.

(10) During the northeastward retreat of the glaciers from the Big Bend area near Hennepin, the Illinois Valley was dammed by a moraine, forming Lake Illinois at an elevation of 600 feet. Many gravel deltas were built into the lake, which persisted until after the Marseilles Morainic System was deposited.

(11) When rapid melting caused the ice front to withdraw from the position of the Valparaiso Morainic System, about 14,500 radiocarbon years ago, drainage from several hundred miles of ice front in Michigan, Indiana, and Illinois was concentrated into the Kankakee Valley, forming the Kankakee Flood.

The outlet afforded by the Illinois Valley was inadequate to accommodate the volume of water, and large areas of the uplands between the moraines were flooded, forming Lake Wauponsee east of the Marseilles Morainic System in the Morris District and Lake Ottawa west of it in the La Salle District. The floodwaters deepened and widened the Illinois Valley, scouring benches on the bedrock through the Morris and La Salle Districts and, farther down the valley, cutting an extensive surface at a level of 500 to 550 feet on the glacial drift. The surface is preserved on major terraces at Hennepin, Henry, Lacon, Chillicothe, Peoria, and Havana, and on smaller areas elsewhere.

(12) After the ice front withdrew from the Valparaiso Morainic System, it readvanced and deposited the Tinley Moraine, largely on the back-slope of the Valparaiso. When the glacier melted back from the Tinley Moraine about 14,000 radiocarbon years ago, Lake Chicago was formed between the glacier and the moraine. The Lake Border Moraines, which occur mainly north of the Waterway area, were deposited during the first, or Glenwood, stage of Lake Chicago, which was at a level of 640 feet above sea level. During the down-cutting of the outlet, along the Des Plaines Valley, prominent beaches were formed at the Glenwood level and also at 620 feet, called the Calumet stage, and at 600 to 605 feet, called the Toleston stage. The latter beaches, only 20 feet above the present Lake Michigan, were briefly reoccupied during later lakes — Algonquin, Nipissing, and Algoma — and some discharge through the outlet may have occurred as recently as 3,000 radiocarbon years ago.

(13) The Chicago Outlet River, the discharge from Lake Chicago, entrenched itself deeply into the Silurian dolomite in the area from Sag Bridge to Joliet, cut a broad bench in the glacial drift in the Morris area (the Lake Cryder shoreline), scoured the bedrock surface westward to La Salle, and cut into glacial deposits from there to the mouth of the Illinois Valley. In the narrower part of the valley, south of Beardstown, it completely eroded the higher terraces, eroded the loess from the bluffs, and widened the valley. In the upper part of the Waterway area, the Chicago Outlet River deposited coarse gravel in bars on the eroded surfaces, and it moved well-rounded pebbles of the Silurian dolomite as much as 6 inches in diameter from the Joliet area at least as far as Buffalo Rock at Ottawa. Some finer gravel was carried as far as Havana, but below Havana the deposits are largely sand with small pebbles.

(14) The Des Plaines River flows on the bedrock floor of the Outlet River as far as Joliet. Below Joliet to the head of the Illinois River, it is in a shallow channel cut into the bedrock. In the Morris area, the Illinois River is entrenched in glacial deposits, but it occupies a shallow channel with only a narrow floodplain. From about 3 miles west of Morris to Starved Rock, the river has entrenched itself in bedrock, and it has a shallow channel with almost no floodplain. Below Starved Rock the river is only shallowly entrenched in glacial outwash and Chicago Outlet River deposits, but it has eroded laterally and has developed a floodplain underlain by silty alluvium. Because of the low gradient of the Illinois Valley, large alluvial fans have been built at the mouths of the tributaries, particularly in the area from the Big Bend at Hennepin to Beardstown. At the mouth of Farm Creek, which erodes into thick glacial sand and gravel deposits, the alluvial fan forced the Illinois River against the west bluffs at Peoria, damming the river and forming the present Lake Peoria. Since the glaciers melted away, the processes of weathering, stream erosion and deposition, sand dune formation, peat accumulation, slumping, and slopewash have been active, and they continue at present.

References: Cady, 1919; Culver, 1922; Fisher, 1925; Willman and Payne, 1942; Horberg, 1953; Bretz, 1955; Wanless, 1957; Willman and Frye, 1970; Willman, 1971.

THE BEDROCK FORMATIONS

The present report is concerned primarily with those bedrock formations that occur at the surface, as mapped on plates 1-7, and are described below. The bedrock formations that underlie the Illinois Waterway area (fig. 4) but are not exposed are also important in the economic development of the area. They contain ground-water reservoirs that are the sources of municipal, commercial, and farm water supplies. They are used for underground storage of gas and other petroleum products. Oil and gas have been produced from these rocks nearby. Coal and clay have been mined from deeply buried formations. A columnar section showing the deeper bedrock formations is given with the Geologic Map of Illinois (Willman and others, 1967). These formations are also described in the following publications:

Morris District - Culver, 1922; Fisher, 1925; Willman and Payne, 1942; Suter et al., 1959; Buschbach, 1964.

La Salle District - Cady, 1919; Willman and Payne, 1942.

Lacon District - Cady, 1919; Horberg, Larson, and Suter, 1950; McComas, 1968.

Peoria District - Udden, 1912; Horberg, Larson, and Suter, 1950; Wanless, 1957; Buschbach and Ryan, 1963.

Havana District - Wanless, 1957; Walker, Bergstrom, and Walton, 1965.

Beardstown District - Wanless, 1957.

Pearl District - Workman and Bell, 1948; Rubey, 1952.

Other references are given in the Bibliography and Index of Illinois Geology through 1965 (Willman et al., 1968).

ORDOVICIAN SYSTEM

Ordovician formations are exposed in the Morris and La Salle Districts. In the Pearl District they underlie the sand and gravel fill in the Illinois Valley. South of the Pearl District they are exposed in the bluffs of the valley near its mouth (Rubey, 1952; Collinson, Swann, and Willman, 1954).

Shakopee Dolomite

The Shakopee Dolomite is exposed along the Waterway only in the La Salle District (Os on pl. 2). It crops out in the north bluffs of the Illinois Valley from Utica west nearly to Split Rock.* In the bluffs it is overlain by the St. Peter Sandstone, except for an area near Pecumsaugan Creek, along the crest of the La Salle Anticline, where about 100 feet of the formation forms the entire bluffs. The Shakopee Dolomite also underlies a large area of the floor of the

*Many of the small towns, villages, and other features mentioned in the following descriptions could not be shown on plates 1-7 but are shown on the topographic maps identified in figure 1.

Illinois Valley at Utica, where it is covered only by soil and local thin patches of sand and gravel. Larger areas that have sand and gravel generally less than 10 feet thick are mapped as Osg on plate 2. The dolomite consists of interbedded pure and argillaceous beds, and it contains thin beds of sandstone and shale. There are few caves in the formation, but green clay locally fills joints and occurs in pockets on and near the top. The entire thickness, 185 to 200 feet, underlies the eastern part of the outcrop area in the valley floor, but the upper half is truncated at the western end of the area.

References: Cady, 1919; Willman and Templeton, 1951.

St. Peter Sandstone

The St. Peter Sandstone is exposed in the La Salle District and in the extreme western part of the Morris District (Osp on pls. 1 and 2). It crops out almost continuously in both the north and south bluffs of the Illinois Valley from Ottawa west to Split Rock. It is particularly well exposed in Starved Rock, Buffalo Rock, and Split Rock and also in silica sand pits at Ottawa and in the north bluffs. It directly underlies the surface soil in much of the valley floor from Ottawa to Utica, but in several areas, mapped as Ospg (pl. 2), it has a thin cover of sand and gravel generally less than 10 feet thick. The St. Peter Sandstone consists almost entirely of very pure silica sand, the upper 50 to 75 feet of which is medium grained, the lower part fine grained. The grains are well rounded, well sorted, and only weakly cemented. The sandstone is largely white, or near white, except for the upper part, which is yellow or yellowish, particularly where overlain by Pennsylvanian rocks. The formation is 150 to 175 feet thick where overlain by younger bedrock formations. Platteville Group limestone locally occupies channels in the top of the sandstone, but generally the sandstone is overlain by Pennsylvanian strata in the outcrop area. Although weakly cemented, the St. Peter becomes "case-hardened" by deposition of secondary silica on exposed surfaces and it maintains nearly vertical faces, as in Starved Rock. In places, pillar-like bodies of gray clay as much as 100 feet across, but generally smaller, extend from the top down for many feet and, locally, entirely through the formation. They have been found at many places in the outcrop region and their possible presence should be considered in selecting sites for major buildings.

References: Lamar, 1928; Willman and Payne, 1942.

Galena and Platteville Groups

In the Waterway area the Galena and Platteville Groups of formations are dominantly limestone mottled with dolomite. Parts of them are exposed in the Morris and La Salle Districts (Op on pls. 1 and 2). The only outcrops of these strata in the Morris District consist of a few feet of the uppermost Galena beds. However, the entire unit, about 250 feet thick, underlies that locality and it also underlies glacial drift, largely sand and gravel, from Aux Sable Creek to Morris (fig. 4). Along Aux Sable Creek the Galena Group is overlain by shale and limestone of the Maquoketa Group, and channels of Pennsylvanian sandstone are locally cut into both groups. In contrast, in the La Salle District the Galena and Platteville Groups were eroded from much of the area before the deposition of the Pennsylvanian rocks, and only the basal beds of the Platteville Group, as much as 30 feet thick, are preserved, at Ottawa and near Starved Rock, in local channels cut into the top of the St. Peter Sandstone. The limestone contains pockets of green and gray clay that are fillings of former caves.

References: Willman and Payne, 1942; Templeton and Willman, 1963.

Maquoketa Group

The Maquoketa Group is exposed only in the Morris District (pl. 1). It consists of three formations: (1) A basal gray to brown shale, the Scales Shale, contains argillaceous limestone beds in the upper part, is about 75 feet thick, and is not exposed, although it locally underlies thin Pennsylvanian strata in the Goose Lake area south of Divine. (2) A middle limestone, the Fort Atkinson Limestone (mapped Of), is commonly 20 to 30 feet thick and varies from pure, pink, crinoidal limestone to fine-grained dolomite and shaly limestone. It is thinned locally by pre-Pennsylvanian erosion. It is best exposed in the area south of Dresden Island Dam but also crops out in several localities near Channahon. (3) An upper, greenish gray shale, the Brainard Shale (mapped Ob), is as much as 50 feet thick and is poorly exposed along the Des Plaines River south of Channahon and on the west side of the Kankakee River near its mouth. In places it is completely truncated by Pennsylvanian Sandstone, as at Divine south of the Dresden Island Dam.

Areas where the Maquoketa Group formations are overlain by thin sand and gravel, generally less than 10 feet thick, are mapped Omg.

References: Culver, 1922; Savage, 1924; Fisher, 1925; Lamar and Willman, 1931, 1933.

SILURIAN SYSTEM

Silurian age dolomite is exposed only in the Morris District (Se on pl. 1). The principal exposures are on the southeast side of the Des Plaines Valley at and east of the curve in the valley north of Millsdale, and on the northwest side of the valley near Channahon. It consists of three formations: (1) The Edgewood Dolomite at the base grades from impure, shaly dolomite at its base to very cherty, purer dolomite at the top. It is about 75 feet thick north of Millsdale but varies from 10 to 100 feet thick. (2) The overlying Kankakee Dolomite is purer, gray to flesh-colored dolomite in thin wavy beds with very thin green clay partings. It is about 40 feet thick. (3) The overlying Joliet Dolomite is largely medium-bedded, light gray to nearly white dolomite, except for a 10- to 15-foot interval at the base which is shaly and has beds of pink crinoidal dolomite and red and green argillaceous dolomite. Only the lower 25-30 feet of the Joliet is exposed in the Morris District, but the upper 25 feet and higher Silurian formations are exposed along the Waterway from Joliet to Lake Michigan, where the Silurian dolomite is 450 to 500 feet thick. The Silurian rocks contain solution-enlarged joints filled with gray clay. Silurian dolomite is also exposed along the Waterway south of the Pearl District.

References: Fisher, 1925; Savage, 1926; Willman, 1943, 1962; Rubey, 1952; Collinson, Swann, and Willman, 1954.

DEVONIAN AND MISSISSIPPIAN SYSTEMS

New Albany Group

A dominantly shale unit, the New Albany Group, is exposed along the Waterway in the Pearl District (Mk or k on pl. 7). Good exposures occur in ravines from Kampsville north for about 4 miles. The lower part of the unit is late Devonian in age and the upper part is early Mississippian (Kinderhookian Series). The Devonian strata consist of five formations: (1) The Sylamore Sandstone, locally present at the base, consists of a trace to a few inches of sand. (2) The Sweetland Creek Shale, a few to several inches thick, consists of green shale. (3) The Grassy Creek Shale, a black shale, is as much as 50 feet thick north of Pearl but thins out entirely near the south line of the Pearl District. The best exposures are in ravines 3 to 5 miles north of Pearl. (4) The Saverton Shale is gray silty shale about 1 foot thick. (5) The Louisiana Limestone is very fine grained, thin-bedded gray limestone 2 to 3 feet thick. The overlying Mississippian rocks consist of two formations: (1) The Glen Park Formation, at the base, is largely oolitic and silty limestone 5 to 6 feet thick. (2) The Hannibal Shale is 75 to 100 feet of silty gray shale, commonly containing siltstone beds in the upper part.

References: Rubey, 1952; Workman and Gillette, 1956; Collinson, 1961, 1968.

MISSISSIPPIAN SYSTEM

Mississippian formations are exposed in the Havana, Beardstown, and Pearl Districts. They also occur along the Waterway south of the Pearl District to the mouth of the Illinois Valley (Rubey, 1952).

Chouteau, Meppen, Burlington, and Keokuk Limestones

The Chouteau, Meppen, Burlington, and Keokuk Formations, mostly cherty limestone, form a unit about 230 feet thick, exposed in the Beardstown and Pearl Districts (Mb or b on pls. 6 and 7). With the exception of the Chouteau, which is part of the Kinderhookian Series, they form the lower part of the Valmeyeran Series (fig. 4) and are mapped as Mvl on the State Geologic Map. They are exposed along the Waterway south of an area west of Meredosia. The unit forms high bluffs on both sides of the valley throughout the Pearl District, rising from the base of the bluffs at the north to the top at the south. The Chouteau Limestone, at the base of the unit, consists of 5 to 20 feet of siliceous, fine-grained, cherty, gray limestone. The Meppen Limestone (Sedalia Limestone before 1968), which occurs at the base of the bluffs south of Pearl, is 6 to 18 feet of brown-weathering, argillaceous, dolomitic limestone that is interbedded with white to gray, coarsely crystalline limestone. The overlying Burlington Limestone is coarsely crystalline, thick-bedded, crinoidal, light gray to white limestone about 90 feet thick. It is mostly cherty, but the lower 40 to 50 feet has beds as much as 10 feet thick that are nearly or entirely free of chert. The overlying Keokuk Limestone is thinner bedded, finer grained, very cherty limestone, 100 to 120 feet thick. It contains shale beds as much as 1 foot thick and zones of buff dolomitic limestone.

References: Rubey, 1952; Workman and Gillette, 1956; Collinson, 1961, 1964.

Warsaw Shale and Salem Limestone

The Warsaw Shale and the Salem Limestone are exposed in the Havana, Beardstown, and Pearl Districts (pls. 5, 6, and 7) and are mapped as a unit (Mws or w). The unit is exposed in the Waterway area from near Browning in the south part of the Havana District to about 10 miles south of the north line of the Pearl District on the east side of the valley. The Warsaw Shale, below, consists largely of calcareous gray shale with limestone beds as much as 5 feet thick. In places, as much as 20 feet of shale does not contain limestone beds. The formation is 50 feet thick; but where it is near the surface, the valley slopes are gentle and the exposures are small. The overlying Salem Limestone consists of granular tan limestone with brown fine-grained dolomitic beds and thin beds of shale. It also is about 50 feet thick.

References: Wanless, 1957; Collinson, 1964.

St. Louis Limestone

Numerous small outcrops of the St. Louis Limestone occur in the Waterway area south of Sheldons Grove in the Havana District, throughout the Beardstown District, and in the north part of the Pearl District near Bluffs (Msl or L on pls. 5, 6, and 7). The St. Louis Limestone is largely very fine grained, medium- and thin-bedded, gray limestone containing some thin shale partings in places. It contains beds of brecciated limestone and a few brown dolomitic beds. Only the lower part of the formation, about 50 feet thick, occurs in the Waterway area because the upper part has been truncated by Pennsylvanian strata that in places fill depressions in the top of the limestone.

References: Rubey, 1952; Wanless, 1957.

PENNSYLVANIAN SYSTEM

Pennsylvanian age rocks occur along the Waterway in six districts, all except the Pearl. They have a maximum thickness of about 600 feet in the La Salle District, in the syncline west of the La Salle Anticline. East of the anticline they are as much as 100 feet thick between Marseilles and Seneca, but they thin out eastward and only small patches occur east of the Dresden Island Dam in the Morris District. Likewise, they thin gradually southward from the Big Bend area in the La Salle District, and the last outcrops along the Waterway are about 4 miles north of Meredosia in the Beardstown District. The Pennsylvanian strata truncate the older formations, which were slightly tilted and eroded before Pennsylvanian time. They directly overlie Galena, Maquoketa, and Silurian formations in the Morris District, Platteville formations and the St. Peter Sandstone in the La Salle District, and Burlington to St. Louis Limestones in the Havana and Beardstown Districts.

The Pennsylvanian rocks differ from the older formations, which are dominantly of one type of rock, in consisting of a sequence of several kinds of rocks in thinner units. The various rock types recur, commonly in a regular order, forming cyclical units. The individual rock types vary in thickness in different parts of the sequence, and the strata are classified into formations on the basis of prominence or dominance of certain types of rocks.

In the Morris District (pl. 1), the lower Pennsylvanian strata (Pa) consist of (1) the Spoon Formation, which is dominantly shale, clay, and sandstone but contains thin coal and limestone beds, all underlying the Colchester (No. 2) Coal Member of the Carbondale Formation, and (2) small areas of a thin lower sandstone and shale that is part of the underlying Abbott Formation. Where the unit has a thin cover of sand and gravel generally less than 10 feet thick, it is mapped Pag. In the Havana and Beardstown Districts (pls. 5 and 6), the Abbott is not known to be present and the Spoon Formation is mapped as Ps or s. In all three districts, these map units are generally less than 50 feet thick.

Three overlying formations (Carbondale, Modesto, and Bond) are mapped as a unit (Pc). The Carbondale Formation, which is at the base, consists of shale, sandstone, coal, clay, and limestone. It contains the major commercial coals — Colchester (No. 2), Springfield (No. 5), Herrin (No. 6), and Danville (No. 7) Coals — and is about 225 feet thick. It is exposed in all districts except the Pearl. On the La Salle Anticline, the Spoon and Abbott Formations are locally absent and Carbondale strata rest directly on the St. Peter Sandstone. Where overlain by sand and gravel generally less than 10 feet thick, the Carbondale is mapped Pcg. The overlying Modesto Formation consists of shale, sandstone, limestone, clay, and thin coals, is about 180 feet thick, and occurs in the La Salle, Lacon, and Peoria Districts (pls. 2, 3, and 4). The Bond Formation, above the Modesto, consists of shale, limestone, clay, and coal, and contains the major limestones. In the Waterway area it has a maximum thickness of about 90 feet, its top is eroded, and it is present only in the La Salle District (pl. 2).

The extensive areas where the coals have been mined by stripping in the Morris, La Salle, and Peoria Districts have, in places, been converted into recreational areas or restored to agriculture. Parts of the strip-mined areas are potential sites for solid-waste disposal. In other places the steep-sloped waste piles are subject to erosion, and some bordering lower areas have been covered by clayey material washed from the waste piles. Where there has been extensive underground mining, as in the La Salle District, the possibility of further subsidence requires consideration in regional planning. Some abandoned mines may also be considered for solid-waste disposal, but those operated by the long-wall mining system, in which most of the coal is removed, are probably more or less effectively closed by subsidence.

References: Udden, 1912; Cady, 1919; Culver, 1922; Willman and Payne, 1942; Wanless, 1957; Kosanke et al., 1960; Smith et al., 1970; Peppers, 1970.

THE UNCONSOLIDATED ROCKS

QUATERNARY SYSTEM - PLEISTOCENE SERIES

The unconsolidated materials that overlie the bedrock formations consist of many kinds of rocks — gravel, sand, silt, clay, peat, marl, and distinctive variations having special names, such as till, loess, alluvium, and colluvium. Most are deposits of streams and rivers, glaciers, lakes, and winds, but some were formed largely by gravity. Although all are sedimentary rocks, many of them contain pieces of igneous and metamorphic rocks and minerals that were transported by glaciers from Canada into the Waterway region. The unconsolidated rocks accumulated in the last 1 to 2 million years — in the Pleistocene Epoch of the Quaternary Period (fig. 3). A long interval of time intervened between deposition of the bedrock formations and deposition of the Pleistocene sediments. The youngest of the bedrock formations, which is Pennsylvanian in age, was deposited about 275 million years ago.

References: Frye, Willman, and Black, 1965; Piskin and Bergstrom, 1967; Willman and Frye, 1970.

NEBRASKAN AND KANSAN STAGES

As the deposits of the Nebraskan and Kansan glaciers have limited extent, are overlain by younger drift, and have only small outcrops, they are not mapped separately. They occur in the Peoria, Havana, and Beardstown Districts (pls. 4, 5, and 6), and very locally in the La Salle District (pl. 2), in the areas mapped tl. They include the Grover Gravel, which consists of chert pebbles in an iron-stained matrix of coarse quartz sand and occurs locally near Banner, where it probably is Tertiary gravel reworked in Nebraskan glacial outwash. Nebraskan glacial deposits southwest of Havana include till, sand, and gravel and are assigned to the Enion Formation. The Kansan glacial drift, included in the Banner Formation, is more widely present, and it locally is as much as 100 feet thick where it fills bedrock valleys. The Sankoty Sand Member of the Banner Formation occurs largely in the deepest part of the bedrock valley. It is generally buried by younger outwash, but the top is exposed locally near Bureau. The sand is medium- and coarse-grained, and it has a maximum thickness of about 100 feet in the Waterway area.

References: Wanless, 1929, 1957; Horberg, 1950, 1953; Walker, Bergstrom, and Walton, 1965; Willman and Frye, 1970; Leonard, Frye, and Johnson, 1971.

ILLINOIAN STAGE

Illinoian drift is present in all the districts, but it is the surface drift, immediately underlying the loess, only in the area below Peoria (fig. 5). Above Peoria, Illinoian drift is present only locally, and it is overlain by Wisconsinan drift. Outcrops are scarce in the Lacon and La Salle Districts and have not been observed in the Morris District. The deposits of Illinoian age include five formations (fig. 3).

Glasford Formation

The Glasford Formation consists largely of till, but it contains sand and gravel in beds 20 to 40 feet thick, as well as in thinner, lenticular bodies. The till is compact, jointed, and deeply oxidized. It is calcareous, except for the upper 5 to 8 feet, which is leached. The gravel is generally more iron stained and cemented than the younger Wisconsinan gravel. Below Peoria, the Glasford Formation is mapped as tl (pls. 4-7). Above Peoria, the formation is included with the overlying Wedron Formation, which also is largely till, and is mapped as tl but with a slightly different pattern from that used below Peoria.

References: Udden, 1912; Cady, 1919; Root, 1935; Willman and Payne, 1942; Horberg, 1953; Wanless, 1955, 1957; Willman, Glass, and Frye, 1963, 1966; Willman and Frye, 1970; Leonard, Frye, and Johnson, 1971.

Pearl Formation

The Pearl Formation consists of sand and gravel that is Illinoian outwash and is generally deeply weathered. It occurs both on the Glasford Formation and outside the area covered by the Illinoian glacier. In the Waterway area the Pearl Formation occurs principally in the Pearl District on the west side of the Illinois Valley south of Pearl, where it consists largely of deltaic deposits in valleys that were dammed by the Illinoian ice. The deposits vary from sandy gravel (mapped gd on pl. 7) to pebbly sand (mapped sd), and they contain some thin silt beds. Although commonly 20 to 40 feet thick, they may be as much as 100 feet thick locally.

References: Root, 1935; Wanless, 1957; Willman and Frye, 1970.

Petersburg, Teneriffe, and Loveland Silts

The Petersburg Silt, 5 to 20 feet of calcareous silt underlying the Glasford Formation, and the Teneriffe Silt, 1 to 3 feet of leached, red-brown, clayey silt overlying the Glasford Formation, are included with it on the maps. The Loveland Silt, 1 to 5 feet of leached, red, clayey silt that occurs outside the area of the Glasford Formation, is overlain by Wisconsinan loesses and is not mapped separately. It occurs only in the Pearl District (pl. 7) in the areas mapped su, gd, and sd.

References: Leighton and Willman, 1950; Frye, Glass, and Willman, 1968; Willman and Frye, 1970.

WISCONSINAN STAGE

A large part of the unconsolidated deposits in the Waterway area is of Wisconsinan age. Except for buried remnants of older drift, all the glacial deposits above Peoria are Wisconsinan, and below Peoria most of the sand, gravel, and floodplain alluvium in the bottomlands and the loess on the bluffs and uplands are Wisconsinan (fig. 5).

References: Leverett, 1899; Barrows, 1910; Udden, 1912; Sauer, 1916; Cady, 1919; Culver, 1922; Fisher, 1925; Root, 1935; Willman and Payne, 1942; Rubey, 1952; Wanless, 1957; Frye, Willman, and Black, 1965; Willman and Frye, 1970; Willman, 1971.

ALTONIAN SUBSTAGE

Although glacial drift of early Wisconsinan (Altonian) age occurs in northern Illinois north of the Waterway area, the only deposit of that age in the

Waterway area is the Roxana Silt, which is dominantly brown or pinkish tan loess. The Roxana Silt mantles the bluffs and uplands below Peoria; it overlies the Sangamon Soil on the Glasford Formation and underlies the Peoria Loess. It is as much as 40 feet thick in the east bluffs of the Illinois Valley near Beardstown. It does not generally exceed 20 feet in thickness in the west bluffs of the valley, and in the upland areas on both sides of the valley it thins rapidly back from the bluffs. It commonly forms the lower one-fourth to one-third of the combined Peoria and Roxana deposits, the thickness of which is shown in inset maps on plates 4-7.

References: Frye and Willman, 1960, 1963; Leonard and Frye, 1960; Frye, Glass, and Willman, 1962.

FARMDALIAN SUBSTAGE

In the bluffs, where the Roxana Silt is thick, only the upper part was leached, but elsewhere all of it was leached during Farmdalian time. The only deposits of Farmdalian age in the Waterway area are the Robein Silt, a peat and/or a silt rich in organic material, 1 to 3 feet thick, that occurs locally on the Roxana Silt, most commonly in the Peoria and Lacon Districts, and the Peddicord Formation, which consists of lake silts about 10 feet thick that occur in and below the Cryder Lake escarpment north of Morris in the Morris District. Below Peoria, the Robein Formation is mapped with the Roxana Silt and the Peoria Loess, and it and the Peddicord are mapped with the Wedron Formation above Peoria.

References: Willman and Frye, 1970; Willman, Leonard, and Frye, 1971.

WOODFORDIAN SUBSTAGE

In the Waterway area above Peoria, most of the unconsolidated rocks are products of the Woodfordian glaciation. The area below Peoria was not covered by the Woodfordian glacier, but the sand and gravel deposits in the terraces and underlying the modern floodplain and the thick loess on the bluffs and uplands are largely Woodfordian. The Woodfordian deposits are classed in six formations (fig. 3).

References: Frye and Willman, 1960; Frye, Willman, and Black, 1965.

Wedron Formation

The Wedron Formation consists of till interbedded with sand and gravel and thin beds of silt. It underlies all the upland areas along the Waterway above Peoria (tl on pls. 1-4). The till occurs in sheet-like bodies 10 to 100 feet thick that terminate in moraines (fig. 5). The till sheets differ in composition: they are sandy, silty, or clayey, pink, yellow, or gray; some have abundant pebbles and cobbles, others only a few. Boulders are present but not abundant. The till is moderately firm and compact but generally lacks jointing. It is calcareous, mostly dolomitic. The upper 1 to 3 feet is leached except where overlain by calcareous loess, in which case the till is calcareous to the top. Sand and gravel beds, as much as 40 feet thick, but generally much thinner, locally separate the till sheets. In the upland areas, the Wedron Formation is as much as 300 feet thick where moraines are present or where bedrock valleys have been filled with till; but it is commonly about 100 feet thick between moraines, and it has been almost entirely eroded from the bottomlands.

References: Cady, 1919; Culver, 1922; Willman and Payne, 1942; Willman, Glass, and Frye, 1963; Willman and Frye, 1970; Willman, 1971

Henry Formation

The Henry Formation consists largely of sand and gravel that was transported by meltwater from the glaciers and deposited in the Des Plaines and Illinois Valleys. It occurs in all districts along the Waterway. The deposits are preserved principally in terraces in the bottomland. They are mapped as high and low terraces, and each terrace is differentiated according to whether it is largely gravel or sand. Thus, four units are differentiated — gh and gl for the gravel and sh and sl for the sand deposits.

The Henry Formation also includes ice-contact deposits that occur in the upland areas. These are kames and eskers, which are small and are not mapped separately from the Wedron Formation, on which they rest, and ice-front deltas, some of which cover large areas and are mapped separately (gd and sd).

The deposits of the Henry Formation commonly have a thin cover of leached silt and soil 1 to 3 feet thick, and generally the upper few inches of the gravel or sand is leached. In places the sand and gravel in the kames and eskers has a cover of till several feet thick.

The surface of the sand and gravel deposits in the high terrace is largely 60 to 80 feet above the floodplain, the interval decreasing down the valley. Above Peoria the deposits are largely fine sandy gravel, but they contain beds of coarse gravel, pebbly sand, and sand, and they generally become finer grained down the valley. Relatively coarse gravel occurs in the northern part of the terraces at Chillicothe and Hennepin. The deposits are mapped gh in the Morris, La Salle, Lacon, and Peoria Districts (pls. 1-4). They comprise large terrace areas, such as Channahon Mound in the Morris District, the terrace at Hennepin in the La Salle and Lacon Districts, the terraces at Henry, Lacon, Chillicothe, and Spring Bay in the Lacon District, and the major terrace at Peoria in the Peoria District. Under the higher parts of the terraces the deposits are as much as 175 feet thick, as indicated by well data, but 125 feet is more common. Large areas of all except the Henry terrace are covered by sand dunes, many of which are 20 to 40 feet high.

Below Peoria the high terrace covers a very large area that extends from Pekin nearly to Beardstown and from the Illinois River eastward beyond the area mapped. The northern part of the terrace is underlain by sandy gravel, but the deposit is largely medium- and coarse-grained sand and pebbly sand 100 to 150 feet thick overlain by fine- to medium-grained dune sand. It is mapped sh in the Peoria and Havana Districts (pls. 4 and 5).

The low-terrace surface is 20 to 30 feet above the floodplain. North of Peoria the deposits from Joliet to Starved Rock consist of coarse gravel, generally cobbly (gl on pls. 1-4). The pebbles and cobbles are dominantly dolomite. The terrace surface is rough with numerous ridges or bars as much as 20 feet high. From Starved Rock to Peoria the gravel is medium to fine and the surface is flatter. The low terrace covers the major part of the bottomland from

Joliet to Channahon, and the gravel is 20 to 40 feet thick. From there to Dresden Island Dam, the gravel is widely present but patchy, generally less than 20 feet thick, and frequently very thin. From Dresden Island to about 4 miles below Morris, the low terrace is an erosional terrace truncating bedrock, till, sand, and fine sandy gravel. The coarse gravel is confined to the part of the terrace that borders the floodplain. It occurs in an area 1/4 to 3/4 mile wide at nearly the same level as the erosional surface, but it is characterized by bar-like ridges. The coarse gravel generally is only 10 to 20 feet thick, but it overlies finer sandy gravel. From 4 miles below Morris to Starved Rock, the terrace is largely underlain by bedrock and the coarse gravel occurs only in small patches along the river and in isolated bars in shallow channels on the terrace. From Starved Rock to Peoria, narrow remnants of the terrace occur in places, largely bordering the high terraces.

South of Peoria the low-terrace remnants are largely pebbly sand (mapped sl), but in places they contain fine sandy gravel. As above Peoria, the deposits are coarser than those in the high terrace. The surface is barely above the floodplain in many localities, particularly south of Beardstown, and the floodplain silts, perhaps only a few feet thick, may overlie extensive areas of these deposits. However, at a depth of 20 to 30 feet these deposits probably overlie older, more sandy deposits.

Kames and eskers, which occur on the upland areas, are composed of materials varying in grain size. In places they contain coarse gravel interbedded with sand and silt. They are most common in the morainic areas but are not abundant (fig. 5).

The materials in the ice-front gravel and sand deltas differ from those in the terraces in being more poorly sorted, in containing more clay in the sandy matrix and in balls of silt, clay, and till, and in occurring in beds dipping steeply westward. Many deposits have a 1- to 3-foot bed of silt in the upper part and a few feet of horizontally bedded gravel above the silt. The sand deltas differ from the gravel deltas only in being largely sand and pebbly sand. The delta deposits vary from 15 to 80 feet thick, but many are in the range from 20 to 30 feet thick. Gravel deltas, mapped gd, occur in the Morris and La Salle Districts (pls. 1 and 2); sand deltas, mapped sd, occur in the La Salle District.

References: Cady, 1919; Culver, 1922; Willman and Payne, 1942; Wanless, 1957; Willman and Frye, 1970; Willman, 1971; Labotka and Hester, 1971.

Equality Formation

Along many of the valleys tributary to the Illinois Valley, remnants of a terrace, the surface of which is 10 to 20 feet above the floodplain, are underlain by 20 to 30 feet of interbedded silt, sandy and clayey silt, and fine sand (st on pls. 4-7). The sediments were deposited in slackwater lakes that formed in the tributary valleys during high-water stages in the Illinois Valley and are part of the Equality Formation. The water-laid deposits are generally overlain by 5 to 10 feet of Peoria Loess. Remnants of the terrace are largely confined to the lower few miles of the valleys.

The upland areas, both east and west of the Marseilles Morainic System, were briefly covered by extensive lakes during the Kankakee Flood (fig. 5). The extent of these lakes in the Waterway area is shown on the inset maps on plates 1 and 2. Sediment in the lakes consists of weakly bedded clayey silt or sandy silt that is generally less than 5 feet thick and is present only locally. In much of the area, till of the Wedron Formation is overlain by 2 to 3 feet of leached brown silt, which in part is leached loess. The water-laid silts are assigned to the Equality Formation. Because they are thin and patchy in occurrence, they are not differentiated from the Wedron Formation on plates 1 and 2.

References: Wanless, 1957; Willman and Payne, 1942; Willman and Frye, 1970; Willman, 1971.

Peoria, Morton, and Richland Loesses

During the Woodfordian glaciation the outwash deposited in the Illinois Valley was the source of the large volume of silt blown from the bottomlands and deposited as loess on the bluffs and uplands. The loess on the bluffs is commonly 80 to 90 percent silt and 5 to 20 percent sand and generally less than 5 percent clay. The grain size decreases progressively back from the bluffs, sand decreasing to less than 1 percent and clay increasing to 10 to 15 percent within a mile from the bluffs. Outside the area covered by the Woodfordian ice (fig. 5), the loess of Woodfordian age is called Peoria Loess. However, the uppermost part of the Peoria Loess may be post-Woodfordian. The Peoria Loess is a buff to tan, calcareous silt. It is readily distinguished from the underlying brown to pink Roxana Silt, which also is largely loess. The advancing Woodfordian glacier overrode the early Woodfordian loess. As the glacier retreated, it deposited the Wedron Formation on the early loess and the winds deposited loess on the Wedron Formation. The loess beneath the Wedron Formation is called Morton Loess, and the loess that accumulated on the Wedron Formation is called Richland Loess. The thickness of the loess is shown on inset maps on all of the plates. The Peoria Loess forms the upper two-thirds to three-fourths of the loess shown on plates 4-7. The Richland Loess forms the entire thickness of the loess on plates 1, 2, and 3 and the northeast corner of plate 4.

References: Smith, 1942; Leighton and Willman, 1950; Wanless, 1957; Frye and Willman, 1960, 1963; Leonard and Frye, 1960; Frye, Glass, and Willman, 1962, 1968; Willman and Frye, 1970; Leonard, Frye, and Johnson, 1971.

WISCONSINAN AND HOLOCENE STAGES

Some of the sediments that began to form during Woodfordian time have continued to be formed up to the present. They are classified into five formations (fig. 3), as follows: (1) the Cahokia Alluvium — deposits of rivers and streams; (2) the Grayslake Peat — organic accumulations in lakes, ponds, and swamps; (3) the Parkland Sand — wind-sorted sand in dunes; (4) the Peyton Colluvium — silty deposits formed by slopewash, creep, and mudflows, and including small alluvial fans; and (5) the Lacon Formation — landslides, rock falls, and slumps. In addition, extensive deposits have been formed by the activities of man.

Cahokia Alluvium

The Cahokia Alluvium is dominantly poorly sorted sandy or clayey silt deposited in the floodplains of rivers and streams, and it occurs in all districts (al on pls. 1-7). It contains lenses of silty sand and, in some areas, silty gravel. Sand and gravel occurs in the channels of the rivers, particularly the Illinois River above Starved Rock, and of most of the tributaries. Many such deposits are replenished by every period of high stream flow. In some of the tributary valleys, particularly those between La Salle and Peoria (pls. 2, 3, and 4), the streams erode glacial sand and gravel, and in these areas relatively clean sand and gravel occurs in the channels and in the floodplains. Below Peoria, where the glacial materials are thinner, the tributary valleys generally contain less gravel and the valleys are entrenched in bedrock. In that area the gravel in the alluvium contains much angular or subangular bedrock material, mostly Pennsylvanian sandstone and shale in the Peoria, Havana, and Beardstown Districts, and mostly Mississippian limestone, chert, and siltstone in the Pearl District.

The Cahokia Alluvium is generally less than 20 feet thick in the Morris and La Salle Districts, where the floodplain is narrow. Below Utica, where the floodplain widens, the alluvium may be as much as 50 feet thick. However, it varies in thickness, and in some localities, where it overlaps benches eroded on earlier sand and gravel deposits, the alluvium thins to only a few feet. In the Morris District (pl. 1), an area where thin alluvium overlies sand and gravel is mapped alg.

At the mouths of their valleys, the tributary streams encounter the flat surface of the Illinois River floodplain, lose velocity, and deposit their sediment in fan-shaped areas, forming alluvial fans. At the mouths of the larger tributary valleys, the alluvial fans have been built up 20 to 30 feet above the floodplain. Some of the smaller, steeper sloped fans extend 40 to 50 feet above the floodplain. The deposits as a whole are dominantly silt, part of which is contributed by the Illinois River, which covers most of the fans during flood stages. The alluvial fans contain more sand and gravel than the alluvium of the floodplains. The sand and gravel is generally more silty and more poorly sorted than the glacial outwash deposits in the terraces. The fan deposits become finer grained outward from the tributary valleys, and at the outer margins they grade into and intertongue with the floodplain deposits. Alluvial fans are present in all districts (af on pls. 1-7) and, in addition to those mapped separately, hundreds of small fans are included with the slopewash in the Peyton Colluvium (mapped sp).

Between La Salle and Beardstown the tributary rivers and streams have built large alluvial fans, a few covering as much as 2 square miles. Because of its low gradient, the Illinois River has not been able to erode the fans, and the growth of the fans has determined the position of the channel of the river. Most of East Peoria is located on an alluvial fan built by Farm Creek; growth of the fan crowded the Illinois River against the west bluff, dammed the river, and formed Lake Peoria above the fan. Above La Salle the river has a steeper gradient and the fans are much smaller. South of Beardstown the fans are also smaller, but many of them may extend much farther than mapped into the bottomland beneath the floodplain alluvium. Also the tributary streams in that area do not have as large a source of easily eroded material as do the streams eroding the thicker glacial deposits farther up the Illinois Valley.

References: Wanless, 1957; Willman and Payne, 1942; Willman and Frye, 1970.

Grayslake Peat

Many of the lakes and ponds that occur on the floodplain of the Illinois River have been filled, or are in the process of being filled, with plant debris partly compacted into peat. These deposits, called the Grayslake Peat, occur in all of the districts along the Waterway (p on pls. 1-7). Peaty beds having a high content of clay or silt are described as muck or silt rich in organic material. Locally the peat contains beds of marl, a deposit containing abundant shells, mostly of snails and clams. Although the presence of peat in the areas mapped has been observed or demonstrated by shallow augering, the thickness of the peat in most areas is not known. In some areas that have been ditched and drained for many years, the peat may have oxidized and therefore only a silt or clay rich in organic material may remain. The peat in the floodplain lakes probably does not exceed 5 to 10 feet in thickness. Peat deposits formed in lakes on the glacial drift in the Waterway area are small and few, and none are mapped. Probably the largest deposits of relatively pure peat, which formerly were worked commercially, occur on the high terrace along the east side of the Peoria District near Manito. The major areas are east of the area mapped. Most peat deposits are unstable for building foundations and for roads, and excavation of the peat is generally required for such structures.

References: Wanless, 1957; Hester and Lamar, 1969; Willman and Frye, 1970. The mapping of the peat is based largely on maps in soil reports published by the University of Illinois Agricultural Experiment Station, Urbana, Illinois. Soil reports are available for the following counties in the Waterway area: Bureau, report no. 20 (1921); Calhoun, 53 (1932); Cass, 71 (1947); Fulton, 51 (1932); Grundy, 26 (1924); La Salle, 5 (1913); Marshall, 59 (1937); Mason, 28 (1924); Morgan, 42 (1929); Peoria, 19 (1921); Pike, 11 (1915); Putnam, 60 (1937); Schuyler, 56 (1934); Tazewell, 14 (1916); Will, 80 (1962); Woodford, 36 (1927).

Parkland Sand

The Parkland Sand consists of the well-sorted fine- and medium-grained sand that occurs in and around sand dunes in all districts along the Waterway (sw on pls. 1-7). The major areas of Parkland Sand occur on sand and gravel terraces in the bottomlands, but many dunes occur also on the east bluffs and uplands adjacent to terraces. Sand dunes are not present on the floodplains or on the west bluffs and uplands. On the west side of the Illinois Valley, no dunes occur on the Henry terrace, but they cover a large part of the Chillicothe terrace. From their distribution and asymmetrical profiles (steeper on the southeast), as well as the barchan shapes of some dunes (crescentic dunes with tapering ends pointing southeast), it is apparent that the dunes were formed by winds blowing dominantly from the northwest.

The dunes on the terraces consist largely of well-sorted medium-grained sand, but in places the sand is fine grained. The sand that migrated onto the uplands east of the valley is largely fine-grained sand. The sand is largely quartz, but it contains about 20 percent feldspar, 1 to 2 percent other minerals, and 1 to 2 percent clay. Although a few small areas of active blowouts expose the sand, most of the dunes became fixed in place after moving only a short distance. They have a cover of sandy soil and silt from a few inches to 2 feet thick. Much of the sand is stained light yellow by iron oxide. Carbonates are generally lacking except in the lower parts of the higher dunes.

In the Waterway area above the Big Bend at Hennepin, sand dunes occur only locally, mostly east of Morris, but south from the Big Bend they cover many square miles. The areas of dunes on the bluffs and uplands are mapped, but on the terraces south of Peoria they cover large areas and they are not mapped separately. The general distribution of the dunes has been mapped (Willman, 1942, figs. 4, 6, and 7; soil reports), and the dunic topography is readily recognized on the topographic maps (fig. 1).

Because the dunes overlie a relatively flat surface on the terrace sand and gravel deposits, the thickness of the dune sand varies with the topography. In many places the low areas between the dunes contain pebbles, showing that the dune sand is confined to the dune; but in some areas there is a pile-up of dunes with the result that the dune sand is thicker than the individual dunes. Many dunes are 20 to 40 feet high. In some areas the dune sand may be as much as 100 feet thick, although the maximum is generally less than 50 feet.

References: Willman, 1942; Wanless, 1957; Walker, Bergstrom, and Walton, 1965; Hunter, 1966; Willman and Frye, 1970; Labotka and Hester, 1971; soil reports listed under Grayslake Peat.

Peyton Colluvium

Material eroded from a steep slope accumulates at the base of the slope and underlies the concave surface that forms a transition zone to the flat surface of the bottomland — either a terrace surface or the floodplain of a river or stream. This material is the Peyton Colluvium, and it is present in all districts along the Waterway (sp on pls. 1-7). In fact, it is present along the base of almost all slopes, except those being eroded by the rivers and streams; but where the slopes have been formed recently, the deposits are not wide enough to map.

The composition of the Peyton Colluvium is controlled by the composition of the material on the slopes directly above it. Because of the general occurrence of loess and till in the bluffs, the Peyton Colluvium is dominantly a pebbly clayey silt; but where loess forms the entire bluff, the deposit is largely silt. In many areas, however, it contains silt, clay, sand, and pebbles from the glacial drift and angular fragments of whatever bedrock materials occur in the bluffs; in some places it contains large blocks of the bedrock.

Because of the steepness of the slope and the short distance, the rapidity, and the intermittence of transportation, the material is very poorly sorted. It contains coarser material close to the steep slope, becomes rapidly finer down the slope, and is finest on the outermost slope, where it grades into the Cahokia Alluvium. On the terraces it ends more abruptly.

Much of the silt and clay in the deposit comes from rain washing the slopes — the slopewash. Mud flows and slow creep move coarser materials into the deposits. Where gullies develop, steep-sloped alluvial cones of coarser material are deposited. Small alluvial fans deposited at the mouths of the larger gullies are included in the area mapped as Peyton Colluvium and give the deposits a scalloped outer margin.

Because the base of the Peyton Colluvium is generally flat — the surface of a terrace or floodplain — the variation in thickness of the Peyton Colluvium is determined largely by the shape of the top surface. The maximum thickness commonly is 20 to 40 feet, but in places, particularly where the deposits extend below the level of the present floodplain, they may be 50 to 75 feet thick.

Because of the steepness of the surface, the upper parts of the colluvium are stable only if undisturbed. If the slope is cut into for roads or foundations, the higher materials may flow or slide, especially if they become saturated by rain or melting snow. Movement is facilitated by their unconsolidated character and their clay content.

References: Willman and Payne, 1942; Wanless, 1957; Willman and Frye, 1970.

Lacon Formation

The Lacon Formation consists of a rubble of angular material that has fallen or slid from higher slopes — deposits formed mainly by gravity. They consist largely of talus (angular blocks dislodged by weathering) or of masses of broken rock produced by landslides or landslips. The material in the Lacon Formation is much coarser than the Peyton Colluvium, which is formed largely by slopewash; however, it generally has a matrix of silty material as a result of slopewash penetrating the porous rubble. The deposits are also less common than the colluvium; they occur only where stream and river erosion has over-steepened the slopes or where activities of man, such as excavations or excessive cultivation and grazing, have changed the stability of the surface. They occur in all districts along the Waterway, but they are in narrow areas too small to map on the 1 inch to 1 mile scale and are generally included in the Peyton Colluvium.

An area along the west bluffs of the Illinois Valley northwest of Lacon (pl. 3) is the type locality of the formation. Large slides occurred in that area because of the presence of the plastic underclay of the Danville (No. 7) Coal in the lower part of the bluffs. Construction of a highway activated the slides and caused repeated rupturing of the concrete slab.

Talus occurs in steep-sloped accumulations at the base of cliffs of consolidated rock formations. These accumulations are very small or absent in the Waterway area above Beardstown, but they occur abundantly at the base of bluffs of the Burlington-Keokuk Limestone in the Pearl District.

Conditions favoring landslides occur in the valley bluffs at many places in the Waterway area. Where glacial deposits are thick, several potential zones of slippage occur. The top of the till, where it is overlain by permeable silt or sand, is a seepage zone in which sliding occurs. In the region below Peoria, the Sangamon Soil is a common cause of slides because it retards water flow and its high clay content favors mass movements. Silt, sand, and gravel beds in the drift carry water, and the discharge at the outcrops contributes to sliding conditions on the slopes below. Such beds are subject to flow if overloaded or unsupported. In the areas of thick loess below Peoria, the loess at the top, commonly 5 to 15 feet thick, is leached and much more subject to sliding than the underlying calcareous loess. In areas of Pennsylvanian rocks, low permeability shales commonly form the top of the bedrock, and slides of the overlying materials occur at this contact. Clay units in Pennsylvanian rocks favor slippage under some conditions. In the unglaciated area south of Pearl, residual clays on the limestone bedrock are plastic materials that retard water flow and are subject to sliding.

References: Ekblaw, 1932; Willman and Payne, 1942; Wanless, 1957; Willman and Frye, 1971; DuMontelle, Hester, and Cole, 1971.

HOLOCENE STAGE

With the exception of a few sand dunes, stream alluvium along small valleys, and some landslides, the deposits that are being formed at present began to accumulate during the Wisconsinan Stage. However, the deposits made by man, which are entirely of Holocene age, have become a significant part of the surficial geology of the Waterway area. The major areas of man-made deposits are the waste piles of coal mines and, to a lesser extent, of clay mines. Strip mine areas (mapped sm) occur in the Morris, La Salle, and Peoria Districts (pls. 1, 2, and 4). The material in the waste piles is a mixture of the overburden on the coal or clay being mined and, consequently, varies in composition. Bedrock materials, mostly shale and sandstone, dominate in some areas, and glacial materials, mostly till and gravel, in others. In places, dune sand is a prominent constituent.

Waste piles of underground mines are conical piles consisting largely of gray shale but containing minor amounts of black slaty shale, underclay, and coal. Several occur in the Waterway area in the La Salle District (pl. 2), and others occur just outside the Waterway area in the Morris and La Salle regions.

Other man-made deposits along the Waterway that do not occur in areas large enough to map are waste piles around quarries and sand and gravel pits and along highway cuts, ditches, the Illinois and Michigan Canal, and the Waterway itself. Exposed areas of silt and clay deposits accumulating in and bordering man-made lakes are not large but will become a more significant part of the surficial geology in years ahead.

References: Cady, 1919; Culver, 1922; Willman and Payne, 1942; Smith and Berggren, 1963; Smith, 1968; Willman and Frye, 1970; Willman, 1971.

MINERAL RESOURCES

The mineral resources along the Illinois Waterway have been under development since the 1830's, and minerals and mineral products became major items of traffic on the Illinois and Michigan Canal when it opened in 1848 (it closed in 1907) and on the Illinois Waterway when it opened in 1933. Mineral products also move on the railroads that follow the Illinois Valley from Chicago to Pekin. South of Pekin, railroads reach or cross the Waterway at Havana, Beardstown, Meredosia, Valley City, Pearl, and Hardin. At present, most of the mineral products used locally are hauled by trucks. The value of the minerals produced in 1970 in counties bordering the Waterway exceeded 150 million dollars (table 2).

The minerals and mineral products that have been produced from deposits in the Waterway area include coal, sand and gravel, crushed limestone and dolomite, portland cement, natural (hydraulic) cement, lime, silica sand, glass, sodium silicate, refractory clay, refractory brick and block, common and face brick, hollow building tile, light-weight aggregate, condensers for zinc smelting, building stone, and peat. The source materials for these industries are sand, gravel, clay, and peat in the Pleistocene deposits; clay, shale, limestone and coal in the Pennsylvanian rocks; limestone and dolomite in the Ordovician, Silurian, Mississippian, and Pennsylvanian rocks; and sandstone in the

TABLE 2 — MINERAL PRODUCTION IN 1970 IN COUNTIES BORDERING THE ILLINOIS WATERWAY (compiled from unpublished data of the Illinois State Geological Survey)

County	Total value all minerals	Minerals produced, in order of value
Cook	$ 46,364,138	Stone, lime, gravel, clay products, sand
Du Page	6,628,369	Clay products, stone, gravel, sand
Will	15,412,413	Stone, coal, gravel, clay products, sand
Grundy	c	Clay products, sand, coal, gravel
La Salle	33,944,902	Silica sand, cement, clay products, gravel, sand, stone
Bureau	818,550	Gravel, sand
Putnam	c	Gravel
Marshall	c	Gravel, sand
Peoria	15,433,444	Coal, stone, gravel, sand
Woodford	c	Gravel, sand
Tazewell	1,831,060	Gravel, sand
Fulton	30,585,365	Coal, gravel, sand
Mason	c	Sand, gravel
Schuyler	c	Gravel, sand
Cass	—	
Brown	230,020	Clay products, stone, sand, crude oil, gravel
Morgan	c	Sand
Pike	1,040,211	Stone, gravel, sand
Scott	736,521	Clay products, stone, sand, gravel
Greene	569,449	Stone, clay products
Calhoun	c	Stone
Jersey	198,885	Stone
Others	6,036,167	
Total	$159,829,494	

c — concealed to avoid disclosing company confidential data; included in "others."

Ordovician rocks. The locations of the major pits, quarries, and mines are shown on plates 1-7; the present mineral producers are shown in figure 6.

All the earth materials have potential usefulness. At present, many of them are most valuable for the agricultural products growing on them, but the materials underlying the soils will become more important as mineral resources as industry expands down the valley. The sand and gravel deposits nearest Chicago, for example, are worked intensively, and large deposits have been worked out and abandoned. As others are exhausted, the undeveloped resources down the valley will be needed.

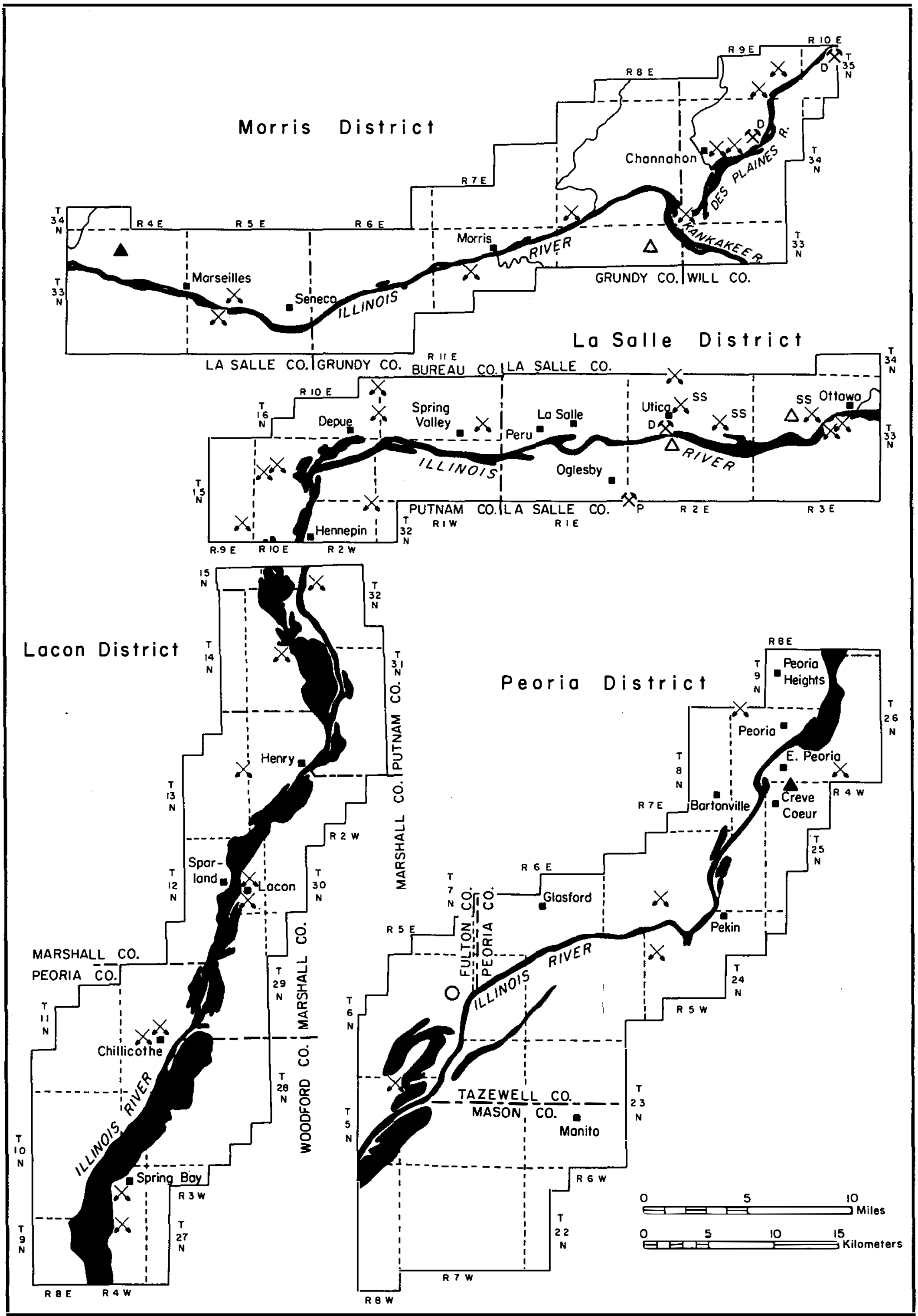
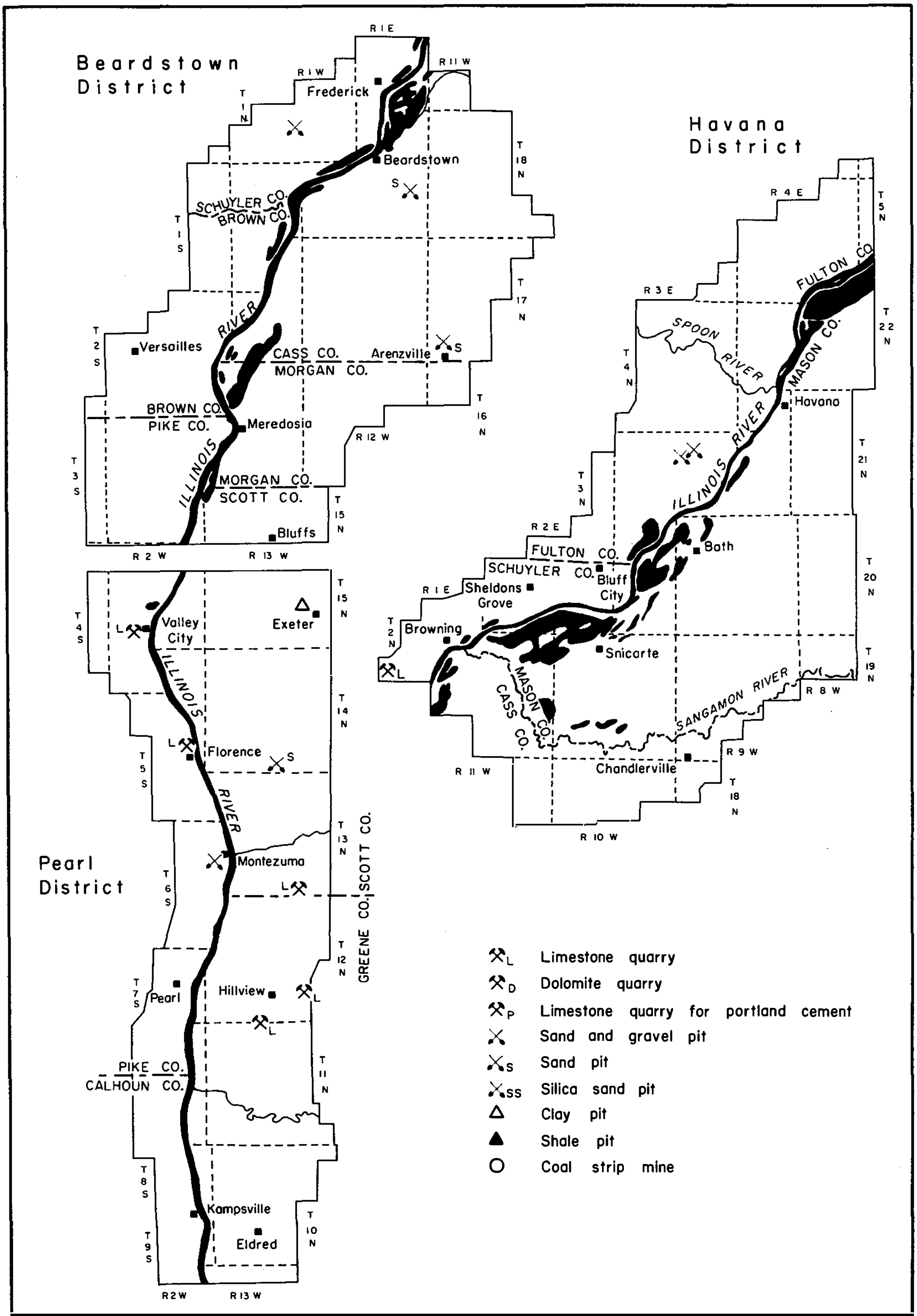


Fig. 6 - Present mineral producers



within the Waterway area.

References: Barrows, 1910; Sauer, 1916; Cady, 1919; Willman and Payne, 1942; Wanless, 1957; Major, 1967a, 1967b, 1967c, 1968; Busch, 1971a, 1971b; Willman, 1971.

Limestone and Dolomite

Limestone and dolomite are quarried along the Waterway for concrete aggregate, agricultural limestone, manufacture of portland cement, and other uses. The major resources are at the northern end of the Waterway in the Morris District and at the southern end in the Pearl District.

In the Morris District (pl. 1), the Silurian dolomite (Se) is quarried at Joliet and in Channahon Mound. It underlies the extensive gravel terraces in the bottomland from Channahon to Joliet, but in much of this area the material is the argillaceous and cherty Edgewood Dolomite.

The Fort Atkinson Limestone (Of) underlies a large area south of Dresden Island Dam, a smaller area north of the Waterway, and part of the bottomland near Channahon. The upper part is coarse-grained, crinoidal, high-calcium limestone, but the lower part is dolomite.

Only the top of the Galena Group (Op) is exposed along Aux Sable Creek east of Morris, but this indicates that 200 to 250 feet of the Galena and the underlying Platteville Group limestones occur at a shallow depth in that area. These strata appear to be largely dolomitic limestone, but they may contain quarriable or minable units of low-magnesian limestone.

In the La Salle District (pl. 2), the La Salle Limestone Member of the Bond Formation (Pc) is 20 to 30 feet thick and in part is interbedded with shale. It is used in the manufacture of portland cement at Oglesby, and it has been quarried for portland cement, road stone, and agricultural limestone at La Salle. The low-magnesian limestone used for portland cement manufacture occurs only in a north-south belt 1 to 2 miles wide on the west side of the La Salle Anticline, but the limestone extends westward nearly to Depue as an impure and shaly dolomitic limestone about 15 feet thick.

The Shakopee Dolomite (Os) is quarried for crushed rock at Utica. It occurs at a shallow depth in an area of nearly 2 square miles of the valley floor between Starved Rock and Utica. Two argillaceous beds 6 to 7 and 8 to 20 feet thick have been used for the manufacture of natural (hydraulic) cement. The stone was first mined in the bluffs at the mouth of Pecumsaugan Creek and along the creek, and the cement was used in the construction of the locks of the Illinois and Michigan Canal, which opened in 1848. Later these beds were mined and quarried at a plant in the valley floor west of Utica, but the plant is now abandoned.

The Platteville Limestone (Op) is as much as 20 feet thick in outcrops at the mouth of Covel Creek, but the area where it has a thin overburden is small. In small areas at Ottawa and near Starved Rock, the limestone is generally less than 10 feet thick.

In the Lacon District (pl. 3), the Lonsdale Limestone Member of the Modesto Formation (Pc) crops out on the west side of the valley near Sparland. The limestone is 5 to 10 feet thick. It has a thin overburden only in small areas near the outcrops.

In the Peoria, Havana, and Beardstown Districts (pls. 4, 5, and 6), limestone beds occur on the west side of the valley in the Spoon (Ps or s) and Carbondale (Pc or c) Formations but are less than 3 feet thick.

In the Havana and Beardstown Districts (pls. 5 and 6), the St. Louis Limestone (Msl or L) and the Salem Limestone (Mws or w) are exposed in places along the valleys and in the lower part of the bluffs on the west side of the Illinois Valley south of Sheldons Grove. The St. Louis is a fine-grained, dense, hard limestone probably suitable for most uses of crushed stone, except where it is very cherty. The Salem Limestone is a softer limestone, but it is relatively pure and particularly suitable for agricultural limestone. At most exposures these limestones have a thin overburden only in small areas.

In the Pearl District (pl. 6) and the southwest part of the Beardstown District (pl. 5), the Burlington and Keokuk Limestones (Mb or b) are exposed at many places in the bluffs on both sides of the valley. Except for the upper part of the Keokuk, which contains some shale beds, the limestone is relatively pure, but it is generally cherty and where cherty it has limited commercial use. However, the lower part of the Burlington locally contains chert-free beds as much as 10 feet thick that are high-calcium limestone. Locally the Meppen and Chouteau Limestones are quarried with the lower part of the Burlington.

References: Cady, 1919; Culver, 1922; Lamar et al., 1934; Lamar and Willman, 1931, 1933, 1955; Willman and Payne, 1942; Lamar, 1957, 1961; Wanless, 1957; Harvey, 1964; Busch, 1969; Willman, 1971.

Clay and Shale

Clay and shale occur in all districts along the Waterway. Pennsylvanian age clays and shales are used in the manufacture of refractories, brick, building tile, light-weight burned-clay aggregate, and refractory clay. The Ordovician Brainard and Scales Shales of the Maquoketa Group in the Morris District and the Mississippian Hannibal and Warsaw Shales in the Beardstown and Pearl Districts are thick shales, but they are largely calcareous and have not been used for ceramic products in the Waterway area.

Two Pennsylvanian clays have been used. The basal clay of the Spoon Formation, which overlies pre-Pennsylvanian formations and in places directly underlies the Colchester (No. 2) Coal, has been used for fire clay brick, for other fire clay products, and for use with shale in brick and tile manufacture. In the Morris District, the clay has been used at Goose Lake north of Coal City, at a shaft mine east of Marseilles, at Dayton, and on the east side of Ottawa. In the La Salle District, the clay has been mined at Ottawa, Twin Bluffs, Buffalo Rock, La Salle Canyon, and south of Utica. In the Lacon District, it was mined in a shaft at Sparland. The underclay of the Danville (No. 7) Coal in the Carbondale Formation has been mined in a shaft at La Salle in the La Salle District and used for the manufacture of condensers for zinc smelting.

The four Pennsylvanian shales that have been used are (1) the Francis Creek Shale in the Carbondale Formation, used for making hollow building tile near Ottawa in the Morris District and at Ottawa and Twin Bluffs in the La Salle District, and for portland cement manufacture at Dixon, the shale for which was taken from waste piles of underground coal mines at Spring Valley in the La Salle District, (2) the Canton Shale in the Carbondale Formation, used for making light-weight aggregate west of Marseilles in the Morris District, (3) the Lawson Shale in the Carbondale Formation, used for making brick at East Peoria in the Peoria District, and (4) the Farmington Shale in the Modesto Formation, used for brick manufacture at Sparland in the Lacon District.

Glacial clays, largely till, occur in all of the districts, but they are pebbly and calcareous, except for the upper few feet, which is leached. In the Chicago area, they are used in the manufacture of brick along the Waterway at Stickney and Blue Island.

References: Udden, 1912; Cady, 1919; Culver, 1922; Lamar, 1931; Willman and Payne, 1942; Wanless, 1957; White, 1959, 1960, 1962; White and Lamar, 1960; White and O'Brien, 1964.

Sand and Gravel

Sand and gravel underlies large areas of the Illinois Valley floor in all districts along the Waterway. In general, the coarser gravels occur in the upper part of the Waterway area and the deposits become finer down the valley. Coarse gravel occurs in the Morris District and in the La Salle District as far west as Buffalo Rock west of Ottawa. Fine to medium gravel occurs in the La Salle District and locally in the Lacon and Peoria Districts. The largest resources of sand and gravel along the Waterway are in the major terrace areas in the Lacon, Peoria, and Havana Districts, where the material is largely sandy gravel and pebbly sand overlain in large areas by medium to fine sand in dunes.

The principal use of the sand and gravel is for aggregate in portland cement concrete and in bituminous concrete, but large quantities are also used on secondary roads and for miscellaneous purposes. Additional uses of these large resources can be anticipated from the application of methods of improving quality by removal of deleterious materials, such as chert, ironstone concretions, and clay balls that occur in some deposits. Because the sands contain 15 to 25 percent feldspar, they are a potential source of feldspar.

In the Morris District (pl. 1), the area mapped as low terrace (gl) contains coarse gravel. The gravel in the high terrace (gh) and beneath alluvium (alg) is finer, more sandy, and more varied in composition. Although large areas of these deposits remain, the areas available for excavation east of the Dresden Island Dam are becoming restricted because of industrial and residential developments.

In the La Salle District (pl. 2), sand and gravel is produced from the ice-front deltas (gd, sd) at Ottawa and Spring Valley, from the low-terrace deposits (gl) near Buffalo Rock, and from interbedded sand and gravel deposits filling a bedrock valley and overlain by till near Marseilles. The principal resources occur in the low terrace and underlying the floodplain alluvium (al) west of Starved Rock, in the Hennepin terrace (gh), and in terraces (gh) along Bureau Creek. Deposits in deltas (gd) and kames and deposits buried by glacial till are present at many places and are suitable for local uses.

In the Lacon District (pl. 3), the major deposits are sandy gravel in the high terrace (gh), but somewhat coarser deposits of fine gravel occur in the low terrace (gl), beneath the floodplain alluvium (al), and beneath a thick overburden of till (tl). The latter deposits are exposed in the lower parts of the bluffs and tributary valleys, and they occur in an almost continuous bed along the east side of the valley. They have a thin overburden only close to the outcrops.

In the Lacon District, large areas of the terraces at Hennepin, Chillicothe, Lacon, and Spring Bay are overlain by medium- to fine-grained dune sand, and in several areas on the east side of the valley, dunes have migrated onto the bluffs and uplands (sw). Medium and coarse water-laid sand occurs in a large area on the central part of the Henry terrace.

The alluvial fans (af) in the Lacon District contain lenses of gravel and sand, but the deposits are very silty and highly varied and they have not been used commercially. The alluvial fans have not seemed attractive enough to encourage investigation of their potential in an area where deposits low in silt and clay are abundant. However, they offer a potential source for the fine sand that is needed for aggregate and is not abundant in the coarser sand and gravel deposits.

In the Peoria District (pl. 4), the principal resources of sand and gravel are the sandy gravel and sand in the high terrace (sh) that extends from north of Pekin to the south edge of the district on the east side of the valley. Coarser gravel occurs in the low terraces (gl) near Pekin and in the terraces at Peoria, but the latter are largely covered by the city. Sand and gravel also underlies the floodplain alluvium (al) and occurs in the alluvial fans, as in the Lacon District. The largest areas and thickest deposits of dune sand in Illinois occur on the terrace that extends from Pekin southwest through the Havana District nearly to Beardstown.

In the Havana District (pl. 5), the major resources of sand and gravel are in the terrace (sh) on which Havana is located. The deposits are largely pebbly sand and medium to coarse sand overlain by medium to fine sand in dunes. Coarser deposits, mostly fine sandy gravel, occur in narrow remnants of the low terrace that border the high terrace but are not mapped. Coarser deposits also underlie the floodplain deposits (al). Sand and gravel deposits overlain by a thick overburden of till and loess occur in scattered localities in the west bluff of the valley and are a source for local supplies.

In the Beardstown and Pearl Districts (pls. 6 and 7), the deposits in the low terrace (sl) and under the floodplain alluvium (al) are largely sand and pebbly sand. Gravel occurs in the deltas (gd) south of Pearl, where it is overlain by loess, and in scattered localities elsewhere, generally overlain by till and loess. Pebbly sand occurs in the deltas (sd) south of Pearl and in dunes (sw) on the uplands on the east side of the valley.

References: Udden, 1912; Cady, 1919; Culver, 1922; Willman, 1931, 1971; Root, 1935; Lamar, 1938; Willman and Payne, 1942; Wanless, 1957; Lamar and Willman, 1958; Ekblaw and Lamar, 1964; Hunter, 1966; Busch, 1967; Labotka and Hester, 1971; soil reports (see Grayslake Peat).

Coal

Minable coal occurs in all districts along the Waterway except the Pearl District. The coals that have been mined are a local coal in the Spoon Formation and the Colchester (No. 2), Springfield (No. 5), Herrin (No. 6), and Danville (No. 7) Coal Members. Other coals generally less than 1 foot thick occur locally.

In the Morris District (pl. 1), the Colchester (No. 2) Coal has been extensively strip mined (sm). Only the northern edge of a large area of strip mining southeast of Morris is in the Waterway area. The coal has also been stripped and locally mined underground in the terrace area from Morris northeast for about 3 miles. The coal is present but more deeply buried in the area west from Morris to east of Ottawa. At Ottawa it has also been strip mined, partly to recover the clay beneath the coal and the shale above it. The coal has an average thickness of about 2 feet, but it is 3 feet thick in some localities. The local coal in the Spoon Formation has been worked south of Dresden Island Dam, and the Herrin (No. 6) Coal has been mined in a small area northeast of Marseilles.

In the La Salle District (pl. 2), three coals have been mined. The Colchester (No. 2) Coal, the oldest and generally the deepest, was called the "third vein" coal in early reports. It averages about 3 to 3 1/2 feet in thickness. It crops out in only a small area on the west slope of the La Salle Anticline near La Salle and Oglesby, but it has been extensively mined from shaft mines in the area from La Salle to Spring Valley. The Herrin (No. 6) Coal, called the "second vein" coal, averages about 3 feet in thickness but is lenticular. The Danville (No. 7) Coal, called the "first vein" coal, also averages about 3 feet in thickness. The lowest coal (No. 2 Coal) has the highest quality and has been mined most extensively. The coals in this district are not mined at present, although unmined areas remain. The locations of the shafts of some of the abandoned mines are shown by the waste piles mapped on plate 2.

In the Lacon District (pl. 3), the Colchester (No. 2) Coal is widely present but is deeply buried, is 1 to 3 feet thick, and has been mined only locally, at Sparland. The Danville (No. 7) Coal is 2 1/2 to 3 1/2 feet thick, crops out in the Sparland area, and has been mined locally. Coals Nos. 5 and 6 are generally less than 1 foot thick and are present only beneath the upland area in the vicinity of Sparland. Coals Nos. 5, 6, and 7 were widely eroded from this area before deposition of the glacial drift.

In the Peoria District (pl. 4), Coals Nos. 2, 5, 6, and 7 have been mined. The Colchester (No. 2) Coal, about 2 1/2 feet thick, has been strip mined (sm) in the bottomland area northeast of Banner, and it occurs at a shallow depth in a low-terrace area southwest of Banner. It underlies all of the district except the eastern part of the Illinois River floodplain and the western part of the terrace area on the east side of the valley southwest of Kingston Mines. The Springfield (No. 5) Coal, 4 to 4 1/4 feet thick, has been mined underground in the west bluffs of the valley from Bartonville to Kingston Mines and north of Liverpool, and in the east bluffs from East Peoria to Pekin. It has been strip mined in the upland southwest of Banner. The Herrin (No. 6) Coal, about 4 feet thick, has been mined in the bluffs near Kingston Mines, and it is 2 1/2 to 3 feet thick where it underlies the upland near Bartonville and the upland from East Peoria to Pekin. The Danville (No. 7) Coal occurs only in the upland areas near Bartonville and from East Peoria to Pekin. It is about 1 1/2 feet thick, and it has been mined only locally and on a small scale.

In the Havana and Beardstown Districts (pls. 5 and 6), the Colchester (No. 2) Coal occurs in the upland areas west of the valley as far south as Frederick, Fulton County, and again in a small area near La Grange, Brown County. It is about 2 1/2 feet thick and has been mined underground on a small scale at many places in the bluffs and along the tributary valleys.

References: Udden, 1912; Cady, 1919, 1915, 1952; Culver, 1922, 1925; Willman and Payne, 1942; Wanless, 1957; Smith, 1961, 1968; Smith and Berggren, 1963; Reinertsen, 1964.

Silica Sand

The St. Peter Sandstone at Ottawa in the La Salle District (Osp, pl. 2) is one of the major sources of silica sand in the country. The sandstone underlies a large terrace area on the west side of Ottawa. It is largely white quartz sand almost free from clay, heavy minerals, and other impurities. The sandstone is the major source for sand that is washed and screened for the manufacture of glass and other products requiring very low iron content. The sand is also used as grinding and polishing sand, sand blast sand, engine sand, filtration sand, sand for hydraulic fracturing, and standard testing sand, and it has many other uses. The sandstone exposed in the bluffs from Ottawa to Utica is overlain by Pennsylvanian rocks and glacial drift, and generally it is discolored a light yellow. It is used principally for steel molding sand. The sandstone is about 150 feet thick where overlain by Pennsylvanian rocks but is somewhat thinner in the terrace areas, where the top part is eroded. The sandstone also occurs on the western edge of the Morris District at the mouth of the Fox River (Osp, pl. 1).

References: Lamar, 1928; Willman and Payne, 1942.

Peat

Peat deposits (mapped p) occur in all districts in swampy depressions, sloughs, and shallow lakes on the floodplain of the Illinois River and, locally, on the terraces. Peat was formerly dug on the terrace about a mile northeast of Manito in the Peoria District. Although the thickness of most of the deposits is not known, they probably are at most only a few feet thick. Most deposits contain silt beds. Although the peat is potentially a source of material for horticultural purposes, the quality and thickness of the deposits require exploration. The areas of peat on the floodplains are subject to flooding, except where they occur in drainage districts protected by levees.

References: Hester and Lamar, 1969; soil reports (see Grayslake Peat).

Ground Water

Supplies of ground water for industrial, municipal, and farm purposes occur in the sand and gravel fill in the Illinois Valley, in gravel beds in the glacial drift, and in the bedrock formations, as described in reports cited below.

Because some of the bedrock formations that are sources of water supply in the region bordering the Waterway crop out along the Illinois Valley, the danger of polluting these aquifers requires consideration in regional planning. The St. Peter Sandstone, which occurs at the surface in a large area in the La Salle District, is an important source of ground water, and because of its high permeability, it is susceptible to pollution. The Silurian dolomite formations in the Chicago area and the Morris District and the Burlington, Keokuk, Salem, and St. Louis Limestones in the Beardstown and Pearl Districts also are important sources of water. Because the water in these formations occurs largely in joint systems, there is little filtering action and pollution can move considerable distances. The Pennsylvanian rocks are less permeable and contain few water-yielding beds. In the large areas where they are exposed along the Waterway, they serve to prevent surface pollution of the underlying aquifers.

The major sources of water supply in the surficial sand and gravel deposits are in the Sankoty Sand, which occurs in the lower parts of the deep valley cut into the bedrock by the Ancient Mississippi River, particularly in the segment from Hennepin to Beardstown. Large supplies of ground water also occur in terrace sand and gravel deposits, particularly below Hennepin, and to a lesser extent in sand and gravel deposits buried by glacial till in the upland areas, principally above Peoria.

References: Willman and Payne, 1942; Horberg, Larson, and Suter, 1950; Bergstrom et al., 1955; Bergstrom, 1956; Hackett and Bergstrom, 1956; Bergstrom and Zeizel, 1957; Wanless, 1957; Selkregg and Kempton, 1958; Suter et al., 1959; Walton, 1964; Walker, Bergstrom, and Walton, 1965; Hughes, Kraatz, and Landon, 1966; Hoover and Schicht, 1967.

Oil and Gas

No commercial production of oil or gas has come from the Waterway area, but both oil and gas have been produced a short distance west of the Illinois Valley in Pike and Brown Counties and not far east of the valley in Sangamon, Morgan, and Macoupin Counties. Gas for farm supplies has been produced from the glacial drift in Bureau and Putnam Counties southwest of Bureau.

References: Wanless, 1957; Meents, 1958, 1960.

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CIRCULAR 478

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