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OCCURRENCE OF GYPSUM IN THE JOHNSON SHALE (PERMIAN) IN NEMAHA COUNTY, NEBRASKA

By

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[redacted]

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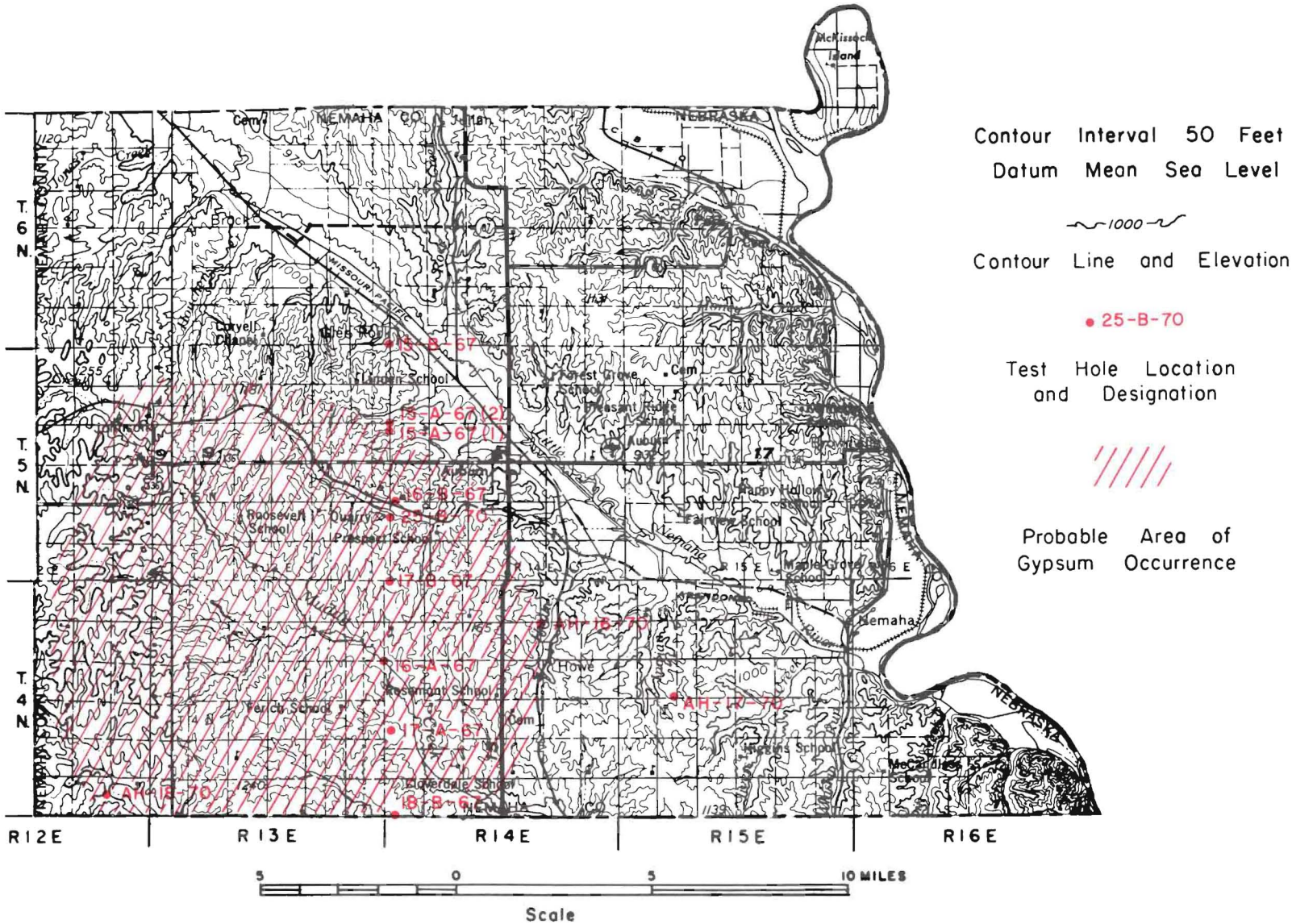


TOPOGRAPHIC MAP OF NEMAHA COUNTY, NEBRASKA, SHOWING LOCATION OF TEST HOLES AND PROBABLE AREA OF GYPSUM OCCURRENCE

Figure 1

OCCURRENCE OF GYPSUM IN THE JOHNSON SHALE (PERMIAN) IN NEMAHA COUNTY, NEBRASKA

ABSTRACT

Recent subsurface investigation in Nemaha County has led to the discovery of a gypsum bed in the lower part of the Johnson Shale (Permian). The gypsum bed is about 10 feet thick and may cover approximately 118 square miles. This report presents the geological and structural framework of this gypsum occurrence and suggests the necessity for additional exploration and drilling to determine the economic feasibility of development.

INTRODUCTION

Investigation of the Johnson Shale in Nemaha County began well over 100 years ago with study and mapping of the surface exposures. Since that time, much more information has become available on the geology of Nemaha County from continued surficial studies and subsurface investigation. Recent subsurface investigation has led to the discovery of gypsum in the southwestern portion of the county in the lower part of the Johnson Shale (Permian).

It is the purpose of this report to call attention to the gypsum-mining potential in Nemaha County, and to encourage further study and development of this resource.

Much of the geological and structural information that is available on the area is included in this report. Summary logs of test holes, including a detailed description of the Johnson Shale, are given in the Appendix. The test holes were drilled in cooperation with the Water Resources Division, U.S. Geological Survey, as a part of the statewide program of groundwater exploration. Also included in the report are X-ray analyses of gypsum samples made by the Department of Geology, University of Nebraska.

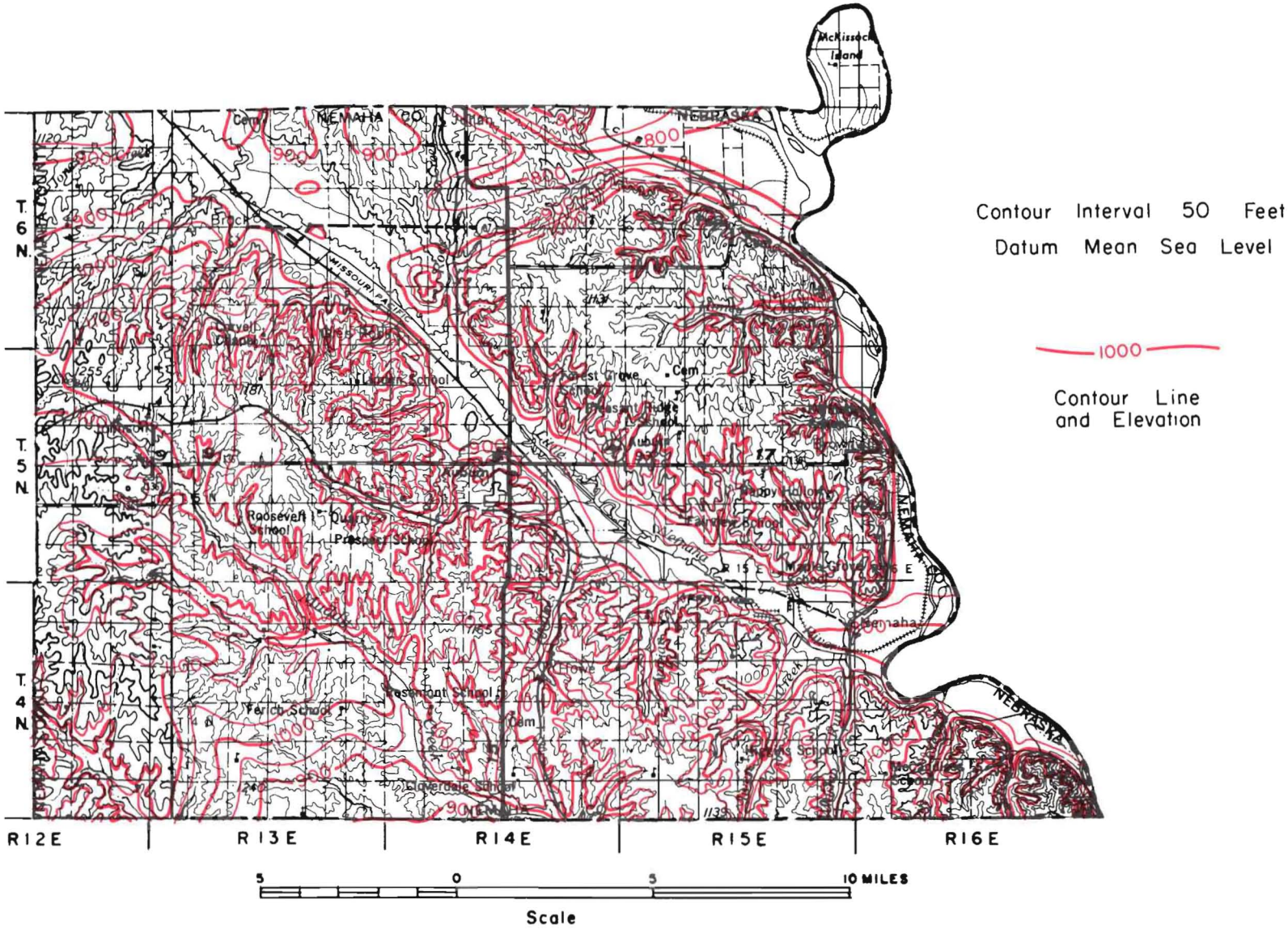
LOCATION OF AREA

A topographic map of Nemaha County (see Figure 1) shows the area in the southwestern part of the county where gypsum deposits probably may be found, and also indicates the location of rotary test holes drilled by the Conservation and Survey Division. Descriptions of these test holes are presented as an Appendix to this report.

GENERAL GEOLOGY

Bedrock Geology

Bedrock is the consolidated rock at the surface or immediately below the soil and unconsolidated mantlerock. A configuration map of the bedrock in Nemaha County is shown in Figure 2. The map is based on information obtained from systematic test drilling as a part of the statewide cooperative groundwater-



BEDROCK CONFIGURATION MAP OF NEMAHA COUNTY, NEBRASKA

Figure 2

investigation program, supplemented by studies of surface exposures and other well records and samples. An understanding of the configuration of the bedrock surface in Nemaha County and adjacent areas has been of great importance and usefulness in finding groundwater supplies. This information is also useful in determining the depth to and the location of rock or mineral deposits such as sand and gravel, limestone, shale, coal, and gypsum. Elevations on top of the bedrock range from less than 800 feet above mean sea level just south of the town of Nemaha in eastern Nemaha County to more than 1150 feet above sea level in the western part of the county. The greatest depth to bedrock in Nemaha County is over 300 feet below the present-day land surface. Another use of information gained from the bedrock configuration map, in conjunction with surface studies, is in preparing a bedrock geologic map that will aid mineral-resource exploration. A geologic bedrock map of Nemaha County, illustrated in Figure 3, shows the distribution of groups ranging from younger Permian to the older Pennsylvanian-age rocks. Outcropping areas of bedrock, generally occurring along the valley sides, are shown in solid black. Most of the upland and valley lowland areas are mantled by variable thicknesses of Quaternary deposits.

A composite section of the rocks of Permian age that are exposed or occur in the subsurface of Nemaha County and their relationship to the complete Permian section of Nebraska are shown in Figure 4.

Structural Geology

The general bedrock structure in Nemaha County is shown by the structural contour map on the base of the Hertha Limestone (Pennsylvanian) (Figure 5). Sedimentary rocks in this county lie within the Forest City Basin. The deepest part of this Basin is just into Richardson County to the south. The faulted eastern flank of the Table Rock Arch is present in the extreme western part of Nemaha County. Structure in the area of gypsum potential, as shown in Figure 5, indicates minor folding in southwestern Nemaha County with regional dip into the Forest City Basin.

The local structure, as shown in Figure 6, was determined from elevations on the base of the Johnson Shale (Permian). These elevations were based on information from outcrop study, shallow drilling data, and oil tests, and over much of the study area would represent the base of the gypsum. From this map it is evident that the dip and strike vary considerably in southwestern Nemaha County.

OCCURRENCE AND PRODUCTION OF GYPSUM IN CENTRAL UNITED STATES

Gypsum is a widely distributed mineral in the United States and has been produced chiefly in areas of dense population.

Gypsum is mined in the surrounding states of Colorado, Kansas, Iowa, and South Dakota (see Figure 7). Gypsum production, based on figures of the U.S. Bureau of Mines for the United States in 1967 and 1968 (Allsman, 1969) is shown in Table 1. Total gypsum production in 1968 reached 10 million tons from 76 active mines, 59 of which were open pit, 16 were underground, and one was both.

TABLE. 1. Production of Gypsum and Gypsum Products in the United States in 1967 and 1968. (Thousand short tons and thousand dollars).

Use	1967 Quantity	1967 Value	1968 Quantity	1968 Value
Uncalcined:				
Portland-cement retarder	3,154	$14,704	3,439	$16,037
Agricultural gypsum	1,280	5,466	1,388	6.222
Other uses[1]	77	712	108	886
Total	4,511	20,882	4,935	23,145
Calcinated (industrial):				
Plate-glass and terra-cotta plasters	33	498	30	464
Pottery plasters	50	1,246	54	1,400
Dental and orthopedic plasters	15	614	15	624
Industrial molding, art, and casting plasters	108	2,408	119	3,078
Other industrial uses[2]	87	3,522	83	3,348
Total	293	8,288	301	8,914
Building:				
Plasters:				
Basecoat	561	10,928	536	10,522
Veneer plaster (basecoat and finishes)	34	1,664	46	2,315
Mill-mixed basecoats (sanded and perlited)	328	8,485	301	7,977
To mixing plants	W	W	W	W
Gaging and molding	80	2,006	76	1,974
Prepared finishes	8	758	8	694
Roof deck	334	5,582	319	5,432
Keene's cement	16	462	17	517
Other[3]	12	583	11	576
Total	1,373	30,468	1,314	30,007
Prefabricated products[4]	7,647[5]	302,630	8,776[5]	342,673
Total		333,098		372,680
Grand total, value		362,268		404,739

W Withheld to avoid disclosing individual company confidential data; included with "Other."

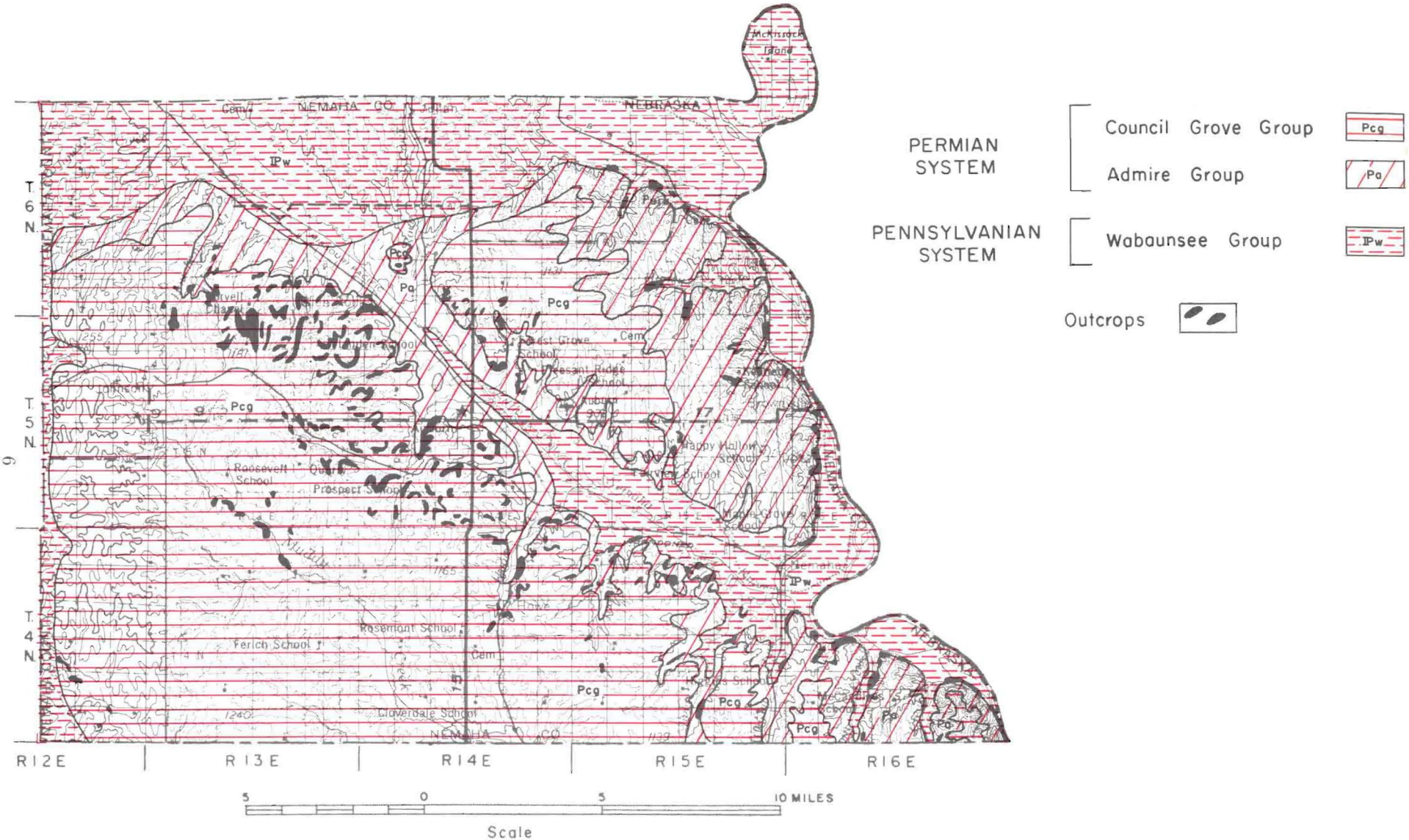
[1] Includes uncalcined gypsum for use in filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.

[2] Includes dead-burned filler, granite polishing, and miscellaneous uses.

[3] Includes joint filler; patching, painter's, insulating, and unclassified building plasters; and quantity and value indicated by symbol W.

[4] Excludes tile.

[5] Includes weight of paper, metal, or other materials.



GEOLOGIC BEDROCK MAP OF NEMAHA COUNTY, NEBRASKA

Figure 3

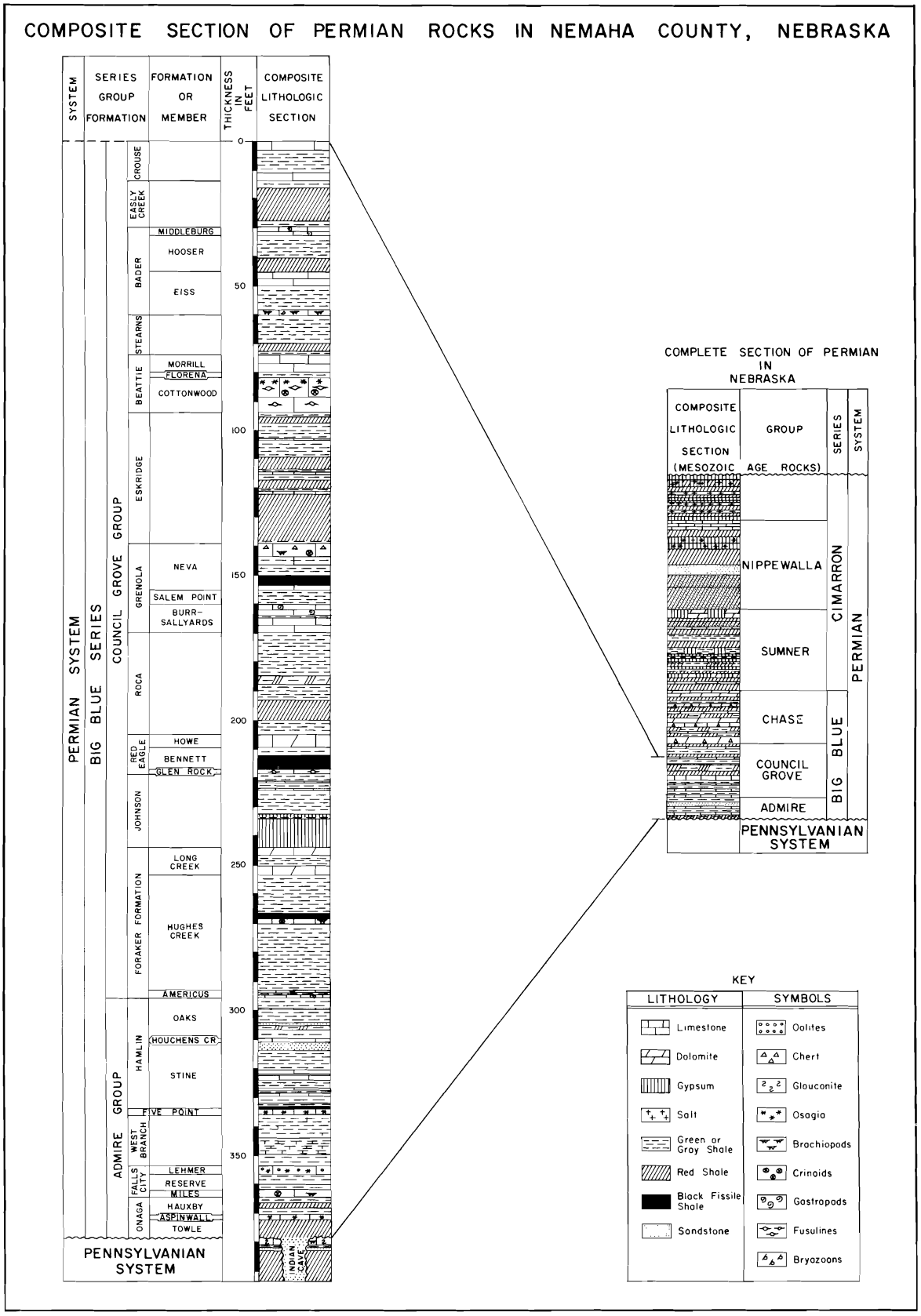
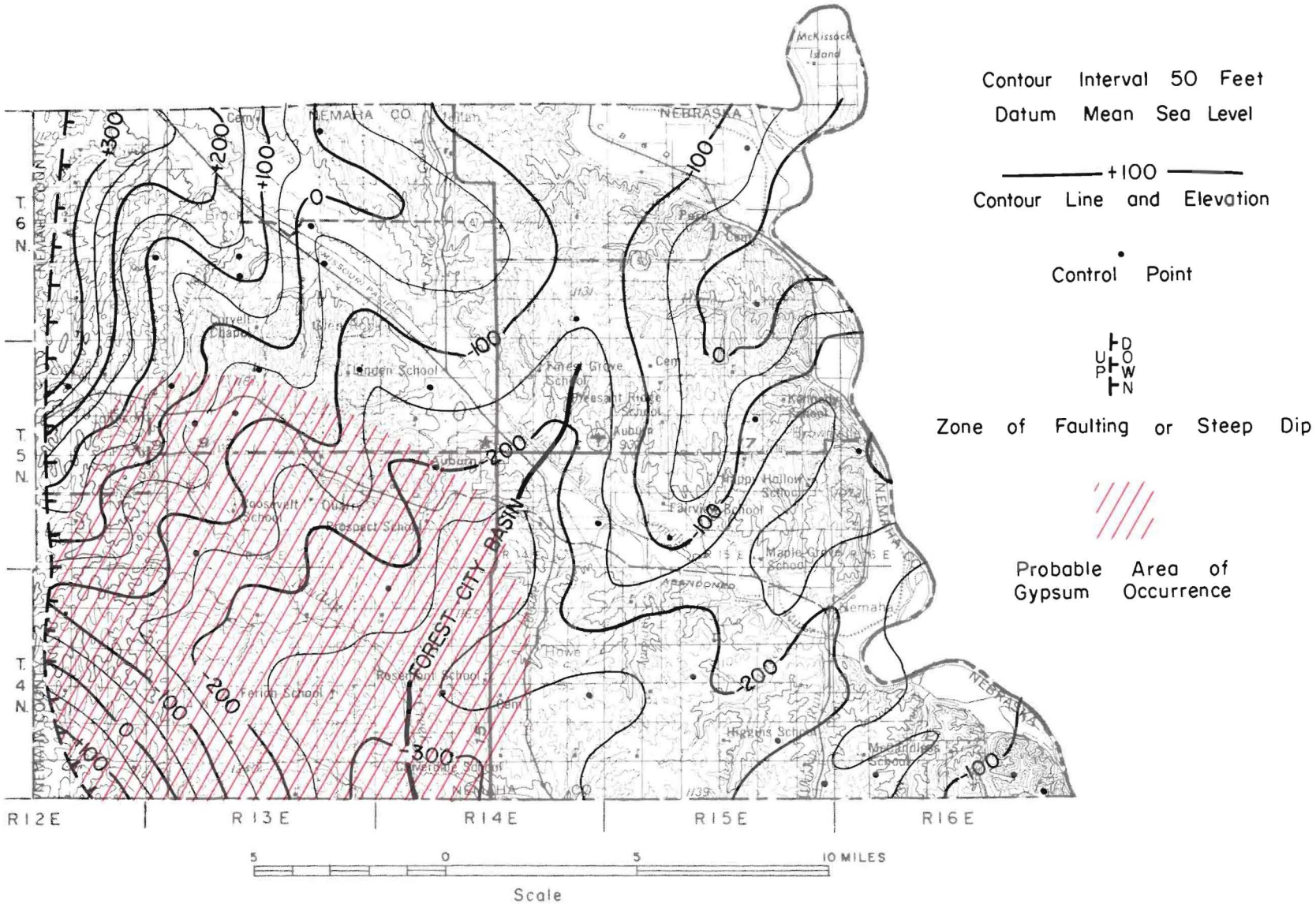
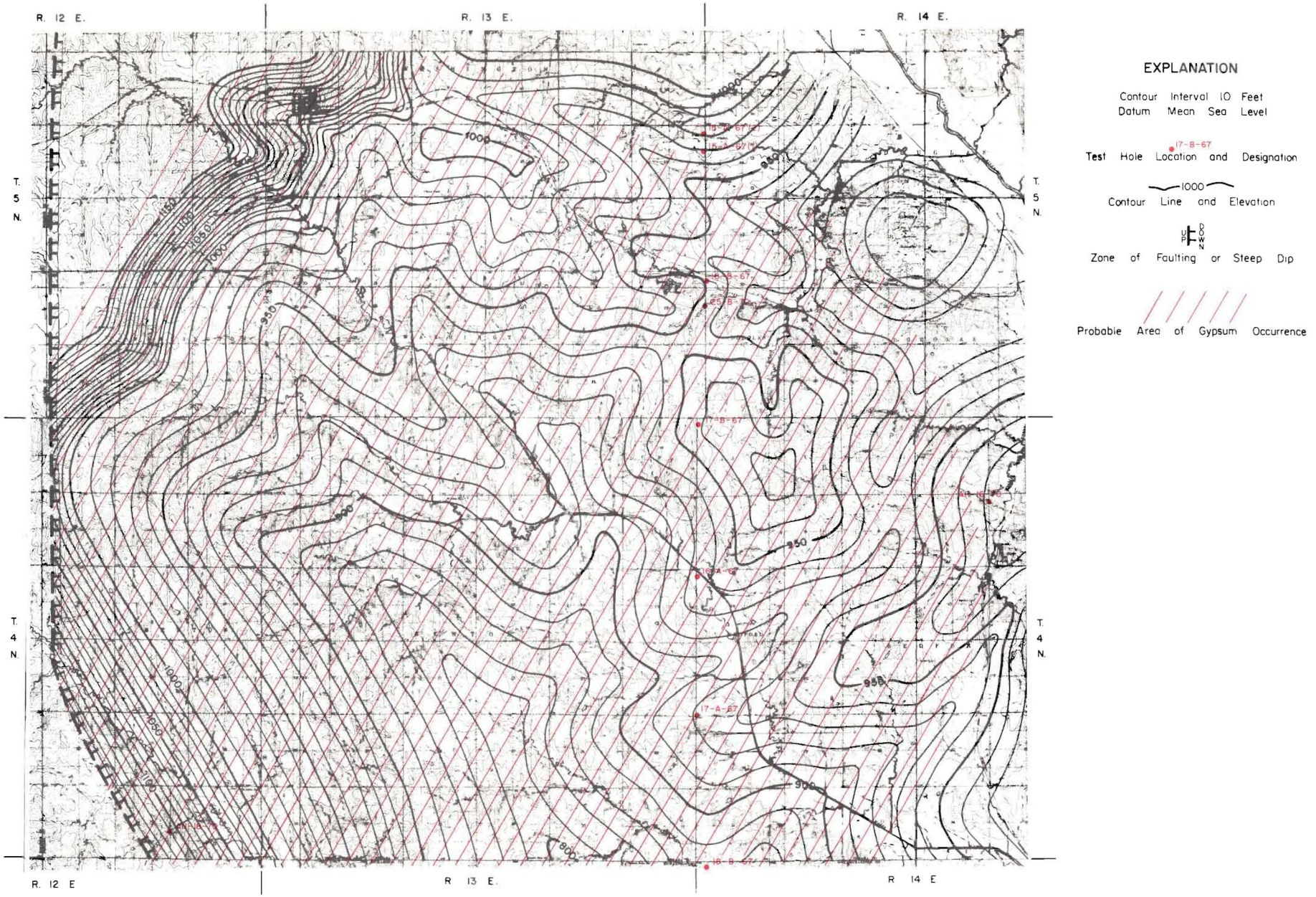

COMPOSITE SECTION OF PERMIAN ROCKS IN NEMAHA COUNTY, NEBRASKA
SYSTEM
SERIES
GROUP
FORMATION
FORMATION OR MEMBER
THICKNESS IN FEET
COMPOSITE LITHOLOGIC SECTION
PERMIAN SYSTEM
BIG BLUE SERIES
COUNCIL GROVE GROUP
ADMIRE GROUP
CROUSE
EASLY CREEK
BADER
MIDDLEBURG
HOOSER
EISS
STEARNS
BEATTIE
MORRILL
FLORENA
COTTONWOOD
ESKRIDGE
GRENOLA
NEVA
SALEM POINT
BURR-SALLYARDS
ROCA
RED EAGLE
HOWE
BENNETT
GLEN ROCK
JOHNSON
FORAKER FORMATION
LONG CREEK
HUGHES CREEK
AMERICUS
HAMLIN
OAKS
HOUCHENS CR
STINE
WEST BRANCH
FIVE POINT
FALLS CITY
LEHMER
RESERVE
MILES
ONAGA
HAUXBY
ASPINWALL
TOWLE
PENNSYLVANIAN SYSTEM
INDIAN CAVE
0
50
100
150
200
250
300
350
COMPLETE SECTION OF PERMIAN IN NEBRASKA
COMPOSITE LITHOLOGIC SECTION (MESOZOIC AGE ROCKS)
GROUP
SERIES
SYSTEM
NIPPEWALLA
SUMNER
CHASE
COUNCIL GROVE
ADMIRE
CIMARRON
BIG BLUE
PERMIAN
PENNSYLVANIAN SYSTEM
KEY
LITHOLOGY
SYMBOLS
Limestone
Dolomite
Gypsum
Salt
Green or Gray Shale
Red Shale
Black Fissile Shale
Sandstone
Oolites
Chert
Glauconite
Osagia
Brachiopods
Crinoids
Gastropods
Fusulines
Bryozoons

Figure 4



STRUCTURAL CONTOUR MAP ON THE BASE OF THE KANSAS CITY GROUP (BASE, HERTHA LIMESTONE) IN NEMAHA COUNTY, NEBRASKA

Figure 5



STRUCTURAL CONTOUR MAP ON THE BASE OF THE JOHNSON SHALE (PERMIAN) IN SOUTHWESTERN NEMAHA COUNTY, NEBRASKA

1 0 1 2 3 4 MILES
SCALE

Figure 6

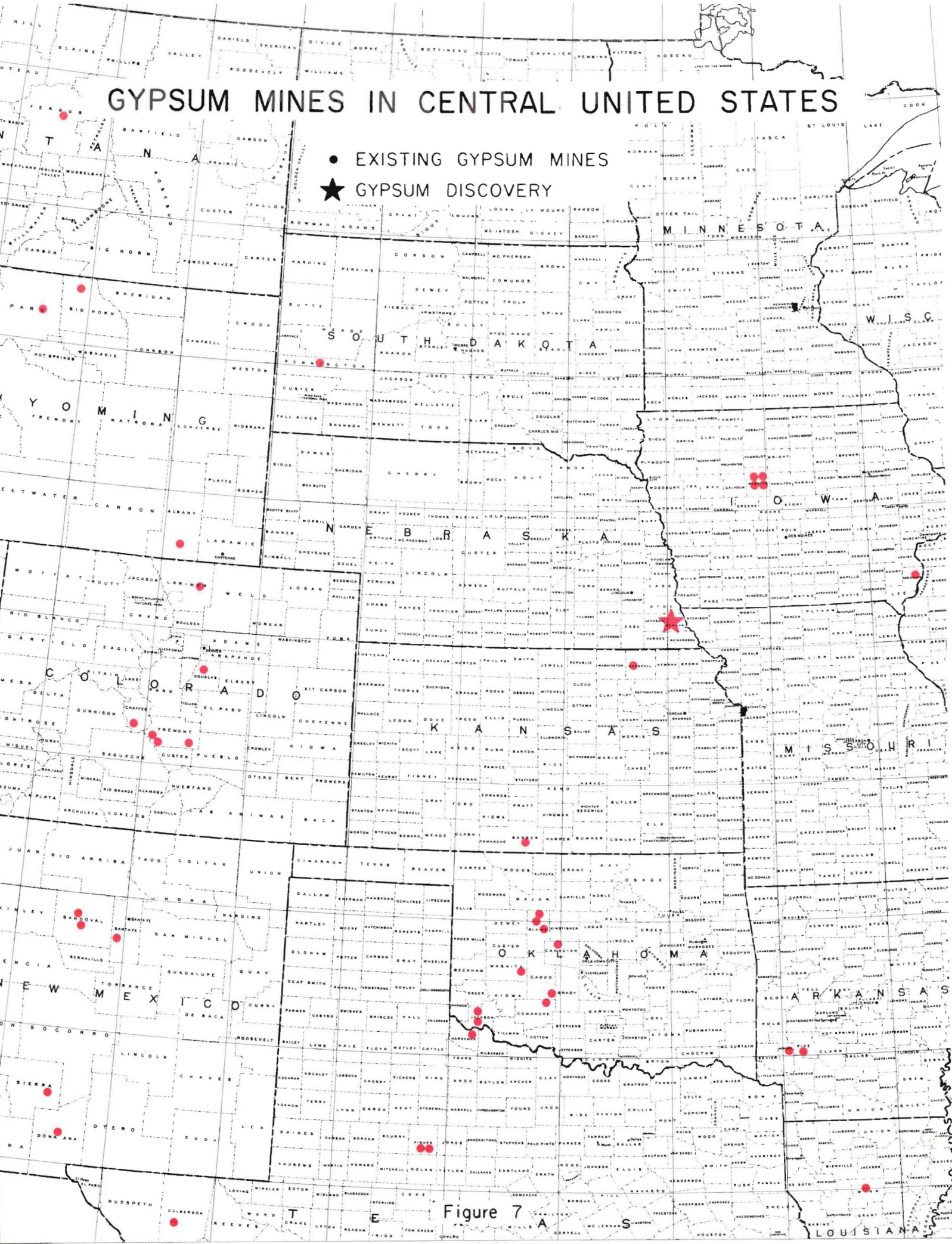

GYPSUM MINES IN CENTRAL UNITED STATES
EXISTING GYPSUM MINES
GYPSUM DISCOVERY
MONTANA
WYOMING
SOUTH DAKOTA
NEBRASKA
COLORADO
KANSAS
OKLAHOMA
TEXAS
NEW MEXICO
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA

Figure 7

OCCURRENCE OF GYPSUM IN NEMAHA COUNTY, NEBRASKA

Although thick deposits of gypsum are not exposed in Nemaha County, Nebraska, subsurface drilling along a north-south line in southwestern Nemaha County indicates that gypsum is present in the lower part of the Johnson Shale 8 to 10 feet in thickness and extending for a distance of about 9 miles. The descriptions of these test holes are presented in the Appendix. A north-south cross section summarizing the drilling across the southwestern part of the county is shown in Figure 8. Electric logs of the test holes indicate that no thick shale seams occur within the main body of the gypsum where drilled. A typical electric log showing the gypsum in Test Hole 17-B-67 is shown in Figure 9.

X-RAY SAMPLE ANALYSES

Samples from Test Hole 25-B-70 from a depth of 95.7 to 105.0 feet were analyzed by Dr. Samuel B. Treves of the University of Nebraska Geology Department.

Ten grams of wet sample were dried at 100° Centigrade for approximately three hours and then pulverized. X-ray analyses were then accomplished by a General Electric XRD5 unit using nickel-filtered copper radiation.

Results of these analyses show that the samples are almost pure gypsum with traces of quartz and clay. See Figure 10.

CONCLUSIONS

Gypsum and anhydrite normally occur as sedimentary strata precipitated from saline water and generally have a wide lateral extent because of their sedimentary mode of origin. Using this as a hypothesis, it is predicted that gypsum deposits in southwestern Nemaha County could cover as much as 118 square miles and have a thickness of 8 to 10 feet.

The gypsum bed in the rotary-drilled test holes (see Appendix) is white and, based upon the X-Ray analyses of samples from Test Hole 25-B-70, appears to be sufficiently pure for the manufacture of gypsum products.

The maximum thickness of overburden in the area of probable gypsum is believed to be about 350 feet. However, detailed exploration may result in finding areas suitable for stripping. Thick deposits of gypsum are not exposed in the outcrops, probably due to the fact that the gypsum is readily leached away when exposed to weathering.

Adequate service facilities including highways, railroads, gas, and electricity are available in the area.

Development of this deposit as a gypsum source requires a more thorough investigation than this study has entailed. Chemical and physical testing of the gypsum to determine its quality would be required. Core drilling on the site would be necessary to determine thickness, purity, and uniformity of the gypsum, the thickness of overburden, groundwater conditions, and areal extent of the deposit.

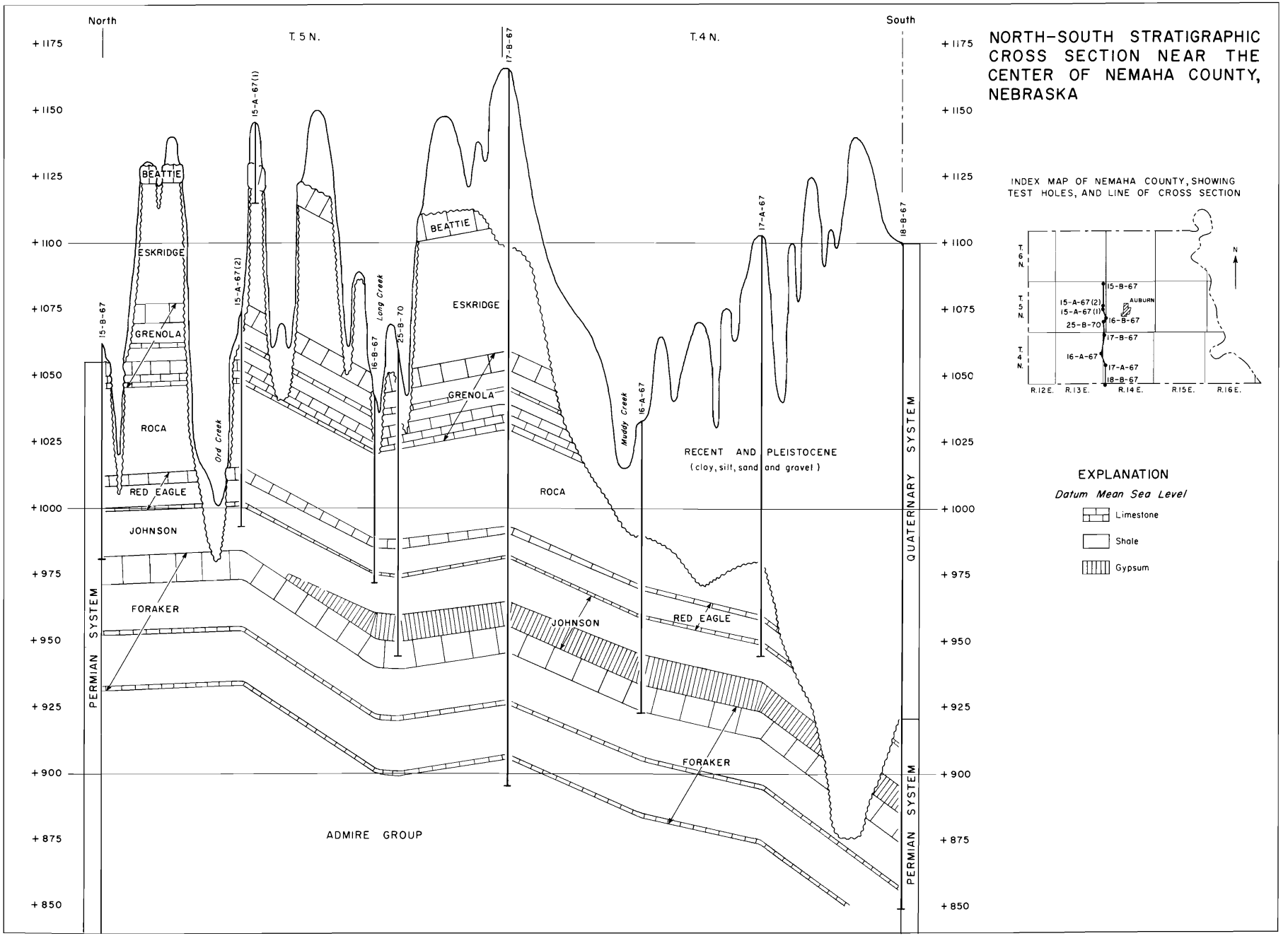

NORTH-SOUTH STRATIGRAPHIC CROSS SECTION NEAR THE CENTER OF NEMAHA COUNTY, NEBRASKA
North
South
T. 5 N.
T. 4 N.
+1175
+1150
+1125
+1100
+1075
+1050
+1025
+1000
+975
+950
+925
+900
+875
+850
15-B-67
15-A-67(1)
15-A-67(2)
16-B-67
25-B-70
17-B-67
16-A-67
17-A-67
18-B-67
Ord Creek
Long Creek
Muddy Creek
BEATTIE
ESKRIDGE
GRENOLA
ROCA
RED EAGLE
JOHNSON
FORAKER
ADMIRE GROUP
PERMIAN SYSTEM
QUATERNARY SYSTEM
RECENT AND PLEISTOCENE
(clay, silt, sand and gravel)
INDEX MAP OF NEMAHA COUNTY, SHOWING TEST HOLES, AND LINE OF CROSS SECTION
T. 6 N.
T. 5 N.
T. 4 N.
R.12E.
R.13E.
R.14E.
R.15E.
R.16E.
AUBURN
N
EXPLANATION
Datum Mean Sea Level
Limestone
Shale
Gypsum

Figure 8

ELECTRIC LOG OF TEST HOLE 17-B-67 SHOWING GYPSUM IN THE JOHNSON SHALE INTERVAL

Location: NW-NW-NW-NW Sec. 6, T. 4 N., R. 14 E., Nemaha County, Nebraska

Total Depth: 270.5 feet Elevation: 1165.6 feet (ground level)

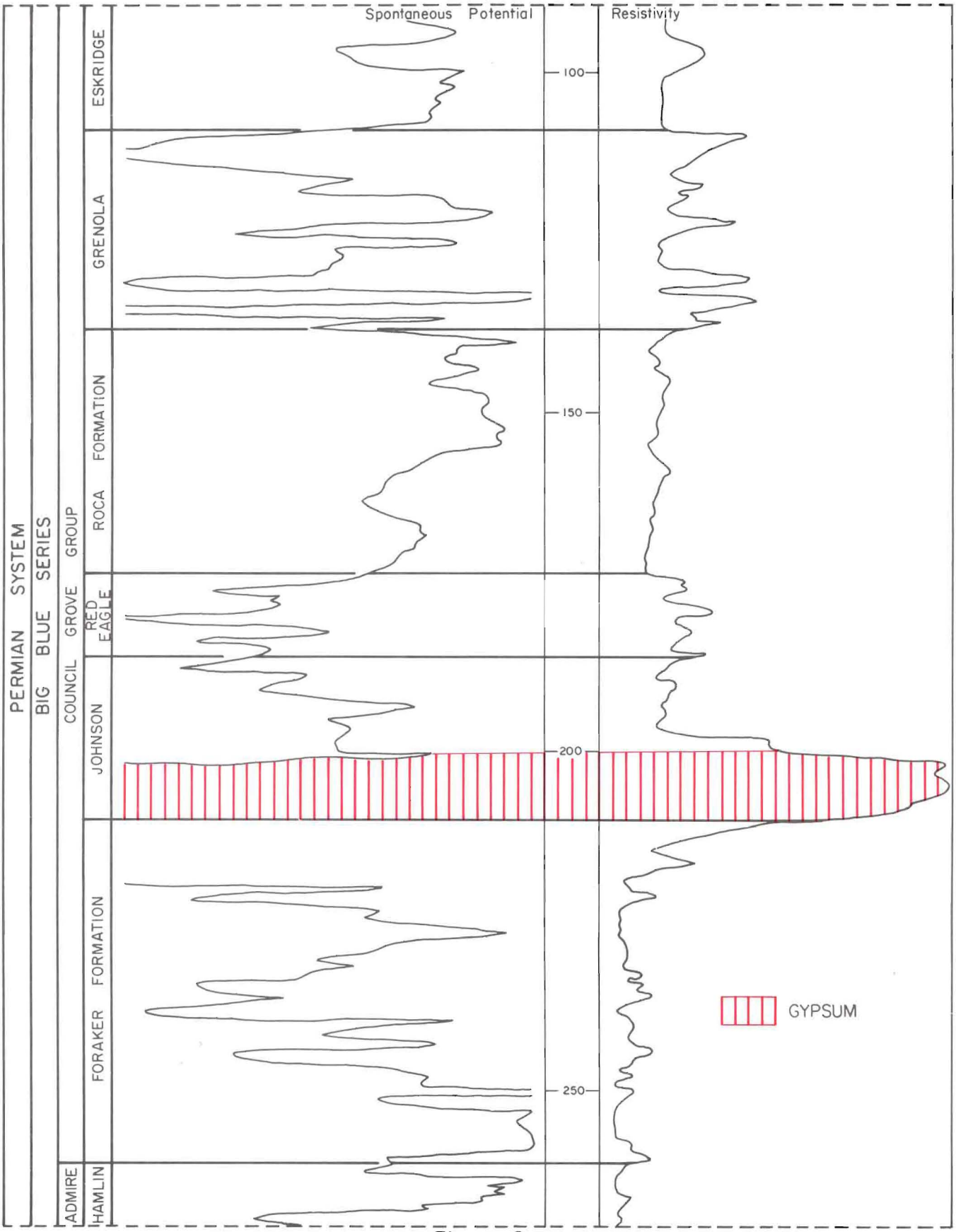
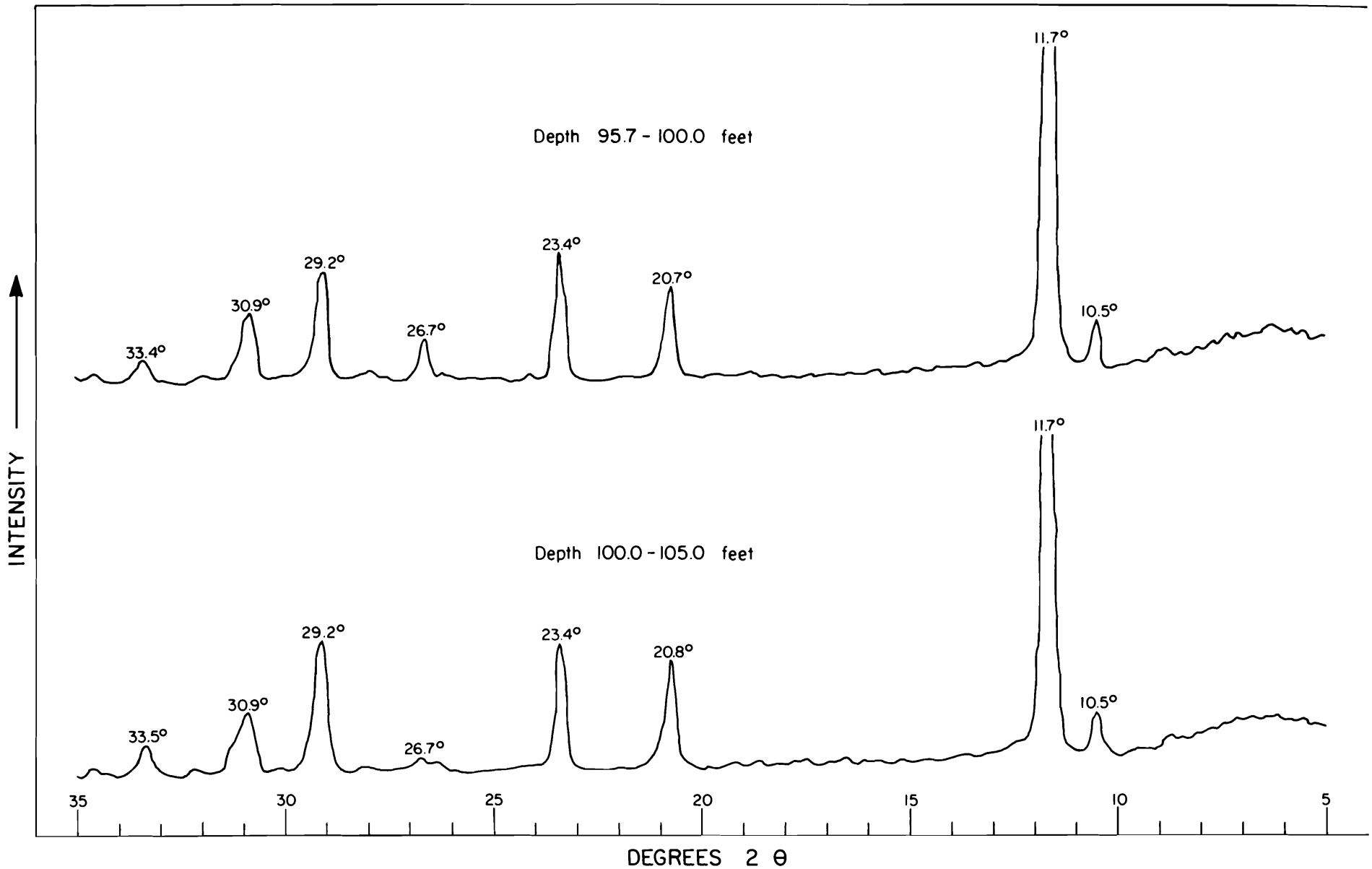


Figure 9



X-Ray Diffractogram of Gypsum Samples from Test Hole 25-B-70.

Figure 10

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APPENDIX

TEST HOLE AH-18-70

Location: C-EL-NE-NW-SE sec. 35, T. 4 N., R. 12 E., Nemaha County, Nebraska.
Total Depth: 57.0 feet.
Elevation: 1118.0 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 9.5
Permian System	
Big Blue Series	
Council Grove Group	
Foraker Limestone Formation	
Long Creek Limestone Member	9.5– 11.5
Hughes Creek Shale Member	11.5– 57.0
Americus Limestone Member (no penetration)	57.0

TEST HOLE 16-A-67

Location: 267 feet south of north section line, 6.5 feet west of east section line (NE-NE-NE sec. 13, T. 4 N., R. 13 E.), Nemaha County, Nebraska.
Total Depth: 1110.0 feet.
Elevation: 1033.4 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 44.4
Permian System	
Big Blue Series	
Council Grove Group	
Roca Shale Formation	44.4– 62.2
Red Eagle Limestone Formation	
Howe Limestone Member	62.2– 64.0
Bennett Shale Member	64.0– 72.7
Glenrock Limestone Member	72.7– 74.0
Johnson Shale Formation	
Shale, very light-gray with interbedded limestone seams	74.0– 76.4
Shale, light greenish-gray	76.4– 85.2
Shale, light greenish-gray with interbedded limestone seams	85.2– 86.9
Gypsum, white with interbedded light greenish-gray shale	86.9– 90.0
Shale, light greenish-gray	90.0– 92.0
Gypsum, white with interbedded light greenish-gray shale and light brownish-gray dolomitic limestone	92.0– 96.0
Gypsum, white	96.0–100.0
Foraker Limestone Formation	
Long Creek Limestone Member	100.0–108.5
Hughes Creek Shale Member	108.5–110.0

TEST HOLE 17-B-67

Location: 198 feet south of north section line, 8.5 feet east of west section line (NW-NW-NW-NW sec. 6, T. 4 N., R. 14 E), Nemaha County, Nebraska.
Total Depth: 270.5 feet.
Elevation: 1165.6 feet (ground level.

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 67.0
Permian System	
Big Blue Series	
Council Grove Group	
Eskridge Shale Formation	67.0–107.4

17-B-67 (continued)

Grenola Limestone Formation	
Neva Limestone Member	107.4–122.3
Salem Point Shale Member	122.3–127.3
Burr Limestone-Legion Shale-Sallyards Limestone Members	127.3–137.4
Roca Shale Formation	137.4–173.5
Red Eagle Limestone Formation	
Howe Limestone Member	173.5–176.5
Bennett Shale Member	176.5–185.0
Glenrock Limestone Member	185.0–186.1
Johnson Shale Formation	
Shale, light greenish-gray with interbedded gray limestone seams	186.1–191.1
Shale, light greenish-gray	191.1–196.6
Gypsum, white	196.6–197.5
Shale, light greenish-gray	197.5–198.8
Gypsum, white with interbedded light greenish-gray shale	198.8–200.0
Gypsum, white	200.0–209.9
Foraker Limestone Formation	
Long Creek Limestone Member	209.9–220.0
Hughes Creek Shale Member	220.0–259.4
Americus Limestone Member	259.4–261.1
Admire Group	
Hamlin Shale Formation	
Oaks Shale Member	261.1–270.5

TEST HOLE AH-16-70

Location: 370 feet south of the north section line, 6.0 feet west of the east section line (NE-NE-NE sec. 10, T. 4 N., R. 14 E.), Nemaha County, Nebraska.
Total Depth: 30.5 feet.
Elevation: 999.5 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 11.5
Permian System	
Big Blue Series	
Council Grove Group	
Johnson Shale Formation	
Shale, pale-olive	11.5– 18.0
Shale, pale-olive, with gypsum nodules	18.0– 21.5
Shale, pale-olive mottled yellowish-brown	21.5– 25.0
Shale, pale-olive mottled yellowish-brown with greenish-gray limestone seams	25.0– 26.0
Shale, light greenish-gray	26.0– 28.0
Shale, pale-olive mottled pale-yellow with interbedded limestone seams	28.0– 29.0
Shale, pale-olive with gypsum nodules	29.0– 29.5
Shale, pale yellowish-brown	29.5– 30.5
Foraker Limestone Formation	
Long Creek Limestone Member (no penetration)	30.5

TEST HOLE 17-A-67

Location: 367.5 feet north of south section line, 4.5 feet east of west section line (NW-SW-SW-SW sec. 19, T. 4 N., R. 14 E.), Nemaha County, Nebraska.
Total Depth: 160.5 feet.
Elevation: 1103.1 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0–123.5

17-A-67 (continued)

Permian System	
Big Blue Series	
Council Grove Group	
Roca Shale Formation	123.5–144.0
Red Eagle Limestone Formation	
Howe Limestone Member	144.0–146.0
Bennett Shale Member	146.0–154.5
Glenrock Limestone Member	154.5–157.3
Johnson Shale Formation	
Shale, light greenish-gray	157.3–160.5

TEST HOLE AH-17-70

Location: NE-NE-NW sec. 20, T. 4 N., R. 15 E. Nemaha County, Nebraska.
Total Depth: 35.5 feet.
Elevation: 1050.0 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 16.5
Permian System	
Big Blue Series	
Council Grove Group	
Johnson Shale Formation	
Shale, pale-olive	16.5– 24.5
Shale, light- to medium-gray	24.5– 26.0
Shale, olive mottled yellow	26.0– 29.5
Shale, light-gray mottled greenish-gray	29.5– 35.5
Foraker Limestone Formation	
Long Creek Limestone Member (no penetration)	35.5

TEST HOLE 15-B-67

Location: 107 feet south of north section line, 11.0 feet west of east section line (NE-NE-NE-NE sec. 1, T. 5 N., R. 13 E.), Nemaha County, Nebraska.
Total Depth: 80.5 feet.
Elevation: 1062.1 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 7.0
Permian System	
Big Blue Series	
Council Grove Group	
Grenola Limestone Formation	
Burr Limestone-Legion Shale-Sallyards Limestone Members	7.0– 17.5
Roca Shale Formation	17.5– 49.5
Red Eagle Limestone Formation	
Howe Limestone Member	49.5– 52.7
Bennett Shale Member	52.7– 60.8
Glenrock Limestone Member	60.8– 62.0
Johnson Shale Formation	
Shale, pale-yellow	62.0– 64.5
Shale, pale-yellow with interbedded pale-yellow limestone seams	64.5– 70.0
Shale, pale-olive	70.0– 71.3
Limestone, pale-olive, very finely crystalline	71.3– 71.6
Shale, pale-olive	71.6– 77.4
Shale, pale-olive with interbedded light-gray shale	77.4– 79.5
Foraker Limestone Formation	
Long Creek Limestone Member	79.5– 80.5

TEST HOLE 15-A-67 (1)

Location: 1663.5 feet south of north section line, 9.0 feet west of east section line (SE-NE-SE-NE sec. 13, T. 5 N., R. 13 E.), Nemaha County, Nebraska.
Total Depth: 30.0 feet.
Elevation: 1145.0 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 14.5
Permian System	
Big Blue Series	
Council Grove Group	
Beattie Limestone Formation	
Cottonwood Limestone Member	14.5– 25.0
Eskridge Shale Formation	25.0– 30.0

TEST HOLE 15-A-67 (2)

Location: 250.0 feet south of north section line, 9.0 feet west of east section line (NE-NE-NE-NE sec. 13, T. 5 N., R. 13 E.), Nemaha County, Nebraska.
Total Depth: 80.5 feet.
Elevation: 1073.3 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 11.3
Permian System	
Big Blue Series	
Council Grove Group	
Grenola Limestone Formation	
Salem Point Shale Member	11.3– 17.3
Burr Limestone-Legion Shale-Sallyards Limestone Members	17.3– 26.4
Roca Shale Formation	26.4– 57.5
Red Eagle Limestone Formation	
Howe Limestone Member	57.5– 63.0
Bennett Shale Member	63.0– 70.6
Glenrock Limestone Member	70.6– 72.6
Johnson Shale Formation	
Shale, light greenish-gray with interbedded limestone seams	72.6– 75.0
Shale, pale-olive	75.0– 80.5

TEST HOLE 25-B-70

Location: 2375 feet south of north section line, 6.5 feet west of east section line (C-EL-SE-SE-NE sec. 25, T. 5 N., R. 13 E.), Nemaha County, Nebraska.
Total Depth: 110.0 feet.
Elevation: 1054.5 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 15.3
Permian System	
Big Blue Series	
Council Grove Group	
Grenola Limestone Formation	
Neva Limestone Member	15.3– 18.8
Salem Point Shale Member	18.8– 23.1
Burr Limestone Member	23.1– 29.6
Legion Shale Member	29.6– 30.7
Sallyards Limestone Member	30.7– 32.9
Roca Shale Formation	32.9– 67.6
Red Eagle Limestone Formation	
Howe Limestone Member	67.6– 72.3
Bennett Shale Member	72.3– 81.0
Glenrock Limestone Member	81.0– 82.6

25-B-70 (continued)

Johnson Shale Formation	
Shale, light greenish-gray with interbedded thin greenish-gray limestone seams	82.6– 88.5
Shale, light greenish-gray with interbedded thin, white, gypsum seams	88.5– 89.0
Shale, light greenish-gray, clay	89.0– 90.0
Shale, light greenish-gray with interbedded light greenish-gray siltsone	90.0– 92.1
Shale, light-gray with interbedded greenish-gray siltstone	92.1– 92.5
Shale, light- to medium-gray with some interbedded white gypsum seams	92.5– 94.8
Shale, light greenish-gray	94.8– 95.7
Gypsum, white	95.7–105.3
Foraker Limestone Formation	
Long Creek Limestone Member	105.3–110.0

TEST HOLE 16-B-67

Location: 443 feet south of north section line, 5.0 feet east of west section line (SW-NW-NW-NW sec. 30, T. 5 N., R. 14 E.), Nemaha County, Nebraska.
Total Depth: 70.5 feet.
Elevation: 1042.0 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0– 23.4
Permian System	
Big Blue Series	
Council Grove Group	
Roca Shale Formation	23.4– 54.1
Red Eagle Formation	
Howe Limestone Member	54.1– 56.3
Bennett Shale Member	56.3– 66.7
Glenrock Limestone Member	66.7– 68.0
Johnson Shale Formation	
Shale, light greenish-gray with interbedded, very finely crystalline, gray limestone	68.0– 70.5

TEST HOLE 18-B-67

Location: 7.5 feet south of north section line, 696 feet east of west section line (NW corner NE-NW-NW sec. 6, T. 3 N., R. 14 E.), Richardson County, Nebraska.
Total Depth: 250.5 feet.
Elevation: 1099.7 feet (ground level).

	Depth (feet)
Quaternary System	
Recent and Pleistocene Series	0.0–179.3
Permian System	
Big Blue Series	
Council Grove Group	
Red Eagle Limestone Formation	
Bennett Shale Member	179.3–189.0
Glenrock Limestone Member	189.0–190.5
Johnson Shale Formation	
Shale, light greenish-gray with interbedded limestone seams	190.5–192.8
Shale, light greenish-gray	192.8–198.0
Limestone, light-gray, very finely crystalline	198.0–198.4
Shale, light greenish-gray, silty	198.4–202.1
Shale, light greenish-gray with interbedded siltstone seams	202.1–202.7
Shale, light greenish-gray with interbedded white gypsum	202.7–205.5
Shale, light greenish-gray	205.5–206.5
Gypsum, white	206.5–216.4
Foraker Limestone Formation	
Long Creek Limestone Member	216.4–227.2
Hughes Creek Shale Member	227.2–250.5