

**KANSAS GEOLOGICAL SURVEY
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GEOLOGY OF SALINE COUNTY

by

D. F. Merriam

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INTRODUCTION

Saline County is located in central Kansas. The eastern part of the county lies in the Flint Hills Uplands, which are composed mainly of Permian rocks. The western part of the county comprises part of the Smoky Hills of the Dissected High Plains and is composed of Cretaceous rocks (Fig.). A distinct stratigraphic break occurs between the two types of outcropping rocks that give rise to two physiographic provinces. In general, Permian outcropping rocks dip gently to the west and Cretaceous units dip northwest.

STRATIGRAPHY

Rocks ranging in age from Precambrian to Recent occur in Saline County. Only those of Permian, Cretaceous, and Quaternary age, however, crop out within the confines of the county. Other rock units are present only in the subsurface (Fig.).

The Precambrian basement consists mainly of slightly metamorphosed sediments of unknown thickness. Rocks of this type and igneous and metamorphic rocks underlie much of the Midcontinent region and form a stable platform on which younger rocks were deposited. The Precambrian basement can be considered as a shallow-buried extension of the Canadian Shield which is exposed farther to the northeast.

Nonconformably overlying the Precambrian basement are rocks of Paleozoic age. These rocks, consisting of alternating sandstone, shale, limestone, and dolomite, are as much as 4,000 feet thick. The lowest Paleozoic rock unit is the Reagan Sandstone. The

Reagan Sandstone together with the units of the Arbuckle Group extends over all of Saline County (Fig.). Overlying the Arbuckle Group are rocks of Simpson, Viola, and Maquoketa age which also are present over all of Saline County (Fig. ,). Rocks of the "Hunton Group" which are Siluro-Devonian in age, occur in most of the county except in the southwestern corner where they have been removed by erosion (Fig.).

Unconformably overlying the "Hunton Group" is the Chattanooga Shale which is Devonian and Mississippian in age (Fig.). This unit is conformably overlain by rocks of Mississippian age (Fig.). At top of the Mississippian section is a unit known as "Mississippi chat" or "PBC," which represents a residual weathered and reworked product. The Pennsylvanian section overlies older rocks with marked unconformity. Alternating sandstone, shale, and limestone units occur throughout the Pennsylvanian and lower part of the Permian in Saline County (Fig. ,). These cyclicly deposited beds are succeeded by Permian-age rocks that consist predominantly of redbeds and evaporites. The upper part of these beds of the Sumner Group are found to crop out in the eastern part of Saline County.

Unconformably overlying Permian rocks are the Kiowa and Dakota Formations, of Cretaceous age (Fig.). These units consist mainly of sandstone and shale. Unconformably overlying the Mesozoic deposits are Cenozoic deposits of Pleistocene and Recent age. These deposits usually occur either as thin-covering deposits on uplands or are confined to Recent stream valleys. Present day geology is shown in Figure .

STRUCTURE

Structurally, Saline County is part of the Salina Basin (Fig.). The Salina Basin, bordered on the east by the Nemaha Anticline and on the west by the Cambridge Arch -- Central Kansas Uplift-- Pratt Anticline complex, is a southward extension of the larger Central Nebraska Basin located mainly farther north. The southern boundary of the basin is an

indistinct, unnamed saddle. Axis of this late Paleozoic basin trends northwest and plunges northward into the deeper part of the basin in north-central Kansas. Prior to the end of Mississippian time the basin formed part of the larger north Kansas Basin.

The Salina Basin, the second largest in Kansas, covers an area of about 12,700 square miles. Maximum thickness of sedimentary rocks overlying the Precambrian basement in the center of the basin is approximately 4,500 feet. Also located within the basin are many minor and important anticlinal features such as the Abilene Anticline. These smaller structures plunge southwestward from the Nemaha Anticline.

OIL AND GAS POSSIBILITIES

Kansas' second largest basin has been little explored for its oil and gas possibilities, although petroleum was discovered in the late 1920's. As of 1956 cumulative oil production was only slightly more than 100 million barrels and gas production was not significant. Most of the important producing fields in the basin occur elsewhere than Saline County. Production by fields and their location is shown in Table and Figure .

Possible producing zones in Saline County include the Reagan Sandstone, Arbuckle Group, Simpson Group, Viola Limestone, Mississippian rocks, sands of the Cherokee Group (Pennsylvanian; Fig.).

By far the greatest amount of production from the basin as of 1959 was from rocks of Mississippian age. Future possibilities are structural traps and combination of structural and stratigraphic traps on the flanks of the basin. The center part of the basin is almost totally unexplored and flank production is not yet completely developed. Few wells have been drilled on the east side of the basin and stratigraphic possibilities there in the Lower Paleozoic formations seemingly should be good.

REFERENCES

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- Merriam, D.F., and Goebel, E.D., 1956, Kansas structural provinces offer varied types of traps: Oil and Gas Jour., v. 54, no. 52, p. 141, 143-145, 147-149, 151, 153-154.
- Merriam, D.F., and Goebel, E.D., 1959a, Alert explorers find Kansas oil: Oil and Gas Jour., v. 57, no. 10, p. 166-168, 171, 175.
- Merriam, D.F., and Goebel, E.D., 1959b, Where's the oil in Kansas?: Oil and Gas Jour., v. 57, no. 11, p. 212-218.
- Schoewe, W.H., 1949, The geography of Kansas, pt. 2, physical geography: Kansas Acad. Sci. Trans. v. 52, no. 3, p. 261-333.

Table . - Oil production in Saline County

Field name and year of discovery	Location of discovery well	Area, acres	Oil production, bbl		Producing wells	Name	Depth ft.	Thickness ft.	Avg. gravity	Type trap, S = structure, St = strata trap
			during 1965	to end of 1965						
Bachofer ('51)	15-15S-2W	200	11,280	164,372	5	Miss.	2,799	6	33	
Bachofer (162)	14-15S-2W	40	1,621	3,797	1	Miss.	2,760	5	33	
Gillberg ('59)	28-14S-2W	280	15,413	104,565	7	Maquo- keta	3,223	8	33	
Gypsum ('63)	27-15S-1W	40	858	3,813	1	Miss.	2,566	5	36	
Gypsum Creek ('44)	4-17S-1W	1,000	62,076	1,138,852	25	Lans.- K.C.	2,072	8		
(Also McPherson Co.) Hunter ('43)	20-16S-1W	1,000	27,467	1,585,696	26	Miss. Douglas "Chat"	2,619 1,841 2,681	14 2	36	S
Hunter North ('48)	8-16S-1W	320	14,780	432,157	8	Miss.	2,674	21	36	
Jackman ('60)	10-15S-1W		no report	2,370		Miss.	2,547	4		
Lindsborg ('38)	8-17S-3W	2,400	82,980	2,129,833	78	Viola	3,381	54	35	
(Also McPherson Co.) Mortimer ('58)	5-16S-1W	320	14,707	44,458	8	Miss.	2,639	14		
Olsson ('29)	10-16S-3W	940	36,157	1,184,834	41	Viola	3,303	12	35	
Pihl ('63)	26-15S-2W	440	84,965	162,328	13	Miss.	2,740	4		
Pliny ('43)	9-16S-1W	120	1,932	21,803	3	Lans.- K.C.	1,990	8		
Salina ('43)	30-14S-2W	4,000	210,566	2,858,021	100	Viola	3,223	8	34	
Shultz ('62)	20-15S-3W	40	8,667	14,389	1	Maquo- keta	3,264			
Smolan ('50)	19-15S-3W	2,900	88,416	4,940,461	83	Viola Maquo- keta	3,383 3,420	15 6	36	
Swenson ('50)	34-15S-3W	300	2,031	80,104	7	Viola Viola	3,386 3,353	6	27 35	
Total Saline County		14,340	663,916	14,871,853	407					

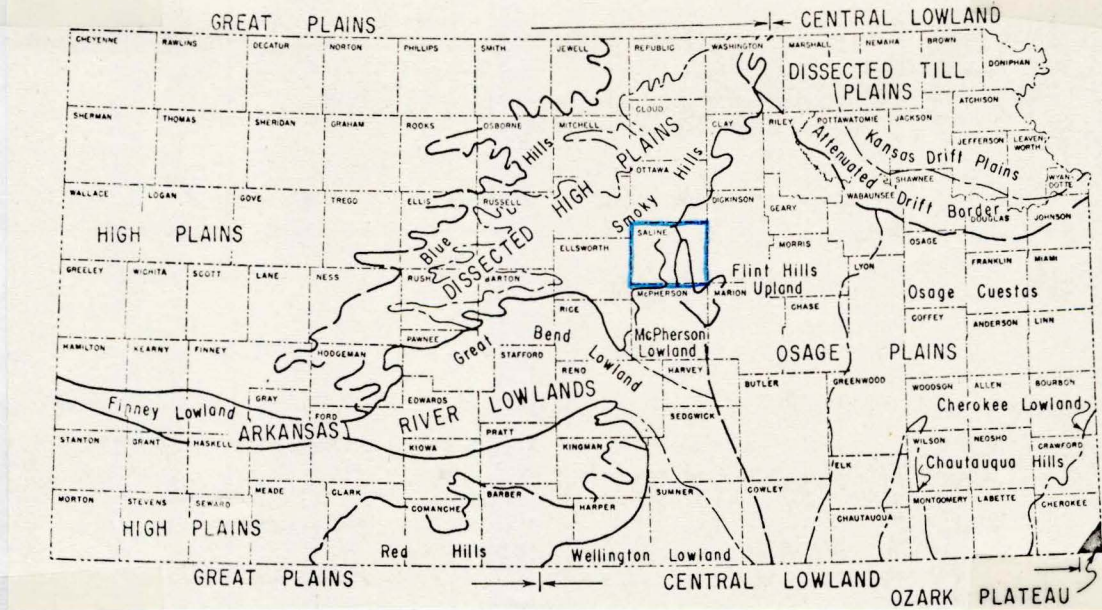


Figure .-Physiographic map of Kansas (Saline County outline with heavy line), adapted from Schoewe, 1949).



Figure .-Major tectonic features of Kansas with special reference to Saline County (heavy outline). A. Major pre-Desmoinesian--post-Mississippian structural features . B. Regional configuration map on top of Precambrian basement complex (adapted from Cole, 1962).

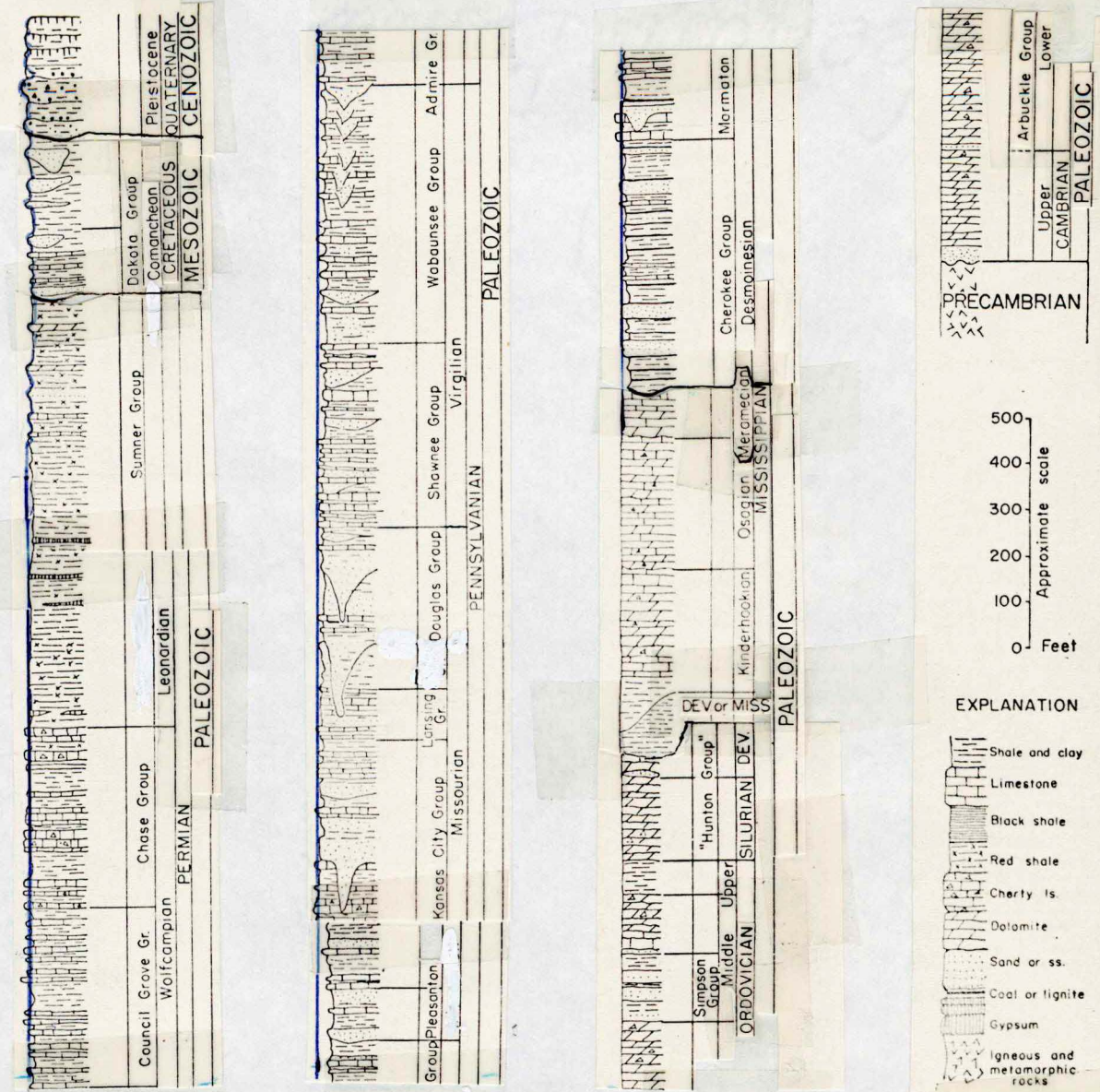


Figure .-Generalized stratigraphic section of rock units present in Saline County, Kansas (adapted from Merriam, 1963).

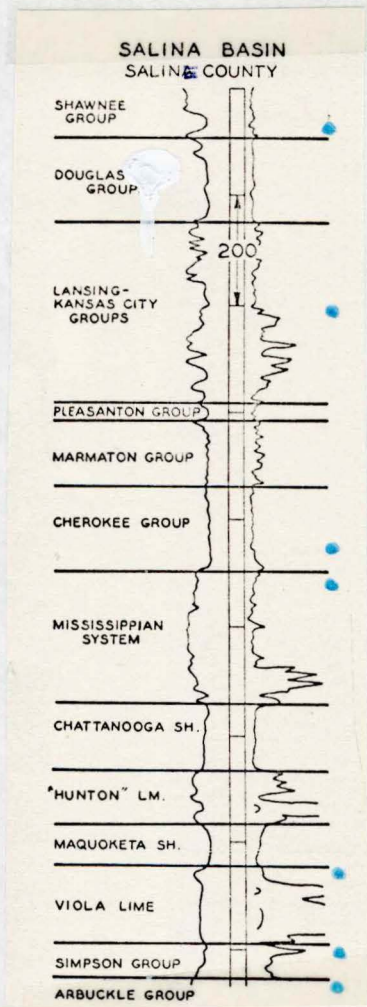


Figure .-Representative electric log of strata present in Salina Basin (from Merriam and Goebel, 1956). • Denotes possible producing zones. Older Reagan Sandstone also possible producing zone but not shown (adapted from Merriam and Goebel, 1959).

ECONOMIC GEOLOGY

Because of the nature of stratigraphic units which occur in Saline County there are only certain resources which could be present. These have been broken down into Proven, Probable and Possible as shown in Table .

Nonfuel Possibilities

Most of the resources which can be construed as nonfuel occur on the surface only. Proven resources include gypsum, salt (and related minerals), which are present only in the subsurface sand and gravel, clay, light-weight aggregate and riprap. Many of these resources are presently being exploited. Other resources occurring in the County which probably could be exploited are volcanic ash and building stone. Possible but not probable resources include utilization of redbeds, perhaps for their iron content and secondary copper enrichment in the redbed units, and brines, which may or may not be associated with petroleum and occur in the subsurface only.

Oil and Gas Possibilities

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By far the greatest amount of production from the basin as of 1965 was from rocks of Mississippian age. Future possibilities are structural traps and combination of structural and stratigraphic traps on the flanks of the basin. The center part of the basin is almost totally unexplored and flank production is not yet completely developed. Few wells have been drilled on the east side of the basin and stratigraphic possibilities there in the lower Paleozoic formations seemingly should be good.

Other Fuel Possibilities

Peat and lignite are known to occur in Saline County.

	PROVEN	PROBABLE	POSSIBLE
FUEL	Crude Oil (s)	Natural Gas (s)	Helium (s) Peat Lignite
NONFUEL	Gypsum Salt (and related minerals (s)) Sand and Gravel Clay Light-weight aggregate Riprap	Volcanic Ash Building stone	Redbeds Copper Brine (s)

(s) subsurface only

The factors that have been considered pertinent for this study are listed in the following outline; although the mineral resources are stressed, the proposed methodology furnishes guidelines for undertaking a regional natural resource study. Most of the Saline County mineral resources are ubiquitous and have high place value rather than high unit value; accordingly, where a particular mineral deposit occurs may be as important as the quality and reserves of that deposit. The accessibility of the resource, the availability of energy sources, the labor force, climate, and land resources of the area -- all are important economic factors.

Part I

1.0 Physical and cultural geography

1.1 The location and dimensions of the county

1.11 Adjacent regions

1.2 Drainage

1.21 Principal rivers and tributaries

1.3 Climate

1.31 Rainfall

1.32 Temperature variation

1.33 Storm frequency

1.34 Quality of atmosphere and prevailing winds

1.4 Water resources

1.41 Available resources

1.42 Quantity and quality of water

1.43 Water problems

- 1.5 The land
 - 1.51 Soils of the region
 - 1.52 Ownership, i. e. , private, industry, government
 - 1.53 Utilization, i. e. , farming, urban, recreational, industrial
- 1.6 The historical background
 - 1.61 Date of settlement and organization
 - 1.62 Origin of early settlers
 - 1.63 Early industries
- 1.7 The people
 - 1.71 Characteristics of the population
 - 1.711 Trends, total and by age and sex
 - 1.712 County distribution and population density
 - 1.713 Rural and urban comparisons
- 1.8 Transportation facilities
 - 1.81 Main highways and secondary roads
 - 1.82 Railways, airlines and bus services
 - 1.83 Pipelines and other transportation
- 1.9 Energy resources
 - 1.91 Crude oil and crude oil products
 - 1.92 Electric power

Part II

- 2.0 The geology of the area
 - 2.1 Describe the physiographic features

- ✓ 2.2 Describe the rocks and deposits making up the geologic features
 - ✓ 2.21 Discuss any features of special significance to present natural resources
 - ✓ 2.22 Discuss any features bearing on future natural resource development
- ✓ 2.3 Point out any impact geological technology might have on the future development of natural resources

Part III

3.0 The mineral resources of the area

3.1 Review of presently known mineral resources

✓ 3.11 Fuels

3.12 Non-fuels

3.121 Availability

3.122 Uses of non-fuel resources

3.2 Historical use of mineral resources

3.3 Trends in value of mineral resources

3.4 Measurement techniques for trends and economic impact of mineral resource utilization

3.41 Use shift analysis to measure the impact of national growth, industry mix, and regional share of markets on the region's economy

3.411 Employment data can be utilized

- 3.42 Use input-output analysis to measure present interindustry transactions and to estimate the impact of change in the region's industrial relationships

Part IV

4.0 Implementation of regional natural resource assessment

4.1 Utilizing the disciplines of geology and economics, the regional resource endowment is catalogued in a five-step program

4.11 The first step is an assessment of the resource-market relationship

4.12 Study of existing geological data on resources and/or field reconnaissance

4.13 Gross market-availability-site analysis

4.14 Resource evaluation in view of potential use specifications

4.15 Evaluation and definition of potential resource into one of three classes, i. e. , proven, probable, or possible

4.2 This method is illustrated using a Saline County resource of deposits of Kaolin-quartz mixtures.

Part V

5.0 Outline of staff and funds required to perform the foregoing resource analysis for all Kansas counties

5.1 Personnel requirements

5.2 Time required

5.3 Probable funds required

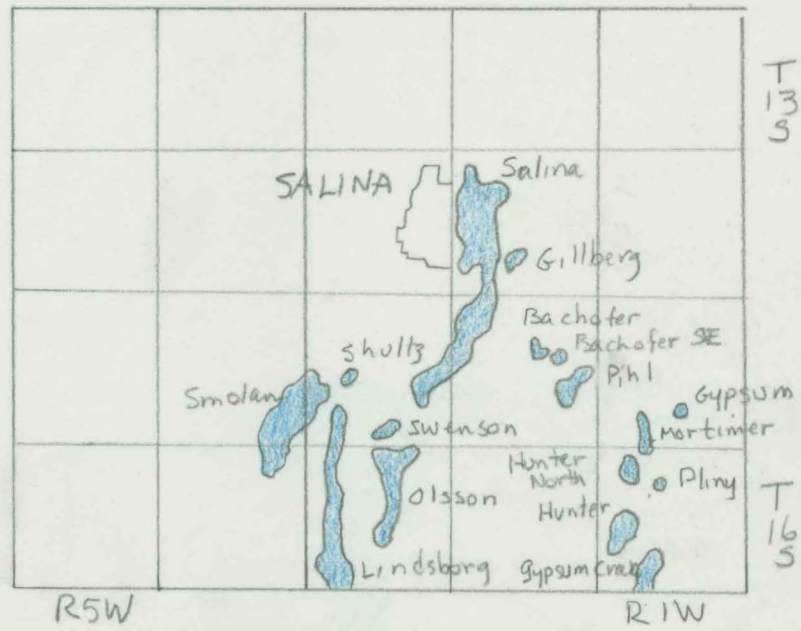


Figure .-Outline of oil-producing areas in Saline County, Kansas.

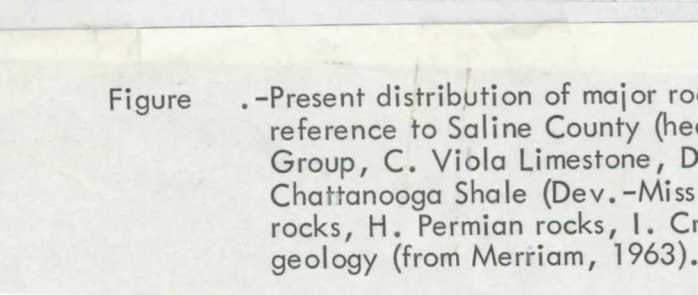
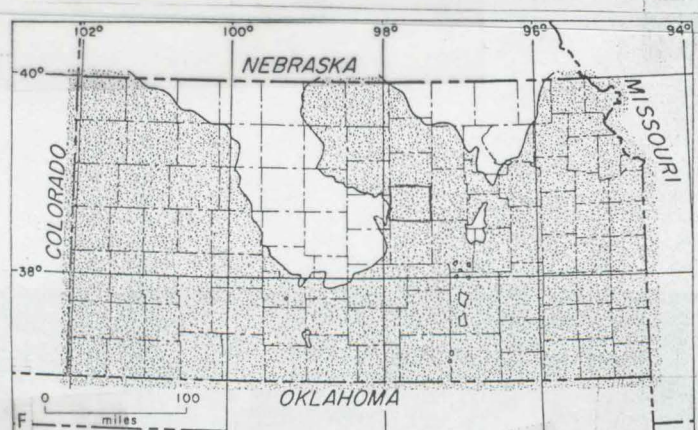
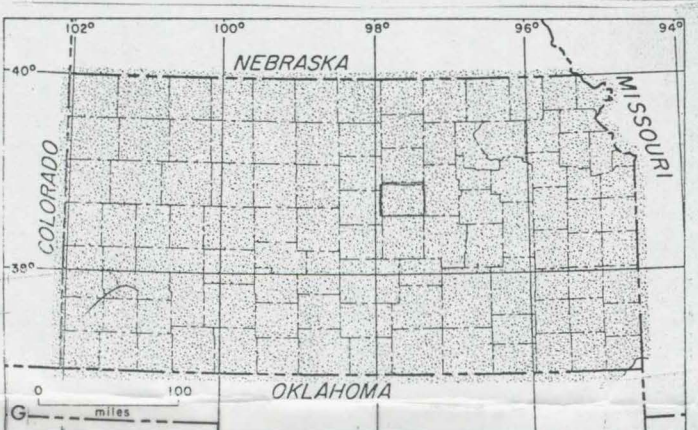
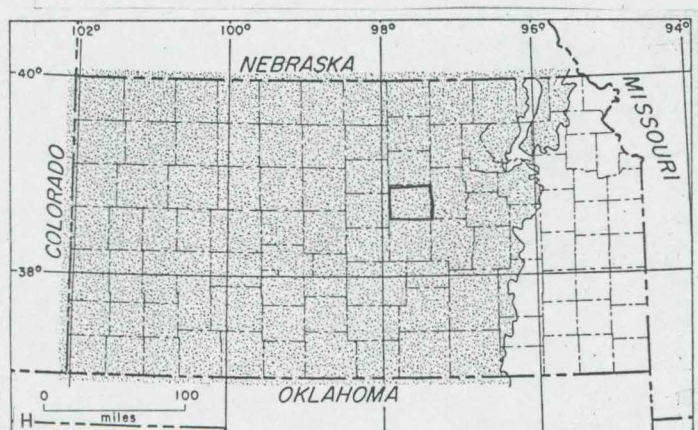
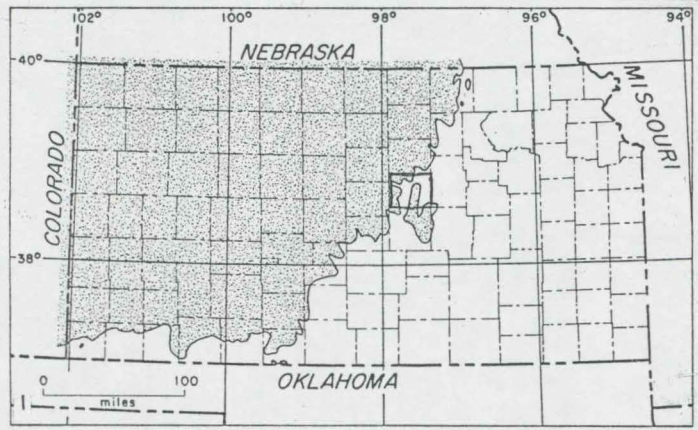
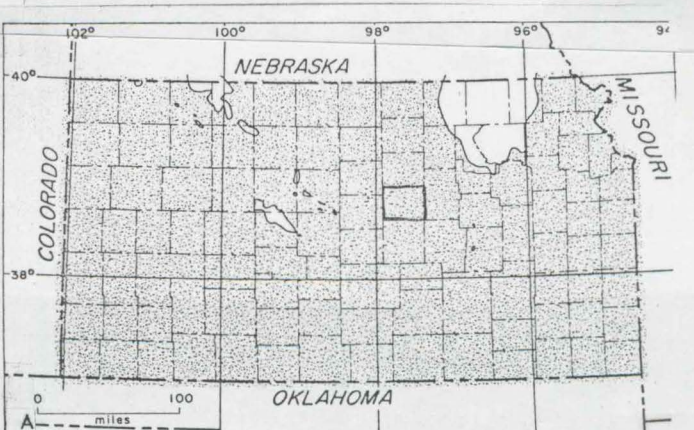
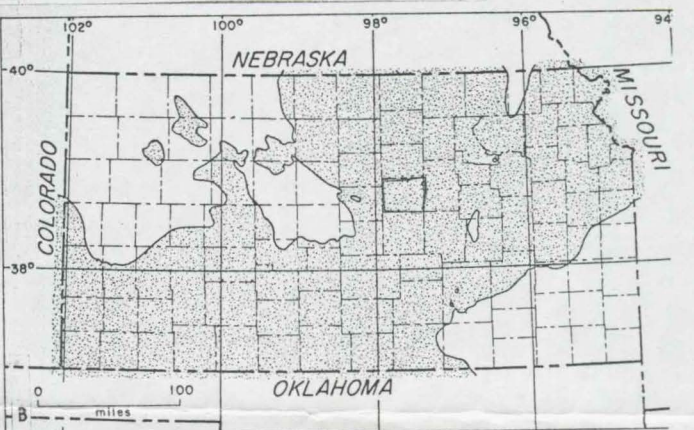
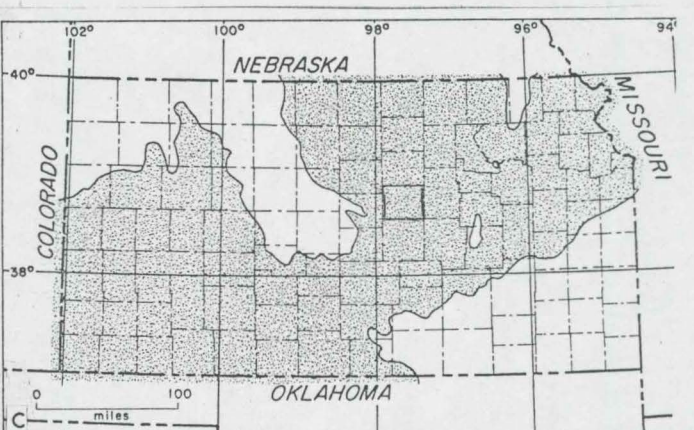
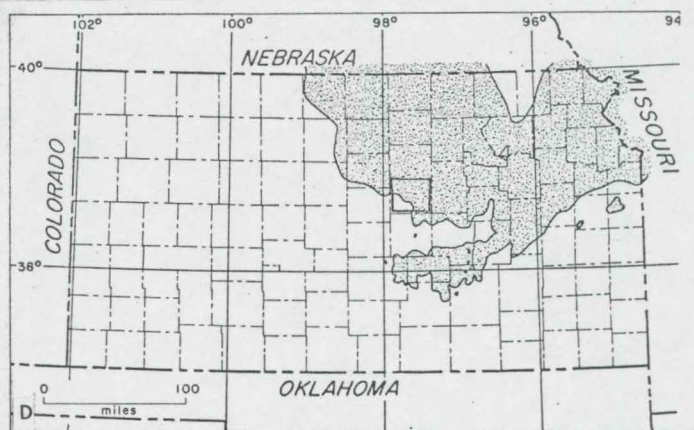
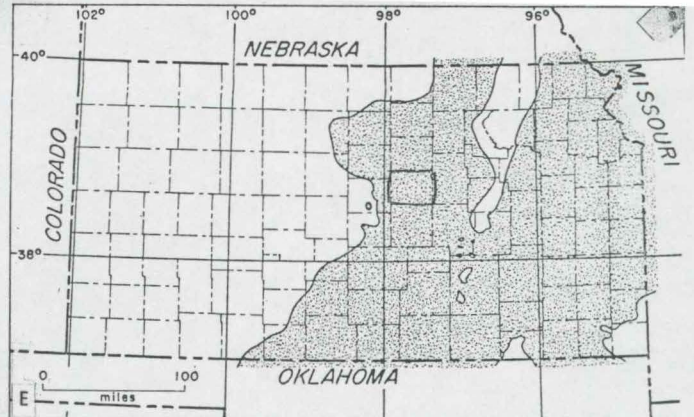
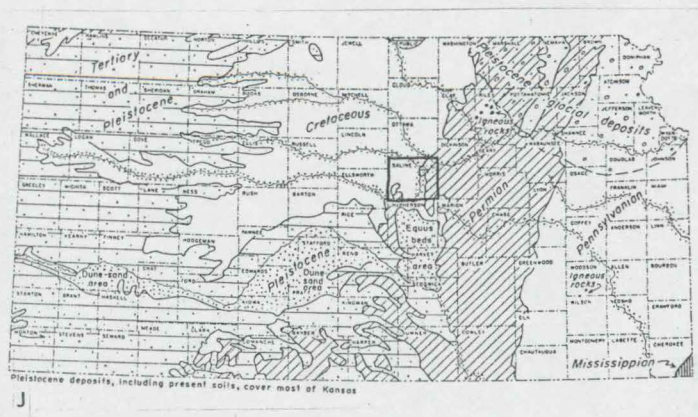


Figure .-Present distribution of major rock unit in the State of Kansas with special reference to Saline County (heavy outline). A. Arbuckle Group, B. Simpson Group, C. Viola Limestone, D. "Hunton Group" (Siluro-Devonian), E. Chattanooga Shale (Dev.-Miss.), F. Mississippian rocks, G. Pennsylvanian rocks, H. Permian rocks, I. Cretaceous rocks, and J. present generalized geology (from Merriam, 1963).