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REPORT OF INVESTIGATIONS 191

GROUNDWATER GEOLOGY OF THE EAST ST. LOUIS AREA, ILLINOIS

BY

ROBERT E. BERGSTROM AND THEODORE R. WALKER

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

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GROUNDWATER GEOLOGY OF THE EAST ST. LOUIS AREA, ILLINOIS

BY

ROBERT E. BERGSTROM AND THEODORE R. WALKER

ABSTRACT

Geologic conditions favorable for large supplies of groundwater are among the factors promoting the concentrated industrial development of the Mississippi River bottomlands of the East St. Louis area, commonly known as the American Bottoms. The water-yielding deposits of the area are permeable sand and gravel in unconsolidated valley fill. The valley fill, which ranges to over 170 feet in thickness, consists partly of Recent alluvium and partly of older alluvium, some of which is glacial outwash material from the Upper Mississippi Valley. Valley-train sand and gravel occur beneath Recent alluvium in the northern part of the area and are present at the surface in terraces bordering the flood plain in the vicinity of Roxana. The lower alluvium south of the Missouri River mouth is older Missouri River sediment mixed with coarse glacial outwash material from the Upper Mississippi Valley. Although Recent cut-and-fill in this portion of the area has produced heterogeneity in the upper two-thirds of the valley fill, there is a general coarsening of material with depth. The most favorable water-yielding deposits usually occur below a depth of 60 to 90 feet, but clean sand and gravel are not present at all places on the American Bottoms. Distribution of permeable deposits and thickness of valley fill are controlled in part by the configuration of the bedrock valley floor.

Recharge of groundwater in the valley fill is by seepage from rainfall and floods and, in certain areas, by percolation from the Mississippi River and its tributaries. Geologic conditions appear favorable locally for greater groundwater exploitation, especially in some areas close to the river where permeable deposits are present and where river recharge might be induced by pumpage.

INTRODUCTION

Location

The East St. Louis area in southwestern Illinois includes the portions of Madison, St. Clair, and Monroe counties that lie within the valley bottom of the Missisippi River between Alton and Dupo, Ill. (fig. 1). The area is known locally as the *American Bottoms.* It includes about 175 square miles, is approximately 30 miles long, and has a maximum width of 11 miles. The principal cities are East St. Louis, Granite City, Wood River, and Alton.

The area has been mapped by the United States Geological Survey, and topographic maps of the following 7½-minute quadrangles are available: Alton, Bethalto, Columbia Bottom, Wood River, Granite City, Monks Mound, Cahokia, and French Village.

Purpose of Report

The East St. Louis area is one of the most highly industrialized areas in Illinois, and the demand for groundwater supplies

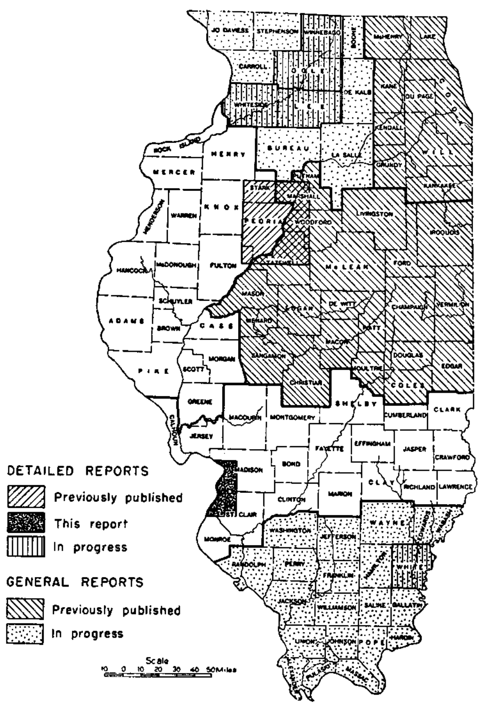


Fig. 1.—Index map showing location of East St. Louis area and major groundwater reports published since 1950 or in progress.

has been great. The total municipal and industrial pumpage of groundwater during 1951 averaged between 100 and 110 million gallons per day (Bruin and Smith, 1953, p. 5). The expansion of existing industries and the influx of new industries indicate that even greater demands will be made on groundwater reservoirs. To develop the groundwater resources to their full potential, careful consideration must be given to the geologic conditions that control the occurrence of groundwater in the area. This report summarizes these conditions and indicates areas favorable or unfavorable for the development of additional supplies. Emphasis is placed on geologic conditions controlling development of the large supplies needed for municipal and industrial purposes. Engineering aspects of the problem, involving detailed hydrologic and production data, have been under investigation for a number of years by the Illinois State Water Survey (Bruin and Smith, 1953).

ACKNOWLEDGMENTS

The authors are indebted to many organizations and persons for assistance in the accumulation of basic data for this investigation. The U. S. Army Corps of Engineers, St. Louis district, supplied logs, samples, maps, and cross sections of test borings, river gauge records, and sounding results. Engineers of the Illinois State Water Survey furnished production figures, water levels, water-quality information, and well locations. E. G. Jones, field engineer for the State Water Survey at Alton, was especially helpful in the collection of information. Well logs and samples were obtained from water well drillers and industries in the East St. Louis area. Engineers of the St. Louis Municipal Waterworks supplied test-boring data. Seismic studies in the area were made by Robert C. Johnson and Robert C. Parks of the Illinois Geological Survey. Carl A. Bays, Consulting Geologist, Urbana, Ill., furnished data on bedrock depths in the Missouri Bottoms west of Alton.

We were assisted by many members of the Geological Survey staff, particularly those of the Division of Groundwater Geology and Geophysical Exploration. Many helpful suggestions and criticisms were made by M. M. Leighton, G. B. Maxey, J. C. Frye, F. C. Foley, H. B. Willman, Leland Horberg, and G. E. Ekblaw.

PREVIOUS INVESTIGATIONS

Early references to the geology of the East St. Louis area are contained in the reports on Madison and St. Clair counties of the first Geological Survey of Illinois, directed by A. H. Worthen (cited below). Subsequent reports on stratigraphy, physiography, and mineral resources were published by Fenneman, and a report on the groundwater resources was published by Bowman and Reeds. The Fenneman and Bowman reports, listed below, have been the primary sources of general geologic information on the area. Other geologic work in the vicinity of East St. Louis has been in connection with larger areal studies or on individual geologic problems. The following publications are concerned with geology of the area, with or without special reference to groundwater:

Bell, A. H., 1929, The Dupo oil field: Illinois Geol. Survey Ill. Pet. 17.

Bowman, Isaiah, and Reeds, C. A., 1907, Water resources of the East St. Louis district: Illinois Geol. Survey Bull. 5.

Drushel, J. A., 1908, Glacial drift under the St. Louis loess: Jour. Geol. v. 16, p. 493-498.

Ekblaw, G. E., and Workman, L. E., 1933, Subsurface geology in the East St. Louis region (abst.): Illinois Acad. Sci. Trans., v. 26, no. 3, p. 101.

Englemann, George, 1947, Carboniferous rocks of St. Louis and vicinity: Am. Jour. Sci., 2nd ser., v. 3, p. 119-120.

Fenneman, N. M., 1907, Stratigraphic work in the vicinity of East St. Louis: Illinois Geol. Survey Bull. 4, p. 213-217.

———, 1909, Physiography of the St. Louis area: Illinois Geol. Survey Bull. 12.

———, 1911, Geology and mineral resources of the St. Louis quadrangle, Mo.-Ill.: U. S. Geol. Survey Bull. 438.

Flint, R. F., 1941, Ozark segment of Mississippi River: Jour. Geol., v. 49, p. 626-640.

Horberg, Leland, 1950, Bedrock topography of Illinois: Illinois Geol. Survey Bull. 73.

Leverett, Frank, 1870, The Illinois glacial lobe: U. S. Geol. Survey Mon. 38, p. 64.

————, 1895, The preglacial valleys of the Mississippi and its tributaries: Jour. Geol., v. 3, p. 740-763.

————, 1921, Outline of the Pleiscene history of Mississippi Valley: Jour. Geol., v. 29, p. 615-626.

Robertson, P., 1937, Drift exposures in St. Louis and St. Louis County (abst.): Missouri Acad. Sci. Proc., v. 3, no. 4, p. 129.

————, 1938, Some problems of the middle Mississippi River during Pleistocene time: St. Louis Acad. Sci. Trans., v. 29, no. 6, p. 169-240.

————, 1940, Some Pleistocene terraces of the Mississipi River (abst.): Geol. Soc. Am. Bull., v. 51, no. 12, pt. 2, p. 2041.

Rubey, W. W., 1952, Geology and mineral resources of the Hardin and Brussels quadrangles (in Illinois): U. S. Geol. Survey Prof. Paper 218.

Wanless, H. R., 1933, Pennsylvanian rocks of Madison and St. Clair counties, Illinois: Illinois Acad. Sci. Trans., v. 26, no. 3, p. 105.

Worthen, A. H., 1866, Madison County: Geol. Survey of Illinois, v. 1, p. 249-263.

————, 1866, St. Clair County: Geol. Survey of Illinois, v. 1, p. 231-248.

Of the following publications, pertaining more specifically to engineering phases of groundwater work, the report by Bruin and Smith contains the most recent and complete information on the hydrology and water quality in the American Bottoms:

Brittain, D., 1875, On the well at the Insane Asylum, St. Louis Co., Missouri: Am. Jour. Sci., 3rd ser., v. 9, p. 61-62.

Broadhead, G. C., 1878, On the well at the Insane Asylum, St. Louis Co.: St. Louis Acad. Sci. Trans., v. 3, p. 216.

Bruin, Jack, and Smith, H. F., 1953, Preliminary investigation of groundwater resources in the American Bottoms: Illinois Water Survey Rept. Inv. 17.

Gleason, C. D., 1935, Underground waters in St. Louis County and City of St. Louis, Missouri: Missouri Div. of Geol. Survey and Water Resources, Bienn. Rept. of State Geologist, 1933-34, app. 5.

Prout, H. A., 1853, Belcher's artesian well in St. Louis: Am. Jour. Sci., 2nd ser., v. 15, p. 460-463.

St. Louis Chamber of Commerce, 1950, The industrial water resources of the St. Louis area.

Searcy, J. K., Baker, R. C., and Durum, W. H., 1952, Water resources of the St. Louis area, Missouri: U. S. Geol. Survey Circ. 216.

Shepard, E. M., 1907, Underground waters of Missouri—their geology and utilization: U. S. Geol. Survey Water Supply Paper 195.

Suter, Max, 1942, Groundwater studies in the East St. Louis district: Illinois Engineer, v. 18, no. 2.

EXTENT AND RELIABILITY OF SUBSURFACE DATA

This report is based on a study of about 700 logs of wells and borings, supplemented by studies of available samples. Most of the logs are of water wells or of test borings made prior to the construction of water wells. Many are logs of borings made by the U. S. Corps of Engineers in connection with levee construction. A few are logs of oil wells or oil test holes. Most of the borings do not extend through the unconsolidated sediments lying above bedrock. Many of the wells were drilled to what the drillers assumed to be bedrock, but it is likely that many of these borings end at large boulders several feet above the bedrock, for nearby wells record greater depths to bedrock. The Corps of Engineers recognizes the possibility that many of their borings end with the bit resting on a boulder lying above bedrock; they label such depths "bit refusal" rather than "bedrock." The term "bit refusal" is preferred to an unqualified designation as bedrock in those cases where the drilling does not actually continue into bedrock for at least a few feet.

In mapping the surface of the bedrock, we have considered as reliable only those wells that have penetrated the underlying rock. The only wells that satisfy this requirement are the oil wells and oil test holes, and these are few. The reliability of the remainder of the logs is open to some question, so a subjective factor was involved in construction of the bedrock surface contour map.

Logs of oil wells and oil test holes are of little value in giving information on the lithology of the unconsolidated material in the American Bottoms because they lack detail in the upper sections. For information on the lithology of the valley fill, reliance must be placed upon logs of shallow borings. Logs obtained from the Corps of Engineers are considered to be the most reliable. The borings from which these logs were made were supervised by field engineers experienced in collecting and recording such data, and the sampling intervals were closely spaced. In addition, many of these logs have been compiled after mechanical analyses were made of the samples. Logs obtained from water-well drillers are less reliable, as many lack detail. Where drillers attempted to classify the sediments into grain sizes, a large personal factor was involved. For example, the sediment in many samples is described as "building sand" or "quicksand"; in such cases much has been left for us to interpret.

Some information also has been obtained from excavations made for the construction of piers and abutments for bridges across the Mississippi River. These give reliable information on bedrock elevations but at best furnish only very generalized information on the nature of the unconsolidated sediments. To supplement the data available on depth to bedrock, a refraction seismograph study was made at locations where well information was lacking.

An attempt was made to obtain additional information on the stratigraphy of the unconsolidated sediments by the electrical earth resistivity method. Twenty-five resistivity stations were set up adjacent to wells or borings for which detailed logs were available and which thus could serve as controls. The results of this work are inconclusive. We decided that unknown factors were influencing the resistivity readings, and this phase of the investigation was halted.

TOPOGRAPHY AND DRAINAGE

The Missouri and Mississippi rivers come together in the northern part of the area, about 5 miles downstream from Alton. Upward from this junction within the area of study and for several miles upstream, these two rivers flow southeast in the same valley, bordered on each side by bluffs of Mississippian limestone (tables 1 and 2). Below this junction the Mississippi River flows south across the area. Through the middle of the area the river valley crosses the western edge of a lowland cut in easily eroded Pennsylvanian ("Coal Measures") rocks and attains its maximum width (approximately 11 miles). In the southwestern part of the area the river crosses the more resistant Mississippian limestone and its valley narrows to about 3½ miles in width. At present, only in the area above Alton is the Mississippi River eroding the valley walls on the Illinois side. It is cutting along the western bluffs throughout the remainder of the area.

Along the river channel, the flood plain ranges in average elevation from 415 feet in the vicinity of Alton to 405 feet in the vicinity of Dupo. In this distance of 30 miles, the river falls 16 feet, a gradient of about 6 inches per mile.

In relatively recent geologic time, the Mississippi River has changed its course frequently in the East St. Louis area, producing a complex variety of land forms and

PLATE 1.—A. Horseshoe Lake bed, Madison County, Ill. View east from highway U.S. 66 near National City. B. Shell Oil Company Wood River Refinery, built on terrace above the Mississippi River flood plain. View southwest from bluffs east of Roxana, Madison County, Ill.

river deposits (Fenneman, 1909, p. 13, 29). Horseshoe Lake(pl. 1A) and other crescent-shaped lakes, swamps, and lowlands in the area mark the location of former meanders abandoned in the process of channel migration. The arcuate ridges and swales that border these meander loops on the concave side were formed as slackwater bars in former channels. East of the meander belt are discontinuous areas of poorly drained lowlands or backwater swamps which have been partially filled by silt and clay from floodwaters of the Mississippi and local tributaries.

In the northern part of the American Bottoms, deposits of sand and gravel occur in terraces that stand above the flood plain. They are eroded remnants of a valley fill of sand and gravel deposited by water from melting glaciers to the north, in the Mississippi drainage basin. These deposits formerly filled the valley to the present levels of the terraces. The low, broad ridge upon which East Alton, Wood River, Roxana,

PLATE 2.—A. Mounds at Cahokia Mounds State Park, Madison Co. B. East bluffs bordering the American Bottoms. Looking northeast from 3 miles northeast of Horseshoe Lake, Madison Co.

and South Roxana are built is a terrace that stands 40 feet or more above the Mississippi River and 25 to 35 feet above the present flood plain (pl. 1B). The terrace is 440 to 450 feet above sea level. The front of the terrace has a sharp rise of 12 to 15 feet. This terrace level is also represented by low flat-topped knolls in the vicinity of Poag and just west of Indian Creek south of Roxana.

Many areas on the American Bottoms are somewhat above the flood plain but are below the level of the terrace at Wood River. North of Horseshoe Lake, the elevation of this intermediate level is 420 to 435 feet. It is more recent than the Roxana terrace but also may represent aggradation during late glacial time.

Between East St. Louis and the eastern bluff is a group of mounds occupying an area of 3 to 4 square miles (pl. 2A). The largest of these, Monks Mound, is about 85 feet high, whereas the smaller ones are only a few feet high. Although some of the mounds are symmetrical, steep, and cone-shaped, indicating an artificial origin, some of them may be remnants of an earlier higher flood plain.

The bluff that forms the eastern edge of the valley rises 150 to 200 feet above the valley bottom. Bedrock is well exposed in the bluffs on the Illinois side of the river in only two places, northwest of Alton in the northern part of the area and south of Stolle in the southern part. Most of the bluffs on the eastern side of the valley (pl. 2B) are covered by a mantle of glacial drift overlain by windblown silt called *loess*. With the exception of the two areas mentioned, the loess also blankets the face of the bedrock bluff. Between Edgemont and Caseyville, however, the loess cover is patchy and there are scattered outcrops of Pennsylvanian bedrock in the bluffs.

Many alluvial fans have been developed below the bluffs on the eastern side of the valley. These fans are composed predominantly of reworked loess which has been picked up by tributary streams in the upland and redeposited where the tributaries enter the main valley. As a result of the deposition of alluvial fans, the elevation of the valley bottom adjacent to the eastern bluff is 30 to 50 feet higher than the general elevation of the valley bottom. The alluvial fans, however, are not to be confused with the terraces of glacial sand and gravel mentioned above, for they gently slope and thin valleyward and have an entirely different lithologic composition.

The upland adjacent to the American Bottoms consists of broad, flat plains separated by relatively narrow, deep valleys. In most places the major tributary streams appear to follow preglacial bedrock valleys. The valley floors have relatively steep gradients as they join the main valley. In contrast, the Mississippi valley bottom slopes gently southward at an average rate of only about 6 inches per mile. In times of heavy rainfall the tributaries carry more water than normally can be confined within their banks in their lower courses across the Mississippi flood plain. Formerly this resulted in numerous floods along those portions of the tributaries that lie within the valley. As a corrective measure, the lower courses of the tributary streams have been straightened and levees constructed to prevent flooding of agricultural lands.

East of Dupo and south of Stolle, where easily dissolved Mississippian limestones are near the surface, the ground is pitted with hundreds of sinkholes 10 to 40 feet deep. This irregular sinkhole topography is markedly different from the flat divides and narrow valleys farther east.

OCCURRENCE AND MOVEMENT OF GROUNDWATER

General Principles

Water flowing over the ground or falling on the ground as rainfall seeps through openings between loose particles of the soil and percolates downward. Below a certain depth, all openings in the loose surface materials and underlying bedrock are filled with water.

The upper surface of the saturated zone is called the *water table*. Its position is determined by the depth at which water stands in wells, borings, and excavations. The water-table surface roughly parallels the surface topography, rising under the uplands and intersecting the ground surface along perennial streams, lakes, and swamps. Its position fluctuates from season to season and year to year. The water table is lowered during periods of prolonged drought; it rises during periods of excessive rainfall. In the East St. Louis region its position is normally at a depth of about 15 to 20 feet below the surface of the valley floor, although concentrated pumpage has lowered it considerably over much of the area.*

The water in the upper part of the saturated zone is unconfined and moves under the influence of gravity in the direction of the water-table slope. In wells that penetrate the saturated zone under these conditions, the water level indicates the level of the water table; these wells are called *water-table wells*.

Where permeable water-bearing formations (aquifers) are overlain by relatively impermeable formations and the water in the aquifers is confined under hydrostatic pressure, artesian conditions exist. Wells penetrating such aquifers are called *artesian*

* For a water-table map of this area see Illinois State Water Survey Rept. Inv. 17, p. 19.

wells. The water levels in artesian wells stand above the bottom of the confining impermeable bed and may be either above or below the level of the water table at any particular place.

Water-table and artesian systems ideally represent two fundamentally different sets of hydrologic conditions. Commonly, however, the confining layer of the artesian aquifer is only relatively impermeable and thus allows slow transmission of water from the system into adjacent aquifers. This is called a *leaky artesian* condition and it most commonly and nearly always prevails in interbedded unconsolidated deposits with different permeabilities, such as the valley fill and glacial deposits in the East St. Louis area.

Aquifers in the East St. Louis Area

VALLEY FILL

For practical purposes, the only aquifer for large-quantity production in the East St. Louis area is valley-fill material, which includes both alluvium and glacial outwash. Groundwater occurs in the valley fill, with its interbedded layers and lenses of varying permeability, primarily under water-table and leaky artesian conditions. At present, this aquifer furnishes all the groundwater pumped from wells in the valley bottom.

BEDROCK

Bedrock aquifers, although in part capable of producing large quantities of water, are now of negligible importance in the American Bottoms because of the possibility of highly mineralized water at depth, the ready availability of water from shallower valley-fill deposits, and the high cost of deep drilling. In many places on the uplands, however, the bedrock is the only groundwater source available and is tapped for domestic supplies. The shallower bedrock formations in this region are not highly productive, and the deeper ones yield highly mineralized water.

GLACIAL DRIFT

Thin deposits of glacial drift are present on the upland adjacent to the area. This material consists of glacial till overlain locally by 50 feet or more of loess. In some places thin beds of sand and gravel within the till furnish enough water for domestic supplies. These local sand and gravel beds are generally found near the base of the till. They are not persistent and their presence normally cannot be predicted prior to drilling.

GEOLOGIC HISTORY

Paleozoic Era

The present landscape of the East St. Louis area has been produced by processes acting only during relatively recent geologic time. A vast amount of earlier time is represented by the indurated sedimentary rocks that underlie the unconsolidated alluvial fill of the American Bottoms (pl. 4). There is virtually no sedimentary record in this area for the time between the formation of the youngest of these sedimentary rocks (Pennsylvanian) and the advance of Kansan ice during the Pleistocene or glacial epoch. A summary of geologic events is given in table 1.

The bedded rocks of the Paleozoic era beneath the valley fill and in the bluffs of the East St. Louis area rest on the eroded surface of much older (pre-Cambrian) rocks at a depth of over 3800 feet. The Paleozoic seas in which these rocks were deposited as sediments alternately advanced and retreated in the area. The position of the shorelines and the character of the sediments deposited were controlled to some extent by activity in the nearby Ozark area, which was uplifted from time to time, beginning early in the Paleozoic era. The sandy and shaly rocks reflect the washing of sands and muds into the shallow seas, whereas the limestones and dolomites suggest clear seas. No doubt crustal movements were gentle, and neither seas nor highlands were strongly or rapidly modified.

At the close of the Pennsylvanian period the sea withdrew and the area became land. It is likely that the area was never again submerged by the sea, though in other parts of the United States thousands of feet of marine sedimentary rocks were formed dur-

TABLE 1.—SUMMARY OF GEOLOGIC HISTORY

Geologic time division				Geologic events in East St. Louis area
Era	Period	Epoch		
Cenozoic	Quaternary	Pleistocene	Recent	Shifting of river channel; modification of flood plain; formation of alluvial fans along bluffs.
			Wisconsin	Deposition of valley trains and loess; dissection of valley-train deposits and formation of terraces.
			Sangamon	Weathering and erosion of till and valley-train deposits; reopening of valley.
			Illinoian	Advance of glacier across American Bottoms and onto bluffs at St. Louis; Mississippi River probably maintained course through or under ice.
			Yarmouth	Weathering and erosion of till and valley-train deposits; reopening of drainage through valley.
			Kansan	Advance of glacial ice; deposition of till; possible damming or restriction of Mississippi Valley.
			Aftonian	Weathering, erosion.
			Nebraskan	Advance of glacial ice, which may have reached this area; deposition of valley train.
	Tertiary			Complex series of crustal movements and erosional cycles; establishment of major drainage lines; major cutting of Mississippi bedrock valley.
Mesozoic	Cretaceous			Erosion.
	Jurassic			
	Triassic			
Paleozoic	Permian			Uplift and erosion.
	Pennsylvanian			Periodic submergences by sea with formation of coal swamps during emergent intervals.
	Mississippian			Submergence; formation of shales and thick limestone formations.
	Devonian			Deposition of lime sediments followed by emergence and erosion.
	Silurian			Deposition of limy sediments along outer margin of a great reef belt; later emergence and erosion.
	Ordovician			Continued submergence, with formation of dolomite, shale, and sandstone; intervals of emergence and erosion.
	Cambrian			Prolonged erosion; later submergence and formation of thick beds of sandstone and dolomite.
Pre-Cambrian				Long period of igneous activity, sedimentation, crustal activity, and erosion.

ing the 250 million years after the Pennsylvanian period.

Mesozoic and Tertiary History

The post-Pennsylvanian history of the East St. Louis area is mainly an account of the wearing down of the land by ancient streams during and after periods of crustal uplift. Four cycles of uplift and erosion are recorded in the bedrock surface of western Illinois (Horberg, 1953, p. 39). Each cycle of erosion was initiated by a period of uplift that gave streams more erosive power and caused them to cut into and partially destroy the existing land surface. The oldest erosion surface, because it was involved in all subsequent periods of uplift, has been largely destroyed, but remnants are preserved in the flat upland surfaces of Calhoun County, 25 miles northwest of Alton.

The crustal uplifts produced many drainage shifts. The latest movement probably established the major drainage patterns in essentially their present form, although many segments of river channels were doubtlessly inherited from early courses. Because the Mississippi River between St. Louis and Cape Girardeau cuts across resistant Mississippian rocks, which have been uplifted along the eastern side of the Ozark dome, instead of flowing across the lowland of the softer Pennsylvanian rocks farther east, it is possible that the river was established in its present channel prior to uplift of the dome. Regional structural and geomorphic relationships suggest that the Mississippi Valley is very old. Furthermore, from regional evidence it appears that it may have been cut essentially to its present depth before the advance of Pleistocene glaciers.

Pleistocene Epoch

The advance of continental glaciers into northern United States during the Pleistocene epoch profoundly modified the landscape. Areas actually overridden by the glaciers were blanketed by unsorted rock debris as the ice melted and dropped its load. Beyond the ice front, sediment-laden meltwaters escaped down valleys toward the sea, partially filling them with glacial sand and gravel deposits that became progressively finer downstream. The river flats, kept free of vegetation by frequent glacial flooding, were subject to wind erosion, and great volumes of silt were picked up and transported to the uplands bordering the valleys. The unsorted ice-laid deposits (till), the sorted water-laid material (outwash), and the wind-transported silts (loess) mantle the bedrock in the American Bottoms and adjacent area.

The history of the earlier glacial advances (Nebraskan and Kansan) in the area is obscure, but later glacial events are better documented. The presence of Illinoian till in St. Louis and along the eastern bluffs of the valley indicates that the Illinoian ice, advancing from the northeast, extended across the American Bottoms.

The "clay," "blue clay," and "blue clay and gravel" that are logged in many wells just above bedrock in the Alton–Wood River area may be pebbly glacial till which could be of Illinoian age or older. Because the Illinoian drift is thin, it is unlikely that the valley was completely filled at that time, although drainage was temporarily blocked or restricted so that ponding took place upstream in the Mississippi, Illinois, and Missouri valleys.

The Wisconsin glacial stage in the East St. Louis area was marked by the downstream spread of outwash as valley trains during ice advances in the north and by deposition of loess on the bluffs. Loess is well exposed in the uplands on the eastern side of the valley, particularly in road cuts along Highway 460 between East St. Louis and Belleville where the road first enters the uplands. The loess deposits indicate that the Mississippi valley bottom was covered with extensive valley-train deposits including glacial rock flour from Wisconsin ice sheets. The nearest approach of Wisconsin ice was during the Tazewell substage when the ice advanced into Shelby County, some 75 miles to the northeast.

During one glacial advance, the flood plain at East St. Louis was aggraded to an elevation of about 445 feet. Remnants of this surface are the terraces at Roxana and Wood River and along Cahokia Creek.

Subsequent river downcutting destroyed this surface in all but the northern portion of the American Bottoms. The Recent river scour and reworking have not been complete, however, for the lower section of the valley fill is believed to be partly glacial in origin. Wood fragments found in the lower part of the fill have been dated by the radioactive carbon method as older than 20,000 years, which dates the wood, and presumably the deposits containing the wood, as at least as old as early Wisconsin.

The large boulders commonly encountered at depths of 80 feet or more, which sometimes limit the depth of drill penetration, are probably remnants of Illinoian or older till.

In Recent time the river has scoured and reworked the upper part of the valley fill in migrating across the broad bottomlands. The channel scouring has taken place chiefly during floods when volume and velocity were high. At the same time, spreading floodwaters have deposited silt and clay along the sides of the channel and in backwater areas. In subsiding and low-water river stages, only fine-grained sediments have been transported, and silting has taken place in the channel. The channel migration, cut-and-fill, and flooding have produced complex, heterogeneous deposits which vary in depth (fig. 4). Soundings at Eads Bridge during river flood have indicated river scour as deep as 80 feet (Woodward, 1881, p. 5). This figure is thought to represent the average depth to which the valley fill has been reworked along the Recent meander belt. Below this depth the deposits are glacial outwash material and older alluvium.

The broad alluvial fans found below the bluffs are also of Recent age. They are composed of reworked loess and have been built outward across the valley fill by tributary streams and slope wash.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE BEDROCK

Regional Relations

The river sediments of the American Bottoms are underlain by consolidated sedimentary rocks over 3800 feet thick, as shown by a well completed at the City Sanatorium in St. Louis in 1869 (Broadhead, 1878).

The bedrock formations, dominantly limestone and dolomite with subordinate amounts of sandstone and shale, dip gently northeastward from the Ozark highlands toward the Illinois Basin. In the area of the American Bottoms, minor folds have been superimposed upon the regional structure so that locally the beds may dip in other directions (plate 4). For example, in the southern part of the area a sharp transverse arch produces reversals of the regional dip. The axis of this fold extends from the vicinity of Waterloo in Monroe County in a northwesterly direction through Dupo on the American Bottoms and across the Mississippi at Arsenal Island into St. Louis. The steeply dipping beds on the southern limb of the arch can be seen in the bluffs south of Dupo. The arch is the controlling structure for the accumulation of oil in the Waterloo and Dupo oil fields of Illinois (Bell, 1929). The Florissant dome north of St. Louis is near the trend of the structure.

Mississippian rocks underlie the valley fill in the western part of the American Bottoms, and Pennsylvanian rocks underlie the bottom sediments in the eastern part. The approximate boundary between Pennsylvanian and Mississippian rocks is shown in plate 3. A summary of formations underlying the American Bottoms is given in table 2.

The Mississippi River now follows a channel underlain, beneath the alluvium, by Mississippian limestones. The widening of the Mississippi Valley between Wood River and Dupo is a result of the river's lateral cutting into the easily eroded shales of the Pennsylvanian and Mississippian (Chester) formations upstream from the resistant Mississippian limestones that are at the surface in the Waterloo-Dupo structure.

Lithology of the Bedrock

Most information on the bedrock formations in the American Bottoms has come

TABLE 2.—GEOLOGIC FORMATIONS OF THE EAST ST. LOUIS AREA AND THEIR GROUNDWATER POSSIBILITIES

Era	System	Series	Group	Formation	Average thickness	Material	Groundwater possibilities in East St. Louis area
Cenozoic	Quaternary	Pleistocene	Recent alluvium		0–100	Sand, gravel, silt, and clay	Permeable sands and gravels are water-yielding.
			Glacial till, outwash, and loess		10–170	Pebbly clay, sand and gravel, and silt	
	Pennsylvanian				100–400	Shale, sandstone, limestone, and coal	Some of the sandstones and limestones have sufficient permeability to yield water for domestic drilled wells.
	Mississippian	Chester			0–200	Sandstone, shale, and limestone	Some of the sandstones, particularly in lower part of the series (Aux Vases), have moderate permeabilities and are fair-to-good groundwater sources, if close to outcrop area or not too deeply buried.
		Iowa	Meramec	Ste. Genevieve	0–150	Sandy oolitic limestone	Yield water from joints and solution channels. Meramec limestones, particularly St. Louis, are potential water sources north of Alton, in St. Louis, and in sinkhole region south of Stolle.
				St. Louis	200–250	Limestone and dolomite, fine grained	
				Salem	50–100	Dolomite and granular fossiliferous limestone	
			Osage	Warsaw	40–140	Shale and argillaceous limestone	Keokuk-Burlington limestones are less cavernous than St. Louis limestone and therefore not as favorable as a groundwater source except along Dupo arch where limestone is close to surface.
				Keokuk-Burlington	200–270	Cherty crinoidal limestone	
				Fern Glen	45–100	Shaly limestone	
			Kinderhook	Chouteau	10–30	Slightly silty fine-grained limestone	Not water-yielding.
Paleozoic				Hannibal-Grassy Creek	5–50	Dark shale	

Devonian				0–30	Sandy limestone and dolomite	Devonian-Silurian limestone may yield water from joints and solution crevices, but at depth encountered the water is highly mineralized.
Silurian	Niagaran	Bainbridge	Moccasin Springs	20–170	Shaly red limestone	
			St. Clair	30–40	Crystalline pink-speckled limestone	
	Alexandrian		Sexton Creek	20–30	Cherty limestone	
			Edgewood	5–30	Silty dolomite	
Ordovician	Cincinnatian		Maquoketa	140–160	Shale and shaly limestone	Not water-yielding.
	Mohawkian		Kimmswick	75–100	Coarse-grained crinoidal limestone	Kimmswick-Joachim limestone not well jointed or cut by solution channels and not considered a likely groundwater source, even of highly mineralized water.
			Decorah	15–30	Limestone and shale	
			Plattin	100–200	Fine-grained limestone	
	Chazy		Joachim	70–120	Silty dolomite	
			St. Peter	135–155	Clean sandstone, poorly cemented	High permeability, but groundwater highly mineralized.
	Prairie du Chien			850±	Dolomite and sandstone	Most of section is dense dolomite with poor groundwater possibilities. Permeable formations contain highly mineralized water.
Cambrian	St. Croixan			1350±	Dolomite, sandstone, and shale	

Ancient granitic and other crystalline rocks referred to the Proterozoic and Archeozoic eras, called per-Cambrian rocks.

from oil test wells, most of which are drilled to the Kimmswick limestone, the producing formation in the Dupo oil field. Some wells have gone to the St. Peter sandstone; only a few have gone deeper.

A sample-study log of one of the deeper oil tests, drilled 2 miles southeast of Dupo, follows.

Lockwood-Dyroff well 1—NW corner NE¼ sec. 26, T. 1 N., R. 10 W., St. Clair Co. Drilled November 1929. Illinois Geological Survey sample-study set 723, studied by F. E. Tippie. The pre-St. Peter correlations are in part based on a study of this well by John Grohekopf and Earl McCracken, Missouri Geological Survey.

	Depth feet
Pleistocene system	
"Soil"	26
Mississippian system	
Iowa series	
Meramec group	
St. Louis limestone	
"Limestone, white, hard"	45
Limestone, slightly oolitic, finely sandy, white, extra fine	50
"Limestone, white, hard"	90
Limestone, finely sandy, light brown, sublithographic; dolomite, sandy, brown, very fine	95
"Limestone, white, hard"	150
Dolomite, cherty, silty, light gray, very fine	155
"Limestone, white, hard"	165
Limestone, slightly sandy and cherty, buff, very fine	170
Dolomite, partly sandy and argillaceous, light brown, very fine	180
"Limestone, white, brown"	210
Limestone, partly oolitic, slightly cherty, brown, very fine	215
Limestone, dolomitic, brown, extra fine	225
Limestone, dolomitic, cherty, partly oolitic, white to light brown, very fine	235
Limestone, brown, sublithographic	240
Limestone, partly oolitic, dolomitic, white to brown, very fine	265
Dolomite, slightly cherty, brown, very fine	273
Salem limestone	
Limestone, dolomitic, oolitic, slightly cherty, brown, very fine	283
Limestone, brown, lithographic	290
Limestone, dolomitic, oolitic, light brown, very fine	305
Limestone, oolitic, cherty, slightly sandy, light brown, fine	325
Limestone, dolomitic, cherty, brown, very fine	335
Limestone, slightly sandy, mottled gray and brown, medium	345
Limestone, slightly sandy, light brown, medium	385
Limestone, slightly dolomitic, gray, brown, mottled very fine	395
Limestone, slightly dolomitic and sandy, gray, brown, medium, conglomeratic	410
Dolomite, gray, very fine	415
Limestone, dolomitic, brownish, gray, very fine to fine	425
Osage group	
Warsaw formation	
Dolomite, slightly argillaceous, brown, gray, little greenish, very fine	445
Dolomite, very argillaceous, cherty, gray, very fine; shale, dolomitic, gray	460
"Shale, blue, soft"	495
Dolomite and shale as above	500
Keokuk-Burlington limestones	
Dolomite, extra cherty, light gray, very fine, glauconitic	515
Dolomite, argillaceous, extra cherty, gray, very fine, glauconitic	530
Limestone, dolomitic, slightly sandy, white, very fine, partly glauconitic; chert, white, abundant, partly glauconitic	676
Limestone, cherty, white, fine to coarse, crinoidal	681
Fern Glen formation	
Dolomite, very argillaceous, green, grading to shale	690
Limestone, cherty, light brown, reddish, sublithographic	695
Limestone, cherty, white, fine to coarse, crinoidal; shale, calcareous, green	700
Limestone, cherty, white, greenish, very fine to fine, crinoidal; shale, calcareous, green, red at base	715
"Shale, blue, soft"	730
Limestone, argillaceous, slightly cherty, white to red, very fine to coarse, crinoidal; shale, calcareous, red, green	750
"Lime, red, soft"	755
Kinderhook group	
Chouteau limestone	
"Lime, gray, hard"	770
Limestone, white, brownish, sublithographic	785
Hannibal shale	
Shale, dark gray to black, few coarse sand grains at base	798
Silurian system	
Dolomite, silty, slightly cherty, white, little pinkish, very fine	825
Dolomite, cherty, light brown, very fine	830
Limestone, dolomitic, cherty, white, very fine to medium	845
Dolomite, slightly cherty, light brown, very fine	868

	Depth feet
Ordovician system	
Maquoketa formation	
Shale, dolomitic, silty, green, gray, very weak	925
Shale, silty, dolomitic, dark brown	935
Siltstone, calcareous, light brown; dolomite, argillaceous, cherty, silty, gray, very fine	950
Shale, calcareous, brownish gray; and limestone, very argillaceous, brownish gray; little chert	1015
Kimmswick limestone	
Limestone, white to light brown, very fine, little coarse	1020
Limestone, white to light brown, fine to lithographic	1030
Limestone, white, buff, fine to coarse	1065
Limestone, cherty, white to light brown, fine to coarse	1110
Dolomite, brown, very fine	1113
Decorah formation	
Limestone, dolomitic, argillaceous, brown, very fine; little shale, gray	1130
Plattin limestone	
Limestone, slightly cherty, light brown, sublithographic	1140
Dolomite, slightly cherty, light brown, very fine	1165
Dolomite as above; limestone, partly cherty, white, brownish, sublithographic	1240
Limestone, slightly cherty, white to buff, very fine	1260
Limestone, slightly cherty, light brown to white, sublithographic	1285
Limestone, slightly cherty, light brown to white, very fine; little dolomite, dark brown, very fine to base	1325
Joachim dolomite	
Dolomite, light grayish brown, very fine; shale, dolomitic, greenish gray	1335
Dolomite, light gray to light brown, very fine	1385
Dolomite, white, buff, very fine, becoming slightly argillaceous and cherty at base	1410
"Lime, gray, soft"	1425
Shale, green, very weak; dolomite, white, light brown, very fine	1433
Dolomite, argillaceous, brown, gray, greenish, very fine	1440
Dolomite, white to brownish, very fine, finely sandy at base	1473
Shale, dolomitic, finely sandy, gray	1478
Glenwood–St. Peter sandstone	
Sandstone, white to red (iron stain), fine to coarse, incoherent, generally rounded and frosted; little shale, sandy, green at base	1632

	Depth feet
Cotter and Everton formations	
Dolomite, cherty, white, very fine, scattered sand grains, iron stain	1645
Sandstone, white, fine to coarse, iron stain	1650
Dolomite, cherty, white, very fine	1690
Dolomite as above; little sandstone, dolomitic, medium, scattered sand grains	1705
Dolomite as above; little shale, slightly dolomitic, gray	1710
Dolomite, cherty, buff, very fine; sandstone, white, incoherent	1725
Dolomite, cherty, partly sandy, white to buff, very fine	1780
Cotter formation	
Dolomite, partly sandy, white to gray, very fine	1800
Dolomite, cherty, slightly sandy, light brown, very fine	1850
Dolomite, sandy, white to light brown, very fine; chert, banded, oolitic; little sandstone, calcareous, white, fine to coarse	1895
Upper Jefferson City formation	
Dolomite, sandy, white, brownish, very fine; chert, white; sandstone, calcareous, white, fine to coarse; shale, calcareous, gray at base	1985
Lower Jefferson City dolomite	
Dolomite, slightly sandy, very cherty, white, gray, light brown, very fine; chert, bluish, white, translucent	2155
Roubidoux formation	
Dolomite, silty, sandy, gray, buff, very fine; much chert, white, opaque, partly sandy	2240
Sandstone, white, fine to medium, subangular, incoherent; dolomite, as above; little bright green shale at base	2285
Gasconade formation	
Dolomite, white, fine to coarse, scattered sand	2307
Dolomite, very cherty, white, very fine to fine, scattered sand	2450
Dolomite, cherty, partly sandy, white to light gray, very fine to fine	2495
Gunter formation	
Dolomite, very sandy, cherty, white, very fine to fine; sandstone, dolomitic, white, fine	2530
Cambrian system	
Eminence dolomite	
Dolomite, very cherty, white, very fine to fine, scattered sand	2575
Shale, sandy, white, very weak, slightly glauconitic	2580
Dolomite, cherty, partly sandy, white to light brown, very fine to fine	2730

	Depth feet
"Lime, gray, hard"	2740
"Sand, gray"	2764
Potosi dolomite	
Dolomite, cherty, sandy, light brown, very fine to fine with some medium, pyritic	2900
"Sand, white; oil"	2904

The log of the City Sanatorium well in St. Louis (Broadhead, 1878) suggests that the Potosi dolomite, encountered in the lower part of Lockwood-Dyroff well 1, may be underlain by at least 800 feet of Cambrian beds, principally dolomite except for shale beds of the Davis formation and basal Lamotte sandstone.

In the eastern portion of the American Bottoms, wells drilled into bedrock penetrate several hundred feet of shale, sandstone, and thin limestone beds of the Pennsylvanian system and the Chester series (Mississippian) before reaching the massive Mississippian limestones that are near the surface south of Stolle and north of Alton. The sample-study log of a well 1½ miles northeast of Horseshoe Lake illustrates the nature of these upper beds.

Kesl–Kusmanoff well 1—660 feet N line, 330 feet W line, SW¼ SE¼ sec. 12, T. 3 N., R. 9 W., Madison Co. Drilled July 1947. Illinois Geological Survey sample-study set 17178, studied by M. P. Meyer and Heinz Lowenstam. Depths adjusted to electric log and drilling time. Core study from 1215 to 1227 and from 1641 to 1687 feet.

	Thickness feet	Depth feet
Pleistocene and Pennsylvanian systems		
No samples	165	165
Samples not studied	35	200
Shale, gray, carbonaceous, micaceous, weak	30	230
Sandstone, argillaceous, silty, gray, very fine to fine, friable; interbedded shale, sandy, gray, carbonaceous	6	236
Mississippian system		
Chester series		
Paint Creek formation		
Limestone, sandy (very fine), buff, very oolitic, medium to coarse, compact	12	248
Limestone, partly argillaceous, buff, fine to medium, crinoidal	3	251
Shale, calcareous, green, weak	12	263
Limestone, argillaceous at top, brown, medium to coarse, fossiliferous, crinoidal	10	273
Shale, calcareous, mottled red and green, weak	8	281
Yankeetown siltstone		
Siltstone, very cherty, calcareous, white, compact; little sandstone, cherty, calcareous, very fine at top	6	287
Renault formation		
Shale, slightly calcareous, green and gray variegated, weak	3	290
Limestone, sandy (fine), glauconitic, light gray, medium	3	293
Sandstone, calcareous, argillaceous, green, very fine, tight; shale, green, gray to purple, weak	7	300
Siltstone, greenish gray, friable; shale, silty, mottled purple and green at top	10	310
Shale, silty, green, purple, weak; shale, red at base	8	318
Sandstone, silty, light gray to green, very fine to fine, friable	13	331
Shale, red and green variegated, weak	9	340
Shale, silty and sandy, calcareous, green, weak; grading to sandstone, argillaceous, silty, very fine, green	15	355
Shale, as above; pyrite	10	365
Aux Vases sandstone		
Sandstone, slightly calcareous, silty, light gray, very fine, friable	5	370
Sandstone, calcareous, light gray, fine, friable	16	386
Iowa series		
Meramec group		
St. Louis formation		
Limestone, buff, partly sandy, fine to oolitic to lithographic	14	400
Samples not studied	295	695
Limestone, very cherty, buff, fine, oolitic	10	705
Dolomite, very cherty, buff, red speckled, extra fine	50	755
Salem limestone		
Limestone, brown, gray speckled, medium, fossiliferous	5	760
Limestone, dolomitic, grayish brown, fine to medium, fossiliferous, oolitic (*Endothyra*)	15	775

	Thickness feet	*Depth feet*
Limestone, dolomitic, gray, black specked, extra fine, medium	20	795
Limestone, grayish brown, medium to coarse, fossiliferous	16	811
Osage group		
Warsaw formation		
Dolomite, silty, slightly glauconitic, gray, extra fine; quartz	14	825
Limestone, dolomitic, silty, slightly glauconitic, gray, extra fine; quartz	5	830
Shale, very dolomitic, calcareous, silty, gray, brittle; quartz	27	857
Limestone, argillaceous, silty, gray, fine; quartz	31	888
Keokuk–Burlington limestone		
Limestone, glauconitic, cherty, buff, coarse	14	902
Limestone, very cherty, glauconitic, light buff, medium to coarse	23	925
Samples not studied	125	1050
Limestone, very cherty, white, medium to coarse	15	1065
Fern Glen limestone		
Limestone, dolomitic, silty, cherty, light gray to green, extra fine	30	1095
Limestone, cherty, argillaceous, silty, green, sublithographic	30	1125
Limestone, as above; grading to little shale, calcareous, mottled red and green	27	1152
Kinderhook group		
Chouteau limestone		
Limestone, white to light buff, lithographic	21	1173
Limestone, red, sublithographic	6	1179
Limestone, light green, sublithographic	5	1184
Hannibal–Grassy Creek shale		
Shale, black, weak	26	1210
Shale, silty, gray, weak	5	1215
Shale, brown, tough, sporangites; "Hardin sand" 1 inch at base, argillaceous, coarse, fine, pyritic at base	4	1219
Silurian system		
Niagaran series		
Dolomite, argillaceous, silty, light gray, pyritic	37	1256
Limestone, dolomitic, argillaceous, gray to greenish gray, fine, some red shale partings	22	1278
Shale, calcareous, greenish gray; few limestone streaks, as above	7	1285
Limestone, dolomitic, argillaceous, greenish gray, fine, with pink and red silty shale partings	20	1305
Limestone, silty, argillaceous, red, fine, scatered coarse crinoidal fragments	14	1319
Shale, calcareous, red, brittle	6	1325
Limestone, dolomitic, argillaceous, silty, red, crinoidal	27	1352
Limestone, white to buff, fine to medium, with red crinoidal; streaks siltstone, argillaceous, red	48	1400
Limestone, as above, dolomitic, less crinoidal	6	1406
Alexandrian series		
Kankakee formation		
Dolomite, slightly calcareous, buff, light brown, fine	15	1421
Limestone, slightly glauconitic, white to light gray, medium crystalline, pyritic, very cherty from 1435 to 1452 feet	31	1452
Edgewood dolomite		
Dolomite, calcareous, light brown, fine, sucrose	20	1472
Ordovician system		
Maquoketa shale		
Shale, light greenish gray, weak; streaks siltstone to sandstone, very fine, friable	28	1500
Samples not studied	95	1595
Shale, silty, green, brown speckled, weak	26	1621
Shale, silty, calcareous, green, grayish brown, weak	11	1632
Kimmswick limestone		
Limestone, buff, red speckled, medium	9	1641
Limestone, buff, medium to coarse, fossiliferous, compact, brown and gray shale partings	46	1687

Plate 4 shows representative graphic logs from several deep wells in the American Bottoms.

Groundwater in the Bedrock Formations

No groundwater supplies are being withdrawn from bedrock formations in the American Bottoms, mainly because adequate water supplies of suitable quality are available in the shallower valley-fill material. Groundwater is obtained in St. Louis from wells drilled into upper Mississippian limestones, although the municipal water supply of St. Louis and the major cities of the American Bottoms is obtained from the Mississippi River.

On the eastern upland bordering the valley, water is obtained from sandstones of the Chester series, from sandstones and fractured limestones of the Pennsylvanian system, and from Mississippian limestones. Belleville formerly obtained its water supply from wells drilled 500 to 600 feet deep, into Chester sandstones, but now obtains its supply from East St. Louis.

Beneath the uplands from East Alton to Belleville, Pennsylvanian and Chester sandstones are potential sources of water. Because of their thinness and low permeability, Pennsylvanian sandstones are rarely suitable for other than domestic wells. Mississippian limestones yield groundwater from solution channels and joints. They are potential sources of groundwater mainly between Prairie du Pont Creek and the Mississippi River in the southern part of the area and north and west of Alton in the northern part of the area.

Water obtained from bedrock commonly is too highly mineralized to be acceptable for domestic or industrial use, particularly at depths greater than 370 to 420 feet below ground level on the flood plain and 515 feet below ground level on the uplands (Bowman and Reeds, 1907, p. 56). In general, mineralization increases with formation depth. Analyses of water from bedrock formations in St. Louis County, Mo., show from 4,415 to 11,010.6 ppm total dissolved solids from pre-St. Peter formations and more than 1,000 ppm from the St. Peter at depths below 800 feet (Gleason, 1935). Because the beds dip to the northeast, a given formation generally yields progressively more highly mineralized water in that direction.

The general movement of groundwater is to the northeast, in the general direction of the regional dip of the bedrock formations. Minor structures, as at Dupo, may modify the direction of this movement. The dip of permeable rocks that crop out around the Ozark highlands and the presence of interbedded relatively impermeable shales produce artesian conditions. In the St. Louis–East St. Louis area, the St. Peter sandstone yields water under artesian pressure, although the pressure is insufficient to produce a flowing well. Artesian wells of low yield also have been reported from other formations in the area.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE VALLEY FILL

Bedrock Valley

As shown in the bedrock surface map (fig. 2) and cross sections (fig. 4 and plate 4), the present Mississippi River Valley occupies a deep bedrock valley that has been partially filled by aggrading processes of the river. In much of the area, the bedrock valley floor lies 100 feet or more beneath the bottom of the present valley; in at least one place its depth is over 170 feet (see fig. 3 for thickness of valley fill above the bedrock). Available data indicate that the bedrock valley has steep walls along the present bluff line but that the valley bottom slopes gently toward the middle. In the vicinity of Dupo, the valley narrows as the river crosses resistant Mississippian limestones. Between Dupo and Alton, soft Pennsylvanian sandstone and shale beds form the eastern wall of the bedrock valley The limestone at Dupo may have resisted downcutting by the river and thus promoted upstream lateral cutting of the Pennsylvanian strata, causing widening of the valley in the middle of the area. Valley widening probably has been aided further by the coincidental location of the weaker beds outside a major bend in the river. The elevation of the bottom of the bedrock valley averages about 310 feet. The bedrock upland bordering the valley on the east ranges in elevation from about 500 feet east of Horseshoe Lake to over 600 feet east of Dupo.

Several types of data suggest that an inner channel, shown within the 280-foot contour lines in figure 2, has been cut at least 20 feet below the average level of the bedrock valley floor.

The log of a test well at Roxana (location A-10) shows 171 feet of valley fill, with bedrock not yet reached. The elevation of bedrock here must be less than 281 feet above sea level. Although there is abundant information from wells in the vicinity of the test hole, reliability of the data concerning depth to bedrock is uncertain. It is likely, however, that bedrock elevation at this location is at least 20 feet below that found in the adjacent area. An oil well between Dupo and East Carondelet penetrated 122 feet of valley fill before reaching bedrock. The bedrock elevation here is 280 feet above sea level, approximately 20 feet lower than in nearby wells. In excavating for the east abutment of Eads Bridge, which connects East St. Louis with St. Louis, bedrock was encountered at 284 feet above sea level. This, too, is approximately 20 feet below the general elevation of the bedrock valley floor.

Another indication of the channel has resulted from seismic work in the area. At several locations in the middle of the valley, bedrock elevations were calculated to be substantially below the elevation of the adjacent bedrock valley floor. Seismic data give elevations for the middle channel that range from 235 feet near the southern border of the area to 260 feet just west of Wood River. It is believed that the indicated 235-foot elevation is too low (possibly by 25 feet) and that the channel floor in this part of the valley is closer to 260 feet above sea level. The basis for this estimate is a Corps of Engineers line of test holes across the Mississippi River four miles to the south, in Monroe County, where the elevation of the channel floor is 256.75 feet. Other seismic stations, apparently over the channel, give elevations of 273, 280, 266, and 263 feet. The linear arrangement of these low elevations and the generally good agreement between seismic results and known elevations tend to confirm the existence of a channel cut below an elevation of 280 feet as far north as Wood River. It is also possible that the channel, at least in the southern part of the area, has an elevation as low as 260 feet. Additional information must be obtained before the exact position and maximum depths of this channel can be determined. On the basis of bedrock elevations given for the Illinois and Upper Mississippi valleys by Horberg (1950), the 280-foot contour line is carried north of Wood River in the bedrock surface map (fig. 2).

Three wells more or less in a line from Monks Mound northeastward also give bedrock elevations somewhat below adjacent areas. These wells record bedrock at an elevation below 290 feet and suggest the presence of a channel—possibly a tributary of the main channel—that swings close to the bluffs north of Caseyville.

In the reach of the Mississippi River known as "Chain-of-Rocks," west of Granite City, the present channel crosses a gently sloping bedrock bench. Along this part of the channel, from approximately a mile north of Merchant's Bridge to a mile north of Chain-of-Rocks Bridge, the river flows partly on bedrock. The shallowness of the water here interferes with river shipping and has led to the construction of Chain-of-Rocks Canal, which serves as a bypass.

Bedrock in the Chain-of-Rocks area is 20 to 80 feet higher than in the remainder of the valley; as a result, the valley fill is thinner by the same amount (fig. 3). As the river is actively eroding the bedrock here, this portion of the bedrock valley is undoubtedly younger than the deeper valley to the east.

The bedrock tributary valleys shown in figure 2 coincide with the present stream valleys. There is, however, a discordance between the bedrock valley and the present Wood River channel between East Alton and Alton where the river enters the American Bottoms. Here the river follows the western side of a mile-wide valley and flows across a spur of Mississippian limestone at an elevation of about 420 feet; half a mile to the east, the bedrock valley is 100 feet deeper and contains about 110 feet of fill.

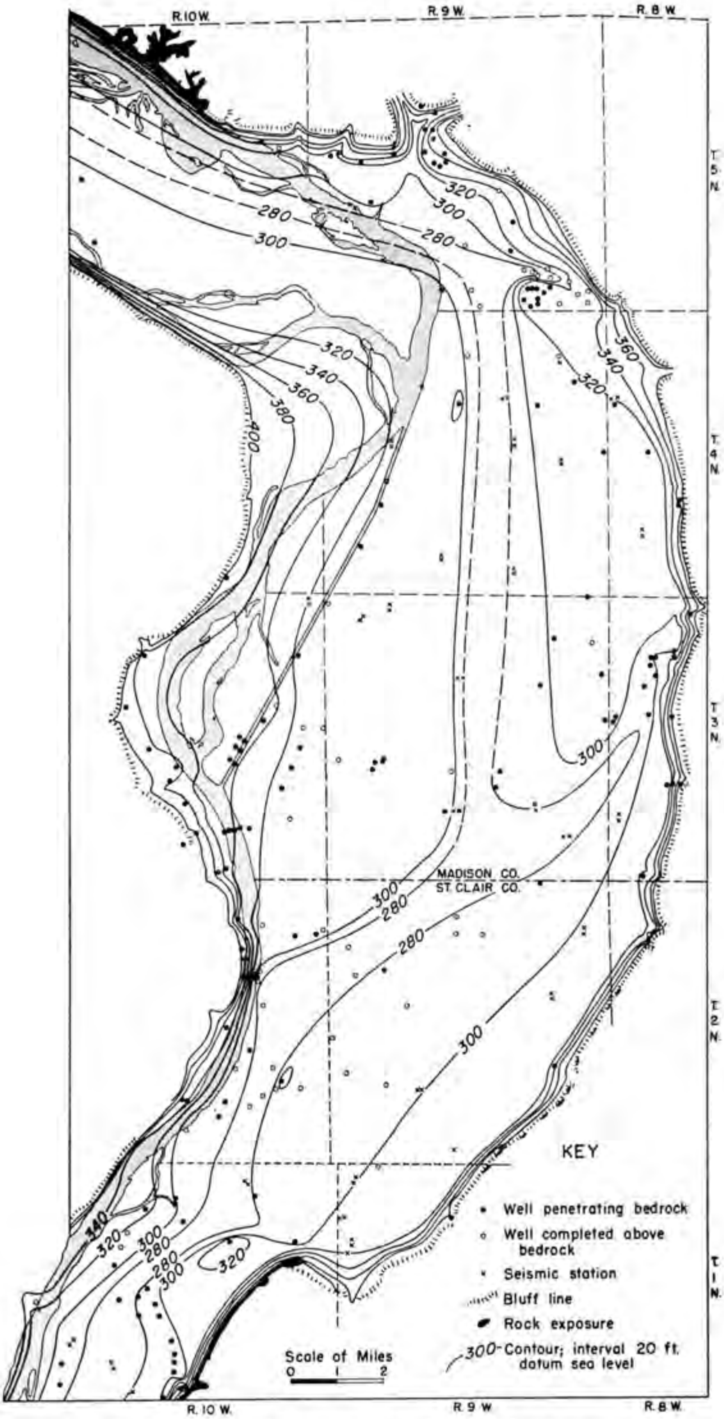


FIG. 2.—Bedrock surface map of the East St. Louis area, Ill.

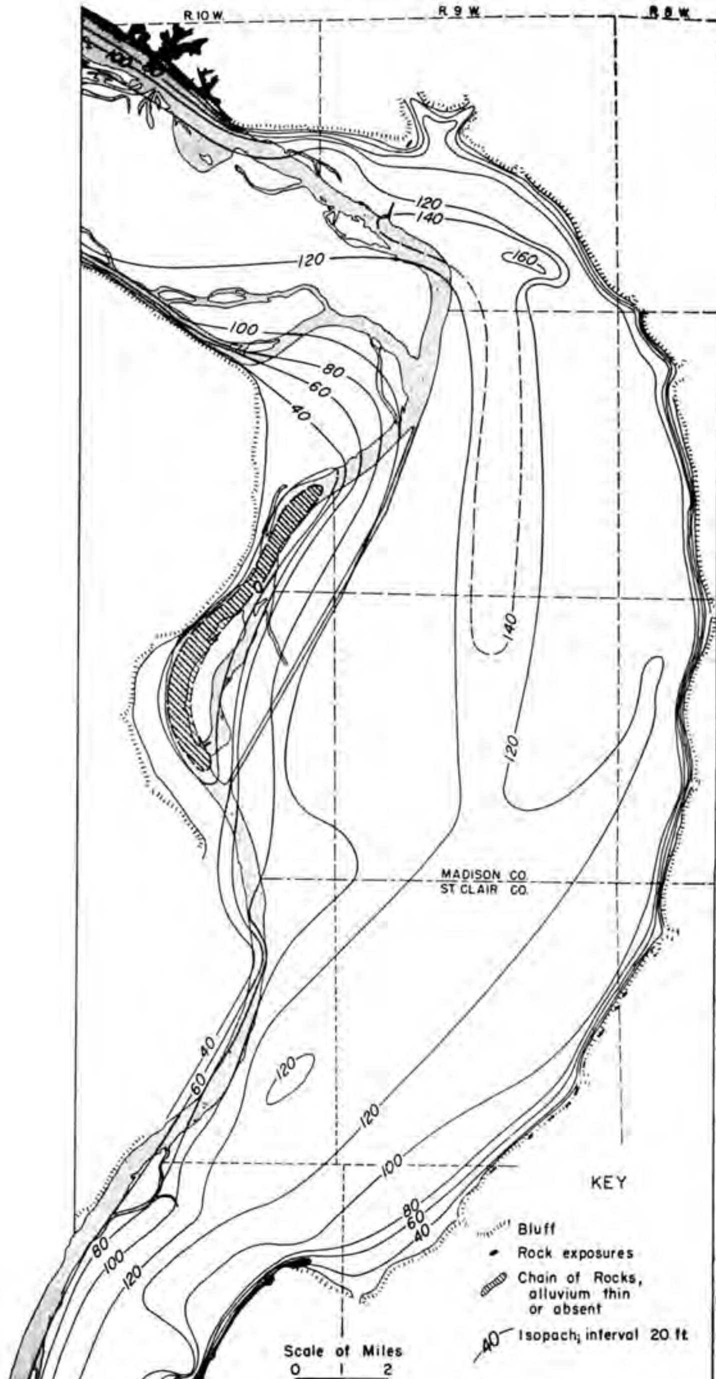


FIG. 3.—Thickness of the valley fill in the East St. Louis area, Ill.

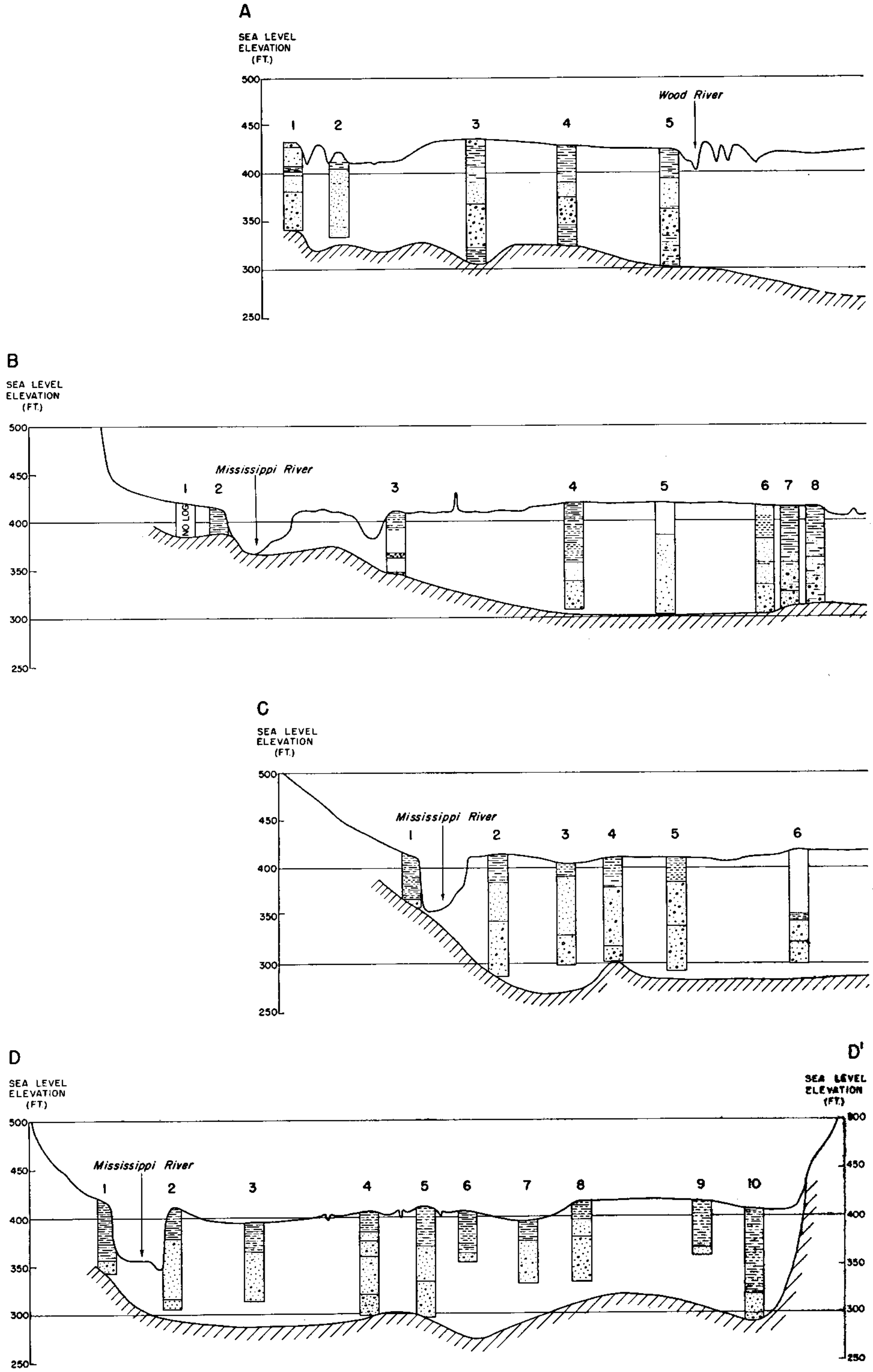


FIG. 4.—Cross sections of the valley fill in the East St. Louis area, Ill.

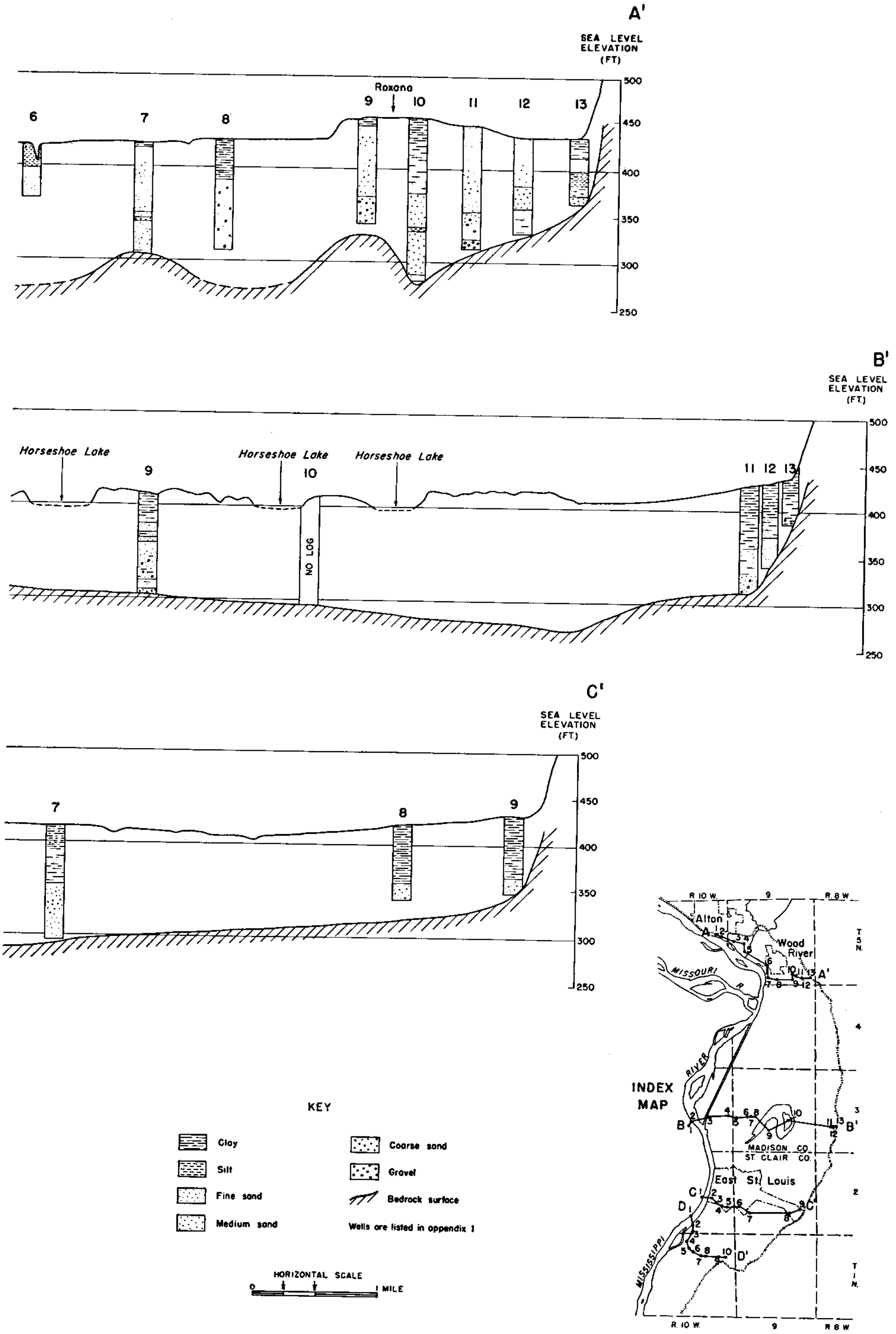

A'
SEA LEVEL ELEVATION (FT)
500
450
400
350
300
250
Roxana
6
7
8
9
10
11
12
13
B'
SEA LEVEL ELEVATION (FT.)
Horseshoe Lake
Horseshoe Lake
Horseshoe Lake
9
10
NO LOG
11 12 13
C'
SEA LEVEL ELEVATION (FT.)
7
8
9
KEY
Clay
Silt
Fine sand
Medium sand
Coarse sand
Gravel
Bedrock surface
Wells are listed in appendix 1
HORIZONTAL SCALE
0
1 MILE
INDEX MAP
R 10 W.
9
R 8 W.
Alton
Wood River
MISSOURI R.
RIVER
MADISON CO.
ST. CLAIR CO.
East St. Louis
MISSISSIPPI
A
A'
B
B'
C
C'
D
D'

FIG. 4.—(cont.)

Valley Fill

The valley fill of the American Bottoms is composed of Recent alluvium and glacial valley-train material derived from the drainage areas of the upper Mississippi and Missouri rivers. Thickness and cross sections of the valley fill are shown in figures 3 and 4.

Valley-train material is found at the surface in the valley only in terraces in the vicinity of Roxana and Wood River. This material is distinctive in composition and texture (see below). Similar material has been found at depth in a few wells near the terrace, separated from overlying Recent alluvium by a rather marked lithologic break. In most of the area, valley-train material is buried beneath the Recent alluvium.

In most of the American Bottoms, differentiation of valley-train and other alluvial deposits, on the basis of mineralogical and textural characteristics or on lithologic breaks, is not possible. South of the Missouri River mouth, the valley fill contains no apparent discontinuity; valley-train material in this area is apparently mixed with older Missouri River alluvium. These deposits, in addition, have been reworked to varying depths by Recent river scour-and-fill.

Glacial Valley-Train Deposits

In the Roxana-Hartford area there is a mineralogical difference between the valley-train and Recent alluvial deposits, but south of the Missouri River mouth the valley fill cannot be separated into glacial outwash and alluvial deposits. The sands of the Roxana–Wood River terrace and those in the lower portion of the valley fill at Hartford average 75 to 80 percent quartz, 8 to 15 percent potash feldspar, 5 to 10 percent plagioclase feldspar, and 2 to 6 percent other material. Over 85 percent of the quartz grains are clear and untinted, and the majority are subrounded to rounded. About 10 percent of the quartz grains are pink. Many have flecks of reddish stain in tiny pits on their surfaces. Washing the sand in dilute hydrochloric acid virtually eliminates the pink color of the quartz grains. However, owing to the large proportion of potash feldspar and pink-tinted quartz grains, dry valley-train sands commonly look pink.

The valley-train deposits underlying the terrace at Roxana are texturally quite distinctive. The bulk of the material below shallow depths consists of well-sorted medium-to-coarse sand; median diameters range from .01 inch (.25 mm) to .03 inch (.76 mm). The small amount of gravel present is of granule size (between 4 and 9 mesh).

The sample study of a well at Roxana illustrates the nature of the valley-train material underlying the terrace.

Illinois State Geological Survey test hole 3 (1954)—Roxana Water Works, SE¼ NE¼ SE¼ SE¼ sec. 27, T. 5 N., R. 9 W., Madison Co. Samples studied by R. E. Bergstrom. Est. elev. 445 feet.

	Thickness feet	*Depth feet*
Pleistocene series		
Wisconsin or older Pleistocene		
Clay and silt, yellowish brown, noncalcareous	10	10
Silt and clay, with fine sand, yellowish brown, lumps of pink clay, slightly calcareous	5	15
Sand, fine, dirty, dark reddish brown, calcareous, pink-stained quartz grains	15	30
No samples	5	35
Sand, medium, light reddish brown, calcareous, subrounded grains, rhyolite porphyry, feldspar, graywacke, milky chert	15	50
Sand, medium to coarse, as above	20	70
Sand, fine to very coarse, light brown, dirty, gray silt, coal, mica	20	90
Sand, medium to coarse, light reddish brown, subrounded to subangular grains, abundant feldspar, reddish siltstone and rhyolite porphyry	15	105
Sand, coarse to medium, as above	10	115
Sand, very coarse, as above	5	120
Sand, very coarse, with granule gravel, subangular to angular grains, chert, reddish siltstone, granite, graywacke	5	127
Pennsylvanian system		
Shale, gray and brown	9½	136½

Textural uniformity, which characterizes the deposits of the terrace, does not appear to be a general feature of the valley-train material. Wells near the terrace but on lower levels in the Hartford–Wood

River area pass through deposits that resemble the valley train mineralogically but range from medium sand to pebble gravel. These deposits occur in the lower 20 to 40 feet of the valley fill; in a few wells there is a rather sharp break in composition between them and the overlying alluvium.

The sample study from a well drilled at the Sinclair refinery at Hartford, one mile west of the Wood River terrace, illustrates the nature of the valley-train material beneath Recent alluvium and the lithologic break that separates them.

Sinclair Oil Company well 2 (1952)—150 feet N, 1750 feet E of SW corner sec. 34, T. 5 N., R. 9 W., Madison Co. Samples studied by R. E. Bergstrom. Est. elev. 431 feet.

	Thickness feet	*Depth feet*
Pleistocene series		
Recent alluvium		
No samples	35	35
Sand, very fine, well sorted, olive gray, mollusk shell fragments, abundant mica, coal, wood	35	70
Silt and clay, with fine sand and small gravel, pebbles to ¾ inch, mollusk shell fragments, calcareous	5	75
Wisconsin or older Pleistocene		
Sand, medium to coarse, yellowish brown, dry sample has pinkish cast, grains subrounded to rounded, slightly calcareous	40	115
Sand and pebble gravel, pebbles to 1½ inches in diameter, abundant chert, limestone, graywacke, rhyolite	7½	122½

At the Shell Oil Company loading dock, a mile west of the above location, the lower part of the river fill is also interpreted as glacial valley train. A sample of wood from this material was obtained from a Shell Oil Co. collector well (fig. 5). It is dated as "older than 24,000 years" by the carbon 14 method, which tends to corroborate the valley-train interpretation (Libby, 1954).

South of the Missouri River mouth, valley-train and other alluvial deposits cannot be differentiated. Wells here penetrate, from top to bottom, 10 to 30 feet of surficial silt and clay, silty sand and gravel, and cleaner sand and gravel. At many places coarse bands, generally at depths greater than 75 feet, contain substantial deposits of granule and pebble gravel. Well samples from these zones have numerous pebbles ranging up to 1½ inches in diameter. Some larger pebbles and even large boulders are reported from the lower depths. Median diameters of the water-yielding deposits below the surficial silt and clay range from .008 inch (.22 mm; fine sand) to .08 inch (2.2 mm; granule gravel) in sieved well samples. It is likely that the larger size does not represent the median diameter of the coarsest deposits in the American Bottoms.

Although logs and samples of most wells south of the Missouri River mouth show a general coarsening with depth and give little evidence of a break within the valley fill, it seems reasonable to refer some of the deeper and coarser sand and gravel to glacial origin and the upper material to Recent alluviation. The evidence for this interpretation is: 1) the presence of glacial valley-train material beneath the Wood River terrace and at lower depths at Hartford, as indicated by distinctive composition and carbon 14 dating; 2) studies of present Mississippi River erosion and sedimentation, which show scour up to 80 feet along the present channel but general transportation of mainly fine material; and 3) the presence of extensive deposits containing pebble gravel and boulders, indicative of high velocities and large volumes of water, 100 feet and more beneath the present flood plain.

The coarse deeper deposits are shown by the sample study of a well between Dupo and East Carondelet, in the southern part of the area. In this well the driller reported a thickness of 20 feet of sand, gravel, and boulders below a depth of 75 feet and, below this material, 17½ feet of sand, gravel, and broken rock.

Illinois Geological Survey test hole 2 (1954)—Lutton farm; 4300 feet S of 80° 32′ 30″ N, 5200 feet E of 90° 15′ W, Cahokia Quadrangle, St. Clair Co. Studied by R. E. Bergstrom. Est. elev. 405 feet.

	Thickness feet	*Depth feet*
Pleistocene series		
Recent and older alluvium		
Silt and clay, dark brownish gray	5	5
Silt and clay, with fine sand, dark brownish gray, calcareous, mica	10	15

FIG. 5.—Shell Oil Co. high-capacity well at Hartford, Ill. Mississippi River in the background.

	Thickness feet	Depth feet
Sand, fine to medium, dirty, dark olive-gray, mica, wood fragments, coal, tiny calcareous spicules, shell fragments	30	45
Sand, coarse to very coarse, with granule gravel, abundant feldspar, granite, graywacke, chert, and dolomite granules	30	75
Gravel, granule size, with coarse to very coarse sand, quartz, granite, chert, dolomite granules (driller reports boulders)	20	95
Gravel, granule size with broken limestone rock, chert (pebble count of 50 pebbles —15 graywacke and fine-grained basic igneous rock; 12 chert, brown, reddish, and cream-colored; 11 quartz; 3 feldspar; 4 limestone; 4 granite; 1 dolomite); broken rock consists of sharp angular limestone, granite, rhyolite porphyry, and chert	10	105
Broken rock (limestone rubble above solid bedrock?) and granule gravel	7½	112½

The lack of a diagnostic composition in the valley-train material in the southern portion of the American Bottoms may be a result of mixing sediments from the Upper Mississippi Valley with those brought in from the Missouri River drainage basin.

OTHER ALLUVIAL DEPOSITS

Samples of Recent alluvial deposits, obtained from wells at shallow depths close to the present river channel, differ from the valley-train deposits in the Hartford–Wood River area. The sands average 65 to 75 percent quartz, 10 to 13 percent potash feldspar, 12 to 15 percent plagioclase feldspar, and 4 to 7 percent other materials. The quartz grains are dominantly clear, untinted and unstained, and subangular to subrounded. The sand samples commonly look gray, in contrast to the valley-train sands, which look pink.

The grains classified above as "other materials" are chert, limestone, jasper, shale, coal, graywacke, and heavy minerals. The alluvial deposits, like the valley-train deposits, are only slightly calcareous, averaging 3 to 4 percent soluble material by weight.

A further characteristic of the alluvium at Hartford and the upper portion of the valley fill in the area in general is the presence of abundant flakes of mica of the phlogopite and biotite varieties, scattered fragments of pearly mollusk shells, tiny rod-like calcium carbonate spicules, and abundant coal fragments.

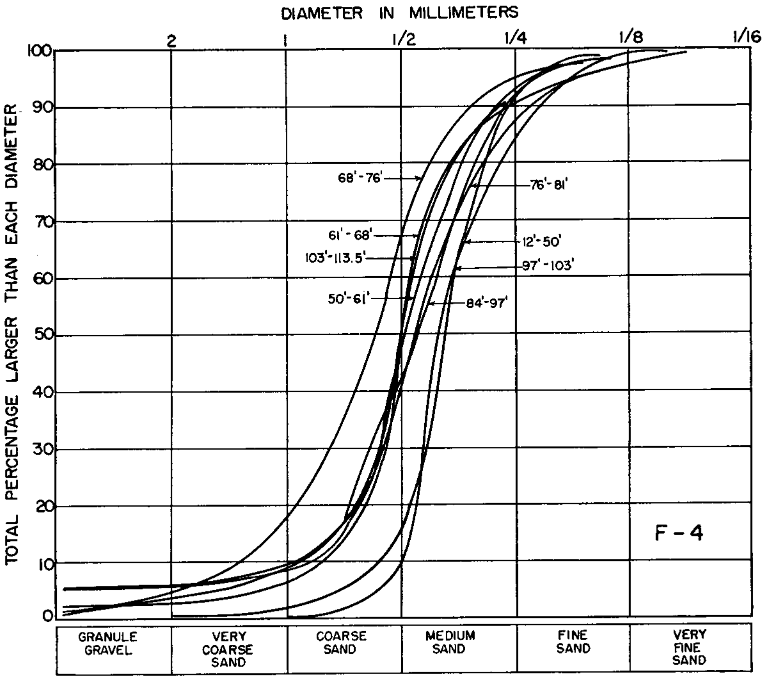
The Recent alluvium ranges in texture from clay to granule gravel. The upper 15 to 30 feet is commonly silt and clay with some fine sand. Below this depth the deposits are highly variable, consisting of clean to dirty sand and gravel. These deposits are underlain in most of the area by coarser sands and gravels. Carbon 14 dating of wood obtained from this lower material indicates that in part at least it is older than Recent. Its exact origin is uncertain. It may be older alluvial, valley-train, or reworked valley-train material. The vertical variations in texture contrast with deposits of the Roxana–Wood River terrace.

The sample study from a well at Granite City is typical of many wells on the American Bottoms. It illustrates the occurrence of the upper silt and clay zone, interbedded sand and gravel deposits below the upper fine-grained beds, the coarser material in the lower part, and the lack of a conspicuous break in lithology.

Union Starch and Refining Company (1952)—950 feet S of 38° 42′ 30″ N, 2350 feet E of 90° 10′ W, T. 3 N., R. 10 W., Madison Co. Illinois Geological Survey sample set 23406. Studied by R. E. Bergstrom. Est. elev. 422 feet.

	Thickness feet	*Depth feet*
Pleistocene series		
Recent and older alluvium		
Soil, clay, and silt, dark gray	10	10
Sand, fine to coarse, subangular grains, abundant feldspar, tiny calcareous spicules, coal	30	40
Sand, medium, with granule gravel, as above, mollusk shell fragments	10	50
Sand, fine, with granule gravel, poor sorting, calcareous spicules, abundant dark grains of igneous rocks, ferromagnesium minerals, and coal	10	60
Gravel, granule size, with coarse sand, granules mainly igneous rocks and feldspar	10	70
No samples	10	80
Sand, medium to fine, calcareous spicules, subangular grains, coal	10	90
No samples	5	95
Sand, very coarse to coarse, with granule gravel, pinkish cast, abundant pink-stained quartz grains, subangular to subrounded grains	15	110
Sand, medium, well sorted, pink, subrounded to subangular grains, abundant pink feldspar	5	115

In figure 6, four mechanical analyses plotted as cumulative frequency curves illustrate the consistency of the valley-train deposits of the Roxana–Wood River terrace compared with deposits of other parts of the American Bottoms. The good sorting of the terrace deposits is indicated in the upper two curves by their steepness. The consistency of the textures with depth is shown by the close spacing of the curves representing different depths. The lower curves, of sam-



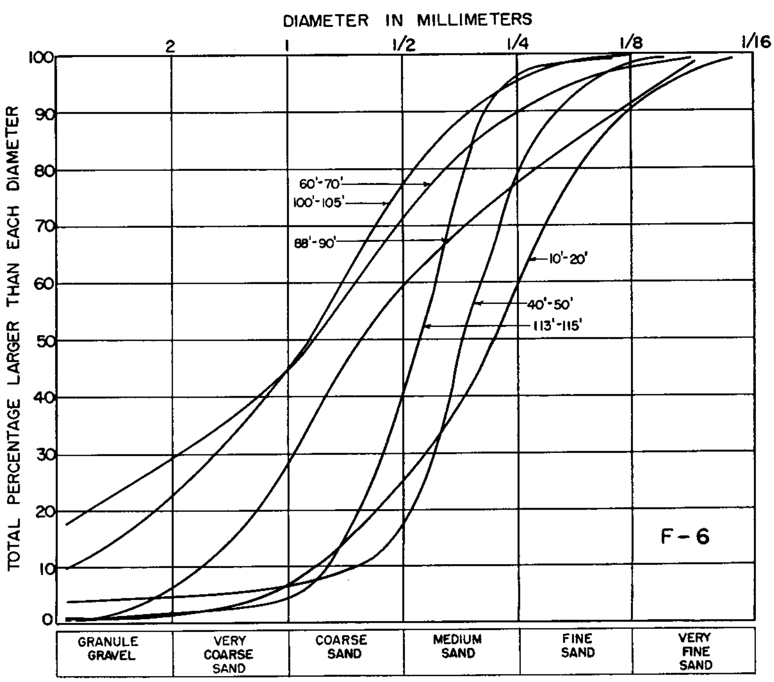
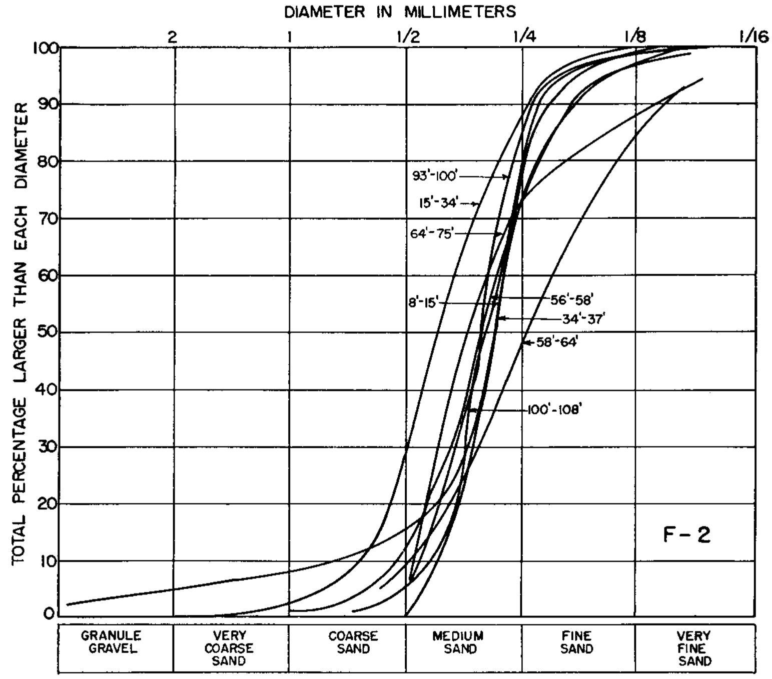


FIG. 6.—Cumulative frequency curves showing mechanical composition of well samples. Wells F-4 and F-2 (top, above and right) are located on terrace at Roxana and Wood River. Wells F-6 and F-9 are on flood plain at Granite City and Monsanto, respectively. Figures beside curves are depths of sample in well. Note good sorting (shown by steepness of curve) and similarity of textures at different depths in well (shown by close grouping of curves) of wells F-4 and F-2 on terrace.


DIAMETER IN MILLIMETERS
2
1
1/2
1/4
1/8
1/16
TOTAL PERCENTAGE LARGER THAN EACH DIAMETER
100
90
80
70
60
50
40
30
20
10
0
93'-100'
15'-34'
64'-75'
8'-15'
56'-58'
34'-37'
58'-64'
100'-108'
F-2
GRANULE GRAVEL
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND

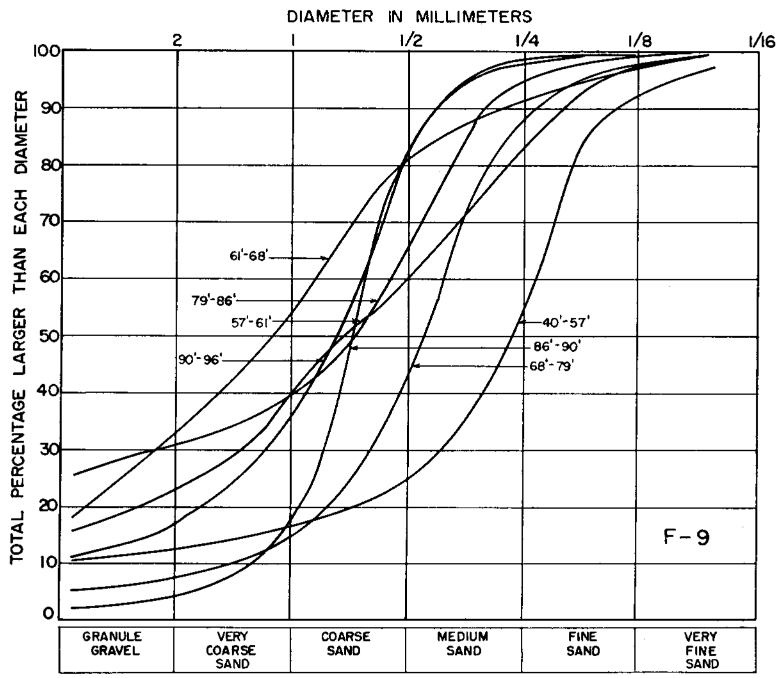

DIAMETER IN MILLIMETERS
2
1
1/2
1/4
1/8
1/16
TOTAL PERCENTAGE LARGER THAN EACH DIAMETER
100
90
80
70
60
50
40
30
20
10
0
61'-68'
79'-86'
57'-61'
90'-96'
40'-57'
86'-90'
68'-79'
F-9
GRANULE GRAVEL
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND

FIG. 6.—(cont.)

ples from wells at Monsanto and Granite City, indicate poorer sorting, greater variation in texture with depth, and occurrence of fairly coarse deposits in the lower part of the valley fill.

The results of mechanical analyses of well samples (appendix 2) must be accepted with caution. The valley-fill material is highly variable throughout, so a small sample is at best characteristic only of the sediment in its immediate vicinity. In addition, these are not undisturbed samples. Some have been collected from wells drilled with cable tool rigs, some from wells drilled with rigs of the reverse rotary type, and others from wells dug with a clam-shell type digger. Most of the samples were collected by the driller or an assistant, so the conditions of collecting are not known. The evidence that these analyses present, therefore, is only suggestive.

DISTRIBUTION OF VALLEY-TRAIN AND OTHER ALLUVIAL DEPOSITS

Alluvium of Recent age probably comprises the major portion of the valley fill, although its thickness varies considerably. Beneath the terrace it is absent and valley-train material is at the surface, whereas in some areas of shallower bedrock, as in the vicinity of Chain-of-Rocks, Recent alluvium extends to bedrock.

In general, the thickness of Recent alluvium is a measure of the scouring effect of the river since the latest Pleistocene glaciation. Deep scouring occurs in the spring when there are floods and in the winter when thick ice jams cause the river to deepen its channel in order to pass beneath the ice. Soundings taken through the river ice prior to the construction of Eads Bridge indicate that at least 80 feet of channel deepening (scour) takes place (Woodward, 1881, p. 5). The effect of this scour (in combination with channel migration) has been to produce an upper blanket of Recent alluvium resting on older deposits, some of them glacial valley-train. The Recent alluvium coarsens with depth as a result of successive periods of scour and deposition, the largest particles settling out first. Coarsening is also general in the older material, below the Recent alluvium. The uppermost portion of the alluvium contains only fine-grained material; its thickness is further increased at the surface by deposition of silt and clay from floodwaters that cover the area after the channel has migrated to a new position. The cross sections (fig. 4) and cumulative frequency curves (fig. 6) illustrate the increase in grain size from the surface down.

The deposits of the Roxana–Wood River terrace and those in the area just south of Alton are exceptions to the general textural pattern of the fill. Several wells just south of Alton (wells A-3 and A-4, fig. 4) penetrate sections of "clay," "clay and silt," and "clay and gravel" at the bottom of the valley fill. The maximum thickness of the material is 25 feet. These deposits may be Illinoian or older. No samples of the lower material could be obtained for study, so the origin of the material is uncertain.

WATER-YIELDING CHARACTERISTICS

The valley-train material underlying the terrace at Roxana and Wood River is well-sorted medium-to-coarse sand throughout most of its thickness, whereas the complex alluvial deposits in other parts of the American Bottoms generally show poor sorting in the upper part and an increase in coarseness with depth. Permeabilities in these deposits are therefore greatest in the deeper parts, especially where clean coarse sand and gravel occur. The sand and gravel, 20 to 50 feet thick at many places, appear to be the most permeable of any deposits in the area, surpassing the finer material of the terrace. From the standpoint of actual well yield, however, the terrace deposits may be as favorable an aquifer as the coarser sand and gravel—despite lesser permeability—because they are considerably thicker, averaging more than 80 feet.

Evaluation of pumping tests in progress in the American Bottoms by the State Water Survey will yield quantitative data on permeabilities and transmissibilities of the deep coarse sand and gravel and the Roxana–Wood River terrace deposits.

The valley fill in some areas, however, such as north of Horseshoe Lake, is composed of fine-to-medium sand and silt throughout most of its thickness and has poor groundwater possibilities. Thus the valley-fill deposits, except for those on the terrace, are characterized not only by excellent groundwater supply potentialities but by inconsistency. The terrace material, on the other hand, probably is somewhat less permeable but is a thicker and more consistent aquifer, although somewhat restricted in lateral extent.

Some drillers in the area drill to bit refusal and then set screen in the lower 10 to 40 feet of the section. However, good water-yielding beds, in Recent alluvium as well as in glacial outwash, are not everywhere restricted to the lower part of the section. In many instances shallower deposits, which might increase the yield of the completed well, are cased off. In the drilling of new wells it is recommended that, where maximum yield and specific capacity are desired, setting screen opposite the shallow permeable deposits as well as opposite the deep permeable deposits be considered.

Groundwater Recharge

The principal means of recharge of groundwater in the valley fill are seepage from rainfall and floods, and percolation from the Mississippi River and its tributaries. Rainfall is probably the most important source for the area as a whole, although where heavy pumpage is concentrated near the river the recharge from the river itself is undoubtedly great. The effectiveness of recharge from both rainfall and floodwaters is significantly influenced by the nature of the material in the upper portion of the valley fill, which throughout most of the area is 10 to 30 feet of silt and clay. This fine-grained material is usually not so impermeable as to prevent appreciable recharge. There is very little runoff because of the low relief; hence most of the rainfall either evaporates or seeps into the soil. Recharge from floodwaters is undoubtedly much less at present than it has been in the past because of the extensive flood-control program, which is continually being expanded. Where floods do occur they probably result in appreciable recharge.

The recharge from tributary streams that cross the valley flat is probably seasonal for the most part. As the gradient of the streams is very low, the normally slow-moving water can carry only the finest material. The bottoms of the channels probably are covered with a relatively thick deposit of mud, which permits only very slow movement of water into the material below. After periods of prolonged rains in the upland watershed areas, the streams rise, their velocities are greatly increased, and they probably scour their channels sufficiently to remove the impermeable mud, which temporarily permits more rapid recharge. Under natural conditions the streams would be subject to considerable periodic flooding, but man-made changes have prevented most of the floods. Courses have been straightened, channels deepened and widened, and levees constructed. As a result, the tributary streams are not now as large a source of recharge as they once were.

The Mississippi River is an important source of recharge where heavy pumpage has lowered the water table below the level of the river (Bruin and Smith, 1953). Lowering the water table causes the development of hydraulic gradient away from the river and toward the area of pumpage. During high-water stages the hydraulic gradient is increased, which in turn increases the effectiveness of recharge.

Although many areas of the river channel are normally floored with silt, which limits water infiltration, permeable sandy areas are probably present in the channel. Observations on the Mississippi indicate that even in comparatively straight reaches, the thread of the stream moves from one side of the channel to the other, producing shoals and deeps and accompanying differences in bottom deposits. Therefore even under ordinary conditions some groundwater recharge from the river is likely. During high-water stages, when the river scours its channel, recharge conditions are improved.

The only area of notably unfavorable conditions for recharge is west of Granite City where the bedrock lies at a shallow depth and the coarse deposits generally found in the lower part of the fill are either very thin or missing (fig. 4, B-B′).

Local Groundwater Conditions in the American Bottoms

The occurrence of thick clean deposits of deep sand and gravel over wide areas in the American Bottoms has been partly responsible for the heavy industrial development of the area. Over 100 million gallons of groundwater a day is consumed by industries. Monsanto, Granite City, and Wood River–Roxana–Hartford are the major pumpage centers (Bruin and Smith, 1953). Major cones of depression have been produced by heavy pumpage in these areas.

Despite the present heavy industrial groundwater consumption, it is likely that much more groundwater could be available if industrial expansion takes place in favorable but unexploited areas, particularly near the river where recharge might be induced.

Although the variability of the valley fill and deficiency of well data in many parts of the American Bottoms make it impractical to show groundwater supply potentialities on a map, a summary of groundwater conditions in the various parts of the American Bottoms follows.

Alton–Wood River–Hartford–Roxana area.—Graphic sections showing the lithology of valley-fill material in the area are given in figure 4. They show that the bedrock surface is quite irregular. The eastern part of the section, beginning with well A-9, shows the nature of the terrace material. It is dominantly medium-to-coarse sand, with little gravel, and fairly uniform from top to bottom. Eastward the terrace surface becomes lower and the deposits are finer and contain more silt.

Clean deposits of sand and gravel are found at depths below 50 feet from Alton southeast to Hartford. Many wells in this belt have encountered clay as much as 25 feet thick overlying the bedrock, but above this material coarse sand and gravel are found. The river-front area from Alton to Hartford is geologically favorable for further groundwater development.

Area along Cahokia diversion channel and Chain-of-Rocks Canal.—The valley-fill material in this area has been investigated in connection with U. S. Army Corps of Engineers channel and levee projects (unpublished data, U. S. Army Corps of Engineers, St. Louis district). Borings penetrated thick deposits of clean sand and gravel, except near the southern end of Chain-of-Rocks Canal, west of Granite City, where the bedrock is shallow and coarse deposits are thin (fig. 3).

Area north and east of Horseshoe Lake along bluffs.—The area just west of the bluffs from the vicinity of Poag south to the Madison County line is the site of the Edwardsville, Troy, and Collinsville wells. The bedrock rises sharply at the eastern margin of the flood plain, but from one-half to three-fourths of a mile west of Highway 157, which follows the base of the bluffs, the bedrock floor is reached at a depth of 100 feet or more. Deposits of clean sand and gravel 20 to 40 feet thick have been penetrated. The coarseness of these deposits decreases toward Horseshoe Lake. Some of the coarsest sand and gravel studied came from the valley fill near the bluffs.

Because of the thick, deep sections of clean sand and gravel, this area is considered geologically favorable for greater groundwater development.

Granite City–Madison area.—The lithology of the valley fill in the Granite City area is shown in figure 4, B-B′. The bedrock surface slopes eastward. Bedrock is exposed in the river channel west of Cabaret Island during low-water stages, but between Granite City and Horseshoe Lake it is about 115 feet below the surface of the flood plain. Deposits of clean sand and gravel 20 to 35 feet thick are encountered at the base of the fill at Granite City and Madison. These deposits become finer toward the east, and within half a mile of Horseshoe Lake they pass into dominantly sand and silt deposits unfavorable for industrial groundwater supplies.

Central belt.—A north-south belt 3 to 4 miles wide, extending from a point opposite the mouth of the Missouri River south to the Madison County line, does not appear to be favorable for the development of large supplies of groundwater. The valley fill in this belt is fine-grained material, apparently of low permeability. The nature of this material is illustrated by well B-9 in figure 4.

East St. Louis.—The deepest part of the bedrock channel appears to pass under East St. Louis, not far east of the eastern pier of Eads Bridge, where the bedrock surface is 284 feet above sea level. Wells in East St. Louis and east of the city were completed in clean sand and gravel of high permeability 20 feet or more thick. To the north, well logs at the National City stock yards record mainly medium-to-coarse sand, with little gravel.

Monsanto–Cahokia–Prairie du Pont–Dupo area.—The southern part of the area, south of East St. Louis, is highly favorable for industrial supplies of groundwater. Monsanto and Cahokia are already heavily developed, but the area to the south, with the same possibilities, has not been exploited. Coarse, permeable sand and gravel deposits are present throughout the area, as indicated by industrial wells and Corps of Engineers levee borings. C-C′ and D-D′ of figure 4 illustrate the lithology of the valley-fill materials and the nature of the bedrock surface. The presence of coarse deposits close to the river in this area favors recharge from the river, if water levels on the flood plain are sufficiently lowered by pumpage.

CONCLUSIONS

Certain generalizations on present and future development of groundwater supplies in the American Bottoms can be made from the preceding discussion.

1. Coarse alluvial and valley-train sands and gravels, generally concentrated near the base of the valley fill, have high permeabilities and are the most favorable deposits for yielding industrial supplies of groundwater.

2. The medium-to-coarse sands that underlie the terrace at Wood River and Roxana are excellent deposits for yielding industrial supplies of groundwater, although they are somewhat restricted in lateral extent and may have slightly lower permeabilities than the coarser deposits in other parts of the American Bottoms.

3. Because the terrace deposits are consistently finer in texture than are the deeper sand and gravel deposits elsewhere in the area, wells situated on the terrace in the Roxana–Wood River area would require finer gravel packs and screens for maximum efficiency than wells constructed in the lower coarse sand and gravel at East St. Louis, Granite City, Monsanto, and Cahokia. Median diameters of the terrace material range from .01 to .03 inches; median diameters of the coarse sand and gravel, .02 to .08 inches.

4. Because of the variable nature of the alluvium over much of the American Bottoms, highly permeable zones are present in some places at depths as shallow as 60 to 70 feet. The practice of setting screens only in the lower portion of wells may result in failure to take full advantage of the water-yielding capabilities of these shallower permeable zones. Therefore, where maximum yield and highest specific capacities are desired, consideration should be given to setting screens through all zones of high permeability that are of sufficient depth that the screens will not be exposed to air as a result of drawdown from heavy pumpage.

5. Greater appreciation of the variability of the valley fill during design and construction would lengthen the life and improve the efficiency of wells. Wells in the American Bottoms have been found to have a much shorter life expectancy than those in the State as a whole. The principal causes of well failures in the area are screen-clogging and the filling of wells with sand. Screen-clogging is partly chemical and partly mechanical (Bruin and Smith, 1953). Sand-clogging will be reduced if careful consideration is given to the texture ranges throughout the screened intervals. The texture of the alluvium may vary greatly within a few feet vertically, making it impossible to select a screen with one slot size optimum for the entire screened interval. Therefore, consideration should be given to the use of

composite screens made up of sections of different slot sizes. The life of many wells also would be increased by the use of carefully constructed gravel-packed wells. Clogging of screens and filling of wells with sand will be at a minimum if the gravel pack surrounding the screen has the proper textural relationship to the material in the adjacent alluvium. A uniform-grain-size gravel with a median grain size between 5 and 10 times the median grain size of the water-yielding formation has been found to give excellent results (Smith, 1954, p. 15).

6. The valley fill appears to be unfavorable for yielding industrial supplies of groundwater in portions of the American Bottoms where glacial alluviation and Recent river cut-and-fill have produced silt and fine sand extending almost to bedrock. Such conditions are believed to be present in a wide belt extending from opposite the mouth of the Missouri River to the area south of Horseshoe Lake.

7. Owing to the shallow permeable deposits along the present Mississippi channel, conditions are probably favorable for recharge from the river in most areas along the river where the water table is sufficiently lowered by pumpage. Induced recharge from the river becomes especially important in the face of increased demand for groundwater because flood-control measures have restricted the normal spreading of floodwater over the American Bottoms, formerly an important factor in recharge.

8. Increased groundwater development appears possible in three areas where present withdrawals are small compared to the potentialities believed to exist. These areas are: 1) between the eastern bluffs and Horseshoe Lake from the Madison–St. Clair county line north to Roxana; 2) along the Mississippi River near the mouth of Wood River; and 3) the East Carondelet–Dupo area in the south, extending to an area east of Cahokia.

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APPENDIX 1

PARTIAL LIST OF WELLS IN THE EAST ST. LOUIS AREA

A-1 Corps of Engineers, boring, 1948. 400 feet E of center W line, sec. 13, T. 5 N., R. 10 W., Madison Co. Elev. 434 feet. Total depth 92 feet, bit refusal. Engineer's field log.

A-2 Owens Illinois Glass Co. well 9. Thorpe Concrete Well Co., 1950. Center of NE ¼ SW¼ sec. 13, T. 5 N., R. 10 W., Madison Co. Elev. 422 feet. Total depth 88 feet. Finished in sand. Driller's log.

A-3 Alton Boxboard Co. test hole H. Layne-Western Co., 1944. 2400 feet E, 1300 feet N, SW corner sec. 18, T. 5 N., R. 9 W., Madison Co. Elev. 436 feet. Total depth 131 feet, on rock. Driller's log.

A-4 Alton Boxboard Co. test hole J. Layne-Western Co., 1944. 200 feet N, 200 feet W, SE corner sec. 18, T. 5 N., R. 9 W., Madison Co. Elev. 428 feet. Total depth 104 feet, on rock. Driller's log.

A-5 Illinois Power Co., Wood River Power Station, test boring 4, 1947. 1500 feet N, 1900 feet E, SW corner sec. 20, T. 5 N., R. 9 W., Madison Co. Elev. 425 feet. Total depth 123 feet, bit refusal. Driller's log.

A-6 Shell Oil Co., loading dock, well W-1, Ranney Well Co., 1952. 2600 feet N, 2700 feet W, SE corner sec. 33, T. 5 N., R. 9 W., Madison Co. Elev. 425 feet. Total depth 118 feet, on bedrock. Driller's log.

A-7 International Shoe Co., Layne-Western Co., 1951. 2200 feet N, 800 feet E, SW corner sec. 34, T. 5 N., R. 9 W., Madison Co. Elev. 429 feet. Total depth 117 feet, finished in clay. Driller's log.

A-8 Shell Oil Co. well 15, Thorpe Concrete Well Co., 1927. 2110 feet from W line, 278 feet from N line SW ¼ sec. 35, T. 5 N., R. 9 W., Madison Co. Elev. 454 feet. Total depth 112 feet 11 inches, finished in coarse sand and gravel. Driller's log.

A-9 Shell Oil Co. well 54, Thorpe Concrete Well Co., 1949. 1900 feet S, 1000 feet W, NE corner sec. 35, T. 5 N., R. 9 W., Madison Co. Elev. 446 feet. Total depth 131 feet, finished in gravel. Driller's log.

A-10 Shell Oil Co., Wood River, test hole 6, Layne-Western Co., 1942. 1100 feet S, 2300 feet E, NW corner sec. 35, T. 5 N., R. 9 W., Madison Co. Elev. 452 feet. Total depth 171 feet, finished in sand. Driller's log.

A-11 Shell Oil Co. test hole 10, Thorpe Concrete Well Co., 1946. 2200 feet S, 1250 feet E, NW corner sec. 36, T. 5 N., R. 9 W., Madison Co. Elev. 435 feet. Total depth 102 feet, finished in sand. Driller's log.

A-12 Shell Oil Co., Recreation Center test well, Roxana, Ill., Harold L. Watson Drilling Co., 1950. 2900 feet N, 1750 feet W, SE corner sec. 36, T. 5 N., R. 9 W., Madison Co. Elev. 270 feet. Total depth 71 feet. Driller's log.

B-2 City of St. Louis River Front Project D. H. 102, 1951. 5350 feet S of 80° 42′ 30″ N, 100 feet E of 90° 12′ 30″ W., St. Louis Co. Elev. 414 feet. Total depth 22.7 feet, bit refusal. Engineer's field log.

B-3 Corps of Engineers, Chain-of-Rocks lock site, boring H-1, 1941. 2600 feet from N line, 240 feet from W line, sec. 23, T. 3 N., R. 10 W., Madison Co. Elev. 412.4. Total depth 73.7 feet, finished in gray limestone. Engineer's field log.

B-4 Hoyt Metal Co., Granite City, Thorpe Concrete Well Co., 1936. 4200 feet S of 38° 42′ 30″ N, 2600 feet E of 90° 10′ W, T. 3 N., R. 10 W., Madison Co. Elev. 421 feet. Total depth 111 feet 6 inches, finished in boulders and sand. Driller's log.

B-5 Granite City Steel Co. well 21, Harold L. Watson Drilling Co., 1946. 4700 feet S of 38° 42′ 30″ N, 5400 feet W of 90° 07′ 30″ W, T. 3 N., R. 9 W., Madison Co. Elev. 421 feet. Total depth 116 feet, finished in sand. Driller's log.

B-6 St. Louis Gas and Coke Co. well. SW ¼ NW ¼ sec. 20, T. 3 N., R. 9 W., Madison Co. Elev. 417 feet. Total depth 114 feet, finished in sand and gravel. Driller's log.

B-7 Koppers Co. test hole 3, Layne-Western Co., 1948. 1900 feet S, 1400 feet E of NW corner sec. 20, T. 3 N., R. 9 W., Madison Co. Elev. 416 feet. Total depth 104 feet, on rock. Driller's log.

B-8 Koppers Co. test hole 4, Layne-Western Co., 1948. 1800 feet S, 2900 feet W, NE corner sec. 20, T. 3 N., R. 9 W., Madison Co. Elev. 417 feet. Total depth 103 feet, finished in sand and boulders. Driller's log.

B-9 Illinois Geol. Survey test hole 1, Charles M. Hayes, 1954. 125 feet E, 250 feet N, SW corner NW ¼ sec. 28, T. 3 N., R. 9 W., Madison Co. Elev. 413. Total depth 111 feet, finished in bedrock. Samples studied by R. E. Bergstrom. Sieve analysis.

B-10 Neidringhous-Sullivan well 2, 1932. 1600 feet from S line, 1825 feet from E line, sec. 22, T. 3 N., R. 9 W., Madison Co. Elev. 411. Total depth 1105, finished in Hannibal shale. Driller's log.

B-11 Village of Troy test hold 3, Layne-Western Co., 1953. Approx. 100 feet N, 3310 feet W of SE corner sec. 20, T. 3 N., R. 8 W., Madison Co. Elev. 430 feet. Total depth 115 feet, finished in shale. Driller's log.

B-12 Village of Troy test hole 4, Layne-Western Co., 1953. Approx. 100 feet N, 2910 feet W of SE corner sec. 20, T. 3 N., R. 8 W., Madison Co. Elev. 432 feet. Total depth 88 feet, finished in shale. Driller's log.

B-13 Village of Troy test hole 1, Layne-Western Co., 1953. Approx. 100 feet N, 1860 feet W of SE corner sec. 20, T. 3 N., R. 8 W., Madison Co. Elev. 437 feet. Total depth 48 feet, finished in shale. Driller's log.

C–1 City of St. Louis River Front Project D. H. 116, 1951. 5700 feet S of 38° 37′ 30″ N, 5300 feet E of 90° 12′ 30″ W, St. Louis Co. Elev. 412 feet. Total depth 53.5 feet, finished in sand and gravel. Engineer's field log.

C–2 Corps of Engineers test hole W–77, 1952–53. 8400 feet N of 38° 35′ N, 3600 feet W of 90° 10′ W, T. 2 N., R. 10 W., St. Clair Co. Elev. 415 feet. Total depth 127 feet, bit refusal. Engineer's field log.

C–3 American Zinc Co., Monsanto, well 6, Harold L. Watson Drilling Co., 1940. 6900 feet N of 38° 35′ N, 750 feet W of 90° 10′ W, T. 2 N., R. 10 W., St. Clair Co. Elev. 405 feet. Total depth 107 feet, finished in soapstone. Driller's log.

C–4 Monsanto Chemical Co. test hole 4, Layne-Western Co., 1948. 5100 feet N of 38° 35′ N, 250 feet W of 90° 10′ W, T. 2 N., R. 10 W., St. Clair Co. Elev. 411 feet. Total depth 110 feet, finished on rock. Driller's log.

C–5 Socony-Vacuum Oil Co. well, Layne-Western Co., 1952. 2400 feet E of 90° 10′ W, 4400 feet N of 38° 35′ N, T. 2 N., R. 10 W., St. Clair Co. Elev. 410 feet. Total depth 117½ feet, finished in gravel and sand. Sample set 22655, studied by P. M. Busch.

C–6 Key Co. well, East St. Louis, Harold L. Watson Drilling Co., 1943. 6200 feet N of 38° 35′ N, 4700 feet W of 90° 07′ 30″ W. Total depth 117 feet, finished in sand and gravel. Driller's log.

C–7 Aluminum Ore Co. well, East St. Louis, Harold L. Watson Drilling Co., 1940. 4100 feet N of 38° 35′ N, 90° 07′ 30″ W, T. 2 N., R. 9 W., St. Clair Co. Elev. 417 feet. Total depth 121 feet, finished in fine sand and mud. Driller's log.

C–8 Illinois State Water Survey well 1, Layne-Western Co., 1951. 1800 feet S, 800 feet E of NW corner sec. 26, T. 2 N., R. 9 W., St. Clair Co. Elev. 422 feet. Total depth 81 feet, finished in sand. Sample set 21485, studied by W. H. Bierschenk.

C–9 Drive-in Theater well, French Village, Harold L. Watson Drilling Co., 1941. 450 feet W of SE corner sec. 23, T. 2 N., R. 9 W., St. Clair Co. Elev. 433 feet. Total depth 82½ feet, finished at shale. Driller's log.

D–1 Anheuser-Busch Co. test hole 1, Ranney Well Co. 2600 feet N of 38° 35′ N, 800 feet E of 90° 12′ 30″ W, St. Louis Co. Elev. 417 feet. Total depth 73 feet, finished on rock. Driller's log.

D–2 Alton and Southern Railroad well 2, Fox Terminal, Harold L. Watson Drilling Co., 1950. 100 feet S of 38° 35′ N, 1100 feet E of 90° 12′ 30″ W, T. 2 N., R. 10 W., St. Clair Co. Elev. 410 feet. Total depth 104 feet, finished in sand. Driller's log.

D–3 Corps of Engineers test hole W–95, 1952–53. 3400 feet S of 38° 35′ N, 1900 feet E of 90° 12′ 30″ W, T. 2 N., R. 10 W., St. Clair Co. Elev. 396 feet. Total depth 82 feet, finished in gravelly sand. Engineer's field log.

D–4 Corps of Engineers seepage well 2, Cahokia, 1952–53. 7250 feet N of 38° 32′ 30″ N, 90° 12′ 30″ W, T. 1 N., R. 10 W., St. Clair Co. Elev. 406 feet. Total depth 108 feet, finished on bedrock. Engineer's field log.

D–5 Corps of Engineers well W24B, Prairie du Pont, 1952–53. 5000 feet N of 38° 32′ 30″ N, 600 feet E of 90° 12′ 30″ W, T. 1 N., R. 10 W., St. Clair Co. Elev. 413 feet. Total depth 117 feet, bit refusal. Engineer's field log.

D–6 Corps of Engineers test hole DH-6-S, 1952. 3600 feet S, 1200 feet W of NE corner sec. 10, T. 1 N., R. 10 W., St. Clair Co. Elev. 416 feet. Total depth 84½ feet, bit refusal. Engineer's field log.

D–7 Corps of Engineers test hole DH, 1950–54. 2300 feet N, of 38° 32′ 30″ N, 1650 feet E of 90° 10′ W, T. 1 N., R. 10 W., St. Clair Co. Elev. 408 feet. Total depth 116 feet, bit refusal.

E–1 Tarlton and Sklar–Dyroff well 1–A, 1943. 1070 feet N, 820 feet W of SE corner sec. 28, T. 1 N., R. 10 W., St. Clair Co. Elev. 403 feet. Total depth 1800 feet, finished in Gasconade dolomite. Sample study 9318, studied by D. Speziale.

E–2 Lockwood–Dyroff well 1, 1924. 150 feet S of NW corner NE ¼ sec. 26, T. 1 N., R. 10 W., St. Clair Co. Elev. 590 feet. Total depth 2904 feet, finished in Potosi dolomite. Sample study 423, studied by F. E. Tippie.

E–3 Sewell–Bayless–Sparks well 1, 1931. SW ¼ NE ¼ SW ¼ sec. 2, T. 1 N., R. 10 W., St. Clair Co. Elev. 410.5 feet. Total depth 2002 feet, finished in Jefferson City dolomite. Sample study 1001, studied by Margaret Blair.

E–4 Monk's Mound well. Center NW ¼ NW ¼ NE ¼ sec. 2, T. 2 N., R. 9 W., St. Clair Co. Elev. 437 feet. Samples studied by J. A. Udden.

E–5 Commonwealth Steel Co. well. NW ¼ SW ¼ sec. 24, T. 3 N., R. 10 W., Madison Co. Elev. 423 feet. Total depth 2085 feet, finished in Jefferson City dolomite. Sample study 226, studied by A. Thurston.

E–6 Kesl–Kusmanoff well 1, 1947. 660 feet from N line. 330 feet from W line, SW ¼ SE ¼ sec. 12, T. 3 N., R. 9 W., Madison County. Elev. 410.6 feet. Total depth 1687 feet, finished in Kimmswick limestone. Sample study 17178, studied by M. P. Meyer and Heinz Lowenstam.

E–7 Penn–Illinois–Poag well 1, 1938. 2400 feet from S line, 3630 feet from E line, sec. 12, T. 9 N., R. 9 W., Madison Co. Elev. 424.6 feet. Total depth 2093 feet, finished in St. Peter sandstone. Sample study 8582, studied by T. C. Buschbach.

E–8 Lindberg Park well, 1932. 1830 feet from N line, 2320 feet from W line, sec. 8, T. 5 N., R. 9 W., Madison Co. Elev. 446.9 feet. Total depth 1200 feet, finished in Maquoketa shale. Sample study 935, studied by L. E. Workman.

F–1 Bethalto city well 3, Thorpe Concrete Well Co., 1951. 2200 feet N, 1200 feet W, SE corner sec. 22, T. 5 N., R. 9 W., Madison Co. Elev. 437 ± feet. Total depth 95 feet, finished in coarse sand, gravelly. Driller's log and sieve analysis.

F–2 Wood River city well 1, Thorpe Concrete Well Co., 1930. 860 feet S, 300 feet E, NW corner sec. 26, T. 5 N., R. 9 W., Madison Co. Elev. 446.7 feet. Total depth 109 feet, finished in pink sand. Sample study 1056, studied by L. E. Workman.

F-3 Shell Oil Co. well 59, Thorpe Concrete Well Co., 1952. NE ¼ SE ¼ SW ¼ sec. 35, T. 5 N., R. 9 W., Madison Co. Elev. 442 feet. Total depth 110 feet, finished in fine sand and small gravel. Samples studied by R. E. Bergstrom and T. R. Walker.

F-4 Shell Oil Co. well 61, Thorpe Concrete Well Co., 1952. NW ¼ SW ¼ SE ¼ sec. 35, T. 5 N., R. 9 W., Madison Co. Elev. 442 feet. Total depth 113 feet, finished in sand and gravel. Sieve analysis.

F-5 Sinclair Oil Co. well 1, Harold L. Watson Drilling Co., 1952. 1750 feet E, 460 feet N, SW corner sec. 34, T. 5 N., R. 9 W., Madison Co. Elev. 431 feet. Total depth 126 feet, finished in medium sand and gravel. Sample study 23403, studied by R. E. Bergstrom. Sieve analysis.

F-6 Union Starch and Refining Co. well, Harold L. Watson Drilling Co., 1952. 1000 feet N, 2800 feet E, SW corner sec. 13, T. 3 N., R. 10 W., Madison Co. Elev. 422 feet. Total depth 115 feet, finished in medium sand. Sample study 23406, studied by R. E. Bergstrom. Sieve analysis.

F-7 Collinsville city well 8, Layne-Western Co., 1951. SE ¼ SE ¼ sec. 31, T. 3 N., R. 8 W., Madison Co. Elev. 424 feet. Total depth 98 feet, finished in shale. Samples studied by W. H. Bierschenk. Sieve analysis.

F-8 Hunter Packing Co. well, Harold L. Watson Drilling Co., 1948. SE ¼ NW ¼ sec. 7, T. 2 N., R. 10 W., St. Clair Co. Elev. 418 feet. Total depth 115½ feet, finished in sand and gravel. Samples studied by R. E. Bergstrom. Sieve analysis.

F-9 Monsanto Chemical Co. well Z-12, Ranney Well Co., 1952. SE ¼ SE¼ SE¼ sec. 22, T. 2 N., R. 10 W., St. Clair Co. Elev. 400 feet. Total depth 97 feet, stopped on rock. Sample study 23443, studied by J. W. Baxter. Sieve analysis.

F-10 Cargill Co., Fox Terminal Elevator well, Harold L. Watson Drilling Co., 1952. NE ¼ SE ¼ NE ¼ sec. 33, T. 2 N., R. 10 W., St. Clair Co. Elev. 410 feet. Total depth 110 feet, finished in medium sand. Sample study 23404, studied by F. B. Titus. Sieve analysis.

APPENDIX 2

SIEVE ANALYSES OF LOWER PART OF VALLEY FILL, AMERICAN BOTTOMS

Sample	Percent by weight retained on screen										
	Mesh										
Well number; depth	4	9	16	24	32	42	60	80	115	170	Pan (silt and clay)
F-1											
65-70	—	—	—	1.2	3.7	7.	22.5	43.7	16.2	5.	.5
75-80	—	—	1.3	1.3	2.6	2.6	22.4	55.4	10.5	2.6	1.
85-90	—	6.6	22.8	27.6	10.4	1.9	13.3	13.3	2.8	.9	—
90-93	—	4.8	22.5	30.6	22.5	4.8	4.8	8.	1.6	—	—
F-2											
76.6- 93.1	—	17.	26.1	19.3	21.5	6.8	4.5	3.4	1.1	—	—
93.1-100.1	—	—	—	.9	4.8	29.8	50.9	10.5	1.9	.9	—
100.1-108.1	—	—	—	—	5.1	23.3	48.	19.4	2.5	1.2	—
F-3											
69- 81	—	—	.5	1.	7.9	24.4	44.5	15.3	4.6	1.	.2
81- 96	1.7	3.7	16.8	24.1	30.9	15.5	4.7	1.2	.7	.2	—
96-103	1.5	2.7	4.5	8.8	25.9	25.6	19.8	8.5	1.7	.5	—
103-110	1.2	1.2	1.9	2.6	24.3	42.4	15.1	7.5	2.4	.7	.2
F-4											
76- 84	1.3	1.8	5.9	6.6	20.9	33.8	15.2	8.2	3.6	1.6	.4
84- 97	25.5	14.	13.8	7.9	12.5	11.8	10.8	2.3	.8	.1	—
97-103	—	.9	2.4	2.4	9.8	49.6	26.5	6.3	.9	.4	.2
103-113	4.7	1.4	2.3	3.8	38.6	30.5	10.9	5.2	1.4	.4	.2
F-5											
70- 75	2.9	9.7	20.	16.2	25.4	17.3	7.8	1.2	.2	—	—
80- 85	7.9	11.	10.1	8.6	25.4	22.4	7.9	6.2	.2	—	—
90- 95	—	.9	2.2	2.9	11.7	41.	31.2	7.6	1.7	.2	.2
100-105	11.7	11.2	14.4	10.8	24.2	13.9	9.1	3.1	.2	—	—
F-6											
60- 70	13.4	16.5	14.6	12.8	14.7	10.5	8.2	3.7	3.5	1.5	.4
80- 88	.5	1.6	4.9	3.8	6.9	8.3	15.9	23.9	16.8	12.1	4.9
95-100	10.7	20.6	30.5	11.3	11.1	6.1	4.4	2.8	1.6	.2	.4
105-110	12.4	6.8	9.0	5.6	22.0	27.7	12.4	2.3	.6	.6	.6
B-9											
60- 65	8.5	12.8	12.8	9.4	15.6	15.6	12.8	7.1	2.3	.9	.9
70- 75	5.9	8.9	13.1	16.5	21.2	18.6	9.7	4.2	.8	.4	.4
80- 85	.4	2.2	10.9	14.5	35.9	22.7	8.2	3.2	.9	.4	.4
90- 95	—	7.7	18.8	24.3	24.8	14.9	6.	2.2	.5	.2	.2
100-105	—	.9	27.7	27.2	25.3	9.5	5.7	2.4	.4	.2	.4
F-7											
75- 80	28.0	24.3	26.8	7.3	6.0	3.6	1.2	.6	.6	.6	.6
85- 90	15.9	11.6	31.	23.5	12.6	3.3	.8	.4	.4	—	—
95-100	1.2	2.4	17.	30.4	31.7	12.8	2.4	1.2	.6	—	—
F-8											
75- 80	5.8	7.1	8.1	8.1	17.8	22.4	15.8	9.9	2.5	1.5	.5
85- 90	11.9	13.5	10.4	17.1	32.8	10.4	2.3	1.	.2	—	—
95-100	3.8	5.3	18.	20.7	39.7	9.5	1.6	.4	—	—	—
F-9											
68-79	5.3	2.3	6.5	8.9	20.1	29.	16.3	5.9	3.2	1.4	.5
79-86	22.5	8.5	8.5	7.9	16.8	19.4	11.4	2.8	.8	.5	.2
86-90	1.1	3.0	13.6	28.2	35.	14.8	2.8	.2	.4	—	.4
90-96	10.2	7.0	17.2	17.2	30.6	13.1	2.9	.4	.4	—	.2
F-10											
70- 75	2.1	8.3	11.9	7.6	16.2	23.4	17.4	8.8	2.6	.9	.2
80- 85	1.4	1.7	2.4	2.9	11.8	12.5	24.8	28.8	6.1	4.6	2.4
90- 95	—	.2	.7	.7	19.	54.3	17.2	4.9	1.9	.4	.2
95-100	—	—	.7	.4	19.8	55.2	19.5	3.4	.4	.2	—

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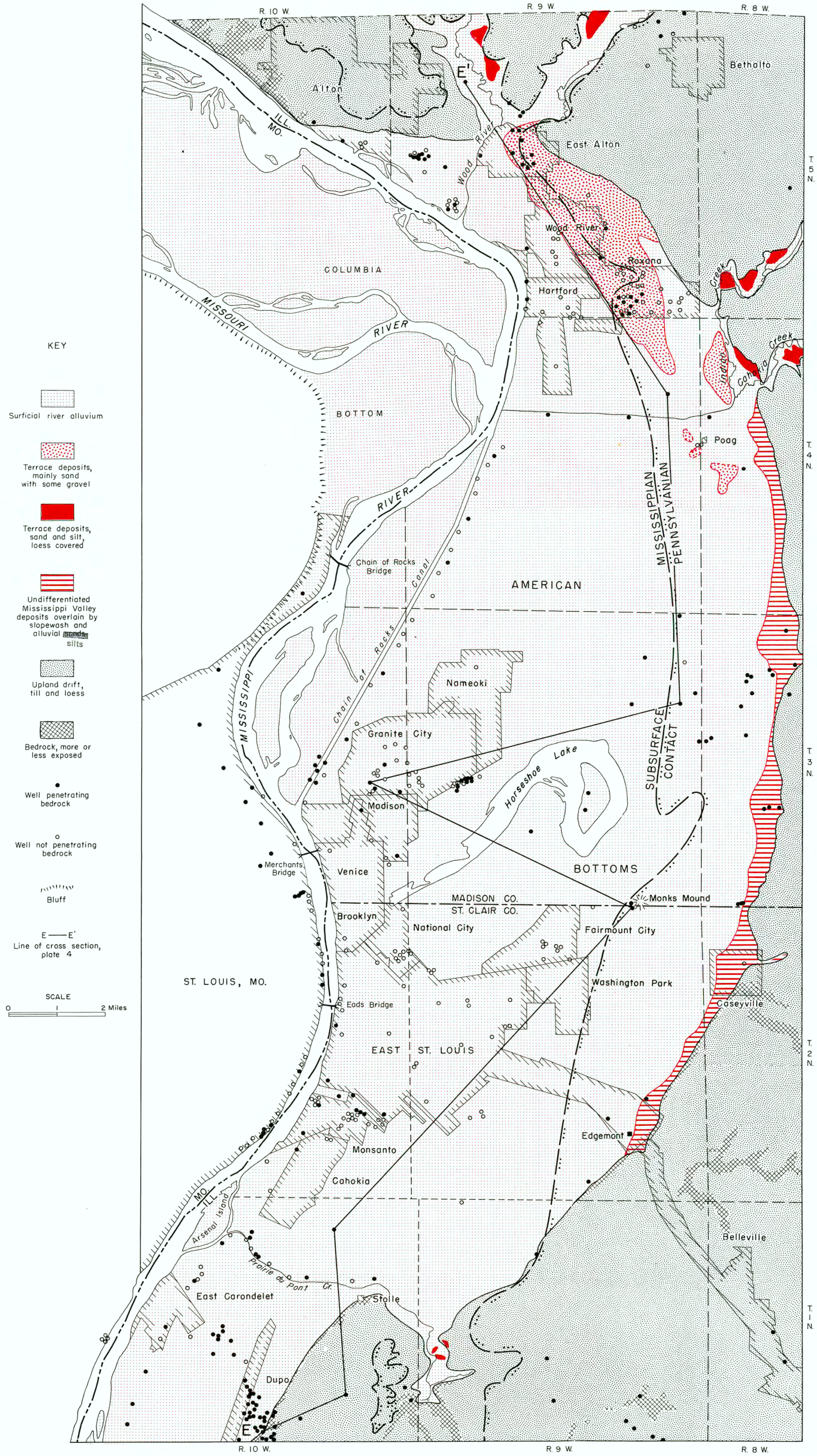
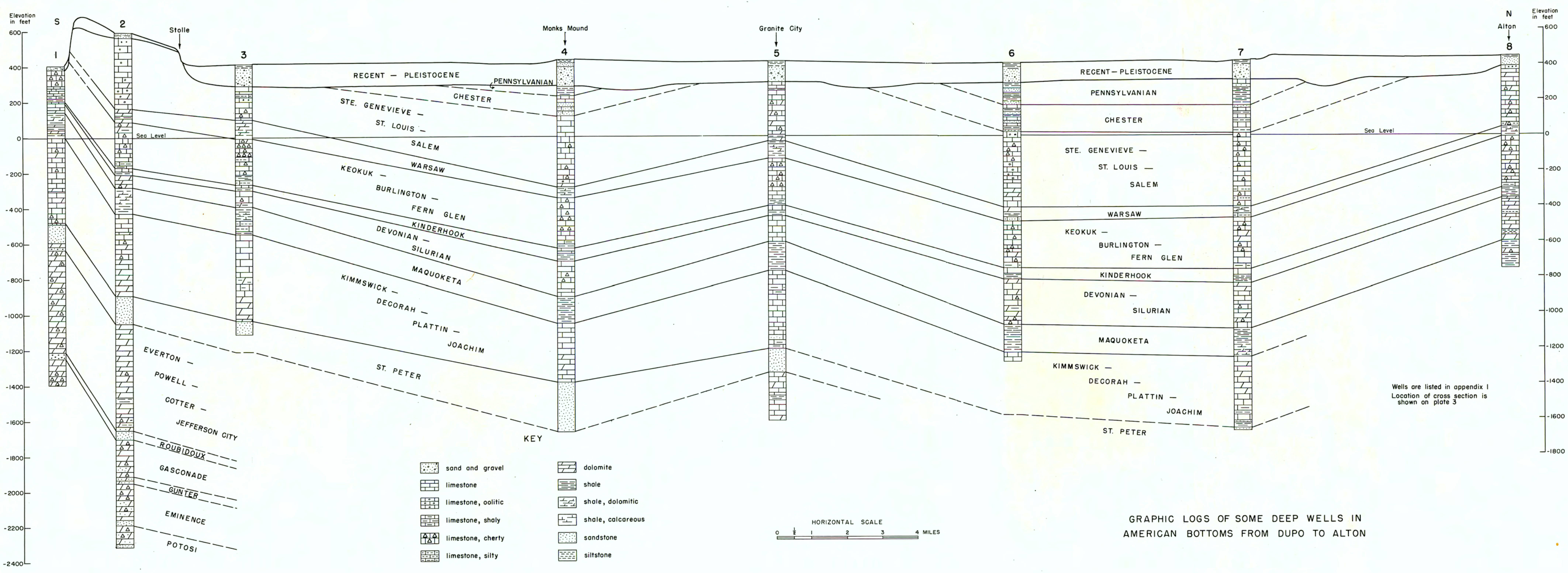


GEOLOGY OF EAST ST. LOUIS AREA, ILLINOIS



GRAPHIC LOGS OF SOME DEEP WELLS IN AMERICAN BOTTOMS FROM DUPO TO ALTON