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GEOLOGY OF THE FREEPORT QUADRANGLE, ILLINOIS

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ABSTRACT

The Freeport Quadrangle is in northwestern Illinois on the south slope of the Wisconsin Arch. The exposed bedrock consists of the Platteville and Galena Dolomites of the Champlainian Series of Ordovician age. The underlying St. Peter and Glenwood Formations are covered by Recent alluvium along the major valleys. The Maquoketa Shale of the Cincinnatian Series overlies the Galena in a small area.

Altonian glaciers of early Wisconsinan age deposited relatively thin drift over the maturely eroded bedrock. The upper layers of the dolomite bedrock are deformed by ice shove in many places. The preservation of depositional features in the valleys, the erratic patterns of drainage diversions, and the absence of end moraines suggest stagnation of the ice sheet followed by melting in place. Meltwater from the ice deposited sand and gravel in the form of kames, kame terraces, kame complexes, eskers, and crevasse fillings. Silts accumulated in lakes dammed by remnants of the ice sheet. Overflow from the lakes cut new steep-walled valleys. Lenses of sandy silts, probably colluvial deposits, overlie the till in places. The Winnebago drift was slightly weathered before a widespread mantle of Peoria Loess, averaging $3\frac{1}{2}$ feet thick, was deposited during Woodfordian time.

The area is well supplied with dolomite and sand and gravel suitable for concrete aggregate, surfacing roads, and agricultural limestone. Water supplies in shallow aquifers are generally adequate throughout the area.

INTRODUCTION

The Freeport Quadrangle covers about 225 square miles in Stephenson County, Illinois, and is named for the city of Freeport, which lies in the southern part of the quadrangle (fig. 1). The northern boundary of the area is the Illinois-Wisconsin state line.

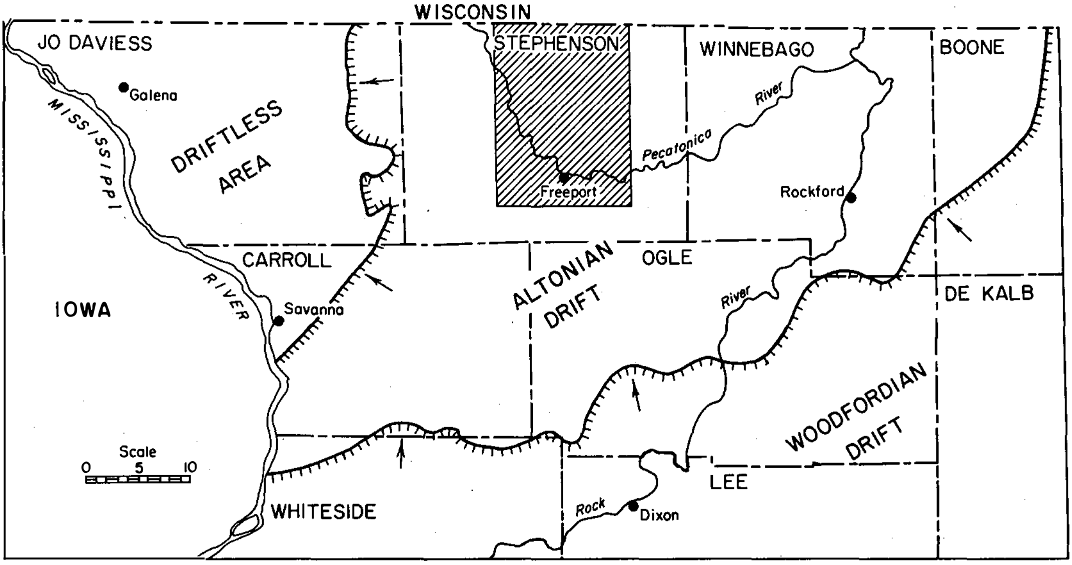

Figure 1. Part of northwestern Illinois showing the location of the Freeport Quadrangle and the relation to the areas of Altonian and Woodfordian glaciation and the driftless area.

Knowledge of the basic geology of the area is important to development and conservation of the mineral resources, to the design of foundations for buildings, bridges, and highways, and to interpretation of soil variations and agricultural productivity. The principal mineral resources in the area are dolomite and sand and gravel, which are used mainly for road metal and concrete aggregate. The geologic map of the area, originally released to the public in 1960 without text, is reissued as plate 1 in the pocket of this report. The map shows the outcrops of bedrock formations and the distribution of the various types of glacial and stream deposits that directly underlie the surface soil.

This report summarizes the geology of the quadrangle. Additional data on wells and outcrops may be consulted in the files of the Illinois State Geological Survey in Urbana.

Physiography.—The Freeport Quadrangle is characterized by gentle hills, except for a few localities where steep-sided canyons were produced by glacial diversion of streams. The area is in the physiographic region called the Rock River Hill Country (Leighton, Ekblaw, and Horberg, 1948). Surface elevations range from 1,080 feet to 747 feet above sea level. The lowest point on the bedrock surface, in the Pecatonica River Valley, is about 572 feet above sea level but is covered by 178 feet of alluvium. The Pecatonica River, which flows eastward to the Rock River and then south-westward to the Mississippi River, is the major drainage of the area. All streams are tributary to it.

Climate.—Page (1949) reports the following annual averages taken from weather records kept at Freeport over about thirty-five years:

Temperature:	47.8° F.
Total precipitation:	Less than 34 inches
Snowfall:	32.1 inches
Frost-free days:	154

He also reports that the coldest month is January with an average temperature of 19.7° F. and the warmest month is July with an average of 73.7° F.

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STRATIGRAPHY

Pleistocene and Ordovician deposits are exposed at the surface in the Freeport Quadrangle. The underlying Ordovician and Cambrian units that are known only from well borings are briefly noted, but their character in nearby areas in northern Illinois has been described (Workman and Bell, 1948; Willman and Templeton, 1952; Foster, 1956; Hackett, 1960; Buschbach, 1964; Bell et al., 1965).

A generalized columnar section of the rock units of the area is given in figure 2. The units exposed at the surface are shown in more detail in figure 3. The surficial geology map (plate 1) shows the rock units exposed on the surface, and the distribution of the bedrock formations beneath the glacial drift is shown in figure 4.

CAMBRIAN SYSTEM—CROIXAN SERIES

The W. T. Rawleigh Company power plant well in Freeport (NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 31, T. 27 N., R. 8 E.) penetrated the deeper formations underlying the area. No samples are available, but a drillers' log indicates the units present and their thickness. The lithologic character of the formations is estimated from deep wells near the quadrangle. The Mt. Simon Sandstone was not encountered in the drilling but is probably about 1,000 feet thick.

Eau Claire Formation

The Eau Claire is largely a glauconitic sandstone with rare dolomite beds. The upper few feet are shale in the wells available for study, and the rest of the 50 feet penetrated in the drilling is sandstone and siltstone with minor shale. The formation is probably about 300 feet thick.

Ironton-Galesville Sandstone

The Ironton-Galesville Sandstone is light-colored quartz sandstone, slightly dolomitic in some zones, and about 100 feet thick.

Franconia Formation

The Franconia Formation consists of glauconitic sandstone, commonly dolomitic, with some glauconitic sandy shale and dolomite beds. It is about 100 feet thick.

SYSTEM	SERIES	GROUP, STAGE	FORMATION, SUBSTAGE	GRAPHIC COLUMN	THICKNESS (feet)	DESCRIPTION
QUATERNARY		Recent			0-30	Alluvium, dune sand
QUATERNARY	Pleistocene	Wisconsinan	Woodfordian		0—4	Loess (Peoria)
QUATERNARY	Pleistocene	Wisconsinan	Farmdalian		0—3	Silt
QUATERNARY	Pleistocene	Wisconsinan	Altonian		0-150	Till, sand and gravel, silts (Winnebago drift)
ORDOVICIAN	Cincinnatian	Maquoketa			90	Shale, green; with thin dolomite beds
ORDOVICIAN	Champlainian	Galena			240	Dolomite, mostly pure, partly cherty, red shale beds at base, argillaceous at top, *Receptaculites*
ORDOVICIAN	Champlainian	Platteville			75-110	Dolomite, mostly argillaceous, partly cherty
ORDOVICIAN	Champlainian	Ancell	Glenwood		2-55	Sandstone, shale, dolomite
ORDOVICIAN	Champlainian	Ancell	St. Peter		280-375	Sandstone, some grains pitted, shale and chert (Kress Member) at base
CAMBRIAN	Croixan		Potosi		95+	Dolomite, glauconitic, sandy
CAMBRIAN	Croixan		Franconia		100	Sandstone and shale, glauconitic; some dolomite
CAMBRIAN	Croixan		Ironton — Galesville		100-125	Sandstone, slightly dolomitic
CAMBRIAN	Croixan		Eau Claire		177+	Sandstone with shale and siltstone

Figure 2. Generalized sequence of strata in the Freeport Quadrangle.

SYSTEM	SERIES	GROUP	FORMATION	MEMBER	GRAPHIC COLUMN	THICK-NESS (ft.)	DESCRIPTION
QUATERNARY	Pleistocene	Recent Stage				0-30	Alluvium, dune sand
		Wisconsinan Stage				0-4	Loess (Peoria), local thin silt (Farmdale) at base
						0-150	Till, sand and gravel, silts (Winnebago drift)
ORDOVICIAN	Cincinnatian	Maquoketa				0-90	Shale, green; dolomite beds
		Galena	Dubuque			25	Dolomite, argillaceous; shale partings
	Champlainian		Wise Lake	Stewartville		35	Dolomite, pure, massive; abundant <u>Receptaculites</u>
				Sinsinawa		40	Dolomite, slightly less pure and less massive than above; gastropods common
			Dunleith	Wyota		21	Dolomite, cherty; rare gastropods
				Wall		12	Dolomite, rare chert
				Sherwood		11	Dolomite, cherty; <u>Receptaculites</u> common
				Rivoli		12	Dolomite, <u>Receptaculites</u> common
				Mortimer		13	Dolomite, cherty
				Fairplay		17	Dolomite, abundant <u>Receptaculites</u>
				Eagle Point		16	Dolomite, cherty throughout
				Beecher		8	Dolomite
				St. James		12	Dolomite, green shale partings
				Buckhorn		9	Dolomite, shaly, thin- to medium-bedded
			Guttenberg			8	Dolomite, red shale beds
		Platteville	Quimbys Mill			9	Dolomite, dense, thin-bedded, cherty
			Nachusa			17	Dolomite, thick-bedded, cherty
			Grand Detour			25	Dolomite, medium-bedded, slightly shaly, cherty
			Mifflin			27	Dolomite, thin-bedded, shaly
			Pecatonica			25	Dolomite, medium- to thick-bedded, locally cherty
		Ancell	Glenwood			2-55	Sandstone, shale, dolomite, (covered)
			St. Peter			300	Sandstone (covered)

Figure 3. Sequence of strata exposed in the Freeport Quadrangle.

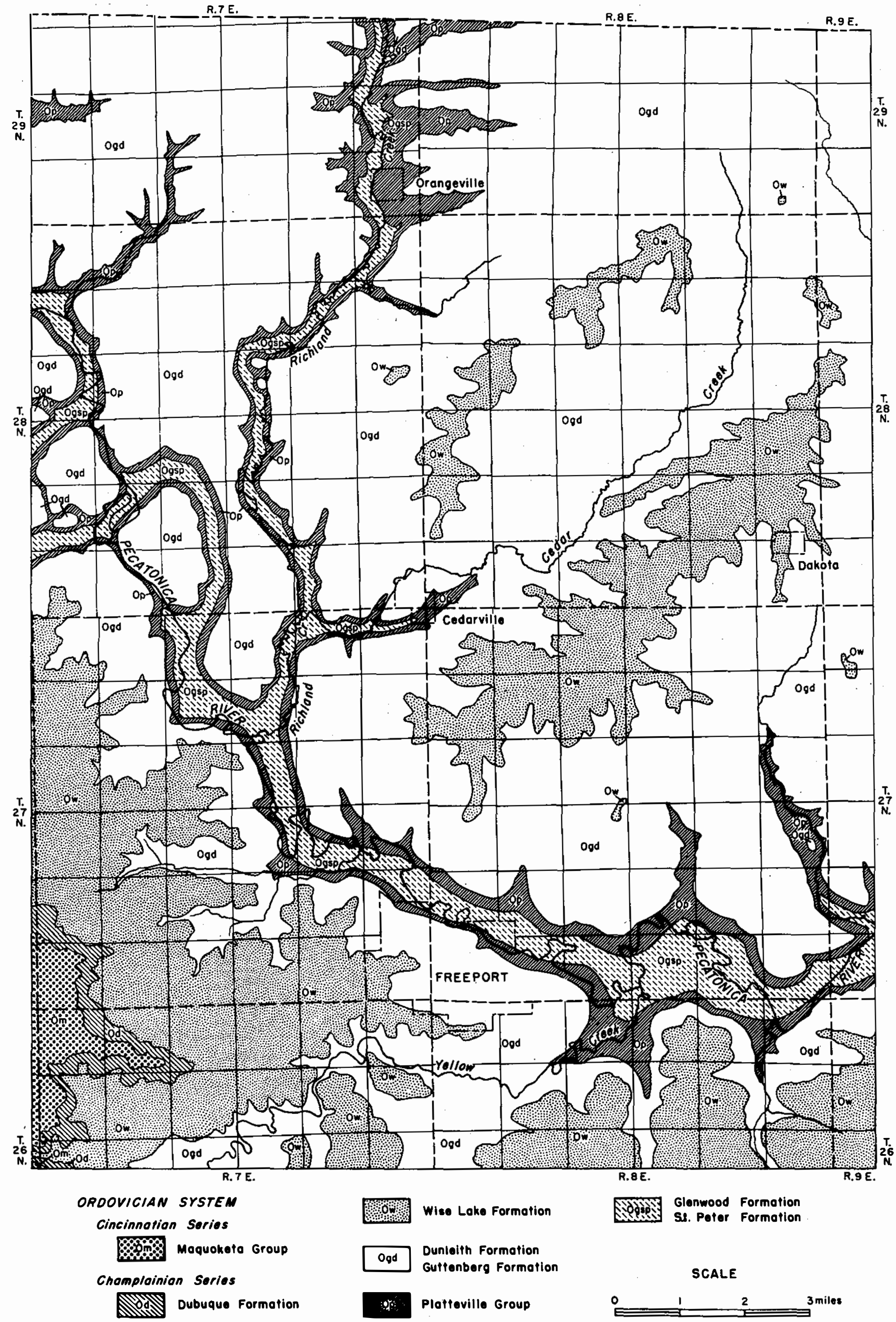

Figure 4. Areal geology of the Freeport Quadrangle.

Potosi Formation

The Potosi Formation is sandy glauconitic dolomite with some crystalline quartz. The upper part is eroded at Freeport where it is only 95 feet thick. A more complete section at Forreston, Ogle County, is 125 feet thick. Pre-St. Peter erosion also removed the Canadian Series (Lower Ordovician) from this area.

ORDOVICIAN SYSTEM—CHAMPLAINIAN SERIES

The classification and regional aspects of the Champlainian strata of Illinois have been described (Templeton and Willman, 1963). The exposed strata are all part of the Platteville and Galena Groups.

ANCELL GROUP

St. Peter and Glenwood Formations

Neither the St. Peter nor the overlying Glenwood is exposed within the quadrangle. However, many wells reach the St. Peter, and both units are present beneath Recent alluvium along the Pecatonica River and Richland Creek (fig. 4). The St. Peter is a quartz sandstone with rounded, frosted grains. Chert conglomerate and shale beds occur at the base. The irregular thickness of the St. Peter is largely related to the unconformity at its base. In the well at Freeport, the St. Peter is 320 feet thick. The Glenwood contains sandstone, greenish shale, and dolomite; it lies on an unconformity and within the area studied ranges from 2 to 55 feet thick.

PLATTEVILLE GROUP

Most of the Platteville Group is exposed within the quadrangle. Exposures are scarce, which requires mapping the group as a unit (plate 1), but individual formations are differentiated in the described sections.

The Platteville is characteristically an argillaceous dolomite, finer grained and more thinly bedded than the overlying dolomite of the Galena Group. It is cherty, shaly, and fossiliferous, and weathering causes reentrants to form along weaker beds. Well borings show that the group varies from 72 feet to 110 feet thick. The Pecatonica and Mifflin Formations are exposed only near Orangeville in geologic section 1.

Pecatonica Formation

The Pecatonica Formation is dolomite, tan with light gray mottlings, fine to medium grained, thin to medium bedded, and locally cherty. Only about 4 feet of the Pecatonica is exposed, but it commonly is about 20 feet thick in this region.

Mifflin Formation

The Mifflin Formation is dolomite, gray to brown, and weathers light colored. It is fine to medium grained, thin bedded, shaly, noncherty, and fossiliferous (fucoids, crinoid stems, brachiopods, gastropods, large ostracodes, and trilobites). It is thinner bedded and more shaly than the Pecatonica. It is 25 to 30 feet thick in this area.

Geologic Section 1

Compiled from exposures 0.65 miles north of Orangeville, in a quarry just east of Illinois Highway 26 and below the quarry in the valley wall of Richland Creek, to a small quarry near water (NW¼ SW¼ SE¼ and NE¼ SE¼ SW¼ sec. 25, T. 29 N., R. 7 E., Stephenson County).

	Thickness Ft.	In.
Platteville Group		
Grand Detour Formation		
Dolomite, light tan to light gray, medium to fine grained, thin bedded; dolomitic shale and shaly dolomite partings every 1 to 4 inches	10	
Dolomite, medium to coarse grained, porous with slit-like pores		3
Dolomite, fine to medium grained; in beds 8 to 12 inches thick, except massive appearing along exposed joint faces in west part of quarry; contains a few bands of chert nodules, shaly dolomite partings in upper 4 inches	5	9
Dolomite, fine grained, dense, a persistent bed throughout the quarry; weathers into 4- by 8-inch rectangular blocks in places		2
Dolomite, fine grained, dense; has greenish gray, slightly dolomitic shale partings up to 1 inch thick		5
Dolomite, cherty, fine to medium grained, massive; rough-weathering surface with secondary calcite	6	6
Dolomite, fine grained; weathers blocky; ¼-inch thick coquina at base		3
Dolomite, medium to fine grained, vuggy, massive	2	3
Mifflin Formation		
Dolomite, medium gray with tan gray near the bedding planes, weathered tan to light tan (nearly white) with blue-gray mottlings, fine-grained with some medium-grained areas, thin bedded; greenish gray shale partings in 9-inch zone near top; fossiliferous bed (Leperditia, fucoids, crinoid stems, brachiopods, gastropods, trilobites) in patches on quarry floor	3	5
Following measured adjacent to above quarry on west side of Illinois Highway 26 down the valley wall of Richland Creek to small quarry at base:		
Covered	10	6
Dolomite, light tan with some light brown and medium gray, weathered light gray, fine to medium grained, thin bedded, fossiliferous; argillaceous dolomite partings	5	6
Covered	3	6
Dolomite, tan with light gray mottling, weathered mottled light tan and light gray; beds up to 4 inches thick, average 1 to 2 inches; reentrant at base	3	2
Pecatonica Formation		
Dolomite, tan with light gray mottlings more prominent than in Mifflin above, weathered orange-brown and blue-gray, fine to medium grained, thin to medium bedded, less argillaceous than Mifflin above	4	2
Base concealed		

Grand Detour Formation

The Grand Detour Formation is dolomite, light tan to light gray, fine to medium grained, thin to thick bedded and slightly shaly; it contains some chert and a few fossils (brachiopods and pelecypods). It is 24 feet 11 inches thick in geologic section 1, and a few feet of the upper part are exposed in geologic section 2.

Nachusa Formation

The Nachusa Formation is dolomite, gray, fine to medium grained, thick to medium bedded, and relatively pure. It is best exposed near Orangeville in geologic section 2 where it is 16 feet 9 inches thick.

Geologic Section 2

Quarry in the valley wall of Richland Creek about one-half mile west of Orangeville (center NE¼ SE¼ sec. 35, T. 29 N., R. 7 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Guttenberg Formation		
Dolomite, tan and gray, weathered light tan and white, fine to coarse grained, vesicular, fossiliferous; in wavy beds 1 to 4 inches thick separated by red-brown shale	6	4
Platteville Group		
Quimbys Mill Formation		
Dolomite, light tan and medium gray, weathered light tan and cream, fine grained, thin bedded; contains fucoids and corals	9	3
Nachusa Formation		
Dolomite, cherty, light tan, light and medium gray, weathered light bluish gray with orange-tan layers, fine to medium grained with coarse-grained fossiliferous layers; medium-bedded coquina lenses about 2 feet apart; abundant light gray fucoids	12	3
Dolomite, as above except slightly shaly; ½-inch clay bed at base	1	2
Dolomite, as above but not shaly and has two coquina beds	3	4
Grand Detour Formation		
Dolomite, cherty, light tan and light brown, weathered mottled light brown and gray, fine to medium grained; more argillaceous than above	2	7
Base concealed		

Quimbys Mill Formation

The Quimbys Mill Formation, at the top of the Platteville Group, is a dense, slightly argillaceous dolomite. It is gray but weathers to light tan and cream colored. It is fine grained and thin bedded with wavy bedding planes. Chert is present locally, and dark red and brown phosphate nodules up to 2 millimeters in diameter are present on the top surface. The irregular surface, which has only about 1 inch of relief, and the phosphatic nodules are local evidence of a widespread unconformity along which the Spechts Ferry Formation, the basal formation in the Galena Group, is missing (Templeton and Willman, 1963). The Quimbys Mill is 9 to 10 feet thick in this area. The surface is exposed in geologic section 2 and in a quarry in the SE¼ NE¼ SE¼ sec. 24, T. 27 N., R. 8 E.

GALENA GROUP

Most of the bedrock exposures in the Freeport Quadrangle are part of the Galena Group. Four formations are differentiated, the Guttenberg at the base, Dunleith, Wise Lake, and Dubuque. The individual formations are mapped separately with the exception of the thin Guttenberg Formation, which is included with the overlying Dunleith Formation. The formations are all dolomite, and the dolomite is more pure than the dolomite of the Platteville Group. The dolomite ranges in grain size from fine to coarse. The coarse grains often occur in clusters, usually 1 to 2 inches across and a few inches apart, so that weathering produces a sugary surface with a pock-marked or honey-combed aspect. The lower part of the group is cherty, and weathering produces reentrants along the layers containing chert nodules. Most of the dolomite is light tan or light gray and weathers to light tan, light gray, or medium gray; it ranges from medium bedded to massive. Large disc-like masses of the sponge Receptaculites, some nearly a foot across, may be found at any horizon but are abundant in three zones. None of the wells penetrate a complete section of the group, and its total thickness, about 240 feet, is estimated from surface exposures.

Guttenberg Formation

The Guttenberg Formation consists of pure vesicular dolomite in 1- to 4-inch beds separated by dark red to red-brown shale in 1/8- to 1/2-inch beds. It is very fossiliferous (brachiopods, gastropods, crinoid stems, cephalopods, bryozoans, and others). The dolomite is largely light tan to light gray, but some of the coarser grained beds have a purplish cast on freshly broken surfaces. The upper surfaces of the more fossiliferous beds weather nearly white. The shale beds weather tan or light gray. The Guttenberg commonly is about 8 feet thick. The best exposure is in geologic section 2.

Dunleith Formation

The Dunleith Formation is the cherty lower part of the Galena Group and includes two of the three *Receptaculites* zones. The formation is well exposed in quarries and outcrops around Freeport. Its general lithology is that typical of the Galena Group as described above. Members are indicated in measured sections (geologic sections 3 through 6), and their individual characteristics as seen in the Freeport Quadrangle are summarized below.

The Dunleith is classified into members largely on the basis of a cyclic repetition from pure beds at the base to more argillaceous beds at the top of each member (Templeton and Willman, 1963). The variation in argillaceousness is weakly developed in this area in which the entire formation is more pure than in the type region near Galena.

Buckhorn Member.—The Buckhorn Member consists of 8 to 10 feet of fine- to medium-grained dolomite that weathers to a bluish gray and is thin to medium bedded. Some beds are pure and vesicular; others are shaly. Some of the shaly beds are fossiliferous. The type locality of the Buckhorn is in a quarry at Buena Vista (geologic section 3). The unit is named for Buckhorn Corners, east of Buena Vista.

St. James Member.—The dolomite of the St. James Member has the typical lithology of the Galena Group. It is thick bedded to massive and is light gray in contrast to the darker Buckhorn Member. It has a few thin, green, shaly partings and is about 12 feet thick. It is well exposed in the quarry at Buena Vista (geologic section 3).

Beecher Member.—The Beecher Member is a massive dolomite, 7 to 8 feet thick, that lacks the green shale of the St. James below and the chert of the Eagle Point Member above. Small lenticular openings on weathered surfaces are casts of a small brachiopod, *Dalmanella*. It is well exposed in geologic sections 3 and 4.

Eagle Point Member.—The Eagle Point Member consists of medium-bedded, relatively pure dolomite with bands of chert nodules. It is about 12 feet thick and is well exposed in geologic sections 3 and 4.

Fairplay Member.—The Fairplay Member differs from the members above and below in that it lacks chert and contains numerous specimens of *Receptaculites*. This is called the Lower *Receptaculites* Zone. The Fairplay is about 17 feet thick and is well exposed in geologic section 4 and in old quarries on the west side of Highway 26 on the south side of Pecatonica Valley at Freeport. The base of the Fairplay is an easily recognized horizon for structure mapping.

Geologic Section 3

Quarry west of Richland Creek at Buena Vista (SW¼ NW¼ NE¼ sec. 15, T. 28 N., R. 7 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Dunleith Formation		
Eagle Point Member		
Dolomite, cherty, light gray with light tan mottlings, fine to coarse grained, in beds 2 to 8 inches thick; mostly pure and vesicular but contains a few thin slightly argillaceous layers	12	7
Beecher Member		
Dolomite, as above but not cherty; contains shaly partings in lower 1½ feet	6	10
St. James Member		
Dolomite, as above but not cherty, thick bedded; contains a 2-inch layer of green-gray dolomitic shale at the top	12	8
Buckhorn Member		
Dolomite, brownish gray and bluish gray, weathers to light gray and light brown, fine to coarse grained; contains scattered small black specks that are pyrite or alteration products of pyrite; pure and vesicular dolomite is interbedded with slightly argillaceous, dense dolomite and dark gray and green dolomitic shale; several fossiliferous beds contain Receptaculites, crinoid stems and plates (?), bryozoa, brachiopods and gastropods; lower 3 feet is largely covered by talus	8	10
Guttenberg Formation		
Dolomite with red shale beds exposed only on quarry floor		4
Base concealed		

Geologic Section 4

Roadcut of Illinois Highway 26 and north wall of Cedar Creek below and west of bridge (NW¼ SW¼ NW¼ sec. 31, T. 28 N., R. 8 E., and NE¼ SE¼ NE¼ sec. 36, T. 28 N., R. 7 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Dunleith Formation		
Sherwood Member		
Dolomite, cherty, mottled light gray to light brown, weathered light tan and light to medium gray, medium to coarse grained	10	
Rivoli Member		
Dolomite, medium gray, medium to coarse grained, thick bedded, not cherty	12	3
Mortimer Member		
Dolomite, cherty, light gray, fine to medium grained, medium bedded; Receptaculites present near base	13	1
Fairplay Member		
Dolomite, mottled light gray and light tan, weathered light gray, fine to coarse grained, pure, slightly vesicular, massive in lower part, Receptaculites abundant in a few beds	17	5
Eagle Point Member		
Dolomite, mostly pure but contains a few slightly argillaceous dense beds near base; contains bands of chert nodules	16	
Beecher Member		
Dolomite, massive, not cherty	8	6
Base concealed at water level		

Mortimer Member.—The Mortimer Member consists of cherty dolomite that is argillaceous at the top. It is about 13 feet thick where well exposed in geologic section 4.

Rivoli Member.—The Rivoli Member is only slightly cherty in this area. It is about 12 feet thick. With the Sherwood Member above, it contains abundant Receptaculites and is called the Middle Receptaculites Zone. It is best exposed in geologic section 4.

Sherwood Member.—The Sherwood Member consists of about 11 feet of cherty dolomite with thin lenses of bentonite about 3 feet below the top. The best exposures are described in geologic sections 4 and 5.

Wall Member.—The Wall Member is medium- to thick-bedded, relatively pure dolomite that contains only a few scattered nodules of chert and is about 12 feet thick. It is well exposed in a quarry on the south side of Freeport (geologic section 5).

Geologic Section 5

Quarry 0.2 mile south of Belt Line Highway on south side of Freeport (SW¼ NE¼ SE¼ sec. 6, T. 26 N., R. 8 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Dunleith Formation		
Wyota Member		
Dolomite, cherty, light grayish brown mottled with tan, pure, slightly vesicular; fine to coarse grained; contains dense fine-grained beds and chert nodules in well defined bands; gastropods present in zone 1-foot thick about 15 feet from top	21	2
Wall Member		
Dolomite, light grayish brown, weathered light gray or tan, fine to coarse grained, medium bedded; contains one discontinuous chert layer	12	2
Sherwood Member		
Dolomite, cherty, light grayish brown mottled with tan; 1-inch fossiliferous bed present 6 inches below top; contains several dense impure beds; chert occurs in scattered nodules rather than in bands	8	8

Wyota Member.—The Wyota Member contains numerous bands of chert nodules and is the prominent chert zone at the top of the Dunleith Formation. It contains gastropods in the upper part. It is about 21 feet thick in geologic section 5 and is also exposed in geologic section 6.

Geologic Section 6

Quarry 0.15 mile south of Belt Line Highway on south side of Freeport (SE¼ NE¼ SW¼ sec. 6., T. 26 N., R. 8 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Wise Lake Formation		
Sinsinawa Member		
Dolomite, light tan and gray, weathered mottled, fine to coarse grained, medium bedded; gastropods and fucoids common	10	2
Dunleith Formation		
Wyota Member		
Dolomite, light tan and light gray, weathered to mottled gray and orange-tan, fine to coarse grained; contains thin, fine-grained, dense beds and a few shaly dolomite partings; chert nodules common in layers; gastropods are present in upper part of unit	14	
Base concealed		

Wise Lake Formation

The Wise Lake Formation consists of relatively pure, thick-bedded to massive, noncherty dolomite. Gastropods are common throughout, and Receptaculites is abundant in the upper member. There are numerous exposures in the Freeport Quadrangle, as shown on the geologic map (plate 1).

Sinsinawa Member.—The Sinsinawa Member is slightly less pure and thinner bedded than the overlying Stewartville Member. The Sinsinawa is about 40 feet thick and the lower part is exposed in geologic section 6. The Sinsinawa is generally separated from the cherty Dunleith below by a sharp reentrant in weathered exposures.

Stewartville Member.—The Stewartville Member is the upper 30 to 35 feet of the Wise Lake Formation. It consists of thick bedded to massive dolomite and is the purest part of the Galena Group. The abundance of Receptaculites in the lower 10 to 15 feet and the more massive character distinguish the Stewartville from the Sinsinawa Member. This is the Upper Receptaculites Zone. No complete section is exposed, but there are numerous exposures like that in geologic section 7.

Geologic Section 7

Compiled from stream cuts and quarries along the north side of Yellow Creek (SE¼ NE¼ NE¼ sec. 13, T. 26 N., R. 6 E., Stephenson County).

	Thickness Ft.	In.
Galena Group		
Dubuque Formation		
Dolomite, medium gray to brown, fine to medium grained, somewhat more argillaceous than the Stewartville	4	11
Dolomite, like below but partly covered	3	
Dolomite, medium to light gray, fine to medium grained, medium bedded; beds separated by argillaceous dolomite layers 1 to 2 inches thick	8	4
Wise Lake Formation		
Stewartville Member		
Dolomite, medium gray to brown, weathered light gray, fine to medium grained, in thick and medium beds	7	11
Dolomite, dark gray-brown, fine to medium grained		4
Dolomite, medium gray to brown, fine to medium grained, massive to medium bedded; contains gastropods	10	5
Base concealed		

Dubuque Formation

The Dubuque Formation consists of fine- to medium-grained dolomite that is pure at the base but becomes progressively more argillaceous upward. Shaly partings between the beds become more prominent upward. The base of the formation is placed at the lowest strong shaly parting. Dolomitic shale beds 1 to 2 inches thick occur at least as low as the middle of the formation. A complete section is not exposed, but the formation is probably 25 to 30 feet thick. About 16 feet of the lower part of the formation is exposed in geologic section 7.

Residual Clay.—Weathering of the Galena Dolomite leaves an insoluble residue of reddish brown unctuous clay. Angular chert fragments commonly are abundant in the clay. The clay is usually only a few inches thick but locally is as much as 1½ feet thick. It is widely present, but it was eroded completely from some areas by the glaciers, and its thickness in many exposures may have been reduced by glacial erosion. The clay is the product of long-continued weathering. It could have been formed during the pre-Wisconsinan part of the Pleistocene, but its development in places may have started as early as the Tertiary Period. It is the Sangamon Soil.

ORDOVICIAN SYSTEM—CINCINNATIAN SERIES

MAQUOKETA GROUP

The Maquoketa Group crops out only in a small area near the southwest corner of the quadrangle. It is pale olive, dolomitic shale that contains light grayish brown, argillaceous dolomite in beds 2 to 6 inches thick, spaced 1 to 2 feet apart. Only 20 feet is exposed (geologic section 8), but the total thickness is estimated to be about 90 feet.

Geologic Section 8

Exposure along east side of road (SW¼ NE¼ SW¼ and NW¼ SE¼ SW¼ sec. 31, T. 27 N., R. 7 E., Stephenson County).

	Thickness Ft.	In.
Maquoketa Group		
Soil, dark gray, on loess	2	
Shale, pale olive (10 Y 6/2) when wet but closer to light greenish gray (5 GY 8/1) when dry, dolomitic; contains several thin beds of argillaceous dolomite	20	6
Base concealed		

QUATERNARY SYSTEM—PLEISTOCENE SERIES

The glacial deposits in the Freeport Quadrangle are of Wisconsinan Age, which is the youngest of the four major intervals of glaciation during the Pleistocene. They commonly rest on the Sangamon Soil—the residual clay on the dolomite bedrock. Wisconsinan glaciation began about 70,000 years ago with advance of the Altonian glacier (Frye, Willman, and Black, 1965). Radiocarbon dates indicate that the Farmdalian interval of ice withdrawal and weathering, which followed the Altonian, began about 28,000 years ago. The Woodfordian glaciation began about 22,000 years ago and ended about 12,000 years ago. The glaciers of that age, spreading westward from the Lake Michigan basin, covered a large region south of the Freeport Quadrangle (fig. 1). Deposits of the later Twocreekan and Valderan Substages are not recognized in this area, and stream alluvium that probably accumulated in the valleys during that time are included in the deposits mapped as Recent alluvium.

WISCONSINAN STAGE

The glacial deposits of the Freeport Quadrangle were deposited during the early Wisconsinan Altonian glaciation, and collectively they are called Winnebago drift. They are mantled by a deposit of wind-blown silt, called Peoria Loess, which was blown from glacial outwash that accumulated in the bottomlands of the major rivers during the Woodfordian glaciation.

Previous studies of the glacial deposits covering this quadrangle and adjacent areas were made by Shaw (1873), Hershey (1893, 1895, 1896a, b and c, 1897a, b and c, and 1901), Leverett (1899), Alden (1918), Leighton (1923), Flint (1931), Shaffer (1954 and 1956), Leighton and Brophy (1961), Hackett (1960), and Kempton (1963).

Altonian Substage

The Freeport area had a topographic relief somewhat greater than at present when it was invaded by the Altonian glacier. Nearly all the valleys are partially filled with glacial drift, and a few are almost entirely filled. The thickest drift in the area, about 150 feet, occurs in the pre-glaciation channel of Cedar Creek, as shown by wells in the village of Cedarville. The drift is generally thin on the higher parts of the hills, and in fact it is represented on many hills by only a few glacial pebbles imbedded in the residual soil.

The Altonian glacier advanced from the east. Striations on the bedrock surface that trend S. 75° W. in Winnebago County and others in Wisconsin north of the Freeport Quadrangle trending northwesterly (Alden, 1918, p. 162) indicate that the direction of flow was probably influenced by the local topography. Glacially disturbed bedrock in the quarry in the W½ sec. 12, T. 26 N., R. 8 E., show glacial movement from the northeast.

The extreme thinness of till on the hills suggests a moderate thickness for the ice. Shaffer (1956, p. 15) estimates at least 500 feet of ice at the margin of the glacier with about 200 feet covering the hilltops.

After covering the area, the glacier appears to have lost its motion and to have melted from the top down. Stagnation of the ice (Flint, 1931; Shaffer, 1956) is indicated by the preservation in the valleys of depositional features—such as kames and eskers—that would have been destroyed if the ice remained active during the retreatal stage, by stream diversion channels resulting from persistence of isolated ice blocks in the valleys, by the thinness of drift in the upland areas, by the abundance of ice-shove features, and by the absence of well-defined end moraines.

Winnebago Drift

The Winnebago drift is named for its wide distribution and good exposure in Winnebago County, a short distance east of the Freeport Quadrangle (Frye and Willman, 1960). The drift was called Illinoian for many years, but its early Wisconsinan age was indicated by the studies of Shaffer (1956) who assigned it to the Farmdale Substage. Recognition of the complexity of the early Wisconsinan deposits resulted in the reclassification in 1960 and the assignment of the drift to the Altonian Substage. Because Farmdale was restricted to post-Altonian deposits, the name was no longer appropriate for these deposits. Therefore, the name Winnebago drift was introduced as a local rock-stratigraphic term that could be used regardless of age assignment.

The Winnebago drift consists of glacial till, stream deposits of sand and gravel, and silts and sands deposited in lakes. Till thinly covers much of the quadrangle, and there are extensive deposits of stratified drift mapped primarily on the basis of geomorphic form. These are kames, kame complexes, kame terraces, eskers or crevasse fillings, and lake deposits. As the loess forms a thin sheet over almost the entire area, it is not differentiated on the geologic map (plate 1).

Glacial till.—The glacial till consists of an unsorted mixture of sand, silt, and clay. It contains scattered pebbles, cobbles, and a few boulders. The till varies from a thin veneer of chert and foreign crystalline pebbles, overlying or partially imbedded in the bedrock residuum, to a maximum exposed thickness of 12 feet. Most samples were very pale brown (10 YR 7/3) when examined in the laboratory, but in outcrops the till has a pinkish cast in many localities.

The pebbles and larger rock fragments are dolomite, granite, syenite, gabbro, rhyolite, basalt, various metamorphic rocks, including quartzite, and others. Native copper was observed in one locality. About 75 to 80 percent of the pebbles are dolomite. The sand and silt fractions of the till are dominantly quartz. From X-ray analyses of the clay fraction of fresh till, Dr. William F. Bradley reported that quartz and chlorite were present in all samples, illite and dolomite in most samples, calcite in many samples, and montmorillonite in some samples. The clay mineralogy and heavy minerals of the Winnebago till have been described recently (Willman, Glass, and Frye, 1963).

The matrix of the till was a silty sand in all twenty samples analyzed by Shaffer (1956). In this respect, the Winnebago till differs from the Woodfordian (Shelbyville) till, which overlies it south of the area studied and is mainly a clayey, sandy silt.

In most exposures, the till is leached to a depth of only one to two feet. The leached zone is usually more clayey than the fresh till. High-silica materials tend to predominate, but some basic igneous rocks are generally present. The leached till is reddish brown (5 YR hue), and this color often penetrates the calcareous till for a few inches to a foot below the leached zone.

Small exposures of till can be seen in many roadcuts and excavations for buildings. Good exposures occur on the north side of the road in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 15, T. 27 N., R. 8 E., on the north side of the road in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 28, T. 28 N., R. 8 E., and on the south side of the road in the NW$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 23, T. 28 N., R. 7 E.

Glaciofluvial Deposits.—Meltwater from the glaciers deposited sand and gravel as kames, kame complexes, kame terraces, eskers, and crevasse fillings at many places in the quadrangle. The gravel has essentially the same composition as the coarse materials of the till. Dolomite makes up the bulk of the deposit, but white and brown chert are common, and some igneous rocks are present. The glaciofluvial deposits range from a few feet to about 40 feet thick. Cross bedding is common and complex. A deposit of this type is well exposed in a pit in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 36, T. 27 N., R. 8 E.

The kames are roughly conical hills of sand and gravel, usually containing lenses of till, that were deposited within or at the margin of the ice. They occasionally are separate from valley sides, as in sec. 1, T. 27 N., R. 7 E., and sec. 12, T. 26 N., R. 7 E., but usually they occur against the sides of valleys. Some of the kames are crescent shaped, as in the NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 7, T. 27 N., R. 8 E. Individual kames commonly are 10 to 20 feet high and from 300 to 600 feet across at the base.

Where several kames are closely spaced, they are mapped as kame complexes. A kame complex extends from the vicinity of Damascus School, in the west central part of the quadrangle, northwestward for about 5 miles into the adjoining Lena Quadrangle.

Kame terraces are differentiated from kames and kame complexes by being elongate and relatively flat-topped or with several high points rising to about the same elevation. They apparently were formed by coalescing kames and deltas that were built into ponds between the ice and the valley walls.

Some elongate ridges, composed of sand and gravel, are interpreted as eskers or crevasse fillings. These occur mainly in the Pecatonica Valley east of Freeport (plate 1). The ridges are 10 to 20 feet high, up to a few hundred feet across, and up to one-third of a mile long.

Glaciolacustrine Deposits.—Many valleys in the area contain deposits of sand and silt that were deposited in lakes formed by ice block dams in the deeper valleys. Some of the lacustrine deposits are interbedded with sand and gravel and till in the valleys. The upper 10 to 18 feet of deposits that fill abandoned segments of small bedrock valleys commonly consist of silts with some sand beds. The silts are calcareous when fresh and in places have calcareous concretions up to $1\frac{1}{2}$ inches in diameter. They are generally laminated and locally cross bedded. The deposits vary from light gray to tan. Beds of fine- to medium-grained calcareous sand are often interbedded with the silts. Thirteen cycles of light tan silt beds, 3 to 6 inches thick, and light gray silt beds, $\frac{1}{2}$ to 1 inch thick, are exposed in one locality (NW$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 13, T. 27 N., R. 8 E.).

No fossils were found in any exposures in this quadrangle, but Leonard (1957) described a terrestrial gastropod fauna from water-laid silts associated with sand and gravel deposits in Winnebago drift near Mt. Carroll, southwest of the Freeport Quadrangle.

About 9 feet of the lake silts are exposed in a roadcut on the east side of Illinois Highway 26 in the village of Orangeville (SW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 36, T. 29 N., R. 7 E.).

Ice-shove features.—As the glacier advanced across the area, it severely eroded the dolomite bedrock—gouging, shattering, thrusting, and folding large bodies of the rock. The degree of deformation of the bedrock appears to be much higher than in most glaciated parts of the state. It resulted largely from the relatively high relief of the surface over which the ice advanced, but the apparent abundance of such features probably is exaggerated because the thinness of the drift results in many exposures of the bedrock surface. Many areas of disturbed bedrock are shown on the geologic map (plate 1).

The disturbed areas are further evidence of the stagnation of the glacier. In most of the state where the ice was active during the retreatal interval, the bedrock generally appears to be planed smooth by the final movement of the ice, and the material eroded is completely mixed in the till. In the region of the Winnebago drift, the transition from solid bedrock through mixed till and shattered bedrock to normal till gives the impression that the process of erosion and mixing was suddenly arrested, that the ice ceased to move.

Large blocks of dolomite are tilted in many localities, and fracture folding was observed in two places. Folding is associated with faulting in the west wall of a quarry in the SW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 8, T. 28 N., R. 8 E.; an ice-shove anticline is exposed in a quarry in the SE$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 5, T. 27 N., R. 8 E. Some of the exposures show more complex features, such as in the quarry in the W$\frac{1}{2}$ sec. 12, T. 26 N., R. 8 E., where till is interlayered with overthrust slices of fractured dolomite. Shattered dolomite overlies sand and gravel in the quarry in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 27, T. 29 N., R. 8 E. and in the quarry in the SW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 8, T. 28 N., R. 8 E.

Drainage Changes.—As the stagnant Winnebago glacier melted downward, an irregular surface of ice and protruding bedrock developed. On this surface, meltwater escaped through temporary valleys, some of which are indicated on the surficial geology map (plate 1). As the ice melting progressed, more of the bedrock was exposed, and the remaining ice stood in valleys, probably as isolated blocks. Some of the blocks became dams for lakes. In places, permanent drainage changes resulted from the overflow of the lakes. The narrowing of a valley, often with a sharp change in direction bordering an area of valley fill shown on the geologic map, are the result of such changes. Major drainage changes are recognized easily by inspection of the bedrock geology map (fig. 4). An exposure along the valley wall of Richland Creek in the NW$\frac{1}{4}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 11, T. 28 N., R. 7 E., shows that the drift in the abandoned segment of the bedrock valley consists of silt and fine sand. Auger borings in other buried valleys penetrate silts and sands, which suggests that many of the ice dams persisted long enough for thick silt deposits to accumulate in the lakes while the diversion channel was being cut down.

Age of the Drift.—The age of the Winnebago drift in the Freeport Quadrangle has been a subject of debate for nearly fifty years. After an early assignment to the Kansan (Hershey, 1897a), the drift was considered to be of Illinoian age for many years (Hershey, 1897b and 1901; Leverett, 1899; Alden, 1918; and Leighton, 1923). Shaffer (1954 and 1956) found that the surface drift had youthful characteristics and was not weathered as severely as Illinoian drift. He found no evidence for a buried drift of older age. Consequently, he assigned the drift to the earliest Wisconsinan glaciation, then called Farmdale. Leighton favored assignment of the drift to the Wisconsinan; but later he restricted the Farmdale to the region east of Freeport and reassigned the drift at Freeport and farther west to the Illinoian (Leighton, 1958; Leighton and Brophy, 1961). As previously noted, the Farmdale drift of Shaffer was renamed Winnebago and assigned to the Altonian Substage (Frye and Willman, 1960). More recent detailed subsurface studies in the area from Rockford eastward to the front of the Woodfordian moraines support the Altonian age for the drift and indicate several intervals of fluctuation of the ice (Hackett, 1960; Kempton, 1963). They did not find evidence for Illinoian glaciation of the area.

In the Freeport Quadrangle, the amount of erosion since deposition of the Winnebago drift does not seem to have been great. Glaciofluvial landforms, especially the kame complex and crevasse fillings in secs. 34 and 36, T. 27 N., R. 8 E., appear to be little modified. The narrow part of the Pecatonica River Valley in sec. 32, T. 28 N., R. 7 E., the gorge north of Cedarville, and valleys associated with drainage changes elsewhere were cut while the ice stood in the area. The fact that they are still unmodified suggests that little bedrock erosion has occurred since glaciation. Drift still chokes some bedrock valleys in which modern streams are now flowing, as in sec. 8, T. 26 N., R. 8 E., and these also suggest that the time since deposition was relatively short.

The degree of weathering is not as great as that on Illinoian drift in central Illinois, although exposures deep enough to expose both fresh and leached till occur on hillsides under conditions favorable for good drainage and deep leaching. In seventeen localities where leached and unleached till were exposed, leaching had proceeded through loess and into the till for an average of 4.4 feet. Leaching into silts (loess, glacial silts, or both) averaged 5.8 feet. The maximum depth of leaching was 11.5 feet in each category. These averages are comparable to those given for the same drift sheet by Alden (1918, pp. 150 and 154) but lower than those of Bretz (1923, p. 241), Leighton (1923, p. 272), and Knappen (1926, p. 70).

The evidence of erosion and weathering favors a Wisconsinan age for the Winnebago drift in this quadrangle.

Farmdalian Substage

After the Altonian glaciers deposited the Winnebago drift, they melted away and the drift was weathered before the overlying Peoria Loess was deposited. The interval of ice withdrawal and weathering is the Farmdalian Substage. Farmdalian deposits are not common in the Freeport area, but lenses of sandy silts, 6 inches to 2 feet 6 inches thick, that locally overlie Winnebago till and underlie the Peoria Loess (Shaffer, 1956, p. 20) are assigned to the Farmdalian Substage. The sandy silt ranges from light gray (10 YR 6.5/2) to very pale brown (10 YR 6.5/4). In most exposures, black pellets of manganese and iron oxides up to 2 or 3 millimeters in diameter are prominent. Pebbles are present in places, as on the east side of the road in the SW$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 5, T. 27 N., R. 7 E. Clay minerals common to all samples are chlorite (poor quality), montmorillonite, and kaolinite. Illite was present in one sample. The sandy silt is exposed along the north side of the railroad, even with a north-south gravel road in the SW$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 22, T. 27 N., R. 7 E., in Freeport about 150 feet east of Illinois Highway 26, and 50 to 70 feet north of the Belt Line Highway in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 6, T. 26 N., R. 8 E.

The silt may have been formed by wind action on the surface of the drift (Shaffer, 1956), or it may be a colluvial deposit derived from higher slopes on the drift surface. The colluvial process could have been initiated by the changing climatic conditions associated with later ice advances of Altonian age farther east, but its stratigraphic relations and the weathering of the underlying drift favor a Farmdalian age.

Woodfordian Substage

Peoria Loess

The Peoria Loess covers most of the earlier Pleistocene deposits throughout the quadrangle. The wind-blown silt is typically very pale brown (10 YR 6.5/4). It is commonly 2 to 4 feet thick but rarely is as much as 8 to 10 feet thick. The average, based on 54 measurements, is 3.4 feet, but the area is almost entirely in slope, and the amount removed by erosion is uncertain.

The loess deposits near the major valleys, such as the Pecatonica River and Richland Creek Valleys, are slightly more sandy than elsewhere, which suggests that some of the deposits are derived from the floodplains of these streams. Most of the loess, however, is part of the widespread mantle of loess derived from the Mississippi River Valley towards which the loess generally thickens.

RECENT STAGE

Since the Peoria Loess was deposited, the land surface has been gradually modified by weathering, slope wash, slumping, and creep, processes referred to as mass wastage. This process started in the Wisconsinan Age, continued into Recent time, and is active at present. In general, all deposits resulting from modification of the glacial deposits are assigned to the Recent Stage, because more definite differentiation as to age is not feasible. These deposits include the Recent alluvium (plate 1), which is largely stream deposits in the bottomlands. Although only the broader floodplains can be mapped, such deposits extend in smaller amounts into all branches of the stream network. The deposits consist largely of silt derived from erosion of the loess, are mostly dark colored from organic material derived from the soils, and include lenses of sand and gravel derived from erosion of the glacial drift. Most of the deposits were transported by the streams when in flood and were deposited in the flooded areas as the waters subsided.

On the floodplain of the Pecatonica River in section 20, T. 2 N., R. 7 E., wind has blown sand from the alluvium into two dunes.

STRUCTURAL GEOLOGY

The Freeport Quadrangle is located on the south slope of the Wisconsin Arch. The structural map on the Glenwood Formation (fig. 5) shows only gentle tectonic features. The structure map is based on wells that reached the Glenwood and on surface exposures and wells that penetrated higher horizons. As the thickness of the units above the Glenwood shows only slight variations, the depth to the Glenwood can be estimated with acceptable accuracy from the exposure of any stratigraphic contact.

Regional dip is to the southwest at an average rate of 20 feet per mile. Except where the bedrock is deformed by glacial shove, the highest dip observed was $5\frac{1}{2}$° N. 18° W. in a quarry in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 1, T. 28 N., R. 7 E., which may be due in part to slumping.

No tectonic faults were found in the area. Joints were measured in six places. Two sets of joints were usually present, one ranging from N. 15° W. to N. 12° E. and the other from N. 76° to S. 82° W.

MINERAL RESOURCES

DOLOMITE

Almost the entire area of the Freeport Quadrangle is underlain by the Galena and Platteville Dolomites. Quarries have been opened and operated intermittently at or near most of the towns and villages. Crushed stone suitable for concrete aggregate, road rock, and agricultural limestone probably can be produced from most parts of the dolomite. Massive beds in the upper part of the dolomite afford a source of a travertine-like building stone (Lamar and Willman, 1955).

The dolomite is as much as 350 feet thick, and it is over 100 feet thick except in a small area along Richland Creek above Orangeville and below the floodplain of Pectonica River.

Chert is moderately abundant in a few zones in the middle part of the dolomite. The upper 100 feet contains no chert and is a pure rock especially suitable for agricultural limestone and other uses of high-purity dolomite (Willman, 1943). It is more porous and slightly softer than the lower part. In places, the upper few feet is broken down by weathering into sand-sized fragments of dolomite. The sand-like material generally is as pure as the underlying firm dolomite. The high-purity chert-free dolomite is present throughout the part of the area that is underlain by the Wise Lake Formation (fig. 4), and outcrops are shown on plate 1.

On most of the hills throughout the quadrangle, the overburden consists of a thin coating of residual clay on the dolomite, patches of till 1 to 10 feet thick, and about 3 feet of loess. Generally, the overburden is thicker on the lower slopes and in the valleys than it is on the higher parts of the hills. In some areas, the overburden consists of the upper ledges of the rock that were crushed by the glaciers and intermixed with till (plate 1).

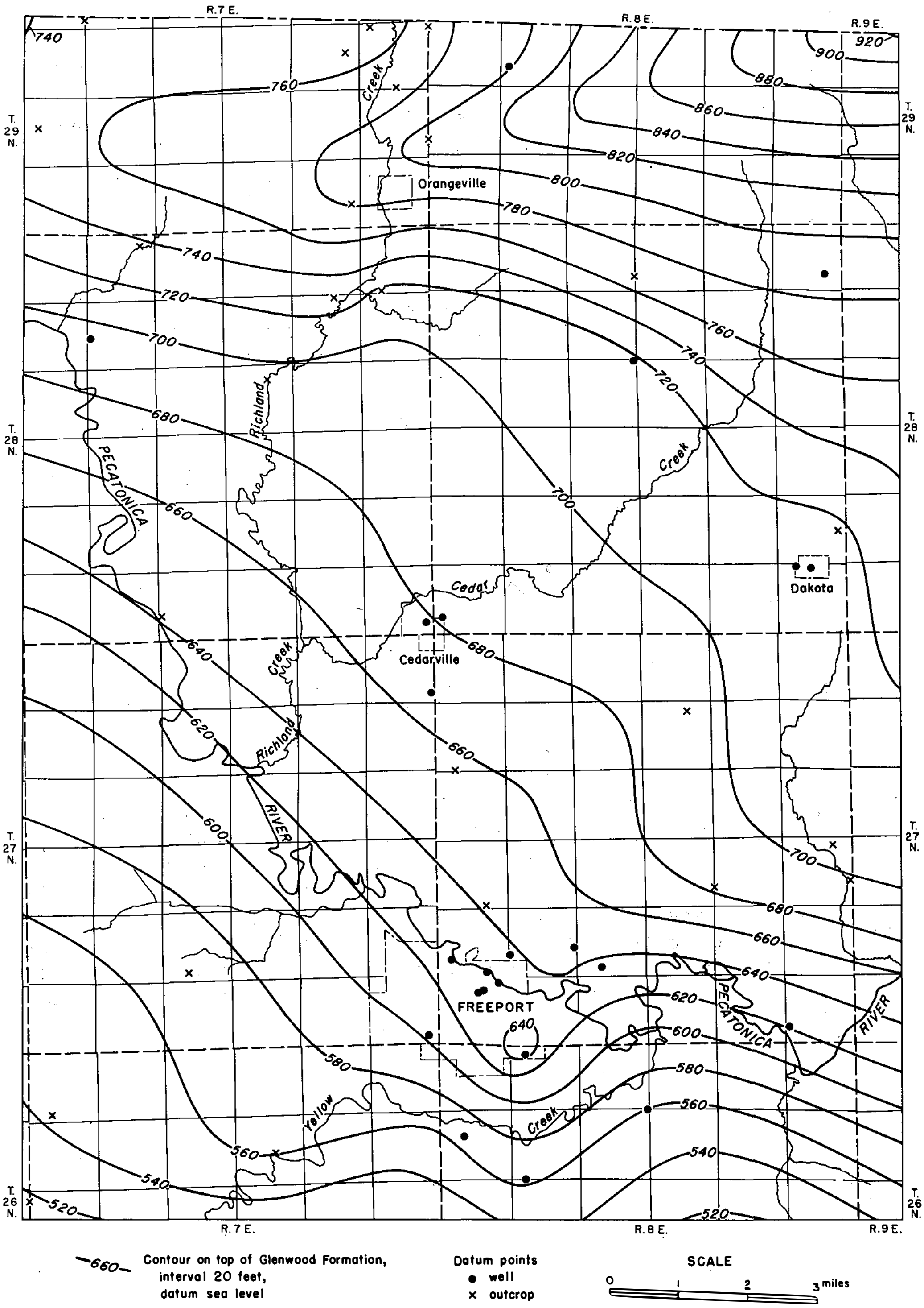

Figure 5. Geologic structure of the Freeport Quadrangle.

SAND AND GRAVEL

Sand and gravel deposits suitable for road surfacing are common along the valleys, and small pits have been opened in many of them. The deposits are generally too small for large operations. The largest deposits are along Pecatonica Valley east of Freeport and south of McConnell (plate 1). Most of the deposits in the area are ice-contact glacial deposits (see Winnebago drift–glaciofluvial deposits), which characteristically are highly variable in coarseness and in abundance of silt and clay in the matrix. These characteristics are not predictable from the surface, and extensive developments of the areas mapped should be based on adequate exploration.

Although the Recent alluvium of Pecatonica Valley (plate 1) is generally silt and silty sand at the surface, considerable bodies of gravel probably occur below the silt cover. They probably could be outlined by drilling and worked by dredging.

CLAY AND SHALE

The surficial loess deposits are generally leached of carbonates throughout the area and may be suitable for the manufacture of common brick and tile. The maximum thickness of suitable material probably does not exceed 5 feet. Although local development of such deposits was common in the past, they are not widely used at present. The glacial till in places may also be suitable for some ceramic uses.

The Maquoketa Shale is locally present in the southwest corner of the quadrangle, but it is mostly calcareous and in part contains thin beds of dolomite. Consequently, it is not suitable for many ceramic uses.

GROUND WATER

Ground water suitable and adequate for domestic uses on farms is generally present throughout the area. The glacial drift in the valleys in places contains sand and gravel with water obtainable from shallow wells. In the hills where the drift is thin, adequate water generally is found in porous layers or fracture zones in the dolomite bedrock. Where larger supplies are needed, wells are drilled to the St. Peter Sandstone. The depth to the St. Peter at any locality can be estimated from the surface elevation (plate 1) and the elevation of the top of the sandstone shown on figure 5. The ground-water resources of the region are discussed by Hackett and Bergstrom (1956).

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