

**KANSAS GEOLOGICAL SURVEY  
OPEN-FILE REPORT 95-62**

**GLACIAL AND PENNSYLVANIAN GEOLOGY  
OF NORTHEASTERN KANSAS**

by

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This field trip focuses on the geology of extreme northeastern Kansas: Douglas, Leavenworth, Wyandotte, and Atchison counties. We will encounter rocks of Pennsylvanian age, deposited about 330 million years ago, and much more recent glacial deposition.

0.0 From the Kansas Geological Survey, head north on U.S. Highway 59 (or Iowa Street). Immediately north of the Survey is Daisy Hill, capped by the Oread Limestone, elevation 1020 feet.

1.8 Junction with U.S. Highway 40 (or Sixth Street). Turn east (right) and pass through a roadcut in the Toronto limestone, the lowermost unit in the Oread Limestone. Below the Toronto is the uppermost shale in the Lawrence Formation.

3.1 Massachusetts Street. Turn north (left).

3.2 The Kansas River. Below is the Bowersock Dam. The elevation of the spillway here is 812 feet above sea level.

5.0 Junction with U.S. Highway 24. Turn east (right). This is known as Teepee Junction, named for the unique architecture of the structure to the east. This concrete building was originally a tourist camp and then a gas station; on the side of the concrete teepee is the high-water mark indicating the crest of the Kansas River during the flood of July 1951. That flood covered all of north Lawrence and the next 2.5 miles of our route to the east. The maximum discharge during the 1951 flood, measured at Lecompton, was 483,000 cubic feet per second (cfs). By comparison, peak discharge during the 1993 flood was 186,000 cfs.

5.8 This low area is a former channel of the Kansas River, which curves a short distance north of the highway.

7.0 The highway again crosses over the former channel of the Kansas River.

7.4 Mud Creek.

7.5 Junction with Kansas Highway 32, which leads east to Bonner Springs and Kansas City.

7.7 Douglas County/Leavenworth County line. Leavenworth County, established in 1855, is one of the oldest counties in the state. It was

named after Fort Leavenworth; the fort was named for Colonel Henry H. Leavenworth, who established it in 1827.

10.2 The hills west of the highway are capped by Oread Limestone and mark the eastern edge of the Oread escarpment. Mount Oread, seven miles to the southwest and the home of the University of Kansas, is the type locality of the Oread Limestone.

12.1 Ninemile Creek drains southeast and joins Stranger Creek northeast of Linwood.

12.6 Reno. This small town is named for General Marcus A. Reno, who became separated from Custer's Seventh Cavalry troops at the Battle of Little Big Horn.

13.6 The Oread-capped ridge to the west has an elevation of 1065 feet, 200 feet higher than the highway at this point. The Oread escarpment trends north/northeast and south/southwest and will be to our west until we climb it at Fort Leavenworth. The escarpment represents a break in the landscape where units in the Oread come to the surface.

17.2 Tonganoxie and the junction with Kansas Highway 16, which leads west to McLouth and Oskaloosa. Tonganoxie was named after a Delaware Indian who owned land in this area; much of the land north of the Kansas River and east of Lawrence was once a Delaware Indian Reserve.

18.2 Tonganoxie Creek drains southeast into Stranger Creek.

19.4 This roadcut shows the Haskell limestone, named for exposures at Haskell Indian Nations University. The Haskell is the lowest member of the Lawrence Formation, separating Robbins shale, above, from the Vinland Shale Member of the Stranger Formation, below. Most of the rock units we will see are shown on the cross section, figure 1, from Archer, Feldman, and Lanier (eds.), 1993, Incised Paleovalleys of the Douglas Group in Northeastern Kansas; Field Guide and Related Contributions, Kansas Geological Survey Open-file report 93-24.

20.7 The Tonganoxie Sandstone Member of the Stranger Formation is exposed in this roadcut. The Tonganoxie is primarily a sandstone unit that represents the channel of a river that drained to the southwest during the Pennsylvanian. The Tonganoxie occurs in a relatively narrow band, never more than 20 miles across, and reaches a thickness of 160 feet in places. It is also an important aquifer, or source of groundwater, in some parts of eastern Kansas.

This outcrop consists of thin, sheet-like sandstone beds that were probably deposited in fresh- to brackish-water sandy tidal flats. These ripple-bedded parallel laminations, called tidal rhythmites, indicate rapid rates of deposition--perhaps as much as 1-2 centimeters with each tidal influx. This outcrop is stratigraphically near the top of the Tonganoxie Sandstone. It was deposited near the end of a time when the sand was filling the ancient valley, just before a return to marine conditions that is represented by the roadcut 0.3 mile back to the west.

21.0 Tonganoxie sandstone.

22.1 Stranger Creek. Stranger is a translation of the Indian name for this creek, "okeetsha," which means "wandering aimlessly about," an apt description of this meandering stream. Stranger Creek drains to the south, then dumps into the Kansas River southeast of Linwood. The Stranger Formation is named for exposures along this stream.

22.4 Cross-bedded Tonganoxie sandstone. The angled lines in this sandstone generally indicate that the sand was deposited by flowing water.

22.7 Turn north (left) on 182nd Street.

23.5 Tonganoxie sandstone.

23.7 Jog a short distance west on Parallel Road, cross Hog Creek, then continue north.

24.7 Turn west (left) on Leavenworth Road.

24.8 Tonganoxie sandstone.

25.5 This road curves along the edge of Little Stranger Creek.

25.7 **STOP 1 .** Bridge over Stranger Creek. A thick sandstone in the Tonganoxie is exposed in the west bank of Stranger Creek and in the cliffs farther south. These sandstones were deposited in an ancient valley by a large river system. This valley was probably twice as wide as today's Missouri River valley, which we will see later. Erosion has carved out grottos in the softer portions of the Tonganoxie. Proceed west.

26.2 Turn north (right) and gradually curve to the west.

26.8 Stop sign at Tonganoxie Road. Continue west. Shallow mines once produced coal in this area from the Sibley coal bed, one of the coals in the Stranger Formation that occurs near the top of the Tonganoxie sandstone. These beds ranged from six to 22 inches in thickness.

27.6 Turn north (right) on 203rd Street.

28.5 We'll make a brief stop at this house, built in 1854, the year Kansas became a territory. Abraham Lincoln slept here on December 1, 1859. During a trip that was considered a warm-up for his later campaign for the presidency, Lincoln gave speeches in Elwood, Troy, Doniphan, Atchison, and Leavenworth. Most of those speeches, given two years before Kansas entered the Union as a non-slave state, dealt with secession and Lincoln's opposition to the extension of slavery into Kansas.

29.7 Turn west (left) on Kissenger Road.

30.1 Stop sign. Turn north (right) on 207th Street.

31.7 Stop sign. Turn east (right) on Dempsey Road. One-half mile west is the town of Jarbalo. This town got its name from a profane Mexican who got stuck in the mud of nearby Stranger Creek. Local settlers who helped him heard him refer to the place as "El Lugar de Diablo," meaning "a devil of a place." The last word was appropriated as a name for the river crossing and the English-speaking settlers corrupted the word into Jarbalo.

32.4 Stranger Creek.

32.9 Cemented glacial drift, in the form of conglomerate, is found in this roadcut. Glacial drift is mostly the clay, sand, pebbles, and cobbles carried along by glaciers that moved into this corner of Kansas less than a million years ago. These glaciers moved about as far south as the Kansas River and as far west as the Big Blue River. In many places along today's route, we'll see large pink boulders of Sioux quartzite, a metamorphic rock that was originally in place in South Dakota, Minnesota, and Iowa. These boulders, called erratics, were picked up by the glaciers and hauled to their present locations in Kansas.

34.2 Stop sign at junction with Leavenworth County Road #5. Continue straight.

35.0 Little Stranger Creek.

35.6 Curve south (right) on Leavenworth County Road #8, or 175th Street.

36.6 Curve east (left) on Fairmount Road.

37.0 Little Sandy Creek.

39.3 The town of Fairmount is north of the road.

41.2 Stop sign at the junction of U.S. Highway 73 and Kansas Highway 7. Continue east on Polfer Road. This crossroad is called Wallula. To the east is Wyandotte County and Kansas City, Kansas. Wallula is a Kickapoo word meaning "evil wind of the dead." Wyandotte County was established in 1859 and named after the Wyandot Indians. With an area of 151 square miles, Wyandotte is the smallest county in Kansas.

42.0 Tonganoxie sandstone.

42.4 Island Creek.

42.6 **STOP 2.** Here the base of the Tonganoxie sandstone is exposed. It has cut down to the Captain Creek Limestone Member of the Stanton Limestone Formation. The upper members of the Stanton included the Stoner limestone, which is normally 12 to 15 feet thick in this area, but has been removed by erosion. The contact between the Tonganoxie and the Captain Creek limestone is an example of a local unconformity, or gap in the record of deposition, and represents a time when the braided stream that formed the ancient valley was still downcutting and eroding the surrounding rocks. The lower portion of the Tonganoxie here is a basal conglomerate with many limestone pebbles. Coal seams and woody plant remains can also be found at this exposure, indicating that the area was forested and the climate was tropical.

42.9 Island Creek.

43.2 Stop sign at 123rd Street. Continue east.

43.7 Island Creek. Loess is exposed in the cut bank just north of the road. Loess is a fine-grained silt that was blown out of valleys that were created by meltwater from glaciers. Loess has the ability to maintain a steep face or slope, thus creating many of the steep-walled draws and valleys we will see. It also forms many of the rolling hills and bluffs along the Missouri River. Loess deposits are visible along I-70 in the Kansas City area and in many other parts of the state. The thickest deposits in Kansas are in Doniphan County, where loess is up to 195 feet thick.

44.3 Stop sign. Turn north (left) on 115th Street.

44.5 The road drops through the Plattsburg Limestone.

44.8 Curve to the east, crossing Island Creek and then following the creek for the next 1.4 miles. Island Creek is the type locality of the Island Creek

shale, which we will see at the next stop. The Island Creek shale is a member of the Wyandotte Limestone.

46.2 Stop sign at the junction with Kansas Highway 5. Turn west (left). Island Creek flows into the Missouri River about a half-mile east of here at an elevation of 740 feet. We passed the lowest elevation on this trip, about 760 feet, about 0.2 miles back. We have also re-entered Leavenworth County. K-5, which winds to Leavenworth over loess-capped hills, is narrow and curvy.

47.5 Little Snell Creek. Here the road curves to the west.

48.7 Stop sign. Turn north (right).

51.6 Kansas Women's Prison. The men's prison, in Lansing, is visible to the west. This is one of four prisons in the Leavenworth area.

52.1 Ninemile Creek. To the east is an exposure of Vilas Shale.

52.3 Sevenmile Creek. This and Ninemile Creek are named for their distance from Fort Leavenworth along the Military Trail that led south to Fort Scott and on to Fort Gibson in Oklahoma. We will cross Fivemile and Threemile creeks in Leavenworth.

53.0 One-quarter mile west is the shaft for one of several deep coal mines that operated in the Lansing-Leavenworth area. These mines were over 700 feet deep and exploit a two-foot-thick seam in the Cherokee Group of rocks that crop out about 140 miles south of here, in the Pittsburg area, where they are more extensively mined. One of the mines here was operated by the Kansas State Penitentiary using prison labor. In places these mines extended east, beneath the Missouri River, and actually mined coal from under Missouri.

53.3 East of the road is the Mount Muncie Cemetery.

53.6 Turn north (right) and enter the Leavenworth National Cemetery on the grounds of the Wadsworth Veterans Hospital. Bear to the right and follow the edge of the bluffs above the Missouri River.

54.9 Go right a short distance to the Riverview Road, then turn left.

55.2 Franklin Street. Turn right.

55.3 Medical Center.

55.6 Veterans Park. Curve to the west.

56.1 Wilson Avenue. Turn north (right) and follow Wilson Avenue as it curves to the west and drops down the hill.

56.6 Second Street. Turn north (right).

56.8 **STOP 3**. Behind the jumble of limestone blocks is the Argentine Limestone Member of the Wyandotte Limestone. This unit has been mined in this area and excavation here has uncovered these mines, whose entrances are to the east near the river. This unit is mined underground to the south of here in the Bonner Springs area and other places in Kansas City, Kansas. Above the Argentine is the Island Creek Shale and the Farley Limestone members of the Wyandotte. Thick loess deposits overlie these exposures. This is the lowest unit, stratigraphically, that we will see on this trip. Continue north on Second Street.

57.1 Fivemile Creek.

57.5 Coal mine. Just east of the road is the site of the Home #1, another deep coal mine in the Cherokee Group.

58.0 Olive Street. Turn east (right), go one block and turn south on the South Esplanade Parkway, overlooking the Missouri River. Return to Second Street.

58.6 Second Street. Continue north.

59.2 Threemile Creek. The Leavenworth County courthouse is to the west.

59.3 Cherokee Street. Turn east (right), go one block, then turn north (left) on North Esplanade Parkway. Pass the Civic Center, the former Missouri Pacific Railroad Station, and continue north for another view of the Missouri River, looking north toward Weston, Missouri.

59.9 Kickapoo Street. Turn west (left) and proceed to Fourth Street.

60.1 Fourth Street. Turn north (right).

60.4 Metropolitan Avenue/Kansas Highway 92. Turn west (left), then get in the right-hand lane.

60.6 Grant Avenue. Turn north (right) and enter Fort Leavenworth, the oldest active fort west of the Mississippi. The fort was established in 1827 and has been the home to many famous soldiers and pioneers, including General Winfield Scott, Kit Carson, Wild Bill Hickok, and Buffalo Bill Cody,

who spent his childhood in this area. Both George Custer and his brother Tom were stationed here; today Tom is buried in the military cemetery at Fort Leavenworth. Fort Leavenworth was the temporary capital of Territorial Kansas in 1854. Today the fort is the site of the Army's Command and General Staff College, where officers learn war strategy. Because of the college, the fort has more officers than enlisted personnel; it also has an international flavor because officers from allied countries receive training here.

61.6 Corral Creek.

61.9 **STOP 4.** The Buffalo Soldier Memorial. This monument commemorates the 9th and 10th cavalries of the U.S. Army. Composed of black soldiers who fought in military campaigns from the Indian wars through World War II. The Indians gave them the nickname "Buffalo Soldiers." The memorial was dedicated by General Colin Powell, who was stationed briefly at Fort Leavenworth. Return to Grant Avenue and continue north.

62.7 Statue of Ulysses S. Grant, erected in 1889. North of the statue is a stone wall that was built by Col. Leavenworth's soldiers in 1827. Turn right and proceed down the hill on Riverside. Stop briefly to observe ruts of the Oregon and Santa Fe trails. A branch of these trails started here, as pioneers landed their wagons and teams from river steamboats and pulled up this steep grade. Turn right, crossing the railroad tracks, and continue north past Sherman Army Airfield.

63.8 Turn west (left) on Sheridan Drive and follow it as it climbs onto Hancock Hill.

64.2 Cemetery for prisoners of the Disciplinary Barracks, the military prison at Fort Leavenworth.

64.8 Fort De Cavagnial picnic area. Fort De Cavagnial was a French fort built in this area in 1744. The French traded with the Kansas Indians and the Spanish. Lewis and Clark visited this site during their trip up the Missouri in 1804. The French left after the area changed hands in the Louisiana Purchase. Continue on Sherman Drive, which follows this ridge, capped by the Oread Limestone at an elevation of 1080 feet, more than 300 feet above the Missouri River to the east.

67.0 Hancock Avenue. Turn right.

68.2 Old U.S. Highway 73. Turn left and pass the Leavenworth Federal Penitentiary and the buffalo corral. The enclosed part of the penitentiary covers 22 acres and was constructed with inmate labor, completed in

1927. The penitentiary is known as the "big top," because of the large domed structure at the entrance, or the "hot house," because of its lack of air conditioning.

68.7 Junction with U.S. Highway 73 and Kansas Highway 7. Turn west (right) on the Amelia Earhart Memorial Highway.

69.3 Thick road cut in the Lawrence Formation, below, and the Oread Limestone, above.

70.3 A slope failure in the shale of the Lawrence Formation is west of the road. To the east is Sentinel Hill.

70.8 Salt Creek.

72.7 Leavenworth Northeast oil field. This field produces oil and gas from the McLouth, Burgess, and Bartlesville sands of the Cherokee Group of rocks. It was discovered in 1984.

74.4 The Lawrence shale beneath the Oread Limestone in the road cut.

74.7 The Plattsmouth Limestone Member of the Oread Limestone. We will be in the Plattsmouth at the next stop.

76.4 Lowemont.

78.0 Round Prairie Church. The elevation here is 1110 feet. This upland area is underlain by the Lecompton Limestone, the next limestone formation above the Oread.

80.3 Roadside park. Entering Atchison County, named after Missouri Senator David R. Atchison, who helped found the town of Atchison in 1854. This area was known to be particularly pro-slavery during the 1850s. According to Jim Shortridge's recent book, *Peopling the Plains*, this part of Kansas received a much heavier influx of settlers from Kentucky, Tennessee, Arkansas, and Missouri than did most of the rest of Kansas. The southern influence is still somewhat evident in the area today.

80.9 Kansas Highway 74 leads west to Potter.

83.9 Turn east (right) on Sherman Road.

85.6 Walnut Creek. Elevation 800 feet.

87.6 A short distance to the east is the Sumner Cemetery, about all that remains of the former river town of Sumner, a place that was heavily

promoted by speculators as the next great river port on the Missouri (see figure 2, from R.W. Baughman, 1961, *Kansas in Maps*, Kansas State Historical Society). The copy of the accompanying birdseye map (figure 3, also from Baughman, 1961) shows what Sumner looked like in the minds of its promoters. The description of U.S. Senator John J. Ingalls, who came to Sumner in 1858 and stayed several years before moving to Atchison, is closer to the truth: The inhabitants, wrote Ingalls, "appeared without any exception to be a shabby, ill-dressed, unthrift people. . . . There are no churches in the place, instead of four, as was represented to me. No respectable residences; no society; no women except a few woebegone, desolate-looking old creatures; no mechanical activity; . . . no schools, no children." In 1858 Sumner had a population of 2000, but the town suffered badly when Atchison was declared the county seat and the railroad went to Atchison instead of Sumner. By 1860, most of the buildings in the town had been torn down or destroyed in a tornado, and the townsite is only accessible today from the river.

89.0 Riverfront Road. Turn east (right).

89.4 **STOP 5** . Atchison Underground Facility. This was once known as the Kereford Quarries, named for the George Kereford family that started mining here in 1927. Actually, these are underground limestone mines on opposite sides of Whiskey Creek. The mine north of the creek is owned by the U.S. military and entrance is restricted. This one is used today for commercial storage, especially for recreational vehicles and boats. As you will see inside the mine, the roof is supported by pillars that are about 25 feet in diameter, with a distance of 35 to 40 feet between pillars. In some of the mines that are today used for storage, the floor has been paved and the walls painted. Not in this mine, however, which consists of approximately 40 acres of mine-out space, only part of which is used for storage.

Both quarries are in the Plattsmouth Member of the Oread Limestone, which is 20 feet thick in this area. At the entrance to the mine, you can see units above the Plattsmouth, including the Heumader shale and the Kereford limestone (figure 4 shows the units at the military storage mine; from Fredericksen and Gentile [eds.], 1972, *Guide to Field Trips*, Association of Engineering Geologists 1972 Annual Meeting, Kansas City, Association of Engineering Geologists). This is the type locality for the Kereford, the uppermost member of the Oread. Above the Kereford is the Jackson Park shale, named for exposures just north of here in Jackson Park, a city park in Atchison. Next comes the Clay Creek limestone and the Stull shale, all members of the Kanwaka Shale. This area was also the site of a deep mine that extracted coal from the Cherokee Group, just like the mines in the Leavenworth area. The coal bed here was three feet thick and at a depth of 1126 feet.

89.8 Return to Sherman Road and turn north (right) and continue to U.S. Highway 73 and K-7.

90.8 U.S. 73 and K-7. Turn north (right).

92.1 To the east is the site of Mount St. Scholastica, formerly a Catholic high school and college. Today it is used as a conference center.

92.2 Plattsmouth limestone is exposed in the parking lot east of the highway.

92.4 Main Street. Turn east (right).

93.0 LUNCH stop at Paolucci's and the F&S Mexican Restaurant. After lunch, continue east on Main to Second Street, then turn north (left).

93.2 We climb out of the floodplain and pass an exposure of the Plattsmouth limestone on the east side of the street.

94.0 Turn east (right) on Shuster and enter the campus of Benedictine College. We will stop briefly to visit the monastery and view the Missouri River. The mouth of Independence Creek is a short distance upstream. St. Joseph, Missouri, is to the northeast. From here continue south to Mound Street, then turn west (right) and return to Second Street.

94.6 Second Street. Turn north (right). Atchison is the birthplace of Amelia Earhart. The noted aviatrix spent most of her childhood with her grandparents in their home on the corner of Santa Fe and North Terrace streets. She was the first woman to fly solo across the Atlantic Ocean, in 1932, and in 1937 she and her co-pilot Frederick J. Noonan disappeared in the Pacific on an around-the-world flight.

95.0 Atchison Hospital.

95.8 Kansas State Youth Center at Atchison.

97.3 Deer Creek, elevation 810 feet. A quarry in the Plattsmouth limestone is east of the road.

99.2 Myers Cemetery is east of the road.

99.6 Quarry in Plattsmouth limestone.

99.7 Independence Creek, named by Lewis and Clark when they reached its mouth on July 4, 1804. To mark the event, Lewis and Clark fired their guns in salute and gave their men an extra ration of whiskey.

99.9 Continue north.

100.7 Rock Creek. Continue east.

102.4 Stop sign. Turn south (right).

103.2 Doniphan. St. John's Church is to the west. This area was originally settled by Kansa Indians and still produces archeological relics. In 1855, the town was founded and named for Alexander W. Doniphan, a hero in the Mexican-American war. By the late 1850s, as many as 20 steamboats a day visited Doniphan, which was also the site of the first grain elevator in the state.

103.6 Turn east (left). This is close to what was once the riverfront of Doniphan. When the river shifted away from Doniphan in 1891, the town was left on a lake with the river some distance away (figure 5 compares a topographic map from 1879 to one from 1990; figure 6 is from Baughman, 1961;). The river's shift, and the lack of a railroad, spelled the end of the Doniphan. Today the river is more than a mile away and there is no trace of the lake.

From here the road follows the base of the bluffs. Numerous quarries in the Oread Limestone are cut into the bluffs just west of the road.

105.2 Levee.

106.6 Piles of sand can be seen in the fields east of the road. This sand was washed in during the flood of 1993.

107.0 **STOP 6** . Turn right on the short gravel road that leads to the river. The Missouri River, at 2533 miles, is the longest river in North America, 200 miles longer than the Mississippi. The average flow at St. Joseph, just upstream, is about 37,000 cfs. During the flood of 1993, the flow reached 335,000 cfs. The greatest flood ever recorded on this stretch of the river was in 1952, at 397,000 cfs. This is also mile 433 on the river, the distance above the confluence with the Mississippi north of St. Louis. The river elevation here is a little over 780 feet.

107.9 Turn east (right) at the intersection. This is the site of the town of Geary City, which was established here in 1856 and named after John W. Geary, the third territorial governor of Kansas (after whom Geary County is named). According to Dan Fitzgerald's *Ghost Towns of Kansas*, Geary City suffered when river traffic declined in the late 1850s, and the town was all but abandoned by the 1860s. By 1907, nothing remained but a store and a church, and those are gone today.

108.0 Brush Creek. We leave the floodplain and climb into the loess hills of Doniphan County, passing what was once the Geary school on the right.

110.1 Deep loess canyon east of the road.

111.4 Cordonier School.

112.1 Deep gulch north of the road.

113.7 Walnut Creek.

114.5 This road south leads to Palermo, across Walnut Creek. Continue east curving north along the edge of the Missouri River.

114.8 Lawrence shale is exposed west of the road and large blocks of Amazonia limestone that have fallen from above litter the hillside.

115.6 Lawrence shale west of the road.

116.8 Stop sign. Continue north.

116.9 Peters Creek. This is the town of Wathena, established in 1856 and named for the Kickapoo chief who once owned the townsite. Proceed north and turn east (right) on U.S. Highway 36.

117.2 Turn left on St. Joseph Street, then left again and follow the base of the bluff to the north. The town of Elwood, Kansas, is located four miles east of here. Just across the Missouri River from Elwood is St. Joseph, Missouri.

118.0 The old house on the west side of the road is rumored to have been used as a location in the movie "Paper Moon," parts of which were filmed in northeastern and west-central Kansas in the early 1970s.

118.6 Browning Lake east of the road. East of the lake is the Missouri River and the St. Joseph Airport. This was the course of the Missouri River until 1952, when the flood cut a new course 2.5 miles east of here, forming this ox-bow lake and separating St. Joseph from its airport (see figure 7, from Buchanan and McCauley, 1987, *Roadside Kansas*, University Press of Kansas).

120.4 Continue north along the base of the bluffs.

121.4 Turn right on an unimproved dirt road, avoiding farm equipment, and continue north.

122.1 STOP 7, at an old dump truck. In the quarry to the west is a section of rock from the Lawrence Formation, complete with Amazonia limestone, through the entire Oread Limestone and into the Kanwaka Shale. The Amazonia is named for a small town across the river in Missouri. It does not occur in the Lawrence area. A number of invertebrate fossils can be found in the upper units here.

At the top of the quarry can be found Kansas-age glacial drift and loess. Glacial material is common throughout this area. Glacial outwash is common in one of the quarries in the bluffs south of Wathena; that outwash includes chunks of local limestone that have been heavily abraded by glacial action and show glacial striae--long, straight grooves or scratches that were carved into the rocks as they were moved by the glaciers.

From here return to Wathena, take U.S. Highway 36 west to Troy, then K-7 south to Atchison, then U.S. 59 to Lawrence.

Some of the information for this field trip guide is from the following sources. See them for more information.

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IOWA SAC AND FOX INDIAN RESERVATION

White Cloud

COUNTY

T 1 S  
T 2 S

HOLT

MISSOURI

R 20 E  
R 21 E

ANDREW

T 2 S  
T 3 S

Highland

Sparks

Fanning

R 21 E  
R 22 E

COUNTY

R 22 E  
R 23 E

T 3 S  
T 4 S

BROWN

Leona

Severence

Denton

TROY

Blair

WATHENA

STOP 7

MISSOURI

COUNTY

Purcell

Huron

Bendena

Doniphan

Shannon

Lancaster

Doniphan

STOP 6

T 56 N  
T 55 N

BUCHANAN C

MISSOURI

COUNTY

Lancaster

Shannon

Atchison

Atchison

Atchison

ATCHISON

STOP 5

T 5 S  
T 6 S

BUCHANAN C

MISSOURI

ingham

Monrovia

Farmington

Parnell

Cummings

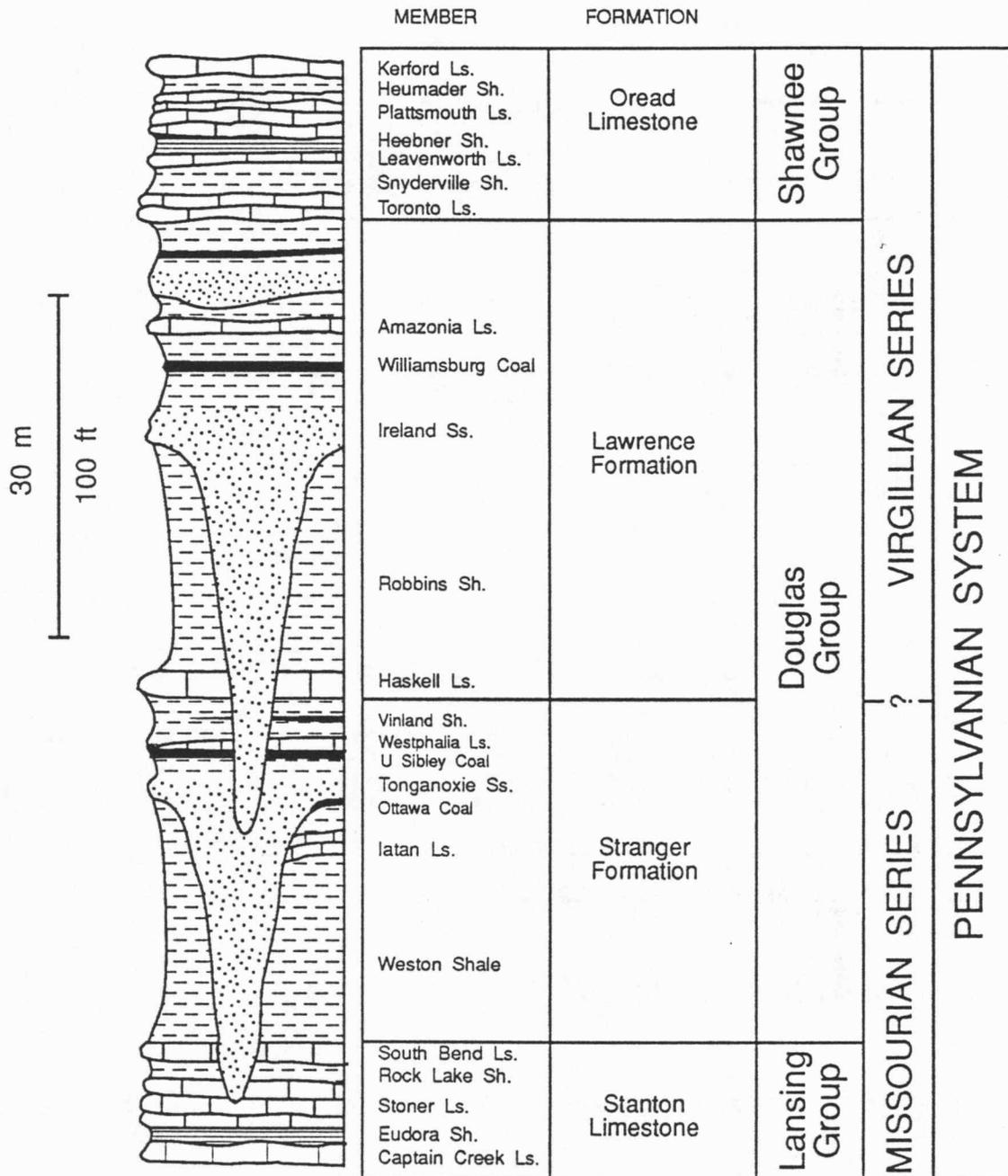
St. Pats

Potter

Oak Mills

Nortonville

St. Pats



Stratigraphic nomenclature in the study interval in Leavenworth Co.

Figure 1

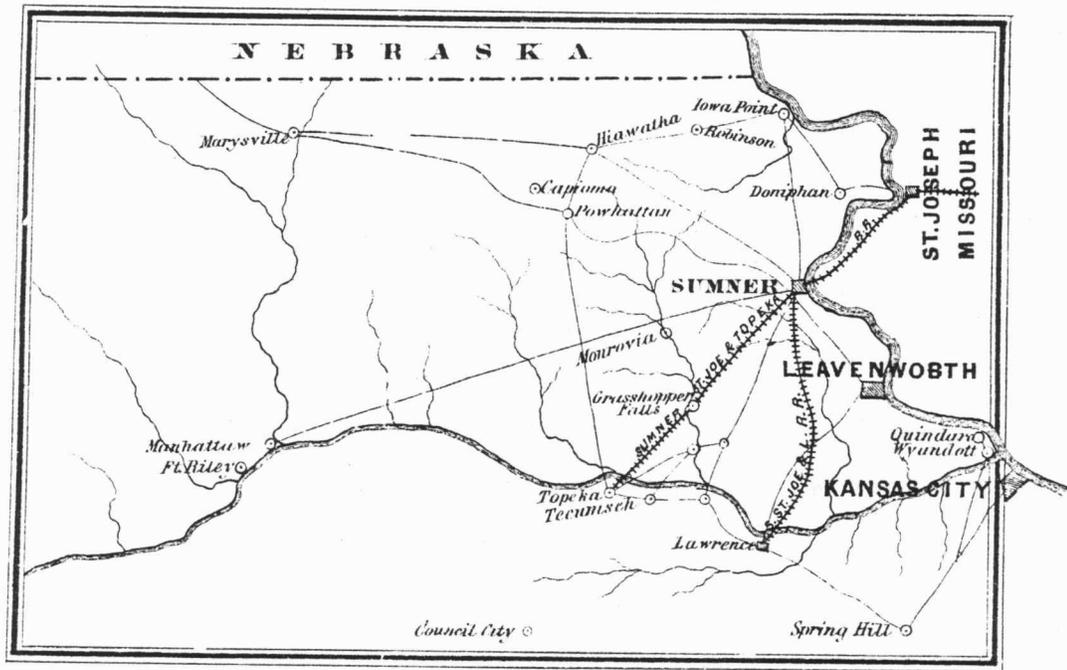
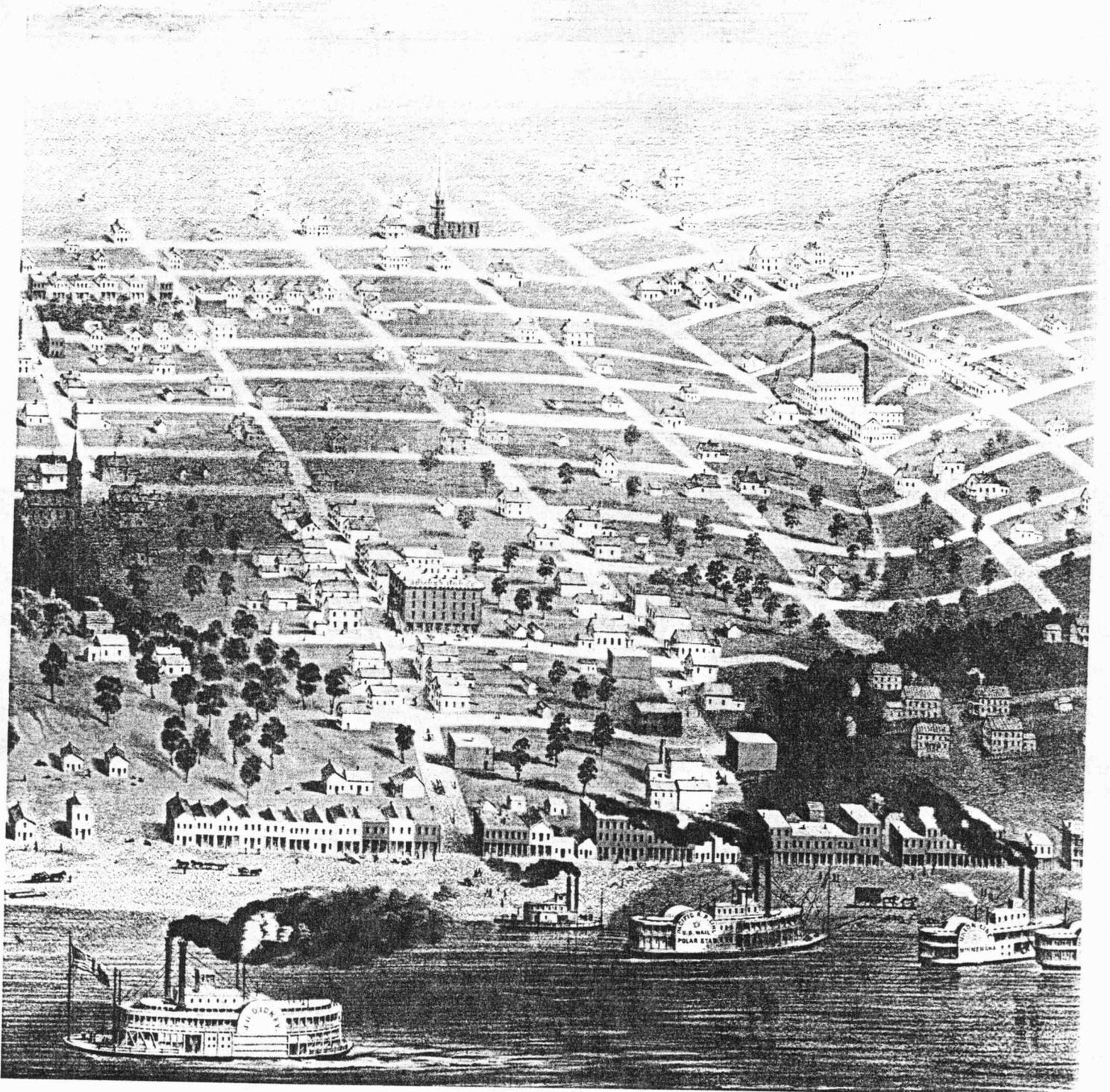
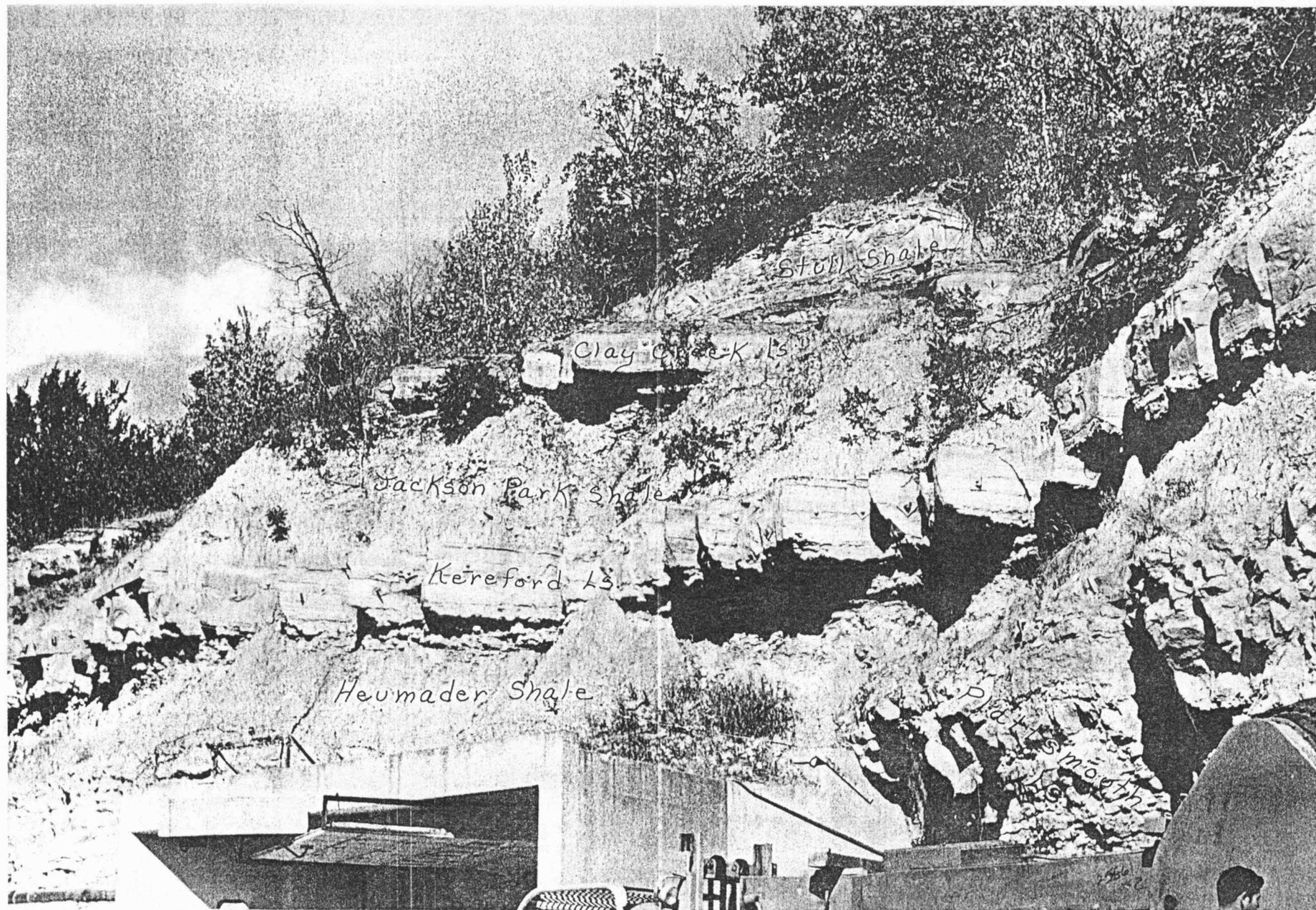


Figure 2

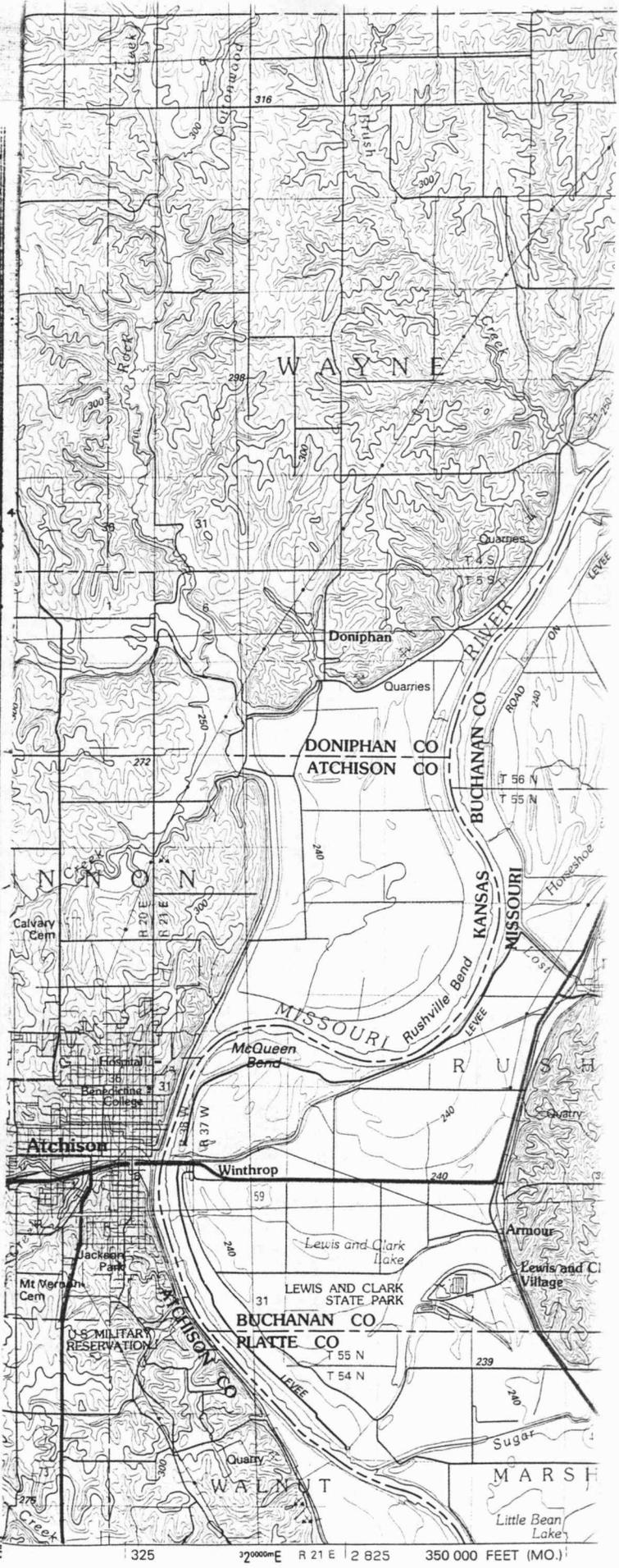
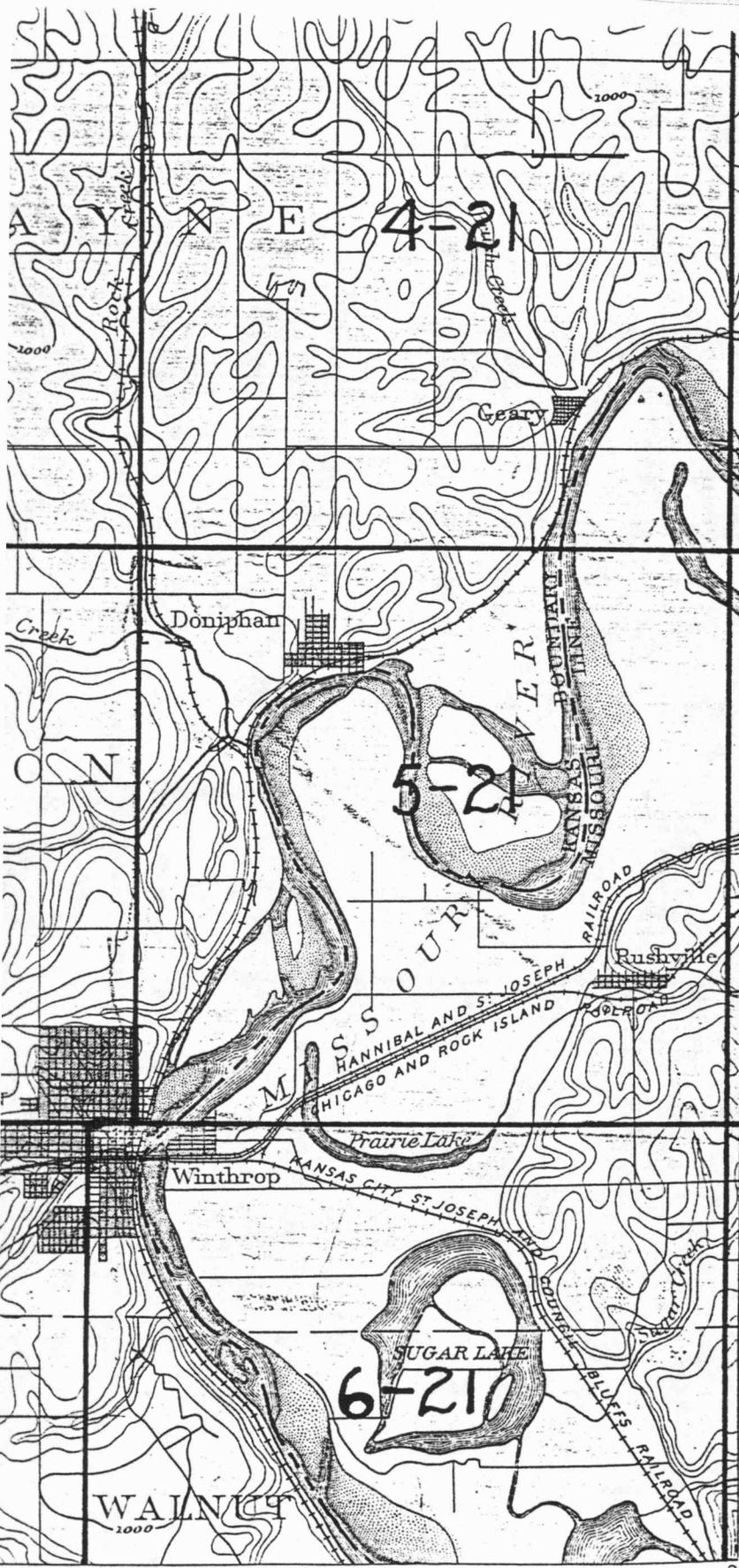
Figure 3





Geology At Atchison Government Storage Mine. Note Bolting Of Outcrops.

Figure 4



Oct. 1893, reprinted 1924.

NOTE.. Missouri River Compiled from Survey made in 1879 by Engineer Corps U.S. Army

ATCHISON, KANSAS-M 1990 3909

Figure 5

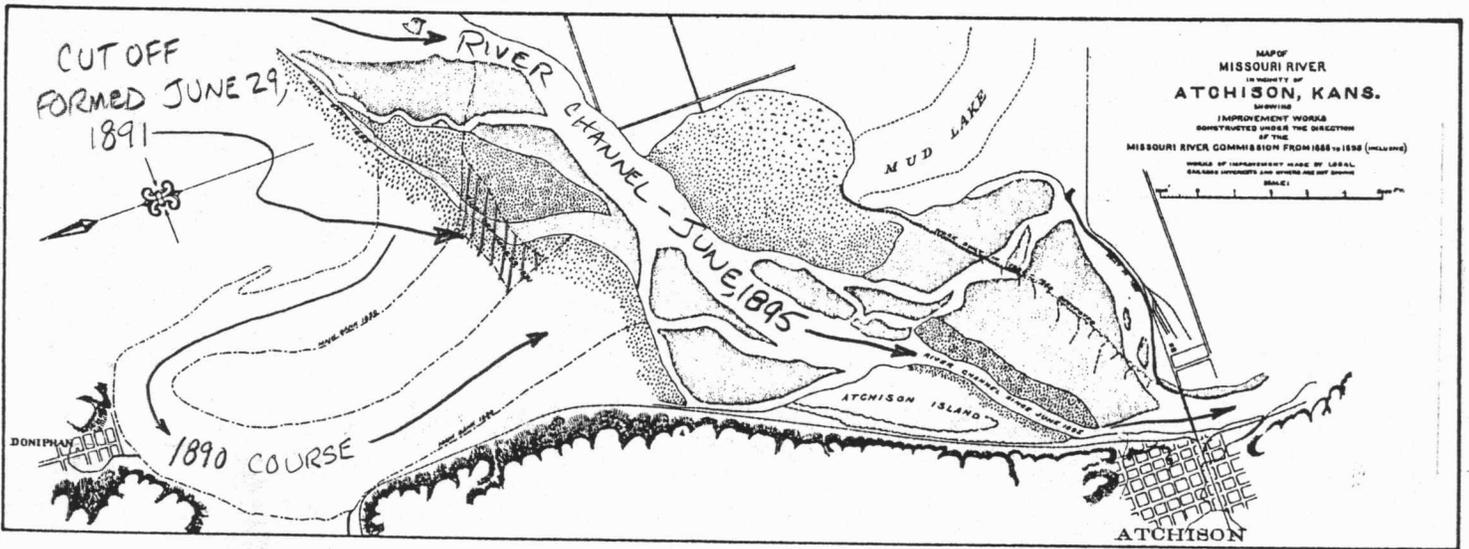
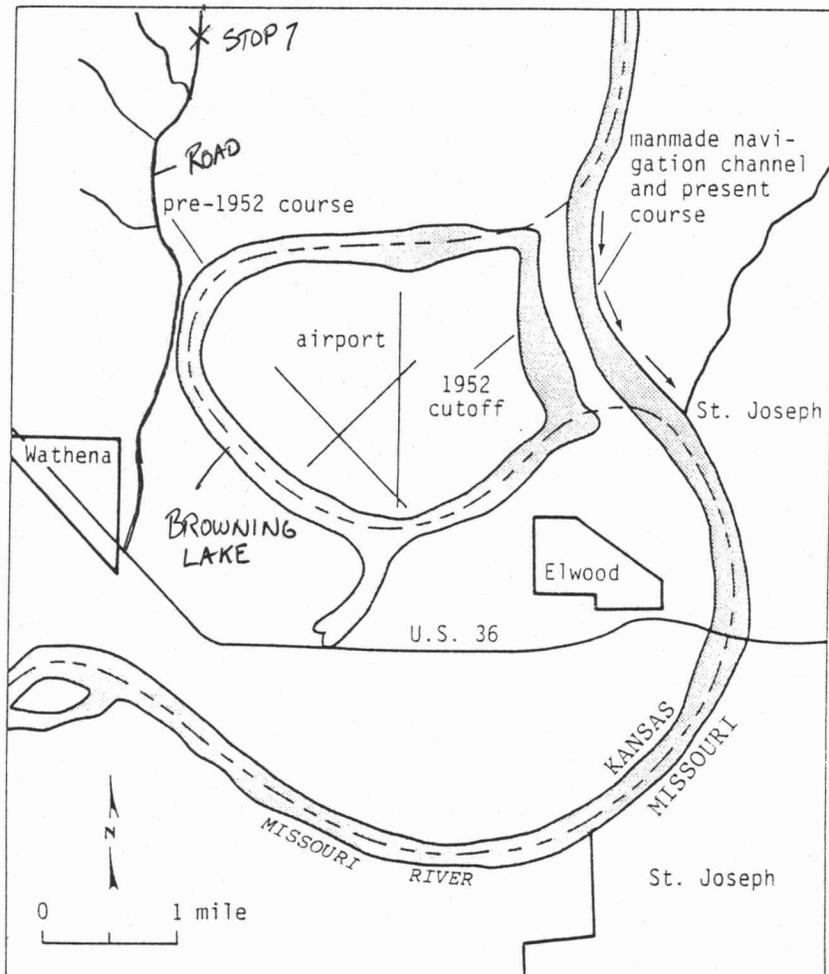


Figure 6



The change of course in the Missouri River at St. Joseph after floods in 1952

Figure 7