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Structure of the Tarkio Limestone Along the Humboldt Fault Zone in Southeast Nebraska


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REPORT OF INVESTIGATIONS

NUMBER 4

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**Structure of the Tarkio Limestone
Along the Humboldt Fault Zone
In Southeastern Nebraska**

R. R. Burchett and J. L. Arrigo

RESEARCH SUPPORTED BY CONTRACT NRC-04-76-315
U.S. NUCLEAR REGULATORY COMMISSION



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STRUCTURE OF THE TARKIO LIMESTONE ALONG THE HUMBOLDT FAULT ZONE
IN SOUTHEASTERN NEBRASKA

Introduction

Southeastern Nebraska is a unique area in that outcrops and subsurface information are available for detailed studies of the uppermost Paleozoic rocks. The Table Rock Arch, a post-Permian structural feature in the outcrop area, trends north-south over the buried Nemaha Uplift. The east margin of the Table Rock Arch is defined by the Humboldt Fault Zone, and eastward from it rock strata are downfaulted or dip steeply into the Forest City Basin (fig. 1). The depth to rocks of Precambrian age ranges from about 500 feet (152 m) near the Nemaha Ridge in eastern Pawnee County to more than 4,200 feet (1280 m) in southeastern Nemaha County, which is the deepest part of the Forest City Basin in Nebraska.

The primary purposes of this investigation were to acquire, by drilling test holes, subsurface data needed to correlate buried strata with strata that crop out and to gain a better understanding of buried structural features in southeastern Nebraska. The top of the Tarkio Limestone, a formation in the Wabaunsee Group of the Virgil Series of the Pennsylvanian System, was chosen as a datum plane for a structure map because the Tarkio underlies most of the study area at a shallow depth and is easily identified in rock cuttings and cores obtained by drilling. All available data on the altitude of this surface

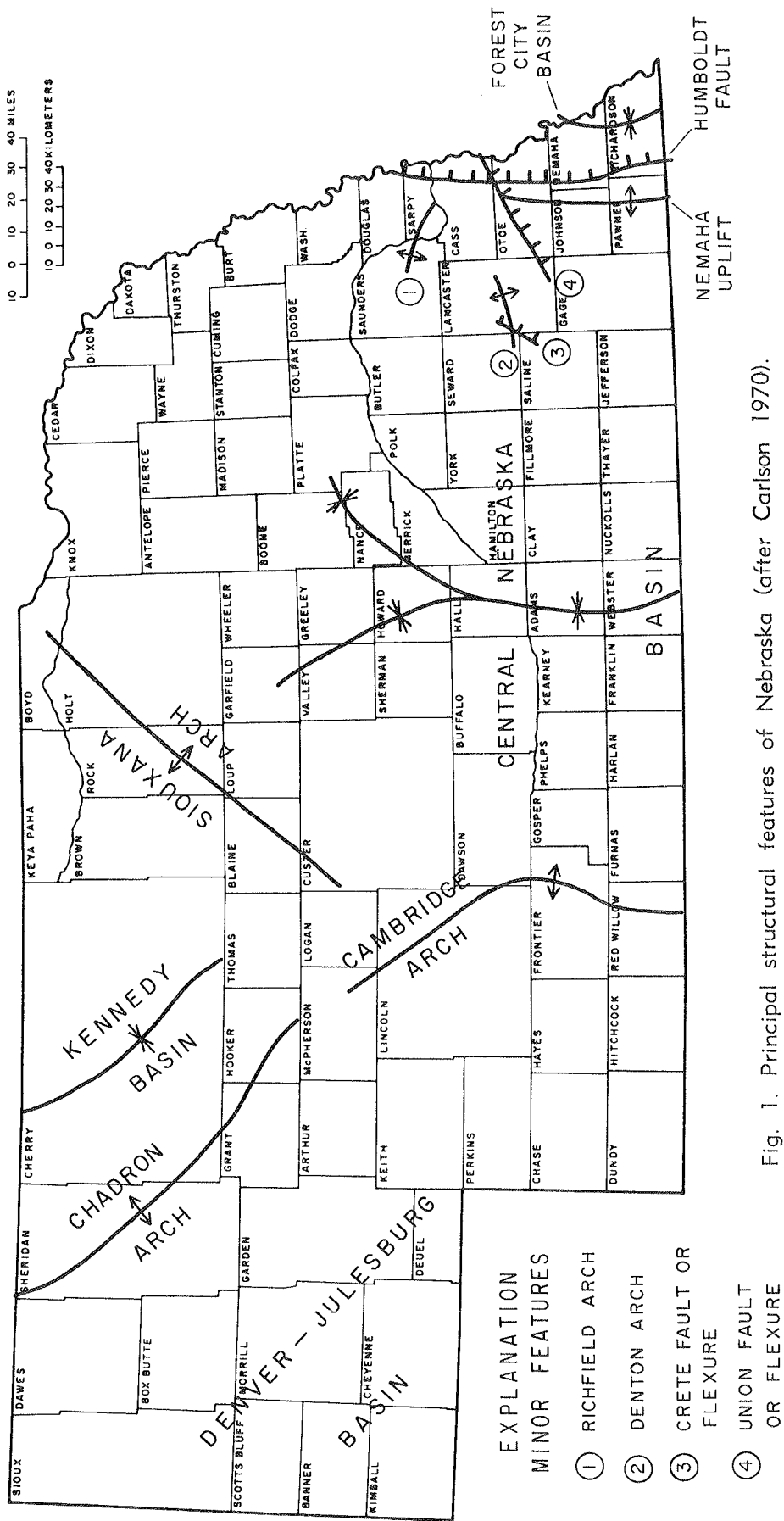


Fig. 1. Principal structural features of Nebraska (after Carlson 1970).

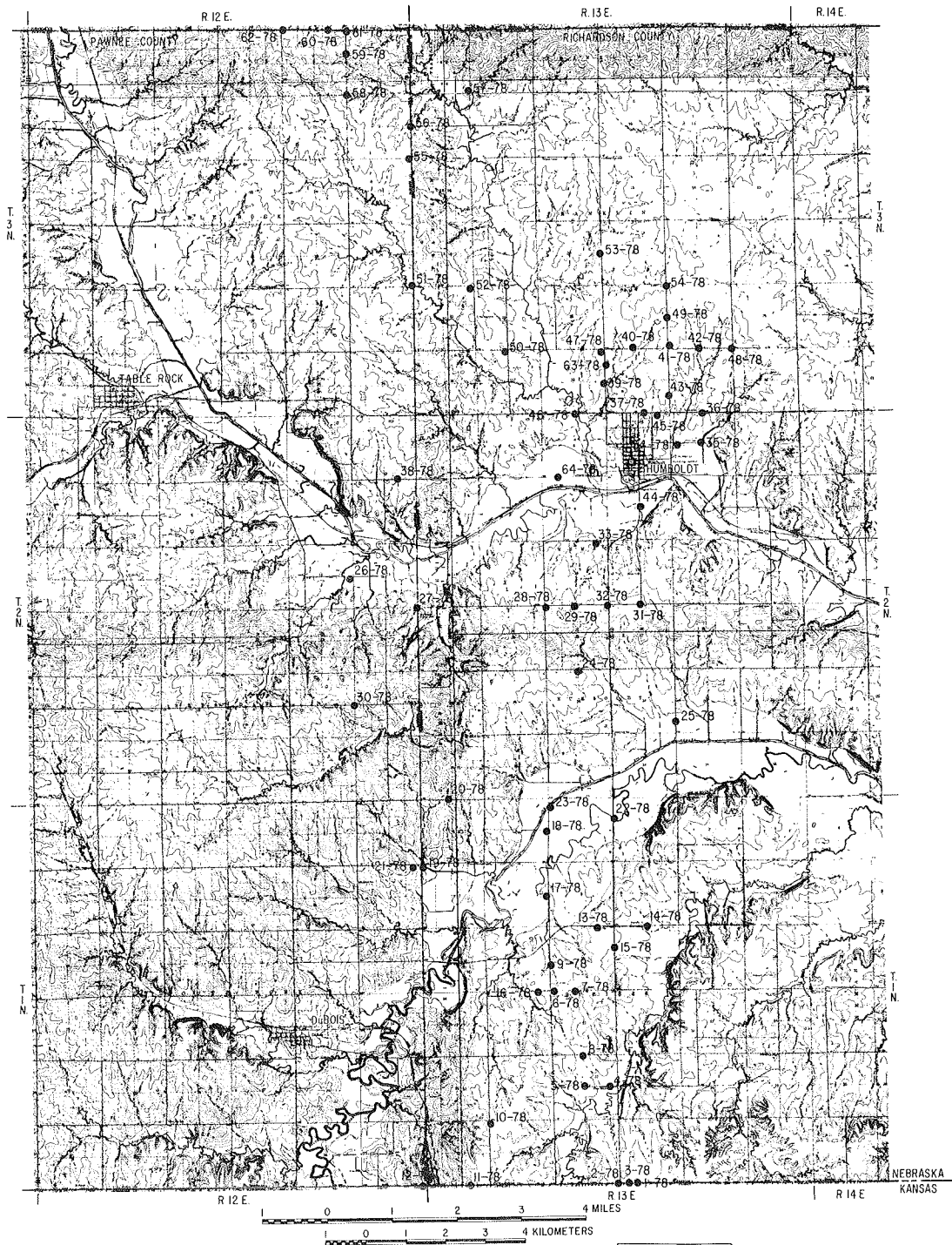
in outcrops and in test holes were used as control points for contour lines depicting the configuration of the Tarkio's upper surface (plate 1).

Scope of Investigation

Sixty-four shallow rotary test holes were drilled in western Richardson and eastern Pawnee counties (fig. 2) by the Rieschick Drilling Company of Falls City, Nebraska. The holes averaged about 150 feet (45.5 m) in depth, and each was logged electrically as well as by visual examination of rock cuttings. Some of the holes penetrated the Tarkio Limestone; others were drilled to an identifiable horizon whose height above or depth below the Tarkio is known, which thus provided a Tarkio datum. The holes were drilled in April, May, and June of 1978 under a cooperative agreement between the Conservation and Survey Division (Nebraska Geological Survey) and the Nuclear Regulatory Commission (Contract NRC-04-76-315).

A binocular microscope was used for examination of the cuttings. Logs of the test holes, based on descriptions of the cuttings, are presented in appendix A. Figures 3 and 4 show a composite section of the Lower Permian and Upper Pennsylvanian rocks drilled in the study area, together with a composite electric log of the rocks penetrated.

A careful reexamination of outcrops along the Humboldt Fault Zone provided additional data for mapping purposes. By determining the altitude of many outcrops, the investigators



● 56-78 Test hole number and location

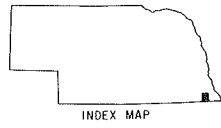
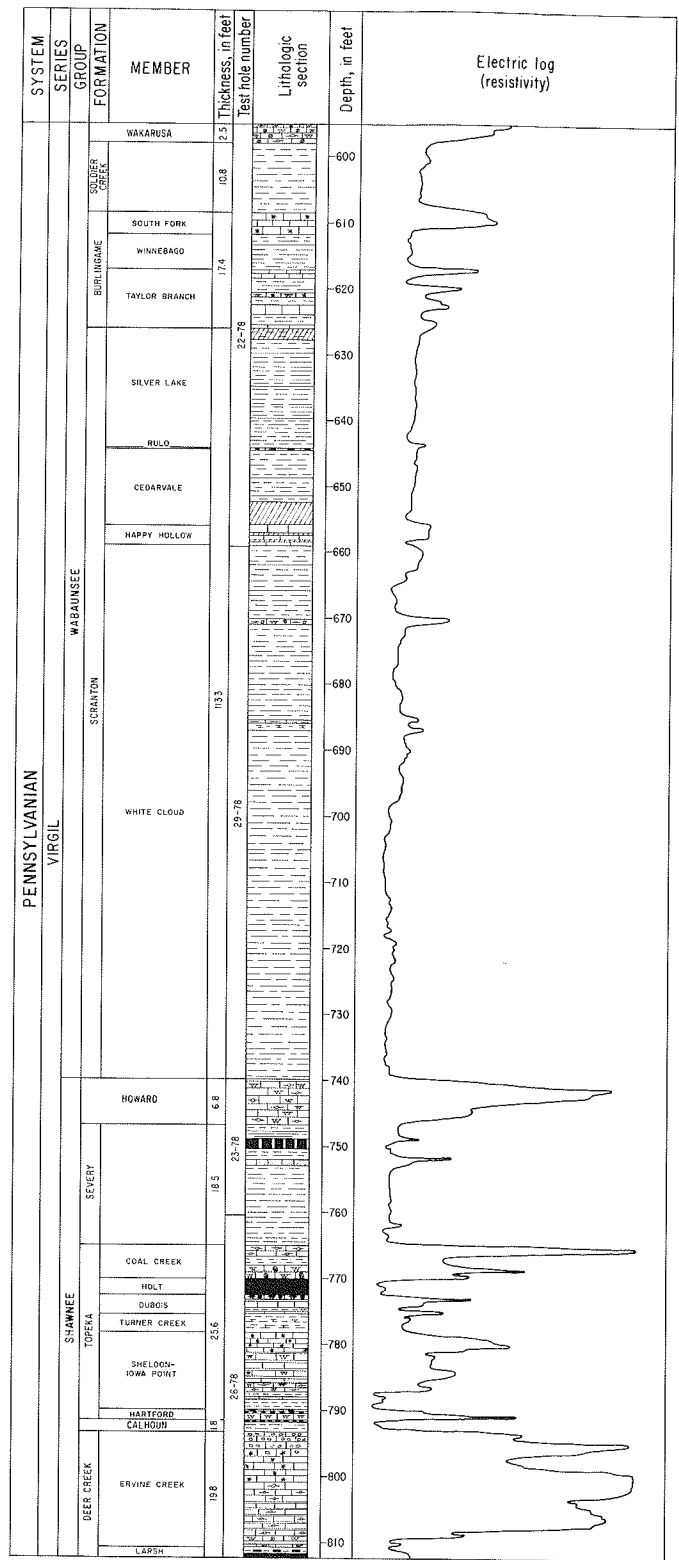
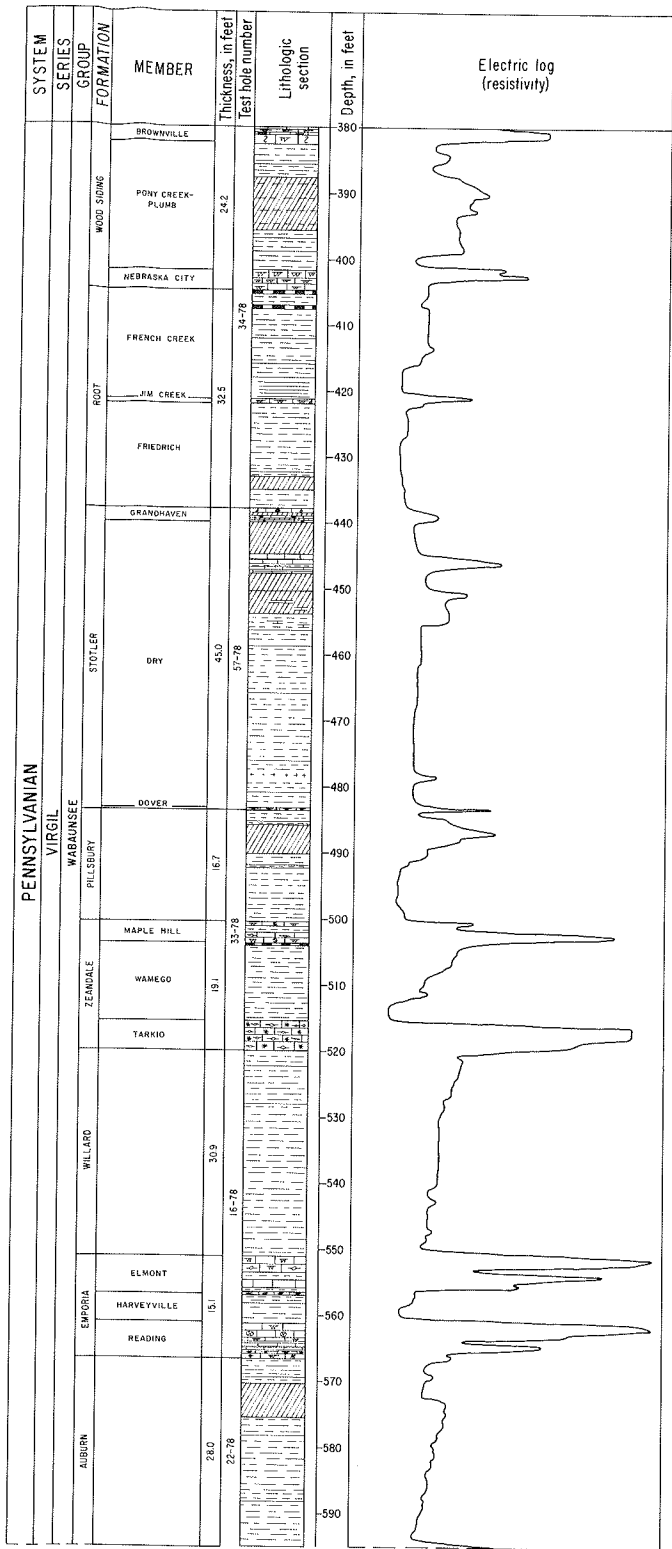


Fig. 2. Location of test holes in western Richardson and eastern Pawnee counties.

Completion October 1978
Principal investigator R.R. Burchett

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KEY TO LITHOLOGY

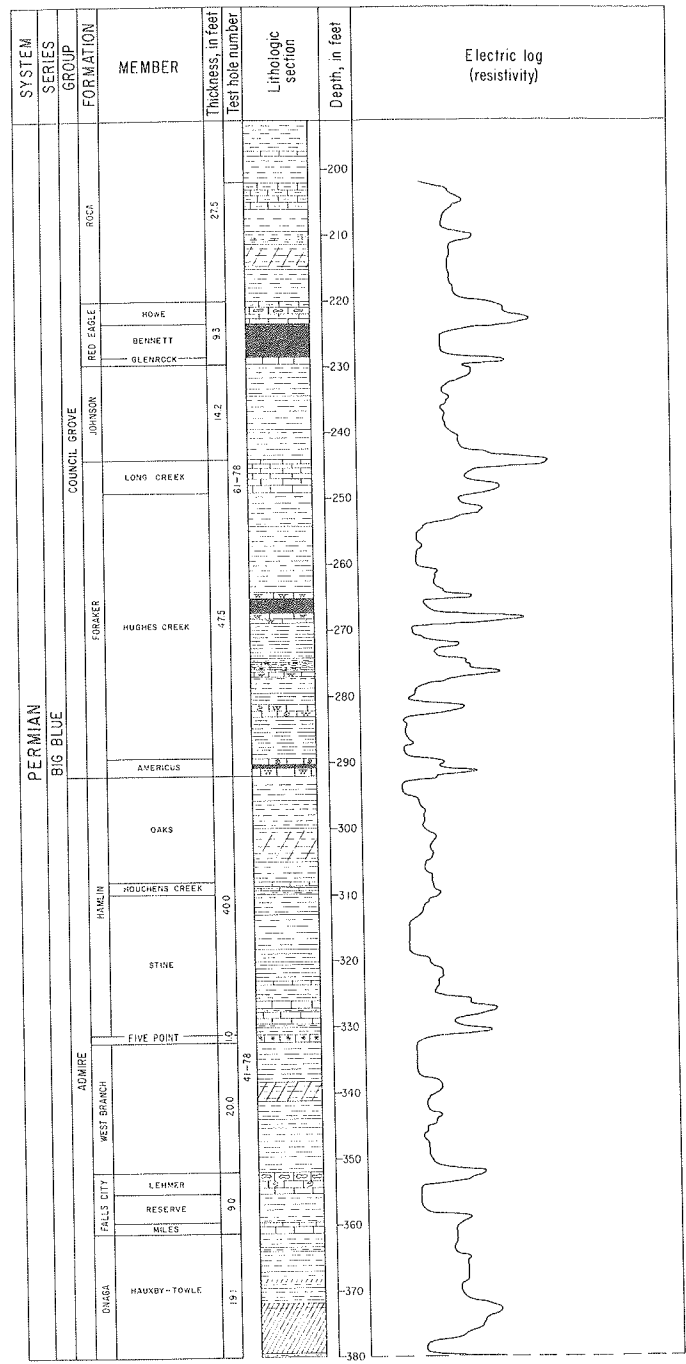
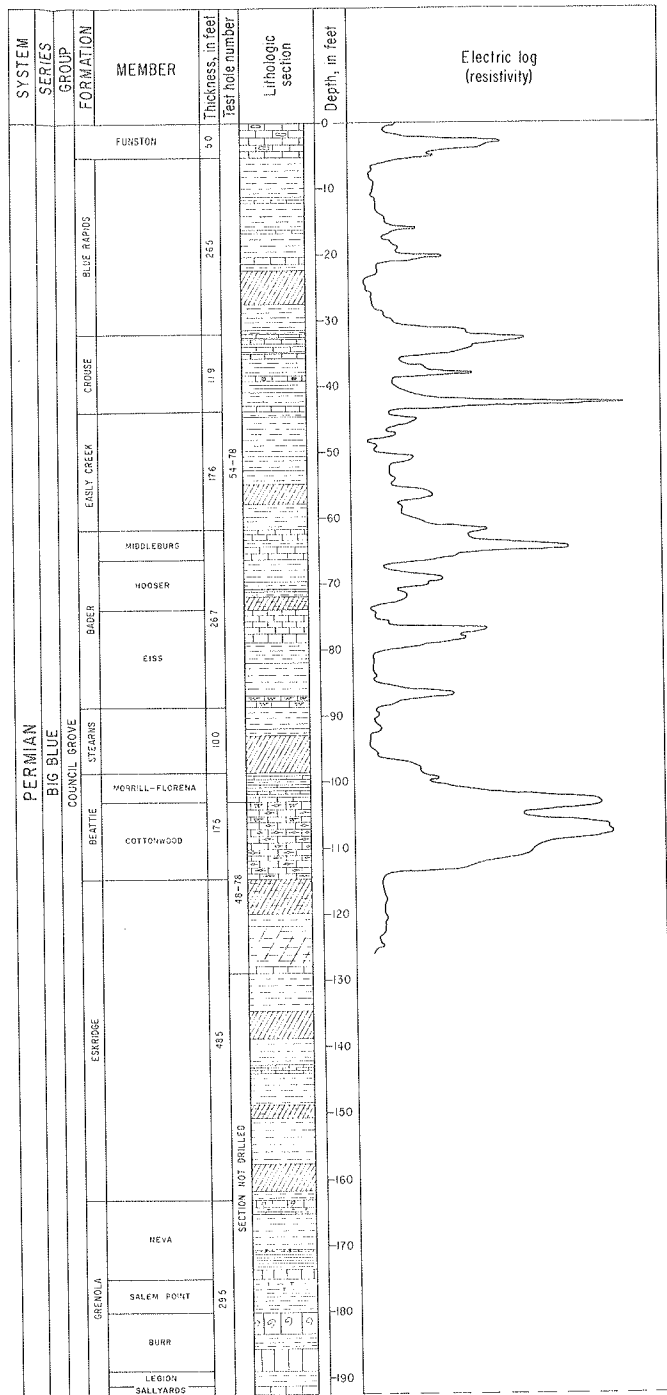
	LIMESTONE		BLACK SHALE
	GREEN OR GRAY SHALE		COAL
	RED SHALE		SANDSTONE

KEY TO SYMBOLS

	VUGS		FUSULINIDS
	OOLITES		PYRITE
	CRINOIDS		BRYOZOANS
	GLAUCONITE		BRACHIOPODS
	OSAGIA		PELECYPDS

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Fig. 3. Composite section of Upper Pennsylvanian rocks in western Richardson and eastern Pawnee counties.



KEY TO LITHOLOGY

	LIMESTONE		BLACK SHALE
	GREEN OR GRAY SHALE		COAL
	RED SHALE		SANDSTONE

KEY TO SYMBOLS

	VUGS		FUSULINDS
	OOLITES		PYRITE
	CRINOIDS		BRYOZOANS
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Compilation October 1976
Principal Investigator R. R. Burdick

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Fig. 4. Composite section of Lower Permian rocks in western Richardson and eastern Pawnee counties.

were able to establish more vertical control points for the structure map. Several structures not previously described became apparent.

Results of Investigation

Interpretations of the Tarkio Structure Map are summarized as follows:

- (1) The Humboldt Fault probably is not a single structure, as previously interpreted. Instead, it is a complex zone of faults and steep dips.
- (2) In addition to the north-south trending Table Rock Arch, two other major structural trends are evident. One is northwest-southeast and is more strongly developed than the other, which is southwest-northeast. The latter is more prominent north and east of the study area (see plate 1).
- (3) The direction and angle of dip exhibited by Pennsylvanian and Permian strata on both sides of the Humboldt Fault Zone differ markedly within very short distances, thus indicating that the structural pattern is highly complex. The greatest dip measured, about 19° NE, was in the SW $\frac{1}{4}$ sec. 34, T. 1 N., R. 13 E., which is adjacent to the state line.
- (4) The altitude of the top of the Tarkio Limestone ranges from about 550 feet (168 m) above mean sea level on the downthrown side of the Humboldt Fault Zone in the northeastern part of the study area to about 1,300 feet (395 m) above mean sea level on the upthrown side near the center of the south border of the study area.

- (5) Faults and/or steep dips in the area probably reflect faulting and steep dips at depth. Deeper structures are indicated by contours drawn on the base of the Hertha Limestone, a formation in the Kansas City Group of the Missouri Series of the Pennsylvanian System (Burchett 1978) and on the surface of Precambrian rocks (Carlson 1967).
- (6) Anticlines of low relief in the Tarkio Limestone reflect similar structures having steeper flanks and more closure at depth. In Richardson County, oil is or has been produced from anticlines in Devonian and older rocks. The abandoned Snethen Oil Field in secs. 29 and 30, T. 2 N., R. 14 E., was developed in one of these anticlines.
- (7) The only fault actually observed in an outcrop within the study area is in the Cottonwood Limestone Member of the Beattie Limestone in the Council Grove Group of the Permian System. Located in the SW $\frac{1}{4}$ sec. 36, T. 3 N., R. 13 E., this fault has a throw of 7.5 feet (2.29 m). The throw along the Humboldt Fault Zone about 0.5 mile (0.80 km) to the west is estimated to be about 50 feet (15.2 m).
- (8) Displacements along the faults not observable in outcrops but indicated on plate 1 are interpretive for the following reasons: Thick glacial deposits mantle the bedrock throughout most of the study area; outcrops are of small areal extent and consist of strata so similar that their correlation is difficult; most individual faults appear

to be of short length; and the distance between outcrops and test holes available for interpretation ranges from 0.1 (0.161 km) to 1 mile (1.61 km). Whether faulting or folding has taken place generally cannot be determined. The greatest interpreted throw of the Tarkio Limestone, about 410 feet (125 m), is in sec. 17, T. 3 N., R. 13 E. A single fault is presupposed but cannot be demonstrated because its location is covered by alluvium and glacial deposits.

- (9) The Humboldt Fault Zone has a significant effect on the mineral resources and groundwater supplies of the area. For 75 years the thicker limestone units of Permian age have been quarried in many places along and near the fault zone. Fractures in the bedrock, associated with the fault zone, serve as reservoirs for water.
- (10) Microearthquakes recently recorded in Kansas and Nebraska indicate that the Humboldt Fault Zone is still active. Past earthquakes of greater magnitude also may have been associated with movements in the same fault zone.

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Appendix A

This appendix consists of descriptions of the sixty-four test holes drilled in western Richardson and eastern Pawnee counties. All locations are shown in figure 2 of the text.

All measurements in this appendix are expressed in feet. To convert to the International System of Units, multiply feet by .3048 to obtain meters.

Test Hole 1-78

Location: Richardson County, SW SW SE SW sec. 34, T. 1 N., R. 13 E., approximately 15 feet north of south section line and 1,495 feet east of west section line.

Ground-level elevation: 1,215.0 feet above mean sea level.

Started: April 21, 1978. Completed: April 21, 1978.

Total depth: 50.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 3.0
Permian System - Big Blue Series - Council Grove Group:		
Grenola Formation:		
Legion Member:		
Shale, yellowish olive.....	3.0	- 5.0
Sallyards Member:		
Limestone, medium gray, finely crystalline.....	5.0	- 6.5
Roca Formation:		
Shale, yellowish brown.....	6.5	- 9.0
Shale, medium to dark gray.....	9.0	- 11.5
Limestone, light brown, finely crystalline to dense, soft.....	11.5	- 11.8
Shale, light to medium gray.....	11.8	- 15.0
Shale, light greenish gray; contains gypsum crystals.....	15.0	- 18.5
Limestone, very light gray to buff, dense, impure.....	18.5	- 21.5
Shale, medium gray.....	21.5	- 22.0
Limestone, very light gray to buff, dense, impure.....	22.0	- 24.0
Shale, light greenish gray.....	24.0	- 24.5
Limestone, buff to light brown, dense.....	24.5	- 26.5
Shale, light greenish gray.....	26.5	- 27.0
Limestone, light brown, dense.....	27.0	- 29.0
Shale, pale olive, mottled with red.....	29.0	- 35.5
Red Eagle Formation:		
Howe Member:		
Limestone, light gray to brown, irregularly crystalline, impure.....	35.5	- 39.5
Bennett Member:		
Shale, black, carbonaceous.....	39.5	- 44.0
Glenrock Member:		
Limestone, light brown, finely crystalline; contains brachiopods and fusulinids.....	44.0	- 45.0
Shale (lost circulation, no sample).....	45.0	- 50.0

Test Hole 2-78

Location: Richardson County, SE corner sec. 33, T. 1 N., R. 13 E., approximately 35 feet north of south section line and 45 feet west of east section line.

Ground-level elevation: 1,183.0 feet above mean sea level.

Started: April 21, 1978. Completed: April 21, 1978.

Total depth: 77.0 feet

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	4.0	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Zeandale Formation:				
Wamego Member:				
Shale, brownish gray, silty.....	4.0	-	10.0	
Shale, dark brown, silty.....	10.0	-	16.0	
Shale, light gray.....	16.0	-	17.5	
Tarkio Member:				
Limestone, brown, coarse to irregularly crystal- line; contains fusulinids and brachiopods....	17.5	-	18.0	
Shale, light greenish gray.....	18.0	-	19.5	
Limestone, brown, finely crystalline; contains brachiopods, fusulinids, and <u>Osagia</u>	19.5	-	20.0	
Shale, orangish brown.....	20.0	-	21.0	
Limestone, yellowish brown, finely crystalline; contains brachiopods, fusulinids, and <u>Osagia</u> ..	21.0	-	23.5	
Willard Formation:				
Shale, light bluish gray.....	23.5	-	29.5	
Shale, light to medium gray.....	29.5	-	45.0	
Shale, medium gray.....	45.0	-	56.0	
Shale, dark gray.....	56.0	-	57.0	
Emporia Formation:				
Elmont Member:				
Limestone, tannish gray, finely crystalline to dense; contains fusulinids and brachiopods...	57.0	-	59.5	
Shale, light to medium gray.....	59.5	-	60.5	
Limestone, light tannish gray, finely crystal- line to dense.....	60.5	-	62.2	
Harveyville Member:				
Shale, light to medium gray.....	62.2	-	66.5	
Reading Member:				
Limestone, medium gray, finely crystalline; contains brachiopods and fusulinids.....	66.5	-	69.5	
Shale, medium gray.....	69.5	-	70.0	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light gray, finely crystalline to dense, impure; contains brachiopods.....	70.0	- 70.5
Shale, medium gray.....	70.5	- 71.5
Limestone, light gray, finely crystalline, impure; contains brachiopods and crinoids....	71.5	- 72.0
Auburn Formation:		
Shale, light gray.....	72.0	- 77.0

Test Hole 3-78

Location: Richardson County, SE SE SW SW sec. 34, T. 1 N., R. 13 E., approximately 15 feet north of south section line and 825 feet east of west section line.

Ground-level elevation: 1,187.0 feet above mean sea level.

Started: April 21, 1978. Completed: April 21, 1978.

Total depth: 77.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 2.0
Clay, light brown.....	2.0	- 4.0
Clay, reddish brown.....	4.0	- 7.0
Permian System - Big Blue Series - Admire Group:		
Onaga Formation:		
Towle Member:		
Shale, greenish gray; contains manganese staining.....	7.0	- 10.0
Shale, olive mottled with red.....	10.0	- 11.0
Shale, dark reddish brown.....	11.0	- 15.5
Shale, reddish brown mottled with olive and green.....	15.5	- 16.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray, irregularly crystalline, impure; contains brachiopods and algal material.....	16.0	- 18.5
Pony Creek-Plumb Members:		
Shale, pale olive.....	18.5	- 21.0
Shale, reddish gray mottled with green.....	21.0	- 23.5

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, greenish gray mottled with orange.....	23.5	- 25.0
Shale, reddish gray.....	25.0	- 28.5
Shale, light greenish gray.....	28.5	- 29.5
Shale, red.....	29.5	- 35.0
Shale, red, interbedded with pale yellow and olive.....	35.0	- 36.0
Limestone, yellow brown, finely crystalline, impure; contains brachiopods and algal material.....	36.0	- 37.0
Shale, light greenish gray, silty.....	37.0	- 41.0
Shale, medium gray.....	41.0	- 43.3
Nebraska City Member:		
Limestone, dark gray, finely crystalline; contains brachiopods and crinoids.....	43.3	- 43.9
Root Formation:		
French Creek Member:		
Coal, black, soft.....	43.9	- 44.1
Shale, light bluish gray.....	44.1	- 50.0
Shale, medium to dark gray.....	50.0	- 59.5
Jim Creek Member:		
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	59.5	- 60.5
Friedrich Member:		
Shale, light to medium gray.....	60.5	- 64.5
Shale, reddish brown.....	64.5	- 67.0
Shale, light greenish gray, interbedded with sandstone, light greenish gray, very finely micaceous.....	67.0	- 68.5
Sandstone, light tannish gray, very finely micaceous, interbedded with shale, greenish gray.....	68.5	- 70.5
Sandstone, light tannish gray, very finely micaceous, interbedded with shale, red.....	70.5	- 73.5
Shale, reddish brown.....	73.5	- 77.0

Test Hole 4-78

Location: Richardson County, NW NE NE SE sec. 28, T. 1 N., R. 13
E., approximately 2,655 feet south of north section line
and 612 feet west of east section line.

Ground-level elevation: 1,068.0 feet above mean sea level.

Started: April 24, 1978. Completed: April 24, 1978.

Total depth: 126.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 5.0
	Clay, brownish gray, sandy.....		5.0	- 11.5
Permian System - Big Blue Series - Admire Group:				
Hamlin Formation:				
Oaks Member:				
	Shale, greenish gray.....		11.5	- 15.0
	Shale, pale yellowish brown mottled with olive and red.....		15.0	- 16.0
	Shale, greenish gray.....		16.0	- 17.0
Houchens Creek Member:				
	Shale, light bluish gray, interbedded with limestone, light gray, dense.....		17.0	- 21.0
Stine Member:				
	Shale, greenish gray.....		21.0	- 29.0
	Shale, medium gray.....		29.0	- 35.0
	Limestone, medium to dark gray, medium to finely crystalline; contains brachiopods, interbedded with shale, dark gray.....		35.0	- 36.0
	Shale, medium gray.....		36.0	- 36.7
	Shale, greenish gray, interbedded with limestone, brownish gray, dense, thin.....		36.7	- 40.0
	Shale, reddish brown.....		40.0	- 42.0
	Shale, light greenish gray.....		42.0	- 42.5
	Limestone, tannish gray, finely crystalline....		42.5	- 43.5
	Shale, light greenish gray.....		43.5	- 45.5
	Shale, reddish gray.....		45.5	- 46.3
	Shale, light greenish gray.....		46.3	- 46.6
	Shale, olive.....		46.6	- 46.8
Five Point Formation:				
	Limestone, light gray, irregularly crystalline; contains algal material.....		46.8	- 49.0
West Branch Formation:				
	Shale, olive.....		49.0	- 50.5
	Shale, light gray.....		50.5	- 56.5
	Shale, greenish gray, interbedded with limestone, tannish gray, dense.....		56.5	- 60.0
	Limestone, light gray, dense, soft.....		60.0	- 61.0
	Shale, light greenish gray.....		61.0	- 63.3
	Shale, dark greenish gray.....		63.3	- 63.5
	Limestone, dark gray, impure.....		63.5	- 65.0
	Shale, dark gray.....		65.0	- 73.5
Falls City Formation:				
Lehmer Member:				
	Limestone, light gray, irregularly crystalline, interbedded with shale, gray.....		73.5	- 76.5
Reserve Member:				
	Shale, medium gray.....		76.5	- 78.2

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Miles Member:		
Limestone, light gray, salt-and-pepper appearance.....	78.2	78.8
Onaga Formation:		
Shale, light greenish gray.....	78.8	79.5
Shale, reddish gray mottled with light greenish gray.....	79.5	87.2
Shale, greenish gray.....	87.2	93.2
Shale, red.....	93.2	98.0
Shale, olive gray.....	98.0	99.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray mottled with olive, very finely crystalline.....	99.5	101.7
Pony Creek-Plumb Members:		
Shale, olive.....	101.7	104.3
Shale, greenish gray.....	104.3	108.0
Shale, red.....	108.0	112.5
Shale, red interbedded with shale, greenish gray.....	112.5	117.0
Shale, olive.....	117.0	118.0
Shale, gray.....	118.0	119.2
Nebraska City Member:		
Limestone, medium gray, finely crystalline, impure; contains brachiopods and crinoids...	119.2	120.0
Root Formation:		
French Creek Member:		
Shale, gray.....	120.0	120.9
Coal, black.....	120.9	121.2
Shale, medium gray.....	121.2	126.0

Test Hole 5-78

Location: Richardson County, SE corner NW sec. 28, T. 1 N., R. 13 E., approximately 2,630 feet south of north section line and 2,632 feet east of west section line.

Ground-level elevation: 1,132.0 feet above mean sea level.

Started: April 25, 1978. Completed: April 25, 1978.

Total depth: 62.0 feet.

Description	Depth, in feet	
	From	To
Quaternary System:		
Soil (no sample).....	0	- 2.0
Pennsylvanian System - Virgil Series - Wabaunsee Group		
Willard Formation:		
Shale, olive mottled with red.....	2.0	- 4.0
Shale, olive mottled with gray and yellow.....	4.0	- 10.0
Shale, brownish olive mottled with gray and yellow.....	10.0	- 25.0
Shale, light gray mottled with yellow.....	25.0	- 32.8
Emporia Formation:		
Elmont Member:		
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	32.8	- 35.5
Shale, medium gray, limy.....	35.5	- 36.8
Limestone, medium gray, finely crystalline; contains brachiopods and fusulinids.....	36.8	- 37.0
Harveyville Member:		
Shale, light gray.....	37.0	- 39.5
Shale, medium gray.....	39.5	- 43.7
Reading Member:		
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	43.7	- 45.9
Shale, medium gray.....	45.9	- 46.1
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	46.1	- 46.5
Shale, medium gray.....	46.5	- 47.2
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	47.2	- 48.8
Auburn Formation:		
Shale, medium gray.....	48.8	- 54.5
Limestone, light gray, finely crystalline; interbedded with shale, greenish gray.....	54.5	- 56.3
Shale, light greenish gray.....	56.3	- 56.5
Shale, light to medium gray.....	56.5	- 60.0
Shale, medium gray.....	60.0	- 62.0

Test Hole 6-78

Location: Richardson County, NW NW NW sec. 21, T. 1 N., R. 13 E., approximately 4 feet south of north section line and 282 feet east of west section line.

Ground-level elevation: 1,117.0 feet above mean sea level.

Started: April 25, 1978. Completed: April 25, 1978.

Total depth: 67.0 feet.

Description	Depth, in feet	
	From	To
Quaternary System:		
Soil (no sample).....	0	4.0
Permian System - Big Blue Series - Admire Group:		
Onaga Formation:		
Shale, reddish brown.....	4.0	5.0
Shale, pale olive.....	5.0	10.0
Shale, pale olive mottled with yellow.....	10.0	18.0
Shale, medium gray, interbedded with limestone, gray, thin.....	18.0	21.0
Shale, reddish brown.....	21.0	21.6
Limestone, dark yellowish brown, medium crystalline; contains manganese staining.....	21.6	22.6
Shale, reddish gray.....	22.6	24.2
Shale, pale olive mottled with yellow and gray.....	24.2	25.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, pale yellow, finely crystalline; manganese staining contains brachiopods.....	25.5	28.0
Pony Creek Formation:		
Plumb Member:		
Shale, olive.....	28.0	31.0
Shale, medium gray.....	31.0	32.7
Shale, black; contains coal, black, soft.....	32.7	32.9
Shale, pale greenish gray.....	32.9	34.0
Shale, reddish brown.....	34.0	40.0
Shale, pale olive-gray.....	40.0	40.3
Shale, medium gray.....	40.3	41.2
Limestone, light tannish gray, finely crystal- line; contains brachiopods.....	41.2	43.4
Shale, gray; contains black carbonaceous material.....	43.4	44.0
Shale, light gray.....	44.0	49.6
Nebraska City Member:		
Limestone, dark gray, finely crystalline, impure; contains brachiopods.....	49.6	50.7
Root Formation:		
French Creek Member:		
Coal, black.....	50.7	50.9
Shale, light gray.....	50.9	60.0
Shale, medium gray.....	60.0	64.4
Jim Creek Member:		
Limestone, light to medium gray, finely crystal- line; contains brachiopods.....	64.4	66.5
Friedrich Member:		
Shale, light gray.....	66.5	67.0

Test Hole 7-78

Location: Richardson County, NW NE NE NW sec. 21, T. 1 N., R. 13 E., approximately 8 feet south of north section line and 2,100 feet east of west line.

Ground-level elevation: 1,177.0 feet above mean sea level.

Started: April 25, 1978. Completed: April 25, 1978.

Total depth: 80.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Hughes Creek Member:		
Limestone, pale yellow, soft, impure, highly weathered.....	0	- 1.0
Shale, pale olive.....	1.0	- 7.0
Shale, medium gray.....	7.0	- 9.0
Shale, olive.....	9.0	- 9.9
Americus Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods and crinoids.....	9.9	- 11.1
Admire Group:		
Hamlin Formation:		
Oaks Member:		
Shale, dark gray to black mottled with olive...	11.1	- 12.0
Limestone, yellow, finely crystalline; contains brachiopods and crinoids.....	12.0	- 12.2
Shale, olive mottled with yellowish brown and gray.....	12.2	- 13.0
Shale, gray mottled with olive.....	13.0	- 14.0
Shale, yellow.....	14.0	- 17.5
Shale, medium gray.....	17.5	- 18.0
Shale, yellow mottled with olive.....	18.0	- 20.0
Shale, greenish gray.....	20.0	- 24.0
Shale, yellow.....	24.0	- 24.5
Shale, red.....	24.5	- 25.5
Shale, pale olive mottled with dark reddish brown.....	25.5	- 27.5
Houchens Creek Member:		
Limestone, yellowish brown, finely crystalline to dense.....	27.5	- 28.0
Shale, greenish gray.....	28.0	- 28.3
Limestone, yellowish brown, finely crystalline to dense.....	28.3	- 29.0
Shale, greenish gray, interbedded with limestone brown.....	29.0	- 30.0

Description	Depth, in feet	
	From	To
Stine Member:		
Shale, olive.....	30.0	- 31.0
Shale, medium gray mottled with olive.....	31.0	- 35.0
Shale, light to medium gray.....	35.0	- 40.0
Shale, medium to dark gray.....	40.0	- 42.5
Limestone, medium gray, finely crystalline; contains brachiopods.....	42.5	- 44.0
Shale, medium to dark gray.....	44.0	- 46.5
Limestone, light greenish gray, finely crystalline.....	46.5	- 48.0
Shale, light greenish gray.....	48.0	- 49.0
Shale, reddish gray.....	49.0	- 50.7
Shale, medium gray.....	50.7	- 51.3
Limestone, light tannish gray, finely crystalline.....	51.3	- 51.9
Shale, light gray.....	51.9	- 52.5
Shale, olive.....	52.5	- 53.0
Shale, dark reddish brown.....	53.0	- 54.0
Shale, reddish yellow.....	54.0	- 55.5
Shale, medium gray.....	55.5	- 56.1
Five Point Formation:		
Limestone, light gray, finely crystalline; contains brachiopods, gastropods, and algal material...	56.1	- 56.9
West Branch Formation:		
Shale, light greenish gray.....	56.9	- 57.2
Shale, medium gray.....	57.2	- 62.7
Limestone, light greenish gray, dense interbedded with shale, greenish gray.....	62.7	- 65.3
Shale, light greenish gray mottled with red....	65.3	- 68.0
Shale, light greenish gray.....	68.0	- 68.3
Shale, medium to dark gray.....	68.3	- 77.5
Falls City Formation:		
Lehmer Member:		
Limestone, dark yellowish orange, soft, porous.....	77.5	- 78.0
Limestone, light to medium gray, finely crys- talline; contains brachiopods.....	78.0	- 79.5
Shale, medium gray.....	79.5	- 80.0

Test Hole 8-78

Location: Richardson County, NE corner NW sec. 28, T. 1 N., R. 13 E., approximately 20 feet south of north section line and 2,625 feet east of west section line.

Ground-level elevation: 1,127.0 feet above mean sea level.

Started: April 26, 1978. Completed: April 26, 1978.

Total depth: 130.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	1.0
Clay, brownish gray.....	1.0 -	6.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Stotler Formation:		
Dry Member:		
Shale, reddish brown.....	6.0 -	13.0
Limestone, cream and dark yellow, finely crystalline; contains crinoids and pyrite, interbedded with shale, reddish brown.....	13.0 -	17.0
Shale, pale olive gray.....	17.0 -	18.0
Shale, red mottled with olive.....	18.0 -	28.7
Shale, olive brown.....	28.7 -	31.3
Shale, medium gray.....	31.3 -	52.6
Dover Member:		
Limestone, bluish gray, finely crystalline; contains brachiopods and crinoids.....	52.6 -	53.7
Shale, light gray.....	53.7 -	54.7
Limestone, light tannish gray and light greenish gray, finely crystalline.....	54.7 -	54.9
Zeandale-Pillsbury Formations:		
Shale, light greenish gray to light gray.....	54.9 -	57.0
Shale, reddish brown.....	57.0 -	59.7
Shale, pale olive mottled with light gray.....	59.7 -	62.0
Shale, medium gray.....	62.0 -	72.0
Shale, light to medium gray.....	72.0 -	80.5
Tarkio Member:		
Limestone, medium gray; contains brachiopods.....	80.5 -	81.9
Shale, light greenish gray interbedded with shale, dark gray with black carbonaceous streaks.....	81.9 -	82.4
Limestone, brownish gray, finely crystalline; contains brachiopods and crinoids.....	82.4 -	82.9
Shale, light greenish gray.....	82.9 -	84.0
Shale, reddish brown.....	84.0 -	85.4
Limestone, cream to white, finely crystalline; contains glauconite, fusulinids, and <u>Osagia</u> ..	85.4 -	90.0

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Willard Formation:				
	Siltstone, light greenish gray, very finely micaceous.....		90.0	- 94.0
	Shale, light and dark olive mottled with yellow and gray.....		94.0	- 98.0
	Shale, light to medium gray.....		98.0	- 117.5
	Shale, light to medium gray, interbedded with limestone, brown, dense, thin.....		117.5	- 117.6
	Shale, medium gray.....		117.6	- 122.5
Emporia Formation:				
Elmont Member:				
	Limestone, brownish gray, very finely crystalline; contains brachiopods.....		122.5	- 123.9
	Shale, medium gray.....		123.9	- 124.2
	Limestone, light gray, very finely crystalline; contains brachiopods.....		124.2	- 126.5
	Shale, greenish gray.....		126.5	- 127.0
	Limestone, light brownish gray, irregularly crystalline; contains pyrite.....		127.0	- 127.5
Harveyville Member:				
	Shale, light to medium gray mottled with olive.....		127.5	- 130.0

Test Hole 9-78

Location: Richardson County, SW NW NW SW sec. 16, T. 1 N., R. 13 E., approximately 2,040 feet north of south section line and 15 feet east of west section line.

Ground-level elevation: 1,040.0 feet above mean sea level.

Started: April 26, 1978. Completed: April 26, 1978.

Total depth: 58.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 2.0
	Clay, reddish brown.....		2.0	- 5.0
	Clay, reddish brown; contains sand and gravel..		5.0	- 12.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Pillsbury Formation:				
	Limestone, reddish brown, irregularly crystalline; contains brachiopods.....		12.0	- 12.5
	Shale, olive.....		12.5	- 15.5
	Shale, red.....		15.5	- 20.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, olive.....	20.0 -	21.3
Shale, medium gray.....	21.3 -	32.1
Zeandale Formation:		
Maple Hill Member:		
Limestone, bluish gray, finely crystalline, contains brachiopods, crinoids, and fusulinids..	32.1 -	33.5
Wamego Member:		
Coal, black.....	33.5 -	33.7
Shale, light greenish gray.....	33.7 -	34.2
Sandstone, greenish gray, very finely micaceous.....	34.2 -	36.8
Shale, light greenish gray.....	36.8 -	37.8
Shale, light greenish gray, very finely micaceous; contains black carbonaceous material....	37.8 -	43.0
Shale, light gray.....	43.0 -	43.5
Shale, medium to dark gray.....	43.5 -	46.5
Tarkio Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods, crinoids and pyrite.....	46.5 -	47.3
Shale, light greenish gray mottled with red....	47.3 -	48.8
Limestone, cream, finely crystalline; contains fusulinids and <u>Osagia</u> , interbedded with shale, light greenish gray.....	48.8 -	54.5
Willard Formation:		
Shale, light greenish gray.....	54.5 -	56.0
Shale, light greenish gray interbedded with red.....	56.0 -	58.0

Test Hole 10-78

Location: Richardson County, NW corner sec. 32, T. 1 N., R. 13 E., approximately 12 feet south of north section line and 10 feet east of west section line.

Ground-level elevation: 1,205.0 feet above mean sea level.

Started: April 26, 1978. Completed: April 26, 1978.

Total depth: 56.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	3.0
Clay, brownish gray and yellow; contains sand and gravel.....	3.0 -	10.0

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Zeandale Formation:				
Wamego Member:				
	Shale, brownish gray.....		10.0	- 11.0
Tarkio Member:				
	Limestone, yellowish brown, finely crystalline; contains fusulinds and <u>Osagia</u>		11.0	- 15.0
	Limestone, yellowish brown, finely crystalline, interbedded with shale, olive.....		15.0	- 16.0
Willard Formation:				
	Shale, olive.....		16.0	- 21.0
	Shale, olive interbedded with gray.....		21.0	- 22.0
	Shale, medium gray.....		22.0	- 48.8
	Shale, black; contains black carbonaceous material.....		48.8	- 49.0
	Shale, medium gray.....		49.0	- 49.5
Emporia Formation:				
Elmont Member:				
	Limestone, medium gray, finely crystalline; contains brachiopods and fusulinids.....		49.5	- 51.0
	Shale, greenish gray.....		51.0	- 52.9
	Limestone, light tannish gray, finely crystal- line; contains brachiopods and fusulinids....		52.9	- 53.4
Harveyville Member:				
	Shale, medium gray.....		53.4	- 56.0

Test Hole 11-78

Location: Richardson County, SE SE SW SE sec. 31, T. 1 N., R. 13 E., approximately 23 feet north of south section line and 1,480 feet west of east section line.

Ground-level elevation: 1,229.0 feet above mean sea level.

Started: April 27, 1978. Completed: April 27, 1978.

Total depth: 107.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 1.0
	Clay, orangish brown; silty; contains sand and gravel.....		1.0	- 7.0

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Clay, orangish brown, silty; contains lime nodules.....	7.0	13.0
Clay, yellowish brown, silty, contains sand and gravel.....	13.0	23.0
Clay, olive-yellow, silty.....	23.0	26.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
South Fork Member:		
Limestone, yellowish brown, very finely crystalline, highly weathered; contains brachiopods and pelecypods.....	26.5	29.5
Winnebago Member:		
Shale, olive gray.....	29.5	32.5
Limestone, yellow, finely crystalline.....	32.5	33.0
Shale, olive gray.....	33.0	34.3
Shale, dark gray.....	34.3	35.0
Taylor Branch Member:		
Limestone, medium gray, finely crystalline.....	35.0	35.5
Shale, dark gray to black.....	35.5	35.7
Limestone, light to medium bluish gray, very finely crystalline; contains pyrite and brachiopods.....	35.7	37.8
Shale, greenish gray.....	37.8	38.1
Limestone, light gray, very finely crystalline.....	38.1	38.9
Scranton Formation:		
Silver Lake Member:		
Sandstone, light brown, silty.....	38.9	41.1
Shale, medium gray, sandy.....	41.1	46.0
Shale, light to medium gray.....	46.0	53.0
Shale, medium gray.....	53.0	55.2
Rulo Member:		
Limestone, light brownish gray, very finely crystalline; contains brachiopods, crinoids, and fusulinids.....	55.2	55.9
Cedarvale Member:		
Shale, medium gray.....	55.9	59.8
Shale, greenish gray.....	59.8	67.5
Happy Hollow Member:		
Limestone, light greenish gray, very finely crystalline, interbedded with shale, light greenish gray.....	67.5	70.0
White Cloud Member:		
Shale, very light greenish gray.....	70.0	75.0
Shale, light to medium gray.....	75.0	83.0
Shale, light gray.....	83.0	88.2
Sandstone, medium gray, silty.....	88.2	88.3
Shale, medium gray, silty, sandy.....	88.3	92.0
Shale, medium gray, silty.....	92.0	107.0

Test Hole 12-78

Location: Pawnee County, SW SE SE SE sec. 36, T. 1 N., R. 12 E.,
approximately 5 feet north of south section line and 200
feet east of west section line.

Ground-level elevation: 1,185.0 feet above mean sea level.

Started: April 27, 1978. Completed: April 27, 1978.

Total depth: 127.5 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 1.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Rulo Member:		
Limestone, yellow, fine to very finely crystalline, highly weathered; contains algal material....	1.5	- 2.0
Cedarvale-White Cloud Members:		
Shale, olive brown.....	2.0	- 3.0
Coal, black; contains black carbonaceous material.....	3.0	- 3.5
Shale, light to medium gray.....	3.5	- 7.0
Shale, light gray.....	7.0	- 11.0
Sandstone, reddish brown, interbedded with shale, gray.....	11.0	- 19.0
Silt, light gray, interbedded with sandstone; very fine grained; contains organic material.....	19.0	- 22.5
Shale, medium gray, silty, sandy.....	22.5	- 32.0
Shale, medium gray, interbedded with siltstone, light gray.....	32.0	- 39.9
Sandstone, brown, very fine grained.....	39.9	- 40.0
Shale, light gray, sandy, interbedded with siltstone, brown.....	40.0	- 44.0
Shale, olive brown, interbedded with sandstone, brown.....	44.0	- 48.0
Sandstone, orangish brown, interbedded with shale, brown.....	48.0	- 50.0
Shale, light gray, silty.....	50.0	- 53.0
Sandstone, brown, very fine grained, interbedded with silt, orangish brown.....	53.0	- 58.0
Shale, light greenish gray; contains trace of coal, black, thin.....	58.0	- 62.5
Sandstone, white to light gray, very fine grained, lime cemented; contains black carbonaceous material.....	62.5	- 64.9
Silt, light gray, interbedded with sandstone, gray, very fine grained.....	64.9	- 68.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light to medium gray, interbedded with siltstone, gray.....	68.0	- 71.0
Siltstone, gray, interbedded with shale, light gray.....	71.0	- 77.0
Siltstone, gray and greenish gray.....	77.0	- 83.0
Siltstone, greenish gray, sandy.....	83.0	- 86.5
Sandstone, light greenish gray.....	86.5	- 87.2
Siltstone, greenish gray, interbedded with sandstone, gray, very fine grained.....	87.2	- 88.0
Limestone, light tannish gray, very finely crystalline to dense.....	88.0	- 89.0
Shale, medium gray, silty.....	89.0	- 102.0
Shale, medium gray, interbedded with sandstone, gray, very fine grained.....	102.0	- 113.0
Shale, medium gray, silty; contains black carbonaceous material.....	113.0	- 116.8
Sandstone, light gray, very fine to fine grained; contains black carbonaceous material.....	116.8	- 117.5
Shale, medium gray, silty.....	117.5	- 118.0
Shale, light gray.....	118.0	- 122.5
Howard Formation:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	122.5	- 123.5
Shale, light gray.....	123.5	- 125.0
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	125.0	- 127.5

Test Hole 13-78

Location: Richardson County, SE SE SW SE sec. 9, T. 1 N., R. 13 E., approximately 33 feet north of south section line and 1,366 feet west of east section line.

Ground-level elevation: 1,120.0 feet above mean sea level.

Started: April 28, 1978. Completed: April 28, 1978.

Total depth: 103.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	1.0	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Stotler-Root Formations:				
French Creek Member:				
Shale, olive brown.....	1.0	-	11.0	
Shale, olive gray.....	11.0	-	12.7	
Shale, black.....	12.7	-	13.5	
Shale, brown.....	13.5	-	14.0	
Jim Creek Member:				
Limestone, medium gray mottled with brown, finely crystalline; contains brachiopods.....	14.0	-	14.4	
Friedrich-Dry Members:				
Shale, brown.....	14.4	-	14.8	
Shale, light gray; contains limy nodules and brachiopods.....	14.8	-	16.0	
Shale, light gray.....	16.0	-	19.0	
Shale, reddish brown.....	19.0	-	22.8	
Shale, light greenish gray, interbedded with limestone, tannish gray, dense.....	22.8	-	25.5	
Shale, red interbedded with light green.....	25.5	-	27.0	
Shale, reddish brown.....	27.0	-	39.0	
Shale, olive.....	39.0	-	41.0	
Shale, medium gray.....	41.0	-	62.2	
Dover Member:				
Limestone, medium to dark gray, finely crystal- line; contains brachiopods.....	62.2	-	63.0	
Pillsbury Formation:				
Shale, light greenish gray, silty, sandy, limy.....	63.0	-	65.0	
Shale, reddish brown.....	65.0	-	69.0	
Shale, olive.....	69.0	-	71.0	
Shale, medium gray.....	71.0	-	79.5	
Zeandale Formation:				
Maple Hill Member:				
Limestone, bluish gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....	79.5	-	81.4	
Wamego Member:				
Coal, black.....	81.4	-	81.6	
Shale, light gray.....	81.6	-	89.0	
Shale, medium gray.....	89.0	-	91.2	
Tarkio Member:				
Limestone, medium to dark gray, finely crystal- line, pebbly texture; contains brachiopods...	91.2	-	92.0	
Shale, light gray interbedded with reddish brown.....	92.0	-	93.3	
Shale, reddish brown.....	93.3	-	95.0	
Limestone, white to cream, finely crystalline; contains glauconite, fusulinids, and <u>Osagia</u> ..	95.0	-	100.5	

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Willard Formation:				
	Shale, light greenish gray interbedded with sandstone, tan, very fine grained.....		100.5	-101.3
	Shale, olive interbedded with gray and brown...		101.3	-103.0

Test Hole 14-78

Location: Richardson County, SE corner SW sec. 10, T. 1 N., R. 13 E., approximately 25 feet north of south line and 2,614 feet east of west section line.

Ground-level elevation: 1,050.0 feet above mean sea level.

Started: April 28, 1978. Completed: April 28, 1978.

Total depth: 137.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 2.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Wood Siding Formation:				
Pony Creek-Plumb Members:				
	Shale, brownish gray.....		2.0	- 6.0
	Shale, reddish brown.....		6.0	- 15.2
	Shale, olive interbedded with gray.....		15.2	- 19.0
Nebraska City Member:				
	Limestone, medium gray, finely crystalline; contains brachiopods.....		19.0	- 20.0
Root Formation:				
French Creek Member:				
	Shale, olive brown.....		20.0	- 20.4
	Coal, black.....		20.4	- 21.0
	Shale, light gray.....		21.0	- 24.5
	Shale, medium gray.....		24.5	- 26.5
	Limestone, medium gray, finely crystalline; contains brachiopods and pyrite.....		26.5	- 27.1
	Coal, black.....		27.1	- 27.2
	Shale, light gray.....		27.2	- 36.0
	Shale, medium gray.....		36.0	- 41.3
Jim Creek Member:				
	Limestone, medium gray, finely crystalline; contains brachiopods.....		41.3	- 43.0
Friedrich Member:				
	Shale, light gray.....		43.0	- 48.0
	Shale, reddish brown.....		48.0	- 51.0

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
	Shale, reddish brown interbedded with greenish gray.....		51.0	- 51.5
Stotler Formation:				
Grandhaven Member:				
	Limestone, cream and light gray, interbedded with shale, red.....		51.5	- 54.0
Dry Member:				
	Shale, light greenish gray, limy.....		54.0	- 55.0
	Shale, reddish brown.....		55.0	- 66.0
	Shale, olive mottled with gray.....		66.0	- 67.3
	Shale, light to medium gray.....		67.3	- 91.6
Dover Member:				
	Limestone, medium to dark gray, very finely crystalline; contains brachiopods and crinoids.....		91.6	- 92.5
Pillsbury Formation:				
	Shale, light greenish gray.....		92.5	- 95.5
	Shale, reddish brown.....		95.5	- 99.0
	Shale, olive.....		99.0	- 100.0
	Shale, medium gray.....		100.0	- 112.0
Zeandale Formation:				
Maple Hill Member:				
	Limestone, medium gray, finely crystalline; contains brachiopods, crinoids, and glauconite.....		112.0	- 113.2
Wamego Member:				
	Shale, medium to dark gray.....		113.2	- 115.0
	Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....		115.0	- 115.4
	Shale, light gray.....		115.4	- 119.0
	Shale, medium gray.....		119.0	- 120.9
Tarkio Member:				
	Limestone, dark gray, irregularly crystalline; pebbly texture; contains brachiopods and crinoids.....		120.9	- 121.6
	Shale, light gray.....		121.6	- 122.7
	Shale, reddish brown.....		122.7	- 124.0
	Shale, greenish gray.....		124.0	- 124.4
	Limestone, cream, irregularly crystalline; contains fusulinids and <u>Osagia</u>		124.4	- 129.0
Willard Formation:				
	Shale, light greenish gray.....		129.0	- 131.0
	Shale, olive interbedded with red.....		131.0	- 133.0
	Shale, light greenish gray.....		133.0	- 135.0
	Shale, light to medium gray.....		135.0	- 137.0

Test Hole 15-78

Location: Richardson County, SE NE SE NE sec. 16, T. 1 N., R. 13 E., approximately 1,670 feet south of north section line and 26 feet west of east section line.

Ground-level elevation: 1,090.0 feet above mean sea level.

Started: May 2, 1978. Completed: May 2, 1978.

Total depth: 107.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 1.0
Clay, brown, sandy.....	1.0	- 7.9
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, dark yellow, very finely crystalline; contains brachiopods and crinoids.....	7.9	- 8.1
Pony Creek-Plumb Members:		
Shale, olive gray mottled with yellow.....	8.1	- 13.4
Limestone, yellowish brown, highly weathered; contains algal material.....	13.4	- 13.6
Shale, light greenish gray.....	13.6	- 15.5
Shale, reddish brown.....	15.5	- 21.0
Shale, olive gray.....	21.0	- 22.0
Shale, medium gray.....	22.0	- 23.7
Nebraska City Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods and crinoids.....	23.7	- 25.5
Root Formation:		
French Creek Member:		
Coal, black.....	25.5	- 25.7
Shale, light gray.....	25.7	- 31.5
Shale, light gray, limy.....	31.5	- 31.9
Shale, light gray interbedded with black; contains traces of coal.....	31.9	- 32.1
Shale, light gray.....	32.1	- 38.0
Shale, medium gray.....	38.0	- 42.0
Shale, medium gray interbedded with dark gray..	42.0	- 45.9
Jim Creek Member:		
Limestone, light to medium gray; contains brachiopods.....	45.9	- 46.2
Friedrich Member:		
Shale, light gray.....	46.2	- 51.5
Shale, reddish brown.....	51.5	- 55.1

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Stotler Formation:				
Grandhaven Member:				
	Limestone, light greenish gray, very finely crystalline; contains brachiopods.....	55.1	-	58.2
Dry Member:				
	Shale, light greenish gray.....	58.2	-	59.2
	Shale, reddish brown.....	59.2	-	71.0
	Shale, light gray interbedded with olive.....	71.0	-	72.0
	Shale, medium gray.....	72.0	-	77.0
	Shale, light to medium gray.....	77.0	-	82.0
	Shale, light gray.....	82.0	-	94.7
Dover Member:				
	Limestone, medium to dark bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	94.7	-	95.7
Pillsbury Formation:				
	Shale, light greenish gray.....	95.7	-	97.0
	Shale, olive interbedded with greenish gray....	97.0	-	99.0
	Shale, reddish brown interbedded with greenish gray and olive.....	99.0	-	102.0
	Shale, olive interbedded with medium gray.....	102.0	-	104.0
	Shale, medium gray.....	104.0	-	107.0

Test Hole 16-78

Location: Richardson County, NE NW NE NE sec. 20, T. 1 N., R. 13 E., approximately 11 feet south of north section line and 895 feet west of east section line.

Ground-level elevation: 1,087.0 feet above mean sea level.

Started: May 2, 1978. Completed: May 2, 1978.

Total depth: 197.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
	Soil (no sample).....	0	-	2.0
	Clay, reddish brown, silty; contains sand and gravel.....	2.0	-	7.0

Description	Depth, in feet	
	From	To
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Tarkio Member:		
Limestone, pale yellow, finely crystalline, highly weathered; contains fusulinids, crinoids, and <u>Osagia</u>	7.0	11.0
Willard Formation:		
Shale, olive mottled with yellow, brown, and red.....	11.0	13.0
Shale, light olive.....	13.0	19.0
Shale, medium gray.....	19.0	41.9
Emporia Formation:		
Elmont Member:		
Limestone, brownish gray, finely to very finely crystalline; contains brachiopods and fusulinids.....	41.9	44.2
Shale, medium gray.....	44.2	45.2
Limestone, gray, finely to very finely crystalline; contains brachiopods, crinoids, bryozoans, and pyrite.....	45.2	46.5
Shale, light greenish gray.....	46.5	47.1
Limestone, light brown, finely crystalline; contains brachiopods.....	47.1	47.5
Harveyville Member:		
Shale, light greenish gray.....	47.5	49.0
Shale, medium gray.....	49.0	52.0
Reading member:		
Limestone, medium gray, finely crystalline.....	52.0	54.5
Shale, medium gray.....	54.5	54.7
Limestone, medium gray, finely to very finely crystalline; contains brachiopods and crinoids.....	54.7	55.5
Limestone, medium gray, finely crystalline, interbedded with shale, gray.....	55.5	55.9
Shale, medium gray.....	55.9	56.0
Limestone, light gray, very finely crystalline and bluish gray, irregularly crystalline; contains algal material.....	56.0	57.0
Auburn Formation:		
Shale, light to medium gray, limy.....	57.0	62.3
Limestone, light gray, finely crystalline, interbedded with shale, greenish gray.....	62.3	63.0
Shale, light greenish gray.....	63.0	70.0
Shale, medium gray.....	70.0	80.0
Wakarusa Formation:		
Limestone, light gray, irregularly crystalline; contains brachiopods, fusulinids, and bryozoans.....	80.0	83.6

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Soldier Creek Formation:		
Shale, medium gray.....	83.6	90.0
Shale, light greenish gray.....	90.0	93.0
Burlingame Formation:		
South Fork Member:		
Limestone, cream and light tannish gray, fine to very finely crystalline; contains algal material.....	93.0	96.0
Winnebago Member:		
Shale, light greenish gray mottled with olive..	96.0	100.0
Shale, medium gray.....	100.0	102.0
Taylor Branch Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods.....	102.0	103.4
Shale, medium gray.....	103.4	104.5
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and pyrite.....	104.5	105.6
Shale, medium gray.....	105.6	107.0
Limestone, light gray, very finely crystalline; contains brachiopods.....	107.0	107.5
Scranton Formation:		
Shale, light greenish gray.....	107.5	111.0
Shale, light to medium gray.....	111.0	128.5
Shale, light greenish gray interbedded with dark greenish gray.....	128.5	140.0
Siltstone, medium gray.....	140.0	140.2
Shale, light greenish gray, silty.....	140.2	141.0
Shale, medium gray, silty, sandy.....	141.0	147.0
Shale, medium gray, interbedded with siltstone, greenish gray.....	147.0	152.5
Siltstone, medium gray, interbedded with sandstone, light greenish gray, very finely micaceous.....	152.5	156.2
Sandstone, light greenish gray, limy.....	156.2	160.0
Silt, medium gray, sandy.....	160.0	178.0
Sandstone, light gray, very fine grained, limy; contains black carbonaceous material.....	178.0	180.5
Silt, medium gray to light greenish gray, interbedded with sandstone, medium gray, very fine grained.....	180.5	197.0

Test Hole 17-78

Location: Richardson County, NE corner SE sec. 8, T. 1 N., R. 13 E., approximately 2,649 feet south of north section line and 20 feet west of east section line.

Ground-level elevation: 986.0 feet above mean sea level.

Started: May 3, 1978. Completed: May 3, 1978.

Total depth: 148.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	5.0
Clay, light brown.....	5.0 -	12.0
Clay, light grayish brown, silty.....	12.0 -	17.5
Clay, dark gray, silty.....	17.5 -	20.0
Clay, brownish gray, very silty; contains sand and gravel.....	20.0 -	22.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Auburn Formation:		
Shale, light gray.....	22.0 -	27.0
Shale, light gray interbedded with greenish gray.....	27.0 -	33.2
Wakarusa Formation:		
Limestone, yellowish brown, finely crystal- line; contains brachiopods.....	33.2 -	35.9
Soldier Creek Formation:		
Shale, olive.....	35.9 -	36.0
Shale, light gray.....	36.0 -	39.5
Shale, light gray, limy.....	39.5 -	42.0
Shale, light to medium gray.....	42.0 -	48.0
Burlingame Formation:		
South Fork Member:		
Limestone, cream, fine to very fine crystal- line; contains glauconite and algal material.	48.0 -	49.0
Winnebago Member:		
Shale, light greenish gray.....	49.0 -	50.0
Shale, olive mottled with gray.....	50.0 -	53.0
Shale, light to medium gray.....	53.0 -	56.0
Taylor Branch Member:		
Limestone, light to medium gray, finely crys- talline; contains pyrite.....	56.0 -	57.0
Shale, light to medium gray.....	57.0 -	59.0
Limestone, bluish gray, irregularly crystal- line; contains brachiopods and algal material.....	59.0 -	61.5

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Scranton Formation:				
Cedarvale Member:				
	Shale, light gray, limy.....		61.5 -	63.0
	Shale, medium to dark gray.....		63.0 -	65.0
	Shale, light gray.....		65.0 -	80.2
Rulo Member:				
	Limestone, bluish gray, irregularly crystalline; contains crinoids and pyrite.....		80.2 -	81.0
White Cloud Member:				
	Shale, light gray.....		81.0 -	85.0
	Shale, very light gray to white, limy.....		85.0 -	87.0
	Shale, light and dark greenish gray.....		87.0 -	92.0
	Shale, light greenish gray, interbedded with limestone, greenish gray, dense.....		92.0 -	97.0
	Shale, light greenish gray.....		97.0 -	100.0
	Shale, light to medium gray.....		100.0 -	115.0
	Shale, medium gray, silty.....		115.0 -	120.0
	Shale, medium gray, silty, interbedded with sandstone, medium gray, very fine grained....		120.0 -	135.0
	Shale, medium gray, silty; contains black carbonaceous material.....		135.0 -	141.5
	Shale, medium gray, silty, interbedded with sandstone, medium gray, very fine grained....		141.5 -	148.0

Test Hole 18-78

Location: Richardson County, NE corner SE sec. 5, T. 1 N., R. 13 E., approximately 2,642 feet south of north section line and 8 feet west of east section line.

Ground-level elevation: 980.0 feet above mean sea level.

Started: May 4, 1978. Completed: May 4, 1978.

Total depth: 122.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0 -	3.0
	Clay, brown, silty, sandy.....		3.0 -	23.0
	Clay, light gray, silty, sandy.....		23.0 -	26.0
	Clay, greenish gray, silty.....		26.0 -	29.0
	Clay, brown, silty.....		29.0 -	32.0
	Sand, medium to very coarse, and gravel, fine to medium; contains reworked shell fragments.....		32.0 -	44.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Burlingame Formation:		
Taylor Branch Member:		
Shale, light gray.....	44.0	- 45.0
Limestone, light to medium gray, coarse to very finely crystalline.....	45.0	- 45.7
Scranton Formation:		
Silver Lake-Cedarvale Members:		
Shale, olive.....	45.7	- 46.5
Limestone, light gray, very finely crystalline.....	46.5	- 47.0
Shale, medium to dark gray.....	47.0	- 52.0
Shale, light to medium gray.....	52.0	- 57.0
Shale, light gray, interbedded with limestone, gray, dense.....	57.0	- 62.0
Shale, light gray.....	62.0	- 70.0
Shale, reddish brown.....	70.0	- 73.0
Shale, light greenish gray.....	73.0	- 75.0
Shale, reddish brown.....	75.0	- 79.5
Happy Hollow Member:		
Limestone, white with red staining, very finely crystalline, interbedded with sandstone, red, very fine grained.....	79.5	- 80.0
Shale, reddish brown.....	80.0	- 80.6
Limestone, white with red staining, very finely crystalline, interbedded with sandstone, red, very fine grained.....	80.6	- 81.0
White Cloud Member:		
Shale, light reddish brown.....	81.0	- 83.0
Shale, greenish gray.....	83.0	- 86.0
Shale, light gray, silty.....	86.0	- 92.0
Shale, light gray, silty, sandy.....	92.0	- 97.2
Limestone, medium to dark gray, irregularly crystalline; contains brachiopods, crinoids, and bryozoans.....	97.2	- 98.0
Shale, light gray.....	98.0	-107.0
Shale, medium gray, silty, sandy.....	107.0	-122.0

Test Hole 19-78

Location: Richardson County, NW corner sec. 7, T. 1 N., R. 13 E.,
 approximately 16 feet south of north section line and 58
 feet east of west section line.

Ground-level elevation: 1,010.0 feet above mean sea level.

Started: May 4, 1978. Completed: May 4, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
<u>Quaternary System:</u>		
Soil (no sample).....	0	- 1.0
Clay, yellowish brown; contains sand and gravel.....	1.0	- 11.0
Clay, yellow mottled with olive; contains sand and gravel.....	11.0	- 16.0
<u>Pennsylvanian System - Virgil Series - Wabaunsee Group:</u>		
<u>Soldier Creek Formation:</u>		
Shale, olive.....	16.0	- 21.0
Shale, medium gray.....	21.0	- 23.0
Shale, light gray.....	23.0	- 24.5
<u>Burlingame Formation:</u>		
<u>South Fork Member:</u>		
Limestone, light gray, very finely crystalline; contains manganese staining and algal material.....	24.5	- 28.6
<u>Winnebago Member:</u>		
Shale, light gray mottled with olive.....	28.6	- 31.0
Shale, medium gray.....	31.0	- 33.2
<u>Taylor Branch Member:</u>		
Limestone, medium gray, very finely crystalline; contains brachiopods.....	33.2	- 34.3
Shale, medium to dark gray.....	34.3	- 38.0
Limestone, light tannish gray, very finely crystalline.....	38.0	- 39.2
Shale, light greenish gray, limy.....	39.2	- 40.2
Limestone, light gray, very finely crystalline; contains pyrite.....	40.2	- 41.0
<u>Scranton Formation:</u>		
<u>Silver Lake Member:</u>		
Shale, light gray.....	41.0	- 57.5
<u>Rulo Member:</u>		
Limestone, gray and brownish gray, very finely crystalline; contains brachiopods and crinoids.....	57.5	- 58.0
<u>Cedarvale-White Cloud Members:</u>		
Shale, light gray.....	58.0	- 61.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light greenish gray.....	61.0	68.0
Shale, light red interbedded with greenish gray.....	68.0	68.5
Shale, light greenish gray mottled with olive..	68.5	69.5
Shale, light greenish gray.....	69.5	72.0
Shale, light gray.....	72.0	82.0
Shale, light gray, silty.....	82.0	92.0

Test Hole 20-78

Location: Richardson County, Center South Line SE SE SW sec. 31, T. 2 N., R. 13 E., approximately 25 feet north of south section line and 2,305 feet east of west section line.

Ground-level elevation: 1,097.0 feet above mean sea level.

Started: May 4, 1978. Completed: May 4, 1978.

Total depth: 77.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	3.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Wamego Member:		
Shale, yellowish brown.....	3.0	10.0
Shale, gray mottled with olive.....	10.0	13.0
Tarkio Member:		
Limestone, yellow and reddish gray, finely crystalline; contains brachiopods and crinoids...	13.0	14.0
Shale, reddish brown.....	14.0	15.0
Limestone, yellowish brown, very finely crystalline; contains <i>Osagia</i> , fusulinids, and manganese staining.....	15.0	16.5
Willard Formation:		
Shale, reddish gray mottled with greenish gray.....	16.5	17.0
Shale, reddish brown.....	17.0	20.0
Shale, greenish gray.....	20.0	22.0
Shale, reddish gray.....	22.0	23.0
Shale, greenish gray.....	23.0	26.0
Shale, light to medium gray mottled with olive.....	26.0	29.0

Description	Depth, in feet	
	From	To
Shale, light to medium gray.....	29.0	- 43.0
Shale, medium gray, limy.....	43.0	- 50.5
Emporia Formation:		
Elmont Member:		
Limestone, bluish gray, very finely crystalline; contains brachiopods and fusulinids.....	50.5	- 52.7
Shale, medium gray.....	52.7	- 56.0
Limestone, light gray, very finely crystalline.....	56.0	- 56.2
Harveyville Member:		
Shale, light to medium gray mottled with olive.....	56.2	- 60.6
Reading Member:		
Limestone, gray, very finely crystalline; contains brachiopods and crinoids.....	60.6	- 63.5
Shale, medium gray.....	63.5	- 64.4
Limestone, light to medium gray, irregularly crystalline; contains brachiopods and crinoids.....	64.4	- 66.4
Auburn Formation:		
Shale, medium gray.....	66.4	- 68.5
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	68.5	- 68.9
Shale, greenish gray.....	68.9	- 69.2
Shale, reddish brown.....	69.2	- 74.0
Shale, olive mottled with gray.....	74.0	- 76.0
Shale, medium gray.....	76.0	- 77.0

Test Hole 21-78

Location: Pawnee County, NE NW NE NE sec. 1, T. 1 N., R. 12 E., approximately 16 feet south of north section line and 665 feet west of east section line.

Ground-level elevation: 1,025.0 feet above mean sea level.

Started: May 5, 1978. Completed: May 5, 1978.

Total depth: 77.0 feet.

Description	Depth, in feet	
	From	To
Quaternary System:		
Soil (no sample).....	0	- 2.0
Clay, reddish brown, silty, sandy.....	2.0	- 7.0
Clay, brown, silty, sandy.....	7.0	- 12.0
Clay, yellowish brown, silty, sandy.....	12.0	- 17.0

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Clay, reddish brown, silty, sandy.....	17.0	- 27.0
Clay, reddish brown, silty, sandy; contains gravel.....	27.0	- 31.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wakarusa Formation:		
Limestone, yellowish gray, very finely crystalline; contains crinoids.....	31.5	- 32.2
Soldier Creek Formation:		
Shale, olive.....	32.2	- 36.0
Shale, light to medium gray.....	36.0	- 41.0
Shale, light gray.....	41.0	- 43.0
Burlingame Formation:		
South Fork Member:		
Limestone, light greenish gray, very finely crystalline to dense; contains crinoids.....	43.0	- 46.0
Winnebago Member:		
Shale, light gray.....	46.0	- 50.5
Taylor Branch Member:		
Limestone, light to medium gray, very finely crystalline; contains brachiopods and bryozoan.....	50.5	- 51.6
Shale, medium to dark gray.....	51.6	- 53.4
Limestone, medium to dark gray, pebbly texture; contains brachiopods and bryozoans.....	53.4	- 53.6
Shale, dark gray.....	53.6	- 55.5
Limestone, light brownish gray, very finely crystalline to dense.....	55.5	- 56.6
Scranton Formation:		
Silver Lake Member:		
Shale, light gray to light greenish gray mottled with olive.....	56.6	- 60.0
Shale, light to medium gray.....	60.0	- 74.7
Rulo Member:		
Limestone, brownish gray, very finely crystalline; contains brachiopods.....	74.7	- 75.1
Cedarvale-White Cloud Members:		
Shale, light to medium gray.....	75.1	- 77.0

Test Hole 22-78

Location: Richardson County, Center West Line NW SW NW sec. 3, T. 1 N., R. 13 E., approximately 1,724 feet south of north section line and 49 feet east of west section line.

Ground-level elevation: 975.0 feet above mean sea level.

Started: May 5, 1978. Completed: May 5, 1978.

Total depth: 152.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 5.0
Sand, brown, very fine, silty.....	5.0	- 30.0
Sand, very fine to very coarse and gravel, fine to very coarse; interbedded with silt, brown.....	30.0	- 34.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, medium gray.....	34.0	- 35.0
Emporia Formation:		
Elmont Member:		
Limestone, light gray, very finely crystalline to dense; contains algal material.....	35.0	- 36.1
Shale, greenish gray interbedded with gray.....	36.1	- 39.0
Limestone, light gray, very finely crystalline; contains pyrite.....	39.0	- 39.5
Harveyville Member:		
Shale, medium gray mottled with olive.....	39.5	- 44.4
Reading Member:		
Limestone, medium to dark gray, very finely crystalline; contains brachiopods.....	44.4	- 47.4
Shale, medium to dark gray.....	47.4	- 48.0
Limestone, bluish gray, very finely crystalline; contains brachiopods, algal material, and pyrite.....	48.0	- 49.5
Auburn Formation:		
Shale, medium gray.....	49.5	- 52.3
Shale, greenish gray.....	52.3	- 53.0
Shale, reddish brown.....	53.0	- 58.0
Shale, olive.....	58.0	- 61.0
Shale, light to medium gray.....	61.0	- 66.0
Shale, medium gray.....	66.0	- 77.5
Wakarusa Formation:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	77.5	- 80.5
Soldier Creek Formation:		
Shale, greenish gray.....	80.5	- 85.0
Shale, medium gray.....	85.0	- 90.8
Burlingame Formation:		
South Fork Member:		
Limestone, cream, irregularly crystalline; contains algal material.....	90.8	- 94.0
Winnebago Member:		
Shale, olive mottled with gray.....	94.0	- 96.0
Shale, medium to dark gray.....	96.0	- 99.5

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Taylor Branch Member:		
Limestone, medium gray, very finely crystalline.....	99.5	- 100.8
Shale, medium to dark gray.....	100.8	- 102.7
Limestone, bluish gray, pebbly texture; contains brachiopods and algal material.....	102.7	- 103.5
Shale, medium gray.....	103.5	- 104.9
Limestone, light tannish gray, very finely crystalline; contains dark brown inclusions..	104.9	- 106.2
Shale, light greenish gray.....	106.2	- 107.7
Limestone, light gray, fine to very finely crystalline.....	107.7	- 108.2
Scranton Formation:		
Silver Lake Member:		
Shale, maroon to red interbedded with light greenish gray.....	108.2	- 110.0
Shale, olive.....	110.0	- 112.0
Shale, medium gray.....	112.0	- 122.0
Shale, light to medium gray.....	122.0	- 126.3
Rulo Member:		
Limestone, brownish gray, very finely crystalline; contains brachiopods and pyrite.....	126.3	- 126.5
Cedarvale Member:		
Shale, light to medium gray.....	126.5	- 134.0
Shale, light greenish gray.....	134.0	- 135.0
Happy Hollow Member:		
Limestone, light greenish gray, very finely crystalline, interbedded with shale, red and green.....	135.0	- 141.5
White Cloud Member:		
Shale, reddish brown mottled with gray, green and olive.....	141.5	- 143.0
Shale, greenish gray mottled with olive.....	143.0	- 146.0
Shale, light to medium gray, interbedded with siltstone, gray.....	146.0	- 152.0

Test Hole 23-78

Location: Richardson County, NW SW NW NW, sec. 4, T. 1 N., R. 13 E., approximately 750 feet south of north section line and 10 feet east of west section line.

Ground-level elevation: 977.0 feet above mean sea level.

Started: May 9, 1978. Completed: May 9, 1978.

Total depth: 167.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	3.0
Clay, grayish brown.....	3.0 -	23.0
Clay, dark gray, sandy.....	23.0 -	28.0
Sand, fine to very coarse and gravel, fine to very coarse.....	28.0 -	42.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
Silver Lake Member:		
Shale, medium gray.....	42.0 -	44.0
Rulo Member:		
Limestone, brownish gray, very finely crystalline; contains brachiopods and pyrite.....	44.0 -	44.1
Cedarvale Member:		
Shale, medium gray.....	44.1 -	51.0
Shale, light greenish gray.....	51.0 -	52.0
Shale, reddish brown.....	52.0 -	55.0
Happy Hollow Member:		
Limestone, light greenish gray, very finely crystalline, interbedded with shale, red and green.....	55.0 -	56.2
White Cloud Member:		
Shale, light greenish gray.....	56.2 -	56.5
Shale, reddish brown mottled with olive.....	56.5 -	58.0
Shale, reddish brown.....	58.0 -	62.0
Shale, light gray.....	62.0 -	75.0
Limestone, dark gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	75.0 -	75.5
Shale, light gray, silty, sandy.....	75.5 -	103.5
Claystone, dark brown.....	103.5 -	103.7
Shale, light gray, silty.....	103.7 -	117.0
Shale, light gray, silty, sandy.....	117.0 -	127.0
Shale, light gray, silty, sandy, interbedded with claystone, dark brown.....	127.0 -	132.0
Shale, light gray, silty.....	132.0 -	146.2
Howard Formation:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, fusulinids, pyrite, and black inclusions.....	146.2 -	153.0
Severy Formation:		
Shale, light gray.....	153.0 -	154.0
Shale, medium to dark gray.....	154.0 -	155.0
Coal, black.....	155.0 -	156.5
Shale, light to medium gray.....	156.5 -	158.2
Sandstone, light gray, very fine grained, lime cemented; contains black carbonaceous material.....	158.2 -	159.1
Shale, light gray, silty.....	159.1 -	167.0

Test Hole 24-78

Location: Richardson County, NW corner NE sec. 28, T. 2 N., R. 13 E., approximately 17 feet south of north section line and 2,630 feet west of east section line.

Ground-level elevation: 1,105.0 feet above mean sea level.

Started: May 9, 1978. Completed: May 9, 1978.

Total Depth: 125.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	1.0
Clay, yellowish brown.....	1.0 -	8.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Maple Hill Member:		
Limestone, yellowish brown, irregularly crystalline; highly weathered, contains brachiopods and crinoids.....	8.5 -	9.5
Wamego Member:		
Shale, olive yellow.....	9.5 -	16.0
Shale, medium gray.....	16.0 -	24.5
Tarkio Member:		
Limestone, white to cream, irregularly crystalline; contains fusulinids and <u>Osagia</u>	24.5 -	26.0
Shale, light bluish gray.....	26.0 -	26.2
Limestone, light gray, finely crystalline.....	26.2 -	27.0
Willard Formation:		
Shale, reddish brown interbedded with olive and greenish gray.....	27.0 -	32.0
Shale, light gray.....	32.0 -	58.9
Emporia Formation:		
Elmont Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	58.9 -	61.0
Shale, light gray.....	61.0 -	62.5
Shale, light greenish gray.....	62.5 -	63.5
Limestone, light greenish gray, very finely crystalline and light tannish gray, irregular crystalline.....	63.5 -	65.0
Harveyville Member:		
Shale, light to medium gray.....	65.0 -	68.8
Reading Member:		
Limestone, gray, fine to very finely crystalline; contains brachiopods, crinoids, and bryozoans.....	68.8 -	72.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium gray.....	72.0	73.0
Limestone, light to medium gray, finely to very finely crystalline; contains brachiopods and crinoids.....	73.0	74.1
Auburn Formation:		
Shale, light gray.....	74.1	78.0
Shale, light greenish gray.....	78.0	79.0
Shale, reddish gray.....	79.0	82.0
Shale, olive.....	82.0	85.0
Shale, light to medium gray.....	85.0	97.5
Wakarusa Formation:		
Limestone, light to medium bluish gray, finely to very finely crystalline; contains brachiopods, crinoids, and fusulinids.....	97.5	100.4
Shale, dark gray to black.....	100.4	100.5
Limestone, light to medium bluish gray, very finely crystalline; contains brachiopods and crinoids.....	100.5	101.0
Soldier Creek Formation:		
Shale, light gray.....	101.0	108.5
Burlingame Formation:		
South Fork Member:		
Limestone, brownish gray, very finely crystalline to dense.....	108.5	109.5
Shale, reddish gray.....	109.5	110.0
Limestone, white to light gray, finely crystalline; contains algal material.....	110.0	112.5
Winnebago Member:		
Shale, light to medium gray.....	112.5	119.5
Taylor Branch Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and pyrite.....	119.5	120.5
Shale, medium gray.....	120.5	122.5
Limestone, bluish gray, pebbly texture; contains algal material.....	122.5	123.5
Shale, light to medium gray.....	123.5	125.0

Test Hole 25-78

Location: Richardson County, NW NW SW SW sec. 26, T. 2 N., R. 13 E., approximately 1,056 feet north of south section line and 20 feet east of west section line.

Ground-level elevation: 973.0 feet above mean sea level.

Started: May 11, 1978. Completed: May 11, 1978.

Total depth: 122.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0 -	4.0
	Clay, brown, sandy.....		4.0 -	7.0
	Sand, very fine to very coarse.....		7.0 -	12.0
	Sand, very fine to very coarse and gravel, very fine to medium.....		12.0 -	17.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Stotler Formation:				
Dry Member:				
	Shale, reddish brown.....		17.0 -	18.0
	Shale, reddish brown mottled with olive.....		18.0 -	19.0
	Shale, medium gray.....		19.0 -	34.3
Dover Member:				
	Limestone, medium to dark gray, irregularly crystalline; contains brachiopods and crinoids...		34.3 -	35.0
Pillsbury Formation:				
	Shale, olive gray.....		35.0 -	37.0
	Shale, light greenish gray.....		37.0 -	39.0
	Shale, reddish brown.....		39.0 -	43.0
	Shale, reddish brown mottled with green, gray and olive.....		43.0 -	45.0
	Shale, medium gray.....		45.0 -	54.5
Zeandale Formation:				
Maple Hill Member:				
	Limestone, medium gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....		54.5 -	56.3
Wamego Member:				
	Coal, black.....		56.3 -	56.4
	Shale, light gray.....		56.4 -	62.0
	Shale, light to medium gray.....		62.0 -	65.5
Tarkio Member:				
	Limestone, cream, irregularly crystalline; contains fusulinids and <u>Osagia</u>		65.5 -	70.0
Willard Formation:				
	Sandstone, reddish brown interbedded with greenish gray, very fine grained.....		70.0 -	72.0
	Shale, light gray.....		72.0 -	76.0
	Shale, light to medium gray, silty, interbedded with sandstone, gray, very fine grained, thin.....		76.0 -	92.0
	Shale, light to medium gray, slightly silty....		92.0 -	103.0
Emporia Formation:				
Elmont Member:				
	Limestone, light to medium bluish gray, irregularly crystalline; contains brachiopods and fusulinids.....		103.0 -	105.3
	Shale, light gray.....		105.3 -	107.0
	Limestone, light gray and light greenish gray, very finely crystalline.....		107.0 -	109.0

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Harveyville Member:				
	Shale, medium gray.....		109.0	- 113.6
Reading Member:				
	Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....		113.6	- 116.8
	Shale, medium gray.....		116.8	- 117.6
	Limestone, medium gray, irregularly crystalline; contains brachiopods and crinoids.....		117.6	- 118.6
Auburn Formation:				
	Shale, medium gray.....		118.6	- 122.0

Test Hole 26-78

Location: Pawnee County, NE corner SE sec. 14, T. 2 N., R. 12 E., approximately 1,330 feet south of north section line and 8 feet east of west section line.

Ground-level elevation: 991.0 feet above mean sea level.

Started: May 11, 1978. Completed: May 11, 1978.

Total depth: 122.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 5.0
	Clay, brown.....		5.0	- 15.0
	Clay, brown, sandy.....		15.0	- 20.0
	Clay, greenish brown, very sandy.....		20.0	- 28.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Scranton Formation:				
White Cloud Member:				
	Shale, dark olive gray.....		28.5	- 33.0
	Shale, light to medium gray.....		33.0	- 40.3
Howard Formation:				
	Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, fusulinids...		40.3	- 42.7
Severy Formation:				
	Coal, black.....		42.7	- 43.1
	Shale, light gray.....		43.1	- 43.5
	Shale, light gray; contains black carbonaceous material.....		43.5	- 45.0
	Shale, light gray, interbedded with sandstone, gray, very fine grained.....		45.0	- 48.0
	Shale, light gray to light greenish gray; contains black carbonaceous material.....		48.0	- 62.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light gray.....	62.0	74.3
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, light to medium bluish gray, irregularly crystalline; contains fusulinids.....	74.3	76.1
Shale, light gray, sandy.....	76.1	77.5
Limestone, bluish gray, very finely crystalline; contains brachiopods and crinoids.....	77.5	78.5
Shale, dark gray to black.....	78.5	78.7
Limestone, bluish gray, very finely crystalline; contains brachiopods and crinoids.....	78.7	79.4
Holt Member:		
Shale, black.....	79.4	82.0
DuBois Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	82.0	82.8
Shale, medium gray.....	82.8	83.0
Limestone, light gray, very finely crystalline.....	83.0	83.7
Shale, medium gray.....	83.7	84.3
Limestone, light tannish gray, very finely crystalline to dense.....	84.3	84.9
Turner Creek Member:		
Shale, light greenish gray, limy.....	84.9	87.5
Sheldon-Iowa Point Members:		
Limestone, light gray and light bluish gray, irregularly to very finely crystalline, interbedded with shale, gray; contains brachiopods and algal material.....	87.5	95.4
Limestone, bluish gray, finely crystalline; contains brachiopods and fusulinids.....	95.4	96.5
Shale, medium gray.....	96.5	97.2
Limestone, medium gray, very finely crystalline; contains brachiopods.....	97.2	97.5
Shale, light gray.....	97.5	99.1
Hartford Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods and pyrite.....	99.1	99.6
Shale, light gray; contains black carbonaceous material.....	99.6	99.9
Limestone, light tannish gray, irregularly crystalline; contains brachiopods.....	99.9	100.7
Calhoun Formation:		
Shale, dark gray.....	100.7	101.0
Shale, light greenish gray.....	101.0	102.2

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Deer Creek Formation:				
Ervine Creek Member:				
	Limestone, light gray to light tannish gray, irregularly crystalline; contains <u>Osagia</u> , algal material, and black inclusions.....		102.2	- 110.0
	Limestone, light tannish gray, finely to very finely crystalline; contains crinoids and fusulinids.....		110.0	- 119.0
	Shale, dark gray; contains black carbonaceous material.....		119.0	- 119.6
	Limestone, light to medium gray, finely crystalline; contains brachiopods.....		119.6	- 120.0
Larsh Member:				
	Shale, light gray; contains black carbonaceous material.....		120.0	- 121.0
	Shale, black.....		121.0	- 122.0

Test Hole 27-78

Location: Richardson County, NW corner sec. 19, T. 2 N., R. 13 E., approximately 35 feet south of north section line and 12 feet east of west section line.

Ground-level elevation: 1,047.0 feet above mean sea level.

Started: May 14, 1978. Completed: May 14, 1978.

Total depth: 177.5 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0	- 4.0
	Clay, brown, sandy.....		4.0	- 11.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Scranton Formation:				
Silver Lake-Cedarvale Members:				
	Shale, yellowish olive.....		11.0	- 17.0
	Shale, medium gray mottled with olive.....		17.0	- 19.0
	Shale, light gray.....		19.0	- 21.0
	Shale, light greenish gray.....		21.0	- 23.0
	Shale, reddish brown.....		23.0	- 26.4
Happy Hollow Member:				
	Limestone, light greenish gray, very finely crystalline, stained red and green.....		26.4	- 27.6

Description	Depth, in feet	
	From	To
Scranton-Severy Formations:		
Shale, reddish brown.....	27.6	28.0
Shale, yellowish olive.....	28.0	30.0
Shale, red mottled with olive.....	30.0	31.0
Shale, light gray.....	31.0	34.0
Shale, medium gray.....	34.0	39.5
Limestone, dark bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	39.5	41.4
Shale, light gray.....	41.4	53.0
Shale, light gray interbedded with sandstone, gray, very fine grained.....	53.0	57.2
Sandstone, light gray, very fine to fine grained, limy, interbedded with shale, light gray, silty.....	57.2	59.2
Shale, light gray, silty.....	59.2	77.0
Shale, light gray, silty, sandy.....	77.0	92.0
Shale, light to medium gray, silty, sandy.....	92.0	104.5
Shale, light gray, limy; contains black carbonaceous material.....	104.5	106.5
Shale, light greenish gray, silty.....	106.5	132.0
Shale, light to medium gray interbedded with sandstone, gray, very fine, grained.....	132.0	152.0
Shawnee Group:		
Topeka Formation:		
Coal Creek Member:		
Limestone, medium to dark gray, irregularly crystalline; contains brachiopods and fusulinids.....	152.0	156.0
Holt Member:		
Shale, black.....	156.0	158.8
DuBois Member:		
Limestone, bluish gray, fine to very finely crystalline; contains brachiopods and crinoids.....	158.8	161.2
Turner Creek Member:		
Shale, light greenish gray.....	161.2	164.6
Sheldon-Curzon Members:		
Limestone, cream, irregularly crystalline and medium gray, finely crystalline, interbedded with shale, greenish gray; contains brachiopods and algal material.....	164.6	171.0
Limestone, light to medium gray, irregularly crystalline interbedded with shale, gray; contains brachiopods, crinoids, and fusulinids.....	171.0	177.5

Test Hole 28-78

Location: Richardson County, NW corner sec. 21, T. 2 N., R. 13 E., approximately 65 feet south of north section line and 15 feet east of west section line.

Ground-level elevation: 1,133.0 feet above mean sea level.

Started: May 15, 1978. Completed: May 15, 1978.

Total depth: 212.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Clay, yellowish brown, silty, sandy.....	2.0	-	12.0	
Sand, fine to very coarse and gravel, fine to coarse; contains reworked limestone.....	12.0	-	19.5	
Clay, brownish gray.....	19.5	-	32.0	
Clay, medium gray, silty.....	32.0	-	47.0	
Silt, medium gray, clayey.....	47.0	-	62.0	
Silt, medium to dark gray, clayey, limy.....	62.0	-	67.0	
Sand, medium to very coarse and gravel, fine to very coarse; contains reworked limestone.....	67.0	-	79.0	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Auburn Formation:				
Shale, olive.....	79.0	-	81.0	
Shale, medium to dark gray mottled with olive..	81.0	-	86.0	
Shale, medium to dark gray.....	86.0	-	95.3	
Wakarusa Formation:				
Limestone, gray, very finely crystalline; contains brachiopods, crinoids, and fusulinids..	95.3	-	98.4	
Soldier Creek Formation:				
Shale, medium gray.....	98.4	-	106.0	
Shale, medium gray interbedded with brown.....	106.0	-	108.0	
Burlingame Formation:				
South Fork Member:				
Limestone, cream, irregularly crystalline; contains algal material.....	108.0	-	110.0	
Winnebago Member:				
Shale, light greenish gray.....	110.0	-	112.0	
Shale, medium to dark gray.....	112.0	-	115.0	
Taylor Branch Member:				
Limestone, gray, very finely crystalline.....	115.0	-	115.5	
Shale, medium gray.....	115.5	-	116.5	
Limestone, gray, very finely crystalline; contains brachiopods.....	116.5	-	117.5	
Shale, medium to dark gray.....	117.5	-	120.7	
Limestone, bluish gray, irregularly crystalline; contains brachiopods and algal material.....	120.7	-	121.5	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium to dark gray, sandy.....	121.5	- 122.8
Limestone, light greenish gray, very finely crystalline.....	122.8	- 123.5
Shale, medium to dark gray.....	123.5	- 125.5
Limestone, light brownish gray, very finely crystalline; contains red staining.....	125.5	- 127.0
Scranton Formation:		
Silver Lake-Cedarvale Members:		
Shale, light to medium gray.....	127.0	- 132.0
Shale, medium to dark gray, silty.....	132.0	- 142.0
Shale, light gray.....	142.0	- 149.0
Shale, light greenish gray.....	149.0	- 151.0
Shale, reddish brown.....	151.0	- 157.6
Happy Hollow Member:		
Limestone, light greenish gray, very finely crystalline, stained red and yellow, interbedded with shale reddish yellow and green.....	157.6	- 161.0
White Cloud Member:		
Shale, medium gray.....	161.0	- 169.5
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	169.5	- 170.6
Shale, light to medium gray.....	170.6	- 181.0
Shale, medium gray, silty, interbedded with sandstone, gray, very fine grained, thin.....	181.0	- 191.0
Shale, light to medium gray, silty, sandy.....	191.0	- 212.0

Test Hole 29-78

Location: Richardson County, NE corner NW sec. 21, T. 2 N., R. 13 E., approximately 25 feet south of north section line and 2,639 feet east of west section line.

Ground-level elevation: 1,125.0 feet above mean sea level.

Started: May 15, 1978 Completed: May 16, 1978.

Total depth: 302.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 4.0
Sand, brown, very fine to medium grained, silty.....	4.0	- 9.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Sand, fine to very coarse, and gravel, fine to medium.....	9.0	26.0
Silt, brownish olive, sandy.....	26.0	34.0
Silt, light gray, sandy.....	34.0	74.0
Silt, light bluish gray.....	74.0	84.0
Silt, light bluish gray interbedded with brownish gray.....	84.0	90.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, light to medium gray.....	90.0	99.2
Emporia Formation:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and fusulinids.....	99.2	101.6
Shale, light gray.....	101.6	103.0
Limestone, light gray to cream, irregularly crystalline; contains algal material.....	103.0	105.5
Harveyville Member:		
Shale, light to medium gray.....	105.5	109.2
Reading Member:		
Limestone, medium gray, finely to very finely crystalline; contains brachiopods and crinoids.....	109.2	112.5
Shale, medium gray.....	112.5	113.0
Limestone, light to medium gray, finely to very finely crystalline; contains brachiopods and crinoids.....	113.0	114.6
Willard Formation:		
Shale, medium gray.....	114.6	117.4
Shale, light greenish gray.....	117.4	117.6
Shale, reddish brown.....	117.6	122.0
Shale, olive mottled with red.....	122.0	125.0
Shale, medium to dark gray.....	125.0	138.5
Wakarusa Formation:		
Limestone, bluish gray, finely to very finely crystalline; contains brachiopods, crinoids, and fusulinids.....	138.5	142.0
Soldier Creek Formation:		
Shale, medium gray.....	142.0	147.0
Shale, light to medium gray.....	147.0	150.0
Limestone, brownish gray, very finely crystalline to dense.....	150.0	151.0
Shale, reddish brown mottled with olive.....	151.0	152.0
Burlingame Formation:		
South Fork Member:		
Limestone, white to light gray, finely to very finely crystalline; contains algal material..	152.0	154.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Winnebago Member:		
Shale, light greenish gray.....	154.0	- 158.0
Shale, medium gray.....	158.0	- 160.5
Taylor Branch Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and pyrite.....	160.5	- 162.2
Shale, medium to dark gray.....	162.2	- 164.8
Limestone, light gray, very finely crystalline; contains algal material.....	164.8	- 167.4
Shale, medium gray.....	167.4	- 169.5
Limestone, light tannish gray, very finely crystalline to dense.....	169.5	- 170.5
Scranton Formation:		
Silver Lake-Cedarvale Members:		
Shale, medium gray.....	170.5	- 189.1
Shale, medium gray interbedded with siltstone, brown.....	189.1	- 195.0
Shale, light greenish gray.....	195.0	- 197.0
Shale, reddish brown.....	197.0	- 202.2
Happy Hollow Member:		
Limestone, light greenish gray, very finely crystalline to dense, stained red, interbedded with shale, reddish gray.....	202.2	- 203.0
White Cloud Member:		
Shale, light olive gray.....	203.0	- 206.0
Shale, light to medium gray.....	206.0	- 214.2
Limestone, bluish gray, pebbly texture contains brachiopods, crinoids, fusulinids, and pyrite.....	214.2	- 215.0
Shale, light to medium gray.....	215.0	- 229.5
Shale, light gray, limy.....	229.5	- 231.0
Shale, light gray, silty.....	231.0	- 262.0
Shale, light to medium gray, silty.....	262.0	- 283.2
Howard Formation:		
Limestone, dark bluish gray, irregular crystalline; contains brachiopods, crinoids, fusulinids, and pyrite.....	283.2	- 285.6
Severy Formation:		
Coal, black.....	285.6	- 286.2
Shale, light to medium gray, silty.....	286.2	- 292.0
Shale, light gray, silty interbedded with sandstone, gray, very fine grained, thin.....	292.0	- 302.0

Test Hole 30-78

Location: Pawnee County, NE corner SE sec. 26, T. 2 N., R. 12 E.,
approximately 2,655 feet south of north section line and
5 feet west of east section line.

Ground-level elevation: 1,178.0 feet above mean sea level.

Started: May 16, 1978. Completed: May 16, 1978.

Total depth: 122.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
<u>Quaternary System:</u>		
Soil (no sample).....	0 -	2.0
Clay, yellowish brown, silty, sandy.....	2.0 -	7.0
Clay, reddish brown, silty, sandy.....	7.0 -	12.0
Clay, light brown, silty, sandy.....	12.0 -	18.0
Sand, fine to very coarse and gravel very fine to medium.....	18.0 -	25.0
Clay, olive brown, silty, sandy.....	25.0 -	32.0
<u>Pennsylvanian System - Virgil Series - Wabaunsee Group:</u>		
<u>Auburn Formation:</u>		
Shale, reddish brown mottled with olive.....	32.0 -	37.0
Shale, olive yellow.....	37.0 -	39.5
Shale, medium gray.....	39.5 -	47.0
Shale, medium to dark gray mottled with gray...	47.0 -	51.5
<u>Wakarusa Formation:</u>		
Limestone, bluish gray, irregularly crystal- line; contains brachiopods, crinoids, fusulinids, and pyrite.....	51.5 -	54.5
<u>Soldier Creek Formation:</u>		
Shale, light to medium gray.....	54.5 -	61.0
Shale, reddish brown.....	61.0 -	63.0
<u>Burlingame Formation:</u>		
<u>South Fork Member:</u>		
Limestone, white to cream, finely to very finely crystalline; contains algal material..	63.0 -	65.0
<u>Winnebago Member:</u>		
Shale, maroon interbedded with limestone, pale red, dense, thin.....	65.0 -	67.0
Shale, medium gray.....	67.0 -	73.1
<u>Taylor Branch Member:</u>		
Limestone, medium gray, very finely crystal- line; contains brachiopods.....	73.1 -	74.2
Shale, medium gray.....	74.2 -	76.0
Limestone, bluish gray, irregularly crystal- line; pebbly, contains brachiopods, crinoids, and algal material.....	76.0 -	77.9
Shale, medium gray.....	77.9 -	82.5
Shale, light gray, limy, interbedded with lime- stone, gray, dense, thin.....	82.5 -	83.5
<u>Scranton Formation:</u>		
<u>Silver Lake-Cedarvale Members:</u>		
Shale, light gray.....	83.5 -	86.0
Shale, medium gray.....	86.0 -	99.2

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium gray, interbedded with siltstone, brown.....	99.2	- 100.5
Shale, light gray, limy.....	100.5	- 103.0
Shale, light greenish gray.....	103.0	- 104.0
Shale, reddish brown.....	104.0	- 107.0
Happy Hollow Member:		
Limestone, light tannish gray, very finely crystalline to dense.....	107.0	- 107.2
White Cloud Member:		
Shale, reddish brown.....	107.2	- 108.0
Shale, light greenish gray.....	108.0	- 109.0
Shale, olive interbedded with red.....	109.0	- 110.0
Shale, olive gray.....	110.0	- 115.0
Shale, medium to light gray.....	115.0	- 119.8
Limestone, dark bluish gray, irregularly crystalline; contains brachiopods, crinoids, fusulinids, and algal material.....	119.8	- 121.0
Shale medium gray, interbedded with siltstone, gray.....	121.0	- 122.0

Test Hole 31-78

Location: Richardson County, SE corner SW sec. 15, T. 2 N., R. 13 E., approximately 60 feet north of south section line and 2,630 feet east of west section line.

Ground-level elevation: 1,120.0 feet above mean sea level.

Started: May 17, 1978. Completed: May 17, 1978.

Total depth: 32.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 1.0
Clay, light brown, silty.....	1.0	- 3.0
Clay, dark brown, silty.....	3.0	- 9.5
Silt, light brown, sandy.....	9.5	- 12.5
Permian System - Big Blue Series - Council Grove Group:		
Beattie Formation:		
Cottonwood Member:		
Limestone, pale yellow, finely to very finely crystalline; contains fusulinids.....	12.5	- 17.0

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Eskridge Formation:				
Shale, light olive.....	17.0	-	22.0	
Shale, reddish brown.....	22.0	-	26.2	
Shale, light olive.....	26.2	-	29.5	
Limestone, light tannish gray, very finely crystalline to dense.....	29.5	-	30.4	
Shale, olive.....	30.4	-	32.0	

Test Hole 32-78

Location: Richardson County, NE corner sec. 21, T. 2 N., R. 13 E., approximately 91 feet south of north section line and 49 feet west of east section line.

Ground-level elevation: 1,115.0 feet above mean sea level.

Started: May 18, 1978. Completed: May 18, 1978.

Total depth: 100.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Clay, reddish brown, silty.....	2.0	-	6.5	
Clay, light brown, silty.....	6.5	-	14.0	
Clay, brownish gray.....	14.0	-	22.8	
Permian System - Big Blue Series - Admire Group:				
Five Point Formation:				
Limestone, cream, irregularly crystalline; contains algal material.....	22.8	-	23.4	
West Branch Formation:				
Shale, light olive.....	23.4	-	26.7	
Shale, dark greenish gray, interbedded with siltstone, dark brown.....	26.7	-	28.0	
Shale, light olive gray.....	28.0	-	31.0	
Shale, yellow.....	31.0	-	32.0	
Shale, light olive gray to greenish gray.....	32.0	-	36.0	
Shale, medium to dark gray.....	36.0	-	45.0	
Shale, olive mottled with yellow.....	45.0	-	45.3	
Falls City Formation:				
Lehmer Member:				
Limestone, yellow, very finely crystalline; pseudo-oolitic.....	45.3	-	46.2	
Reserve Member:				
Shale, medium gray.....	46.2	-	51.0	

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Miles Member:		
Limestone, bluish gray, pebbly texture; contains black inclusions.....	51.0	51.4
Onaga Formation:		
Hauxby-Towle Members:		
Shale, light greenish gray.....	51.4	55.4
Shale, greenish gray interbedded with reddish gray.....	55.4	63.5
Shale, reddish brown.....	63.5	68.5
Shale, greenish gray.....	68.5	69.0
Shale, olive mottled with gray.....	69.0	70.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray, very finely crystalline; contains brachiopods and glauconite.....	70.0	72.1
Pony Creek-Plumb Members:		
Shale, medium to light gray.....	72.1	75.0
Shale, reddish brown mottled with olive.....	75.0	75.4
Shale, olive mottled with gray.....	75.4	76.0
Shale, medium gray.....	76.0	76.5
Shale, reddish brown interbedded with gray.....	76.5	87.0
Shale, light greenish gray mottled with olive..	87.0	88.0
Shale, medium gray.....	88.0	90.5
Nebraska City Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....	90.5	92.5
Root Formation:		
French Creek Member:		
Coal, black.....	92.5	93.0
Shale, light greenish gray.....	93.0	98.0
Coal, black.....	98.0	98.1
Shale, medium to light gray.....	98.1	100.0

Test Hole 33-78

Location: Richardson County, NE NW NE NE sec. 16, T. 2 N., R. 13 E., approximately 15 feet south of north section line and 850 feet west of east section line.

Ground-level elevation: 1,004.0 feet above mean sea level.

Started: May 18, 1978. Completed: May 18, 1978.

Total depth: 107.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	5.0
Clay, reddish brown, silty.....	5.0	15.0
Clay, reddish brown, silty, sandy.....	15.0	20.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Root Formation:		
French Creek Member:		
Shale, medium to dark gray.....	20.0	25.5
Jim Creek Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	25.5	26.2
Friedrich Member:		
Shale, light gray.....	26.2	38.0
Shale, light gray mottled with red.....	38.0	40.0
Shale, light gray.....	40.0	46.0
Shale, reddish gray.....	46.0	46.5
Limestone, light gray stained pale red, very finely crystalline.....	46.5	46.7
Shale, maroon interbedded with gray.....	46.7	47.2
Shale, light greenish gray.....	47.2	48.7
Shale, reddish brown.....	48.7	49.5
Stotler Formation:		
Grandhaven Member:		
Limestone, reddish brown, dense, interbedded with shale, reddish brown.....	49.5	51.0
Dry Member:		
Shale, reddish brown.....	51.0	56.0
Shale, olive.....	56.0	57.0
Shale, light gray.....	57.0	62.0
Shale, light to medium gray.....	62.0	67.5
Dover Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	67.5	68.4
Pillsbury Formation:		
Shale, light gray.....	68.4	70.0
Shale, light greenish gray.....	70.0	70.5
Shale, reddish brown.....	70.5	75.5
Shale, olive.....	75.5	76.5
Shale, light to medium gray.....	76.5	85.1
Zeandale Formation:		
Maple Hill Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....	85.1	85.4
Shale, dark gray.....	85.4	86.5
Limestone, bluish gray to medium gray, fine to very finely crystalline; contains brachiopods, crinoids, and fusulinids.....	86.5	88.1
Wamego Member:		
Shale, light gray.....	88.1	100.0

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Tarkio Member:		
Limestone, cream, irregularly crystalline; contains fusulinids and <u>Osagia</u>	100.0	104.5
Willard Formation:		
Shale, light gray.....	104.5	107.0

Test Hole 34-78

Location: Richardson County, NE NW NW SW sec. 2, T. 2 N., R. 13 E.,
approximately 2,660 feet south of north section line and
650 feet east of west section line.

Ground-level elevation: 1,013.0 feet above mean sea level.

Started: May 19, 1978. Completed: May 19, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	2.0
Permian System - Big Blue Series - Admire Group:		
Falls City Formation:		
Lehmer Member:		
Limestone, dark yellow, pebbly texture, porous.....	2.0	3.0
Reserve Member:		
Shale, light olive.....	3.0	7.7
Miles Member:		
Limestone, light tannish gray, irregularly crystalline; contains brachiopods and bryozoans.....	7.7	8.3
Onaga Formation:		
Hauxby-Towle Members:		
Shale, yellowish olive.....	8.3	10.7
Shale, olive.....	10.7	14.0
Shale, greenish gray mottled with red.....	14.0	16.0
Shale, greenish gray and light gray mottled with olive.....	16.0	18.5
Shale, reddish brown mottled with olive.....	18.5	20.0
Shale, reddish brown.....	20.0	26.0
Shale, olive gray.....	26.0	26.8

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, pale yellow, very finely crystalline; contains brachiopods and manganese staining..	26.8	- 29.0
Pony Creek-Plumb Members:		
Shale, olive mottled with gray.....	29.0	- 32.0
Shale, medium gray.....	32.0	- 34.0
Shale, reddish brown interbedded with greenish gray.....	34.0	- 42.0
Shale, olive.....	42.0	- 43.0
Shale, light gray.....	43.0	- 45.0
Shale, medium gray.....	45.0	- 48.0
Nebraska City Member:		
Limestone, medium to dark gray, finely crystal- line, impure; contains brachiopods.....	48.0	- 51.0
Root Formation:		
French Creek Member:		
Coal, black.....	51.0	- 51.5
Shale, light gray.....	51.5	- 53.2
Coal, black.....	53.2	- 53.5
Shale, light gray.....	53.5	- 64.0
Shale, light to medium gray.....	64.0	- 67.2
Jim Creek Member:		
Limestone, medium gray, very finely crystalline, impure; contains brachiopods.....	67.2	- 68.0
Friedrich Member:		
Shale, light gray.....	68.0	- 78.0
Shale, light greenish gray.....	78.0	- 79.0
Shale, reddish brown.....	79.0	- 81.0
Shale, light gray.....	81.0	- 83.5
Stotler Formation:		
Grandhaven Member:		
Limestone, light gray, very finely crystalline.....	83.5	- 83.8
Shale, light gray.....	83.8	- 86.5
Limestone, light gray, very finely crystalline; contains red and green staining.....	86.5	- 86.8
Dry Member:		
Shale, light gray mottled with red.....	86.8	- 87.5
Shale, light gray.....	87.5	- 92.0

Test Hole 35-78

Location: Richardson County, SE corner NW sec. 2, T. 2 N., R. 13 E., approximately 2,595 feet south of north section line and 2,545 feet east of west section line.

Ground-level elevation: 990.0 feet above mean sea level.

Started: May 19, 1978. Completed: May 19, 1978.

Total depth: 167.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	5.0
Silt, dark brown, clayey, sandy.....	5.0 -	22.0
Silt, light brown, clayey, sandy.....	22.0 -	40.0
Clay, light gray.....	40.0 -	45.0
Sand, fine to very coarse, and gravel, very fine to medium, interbedded with silt, dark gray.....	45.0 -	55.0
Permian System - Big Blue Series - Admire Group:		
Hamlin Formation:		
Stine Member:		
Shale, olive mottled with gray.....	55.0 -	60.0
Shale, light reddish brown mottled with olive..	60.0 -	61.0
Shale, light gray.....	61.0 -	63.0
Five Point Formation:		
Limestone, white to light gray, irregularly crystalline; contains brachiopods and algal material.....	63.0 -	63.5
West Branch Formation:		
Shale, light greenish gray.....	63.5 -	64.0
Shale, light gray.....	64.0 -	67.0
Shale, light greenish gray, limy.....	67.0 -	70.0
Shale, light greenish gray interbedded with pale reddish brown.....	70.0 -	72.0
Shale, light greenish gray, limy.....	72.0 -	76.0
Shale, medium gray, limy.....	76.0 -	79.0
Shale, light to medium gray.....	79.0 -	86.0
Falls City Formation:		
Lehmer Member:		
Limestone, light gray, finely to very finely crystalline, pseudo-oolitic in part.....	86.0 -	88.2
Shale, light gray.....	88.2 -	88.4
Limestone, light gray, very finely crystalline.....	88.4 -	89.1
Reserve Member:		
Shale, medium gray.....	89.1 -	92.5

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Miles Member:				
	Shale, light greenish gray; contains hard limy zones.....		92.5	- 93.5
Onaga Formation:				
Hauxby-Towle Members:				
	Shale, light greenish gray.....		93.5	- 98.0
	Shale, light gray interbedded with red and green.....		98.0	- 103.0
	Shale, light gray to light greenish gray.....		103.0	- 106.0
	Shale, brown.....		106.0	- 112.0
	Shale, olive mottled with gray.....		112.0	- 113.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Wood Siding Formation:				
Brownville Member:				
	Limestone, pale yellowish gray, finely to very finely crystalline; contains brachiopods and bryozoans.....		113.5	- 116.0
	Shale, olive mottled with gray.....		116.0	- 118.2
	Limestone, yellow, finely crystalline, sandy; contains bryozoans.....		118.2	- 118.8
Pony Creek-Plumb Members:				
	Shale, light gray.....		118.8	- 121.0
	Shale, light greenish gray.....		121.0	- 122.0
	Shale, reddish brown interbedded with greenish gray.....		122.0	- 130.0
	Shale, olive.....		130.0	- 131.0
	Shale, light gray.....		131.0	- 132.0
	Shale, light to medium gray.....		132.0	- 136.4
Nebraska City Member:				
	Limestone, medium to dark gray, very finely crystalline, impure; contains brachiopods, crinoids, and bryozoans.....		136.4	- 137.3
Root Formation:				
French Creek Member:				
	Coal, black.....		137.3	- 137.5
	Shale, light gray.....		137.5	- 140.0
	Coal, black.....		140.0	- 140.2
	Shale, light gray.....		140.2	- 143.0
	Sandstone, light gray, very fine grained, lime cemented, very finely micaceous.....		143.0	- 144.0
	Shale, medium gray, silty.....		144.0	- 152.0
	Shale, medium gray.....		152.0	- 156.3
Jim Creek Member:				
	Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....		156.3	- 158.0
Friedrich Member:				
	Shale, light greenish gray.....		158.0	- 163.0
	Shale, light gray.....		163.0	- 167.0

Test Hole 36-78

Location: Richardson County, SE corner SW sec. 35, T. 3 N., R. 13 E., approximately 85 feet north of south section line and 2,515 feet east of west section line.

Ground-level elevation: 1,071.0 feet above mean sea level.

Started: May 24, 1978. Completed: May 24, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Clay, yellowish brown, silty, sandy.....	0 -	2.5
Permian System - Big Blue Series - Admire Group:		
Hamlin Formation:		
Stine member:		
Limestone, dark brown, irregularly crystalline.	2.5 -	3.0
Shale, light gray.....	3.0 -	4.0
Limestone, light tannish gray, very finely crystalline.....	4.0 -	4.3
Shale, light greenish gray.....	4.3 -	5.0
Shale, light gray.....	5.0 -	6.0
Limestone, light gray, very finely crystalline; contains fossil fragments.....	6.0 -	6.2
Shale, olive mottled with gray and brown.....	6.2 -	9.5
Limestone, pale yellow, irregularly crystalline; contains algal material.....	9.5 -	9.6
Shale, gray mottled with red, brown, and olive.....	9.6 -	13.2
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains brachiopods and algal material.....	13.2 -	14.1
West Branch Formation:		
Shale, olive gray.....	14.1 -	15.5
Shale, medium gray.....	15.5 -	18.0
Shale, greenish gray.....	18.0 -	21.0
Shale, pale reddish brown.....	21.0 -	21.5
Shale, light greenish gray, limy.....	21.5 -	25.4
Shale, dark gray.....	25.4 -	27.2
Shale, light gray, limy.....	27.2 -	30.0
Shale, dark gray.....	30.0 -	31.0
Shale, medium gray.....	31.0 -	34.7
Falls City Formation:		
Lehmer Member:		
Limestone, light and medium gray, irregularly to very finely crystalline; contains pelecypods.	34.7 -	37.5
Reserve Member:		
Shale, dark gray.....	37.5 -	41.2

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Miles Member:		
Limestone, light to medium gray, irregularly crystalline; contains brachiopods.....	41.2	- 41.8
Onaga Formation:		
Hauxby-Towle Members:		
Shale, light greenish gray.....	41.8	- 47.0
Shale, light greenish gray interbedded with pale red.....	47.0	- 52.0
Shale, light greenish gray to light gray.....	52.0	- 54.0
Shale, reddish brown.....	54.0	- 58.0
Shale, greenish gray mottled with olive.....	58.0	- 59.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light greenish gray and yellow, very finely crystalline; contains brachiopods and glauconite.....	59.5	- 61.3
Pony Creek-Plumb Members:		
Shale, olive mottled with green and gray.....	61.3	- 68.0
Shale, reddish brown.....	68.0	- 76.0
Shale, olive.....	76.0	- 76.5
Shale, light to medium gray.....	76.5	- 79.0
Nebraska City Member:		
Limestone, medium to dark gray, finely crystalline, impure; contains brachiopods....	79.0	- 80.2
Root Formation:		
French Creek Member:		
Shale, light gray.....	80.2	- 80.7
Coal, black.....	80.7	- 81.2
Shale, light gray.....	81.2	- 85.0
Coal, black.....	85.0	- 85.3
Shale, light greenish gray.....	85.3	- 86.0
Shale, light gray, silty.....	86.0	- 92.0

Test Hole 37-78

Location: Richardson County, SE SW SW SE sec. 34, T. 3 N., R. 13 E., approximately 75 feet north of south section line and 2,040 feet west of east section line.

Ground-level elevation: 1,068.0 feet above mean sea level.

Started: May 24, 1968. Completed: May 24, 1978.

Total depth: 107.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 4.0
Clay, light brown, silty.....	4.0	- 7.0
Clay, reddish brown, silty.....	7.0	- 12.0
Clay, yellowish olive, silty.....	12.0	- 17.5
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Americus Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....	17.5	- 18.0
Admire Group:		
Hamlin Formation:		
Oaks-Stine Members:		
Shale, black.....	18.0	- 19.0
Shale, brownish olive.....	19.0	- 19.3
Shale, medium gray.....	19.3	- 23.0
Shale, light gray.....	23.0	- 24.0
Shale, light greenish gray.....	24.0	- 29.0
Shale, light greenish gray interbedded with pale red.....	29.0	- 32.0
Shale, light greenish gray, interbedded with siltstone, tan.....	32.0	- 36.0
Shale, light greenish gray.....	36.0	- 43.0
Shale, medium to dark gray.....	43.0	- 47.4
Limestone, light to medium gray, very finely crystalline; contains brachiopods.....	47.4	- 48.0
Shale, medium gray.....	48.0	- 50.5
Limestone, light to medium gray, very finely crystalline.....	50.5	- 52.2
Shale, greenish gray.....	52.2	- 54.0
Limestone, light gray, fine to very finely crystalline.....	54.0	- 54.5
Shale, gray interbedded with greenish gray.....	54.5	- 58.0
Shale, olive.....	58.0	- 61.7
Shale, medium gray.....	61.7	- 62.4
Five Point Formation:		
Limestone, white to light gray, irregularly crystalline; contains brachiopods and algal material.....	62.4	- 67.0
West Branch Formation:		
Shale, light greenish gray, interbedded with claystone, gray.....	67.0	- 69.5
Shale, light greenish gray.....	69.5	- 75.0
Shale, light to medium gray.....	75.0	- 84.2
Falls City Formation:		
Lehmer Member:		
Limestone, medium to dark gray, pebbly texture, porous.....	84.2	- 87.8
Reserve Member:		
Shale, medium to dark gray.....	87.8	- 92.0

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Miles Member:				
Limestone, light to medium gray, irregularly crystalline; contains brachiopods, crinoids, algal material, and black inclusions.....	92.0	-	93.2	
Onaga Formation:				
Hauxby-Towle Members:				
Shale, light greenish gray interbedded with pale red.....	93.2	-	97.0	
Shale, light greenish gray.....	97.0	-	102.0	
Shale, reddish brown.....	102.0	-	107.0	

Test Hole 38-78

Location: Pawnee County, SE SW SE sec. 1, T. 2 N., R. 12 E., approximately 15 feet north of south section line and 1,640 feet west of east section line.

Ground-level elevation: 1,107.0 feet above mean sea level.

Started: May 24, 1978. Completed: May 24, 1978.

Total depth: 100.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	0.5	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Wakarusa Formation:				
Limestone, yellowish brown, fine to very finely crystalline, highly weathered; contains brachiopods, crinoids, and fusulinids.....	0.5	-	3.5	
Burlingame-Soldier Creek Formations:				
Shale, olive yellow.....	3.5	-	8.0	
Shale, gray mottled with olive, red, and green.....	8.0	-	15.0	
Shale, light gray.....	15.0	-	20.0	
Shale, medium gray.....	20.0	-	26.5	
Taylor Branch Member:				
Limestone, bluish gray, irregularly crystalline; contains brachiopods and algal material.....	26.5	-	27.3	
Shale, light gray.....	27.3	-	28.0	
Limestone, light gray, very finely crystalline.....	28.0	-	28.8	
Shale, light greenish gray.....	28.8	-	29.0	
Shale, medium to dark gray.....	29.0	-	30.4	

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light tannish gray, dense; contains glauconite.....	30.4	32.0
Scranton Formation:		
Shale, light greenish gray, silty.....	32.0	34.0
Shale, light gray, silty.....	34.0	44.0
Shale, medium gray, silty interbedded with sandstone, gray, very fine grained, thin.....	44.0	66.0
Limestone, light tannish gray, very finely crystalline to dense.....	66.0	66.8
Shale, light greenish gray.....	66.8	73.0
Shale, reddish brown.....	73.0	76.0
Limestone, light tannish gray, very finely crystalline; contains brachiopods and fusulinids.....	76.0	77.3
Shale, olive.....	77.3	79.0
Shale, medium gray.....	79.0	92.0
Shale, medium gray, silty interbedded with sandstone, gray, very fine grained, thin.....	92.0	100.0

Test Hole 39-78

Location: Richardson County, SE corner NE, sec. 33, T. 3 N., R. 13 E., approximately 2,565 feet south of north section line and 10 feet west of east section line.

Ground-level elevation: 1,055.0 feet above mean sea level.

Started: May 25, 1978. Completed: May 25, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Road fill (no sample).....	0	4.0
Sand, very fine to medium silty.....	4.0	7.0
Clay, brown, silty, sandy.....	7.0	20.0
Permian(?) - Pennsylvanian(?) Systems:		
Shale, light gray, silty.....	20.0	25.0
Shale, light gray mottled with olive.....	25.0	30.0
Shale, light gray, silty, interbedded with sandstone, brown, very fine grained.....	30.0	35.0
Shale, light gray, silty.....	35.0	46.7
Sandstone, light gray, very fine grained, lime cemented, interbedded with silt, gray.....	46.7	49.6
Shale, light gray, silty interbedded with sandstone, gray, very fine grained.....	49.6	70.2

Description	Depth, in feet	
	From	To
Sandstone, medium gray, fine to medium grained; contains black carbonaceous material.....	70.2	- 73.0
Coal, black.....	73.0	- 73.2
Shale, light gray.....	73.2	- 74.0
Shale, medium gray.....	74.0	- 79.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Maple Hill Member:		
Limestone, light to medium gray, irregularly crystalline; contains brachiopods, crinoids, fusulinids, and pyrite.....	79.0	- 81.0
Wamego Member:		
Coal, black.....	81.0	- 82.0
Shale, light gray.....	82.0	- 86.0
Shale, light to medium gray.....	86.0	- 92.0

Test Hole 40-78

Location: Richardson County, SE corner SW sec. 27, T. 3 N., R. 13 E., approximately 10 feet north of south section line and 2,900 feet west of east section line.

Ground-level elevation: 1,113.0 feet above mean sea level.

Started: May 25, 1978. Completed: May 25, 1978.

Total depth: 107.0 feet.

Description	Depth, in feet	
	From	To
Quaternary System:		
Soil (no sample).....	0	- 2.0
Silt, yellowish brown, sandy.....	2.0	- 9.6
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Long Creek Member:		
Limestone, yellow, very finely crystalline, highly weathered.....	9.6	- 10.0
Hughes Creek Member:		
Shale, yellow.....	10.0	- 17.0
Shale, yellowish olive.....	17.0	- 22.5
Shale, light gray.....	22.5	- 24.4
Limestone, medium to dark gray, very finely crystalline; contains brachiopods.....	24.4	- 25.0
Shale, black.....	25.0	- 27.0
Shale, light to medium gray.....	27.0	- 27.5

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light gray, finely crystalline; contains brachiopods and fusulinids.....	27.5	29.0
Shale, medium gray.....	29.0	32.0
Shale, medium gray, interbedded with limestone, gray, irregularly crystalline; contains brachiopods.....	32.0	35.0
Limestone, light gray, irregularly crystalline; contains brachiopods, interbedded with shale, medium gray.....	35.0	39.0
Shale, medium to dark gray.....	39.0	42.0
Limestone, bluish gray, pebbly texture; contains brachiopods, crinoids, and algal material.....	42.0	42.8
Shale, medium gray.....	42.8	50.6
Americus Member:		
Limestone, dark gray, irregularly crystalline, impure; contains brachiopods and crinoids....	50.6	51.5
Shale, light gray.....	51.5	52.0
Limestone, medium to dark gray, irregularly crystalline; contains brachiopods and crinoids.....	52.0	53.0
Shale, dark gray to black.....	53.0	53.8
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	53.8	54.1
Admire Group:		
Hamlin Formation:		
Shale, dark gray.....	54.1	57.5
Shale, light gray, limy.....	57.5	62.0
Shale, greenish gray, limy.....	62.0	63.0
Shale, pale red, limy.....	63.0	65.0
Shale, light greenish gray, limy.....	65.0	70.0
Shale, pale reddish brown, limy.....	70.0	70.7
Shale, light gray to light greenish gray.....	70.7	74.0
Shale, medium gray.....	74.0	82.0
Shale, medium gray, limy.....	82.0	85.9
Limestone, light gray, very finely crystalline.....	85.9	88.0
Shale, light gray to light greenish gray.....	88.0	90.0
Shale, light gray interbedded with olive.....	90.0	92.0
Shale, medium to dark gray.....	92.0	93.5
Five Point Formation:		
Limestone, cream, finely crystalline; contains brachiopods and crinoids.....	93.5	94.0
West Branch Formation:		
Shale, olive gray.....	94.0	98.0
Shale, pale red.....	98.0	98.4
Shale, greenish gray.....	98.4	100.0
Limestone, cream, very finely crystalline; contains glauconite.....	100.0	100.5
Shale, greenish gray.....	100.5	101.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, greenish gray interbedded with pale red.....	101.0	104.0
Shale, greenish gray.....	104.0	105.0
Shale, light to medium gray.....	105.0	107.0

Test Hole 41-78

Location: Richardson County, SW corner sec. 26, T. 3 N., R. 13 E., approximately 20 feet north of south section line and 100 feet east of west section line.

Ground-level elevation: 1,142.0 feet above mean sea level.

Started: May 25, 1978. Completed: May 25, 1978.

Total depth: 152.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	2.0
Clay, light brown.....	2.0	9.0
Clay, reddish brown, silty.....	9.0	14.0
Clay, reddish brown, silty, sandy.....	14.0	17.0
Sand, medium to coarse.....	17.0	36.5
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Hughes Creek Member:		
Limestone, medium gray, very finely crystalline, impure; contains brachiopods.....	36.5	37.0
Shale, medium gray.....	37.0	40.5
Limestone, medium gray, finely crystalline; contains crinoids.....	40.5	41.0
Shale, light to medium gray, limy.....	41.0	46.0
Shale, medium to dark gray.....	46.0	50.0
Limestone, medium to dark gray, finely crystalline; contains brachiopods and crinoids.....	50.0	52.0
Shale, light to medium gray.....	52.0	59.3
Shale, medium gray, limy.....	59.3	61.0
Americus Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods and crinoids.....	61.0	61.7
Shale, dark gray.....	61.7	62.5
Limestone, medium to dark gray, irregularly crystalline; contains brachiopods and crinoids, interbedded with shale, black.....	62.5	63.0

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Admire Group:				
Hamlin Formation:				
Oaks Member:				
Shale, medium gray.....	63.0	-	66.0	
Shale, greenish gray.....	66.0	-	70.0	
Shale, light gray interbedded with pale red, limy.....	70.0	-	75.0	
Shale, light greenish gray to cream, limy.....	75.0	-	78.0	
Houchens Creek Member:				
Limestone, light tannish gray, very finely crystalline.....	78.0	-	79.5	
Stine Member:				
Shale, light gray.....	79.5	-	83.0	
Shale, light to medium gray.....	83.0	-	88.0	
Shale, medium to dark gray.....	88.0	-	93.0	
Limestone, light to medium gray, very finely crystalline; contains brachiopods.....	93.0	-	93.5	
Shale, light gray.....	93.5	-	96.0	
Limestone, light gray, very finely crystalline.....	96.0	-	97.0	
Shale, light gray.....	97.0	-	97.5	
Limestone, light gray, very finely crystalline.....	97.5	-	99.5	
Shale, medium gray.....	99.5	-	101.0	
Five Point Formation:				
Limestone, cream, irregularly crystalline.....	101.0	-	101.8	
West Branch Formation:				
Shale, light gray.....	101.8	-	108.0	
Shale, light greenish gray interbedded with pale red, limy.....	108.0	-	111.0	
Shale, light to medium gray.....	111.0	-	113.6	
Shale, light gray, limy.....	113.6	-	115.0	
Shale, medium gray.....	115.0	-	122.0	
Falls City Formation:				
Lehmer Member:				
Limestone, gray, very finely crystalline.....	122.0	-	124.5	
Reserve Member:				
Shale, light gray.....	124.5	-	129.0	
Miles Member:				
Limestone, light to medium gray, irregularly crystalline; contains black inclusions.....	129.0	-	131.0	
Onaga Formation:				
Hausby-Towle Members:				
Shale, light greenish gray, limy.....	131.0	-	134.0	
Shale, light greenish gray interbedded with pale red.....	134.0	-	138.0	
Shale, reddish brown.....	138.0	-	143.0	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light gray and greenish gray, very finely crystalline; contains brachiopods and glauconite.....	143.0	145.0
Pony Creek-Plumb Members:		
Shale, olive.....	145.0	147.0
Shale, reddish brown.....	147.0	152.0

Test Hole 42-78

Location: Richardson County, NE corner NW sec. 35, T. 3 N., R. 13 E., approximately 15 feet south of north section line and 2,695 feet west of east section line.

Ground-level elevation: 1,112.0 feet above mean sea level.

Started: May 26, 1978. Completed: May 26, 1978.

Total depth: 152.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	5.0
Silt, yellowish brown, silty, sandy.....	5.0	10.0
Sandstone, yellowish brown, very fine grained, highly weathered.....	10.0	15.3
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Long Creek Member:		
Limestone, yellow, irregularly crystalline, porous, vuggy.....	15.3	16.0
Silt, yellow.....	16.0	19.5
Limestone, pale yellow, very finely crystalline.....	19.5	20.0
Hughes Creek Member:		
Shale, light gray.....	20.0	25.0
Shale, medium gray.....	25.0	29.5
Shale, light gray.....	29.5	33.0
Limestone, medium to dark gray, finely crystalline; contains brachiopods.....	33.0	33.6
Shale, black.....	33.6	36.0
Limestone, light to medium gray, finely to very finely crystalline; contains brachiopods.....	36.0	37.0
Shale, light gray.....	37.0	40.0

Description	Depth, in feet	
	From	To
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	40.0	40.4
Shale, light gray.....	40.4	42.0
Limestone, medium gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....	42.0	42.6
Shale, light gray.....	42.6	43.5
Limestone, medium gray, finely crystalline; contains brachipods.....	43.5	44.9
Shale, dark gray.....	44.9	49.0
Limestone, bluish gray, irregularly crystal- line; pebbly texture; contains brachiopods and algal material.....	49.0	51.0
Shale, medium to dark gray.....	51.0	56.0
Shale, dark gray.....	56.0	59.0
Americus Member:		
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	59.0	60.2
Shale, black.....	60.2	61.0
Limestone, medium gray, irregularly crystalline; contains brachiopods and algal material.....	61.0	61.2
Admire Group:		
Hamlin Formation:		
Oaks Member:		
Shale, medium gray.....	61.2	65.0
Shale, greenish gray.....	65.0	69.5
Shale, light gray interbedded with pale red....	69.5	72.0
Shale, light greenish gray.....	72.0	76.0
Houchens Creek Member:		
Limestone, tannish gray, very finely crystalline.....	76.0	77.0
Stine Member:		
Shale, light gray to greenish gray, silty.....	77.0	80.0
Shale, medium gray.....	80.0	87.0
Shale, dark gray.....	87.0	88.0
Shale, light gray, limy.....	88.0	90.0
Shale, medium gray, silty.....	90.0	92.0
Shale, light gray, limy.....	92.0	94.5
Gypsum, white.....	94.5	95.8
Shale, light gray to greenish gray.....	95.8	98.0
Shale, olive.....	98.0	100.0
Shale, medium gray.....	100.0	102.0
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains brachiopods and algal material.....	102.0	104.0
West Branch Formation:		
Shale, light gray.....	104.0	108.0
Shale, greenish gray.....	108.0	109.0
Shale, light greenish gray interbedded pale red, limy.....	109.0	114.0
Shale, dark gray to black.....	114.0	115.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light gray, limy.....	115.0	- 120.0
Shale, light gray.....	120.0	- 123.0
Falls City Formation:		
Lehmer Member:		
Limestone, gray, very finely crystalline, oolitic.....	123.0	- 126.0
Reserve Member:		
Shale, medium to light gray.....	126.0	- 130.0
Miles Member:		
Limestone, bluish gray, finely crystalline, pebbly texture; contains black inclusions....	130.0	- 132.0
Onaga Formation:		
Hauxby-Towle Members:		
Shale, greenish gray.....	132.0	- 135.0
Shale, medium gray interbedded with pale red...	135.0	- 137.0
Shale, light gray interbedded with greenish gray, limy.....	137.0	- 139.0
Limestone, cream, very finely crystalline.....	139.0	- 140.0
Shale, reddish brown.....	140.0	- 145.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, pale yellowish gray, finely to very finely crystalline; contains brachiopods and crinoids.....	145.5	- 147.5
Pony Creek-Plumb Members:		
Shale, light gray.....	147.5	- 148.0
Shale, olive.....	148.0	- 149.5
Shale, light gray mottled with red.....	149.5	- 150.0
Shale, light greenish gray.....	150.0	- 152.0

Test Hole 43-78

Location: Richardson County, SW NW SW sec. 35, T. 3 N., R. 13 E.,
approximately 1,700 feet north of south section line and
20 feet east of west section line.

Ground-level elevation: 1,110.0 feet above mean sea level.

Started: May 26, 1978. Completed: May 26, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	1.0
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Long Creek Member:		
Limestone, yellow, very finely to irregularly crystalline, porous, vuggy.....	1.0	2.0
Shale, yellow.....	2.0	6.0
Limestone, pale yellow, irregularly crystalline.....	6.0	7.5
Hughes Creek Member:		
Shale, yellow brown.....	7.5	10.0
Shale, olive yellow.....	10.0	14.0
Shale, medium gray.....	14.0	17.0
Shale, olive.....	17.0	21.2
Limestone, medium to dark gray, very finely crystalline; contains brachiopods.....	21.2	21.7
Shale, black.....	21.7	23.0
Shale, medium gray.....	23.0	24.0
Limestone, light to medium gray, fine crystalline; contains brachiopods.....	24.0	26.0
Shale, medium gray.....	26.0	28.5
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	28.5	29.5
Shale, medium gray.....	29.5	32.0
Limestone, medium gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....	32.0	33.0
Shale, light gray, limy.....	33.0	35.0
Shale, medium to dark gray.....	35.0	39.0
Limestone, bluish gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....	39.0	41.0
Shale, medium to dark gray.....	41.0	48.4
Americus Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods, crinoids, and algal material.....	48.4	49.1
Shale, black.....	49.1	50.0
Limestone, dark gray, finely crystalline; contains brachiopods and crinoids.....	50.0	50.1
Admire Group:		
Hamlin Formation:		
Oaks-Stine Members:		
Shale, medium gray.....	50.1	54.0
Shale, greenish gray.....	54.0	58.0
Shale, greenish gray interbedded with pale red.....	58.0	61.0
Shale, greenish gray, interbedded with limestone, tan, dense.....	61.0	66.0

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light greenish gray, silty.....	66.0	- 70.0
Shale, light to medium gray.....	70.0	- 74.0
Shale, medium to dark gray.....	74.0	- 78.0
Limestone, light brownish gray, very finely crystalline.....	78.0	- 78.4
Shale, light gray.....	78.4	- 81.0
Limestone, light brownish gray, very finely crystalline.....	81.0	- 82.3
Shale, light greenish gray.....	82.3	- 83.7
Limestone, light tannish gray, very finely crystalline; contains fossil fragments.....	83.7	- 84.1
Shale, light greenish gray.....	84.1	- 84.6
Shale, medium gray.....	84.6	- 85.0
Shale, greenish gray mottled with olive.....	85.0	- 87.0
Limestone, cream, irregularly crystalline.....	87.0	- 89.0
Shale, pale reddish brown.....	89.0	- 91.0
Shale, dark gray.....	91.0	- 92.0

Test Hole 44-78

Location: Richardson County, SW corner NE sec. 10, T. 2 N., R. 13 E., approximately 2,440 feet south of north section line and 2,665 feet east of west section line.

Ground-level elevation: 980.0 feet above mean sea level.

Started: May 30, 1978. Completed: May 30, 1978.

Total depth: 152.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 10.0
Silt, dark brown, clayey.....	10.0	- 16.0
Silt, light brown, clayey.....	16.0	- 21.0
Silt, dark gray to dark brown.....	21.0	- 31.0
Silt, dark greenish gray.....	31.0	- 36.0
Sand, medium to coarse and gravel, very fine to medium.....	36.0	- 40.0
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Hughes Creek Member:		
Shale, black.....	40.0	- 41.0
Shale, medium gray.....	41.0	- 42.7

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light to medium gray, very finely crystalline; contains brachiopods, fusulinids, and pelecypods.....	42.7	- 44.0
Shale, medium gray, interbedded with sandstone, gray, very fine grained.....	44.0	- 54.0
Shale, dark gray.....	54.0	- 59.0
Shale, medium to dark gray.....	59.0	- 66.0
Americus Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods, crinoids, and pelecypods.....	66.0	- 68.3
Shale, black.....	68.3	- 69.0
Shale, medium gray.....	69.0	- 72.8
Admire Group:		
Hamlin Formation:		
Oaks-Stine Members:		
Limestone, medium to dark gray, finely crystalline, interbedded with shale, greenish gray..	72.8	- 73.1
Shale, greenish gray, limy.....	73.1	- 77.0
Shale, greenish gray to medium gray.....	77.0	- 80.0
Shale, light gray interbedded with pale red; contains gypsum.....	80.0	- 85.0
Shale, light greenish gray, interbedded with claystone, tan.....	85.0	- 88.0
Shale, light to medium gray.....	88.0	- 92.0
Shale, medium to dark gray.....	92.0	- 96.0
Limestone, medium gray, very finely crystalline; contains fossil fragments, interbedded with shale, greenish gray.....	96.0	- 100.5
Limestone, light tannish gray, very finely crystalline.....	100.5	- 101.0
Shale, medium to dark gray.....	101.0	- 105.0
Shale, olive.....	105.0	- 107.0
Shale, medium to dark gray.....	107.0	- 109.0
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains algal material.....	109.0	- 109.3
West Branch Formation:		
Shale, medium gray.....	109.3	- 112.5
Shale, greenish gray.....	112.5	- 113.0
Shale, medium to dark gray interbedded with pale red.....	113.0	- 117.0
Shale, medium gray, limy.....	117.0	- 122.0
Shale, medium gray.....	122.0	- 128.7
Falls City Formation:		
Lehmer Member:		
Limestone, gray, very finely crystalline, porous; contains gypsum.....	128.7	- 131.0
Reserve Member:		
Shale, medium gray.....	131.0	- 133.3

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Miles Member:				
Limestone, light gray, very finely crystalline, interbedded with shale, greenish gray.....	133.3	-	134.5	
Onaga Formation:				
Shale, greenish gray, limy.....	134.5	-	139.0	
Shale, greenish gray interbedded with pale red.....	139.0	-	141.0	
Shale, light greenish gray.....	141.0	-	144.0	
Shale, reddish brown.....	144.0	-	149.6	
Shale, light gray mottled with olive.....	149.6	-	152.0	

Test Hole 45-78

Location: Richardson County, NW NE NE sec. 3, T. 2 N., R. 13 E.,
approximately 20 feet south of north section line and
780 feet west of east section line.

Ground-level elevation: 1,068.0 feet above mean sea level.

Started: May 30, 1978. Completed: May 30, 1978.

Total depth: 100.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	1.0	
Permian System - Big Blue Series - Admire Group:				
Hamlin Formation:				
Oaks-Stine Members:				
Shale, greenish gray.....	1.0	-	3.0	
Shale, reddish brown.....	3.0	-	4.0	
Shale, yellowish brown.....	4.0	-	10.0	
Shale, yellowish brown interbedded with greenish gray.....	10.0	-	12.0	
Shale, pale olive.....	12.0	-	15.0	
Shale, light to medium gray.....	15.0	-	20.0	
Shale, medium to dark gray.....	20.0	-	24.0	
Limestone, medium gray, very finely crystalline; contains brachiopods.....	24.0	-	24.5	
Shale, medium gray.....	24.5	-	26.8	
Limestone, light to medium gray, very finely crystalline.....	26.8	-	29.0	
Shale, greenish gray.....	29.0	-	29.5	
Limestone, light gray, very finely crystalline; contains fossil fragments.....	29.5	-	30.2	
Shale, olive.....	30.2	-	34.0	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium to dark gray.....	34.0	- 36.2
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains algal material.....	36.2	- 37.0
West Branch Formation:		
Shale, light gray.....	37.0	- 41.0
Shale, greenish gray.....	41.0	- 45.0
Shale, light greenish gray interbedded with pale red.....	45.0	- 48.0
Shale, medium gray, interbedded with claystone, tan.....	48.0	- 54.0
Shale, light gray.....	54.0	- 58.0
Falls City Formation:		
Lehmer Member:		
Limestone, medium to dark gray, irregularly crystalline; contains fossil fragments.....	58.0	- 61.0
Reserve Member:		
Shale, medium gray.....	61.0	- 65.1
Miles Member:		
Limestone, light to medium gray, irregularly crystalline, impure; contains brachiopods....	65.1	- 66.0
Onaga Formation:		
Hauxby-Towle Members:		
Shale, light greenish gray, limy.....	66.0	- 70.0
Shale, light greenish gray interbedded with pale red.....	70.0	- 75.0
Shale, reddish brown.....	75.0	- 81.0
Shale, greenish gray interbedded with olive....	81.0	- 82.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Wood Siding Formation:		
Brownville Member:		
Limestone, light greenish gray, very finely crystalline; contains brachiopods and glauconite.....	82.0	- 84.0
Pony Creek-Plumb Members:		
Shale, olive.....	84.0	- 87.0
Sandstone, yellowish brown, very fine grained..	87.0	- 87.5
Shale, greenish gray interbedded with pale red.....	87.5	- 90.0
Shale, reddish brown.....	90.0	- 99.0
Shale, olive.....	99.0	- 100.0

Test Hole 46-78

Location: Richardson County, NW corner NE sec. 4, T. 2 N., R. 13 E., approximately 15 feet south of north section line and 2,565 feet west of east section line.

Ground-level elevation: 1,005.0 feet above mean sea level.

Started: May 30, 1978. Completed: May 30, 1978.

Total depth: 92.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 3.0
Clay, reddish brown, silty.....	3.0	- 9.0
Silt, brownish gray, sandy.....	9.0	- 10.0
Sand, fine to very coarse, and gravel, very fine to fine.....	10.0	- 23.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Wamego Group:		
Shale, yellowish brown.....	23.0	- 24.0
Shale, light gray.....	24.0	- 32.0
Shale, medium gray.....	32.0	- 37.0
Shale, greenish gray.....	37.0	- 37.3
Tarkio Member:		
Limestone, cream, irregularly crystalline; contains fusulinids, <u>Osagia</u> , pseudo-oolites, and glauconite.....	37.3	- 41.6
Willard Formation:		
Shale, reddish brown.....	41.6	- 42.7
Shale, greenish gray, silty.....	42.7	- 47.0
Shale, medium gray.....	47.0	- 62.0
Shale, medium gray, interbedded with siltstone, gray.....	62.0	- 67.0
Shale, medium gray.....	67.0	- 75.0
Emporia Formation:		
Elmont Member:		
Limestone, light to medium bluish gray, finely to very finely crystalline; contains brachiopods and crinoids.....	75.0	- 77.1
Shale, light gray.....	77.1	- 79.0
Limestone, light tannish gray, very finely crystalline to dense.....	79.0	- 79.5
Shale, light greenish gray.....	79.5	- 81.0
Limestone, light greenish gray to tannish gray, very finely crystalline.....	81.0	- 81.6

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Harveyville Member:				
Shale, greenish gray.....	81.6	-	84.4	
Shale, medium gray.....	84.4	-	84.8	
Reading Member:				
Limestone, bluish gray, fine to very finely crystalline; contains brachiopods, crinoids, and pyrite.....	84.8	-	86.7	
Shale, medium gray.....	86.7	-	89.0	
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	89.0	-	90.2	
Auburn Formation:				
Shale, greenish gray to light gray.....	90.2	-	92.0	

Test Hole 47-78

Location: Richardson County, NE corner sec. 33, T. 3 N., R. 13 E., approximately 15 feet south of north section line and 80 feet west of east section line.

Ground-level elevation: 1,101.0 feet above mean sea level.

Started: May 30, 1978. Completed: May 30, 1978.

Total depth: 137.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Silt, reddish brown, clayey, sandy.....	2.0	-	7.0	
Silt, reddish brown, sandy.....	7.0	-	11.0	
Sand, fine to very coarse, and gravel, very fine to medium, interbedded with silt, brown.	11.0	-	16.0	
Silt, light brown, clayey.....	16.0	-	26.0	
Silt, light tan, clayey.....	26.0	-	62.5	
Permian(?) - Pennsylvanian(?) Systems:				
Shale, medium gray.....	62.5	-	67.0	
Shale, medium gray, silty.....	67.0	-	70.9	
Sandstone, light gray, very fine to fine grained, lime cemented; contains black carbonaceous material.....	70.9	-	72.0	
Shale, light gray, silty.....	72.0	-	77.0	
Shale, light gray, silty, interbedded with sandstone, gray, very fine grained.....	77.0	-	82.0	
Shale, light gray, silty.....	82.0	-	116.0	
Sandstone, light gray, very fine to fine grained; contains pyrite.....	116.0	-	116.4	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light gray, silty.....	116.4	127.0
Shale, light gray, silty; contains trace of coal.....	127.0	132.8
Sandstone, light gray, very fine to fine grained, lime cemented; contains pyrite.....	132.8	133.9
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Coal, black.....	133.9	134.8
Shale, light gray.....	134.8	137.0

Test Hole 48-78

Location: Richardson County, NE corner sec. 35, T. 3 N., R. 13 E., approximately 15 feet south of north section line and 190 feet west of east section line.

Ground-level elevation: 1,153.0 feet above mean sea level.

Started: June 5, 1978. Completed: June 5, 1978.

Total depth: 137.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	3.0
Sand, very fine to very coarse, and gravel, very fine to medium.....	3.0	22.0
Sand, very fine to fine, silty.....	22.0	32.0
Silt, yellowish brown, sandy.....	32.0	48.0
Silt, medium gray and yellowish brown, sandy..	48.0	55.0
Permian System - Big Blue Series - Council Grove Group:		
Crouse Formation:		
Limestone, cream, irregularly crystalline, contains brachiopods and algal material.....	55.0	56.7
Easley Creek Formation:		
Shale, light gray, silty.....	56.7	60.0
Shale, light olive gray.....	60.0	63.0
Shale, reddish brown.....	63.0	64.0
Shale, light greenish gray.....	64.0	64.5
Shale, reddish brown.....	64.5	66.0
Shale, greenish gray.....	66.0	66.5
Shale, reddish brown.....	66.5	70.0
Shale, olive gray, silty.....	70.0	72.0

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Bader Formation:		
Middleburg Member:		
Limestone, yellow, coarse to very finely crystalline, porous.....	72.0	74.0
Hooser Member:		
Shale, light gray to olive gray.....	74.0	77.0
Shale, white to light gray, interbedded with sandstone, light gray, very fine grained.....	77.0	79.0
Shale, gray interbedded with green, red and olive.....	79.0	84.9
Eiss Member:		
Limestone, white, very finely crystalline, porous.....	84.9	87.3
Shale, light olive.....	87.3	89.0
Shale, medium gray.....	89.0	94.5
Limestone, medium gray, finely to very finely crystalline; contains brachiopods.....	94.5	96.3
Stearns Formation:		
Shale, light gray and greenish gray.....	96.3	102.0
Shale, reddish brown.....	102.0	105.0
Shale, cream, limy.....	105.0	108.0
Beattie Formation:		
Morrill-Florena Members:		
Limestone, light tannish gray, very finely crystalline.....	108.0	108.6
Shale, light gray to white.....	108.6	109.0
Limestone, light tannish gray, very finely crystalline; contains gypsum.....	109.0	111.0
Cottonwood Member:		
Limestone, cream to light gray, finely to irregularly crystalline; contains fusulinids...	111.0	122.5
Eskridge Formation:		
Shale, pale red interbedded with gray.....	122.5	128.0
Shale, greenish gray.....	128.0	137.0

Test Hole 49-78

Location: Richardson County, SW corner NW sec. 26, T. 3 N., R. 13 E., approximately 2,635 feet south of north section line and 20 feet east of west section line

Ground-level elevation: 1,145.0 feet above mean sea level.

Started: June 6, 1978. Completed: June 6, 1978.

Total depth: 152.0 feet.

<u>Description</u>	<u>Depth, to feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	2.0
Silt, brown, clayey.....	2.0 -	9.0
Silt, reddish brown, sandy.....	9.0 -	14.0
Sand, medium to very coarse and gravel, very fine to coarse, interbedded with clay, brown.....	14.0 -	25.0
Sand, medium to very coarse, and gravel, very fine to coarse.....	25.0 -	53.0
Permian System - Big Blue Series - Council Grove Group:		
Red Eagle Formation:		
Bennett Member:		
Shale, pale yellow, sandy, silty.....	53.0 -	55.0
Shale, black.....	55.0 -	59.7
Glenrock Member:		
Limestone, pale yellow, very finely crystalline.....	59.7 -	60.2
Shale, light gray, limy.....	60.2 -	62.0
Johnson Formation:		
Shale, yellowish olive.....	62.0 -	74.5
Foraker Formation:		
Long Creek Member:		
Limestone, yellowish brown, irregularly to very finely crystalline, porous, vuggy; contains algal material.....	74.5 -	80.0
Hughes Creek Member:		
Shale, pale yellow, interbedded with limestone, yellow, dense.....	80.0 -	84.0
Shale, light to medium gray.....	84.0 -	92.0
Shale, light gray.....	92.0 -	96.5
Limestone, medium to dark gray, finely crystalline; contains brachiopods.....	96.5 -	97.5
Shale, black.....	97.5 -	100.0
brachiopods and fusulinids.....	100.0 -	101.2
Shale, medium gray.....	101.2 -	104.0
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	104.0 -	104.5
Shale, light gray.....	104.5 -	106.0
Limestone, medium gray, finely crystalline; contains brachiopods and crinoids.....	106.0 -	109.3
Shale, medium gray.....	109.3 -	113.5
Limestone, medium gray, finely crystalline; contains brachiopods and algal material.....	113.5 -	115.5
Shale, medium gray.....	115.5 -	124.5
Americus Member:		
Limestone, bluish gray, irregularly crystalline; contains brachiopods and crinoids.....	124.5 -	125.0
Shale, black.....	125.0 -	125.5
Limestone, light to medium gray, finely crystal- line; contains brachiopods and crinoids.....	125.5 -	126.0

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Admire Group:			
Hamlin Formation:			
Oaks-Stine Members:			
	Shale, medium to dark gray.....	126.0	- 129.4
	Shale, light gray, limy.....	129.4	- 130.3
	Shale, greenish gray, limy.....	130.3	- 135.0
	Shale, greenish gray interbedded with pale red.....	135.0	- 139.0
	Shale, light tan to cream.....	139.0	- 143.0
	Shale, light tan to cream, interbedded with siltstone, tan.....	143.0	- 146.0
	Shale, medium gray.....	146.0	- 149.0
	Shale, olive gray.....	149.0	- 152.0

Test Hole 50-78

Location: Richardson County, NE corner NW sec. 32, T. 3 N., R. 13 E., approximately 20 feet south of north section line and 2,560 feet east of west section line.

Ground-level elevation: 1,085.0 feet above mean sea level.

Started: June 6, 1978. Completed: June 6, 1978.

Total depth: 152.0 feet.

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Quaternary System:			
	Soil (no sample).....	0	- 2.0
	Silt, reddish brown, clayey.....	2.0	- 7.0
	Silt, pale brown, sandy.....	7.0	- 15.0
	Sand, medium to coarse, and gravel, very fine to fine.....	15.0	- 16.0
	Clay, light brown.....	16.0	- 29.0
	No sample, lost circulation.....	29.0	- 42.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:			
Willard Formation:			
	Shale, pale olive, interbedded with siltstone, olive.....	42.0	- 44.0
	Shale, medium gray, silty.....	44.0	- 47.0
	Shale, medium gray mottled with olive.....	47.0	- 62.0
	Shale, light gray.....	62.0	- 72.0

	<u>Depth, to feet</u>	
	<u>From</u>	<u>To</u>
Emporia Formation:		
Elmont Member:		
Limestone, brownish gray, very finely crystalline, contains brachiopods, fusulinids, and pyrite..	72.0	- 74.3
Shale, medium to light gray.....	74.3	- 76.3
Claystone, light gray.....	76.3	- 77.0
Limestone, light tannish gray, very finely crystalline.....	77.0	- 77.5
Claystone, light greenish gray.....	77.5	- 78.5
Limestone, light gray, very finely crystalline.....	78.5	- 79.3
Harveyville Member:		
Shale, greenish gray.....	79.3	- 79.7
Shale, medium gray.....	79.7	- 81.3
Reading Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....	81.3	- 84.5
Shale, medium gray.....	84.5	- 85.5
Limestone, light gray, irregularly crystalline; contains brachiopods, crinoids, and pyrite...	85.5	- 86.5
Auburn Formation:		
Shale, medium gray.....	86.5	- 88.0
Shale, greenish gray.....	88.0	- 91.3
Shale, dark reddish brown.....	91.3	- 94.0
Shale, reddish brown mottled with green and brown.....	94.0	- 95.3
Shale, greenish gray, interbedded with limestone, greenish brown, dense.....	95.3	- 102.0
Shale, light gray.....	102.0	- 107.0
Shale, medium gray.....	107.0	- 117.2
Wakarusa Formation:		
Limestone, light to medium gray, irregularly crystalline; contains brachiopods, crinoids, fusulinids, and pyrite, interbedded with shale, gray.....	117.2	- 121.3
Soldier Creek Formation:		
Shale, light gray.....	121.3	- 128.0
Burlingame Formation:		
South Fork Member:		
Limestone, tan, very finely crystalline to dense.....	128.0	- 129.0
Shale, light greenish gray.....	129.0	- 130.8
Limestone, cream, irregularly crystalline; contains <u>Osagia</u> , oolites, and algal material.....	130.8	- 132.5
Winnebago Member:		
Shale, light greenish gray, interbedded with limestone, tan dense.....	132.5	- 138.0
Taylor Branch Member:		
Limestone, medium to dark gray, very finely crystalline to dense; contains bryozoans.....	138.0	- 138.4

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, light gray.....	138.4	- 139.0
Limestone, medium gray, very finely crystalline to dense.....	139.0	- 141.0
Shale, light gray.....	141.0	- 147.0
Shale, medium gray.....	147.0	- 150.0
Limestone, dark gray, irregularly crystalline; contains algal material and brachiopods.....	150.0	- 152.0

Test Hole 51-78

Location: Pawnee County, SE corner sec. 24, T. 3 N., R. 12 E., approximately 150 feet north of south section line and 60 feet west of east section line.

Ground-level elevation: 1,074.0 feet above mean sea level.

Started: June 7, 1978. Completed: June 7, 1978.

Total depth: 182.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 3.0
Silt, brown, clayey.....	3.0	- 17.0
Silt, medium gray.....	17.0	- 27.0
Silt, medium gray, sandy.....	27.0	- 32.0
Sand, fine to very coarse and gravel, very fine to medium.....	32.0	- 36.0
Silt, medium gray, sandy.....	36.0	- 62.0
Silt, light gray.....	62.0	- 96.0
Sand, fine to very coarse and gravel very fine to medium.....	96.0	- 107.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Scranton Formation:		
White Cloud Member:		
Shale, light to medium gray.....	107.0	- 122.0
Limestone, brownish gray, very finely crystalline to dense.....	122.0	- 122.1
Shale, light to medium gray.....	122.1	- 155.0
Howard Formation:		
Limestone, medium to dark bluish gray, irregularly crystalline; contains brachiopods, crinoids, fusulinids, and pyrite.....	155.0	- 160.0

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Severy Formation:				
Shale, black.....	160.0	-	161.0	
Shale, light gray, silty.....	161.0	-	162.0	
Shale, black.....	162.0	-	163.0	
Coal, black.....	163.0	-	164.0	
Shale, light gray.....	164.0	-	167.0	
Sandstone, light gray, very fine grained, interbedded with shale, light gray.....	167.0	-	168.2	
Shale, light gray, silty, sandy.....	168.2	-	172.0	
Shale, light to medium gray, silty.....	172.0	-	182.0	

Test Hole 52-78

Location: Richardson County, NE corner sec. 30, T. 3 N., R. 13 E., approximately 90 feet south of north section line and 15 feet west of east section line.

Ground-level elevation: 1,125.0 feet above mean sea level.

Started: June 8, 1978. Completed: June 8, 1978.

Total depth: 197.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Silt, reddish brown, clayey.....	2.0	-	7.0	
Silt, reddish brown, sandy.....	7.0	-	12.0	
Silt, brown, clayey, sandy.....	12.0	-	52.0	
Silt, medium gray.....	52.0	-	62.0	
Silt, brownish gray.....	62.0	-	67.0	
Silt, light gray, sandy.....	67.0	-	72.0	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Soldier Creek Formation:				
Shale, greenish gray interbedded with olive....	72.0	-	78.0	
Burlingame Formation:				
South Fork Member:				
Limestone, light gray to cream, finely crystal- line, porous; contains crinoids, interbedded with shale, red and green.....	78.0	-	85.0	
Winnebago Member:				
Shale, brown.....	85.0	-	86.0	
Shale, medium gray.....	86.0	-	92.0	
Shale, medium to dark gray.....	92.0	-	97.0	

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Taylor Branch Member:				
Limestone, dark gray, irregularly crystalline; contains algal material.....	97.0	-	98.0	
Shale, medium gray.....	98.0	-	98.5	
Limestone, light gray, very finely crystalline.....	98.5	-	99.3	
Shale, medium gray.....	99.3	-	101.8	
Limestone, light tannish gray, finely crystalline to dense.....	101.8	-	103.0	
Scranton Formation:				
Cedarvale-White Cloud Members:				
Shale, medium to light gray.....	103.0	-	107.0	
Shale, medium gray, silty.....	107.0	-	112.0	
Shale, medium gray, silty, interbedded with sandstone, gray, very fine grained.....	112.0	-	117.0	
Shale, medium gray, silty.....	117.0	-	134.5	
Shale, black.....	134.5	-	135.0	
Shale, medium gray.....	135.0	-	139.7	
Limestone, light greenish gray, very finely crystalline, interbedded with shale, greenish gray.....	139.7	-	150.0	
Limestone, cream, irregularly crystalline; contains algal material.....	150.0	-	151.2	
Shale, brownish olive.....	151.2	-	153.0	
Shale, medium to dark gray.....	153.0	-	154.0	
Limestone, bluish gray, irregularly crystalline; contains crinoids and fusulinids.....	154.0	-	155.5	
Shale, medium gray.....	155.5	-	181.4	
Shale, medium gray, interbedded with limestone, brown, dense, thin.....	181.4	-	197.0	

Test Hole 53-78

Location: Richardson County, SE corner NE sec. 21, T. 3 N., R. 13 E., approximately 5 feet north of south section line and 22 feet west of east section line.

Ground-level elevation: 1,107.0 feet above mean sea level.

Started: June 8, 1978. Completed: June 8, 1978.

Total depth: 197.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	1.0	
Clay, brown, silty.....	1.0	-	13.0	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Silt, brown, clayey, sandy.....	13.0	- 32.0
Silt, light brown, clayey, sandy.....	32.0	- 52.0
Silt, medium gray.....	52.0	- 62.0
Silt, brownish gray.....	62.0	- 67.0
Silt, light gray, sandy.....	67.0	- 72.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Soldier Creek Formation:		
Shale, greenish gray interbedded with olive....	72.0	- 78.0
Burlingame Formation:		
South Fork Member:		
Limestone, light gray to cream, finely crystalline, porous; contains crinoids, interbedded with shale, red and green.....	78.0	- 85.0
Winnebago Member:		
Shale, brown.....	85.0	- 86.0
Shale, medium gray.....	86.0	- 92.0
Shale, medium to dark gray.....	92.0	- 97.0
Taylor Branch Member:		
Limestone, dark gray, irregularly crystalline; contains algal material.....	97.0	- 98.0
Shale, medium gray.....	98.0	- 98.5
Limestone, light gray, very finely crystalline.....	98.5	- 99.3
Shale, medium gray.....	99.3	- 101.8
Limestone, light tannish gray, finely crystalline to dense.....	101.8	- 103.0
Scranton Formation:		
Cedarvale-White Cloud Members:		
Shale, medium to light gray.....	103.0	- 107.0
Shale, medium gray, silty.....	107.0	- 112.0
Shale, medium gray, silty, interbedded with sandstone, gray, very fine grained.....	112.0	- 117.0
Shale, medium gray, silty.....	117.0	- 134.5
Shale, black.....	134.5	- 135.0
Shale, medium gray.....	135.0	- 139.7
Limestone, light greenish gray, very finely crystalline, interbedded with shale, greenish gray.....	139.7	- 150.0
Limestone, cream, irregularly crystalline; contains algal material.....	150.0	- 151.2
Shale, brownish olive.....	151.2	- 153.0
Shale, medium to dark gray.....	153.0	- 154.0
Limestone, bluish gray, irregularly crystalline; contains crinoids and fusulinids.....	154.0	- 155.5
Shale, medium gray.....	155.5	- 181.4
Shale, medium gray, interbedded with limestone, brown, dense, thin.....	181.4	- 197.0

Test Hole 53-78

Location: Richardson County, SE corner NE sec. 21, T. 3 N., R. 13 E., approximately 5 feet north of south section line and 22 feet west of east section line.

Ground-level elevation: 1,107.0 feet above mean sea level.

Started: June 8, 1978. Completed: June 8, 1978.

Total depth: 122.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	1.0
Clay, brown, silty.....	1.0 -	13.0
Sand, fine to very coarse, and gravel, very fine to medium.....	13.0 -	54.0
Silt, light tan.....	54.0 -	58.0
Silt, gray.....	58.0 -	66.0
Permian System - Big Blue Series - Council Grove Group:		
Stearns Formation:		
Shale, light greenish gray.....	66.0 -	68.0
Shale, reddish brown.....	68.0 -	70.0
Shale, reddish brown interbedded with greenish gray.....	70.0 -	72.0
Beattie Formation:		
Morrill-Florena Members:		
Shale, cream to white.....	72.0 -	74.3
Limestone, white to light gray, very finely crystalline.....	74.3 -	75.0
Limestone, white to light gray, very finely crystalline, interbedded with shale, light gray.....	75.0 -	76.2
Limestone, white to light gray, very finely crystalline, porous.....	76.2 -	77.0
Cottonwood Member:		
Limestone, cream, fine to irregularly crystalline; contains fusulinids.....	77.0 -	88.0
Eskridge Formation:		
Shale, light bluish gray.....	88.0 -	93.0
Shale, reddish brown.....	93.0 -	99.0
Shale, light gray.....	99.0 -	102.0
Shale, gray interbedded with black.....	102.0 -	103.2
Limestone, medium gray, very finely crystalline.....	103.2 -	104.0
Shale, dark gray.....	104.0 -	104.8
Limestone, brownish gray, very finely crystalline to dense.....	104.8 -	105.5

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium gray, interbedded with limestone, tannish gray, dense.....	105.5	107.0
Shale, yellowish olive, silty.....	107.0	112.0
Shale, green interbedded with red.....	112.0	114.0
Limestone, light tannish gray, very finely crystalline to dense.....	114.0	116.0
Limestone, light greenish gray, dense.....	116.0	116.7
Shale, pale olive.....	116.7	117.5
Shale, reddish brown.....	117.5	120.0
Shale, greenish gray, limy.....	120.0	122.0

Test Hole 54-78

Location: Richardson County, NW corner sec. 26, T. 3 N., R. 13 E., approximately 15 feet south of north section line and 10 feet east of west section line.

Ground-level elevation: 1,154.0 feet above mean sea level.

Started: June 8, 1978. Completed: June 8, 1978.

Total depth: 137.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	3.0
Silt, brown, clayey.....	3.0	8.0
Silt, reddish brown, clayey.....	8.0	12.0
Silt, orangish brown, clayey.....	12.0	19.0
Permian System - Big Blue Series - Council Grove Group:		
Funston Formation:		
Limestone, pale yellow, irregularly crystalline; porous.....	19.0	24.0
Blue Rapids Formation:		
Shale, greenish gray.....	24.0	30.5
Limestone, pale yellow, coarsely crystalline...	30.5	31.0
Shale, pale olive.....	31.0	35.0
Limestone, light gray, very finely crystalline.....	35.0	35.4
Shale, olive interbedded with beige.....	35.4	39.0
Limestone, light gray, very finely crystalline.....	39.0	40.0
Shale, yellowish olive.....	40.0	41.0
Shale, reddish brown mottled with gray.....	41.0	46.0
Shale, medium gray.....	46.0	48.0
Shale, light greenish gray.....	48.0	50.5

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Crouse Formation:		
Limestone, white to light gray, finely to very finely crystalline.....	50.5	51.0
Limestone, light tan, dense, interbedded with shale, cream.....	51.0	54.0
Shale, yellowish olive.....	54.0	56.5
Limestone, medium gray, finely to very finely crystalline; contains crinoids.....	56.5	57.4
Shale, dark gray.....	57.4	59.0
Shale, dark gray mottled with olive.....	59.0	61.1
Limestone, light tannish gray, very finely crystalline to dense.....	61.1	62.4
Easley Creek Formation:		
Shale, brown.....	62.4	63.0
Shale, cream.....	63.0	69.0
Shale, pale olive.....	69.0	71.0
Shale, pale olive interbedded with gray.....	71.0	73.0
Shale, reddish brown.....	73.0	76.0
Shale, reddish brown interbedded with greenish gray.....	76.0	78.0
Shale, olive interbedded with sandstone, brown, fine grained.....	78.0	80.0
Bader Formation:		
Middleburg Member:		
Limestone, light gray, fine to very finely crystalline; contains red and yellow staining.....	80.0	81.5
Shale, medium gray.....	81.5	82.5
Limestone, light to medium gray, very finely crystalline.....	82.5	84.2
Hooser Member:		
Shale, light to medium gray.....	84.2	87.5
Shale, light gray, limy.....	87.5	90.0
Shale, reddish brown mottled with greenish gray.....	90.0	92.0
Eiss Member:		
Limestone, cream, finely to coarsely crystalline; contains red staining.....	92.0	96.0
Shale, medium gray.....	96.0	105.0
Limestone, light to medium gray, finely to very finely crystalline; contains brachiopods.....	105.0	106.5
Stearns Formation:		
Shale, light greenish gray.....	106.5	111.0
Shale, reddish brown.....	111.0	116.6
Beattie Formation:		
Morrill-Florena Members:		
Limestone white, very finely crystalline to dense, interbedded with shale, greenish gray.....	116.6	121.3
Cottonwood Member:		
Limestone, cream, irregularly crystalline; porous; contains fusulinids and gypsum.....	121.3	132.0

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Eskridge Formation:			
	Shale, olive gray.....	132.0	- 133.0
	Shale, light gray.....	133.0	- 137.0

Test Hole 55-78

Location: Pawnee County, SE corner sec. 12, T. 3 N., R. 12 E., approximately 15 feet north of south section line and 30 feet west of east section line.

Ground-level elevation: 1,156.0 feet above mean sea level.

Started: June 9, 1978. Completed: June 9, 1978.

Total depth: 257.0 feet.

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Quaternary System:			
	Soil (no sample).....	0	- 5.0
	Silt, brown, clayey.....	5.0	- 27.0
	Silt, grayish brown, clayey, sandy.....	27.0	- 32.0
	Silt, grayish brown, clayey.....	32.0	- 37.0
	Silt, gray, clayey.....	37.0	- 47.0
	Silt, medium to dark gray.....	47.0	- 58.0
	Sand, medium to very coarse, and gravel, fine to very coarse.....	58.0	- 76.0
	Clay, brown.....	76.0	- 77.0
	Sand, medium to very coarse, and gravel, fine to very coarse.....	77.0	- 98.0
	Silt, medium gray.....	98.0	- 107.0
	Silt, light gray.....	107.0	- 120.0
	Sand, fine to very coarse, and gravel, fine to medium.....	120.0	- 122.0
	Silt, light gray.....	122.0	- 132.0
	Silt, light gray interbedded with brown.....	132.0	- 137.0
	Silt, light gray, sandy.....	137.0	- 142.0
	Sand, medium to very coarse, and gravel, fine to medium.....	142.0	- 152.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:			
Burlingame Formation:			
Winnebago Member:			
	Shale, medium gray.....	152.0	- 161.5
Taylor Branch Member:			
	Limestone, light gray, finely crystalline.....	161.5	- 164.0
	Shale, light gray.....	164.0	- 165.8

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light tannish gray, finely crystalline to dense.....	165.8	- 168.0
Scranton Formation:		
Cedarvale-White Cloud Members:		
Shale, light to medium gray, silty.....	168.0	- 193.0
Shale, black.....	193.0	- 194.0
Shale, light to medium gray.....	194.0	- 197.0
Shale, light greenish gray.....	197.0	- 199.0
Shale, light greenish gray interbedded with olive and gray.....	199.0	- 202.0
Shale, medium to dark gray.....	202.0	- 213.5
Limestone, dark gray, finely crystalline; contains brachiopods, bryozoans, and fusulinids.	213.5	- 215.0
Shale, light gray.....	215.0	- 230.0
Limestone, brownish gray, very finely crystalline.....	230.0	- 230.5
Shale, light gray.....	230.5	- 234.0
Limestone, brown, dense.....	234.0	- 234.5
Shale, light to medium gray.....	234.5	- 242.0
Shale, medium gray, silty.....	242.0	- 257.0

Test Hole 56-78

Location: Richardson County, SW corner NW sec. 7, T. 3 N., R. 13 E., approximately 2,590 feet south of north section line and 22 feet east of west section line.

Ground-level elevation: 1,135.0 feet above mean sea level.

Started: June 12, 1978. Completed: June 12, 1978.

Total depth: 242.0 feet.

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0	- 2.0
Silt, brown, clayey.....	2.0	- 8.0
Sand, very fine to medium.....	8.0	- 62.0
Sand, very fine to very coarse, and gravel, fine to medium.....	62.0	- 92.0
Sand, very fine to coarse, interbedded with clay, brown.....	92.0	- 108.0
Silt, light brown, sandy.....	108.0	- 130.0
Sand, very fine to very coarse, and gravel, fine to medium.....	130.0	- 138.0

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Willard Formation:				
	Shale, medium gray.....		138.0	- 139.0
Emporia Formation:				
	Limestone, light to medium gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....		139.0	- 141.0
	Shale, light gray.....		141.0	- 142.9
	Limestone, light gray, finely to very finely crystalline.....		142.9	- 143.5
	Shale, light greenish gray.....		143.5	- 144.2
	Limestone, light tannish gray, finely crystalline to dense.....		144.2	- 144.6
Harveyville Member:				
	Shale, medium gray.....		144.6	- 147.2
Reading Member:				
	Limestone, medium gray, finely to very finely crystalline; contains brachiopods, crinoids, fusulinids, algal material, pyrite, and black inclusions.....		147.2	- 152.4
Auburn Formation:				
	Shale, medium gray interbedded with greenish gray.....		152.4	- 155.5
	Shale, reddish brown.....		155.5	- 159.0
	Shale, medium gray.....		159.0	- 176.0
Wakarusa Formation:				
	Limestone, medium gray, very finely crystalline, contains brachiopods, crinoids, and fusulinids.....		176.0	- 180.0
Burlingame-Soldier Creek Formations:				
	Shale, light bluish gray.....		180.0	- 184.5
	Shale, reddish brown.....		184.5	- 186.0
	Siltstone, greenish gray.....		186.0	- 190.0
	Shale, greenish gray mottled with olive.....		190.0	- 194.0
	Shale, medium gray.....		194.0	- 204.0
Taylor Branch Member:				
	Limestone, medium to dark gray, irregularly crystalline; contains brachiopods, crinoids, and algal material.....		204.0	- 204.5
	Shale, medium gray.....		204.5	- 206.0
	Limestone, light tannish gray, very finely crystalline to dense.....		206.0	- 208.5
Scranton Formation:				
Cedarvale-White Cloud Members:				
	Shale, light to medium gray, silty.....		208.5	- 221.0
	Shale, black.....		221.0	- 222.0
	Shale, greenish gray.....		222.0	- 225.0
	Shale, greenish gray mottled with red, olive, and yellow.....		225.0	- 235.0
	Shale, light gray.....		235.0	- 242.0

Test Hole 57-78

Location: Richardson County, SE SE SE SE sec. 6, T. 3 N., R. 13 E., approximately 300 feet north of south section line and 2 feet west of east section line.

Ground-level elevation: 1,110.0 feet above mean sea level.

Started: June 12, 1978. Completed: June 13, 1978.

Total depth: 212.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Sand, very fine to very coarse, silty, clayey.....	2.0	-	7.0	
Silt, brown, sandy.....	7.0	-	17.0	
Sand, medium to very coarse, and gravel, fine to coarse.....	17.0	-	32.0	
Silt, beige, clayey.....	32.0	-	42.0	
Silt, gray, clayey.....	42.0	-	57.0	
Silt, medium to dark gray, clayey.....	57.0	-	67.0	
Silt, light bluish gray, clayey.....	67.0	-	82.0	
Silt, light bluish gray interbedded with yellowish green, clayey.....	82.0	-	87.0	
Silt, medium gray, clayey.....	87.0	-	96.0	
Sand, very fine to medium.....	96.0	-	97.0	
Silt, medium gray, clayey.....	97.0	-	107.0	
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Root Formation:				
French Creek Member:				
Shale, reddish brown.....	107.0	-	109.0	
Shale, light gray mottled with olive.....	109.0	-	113.0	
Shale, medium gray, interbedded with black.....	113.0	-	116.5	
Sandstone, light gray, very fine grained.....	116.5	-	118.0	
Shale, light gray.....	118.0	-	127.0	
Shale, dark gray.....	127.0	-	129.3	
Jim Creek Member:				
Limestone, medium gray, very finely crystalline, impure; contains brachiopods, crinoids, and bryozoans.....	129.3	-	129.8	
Friedrich Member:				
Shale, light gray.....	129.8	-	139.5	
Stotler Formation:				
Grandhaven Member:				
Limestone, light gray to cream, finely to very finely crystalline; contains brachiopods, crinoids, and red and green staining.....	139.5	-	141.5	

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Dry Member:		
Shale, reddish brown interbedded with gray.....	141.5	- 146.2
Limestone, light gray to cream, very finely crystalline, contains black inclusions and red and green staining.....	146.2	- 149.0
Shale, reddish brown.....	149.0	- 152.0
Shale, reddish brown, interbedded with lime- stone, greenish brown, dense.....	152.0	- 155.0
Shale, olive interbedded with limestone, gray, finely crystalline.....	155.0	- 157.7
Shale, light to medium gray.....	157.7	- 167.0
Shale, light gray.....	167.0	- 177.0
Shale, light gray, silty.....	177.0	- 184.0
Dover Member:		
Limestone, medium gray, finely crystalline; contains brachiopods.....	184.0	- 184.5
Pillsbury Formation:		
Shale, light gray.....	184.5	- 186.5
Shale, light greenish gray, interbedded with limestone, greenish gray, dense.....	186.5	- 190.0
Shale, olive and gray, interbedded with lime- stone, tan, dense.....	190.0	- 193.0
Shale, greenish gray.....	193.0	- 194.0
Shale, medium gray.....	194.0	- 198.0
Zeandale Formation:		
Maple Hill Member:		
Limestone, light to medium gray, finely to very finely crystalline; contains brachiopods, crinoids, fusulinids, and pyrite.....	198.0	- 200.5
Shale, medium to dark gray.....	200.5	- 203.0
Limestone, medium gray, finely crystalline; contains brachiopods, crinoids, fusulinids, and black carbonaceous material.....	203.0	- 208.0
Wanego Member:		
Coal, black.....	208.0	- 209.5
Shale, light gray.....	209.5	- 212.0

Test Hole 58-78

Location: Pawnee County, NW corner sec. 12, T. 3 N., R. 12 E.,
approximately 61 feet south of north section line and
18 feet east of west section line.

Ground-level elevation: 1,186.0 feet above mean sea level.

Started: June 13, 1978. Completed: June 14, 1978.

Total depth: 376.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
			<u>From</u>	<u>To</u>
Quaternary System:				
	Soil (no sample).....		0 -	2.0
	Silt, yellowish brown, clayey.....		2.0 -	27.0
	Silt, yellowish brown, sandy.....		27.0 -	32.0
	Silt, yellowish brown.....		32.0 -	47.0
	Sand, fine to very coarse, and gravel, fine to medium.....		47.0 -	57.0
	Silt, gray to olive gray.....		57.0 -	83.0
	Sand, medium to very coarse, and gravel, very fine to fine.....		83.0 -	145.0
	Clay, light gray.....		145.0 -	152.0
	Clay, light gray, interbedded with silt, medium gray.....		152.0 -	165.0
	Sand, very fine to coarse, and gravel, very fine to fine.....		165.0 -	202.0
Permian(?) - Pennsylvanian (?) Systems:				
	Shale, light gray to white.....		202.0 -	207.0
	Shale, medium to dark gray.....		207.0 -	216.0
	Shale, medium gray, interbedded with siltstone, light gray.....		216.0 -	217.2
	Shale, medium gray.....		217.2 -	222.7
	Shale, light greenish gray.....		222.7 -	225.0
	Shale, light greenish gray interbedded with pale red.....		225.0 -	227.0
	Shale, greenish gray mottled with red, olive and brown.....		227.0 -	235.0
	Shale, light gray to white, interbedded with sandstone, light gray, very fine grained.....		235.0 -	240.0
	Shale, light gray.....		240.0 -	242.0
	Shale, reddish brown.....		242.0 -	259.0
	Shale, reddish brown mottled with olive and gray.....		259.0 -	263.0
	Shale, medium to dark gray.....		263.0 -	282.0
	Shale, medium gray interbedded with greenish gray, limy.....		282.0 -	284.0
	Limestone, light tannish gray, irregularly crystalline, contains brachiopods and crinoids.....		284.0 -	285.0
	Shale, light greenish gray.....		285.0 -	288.0
	Shale, olive brown.....		288.0 -	291.0
	Shale, medium gray.....		291.0 -	317.0
	Shale, light gray.....		317.0 -	327.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:				
Stotler Formation:				
Dover Member:				
	Limestone, dark gray, finely crystalline; contains brachiopods and pyrite.....		327.0 -	327.6
Pillsbury Formation:				
	Shale, light greenish gray interbedded with light gray.....		327.6 -	331.0

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
	Shale, reddish brown mottled with olive.....	331.0	- 334.0
	Shale, light gray.....	334.0	- 337.5
Zeandale Formation:			
Maple Hill Member:			
	Limestone, medium gray, finely crystalline, impure; contains brachiopods, crinoids, and pyrite.....	337.5	- 338.3
Wamego Member:			
	Coal, black.....	338.3	- 338.9
	Shale, light gray interbedded with greenish gray.....	338.9	- 346.1
	Sandstone, light gray, very fine grained.....	346.1	- 348.0
	Shale, light gray.....	348.0	- 358.3
Tarkio Member:			
	Limestone, cream, finely crystalline; contains fusulinids and <u>Osagia</u>	358.3	- 365.5
Willard Formation:			
	Shale, medium gray mottled with red.....	365.5	- 370.0
	Shale, medium gray.....	370.0	- 376.0

Test Hole 59-78

Location: Pawnee County, SW NW SW NW sec. 1, T. 3 N., R. 12 E., approximately 1,915 feet south of north section line and 18 feet east of west section line.

Ground-level elevation: 1,173.0 feet above mean sea level.

Started: June 14, 1978. Completed: June 14, 1978.

Total depth: 242.0 feet.

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Quaternary System:			
	Soil (no sample).....	0	- 5.0
	Silt, brown, clayey.....	5.0	- 20.0
	Sand, very fine to medium.....	20.0	- 42.0
	Sand, very fine to very coarse.....	42.0	- 72.0
	Sand, very fine to very coarse, and gravel, very fine to medium.....	72.0	- 107.0
	Sand, very fine to medium.....	107.0	- 135.5

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Permian System - Big Blue Series - Council Grove Group:		
Foraker Formation:		
Americus Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods.....	135.5	136.0
Shale, light to medium gray.....	136.0	136.2
Limestone, light to medium gray, irregularly crystalline; contains brachiopods and crinoids.....	136.2	138.1
Shale, black.....	138.1	138.5
Limestone, bluish gray, finely crystalline; contains brachiopods and crinoids.....	138.5	138.9
Admire Group:		
Hamlin Formation:		
Oaks-Stine Members:		
Shale, medium gray.....	138.9	143.0
Limestone, bluish gray, finely crystalline; contains algal material and black inclusions.....	143.0	143.5
Shale, cream to light gray, limy.....	143.5	145.0
Shale, light greenish gray, limy.....	145.0	149.0
Limestone, light greenish gray, very finely crystalline, interbedded with shale, greenish gray, sandy.....	149.0	156.0
Shale, olive mottled with green.....	156.0	158.0
Shale, brownish olive.....	158.0	161.0
Shale, light gray.....	161.0	163.0
Shale, medium to dark gray.....	163.0	164.0
Limestone, light to medium gray, very finely crystalline.....	164.0	164.5
Shale, light gray.....	164.5	166.0
Limestone, light to medium gray, very finely crystalline.....	166.0	167.0
Shale, medium gray.....	167.0	167.9
Limestone, bluish gray, irregularly crystalline; contains algal material and black inclusions.....	167.9	168.5
Shale, greenish gray.....	168.5	169.1
Limestone, light tannish gray, very finely crystalline.....	169.1	170.2
Shale, reddish brown interbedded with gray.....	170.2	172.3
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains brachiopods, algal material, and glauconite.....	172.3	173.6
West Branch Formation:		
Shale, pale red interbedded with olive, gray and brown.....	173.6	180.5
Shale, medium gray.....	180.5	182.0
Limestone, cream, irregularly crystalline; contains algal material.....	182.0	182.8

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, medium gray.....	182.8	- 183.0
Shale, green.....	183.0	- 185.0
Limestone, white, very finely crystalline; interbedded with shale, greenish gray.....	185.0	- 192.0
Shale, dark gray.....	192.0	- 194.0
Shale, medium to dark gray, interbedded with limestone, gray, dense.....	194.0	- 197.0
Shale, medium gray.....	197.0	- 201.5
Falls City Formation:		
Lehmer Member:		
Limestone, light gray, very finely crystalline, porous; contains oolites and gypsum.....	201.5	- 204.2
Onaga Formation:		
Shale, medium gray.....	204.2	- 206.5
Shale, greenish gray, limy.....	206.5	- 212.0
Shale, reddish brown.....	212.0	- 215.7
Shale, greenish gray, limy.....	215.7	- 216.7
Shale, reddish brown.....	216.7	- 224.1
Wood Siding Formation:		
Brownville Member:		
Limestone, pale yellow, finely to very finely crystalline; contains brachiopods and glauconite.....	224.1	- 226.0
Pony Creek-Plumb Members:		
Shale, light gray.....	226.0	- 228.0
Sandstone, light gray to greenish gray, very fine grained.....	228.0	- 229.0
Shale, light greenish gray.....	229.0	- 230.0
Claystone, light greenish gray.....	230.0	- 231.0
Shale, reddish brown.....	231.0	- 239.0
Shale, dark olive gray, interbedded with limestone, gray, dense.....	239.0	- 242.0

Test Hole 60-78

Location: Nemaha County, SE corner SW SE sec. 35, T. 4 N., R. 12 E., approximately 15 feet north of south section line and 1,345 feet west of east section line.

Ground-level elevation: 1,203.0 feet above mean sea level.

Started: June 20, 1978. Completed: June 20, 1978.

Total depth: 148.0 feet.

Description	Depth, in feet	
	From	To
Quaternary System:		
Soil (no sample).....	0	2.0
Silt, yellowish brown, clayey.....	2.0	12.0
Silt, yellowish brown, sandy.....	12.0	16.0
Sand, fine to very coarse, and gravel, very fine to medium.....	16.0	19.0
Clay, brown.....	19.0	24.0
Silt, brownish gray, silty.....	24.0	34.0
Sand, medium to very coarse.....	34.0	37.0
Silt, olive brown, clayey.....	37.0	42.0
Sand, medium to very coarse, and gravel, very fine to coarse.....	42.0	59.0
Silt, olive gray.....	59.0	62.0
Silt, medium gray.....	62.0	87.0
Silt, dark gray.....	87.0	96.0
Silt, brown, clayey.....	96.0	101.0
Permian System - Big Blue Series - Council Grove Group:		
Roca Formation:		
Limestone, white to pale yellow, irregularly crystalline.....	101.0	102.0
Shale, medium gray.....	102.0	105.0
Limestone, tannish gray, very finely crystalline to dense.....	105.0	107.1
Shale, yellowish green, clayey.....	107.1	116.5
Red Eagle Formation:		
Howe Member:		
Limestone, dark yellowish orange, irregularly crystalline.....	116.5	118.0
Bennett Member:		
Shale, black.....	118.0	123.0
Glenrock Member:		
Limestone, medium gray, finely crystalline; contains fusulinids.....	123.0	124.0
Johnson Formation:		
Shale, light to medium gray.....	124.0	126.5
Shale, light bluish gray, silty.....	126.5	131.5
Shale, light beige.....	131.5	135.6
Foraker Formation:		
Limestone, pale olive, finely to very finely crystalline.....	135.6	137.0
No sample, lost circulation.....	137.0	148.0

Test Hole 61-78

Location: Nemaha County, SW corner sec. 36, T. 4 N., R. 12 E.,
approximately 10 feet north of south section line and 35
feet east of west section line.

Ground-level elevation: 1,178.0 feet above mean sea level.

Started: June 21, 1978. Completed: June 21, 1978.

Total depth: 242.0 feet.

	<u>Description</u>		<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>		
Quaternary System:				
Soil (no sample).....	0	-	2.0	
Silt, grayish brown, clayey, sandy.....	2.0	-	17.0	
Sand, fine to very coarse and gravel, very fine to medium.....	17.0	-	28.0	
Silt, dark olive gray.....	28.0	-	42.0	
Silt, medium gray.....	42.0	-	57.0	
Silt, pale brown.....	57.0	-	75.0	
Permian System - Big Blue Series - Council Grove Group:				
Roca Formation:				
Limestone, white to yellow, finely crystalline, interbedded with shale, pale yellow.....	75.0	-	79.2	
Shale, reddish brown mottled with pale green...	79.2	-	82.5	
Shale, pale green, interbedded with limestone, tan, dense.....	82.5	-	84.2	
Shale, pale green mottled with red.....	84.2	-	88.0	
Shale, pale green to light olive.....	88.0	-	93.0	
Red Eagle Formation:				
Howe Member:				
Limestone, pale yellow, finely crystalline, porous, vuggy.....	93.0	-	96.3	
Bennett Member:				
Shale, brownish gray, silty.....	96.3	-	101.5	
Glenrock Member:				
Limestone, pale yellow, finely to very finely crystalline, porous.....	101.5	-	102.3	
Johnson Formation:				
Shale, pale olive.....	102.3	-	116.5	
Foraker Formation:				
Long Creek Member:				
Limestone, pale yellow, finely to very finely crystalline, porous, vuggy.....	116.5	-	122.0	
Hughes Creek Member:				
Shale, light to medium gray, limy.....	122.0	-	127.0	
Shale, medium gray.....	127.0	-	137.0	
Limestone, dark gray, very finely crystalline; contains brachiopods.....	137.0	-	137.9	

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Shale, dark gray to black.....	137.9	- 140.0
Limestone, light to medium gray, very finely crystalline; contains brachiopods.....	140.0	- 141.5
Shale, medium gray.....	141.5	- 146.7
Shale, light gray, interbedded with limestone, light gray, dense.....	146.7	- 149.5
Shale, medium gray.....	149.5	- 153.5
Limestone, light to medium gray, finely crystalline; contains brachiopods and crinoids.....	153.5	- 155.2
Shale, medium gray.....	155.2	- 161.7
Americus Member:		
Limestone, medium to dark gray, finely crystalline; contains brachiopods and crinoids.....	161.7	- 162.7
Shale, dark gray to black.....	162.7	- 163.3
Limestone, bluish gray, finely crystalline; contains brachiopods and crinoids.....	163.3	- 164.2
Admire Group:		
Hamlin Formation:		
Oaks-Stine Members:		
Shale, medium gray.....	164.2	- 169.0
Shale, light gray, limy.....	169.0	- 176.0
Shale, light greenish gray, interbedded with limestone, tan, dense.....	176.0	- 182.0
Shale, light gray interbedded with olive.....	182.0	- 185.0
Shale, light to medium gray, limy.....	185.0	- 195.0
Shale, pale brown.....	195.0	- 196.0
Shale, light greenish gray.....	196.0	- 197.3
Five Point Formation:		
Limestone, cream, irregularly crystalline; contains brachiopods, algal material, and glauconite.....	197.3	- 199.2
West Branch Formation:		
Shale, pale brown and greenish gray, interbedded with limestone, gray, dense.....	199.2	- 202.0
Shale, olive mottled with red, green, and gray.....	202.0	- 205.0
Shale, medium gray.....	205.0	- 207.7
Limestone, light greenish gray, finely crystalline; contains brachiopods.....	207.7	- 208.5
Shale, medium gray.....	208.5	- 212.0
Shale, light greenish gray, limy.....	212.0	- 218.0
Shale, medium to light gray, limy.....	218.0	- 227.0
Falls City Formation:		
Lehmer Member:		
Limestone, dark gray, pebbly texture; contains pseudo-oolites, interbedded with limestone, medium to dark gray, very finely crystalline.....	227.0	- 232.0

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Onaga Formation:			
	Shale, light greenish gray.....	232.0	- 235.0
	Shale, pale red, limy.....	235.0	- 242.0

Test Hole 62-78

Location: Nemaha County, SW corner sec. 35, T. 4 N., R. 12 E., approximately 67 feet north of south section line and 24 feet east of west section line.

Ground-level elevation: 1,240.0 feet above mean sea level.

Started: June 22, 1978. Completed: June 22, 1978.

Total depth: 250.0 feet.

	<u>Description</u>	<u>Depth, in feet</u>	
		<u>From</u>	<u>To</u>
Quaternary System:			
	Soil (no sample).....	0	- 3.0
	Silt, reddish brown, clayey.....	3.0	- 10.0
	Sand, fine to very coarse.....	10.0	- 14.0
	Silt, light brown, clayey, sandy.....	14.0	- 37.0
	Clay, yellowish brown, silty.....	37.0	- 42.0
	Silt, brownish gray, sandy.....	42.0	- 67.0
	Sand, very fine to medium.....	67.0	- 92.0
	Sand, very fine to coarse and gravel, very fine to coarse.....	92.0	- 107.0
	Sand, very coarse, and gravel, very fine to coarse.....	107.0	- 137.0
	Sand, medium to very coarse, and gravel, very fine to fine.....	137.0	- 217.0
	Sand, medium to coarse, and gravel, very fine to very coarse.....	217.0	- 227.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:			
Zeandale Formation:			
Wamego Member:			
	Shale, medium gray.....	227.0	- 230.4
Tarkio Member:			
	Limestone, cream, irregularly crystalline; contains fusulinids and <u>Osagia</u>	230.4	- 237.5
Willard Formation:			
	Shale, reddish brown mottled with gray, green and olive.....	237.5	- 239.0
	Shale, light bluish gray, silty.....	239.0	- 242.0
	Shale, medium gray.....	242.0	- 250.0

Test Hole 63-78

Location: Richardson County, SW SW NW NW sec. 34, T. 3 N., R. 13 E., approximately 1,205 feet south of north section line and 20 feet east of west section line.

Ground-level elevation: 1,103.0 feet above mean sea level.

Started: June 23, 1978. Completed: June 23, 1978.

Total depth: 205.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	2.0
Silt, reddish brown, clayey.....	2.0 -	7.0
Silt, yellowish brown, clayey.....	7.0 -	11.0
Silt, grayish brown.....	11.0 -	17.0
Silt, light brown.....	17.0 -	31.0
Permian(?) - Pennsylvanian(?) Systems:		
Limestone, brownish gray, irregularly crystal- line; contains fossil fragments.....	31.0 -	32.0
Shale, reddish brown.....	32.0 -	35.0
Shale, pale olive.....	35.0 -	40.0
Limestone, yellowish brown, finely crystalline; contains brachiopods.....	40.0 -	41.2
Shale, olive-gray.....	41.2 -	46.0
Shale, medium to light gray.....	46.0 -	62.0
Shale, medium gray, silty, sandy.....	62.0 -	114.2
Sandstone, medium gray, very fine grained.....	114.2 -	116.0
Shale, greenish gray, silty, limy.....	116.0 -	122.0
Shale, medium gray.....	122.0 -	127.5
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Zeandale Formation:		
Maple Hill Member:		
Limestone, dark gray, very finely crystalline; contains brachiopods, crinoids, fusulinids, and pyrite.....	127.5 -	128.5
Wamego Member:		
Coal, black.....	128.5 -	129.3
Sandstone, gray to greenish gray, very fine grained.....	129.3 -	133.3
Shale, light gray, silty.....	133.3 -	146.1
Tarkio Member:		
Limestone, medium to dark gray, irregularly crystalline, pebbly, impure; contains fossil fragments.....	146.1 -	146.7
Shale, greenish gray, interbedded with limestone, tan, dense.....	146.7 -	149.2

<u>Description</u>	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Limestone, light gray to cream, very finely to irregularly crystalline; contains fusulinids, <u>Osagia</u> , and glauconite.....	149.2	152.0
Willard Formation:		
Shale, light gray to greenish gray, silty, sandy, limy.....	152.0	157.0
Shale, medium gray, silty.....	157.0	183.4
Emporia Formation:		
Elmont Member:		
Limestone, medium gray to tannish gray, irregularly to very finely crystalline; contains brachiopods and crinoids.....	183.4	185.5
Shale, medium gray.....	185.5	188.0
Limestone, light greenish gray to tannish gray, very finely crystalline.....	188.0	190.2
Harveyville Member:		
Shale, dark greenish gray.....	190.2	193.8
Reading Member:		
Limestone, medium gray, very finely crystalline; contains brachiopods and crinoids.....	193.8	196.5
Shale, dark gray.....	196.5	197.8
Limestone, medium gray, irregularly crystalline; contains brachiopods.....	197.8	198.2
Auburn Formation:		
Shale, medium gray interbedded with greenish gray, limy.....	198.2	201.0
Shale, reddish brown.....	201.0	205.0

Test Hole 64-78

Location: Richardson County, SE corner SW SW sec. 4, T. 2 N., R. 13 E., approximately 22 feet north of south section line and 1,285 feet east of west section line.

Ground-level elevation: 985.0 feet above mean sea level.

Started: June 23, 1978. Completed: June 23, 1978.

Total depth: 107.0 feet.

	<u>Depth, in feet</u>	
	<u>From</u>	<u>To</u>
Quaternary System:		
Soil (no sample).....	0 -	5.0
Silt, light brown, clayey.....	5.0 -	17.0
Silt, gray to greenish gray.....	17.0 -	28.0
Sand, fine to very coarse, and gravel, very fine to medium.....	28.0 -	32.0
Pennsylvanian System - Virgil Series - Wabaunsee Group:		
Willard Formation:		
Shale, medium gray, silty.....	32.0 -	59.0
Emporia Formation:		
Elmont Member:		
Limestone, light brownish gray, very finely crystalline; contains brachiopods.....	59.0 -	61.5
Shale, medium gray.....	61.5 -	62.7
Limestone, light gray, finely to very finely crystalline; contains calcite crystals.....	62.7 -	64.0
Shale, light greenish gray.....	64.0 -	64.5
Limestone, light greenish gray, very finely crystalline.....	64.5 -	65.0
Harveyville Member:		
Shale, medium gray.....	65.0 -	68.2
Reading Member:		
Limestone, medium gray to tannish gray, finely to very finely crystalline; contains brachiopods, crinoids, algal materials, and pyrite, interbedded with shale, gray.....	68.2 -	73.5
Auburn Formation:		
Shale, medium gray.....	73.5 -	76.0
Shale, reddish brown.....	76.0 -	81.0
Shale, olive to greenish gray.....	81.0 -	83.0
Shale, medium gray.....	83.0 -	96.0
Wakarusa Formation:		
Limestone, light to medium bluish gray, finely crystalline; contains brachiopods, crinoids, and fusulinids.....	96.0 -	100.0
Soldier Creek Formation:		
Shale, medium gray to dark greenish gray.....	100.0 -	107.0