

GEOMORPHOLOGY OF THE LOWER SALINE RIVER VALLEY
IN NORTHCENTRAL KANSAS

by

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B. S., Kansas State University, 1972

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1974

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INTRODUCTION

Purpose of Investigation

The lower Saline River is of interest because it lies downstream from Wilson Valley, an abandoned channel of the upper Saline River (Fig. 1).

The Kansan age strath of the Saline River is below the surface of the floodplain at the river's mouth. The study was undertaken to determine the factors which might have caused the capture of the western drainage and to determine the topographic relationship among the river terraces that were formed during the glacial stages in central Kansas.

In order to study the drainage history of the region, alluvial deposits were examined and longitudinal profiles of the lower Saline River were prepared for each of the recognized glacial stages.

Location

The principal area of study was the Saline River valley and Elkhorn Creek in eastern Lincoln County, Kansas in T. 12 S., R. 7 W.; T. 12 S., R. 6 W.; and T. 13 S., R. 7 W. Longitudinal profiles were prepared for the lower Saline River, which consists of that part of the Saline River from below the upper end of Wilson Valley in eastern Russell County in Sec. 11, T. 13 S., R. 11 W. to the confluence of the valleys of the Saline and Smoky Hill Rivers north of Salina in T. 13 S., R. 3 W. (fig. 1 and 2).

Previous Investigations

Drainage Changes in North Central Kansas.--Several major drainage changes resulted from stream piracy during the Pleistocene Epoch in north central Kansas. The Republican River abandoned the Belleville channel in northern Jewell and Republic Counties and the Smoky Hill River abandoned the McPherson channel in McPherson and Sedgwick Counties and the Saline River abandoned the Wilson

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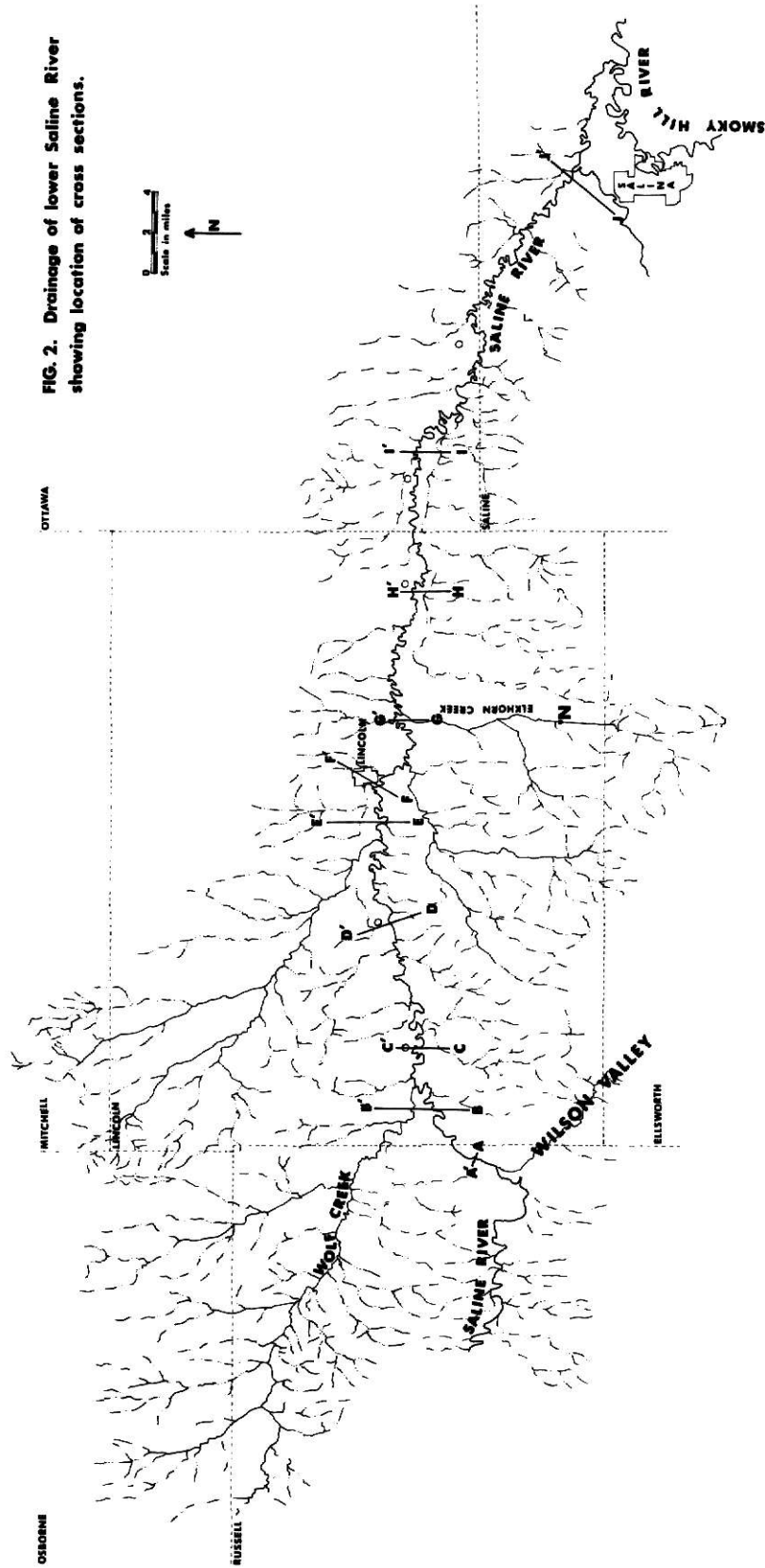


FIG. 2. Drainage of lower Saline River showing location of cross sections.

valley in southwestern Lincoln County and northwestern Ellsworth County (Fig. 1). The drainage changes occurred in early Illinoian time based on the Kansan age Pearlette ash which is found in some of the abandoned channels (Bayne and Fent, 1963). The abandonment of Wilson valley and the McPherson channel are significant factors in the history of the lower Saline River because of the control that they had on base level at the valley mouth and the addition of the large drainage area that existed at a considerably higher elevation.

Pearlette ash was reported from the lower part of the alluvium of the Smoky Hill River south of Salina (Bayne and Fent, 1963, p. 372). South of Salina, Kansan age deposits occupy a well defined channel overlain by Wisconsinan and Recent deposits with Illinoian deposits 70 feet higher than the present floodplain (Fig. 3). Bayne and Fent (1963, p. 371) believed that the levels of maximum downcutting during the Kansan and Wisconsinan time cross just below Salina, with the Wisconsinan sediments overlying the Kansan sediments above Salina and the Kansan deposits are at a higher elevation than are the Wisconsinan deposits below Salina.

The lower Smoky Hill River, which is that part downstream from the McPherson channel (Fig. 1), captured the upper Smoky Hill River by eroding the valley headward because the bedrock floor of the lower Smoky Hill River was approximately 120 feet below that of the upper Smoky Hill River (Bayne and Fent, 1963, p. 370, 374). With the capture of the Upper Smoky Hill River during Early Illinoian time, the river downcut the Smoky Hill valley above the McPherson channel, removed the arkosic sediments of Kansan age, and deposited a thick layer of arkosic sediments downstream that now is the high terrace near Salina. More downcutting during the Wisconsinan stage removed all unconsolidated Illinoian deposits, but left a wedge of Kansan age sediments in the bottom of the channel. These Kansan age sediments thin from Assaria northward to Salina (Fig. 4).

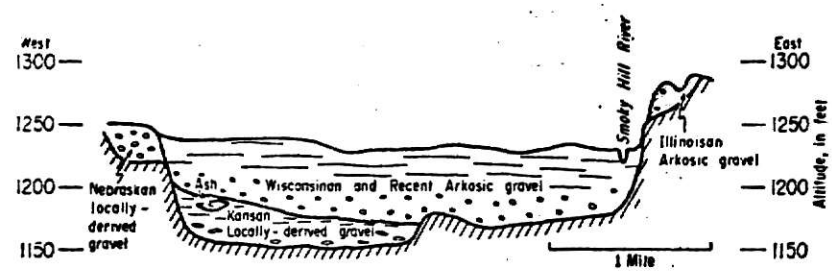


Fig. 3. Hypothetical composite cross section through Smoky Hill River valley based on test hole, well log, and outcrop data 1 to 4 miles south of Salina, Kansas. (from Bayne and Fent, 1963, p. 376)

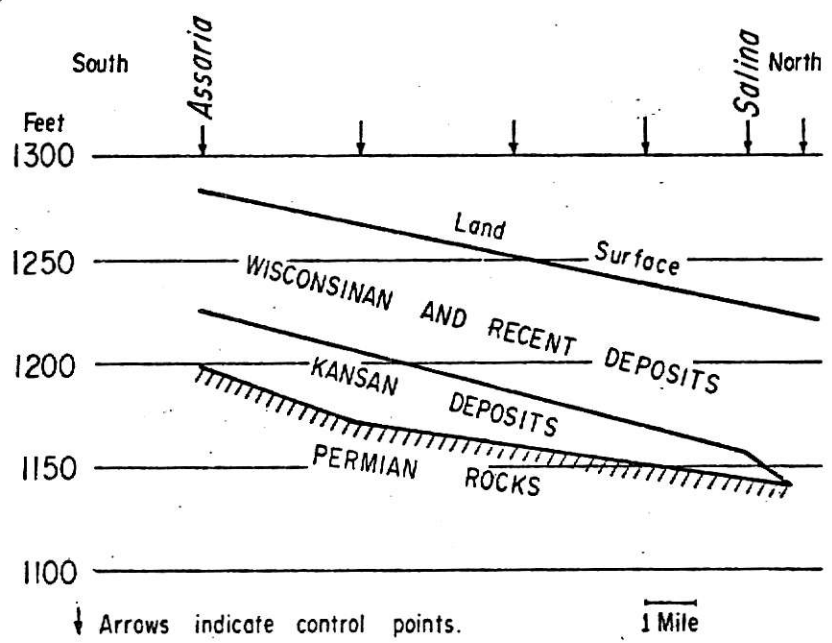


Fig. 4. Longitudinal section through Smoky Hill River valley from Assaria north to confluence with Saline River valley near Salina, Kansas. (from Bayne and Fent, 1963, p. 372)

Bayne and Fent (1963, p. 371) recognized a strath 40 feet above bedrock cut during Wisconsinan time on the northeast side of the Saline River valley at its confluence with the Smoky Hill River. They identified this terrace deposit as Kansan age because of the lack of arkosic gravel.

Paleoclimates of Western Kansas.--Frye and Leonard (1952, 1965, 1967), using both paleosols and fossil mollusks, have determined a generalized view of the climate of the central Great Plains during the Late Pliocene and Pleistocene.

The Late Pliocene ended with a long period of stability that resulted in the formation of the deeply developed "Ogallala Climax" soil into which Nebraskan age streams cut deeply (Frye and Leonard, 1965, p. 208; Frye, 1973, p. 277). Two episodes of Nebraskan age glaciation, separated by a period of stability and soil formation, are recognized in eastern Nebraska (Reed and others, 1965, p. 194). The climate became cooler and wetter during the Nebraskan stage and climaxed in Kansan time as indicated by the large number of branchiate gastropods in the faunal assemblages (Frye and Leonard, 1965, p. 211). The Aftonian was a period of regional stability and soil formation under a semiarid climate similar to that during the development of the "Ogallala Climax" soil, but of less duration as indicated by the thinner profile (Frye, 1973, p. 279).

The most extensive Pleistocene glaciation west of the Mississippi River was during the Kansan stage. Frye (1973, p. 279 (Fig. 5) stated that most major streams cut their valleys to the maximum depth of their bedrock valley floors during the earliest stage of the Kansan stage and in the western part of the central interior etched most major topographic escarpments to approximately their form. Three stades are recognized during the Kansan, with alluvial fills of the major valleys from the last advance. The Yarmouth soil profile is similar to the Afton and indicates a long interval of topographic stability, high temperatures and minimal erosion or deposition (Frye, 1973, p. 279).

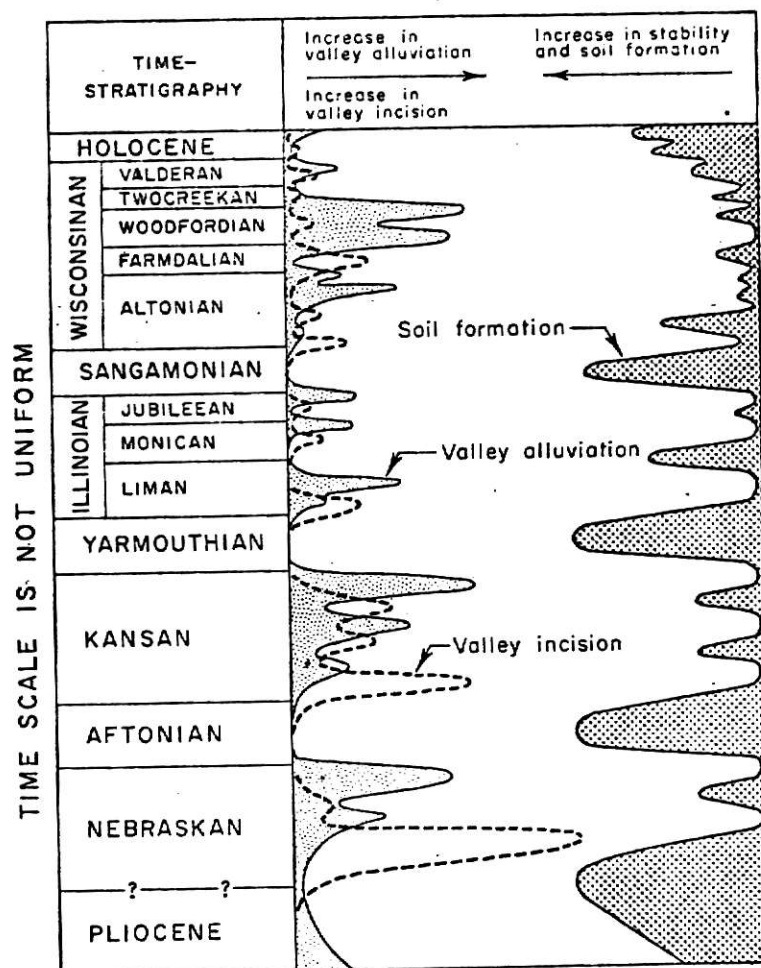


FIG. 5. Generalized curves show average conditions in the continental interior for intensities of (1) valley incision, (2) valley alluviation, and (3) soil formation accompanying times of relative stability of much of the surface area. Time scale is not uniform.

from Frye, 1973, p. 278

Frye and Leonard (1965, p. 211) stated that the Illinoian is the least conspicuous glacial stage in the southern Great Plains, though in Illinois the climate was as wet as the preceding Kansan stage. The Illinoian climate, in the Great Plains, was neither as moist nor as cool as the preceding Kansan. The Sangamon soil must have formed under conditions similar to the Afton and Yarmouth, but its shallower profile indicates a shorter time of development (Frye, 1973, p. 281).

During the Wisconsinan, the greatest downcutting was pre-Bradyan Early Wisconsinan. In northern and west central Kansas the Late Wisconsinan does not form a distinctive terrace that can be distinguished from the recent deposits, and in most places is mapped as a part of the Recent (Frye and Leonard, 1965, p. 214).

During the Pleistocene Epoch, western Kansas was principally grassland, although trees may have occupied some ridges during the glacial stages (Frye and Leonard, 1965, p. 212).

Chronology.--The Pearlette ash has been the basis for correlation of much of the Pleistocene stratigraphy of the Great Plains, which until recently had been considered a single ash fall. Naeser and others (1973, p. 188) have determined three different age dates by fission track dating for what had been called Pearlette ash. The oldest ash dated by them is approximately 2.0 m.y. (million years) old. Kansan age sediments at some localities are overlain by an ash 0.6 m.y. old or underlain by an ash 1.2 m.y. old.

PHYSIOGRAPHY

Landforms

The region is within the Blue Hills and Smoky Hills physiographic subdivisions of the Dissected High Plains section of the Great Plains physiographic

province (Shoewe, 1949, p. 309). The Greenhorn escarpment is the boundary between the two subdivisions. The Blue Hills are mesa-like with flat surfaces and steep, often benched, slopes whereas the Smoky Hills are maturely dissected hills and mounds capped by resistant sandstone bodies of the Dakota Formation and Kiowa Formations (Bayne and others, 1971, p. 4). Local maximum relief is about 300 feet.

Drainage Patterns

The general drainage pattern for the area is dendritic, but locally many smaller creeks in eastern Lincoln County follow the N-S joints in the rock (Fig. 2) so that the creeks intersect the river at right angles. Some stream patterns are effected by sandstone lenses within the Dakota Formation and Kiowa Formations. The tributary streams of the Saline River seem to be gaining drainage area at the expense of the Smoky Hill watershed as indicated by the barbed drainage pattern at the headwaters of some creeks (Bayne and others, 1971, p. 4). The headwaters of Elkhorn creek (Fig. 2 and 6) were pirated from Clear Creek, a tributary of the Smoky Hill River, as indicated by barbed drainage. The offset in the valley at Lincoln was caused by the river following the $N40^{\circ}W$ joints as it cut through the resistant "Lincoln Quartzite" lens in the Dakota Formation (Fig. 7).

Floodplain

The floodplain of the Saline River developed during Wisconsinian and Recent time. The true floodplain of the river is a low bench adjacent to the channel in most places. The river has a tightly meandering course, with many abandoned meander scars as can be seen in Fig. 8, 9, 10, and 11. At B and C, in Fig. 9, the meanders are migrating downstream. Many younger abandoned meanders have been aggraded to form part of the floodplain (see I, Fig. 10 and J, Fig. 11). The river is just beginning to develop a new floodplain as evidenced by shifting

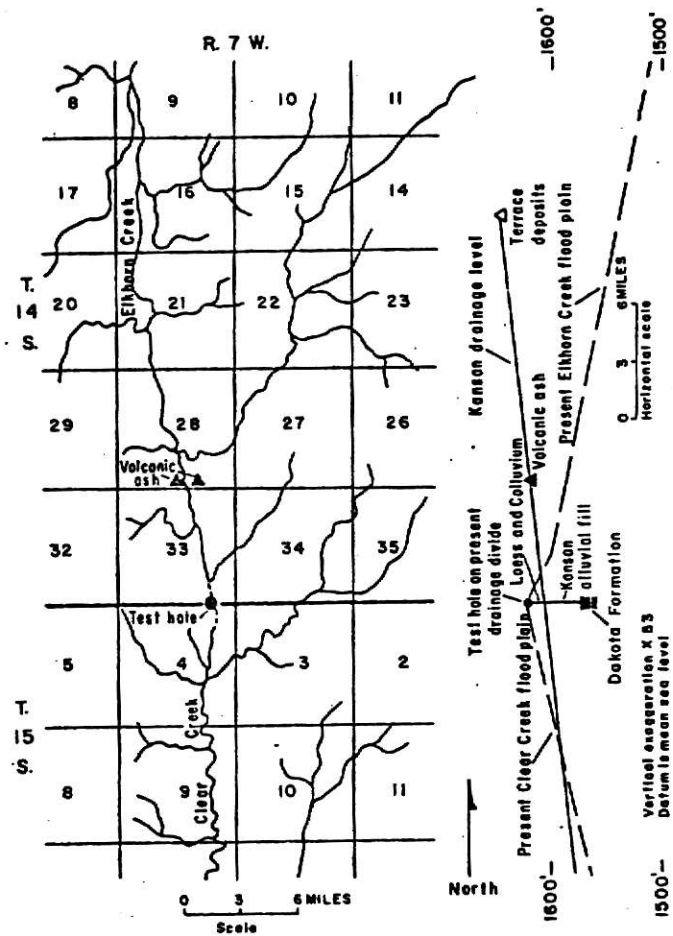
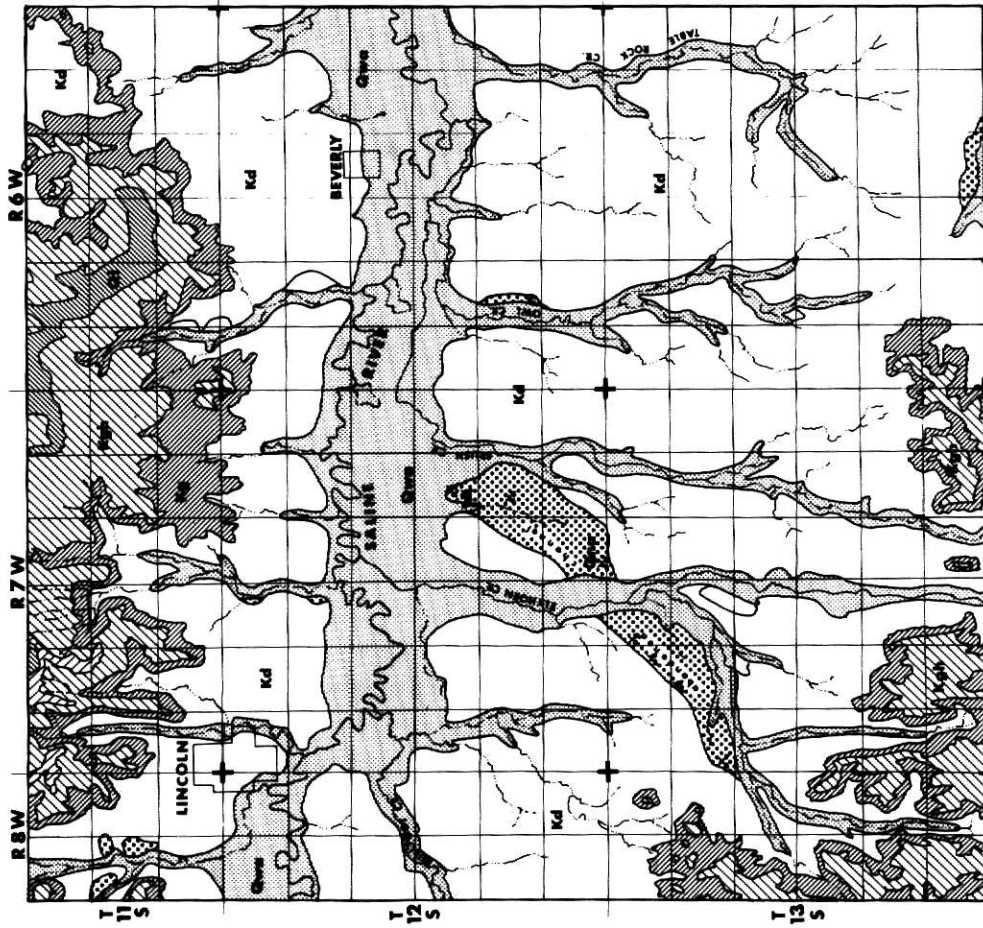


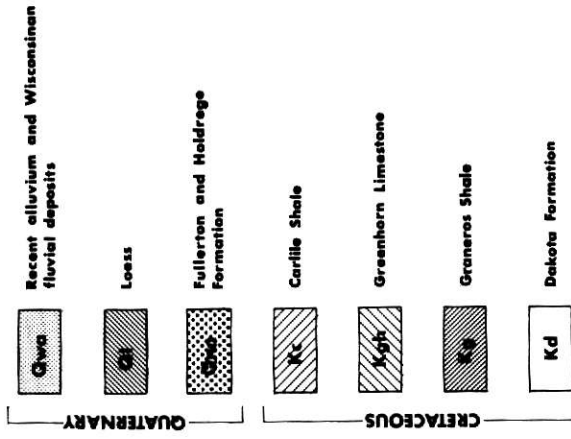
FIGURE 6.—Map illustrating capture of headwaters of Clear Creek by Elkhorn Creek.
(from Boyne and others, 1971, p. 33)

FIG. 7

GEOLOGIC MAP OF SALINE RIVER VALLEY, EASTERN LINCOLN COUNTY



EXPLANATION



Revised from Berry (1932), plate 1



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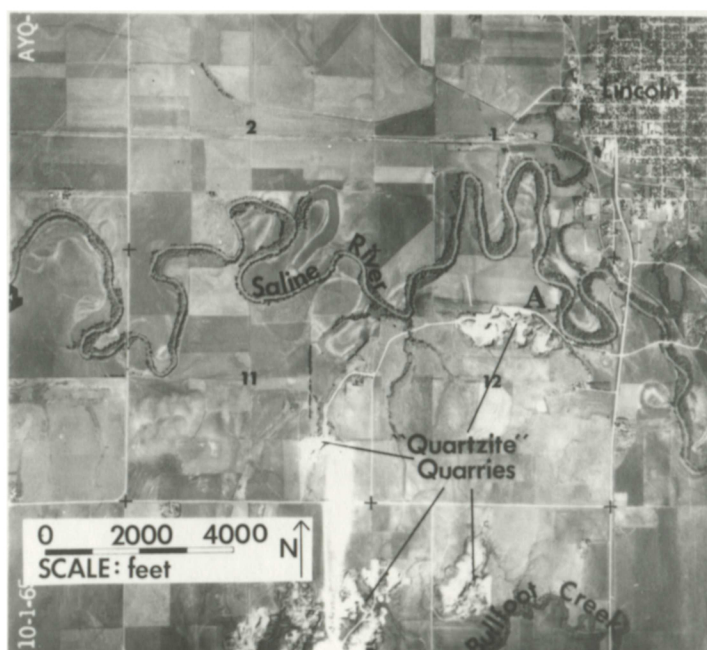


Fig. 8. Aerial photo of Saline River west of Lincoln showing meanders, meander scars, and the constriction of the valley at Lincoln.



Fig. 9. Aerial photo of Saline River southeast of Lincoln showing meanders and meander scars.



Fig. 10. Aerial photo of Saline River four miles east of Lincoln showing meanders, meander scars, and abandoned stream channels.



Fig. 11. Aerial photo of Saline River at Beverly showing meanders, meander scars, and parallel flow of Owl Creek

meanders and cutoffs. The broad level surface of the alluvium is the Wisconsinan terrace which is subject to severe flooding. The river has developed a set of natural levees along its banks. The margins of the valley are flanked by gently sloping coalescing alluvial fans associated with small tributaries, causing a depression in the middle of the valley as at F, G, and E, Fig. 10.

The river occupied the middle of the valley, sections 13, 14, and 15 on Figure 10, instead of its present position along the north wall. Many old abandoned meanders exist which have no topographic expression. The meander at F is a topographic feature whereas at E an older meander is not evident topographically on the ground. Four test holes were hand-augered across the feature at E in order to establish that it is an abandoned meander. At the center of the meander, sand and gravel was encountered at 17 feet below the surface. On both sides of the meander, holes augered to 26 feet encountered only clayey backswamp deposits. The ridge of gravel indicates this feature probably is old channel. The size of the abandoned meanders approximates that of the present river indicating approximately the same quantity of flow as the present river. The smaller features at D, G, and H, Fig. 10, are probably abandoned creek channels because of their smaller size and much smaller meander radii.

After Brush Creek, Owl Creek, and Table Rock Creek enter the floodplain, they flow parallel to the river for several miles before joining it (Fig. 2). The parallel drainage must in part be caused by the natural levees of the river and by abandonment of meanders by the river. An indication of the effect of meander abandonment on the development of parallel drainage is seen where Owl Creek joins the river (see K, Fig. 11). The creek must have flowed into a meander that was subsequently abandoned and the part of the meander above the creek was filled to the level of the Wisconsinan terrace. If several successive

meanders were abandoned in this way, the creek could lengthen a considerable distance down the floodplain parallel to the river.

GEOLOGY

The geology of an area is important in understanding the development of a river valley because of the differences in the resistance of different lithologies to weathering and erosion, the differences in the caliber of sediment contributed to the bedload of the stream, and the rate of decrease in grain size of the bedload. The channel of the lower Saline River is cut into the Dakota Formation and Kiowa Formation, Lower Cretaceous Series, except where it joins the Smoky Hill River, it is cut into the Wellington Formation, Lower Permian Series. The rocks cropping out in the area of investigation are in Fig. 12.

Permian System - Lower Permian Series

Wellington Formation.--The upper part of the Wellington Formation, that part found in the study area, is predominately silty shale, but contains some argillaceous limestone, dolostone, and calcareous siltstone (Zeller, 1968, p. 50). The formation has no resistant zones that would result in nick points or control valley width. The contribution to the bedload of the stream would be small, consisting of soft shale particles, with most of the weathering products carried either as suspension or solution load.

Cretaceous System - Lower and Upper Cretaceous Series

Kiowa Formation.--The Kiowa Formation is chiefly a light-gray to black shale containing sandstone lenses that are most abundant in the upper part. The sandstone lenses are calcite cemented ranging from loosely-cemented to well-cemented with complete filling of pore space by cement (Zeller, 1968, p. 55).

Fig. 12. —Generalized section of outcropping rock units

Era	System	Series	Stage or group	Formation or rock unit	Member	Thickness, feet	Character of material	
Cenozoic	Quaternary	Pleistocene	Recent and Wisconsinan	Alluvium and terrace deposits		30-60	Clay, silt, sand, and gravel in stream channels and underlying terraces adjacent to streams.	
			Wisconsinan and Illinoian	Peoria and Loveland Formations		0-10	Eolian silt locally present in upland areas and in Wilson valley.	
			Illinoian	Crete Formation				
			Kansan	Sappa Formation		0-70	Clay, silt, and locally sand and volcanic ash in upper part, sand and gravel in lower part. In high terrace position.	
				Grand Island Formation				
			Nebraskan	Fullerton Formation		0-45	Clay, silt, sand, and gravel. In high terrace position and in the basal part of Wilson valley.	
				Holdrege Formation				
		Tertiary	Pliocene		Ogallala Formation		0-3.5	Soil caliche ("algal limestone") in highest topographic position in divide areas.
	Mesozoic	Cretaceous	Upper Cretaceous	Colorado	Carlisle Shale	Fairport Chalk	0-15	Shale, chalky shale, and chalk; some bentonite.
Greenhorn Limestone					Pfeifer Shale	18-21	Chalky shale, chalk, and limestone; contains very thin bentonite beds.	
					Jetmore Chalk	20	Chalk, chalky shale, and limestone.	
					Hartland Shale	20	Chalky shale containing several bentonite beds.	
					Lincoln Limestone	5-20	Chalky limestone and shale.	
					Graneros Shale	35-40	Shale and locally sandstone and coquina limestone beds.	
Lower(?) Cretaceous					Dakota Formation	Janssen Clay	0-250	Clay, silt, sand, sandstone, siltstone, shale, and lignite.
			Terra Cotta Clay					
			Kiowa Formation	0-150		Shale, clay, sandstone, and siltstone.		
Paleozoic			Permian	Lower Permian	Sumner	Wellington Formation		0-15

(from Bayne and others, 1971, p. 7)

Dakota Formation.--The Dakota Formation is largely claystone, siltstone, mudstone, and shale, but locally contains abundant sandstone lenses of highly variable thickness and hardness (Zeller, 1968, p. 55). The sandstone lenses are cemented with iron oxides or calcite and range from loosely-cemented to well-cemented.

Physiography of the Kiowa Formation and Dakota Formation Outcrops.--The relief along the Kiowa-Dakota outcrop is dependent on the occurrence and resistance of the sandstone lenses. The lenses of sandstone form the caprocks on all of the hills not capped by the Greenhorn Limestone whereas the mudrock areas are of low relief with gentle slopes. The lenses account for irregularities in valley width (see Fig. 13) and may have acted to control stream gradients. The very well calcite-cemented sandstones are known locally as the "Lincoln Quartzite" and are quarried for aggregate. Most sand, predominately quartz, of the Kiowa and Dakota formations is medium to fine-grained with a median diameter of 0.23 millimeters (Mack, 1962, p. 30).

Cretaceous System - Upper Cretaceous Series

Graneros Shale.--The Graneros Shale is noncalcareous montmorillonite-rich shale that is, in general, moderately silty (Bayne and others, 1973, p. 23) and forms gentle erosional slopes.

Greenhorn Limestone.--The Greenhorn Limestone consists of thin-bedded chalky limestone and calcareous shale, which is more resistant than the underlying Dakota Formation and Graneros Shale to erosion and forms a steep outcrop face. Limestone gravels in many of the terrace deposits were derived from the Greenhorn Limestone.

Quaternary System - Pleistocene Series

The Pleistocene deposits of the region are alluvial clays, silts, sands, and gravel, volcanic ash, and loess deposits. The closest that the the conti-

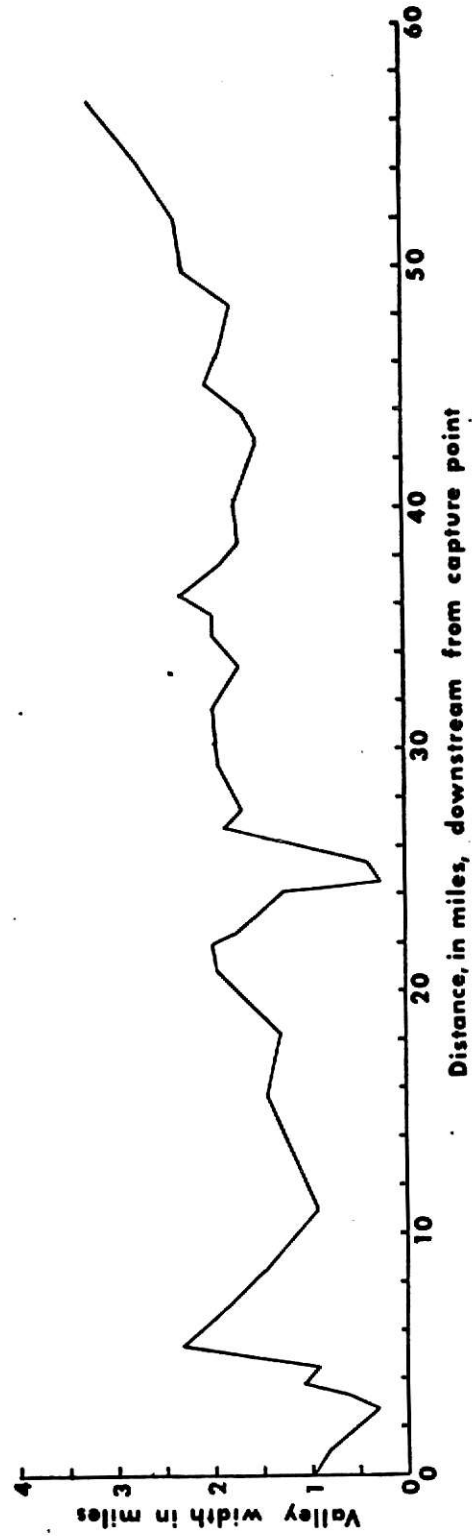


Fig. 13. Width of lower Saline River valley

mental ice sheets ever got to the region was northeast Kansas during the Nebraskan and Kansan stages. The climatic cycles that resulted in the periods of glaciations had a direct effect upon the Pleistocene deposits of the region. The glacial stages began with a period of downcutting by the streams, followed by deposition of coarse sediments, which became progressively finer as the glaciers retreated. The interglacial stages were periods of stability with little or no deposition and development of deep soil profiles.

Nebraskan Stage.--Deposits of the Holdrege Formation and Fullerton Formation exist within the Wilson valley on a bedrock bench that is higher than the base of the Kansan age deposits (Bayne and others, 1971, p. 29) (Fig. 14b). Also of probable Nebraskan age are the physiographically high terraces associated with a few tributaries to the Saline River. Fent (1974, personal communication) believes the terrace on the south side of the Saline River in eastern Lincoln County is of Nebraskan age based on physiographic position. The terrace deposits are composed of gravel of mostly sandstone and limestone pebbles, quartz sand, and clay. The tributary terrace deposits in the eastern part of Lincoln County are coarser than those in the western part of the county reflecting increased contributions of sediment from the Dakota Formation.

Kansan Stage.--The Grand Island Formation and Sappa Formation have been recognized in Wilson valley by the presence of Pearlette ash and fossil mollusk assemblages that occur within the Sappa Formation (Bayne and others, 1971, p. 30). Because of its relation to the climatic terraces of the Smoky Hill River in Ellsworth County (Fig. 14), the ash represents the last of the three ash falls reported by Naeser and others (1973).

The deposits of Wilson valley are arkosic sands and gravels containing many pebbles of vein quartz derived from the Ogallala Formation in western Kansas. The quartz sand of the Ogallala Formation is considerably coarser than that derived from the Dakota Formation. The Kansan stage deposits of the lower

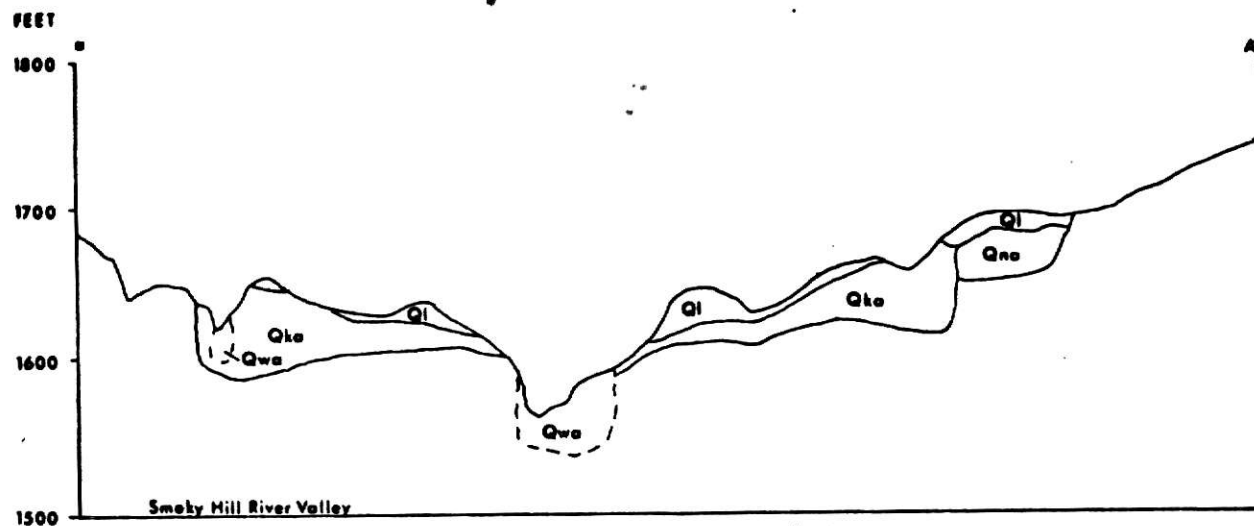


Fig. 14a. Cross section of the Smoky Hill River, Ellsworth County, Kansas

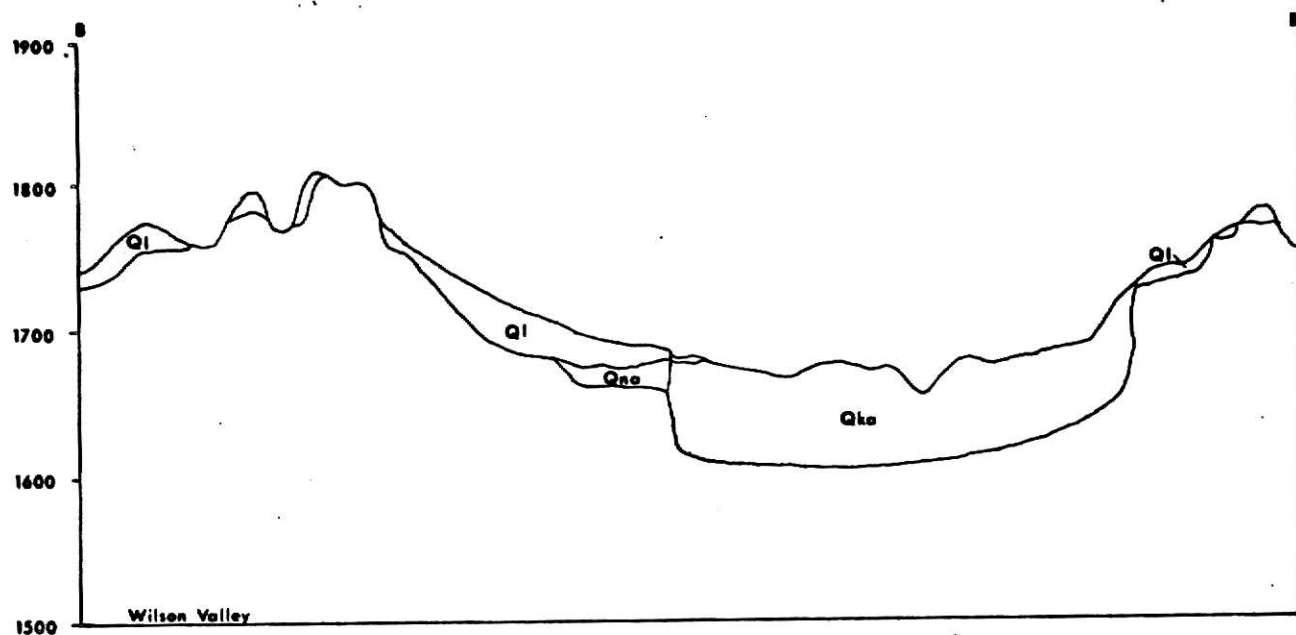
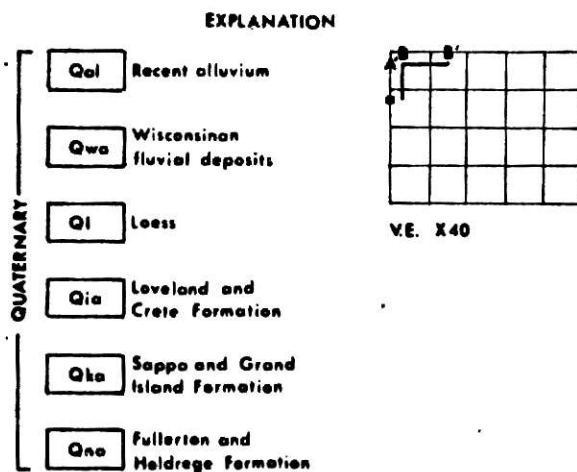


Fig. 14b. Cross section of Wilson valley, Ellsworth County



Saline River and the lower Smoky Hill River are non-arkosic and reflect the mineralogy of the Cretaceous age rocks exposed in drainage basins of Kansan age.

Illinoian Stage.--The capture of the upper Saline River by the lower Saline River introduced arkosic sediments into the lower Saline River valley providing a means of differentiating pre-Illinoian sediments from Illinoian and younger sediments. A high Illinoian age terrace, on the south side of the valley near the junction with the Smoky Hill River, is indicated by the arkosic gravel (Fent, 1974, personal communications).

Wisconsinan Stage.--The alluvium of the valley is of Wisconsinan age and Recent age. The sediments are composed of a mixture of locally derived gravel and arkosic gravel derived from western Kansas.

METHODS OF INVESTIGATION

Cross sections of the valley were prepared from test-hole data for Lincoln County (Berry, 1952), Ottawa County (Mack, 1962), and Saline County (Latta, 1949). Additional logs were provided by O. S. Fent, Hydraulic Drilling Company, Salina, Kansas. Cross sections were used to determine if any strath terraces existed in the valley. More test-hole data than are available would have been desirable because of the small differences in the elevations of suspected terraces in western Lincoln County. Topographic maps and air photos of the region were examined to determine the presence of terraces; suspected terraces were examined in the field.

The existence of bedrock terraces can be established best by developing the cross sections of the valley and the long profile together. Stratigraphic columns of the logs were prepared in order to help interpret which are actually strath terraces and which are colluvial. The logs were used also to interpret

the development of the floodplain. Because most test holes are at least a half mile apart, it is often difficult to tell whether the bottom elevation represents the valley wall or a strath terrace. The bedrock is irregular making it difficult to judge whether one or more surfaces are indicated.

In determining longitudinal profiles of rivers, strath elevations are preferable to terrace surface elevations, though in many cases it is advisable probably to use both. The accuracy of surface elevations of terraces can be questioned because they may be eroded or overlain with loess. Surface elevations are easier to obtain than test-hole data.

The drill cuttings from selected test holes in the Saline and Smoky Hill River valleys are examined to determine whether the sediment was arkosic. This was done to establish the pre-Illinoian age terraces in the region.

GEOMORPHOLOGY OF THE LOWER SALINE RIVER

Interpreting the development of the lower Saline River is complicated because the lower Saline River captured the upper Saline River. The valley is similar to those of the Smoky Hill River below McPherson channel and the Republican River below Belleville channel in that the Kansan age strath is low physiographically. Much physiography of the region was established by the end of the Kansan stage. To avoid repetition, the geomorphology and conclusions are discussed together.

Problems of Correlation

The correlation of Pleistocene deposits, even over short distances, is difficult because of their isolation and the deposits of each glacial and interglacial stage generally reflect similar source areas. Criteria used in correlation are paleosols, physiographic position, vertebrate and mollusk fossil assemblages, and volcanic ash within the deposits.

The best criterion to determine the age of terrace deposits has been either Pearlette ash and/or fossil mollusk assemblages. The topographic position of a terrace or terrace deposits is useful in correlation, but is inadequate without other evidence. The relative position of terrace deposits and inferences about events on other rivers in northern Kansas are the primary means of correlation on the lower Saline River.

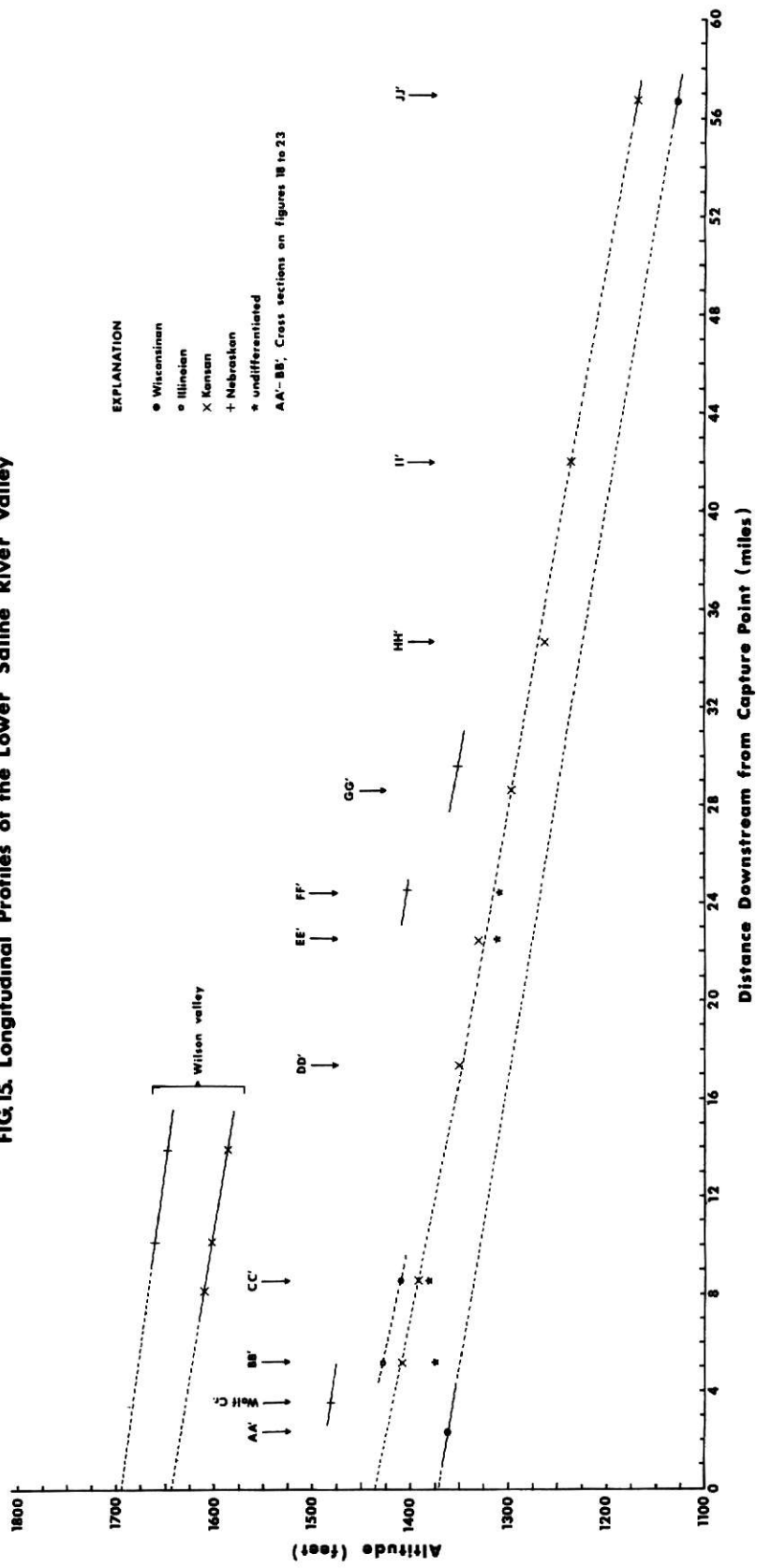
Arkosic sediments indicate post-Yarmouthian drainage of areas where the Ogallala Formation crops out in western Kansas. The terrace deposits above the Wisconsin terrace on the lower Saline River are associated with tributary streams, therefore, the mineralogy of these older terrace deposits gives no indication of age.

The Longitudinal Profile

Nebraskan Stage.--Terraces of Nebraskan age are poorly preserved on the lower Saline River. A gravel deposit of probably Nebraskan age occurs 30 feet above the floodplain of Wolf Creek two miles west of profile BB (Fig. 15) in Sec. 7 T. 12 S., R. 10 W. The terrace deposit remnant, composed of limestone gravel, is on top of a "Lincoln Quartzite" lens which causes a narrow constriction in the valley. A Nebraskan age stream gradient of 3.5 ft./mi. (feet/mile) existed in western Lincoln County, assuming that the erosional surface on top of the "Lincoln Quartzite" at Lincoln is also of Nebraskan age and acted as a temporary base level. An abandoned channel of Elkhorn Creek, (Fig. 7) six miles east of Lincoln, believed to be Nebraskan age, is 50 ft. below the sandstone at Lincoln. If the two points are of the same age, then there was a considerable change in stream level across the sandstone lens.

Kansan Stage.--The approximate level of the Kansan age strath at the confluence of the Smoky Hill and Saline Rivers is known from the work of Bayne and Fent (1963) and from the bedrock elevation map of the Smoky Hill River at Salina (Fig. 16). The deep narrow channel that exists in the Smoky Hill River valley

FIG.15. Longitudinal Profiles of the Lower Saline River Valley



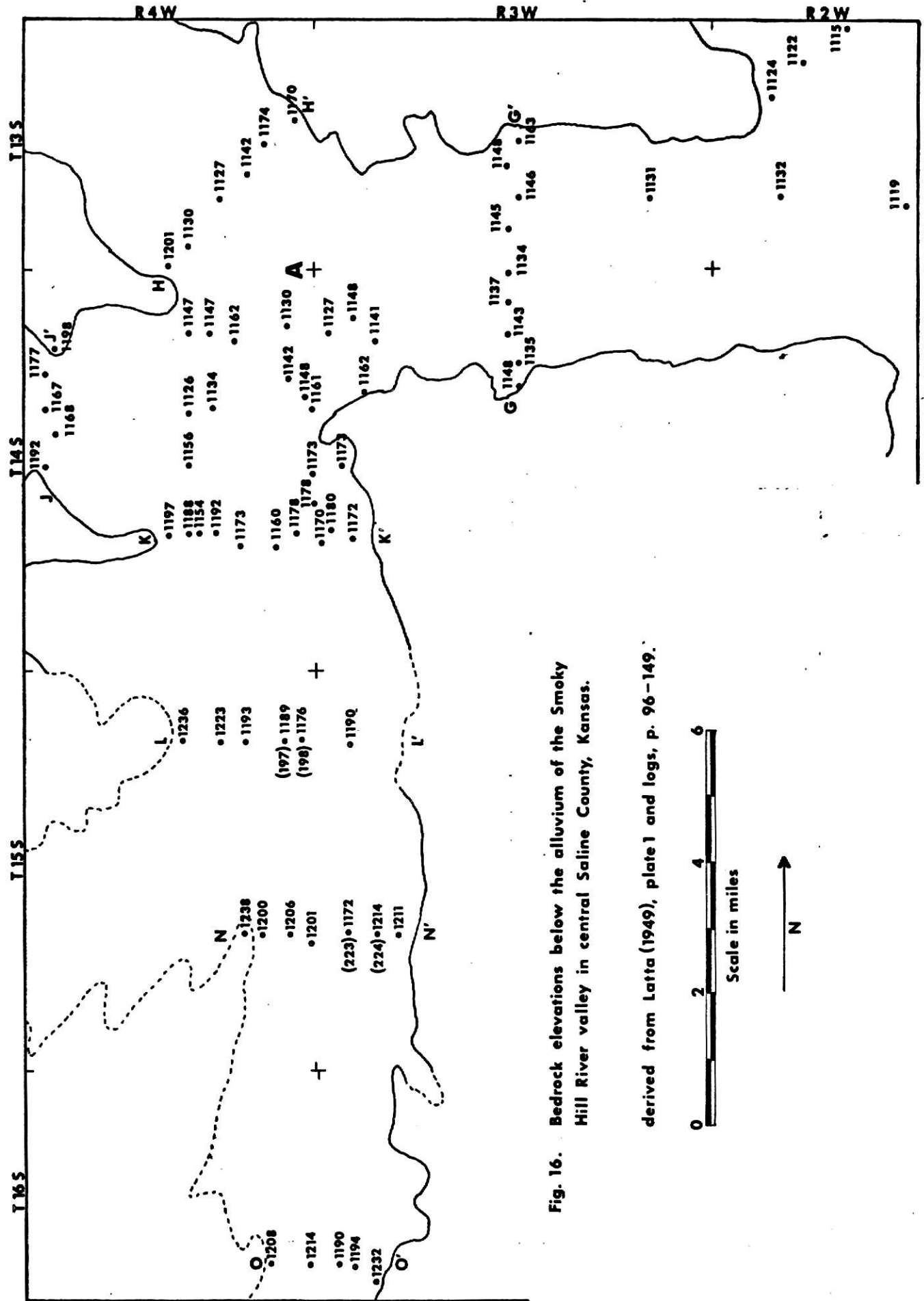
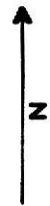


Fig. 16. Bedrock elevations below the alluvium of the Smoky Hill River valley in central Saline County, Kansas.

derived from Latta (1949), plate 1 and logs, p. 96-149.



Scale in miles



(Fig. 16) is of Kansan age as indicated by locally derived non-arkosic well cuttings of the lower sections of test holes 223 on profile NN' and 197 and 198 on profile LL', (Fig. 16) (Table 1).

In the lower Smoky Hill valley south of Salina, the Kansan age sediments are the lowest part of the alluvial fill. At the mouth of the Saline River valley, HH' (Fig. 16) on the northeast side, a strath terrace exists at an elevation of approximately 1170 ft., 55 feet below the surface of the floodplain that Bayne and Fent (1963, p. 371) called Kansan because of the absence of arkosic sediments. The Kansan strath at the mouth of the Saline River may be lower than that because the bedrock elevation in test hole 223 on profile NN' (Fig. 16) is 1172 feet, which is the same as the supposed Kansan level at HH', although it is eight miles farther upstream.

The Kansan age gradient between test hole 234 on profile OO' and 223 on profile NN' is 4.4 ft./mi. The gradient seems very low for such a short tributary and must reflect the low resistance to erosion of the Wellington Formation and a considerable period of time of stability. A similar gradient must have existed to Salina. If an average stream gradient of 3.0 ft./mi. is assumed from test hole 234 on profile OO' to point A (Fig. 16) then the elevation in Kansan time at point A would be 1145 ft. If a gradient of 4.0 ft./mi. is assumed, then the elevation at point A would be 1130 feet which is as low as the Wisconsinan of profile HH'. It is doubtful if stream gradients as flat as 4.0 ft./mi. would have existed on such a short tributary and unlikely if they were lower than 3.0 ft./mi.

The equilibrium level of the Kansan age lower Smoky Hill River south of Salina must have been established by the much longer and larger Saline River. The Kansan age elevation and gradient of the Smoky Hill River below Salina should be similar to the lower Saline River. Any great changes in elevation and/or gradient would reflect control by the sandstone lenses within the Kiowa Formation

and Dakota Formation.

The strath terrace on the northeast side of the Saline River on profile HH' (Fig. 16) may actually be of Nebraskan age, considering the Kansan age bedrock elevations south of Salina. A factor that may complicate the validity of some of the conclusions is the unknown effect of salt solution within the Wellington Formation on the area. Interpretations stated indicate the Kansan strath was very close to the level of the Wisconsinan at the mouth of the Saline River.

Frye (1973, p. 279) stated that most streams were incised to the greatest depth during the Kansan stage (Fig. 5). An indication of this is the Kansas till in a narrow channel below the present floodplain of the Kansas River at Kansas City (O'Connor and Fowler, 1963, p. 629). They believed that the deeper part of the Kansas River valley, that part occupied by the coarser alluvial fill between Manhattan and Kansas City, was eroded to its present depth just prior to, or during the climax of, Kansan glaciation in eastern Kansas. In support of this view is the discovery of buried glacial till overlying alluvial gravels east of St. Marys in the bedrock channel area (Gilliland, 1973, p. 37). Bayne and Walters, (1959, p. 25) reported that Kansan age sediments, occupying a channel found below the floodplain of the Republican River in Cloud County, were deposited by Buffalo Creek of Kansan age (Fig. 17).

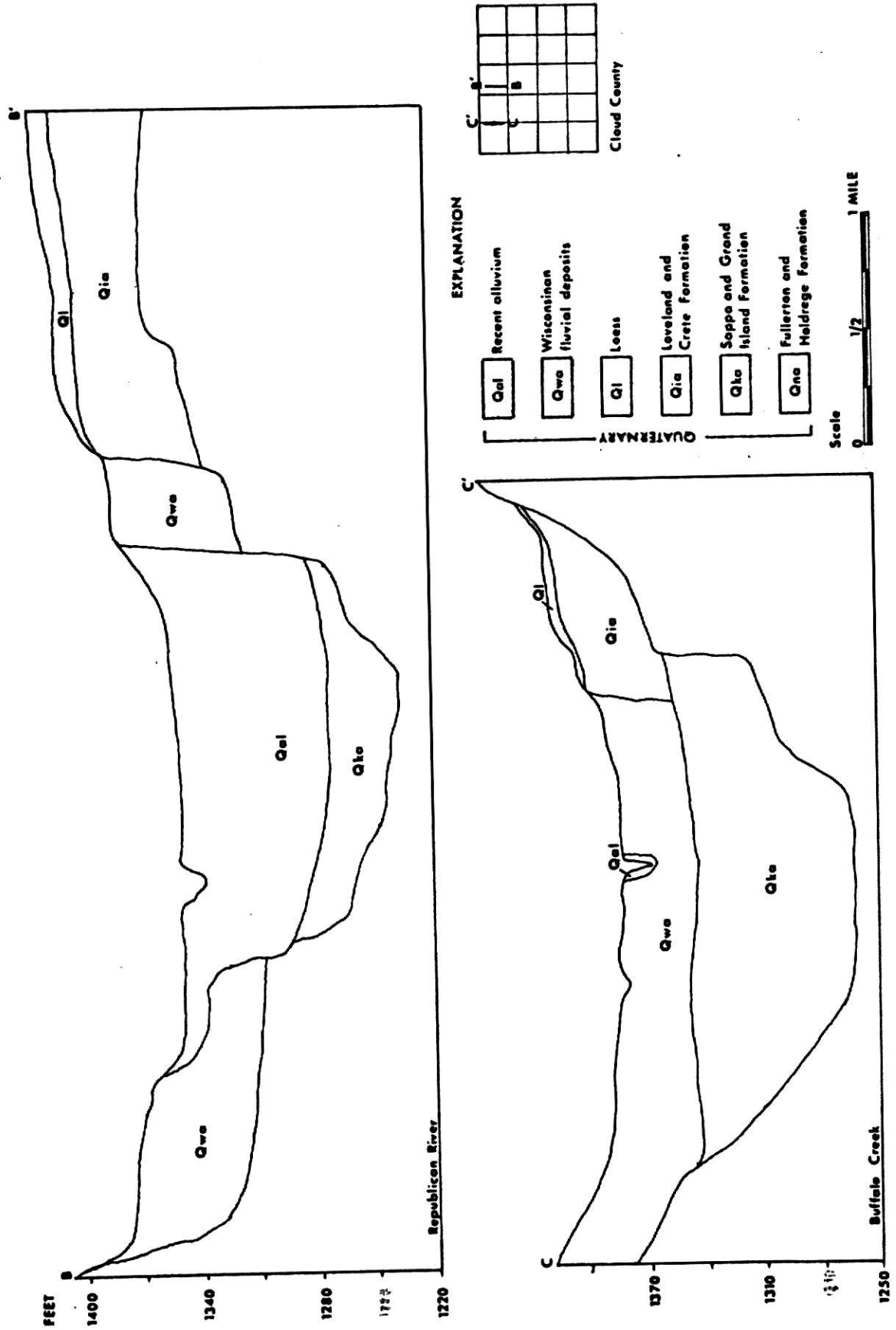
The Kansan age terrace gradients derived from the longitudinal profiles of Bayne and Fent (1963, p. 370) of the lower Smoky Hill River are 1.2 ft./mi. as compared with 2.8 ft./mi. for the Wisconsinan. Beck (1959, p. 31) reported the floor of the Kansan age terrace deposits range from 20 to 40 feet above the present floodplain of the Kansas River. The gradient of the Kansan age strath between Salina and Manhattan is 1.24 ft./mi. if the Kansan age strath is assumed to be 30 feet above the present floodplain at Manhattan. The Wisconsinan age strath has a slope of 2.8 ft./mi., the same as the surface gradient. The slightly steeper Kansan age strath gradient than surface gradient probably reflects the

erosion of the top of the Kansan deposits at Salina.

If the idea of regional maximum incision by streams during the Kansan stage is valid, then it could be assumed that a similar history of downcutting occurred on the lower Saline River. If the traditional view of a topographically high Kansas age strath on the Kansas River is assumed, then there was a very low stream gradient between the Flint Hills and Salina unless the Flint Hills have been uplifted by isotatic rebound since the Kansan stage. It would appear that the lower Saline River would also have had a low gradient and, therefore, the Kansan strath would occupy a low topographic position in relation to the other climatic terrace deposits.

Wolf Creek was considerably lower in elevation than the upper Saline River during the Kansan as is indicated by much shorter tributaries to the upper Saline River from the north than to Wolf Creek from the south (Fig. 2). The tributaries to the Saline River upstream from Wilson valley have much steeper gradients than other streams in the area, indicating that the Saline River has degraded more than other streams in the area since the early Illinoian. Wolf Creek and its tributaries have lower gradients than the upper Saline River directly above Wilson valley. The upper Saline River was captured by the headward erosion of a tributary of the lower Saline River in a valley possibly as much as 200 ft. lower than Wilson valley.

The width of most of the present stream valleys in northern Kansas was established by the end of the Kansan stage. During Kansan time the upper Smoky Hill River in Ellsworth County occupied a valley that was from 3.0 to 3.5 mi. wide (Fig. 14a); Wilson valley was of similar width (Fig. 14b). In Ellsworth County, the rapid incision of the river after the abandonment of the McPherson channel preserved an identifiable Kansan surface. Buffalo Creek, in northwestern Cloud County had a Kansan age valley more than two miles wide just before it joined the Republican River. The drainage area is only slightly larger than that



of Wolf Creek, with both streams cutting the Dakota Formation. Therefore, the width of the Saline River valley below Wolf Creek could easily have been developed by lateral erosion in later Kansan time.

The Kansan age Smoky Hill River valley in Ellsworth County (Fig. 14a) is as wide as the present valley below Salina. In the area of profiles OO' to NN' (Fig. 16) which is an area where the Wisconsinan valley is wider than the Kansan, the Wisconsinan age Smoky Hill valley is only 2.0 to 2.5 miles wide. The Saline River valley near its mouth and the Smoky Hill River valley directly below Salina are 3.0 to 3.5 miles wide (Fig. 16). The above cited differences in width indicate that the width of the valley of the lower Saline River and Smoky Hill River south of Salina was not established during the Wisconsinan, but during the period of lateral erosion at the end of the Kansan.

The wide bedrock floors shown on cross sections GG' (Fig. 21), HH' (Fig. 22) and II' (Fig. 22) represent the Kansan strath level and with the known Kansan strath elevation at cross section JJ' (Fig. 23), gives a stream gradient for the lower Saline River during the Kansan of approximately 4.5 ft./mi. The examination of well cuttings from selected test holes in Lincoln County indicates that this is a valid conclusion. Non-arkosic, pre-Illinoian, sediments are found at the bottom of the valley fill in several test holes (Table 1). The test holes were selected away from the valley wall in order to avoid sediments associated with tributaries. The top part of the gravels is arkosic indicating post-Kansan erosion and deposition.

Illinoian Stage.--No Illinoian terrace deposits were identified in Lincoln County. Illinoian age sediments aggraded to a level 70 feet above the present floodplain at the mouth of the Saline River valley and in the Smoky Hill River valley south of Salina. It is not known how thick the Illinoian sediments were in Lincoln County, because they probably were removed by erosion during the

Table 1. - Analysis of selected test holes, Saline and Smoky Hill Rivers

Longitudinal Profile	Profile*	Test Hole	Rock Fragments					Remarks
			Feldspar	Qtz Pebbles	Limestone	Sandstone	Shale	
HH'	OO'	223			X		X	depth 78-85 ft., 63-70 ft.
	OO'	223	X	X				depth 50-54.5 ft.
	OO'	224	X	X				40.5-54 ft.
	LL'	198		Tr	X	X	X	60-71.5 ft.
	LL'	198	X	X	Tr	Tr		50-60 ft.
	LL'	197		Tr	X	X		52-58 ft., 37.5-52 ft.
	LL'							
	HH'	12-6-16da		5%	X	X		50-54.5 ft.
		12-6-16da	X	X	X	X		40-50 ft.
		12-6-21aa	X	X	Tr	Tr		35-45 ft.
		12-6-21da			X	X		37-49 ft.
				Tr	X	X		30-37 ft.
			X	X	X	X		23-30 ft.
		12-6-16aa	X	X	X	X		47-50.5 ft.
	EE'	GG'	X	X	X	X		60-64.5 ft.
		12-8-10aa		Tr	X	X		50-53.5 ft.
			X	X	X	X		47-50 ft.
BB'	EE'	12-10-20da	X	X	X	X		60-63.5 ft.
CC'	FF'	12-10-23aa			X	X	X	36.5-40 ft.
			X	X	X	X		33-36.5 ft.

Tr = less than 3%

X = 5%

*OO' and LL' from Latta, 1949, HH', GG', EE', and FF' from Berry, 1952.

Wisconsinan stage.

Wisconsinan Stage.--A deep narrow channel was cut into the bedrock floor of the valley as indicated on cross sections AA' (Fig. 18) and BB' (Fig. 19, test hole 12-10-20da). The gradient of the narrow channel from AA' to the 1130 feet strath on cross section JJ' is 4.25 ft./mi. which is lower than the Kansan age strath gradient of 4.74 ft./mi. The lower Wisconsinan age gradient would be expected with the increase in stream length that resulted from the capture of the upper Saline River. The narrow channel may have extended no farther than cross section GG'. Points 18, 10, 7, and 6 (Fig. 15) form a straight line indicating this may be a strath terrace with a very low gradient of 2.5 ft./mi. Structural control of base level by a large lens of "Lincoln Quartzite" must exist below cross section GG' if a gradient of 2.5 ft./mi. exists.

The narrow channel that exists in the western part of Lincoln County probably continues downstream to Salina because the narrow channel on cross section BB' (Fig. 19) indicates a stream was rapidly downcutting, which a stream of a low gradient could not do.

Test hole F 13-7-2dad (Appendix 1, N on Fig. 2) indicates that a deep narrow Wisconsinan channel exists in eastern Lincoln County on Elkhorn Creek. The alluvium is 74 feet thick at this point whereas test holes indicate it is only 60 feet thick in the Saline River valley at the confluence of Elkhorn Creek (Line FF', Fig. 15). Alluvium should thicken toward the valley mouth so, therefore, a deep narrow channel must exist in the Saline River valley. The gradient of the present surface between test hole F 13-7-2dad and the Saline River is 13.1 ft./mi., but from known bedrock elevations a gradient of 10.3 ft./mi is inferred. The bedrock gradient should not be lower than the surface gradient. If it is assumed that the gradients are the same for the bedrock as for the surface, then a bedrock elevation of 1270 feet is obtained for the Saline River at Line GG' on Figure 15, which is intermediate between the observed bedrock

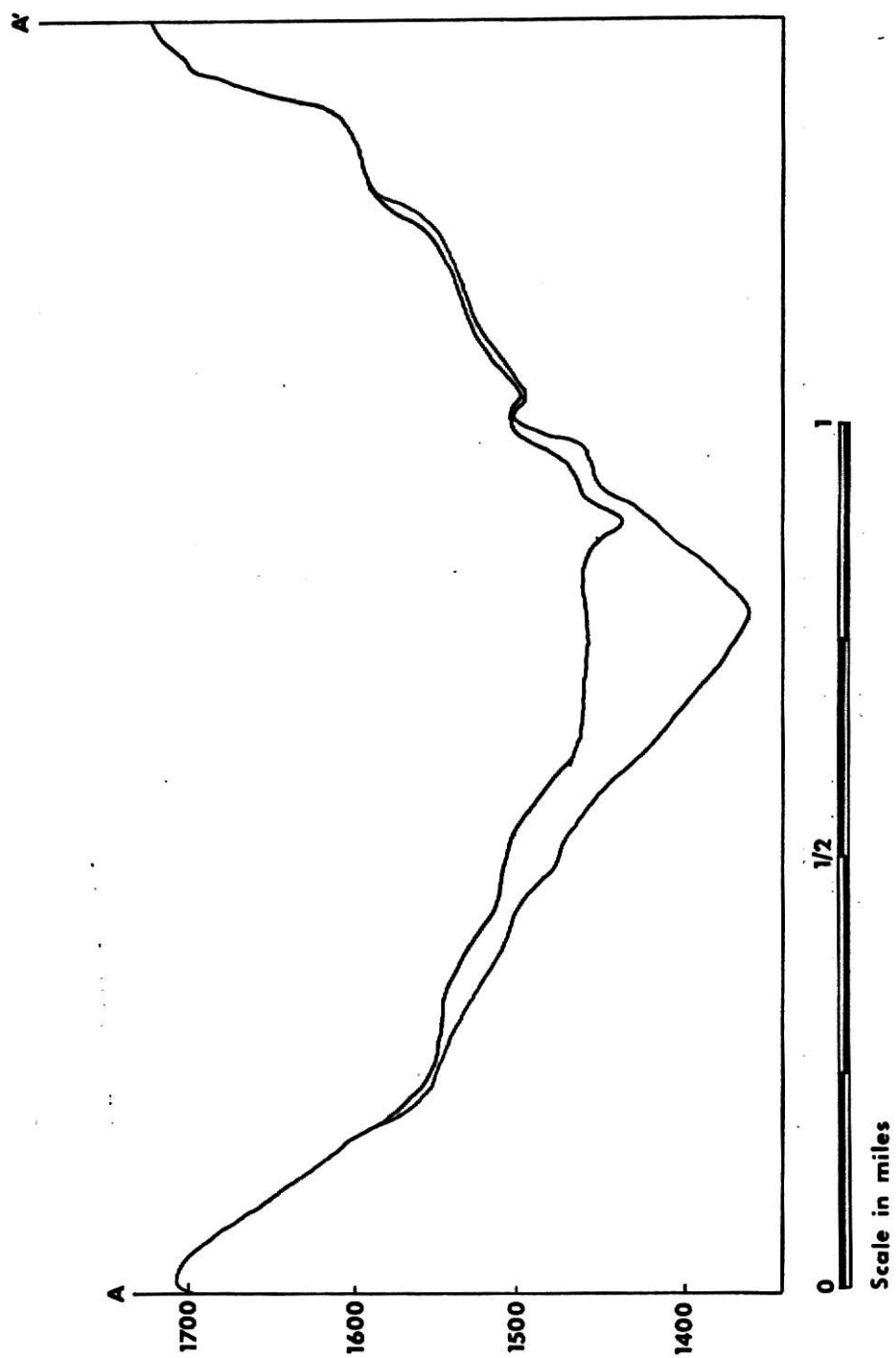
depth of 1291 feet and the projected depth of 1250 feet for the Wisconsin. The calculated value could be too high for two reasons. The test hole, F 13-71dad, on Elkhorn Creek may not be at the strath's deepest point and/or the gradient of the creek may have been steeper than at present. If the river was actively downcutting, the creek's profile would be in non-equilibrium and, therefore, steeper than a profile that developed under a period of stability.

The drainage area above profile BB' was increased from 292 sq. mi. to 1230 sq. mi. with the capture of the upper Saline River. The discharge at the mouth of the Saline River valley was probably at least as much if not greater during the Illinoian and Wisconsin as it was during the wetter Nebraskan and Kansas.

Cross Sections of the Valley

Section AA' (Fig. 18, Fig. 2).--The cross section shows the V-shaped valley that was cut into the former divide between the upper and lower Saline Rivers. The deepest bedrock is at a lower elevation than was encountered in the test holes in either profile BB' or CC' indicating the existence of a narrow Wisconsin age channel in the bedrock downstream from AA'.

Section BB' (Fig. 19, Fig. 2).--The cross section is 5.5 miles downstream from the point of capture of the upper Saline River by the lower Saline River and directly below the junction of Wolf Creek valley with the Saline River valley. The clay and gravel sediments and topographic position of the sediments indicate test hole 12-10-4cc was drilled into colluvium. The strath encountered in test holes 12-10-29aa, 12-10-20ad, and 12-10-20aa is a post-Kansan age surface over a mile wide, probably of Illinoian age which is wider than the 3.1-mile long stream of Kansan age that occupied the valley could have developed. The bedrock of test hole 12-10-17aa on the Wolf Creek side of the valley is lower than that of the three previous test holes and is probably the Kansan age strath

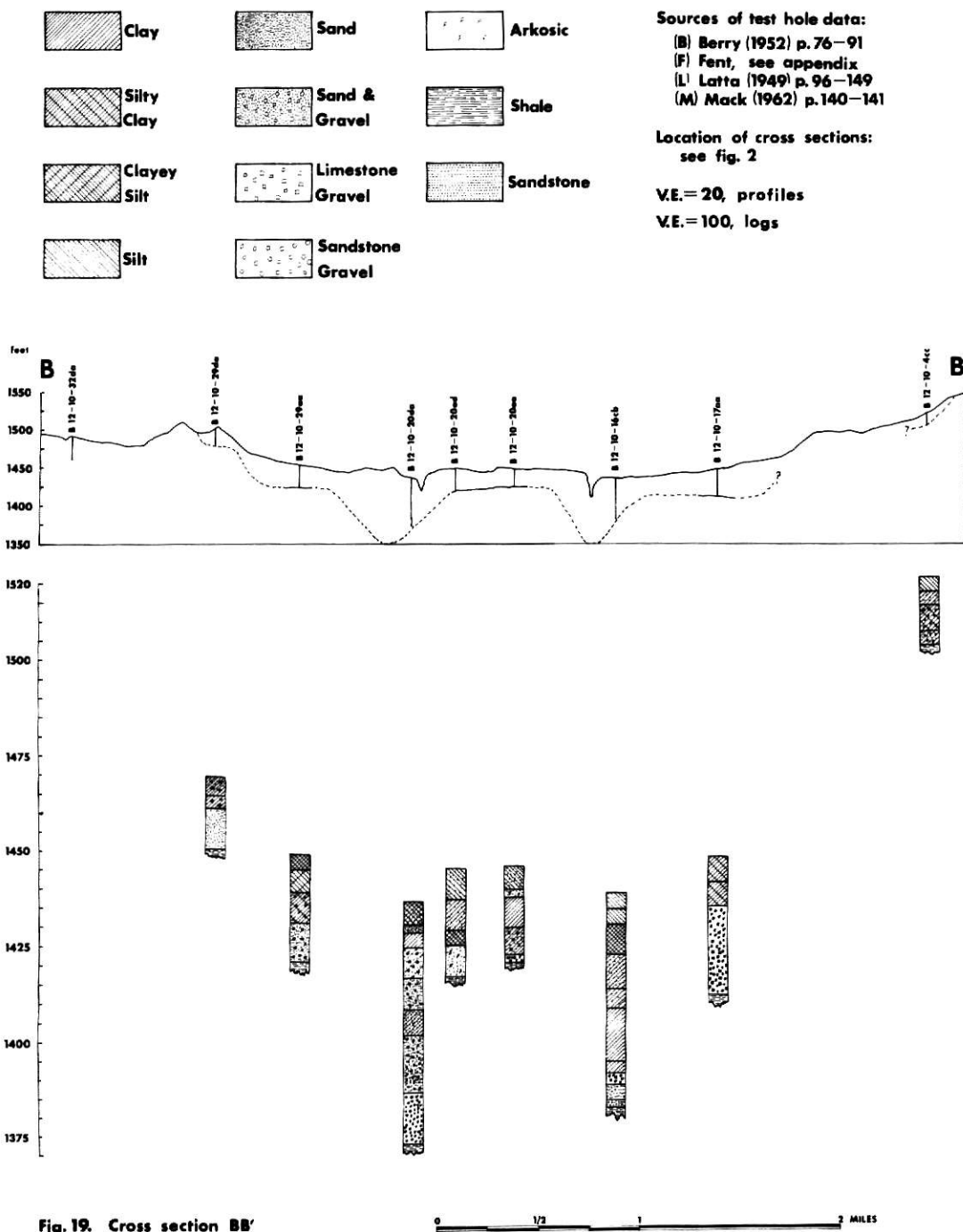


Location: see fig.2

Source: U.S. Army Corps of Engineers, Wilson Dam
V.E.=10

Fig. 18. Cross section AA', lower Saline River valley.

Cross Sections of the Lower Saline River Valley



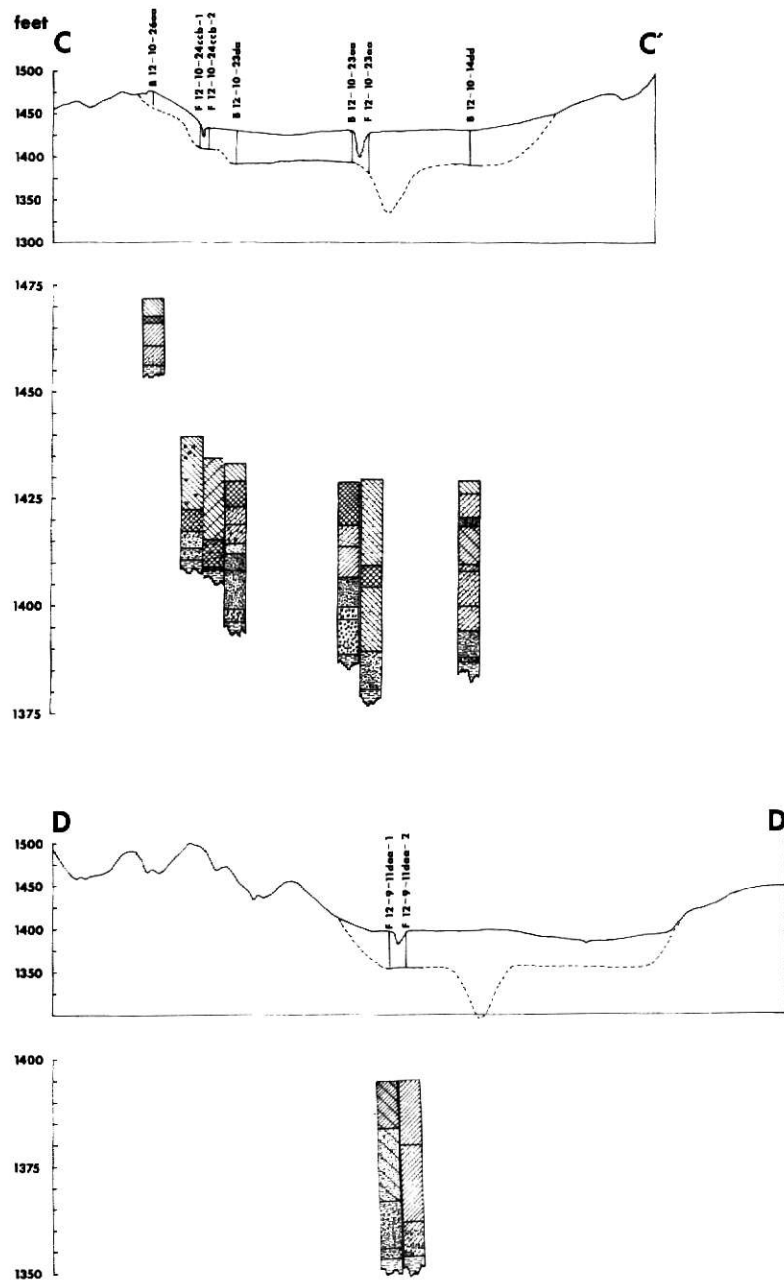


Fig. 20. Cross sections CC', DD'

0 1/2 1 2 MILES

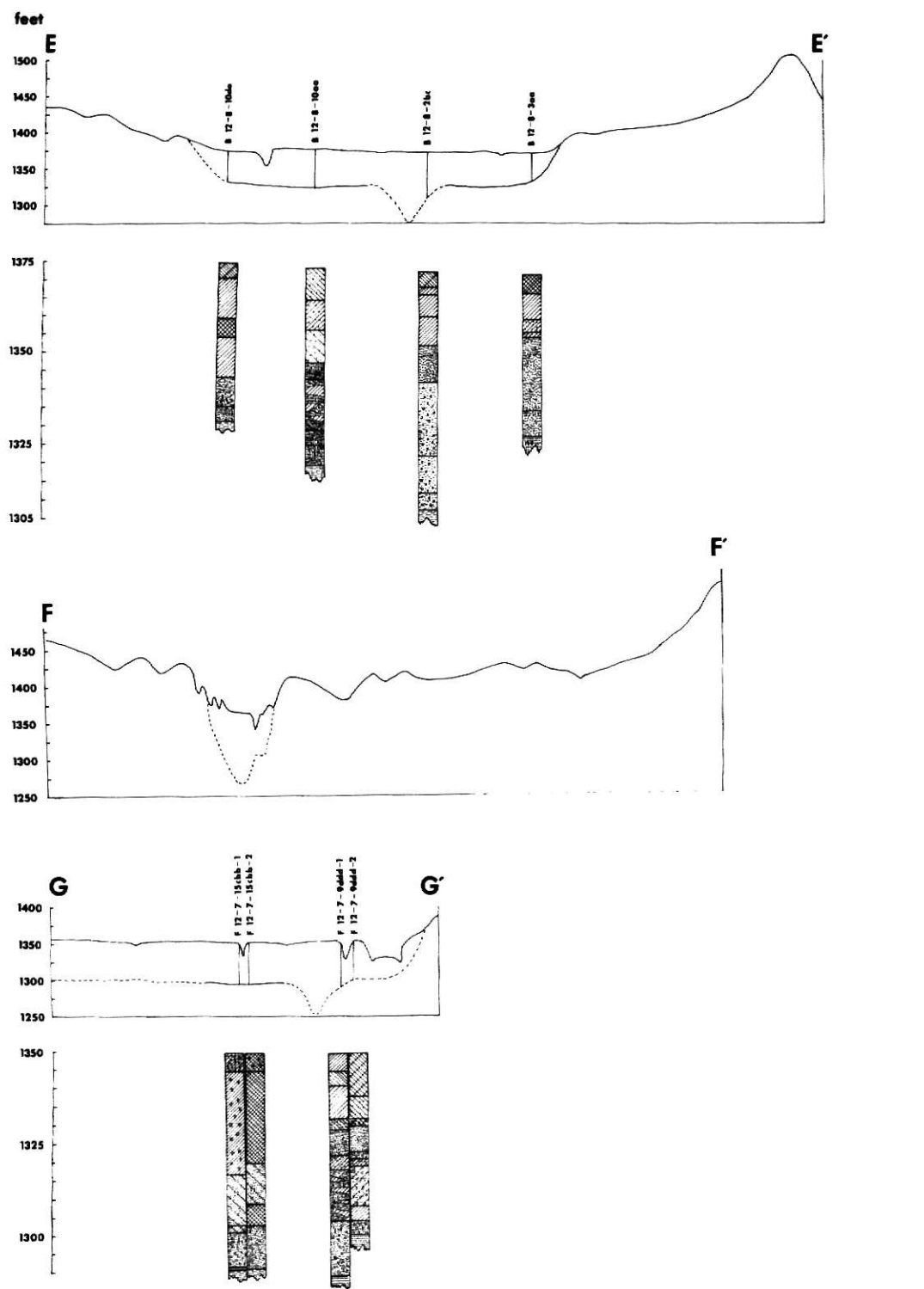


Fig. 21. Cross sections EE', FF', GG'

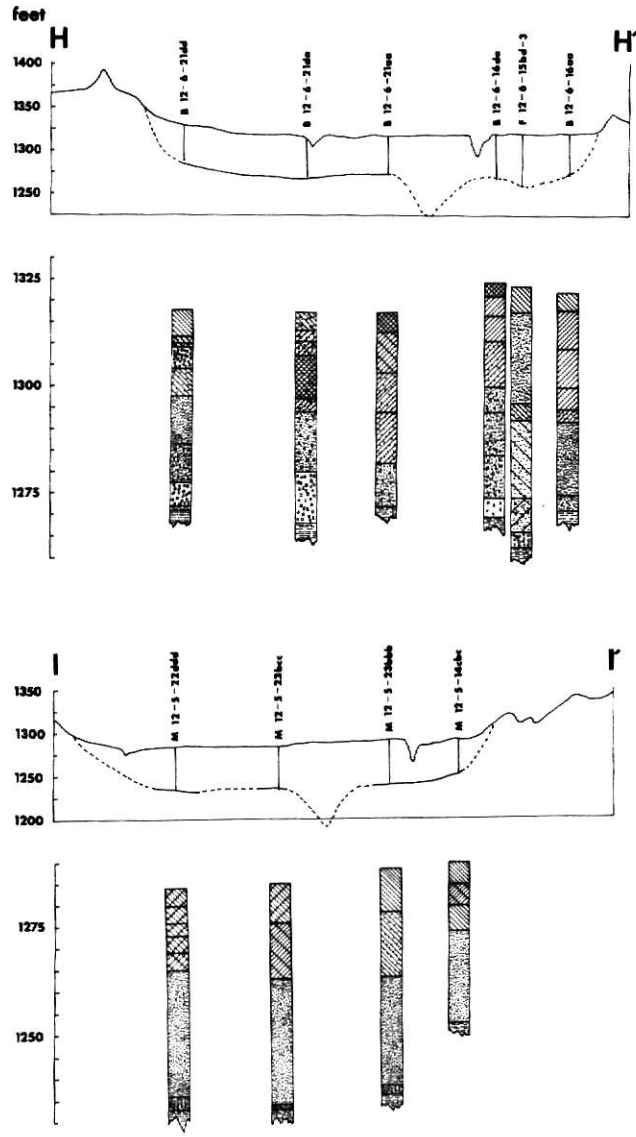


Fig. 22. Cross sections HH', II'



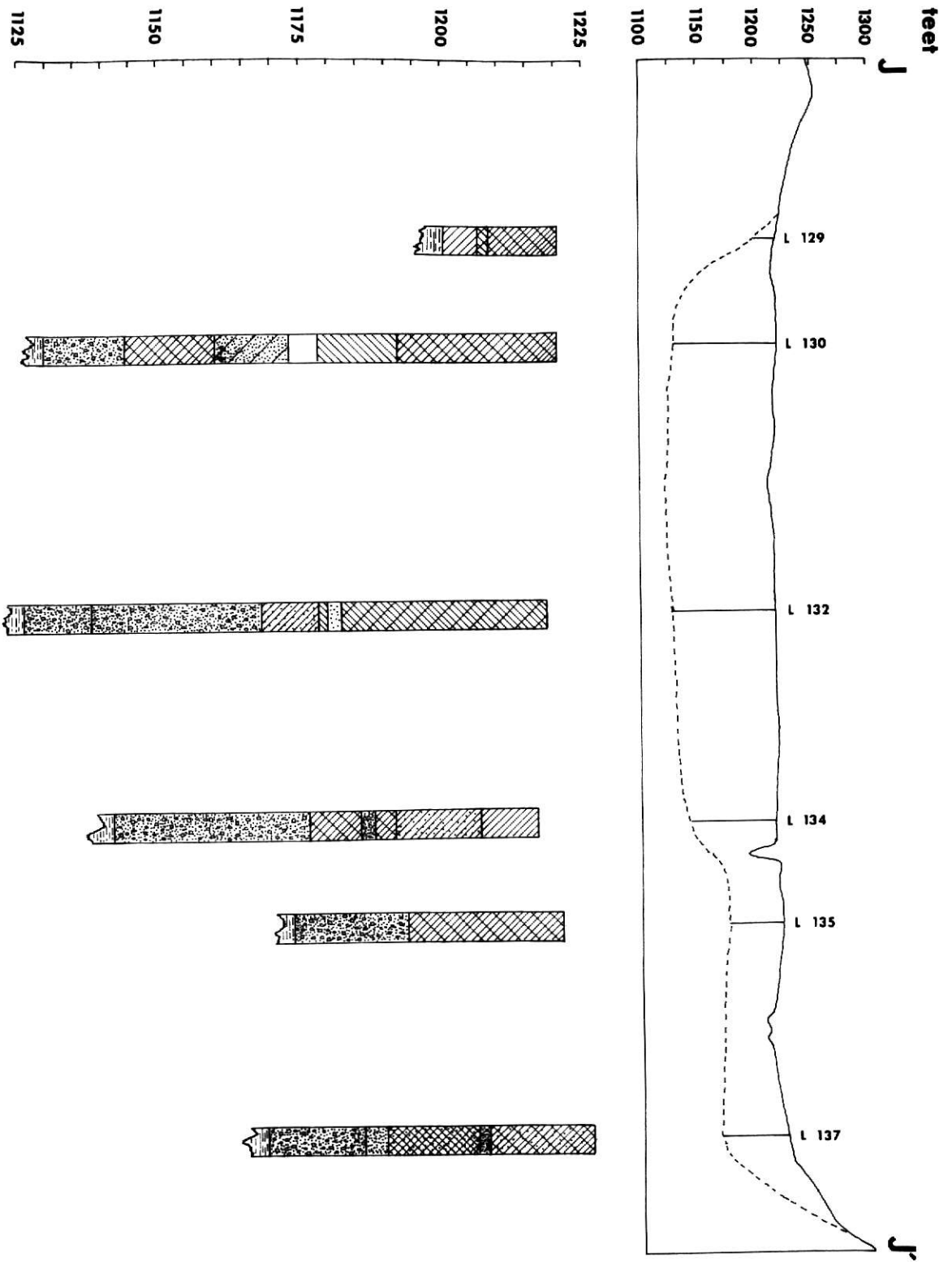


Fig. 23. Cross section JJ'

0 1/2 1 2 MILES

based on projections from lines EE' and HH' on Figure 15. The Illinoian age stream did not downcut below the Kansan strath. The lowering of the stream gradient that would have existed at cross section BB' on Figure 19 in the Illinoian would result in a stream that would tend to aggrade below BB'. Test hole 12-10-20da intersected the side of a deep Wisconsinan channel as indicated by lower bedrock elevations obtained in studies by the Corps of Engineers at Wilson Dam (Line AA', Fig. 15).

Section CC' (Fig. 20, Fig. 2).--Test hole 12-10-26aa is located on a high tributary terrace of probable Nebraskan age. The bedrock of test holes 12-10-23da, 12-10-23aa, and 12-10-14dd is believed to be the Kansan-age strath. The lower part of the gravel of test hole 12-10-23aa is non-arkosic (Table 1) indicating its Kansan age. The narrow Wisconsinan channel must exist in this profile and probably all other profiles downstream though it is not indicated by any of the test holes of these profiles.

Section DD' (Fig. 20, Fig. 2).--The strath encountered in the two test holes is Kansan age based on projections from cross sections CC' and EE'.

Section EE' (Fig. 21, Fig. 2).--The profile shows the broad flat Kansan-age strath. The lower gravel from test hole 12-8-10aa is non-arkosic Kansan age sediment (Table 1). The sediments from the lower zone of test hole 12-8-2bc are arkosic indicating the Wisconsinan age of the narrow channel that was incised into the Kansan-age strath.

Section FF' (Fig. 21, Fig. 2).--The section demonstrates the considerable narrowing of the valley which occurs near Lincoln because of the large lens of "Lincoln Quartzite". The rock is a very resistant, massive, calcite-cemented sandstone with almost no pore space. The top of the unit probably represents maximum Nebraskan age downcutting above Lincoln. The top is a broad flat surface as exposed in quarries south of Lincoln.

Sections GG', HH', and II' (Fig. 21, 22, 22, Fig. 2).--No strath terraces are indicated by any of the test holes. The flat strath is of Kansan age as indicated by non-arkosic lower gravels from test holes 12-6-16da and 12-6-21da (Table 1). The sediments of test hole 12-6-21aa are arkosic indicating it must be close to the Wisconsinan-age bedrock channel.

In eastern Lincoln County there are several terraces of tributaries, the present surfaces of which are approximately 50 feet higher than the present floodplain, believed to be of Nebraskan age based on physiographic position. One terrace deposit is an abandoned channel of Elkhorn Creek (Fig. 7).

Section JJ' (Fig. 23, Fig. 2).--Section JJ' is across the Saline River valley at its confluence with the Smoky Hill River valley. The alluvium is 90 feet thick, containing a zone of peat.

Elkhorn Creek

Elkhorn Creek occupied the northeast-trending channel shown in Figure 7 that was abandoned because of downcutting at the beginning of the Kansan stage. If the abandoned creek channel was of Kansan age, a stream gradient of 6.7 ft./mi. or greater would have had to exist downstream to Salina.

Bayne and others (1971, p. 32) believed the capture of the headwaters of Clear Creek by Elkhorn Creek was post-Kansan because volcanic ash occurs in a former terrace of Clear Creek (Fig. 6). The capture may be older than this considering that three ages for the Pearlette ash are recognized now. Once the Greenhorn limestone that capped the divide was breached, Elkhorn Creek could have cut rapidly headward and downward through the Graneros Shale and Dakota Formation.

Valley Alluvium

The wide strath was developed by the end of the Kansan stage with non-arkosic gravels deposited on top of it. The incision of the narrow channel during the Wisconsinan stage resulted in the erosion of the top of the Kansan-age

gravel deposits. The aggradation during the Wisconsin stage deposited arkosic gravels on top of the Kansan gravels resulting in no distinct difference in the elevation of the gravels in the floodplain (see 12-6-16da, 12-6-21da, 12-8-10aa, and 12-10-23aa, Table 1). The cutoff of meanders as the river moved across the floodplain resulted in the deposition of sand and gravel lens within the silt and clay.

SUMMARY

The major periods of incision by the lower Saline River were during the Nebraskan and Kansan stages. The river had cut the wide bedrock strath that is below the floodplain by the end of the Kansan stage.

Very little is known of the Illinoian stage, though it is believed that the lower Saline River is similar to the Smoky Hill River below McPherson channel and to the Republican River below Belleville channel; no downcutting of the bedrock occurred during this time. By the end of the Yarmouthian stage, the lower Saline River occupied a valley as much as 200 feet below the upper Saline River valley. A tributary to the lower Saline River was able to erode headward capturing the western drainage.

The Saline River was able to cut a narrow channel into the Kansan age strath during the Wisconsin, but it quickly began to aggrade before it could erode laterally.

ACKNOWLEDGMENTS

The writer wishes to thank Dr. Henry V. Beck, major professor, for his assistance in the investigation. I am grateful to O. S. Fent for the loan of the drilling logs and his opinions on the area. The help of Lyle Cline with some of my field work was greatly appreciated. Thanks to O. W. Bidwell, Robert Cullers, and Page C. Twiss for their review and criticism of the thesis.

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APPENDIX

Test Hole Logs Provided by O. S. Fent,
Hydraulic Drilling Company, Salina, Kansas

Test holes drilled for the city of Beverly Nov. 12 - 16, 1970

12- 6-15aa (3), Southwest corner of Beverly. End of street, Sec. 15, T. 12
S., R. 6W.

Alluvium:

0	2	Silty loam
2	6	Silt, buff
6	27	Sand, fine to medium, very little silt, soft, buff
27	31	Silt, soft, blue-gray, and sand, fine
31	49	Sand, fine to medium and silt, very soft, blue-gray
49	57	Gravel, medium to fine and sand; contains much clay, blue-gray, sandy, soft
57	60.7	Gravel, medium to fine, clean

Dakota formation:

60.7	61	Shale, firm, blue-gray
Estimated yield, 100 gallons per minute		

Logs of Lincoln County bridge site test in SE corner Sec. 9, T.
12 S., R. 7W, Drilled for Foster & Company Engineers April 29, 1968.

12-7-9ddd (1), 9 ft. left of Sta. 555 plus 85

Alluvium:

0	5	Clay, silty, alternating light and dark gray-brown
5	9	Silt, clayey, buff
9	18	Clay, silty, light gray
18	21	Silt, soft, fine sandy, light gray
21	28	Sand, fine to coarse
28	32	Clay, carbonaceous, sandy, dark gray
32	46	Gravel, fine to medium and sand; interbedded with clay, dark gray
46	61	Gravel, fine to medium and sand

Dakota formation:

61	66	Sandstone, soft, fine, light gray to white (Bearing point at 61 ft.)
66	67	Sandstone, hard, fine, light gray to white

12-7-9ddd (2), 20 ft. left of Sta. 558 plus 45

Alluvium:

0	12	Silt, clayey, dark gray
12	18	Silt, soft, sandy, light gray
18	20	Silt, sand fine and clay, dark gray; contains some gravel, fine
20	27	Sand, fine to coarse
27	29	Gravel, fine to medium and sand
29	31	Clay, soft, sandy, dark gray; contains much wood

31	42	Gravel, fine to medium and sand, much clay, dark gray
42	46	Clay, dark gray, firm
46	50	Gravel, fine to coarse and sand

Dakota formation:

50	56	Sandstone, fine, hard, light gray. Much interbedded clayey shale 53 to 56. (Bearing point at 50 ft.)
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Logs of Test Holes for Bridge over Elkhorn Creek, Center West Line
Sec. 15, T. 12 S., R 7 W., Lincoln County, Kansas December 21, 1969

12-7-15cbb (1), 4 ft. south of south end of existing bridge, on west road
shoulder. Approx. Elev. 1350

Alluvium:

0	5	Gravel, very coarse and clay, gray
5	33	Clay, gray; contains some gravel
33	47	Sand, fine to coarse, silt, gray and wood
47	49	Clay, silty, gray
49	58.5	Gravel, coarse to fine and sand, much wood

Dakota formation:

59.5	59.5	Sandstone, soft; contains pyrite
59.5	60	Shale, firm, dark gray
		Bearing point for H pile approx. 59.5 ft. below land surface

12-7-15cbb (2), 27 ft. north and 5 ft. west of center of north end of existing
bridge. Approx. Elev. 1350.

Alluvium:

0	5	Clay, silt, and limestone rubble
5	30	Silt and clay, buff and olive
30	41	Sand, coarse to fine and silt
41	47	Silt and clay, gray
47	59	Gravel, coarse to fine and sand

Dakota formation:

59	60	Shale, clayey, firm, dark gray
		Bearing point for H pile approx. 60 ft. below land surface.

A Log of Test Holes Drilled for Lincoln County Bridge Site April 28,
1966. Saline River Bridge South of Vesper NE NE SE, Sec. 11, T. 12,
S., R. 9 W. Lincoln County April 30, 1966.

12-9-11daa (1), 27 ft. north and 6 ft. west of north west corner of bridge.
Elev. 0.1 ft. below center of north end of bridge floor.

Alluvium:

0	15	Clay, silty, soft, dark gray and gray-brown
15	33	Clay, silty, buff, (dark zone at 23 ft.)
33	41	Clay, silty, soft, light gray; interbedded with gravel, medium to fine and sand

Dakota formation:

41	43	Clay, fairly soft, yellow, blue-gray and red
43	50	Clay, silty, fairly firm, light gray mottled red-brown (Pile penetration to about 48 ft.)

12-9-11daa (2), 24 ft. south and 2 ft. east of southeast corner of bridge.
Elev. 0.5 ft. below south end of bridge floor.

Alluvium:

0	11	Clay, silty, gray and buff
11	22	Sand, fine to coarse and silt, buff; little gravel, fine to medium
28	39	Gravel, fine and sand, some gravel, medium
39	41	Clay, soft, sandy, dark gray
41	41.5	Gravel, medium to fine and sand

Dakota formation:

41.5	43	Clay, yellow and light gray, soft
43	45	Clay, light gray, silty
45	46	Sandstone, hard, fine, pyritic.

(Pile to 45 ft. at this spot. This zone will be present only sporadically, vertically, and horizontally)

12-10-23aa (3)

Alluvium:

0	5	Silt, fine sandy, gray-brown
	20	Silt, soft, fine sandy, buff
	25	Silt, clayey, light gray
	40	Silt, fine sandy, buff
	49	Sand, fine to coarse, little gravel, fine to medium

Dakota formation:

49	55	Clay, hard, blue-gray mottled red
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Logs of Test Holes for Replacement Bridge 3/4 Mile South of Saline River South of Sylvan Grove, on West Line NE SW SW Sec. 24, T. 12 S., R. 10 W., Lincoln County October 16, 1969

12-10-24ccb (1), 37 ft. south and 6 ft. west of center of south end of existing bridge.

Colluvium and Alluvium:

0	17	Silt, dark and light gray; contains some limestone rubble
17	22	Clay, silty, sandy, light gray
22	26	Gravel, medium to fine and sand
26	28	Clay, light gray
28	28.7	"Mortar", Gravel and sand, firmly cemented by calcite.

Dakota formation:

28.7	30	Clay-shale, fairly soft, light gray, mottled red (Point bearing on top of mortar bed at 28 ft. estimated bearing strength, 8 tons per square foot. If mortar bed is penetrated, H pile would probably drive to about 37 ft.)
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12-10-24ccb (2), 37 ft. north and 8 ft. east of center of north end of existing bridge.

Colluvium and Alluvium:

0	19	Silt, slightly clayey, dark gray-brown and light gray
19	25.5	Clay, silty, light gray; contains much gravel, fine to coarse
25.5	26	"Mortar", Gravel and sand, firmly cemented by calcite

(Point bearing at 25.5 ft., Estimated 8 tons/sq. ft.)

Dakota formation:

26	36	Clay-shale, fairly soft, light gray, mottled red.
36	37	Shale, clayey, firm, gray mottled red.

(If mortar bed is driven through, H pile would drive to about 36 ft.)

Bucher & Willis. Logs of Lincoln Co. Proj. No. 53-S-454(9)
SE NE SE Sec. 21, T. 13 S, R. 7 W.

13-7-21dad (1), 2' rt. sta 125 plus 00. Elev. 101.09

Alluvium:

0	62	Silt and clay, light and dark gray
62	68	Silt, very soft, sandy, light gray
68	74	Sand, fine to medium, some sand, coarse

Dakota formation:

74	76	Shale, clayey, firm, gray
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GEOMORPHOLOGY OF THE LOWER SALINE RIVER VALLEY
IN NORTHCENTRAL KANSAS

by

ROYCE LYLE CLINE

B. S., Kansas State University, 1972

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements of the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1974

The lower Saline River in northcentral Kansas occupies a valley downstream and 200 feet below Wilson valley which was abandoned as a result of stream piracy at the beginning of the Illinoian stage. Cross sections and longitudinal profiles were prepared of the lower Saline River to establish the age relationships between terraces in the valley. Pre-Illinoian sediments can be differentiated from post-Sangamon sediments by the absence of arkosic sediments in the pre-Illinoian alluvial deposits. Most downcutting and valley widening by the lower Saline River had occurred by the end of the Kansan age; however, a narrow channel of Wisconsinan age was cut through the wide strath of Kansan age. The valley is similar in development to that of the lower Smoky Hill River downstream from McPherson channel and the lower Republican River downstream from Belleville channel. Physiographic position cannot be considered a valid criterion for determining age of terrace deposits in northcentral Kansas.