KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 94-59

FLINT HILLS FIELD TRIP
November 1, 1994

by

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0.0 Leave parking lot behind Moore Hall and head for Iowa Street - U.S. Highway 59.

0.2 Turn north on Iowa Street.

0.4 Pioneer Cemetery lies immediately to the west and contains the grave of Raymond C. Moore, the namesake of Moore Hall.

0.5 Road cut through the Plattsburg Member of the Oread Limestone, which caps the ridge known as Daisy Hill and also Mount Oread where the main campus of the University of Kansas is located just to the northeast.

1.5 Stoplight at 9th Street. Proceed north and begin to drop off the north side of the cuesta formed by the Oread Limestone.

2.0 Tollbooth. Take a ticket and follow arrows indicating I-70 West. This is the lowest point of the field trip both topographically and stratigraphically. Our elevation is about 835 feet and the underlying bedrock is in the lower part of the Lawrence Formation, a thick shale and sandstone unit beneath the Oread Limestone. These units are Pennsylvanian in age, deposited about 300 million years ago when eastern Kansas was covered by a shallow sea. The first 58 miles of this trip will be through Pennsylvanian rocks, except for some recent glacial and alluvial deposits.

3.4 West Lawrence interchange. Merge with west bound traffic.

5.6 Baldwin Creek.

6.3-6.7 Oread Limestone, one of the most prominent formations in eastern Kansas, averages about 52 feet in thickness in the northern part of the state. The Oread was named for Mount Oread, the hill that overlooks downtown Lawrence. The hill's name came from the home of Eli Thayer, a Massachusetts resident who was one of the foremost promoters of the New England Emigrant Aid Society, which helped to settle Kansas in the 1850s. Mount Oread was the name of Thayer's home; he also operated the Oread Female Seminary near Worcester, Massachusetts.

7.2 Plattsmouth limestone. The Oread Formation is made up of four smaller limestone layers. The Plattsmouth limestone is the thickest of those limestones.

9.2 Oakley Creek.

8.5-9.7 Numerous outcrops of Lecompton Limestone.

10.3 Tecumseh Shale, overlain by Deer Creek Limestone.

11.5 Tecumseh Shale, overlain by Deer Creek Limestone. This shale layer is up to 65 feet thick near the Kansas River.

12.0 Deer Creek Limestone.

12.3 Lecompton is visible to the northeast. This small town was once the capital of territorial Kansas and was known as a proslavery stronghold. Today, bald eagles often roost in the winter in the trees along the Kansas River near Lecompton--in fact, the town was once called Bald Eagle.

15.1 Topeka Limestone.

15.8 The town of Big Springs, south of the highway, is named after a series of springs that flowed near here. Wagon ruts from the Oregon trail are visible as terrace-like swales of earth in the pasture south of the road. Also at about this point the road crosses a feature that geologists call the Big Springs Anomaly. According to precise measurements by geophysicists, magnetic levels in this area are significantly higher than in the surrounding countryside. These readings are intriguing because they give clues about the subsurface. For example, the Big Springs Anomaly indicates that the underground igneous rock contains more magnetite than in other areas, producing the higher magnetic readings. Geologists have mapped magnetic levels across Kansas; they use the information to explore for oil and gas and to understand the geologic history of Kansas.

15.9 Calhoun Shale, overlain by Topeka Limestone.

16.5 Spring Creek.

16.7 Topeka Limestone.

16.8 Shawnee/Douglas county line and the Oregon Trail crossing. Here I-70 passes over U.S. Highway 40, one of the major east-west routes through Kansas before the days of the interstate highway system. Between Topeka and Lawrence, U.S. 40 closely follows the path of the old Oregon Trail. When gold was discovered in California in 1848, traffic along the Oregon Trail increased. One branch of the trail ran from Independence, Missouri, to Topeka, then northwest to Marysville, and into Nebraska; its course would

have crossed I-70 at about this point. Wagon ruts are not visible at this location.

17.4 & 18.0-18.3 Topeka Limestone, which is named for the Kansas capital, is 33 to 55 feet thick.

19.0 Deer Creek Limestone.

19.3 Whetstone Creek.

19.5 Deer Creek Limestone.

19.7 Calhoun Shale, overlain by Topeka Limestone.

20.6 Tecumseh Creek flows into the Kansas River 1.5 miles north of here, near the town of Tecumseh, which was named after the most famous of the Shawnee Indian chiefs.

20.7 Deer Creek Limestone. The Ervine Creek Member of the Deer Creek Limestone is 14 to 18 feet thick in this area. It has been extensively quarried south of the highway along Tecumseh Creek.

21.3-21.6 Calhoun Shale overlain by Topeka Limestone.

21.9 Stinson Creek is named after the founder of the town of Tecumseh, which is situated near the stream's mouth.

22.0 Ervine Creek limestone, the uppermost member of the Deer Creek Limestone, is exposed on the south side of the eastbound lane of I-70.

22.3 Topeka service area.

22.5 Topeka Limestone is exposed on the north side of westbound I-70.

23.5 East Topeka Interchange. I-70 separates from the Turnpike here. Take I-70 west. To the southwest, the Turnpike leads to Emporia, Wichita, and Oklahoma.

23.7 Kansas Turnpike tollbooth.

24.5 Deer Creek, which is dammed 1.5 miles to the south to form Lake Shawnee. The Deer Creek Limestone is named after exposures along this stream.

26.1 Topeka Limestone.

26.4 Shunganunga Creek.

26.8 Tenth Avenue exit. The Kansas Statehouse and other state office building are accessible from this exit. Construction on the Kansas Statehouse began in 1867, using Fort Riley limestone, quarried near Junction City. Construction on the west wing began in 1869, using Cottonwood limestone, dug near Cottonwood Falls in Chase County. Located on a 20-acre square in the center of Topeka, the Statehouse features murals by John Steuart Curry on its second floor.

Since Kansas was organized as a territory in 1854, the legislature has met at four locations in addition to Topeka. The 1855 legislature, called the Bogus Legislature because many of its members were elected by proslavery Missourians, met at Pawnee in Fort Riley and at Shawnee Mission. Later legislatures met at Lecompton and Lawrence, before Topeka was voted the permanent state capital.

27.9 The twin spires of St. Joseph's Catholic Church are visible south of the highway. Topeka is the childhood home of Survey staff members Larry Brady and Andrea Yewell.

29.7 Here I-70 crosses Ward Creek, which flows a short distance north and empties into the Kansas River. The Kansas, or Kaw, drains almost all of northern Kansas, eastern Colorado, and most of Nebraska south of the Platte River. The Kansas begins at the confluence of the Republican and Smoky Hill rivers near Junction City and empties into the Missouri River at Kansas City. Other rivers that drain into the Kaw include the Solomon, Saline, Delaware, Blue, and Wakarusa. In all, the Kaw drains a watershed of more than 60,000 square miles, carrying an average of 4.75 million acre-feet of water per year. In northeastern Kansas, where groundwater supplies can be rare, the Kaw is an important water source, and it is no accident that many of the state's major cities--Topeka, Lawrence, Kansas City--are perched on its banks.

34.2 Just north of I-70 is a view of the Kansas River. This is also the westbound exit for Gage Boulevard. One mile south is Gage Park and the Topeka Zoo, which is noted for its tropical rain forest and its gorilla exhibit.

31.3 Interchange for U.S. 75, which exits to the north and joins I-70 for a short distance to the west. The eastbound exit for Gage Boulevard and Gage Park is at this interchange.

32.2 On the hill to the north is Cedar Crest, the official resident of the governor of Kansas.

32.7 North of I-70 is the Menninger Foundation, a nationally known center for the treatment of and research into psychiatric disorders. The main building, which is modeled after Independence Hall in Philadelphia, contains a collection of Sigmund Freud's papers.

33.2 Exit for Wanamaker Road and U.S. Highway 75 By-pass South. The Kansas Museum of History and the Menninger Foundation are accessible from this exit.

33.9 The Kansas Museum of History, operated by the State Historical Society, opened in 1984 with exhibits related to the history of Kansas.

34.1 I-470 interchange. This road loops around the western and southern edges of Topeka before intersecting with the Kansas Turnpike and I-70.

34.9 Burlingame Limestone Member of the Bern Limestone. Fusulinid fossils and algal remains are common in this limestone layer, which ranges in thickness from 1 to 25 feet.

36.2 Kansas Highway 4 interchange. This highway cuts through the Flint Hills south of I-70.

36.5 Auburn Shale, overlain by the Emporia Limestone.

36.9 Emporia Limestone.

37.9 Blacksmith Creek, a small creek that joins Mission Creek and drains into the Kansas River.

38.0 Here the road passes through a hill called Hickory Knob. Along the road, the Scranton Shale is overlain by the Bern Limestone.

38.5 Mission Creek.

39.8 Willard Shale.

40.2 & 40.5 Zeandale Limestone, which was named for a small town east of Manhattan. Zea is the Greek word for grain, and that part of the Kansas River valley was known as Zeandale Bottoms.

40.9 Willard Shale, overlain by Zeandale Limestone.

41.3 Vassar Creek.

42.0 Willard Shale overlain by the Tarkio Limestone Member of the Zeandale Limestone. This Pennsylvanian limestone is gray, but it weathers to a deep yellow-brown. It is characterized by an abundance of large fusulinids.

43.3 Wabaunsee/Shawnee county line. Wabaunsee County was named for a Pottawatomi chief whose name meant "Dawn of Day." This area was once

part of a 900-square-mile Pottawatomi reservation that stretched 30 miles north and west from Topeka. A 120-square-mile Pottawatomi reservation still exists about 15 miles to the north, in Jackson County. The Pottawatomi language provided what is probably the best-known Indian phrase in America--"kemo sabé"--which means faithful friend and was used by television's Tonto in reference to the Lone Ranger.

43.9 Post Creek.

44.9 Dover Limestone Member of the Stotler Limestone.

47.1 Pillsbury Shale, overlain by the Stotler Limestone. In places, the Pillsbury Shale contains a thin bed of coal.

47.3 Keene Road exit. Taken south, this road intersects with K-4, which meanders through the Flint Hills. K-4 passes through Eskridge--a town that bills itself as the Gateway to the Flint Hills--and past a pretty man-made reservoir called Lake Wabaunsee. Buffalo Mound is clearly visible on the western horizon.

47.5 Dry Creek.

48.9 Brownville limestone, overlain by Towle shale.

49.5 Brownville Limestone Member of the Wood Siding Formation, overlain by the Towle Shale Member of the Onaga Shale. In this outcrop the Brownville limestone, which is actually bluish-gray, is stained red by the overlying red-colored Towle shale. The contact between these two units was once defined as the boundary between rocks of Pennsylvanian age, below, and younger strata of Permian age, above. This boundary has recently been redefined as the base of the Neva Limestone which is higher in the section. In other locations, Indian Cave sandstone may occur at the base of Towle shale and may cut down into the underlying rocks. Indian Cave sandstone is exposed about 8 miles southeast of here in the banks of Mission Creek at a location called Echo Cliffs.

50.3 At this point the road passes an exposure of Janesville Shale and crosses Buffalo Mound. At 1,273 feet elevation, this hill is more than 300 feet above Mill Creek valley, just to the north. It was reportedly named because its shape resembles a buffalo's back. Geologists consider Buffalo Mound a landmark on the eastern edge of the Flint Hills. It is capped by Grenola Limestone, the uppermost Pennsylvanian Formation in Kansas, and its outcrops are good locations for collecting fusulinid fossils.

51.2 STOP 1. Take exit 338, the Vera Road exit. Park on the I-70 Exit ramp. The West Branch shale is overlain by the Five Point limestone, both members of Janesville Shale, which is exposed at this exit. In the northwest corner of this

intersection is an unnamed coal bed in the West Branch shale that we will examine. Coal beds are much more common in the older Pennsylvanian rocks of eastern and southeastern Kansas. From Stop 1 proceed south on the gravel road. The elevation here is 1010 feet.

52.8 Dog Creek. Dog Creek flows in to Mill Creek three miles north of here.

53.8 Road cut in the Roca Shale.

54.3 The road crests a ridge at an elevation of 1273 feet, the same elevation as Buffalo Mound. The low flat-topped hills just east and west of the road are capped by the Cottonwood Limestone Member of the Beattie Limestone. The next limestone below the Cottonwood is the Neva, which is the newly designated base of the Permian system. This limestone is pretty close to road level as we cross this ridge.

54.9 Turn west.

55.9 Turn south.

56.1 STOP 2. Johnson Shale. Here we will collect Pennsylvanian fossils and calcite-lined geodes that are weathering out of the outcrop. The most common fossils at this location are seashell-shaped brachiopods, net-like bryozoans, corals, crinoids, and fusulinids, single-celled animals whose fossils resemble a grain of wheat.

57.0 Snokomo School House. This school house was built in 1883 and is named for Snokomo Creek, a short distance west of the road.

58.1 Cottonwood limestone is exposed on the east side of the road (elevation 1300 feet). We are now in Permian rocks, deposited roughly 280 million years ago under conditions similar to those of Pennsylvanian times. In fact, because the depositional conditions were similar, rocks of Permian and Pennsylvanian age look much the same. That is at least one of the reasons why the dividing line between Permian and Pennsylvanian rocks is difficult to discern.

59.5 Turn west onto Skyline Scenic Drive.

64.5 Here the road climbs on a ridge capped by the chert-bearing Wreford Limestone and follows the drainage divide between Kuenzli Creek to the east and Mill Creek to the west.

68.2 This large radar dome houses the antenna for the NEXRAD radar system of the U.S. Weather Service. This is the most advanced radar system yet developed to view and interpret severe storms. It is a Doppler radar system, which can detect rotation and wind shear in thunderstorms and can be used

to give more accurate warnings of approaching severe storms. This radar covers all of northeastern Kansas and adjacent areas and is used on local television weather reports. NEXRAD radars are also located in Wichita and in Pleasant Hill, Missouri, just southeast of Kansas City.

68.3 Nearby are oil wells in the Steuwe oil field.

69.2 The road drops into the Mill Creek Valley passing through outcrops of the Funston Limestone.

70.5 Stop sign. This crossroad is known as Allendorph.

71.0 South Branch Mill Creek.

71.2 Stop sign on Kansas Highway 99. Turn north.

71.7 West Branch Mill Creek. This stream joins the South Branch of Mill Creek a short distance downstream to form Mill Creek. Mill Creek drains much of Wabaunsee County and flows into the Kansas River northeast of Maple Hill.

72.7 Alma, the county seat of Wabaunsee County. Alma is well known for its cheese factory, located on the town's east edge. Turn west (left) on 3rd street passing by the county courthouse.

73.0 Fork in the road. As Yogi Berra once said, "When you come to a fork in the road, take it." In this case, take the right fork.

73.2 Alma Cemetery, turn west (left).

73.5 Thin-bedded limestone in the lower part of the Cottonwood Limestone Member of the Beattie Limestone.

74.5 Crouse Limestone.

75.2 Here the road climbs onto uplands underlain by the Wreford Limestone, one of the cherty units of the Flint Hills.

76.0 Here geologic structure is exposed as dipping beds, especially the Funston Limestone. These dips reflect deformation of beds overlying the granite Nemaha Ridge and Humboldt Fault zone in the subsurface. This area was structurally active in the Pennsylvanian Period. Later structural movement has affected these younger beds.

77.8 Loire Creek.

78.4 STOP 3. The view to the northeast again shows southeasterly dips in the surface rocks. Geologists have mapped a deep graben or down-faulted block just south of here that may be producing what are, for Kansas strong dips. Most rocks in the region dip or get deeper as you go west and northwest. Because the Nemaha Ridge lifted these rocks up, they dip strongly to the east, the opposite of most rocks in the area.

78.7 The hills south of the road are capped by the Florence Limestone Member of the Barneston Limestone Formation.

80.2 Crouse Limestone in road cut and creek bank.

80.4 The very cherty Schroyer Limestone Member of the Wreford Limestone.

81.4 This isolated hill is an outlier of the Florence Limestone.

82.3 Cherty outcrops of the Schroyer Limestone.

83.4 & 83.5 Cherty exposures of the Florence Limestone Member of the Barneston.

84.9 Geary County line. Geary County is named after territorial governor John Geary, who later moved to San Francisco, where Geary Street is named after him.

86.9 Junction with Kansas Highway 177. Head south (left).

87.0 Schroyer Limestone in road cut.

88.5 Poole Creek.

89.1 Florence limestone, named after the small town in Marion County.

89.89 Horne Branch.

91.0 Elevation 1500 feet. Here we are 665 feet above the West Lawrence tollbooth.

93.5 Florence limestone.

94.9 Florence limestone.

95.4 A quarter mile west is Moss Spring. These gently rolling uplands along the crest of the Flint Hills are capped by the Barneston Formation. Two limestones make up the Barneston, the very cherty Florence that is seen in several road cuts and the Fort Riley, a purer, more massive limestone at the top of the Barneston. The Fort Riley is prone to dissolution, forming solution

channels similar to those at the washed out outlet at Milford Dam. Sinkholes and caves can also form in the Fort Riley. These solution channels act like underground passageways for groundwater. Where the passageways reach the surface springs occur. The gentle backslope of the Flint Hills is famous for its springs. Moss Spring is just one such spring. Better known are Diamond Springs and Lost Spring, both stops along the Santa Fe Trail west of Council Grove.

97.5 Entering Morris County, named after an Ohio Senator in 1859.

97.8 West Branch of Mill Creek. This is the uppermost reach of the creek we crossed on the south edge of Alma.

98.5 Munkers Creek. This creek at one time flowed northeast into the West Branch of Mill Creek but was captured by a south-flowing stream and makes a U-turn near Alta Vista and heads for the Neosho River and Council Grove Lake south of here.

98.8 Kansas Highway 4 heads east from here towards Eskridge. From here south the highway follows the county line between Wabaunsee to the east and Morris to the west.

99.8 K-4 heads west from here to Dwight, 5 miles.

107.5 Munkers Creek. This creek forms a large cove on Council Grove Lake just southwest of here. Council Grove Lake was constructed by the U.S. Army Corps of Engineers by damming the Neosho River.

107.8 Limestone in the Wreford. The hills east of the highway are capped by the Barneston Formation.

109.4 Richey Creek.

109.5 Wreford Limestone.

110.3 Schroyer Limestone Member of the Wreford.

111.4 Funston Limestone.

112.4 Junction with U.S. Highway 56. On the northeast corner is the Madonna of the Trail. She may not be a "material girl" but she is quite substantial none-the-less. Just west of here is the Neosho River. Cross it and enter beautiful downtown Council Grove.

112.6 Downtown Council Grove. Stop here for lunch at the historic Hays House founded by Seth Hays. Council Grove was an important stop on the Santa Fe

trail, serving as a jumping off point for the trip west. From 1846 to 1872 Council Grove was the headquarters for the Kansa Indian Reservation, the tribe that supplied the state's name. The Kansa were living in northeastern Kansas when Europeans first came into the state, but in 1846 were re-located to 250,000 acres here in the Neosho River valley. When the Kansa came to Council Grove, they numbered about 1500. When they were moved again to an even smaller reserve in Oklahoma in 1872, they were down to 600 tribe members. Today fewer than 10 full-blooded Kansa (or Kaw) remain in Oklahoma.

After leaving the Hays House, turn south on U.S. Highway 77.

113.0 Elm Creek.

114.1 The two limestone members of the Wreford Limestone are exposed in this road cut. The lower limestone is the Threemile, the upper is the Schroyer; they are separated by the Havensville shale.

116.9 Fourmile Creek.

117.2 & 118.2 Schroyer limestone member.

119.6 Florence Limestone Member of the Barneston.

120.6 Fort Riley Limestone of the Barneston.

121.1 Entering Chase County, named after Salmon P. Chase, an Ohio senator and chief justice of the Supreme Court. Chase County was recently the subject of a book called *Prairyerth* by noted author William Least Heat Moon, perhaps better known for his earlier best-seller *Blue Highways*. Each chapter of *Prairyerth* describes a section of Chase County based on 7-1/2 minute topographic maps. Many of the maps Moon (also known as William Trogdon) used in researching the book were purchased from the KGS.

125.2 Florence limestone.

125.5 Matfield Shale.

125.9 Schroyer limestone.

126.7 Funston Limestone.

128.6 Fox Creek.

129.1 Lower Fox Creek School.

129.4 Cottonwood limestone in creek west of the road

129.6 STOP 4. The Z-Bar Ranch is also known as the Spring Creek Ranch and soon will be a National Monument. The ranch covers more than 10,000 acres, mostly extending north and south along the highway. The ranch house here is constructed of Cottonwood limestone. The large iron "K" along the road is the brand of a Rice County rancher and feedlot owner, Kenny Knight, who leases some of the pastures. Cattle are pastured here in the summer, then moved to the feedlot in the fall for finishing.

132.0 Junction U.S. Highway 50.

132.1 Easly Creek Shale.

132.4 Fox Creek.

133.0 Strong City. This town was named after William Barstow Strong, a president of the Santa Fe Railroad. Junction with the main street of Strong City, turn south (right) and travel across the flood plain of the Cottonwood River to Cottonwood Falls. These towns were once connected by horsedrawn street cars and are sometimes called Twin Cities.

134.4 Cottonwood River. This river has its source in western Marion County and flows east to join the Neosho, east of Emporia. The river's elevation here is about 1153 feet. Just upstream is a low dam and the remains of an old mill that once operated on the river.

Immediately after crossing the river turn west on Main Street, go one block and turn south on Broadway, the main business area of Cottonwood Falls. Broadway ends at the Chase County Courthouse. Completed in 1873, it is the oldest courthouse still in use in Kansas and certainly the most photographed. We will stop for a short tour. Whiners will be locked up in the second floor jail, which has been vacated for our private use.

135.0 Return to K-177 and turn south.

136.8 Buck Creek.

139.8 Road cut in Wreford Limestone, Schroyer limestone underlain by Havensville shale, and Threemile limestone.

142.2 Bazaar Cemetery and Roadside Park. The small village of Bazaar is a half mile east and was once an important cattle shipment point on the Santa Fe railroad. From here south, K-177 follows the Santa Fe railroad southward up the valley of the South Fork of the Cottonwood River. River valleys provide a low grade for railroads in crossing the Flint Hills.

143.5 Rock Creek.

145.8 Baker Creek.

146.3 One mile west of this curve is the Knute Rockne Memorial Monument marking the site of the 1931 plane crash that claimed the life of the famous Notre Dame football coach.

147.0 Nickel Creek.

147.9 Kirk Creek.

149.3 Crocker Ranch on the west side of the road is listed on the National Register of Historic Places.

149.8 Crocker Creek.

149.9 Pioneer Bluffs Ranch, also known as the Rogler Ranch, is on the east side of the road. It is listed on the National Register of Historic Places.

151.3 Matfield Green. Named for a suburb of London. The name Matfield Green reflects the strong English influence in the early cattle industry in Kansas that is reflected in other town names such as Runneymede, Cambridge, Victoria and Studley. Turn east (left) on the main street leading through town. Matfield Green is also the part-time home of Wes Jackson, founder of the Land Institute in Salina, an organization devoted to developing sustainable agriculture. Jackson is the author of several books about environmental issues and in 1992 was named a MacArthur Fellow. Jackson, his relatives, and friends own several buildings in Matfield Green.

151.8 South Fork Cottonwood River. Elevation 1308 feet.

152.5 Funston Limestone in road cut.

153.1 Turn south at T-road.

153.3 Cross Shaw Creek and then pass over the Kansas Turnpike. Follow Little Cedar Creek for 2 miles south.

154.7 T-road south, continue east.

157.3 T, turn south.

157.5 Little Cedar Creek. Elevation 1497 feet.

158.0 Turn east (left).

158.6 Cattle guard elevation 1600 feet. Though this looks like a private road, it is a public road through open-range pastures. Cattle guards keep cattle from moving from one pasture to the next; cattle guards make gates unnecessary.

159.7 Cattle guard.

160.8 Cattle guard.

161.7 Cattle guard.

162.1 Windmill south of the road, elevation 1650 feet.

162.9-163.1 Matfield Shale in road cut containing large blocks of the upper Kinney limestone.

163.4 Oil wells in the Teeter-Scott oil field. This is only one of the linear oil fields found in this area that produce from the Bartlesville Sand, a channel sandstone deposited in the Cherokee Group of the Pennsylvanian Period. These rocks crop out in southeastern Kansas. The Bartlesville Sands are very linear in this area, perhaps because the streams that deposited theses sands were structurally controlled and followed pre-existing fracture patterns. A long linear trend just south of here was named the "Golden Lanes" by oil producers because of the rich fields found along it.

163.5 Texaco Hill. The T-road south leads 4 miles toward Teeterville, which was once home to oil field workers during the development of the nearby fields but is today a ghost town.

164.1 Cattle guard. Here the road follows the drainage divide between Fall River to the south and the Verdigris River to the north. Runoff on both sides of the road does not mix until the two rivers join about 50 southeast of here near Neodesha.

164.0 Cattle guard. Entering Greenwood County.

165.1 T-road south. This road leads south to Thrall.

165.5 This radio tower marks the highest point of the trip--elevation 1665 feet. This hill is capped by the Barneston Limestone, marking its easternmost outcrop south of the Neosho River.

165.6 Cattle guard.

167.0 Oil field service road leads west. From here at an elevation of 1650 feet, we drop down the steep eastern face of the Flint Hills escarpment.

167.7 Cattle guard.

168.7 Kenbro is the name of the corner, turn east. Elevation 1427 feet.

169.2 Cattle guard.

169.9 Americus Limestone Member of the Foraker Limestone. This formation is a prominent escarpment-former in the southern Flint Hills.

171.0 South Branch of the Verdigris River.

171.8 Cross roads, elevation 1216 feet. We have dropped 400 feet from the crest of the Flint Hills.

171.9 South Branch of the Verdigris River.

172.3 The hills to the south are capped by the Foraker Limestone.

172.8 Low water crossing and T-road north.

173.8 T-road north.

175.3 Turn north (left).

175.6 Turn east (right).

176.1 T-road, turn north (left).

176.5 T-road turn east (right).

177.1 South Branch Verdigris River.

177.6 T-road south.

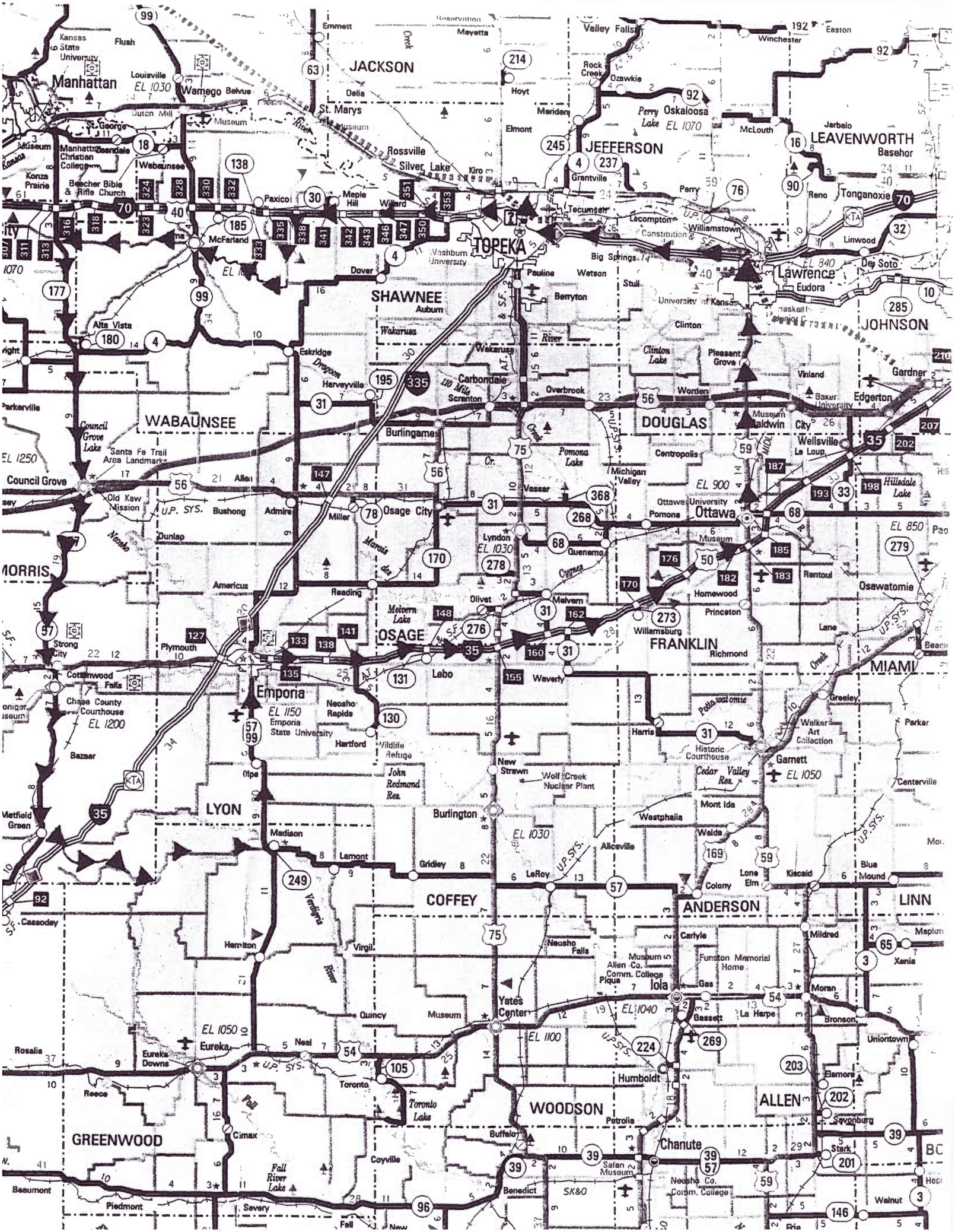
177.7 In road ditch north of the road is a small coal seam in the Scranton Shale. To the east we climb onto the Bern Limestone escarpment. This is the same limestone that caps Burnetts Mound in southwest Topeka.

178.6 Bern Limestone in road cut overlies Scranton Shale.

178.7 T-road south.

179.0 Oil wells in the Seeley-Wick field. This field is part of the long southwest to northeast trend of oil fields known as the "Golden Lanes." Production is from the Bartlesville sandstone at the depth of about 1800 feet.

179.8 Junction with K-99. Madison is 1 mile east. Return to Lawrence by taking K-99 north to Emporia and then taking I-35 and U.S. 59.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Vassar
Lyndon
Quenemo
Melvern Lake
Olivet
Reading
Americus
Dunlap
Neosho
Marais des Cygnes
Homewood
Princeton
Rantoul
Osawatomie
MORRIS
OSAGE
Strong City
Plymouth
Olivet
Melvern
Willamsburg
FRANKLIN
Richmond
Lane
MIAMI
Cottonwood Falls
Chase County Courthouse
Emporia
Neosho Rapids
Lebo
Waverly
Greeley
Potawatomie
Harris
Walker Art Collection
Parker
Bazaar
Hartford
Wildlife Refuge
John Redmond Res.
New Strawn
Wolf Creek Nuclear Plant
Historic Courthouse
Garnett
Cedar Valley Res.
Centerville
Ottumwa
LYON
Burlington
Westphalia
Mont Ida
Madison
Lamont
Gridley
Alicevile
Welda
Greenfield
LeRoy
Colony
Lone Elm
Kincaid
Blue Mound
COFFEY
ANDERSON
LINN
Cassoday
Harmiton
Virgil
Carlyle
Mildred
Maple
Neosho Falls
Allen Co. Comm. College
Funston Memorial Home
Iola
Gas
Moran
Xenia
Yates Center
Quincy
Museum
Bassett
La Harpe
Bronson
Uniontown
Rosalia
Eureka Downs
Eureka
Neal
Reece
Toronto
Toronto Lake
Humboldt
Elmore
ALLEN
Savonburg
WOODSON
Petrolia
GREENWOOD
Cimax
Buffalo
Coyville
Chanute
Stark
Safari Museum
Neosho Co. Comm. College
Beaumont
Piedmont
Severy
Fall River Lake
Benedict
SK&O
Walnut

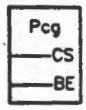
Paleozoic

PERMIAN SYSTEM

Wolfcampian Series

Chase Group

Nolans Limestone, Odell Shale, Winfield Limestone (base WF), Doyle Shale, Barneston Limestone (base BA) with Fort Riley Limestone Member (base FR), Matfield Shale, and Wreford Limestone



Council Grove Group

Speiser Shale, Funston Limestone, Blue Rapids Shale, Crouse Limestone (base CS), Easly Creek Shale, Bader Limestone (base BE), Stearns Shale, Beattie Limestone, Eskridge Shale, and Neva Limestone

PENNSYLVANIAN SYSTEM

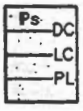
Virgilian Series

Admire Group

Grenola Limestone, Roca Shale, Red Eagle Limestone (base RE), Johnson Shale, Foraker Limestone (base FO), Janesville Shale with Five Point Limestone Member (base FP), Falls City Limestone, and Onaga Shale

Wabaunsee Group

Wood Siding Formation, Root Shale, Stotler Limestone (base ST), Pillsbury Shale, Zeandale Limestone (base Z), Willard Shale, Emporia Limestone (base E), Auburn Shale, Bern Limestone (base BR), Scranton Shale, Howard Limestone (base H), and Severy Shale

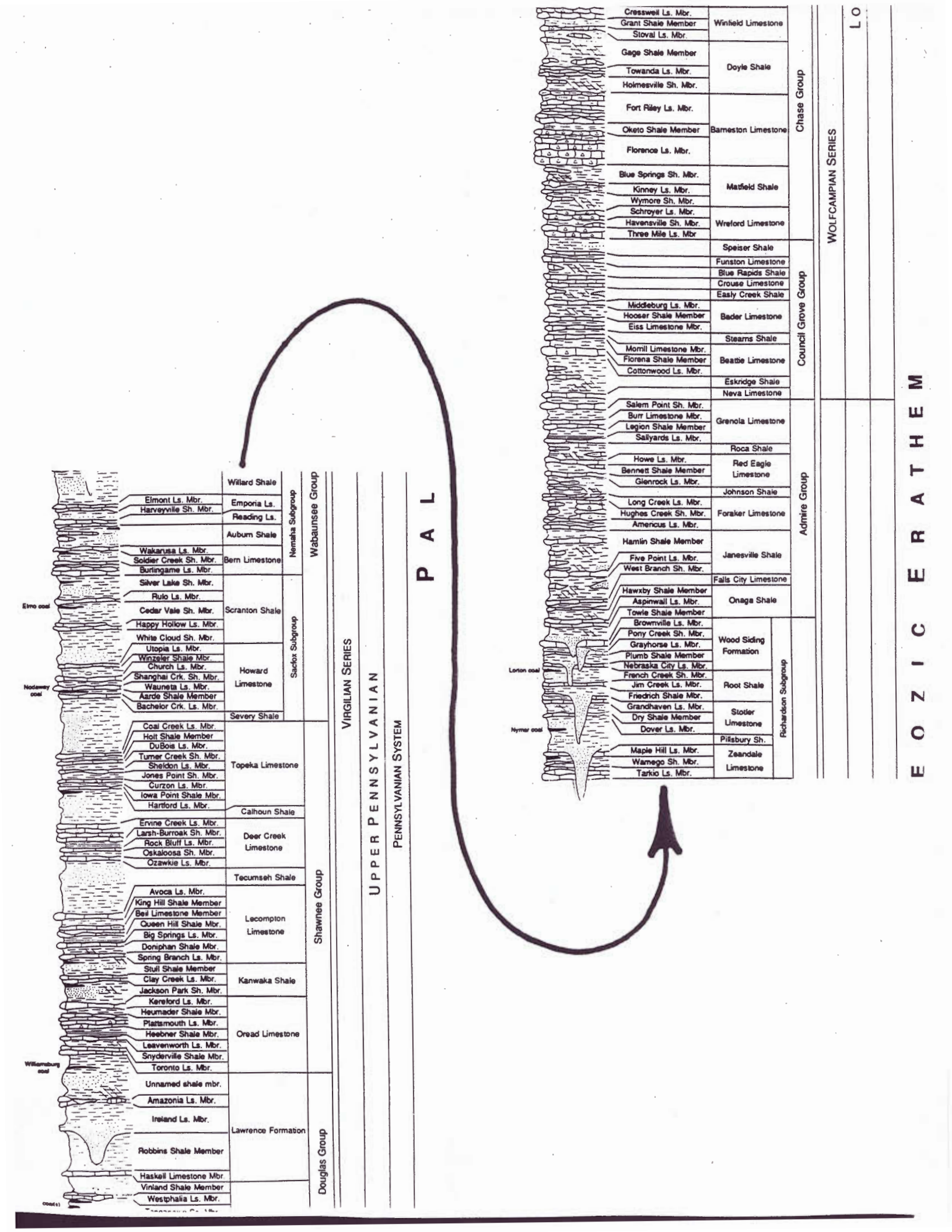


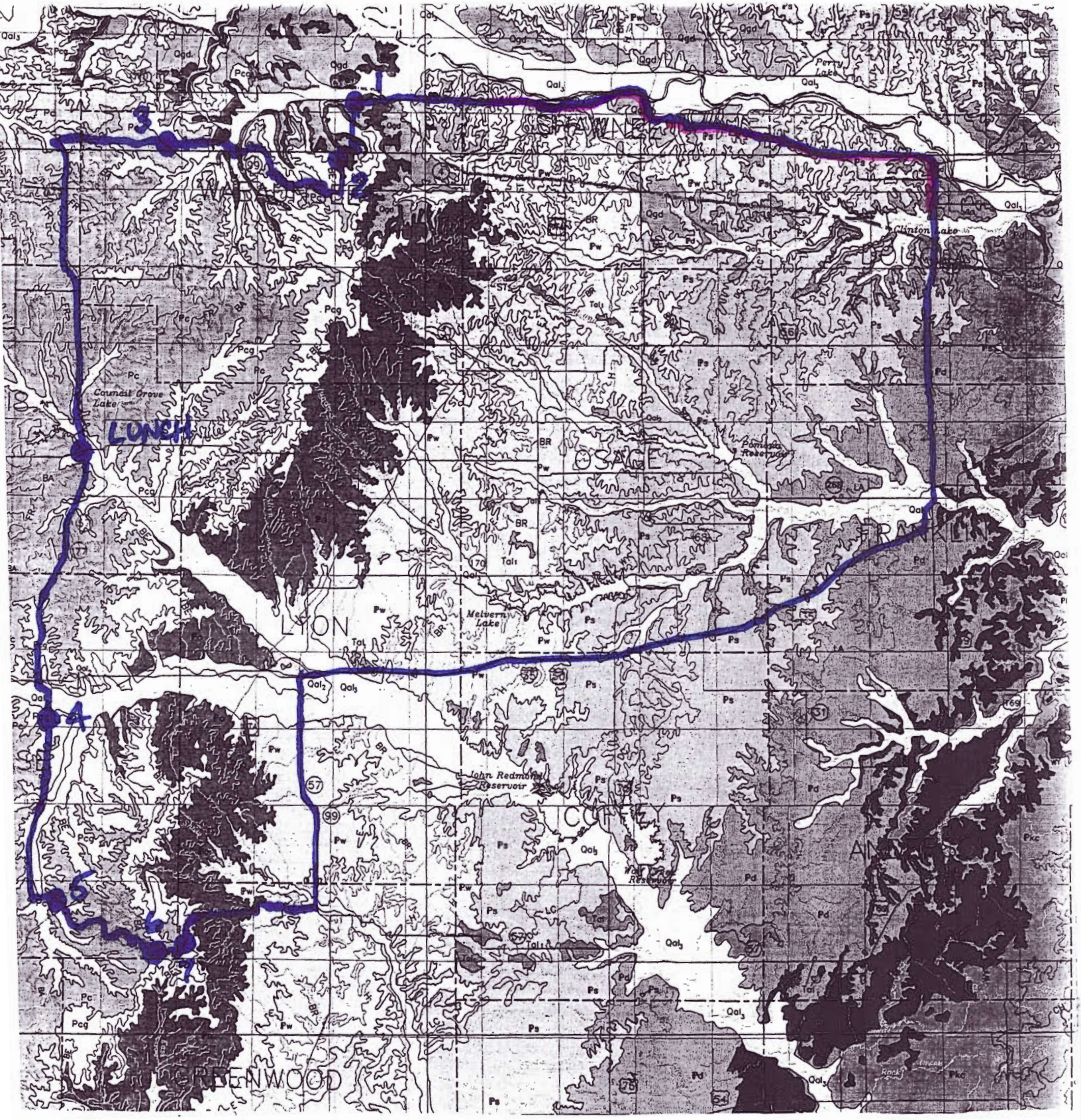
Shawnee Group

Topeka Limestone, Calhoun Shale, Deer Creek Limestone (base DC), Tecumseh Shale, Lecompton Limestone (base LC), Kanwaka Shale, Oread Limestone with Plattsmouth Limestone Member (base PL)

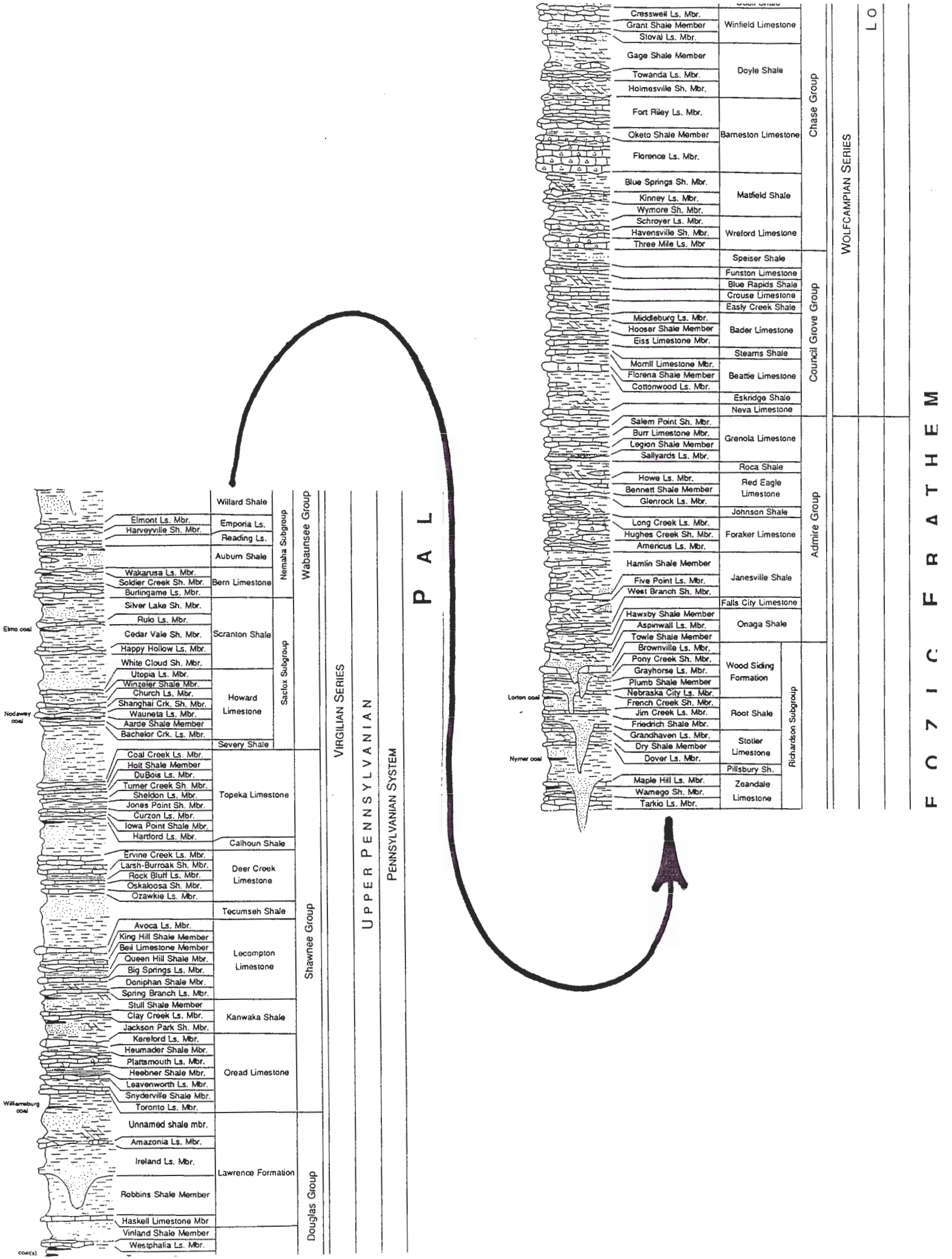
Douglas Group

Lawrence Formation (base LA) and Stranger Formation


Willard Shale
Elmont Ls. Mbr.
Emporia Ls.
Harveyville Sh. Mbr.
Reading Ls.
Auburn Shale
Wakarusa Ls. Mbr.
Soldier Creek Sh. Mbr.
Bern Limestone
Burlingame Ls. Mbr.
Nemaha Subgroup
Silver Lake Sh. Mbr.
Rulo Ls. Mbr.
Elmo coal
Cedar Vale Sh. Mbr.
Scranton Shale
Happy Hollow Ls. Mbr.
White Cloud Sh. Mbr.
Utopia Ls. Mbr.
Winzeler Shale Mbr.
Church Ls. Mbr.
Shanghai Crk. Sh. Mbr.
Nodaway coal
Wauneta Ls. Mbr.
Aarde Shale Member
Howard Limestone
Bachelor Crk. Ls. Mbr.
Severy Shale
Sacfox Subgroup
Wabaunsee Group
Coal Creek Ls. Mbr.
Holt Shale Member
DuBois Ls. Mbr.
Turner Creek Sh. Mbr.
Sheldon Ls. Mbr.
Jones Point Sh. Mbr.
Curzon Ls. Mbr.
Iowa Point Shale Mbr.
Hartford Ls. Mbr.
Topeka Limestone
Calhoun Shale
Ervine Creek Ls. Mbr.
Larsh-Burroak Sh. Mbr.
Rock Bluff Ls. Mbr.
Oskaloosa Sh. Mbr.
Ozawkie Ls. Mbr.
Deer Creek Limestone
Tecumseh Shale
Avoca Ls. Mbr.
King Hill Shale Member
Beil Limestone Member
Queen Hill Shale Mbr.
Big Springs Ls. Mbr.
Doniphan Shale Mbr.
Spring Branch Ls. Mbr.
Lecompton Limestone
Stull Shale Member
Clay Creek Ls. Mbr.
Jackson Park Sh. Mbr.
Kanwaka Shale
Kereford Ls. Mbr.
Heumader Shale Mbr.
Plattsmouth Ls. Mbr.
Heebner Shale Mbr.
Leavenworth Ls. Mbr.
Snyderville Shale Mbr.
Toronto Ls. Mbr.
Oread Limestone
Shawnee Group
Williamsburg coal
Unnamed shale mbr.
Amazonia Ls. Mbr.
Ireland Ls. Mbr.
Robbins Shale Member
Haskell Limestone Mbr.
Vinland Shale Member
Westphalia Ls. Mbr.
Lawrence Formation
Douglas Group
coal(s)
VIRGILIAN SERIES
UPPER PENNSYLVANIAN
PENNSYLVANIAN SYSTEM
PAL
Cresswell Ls. Mbr.
Grant Shale Member
Stoval Ls. Mbr.
Winfield Limestone
Gage Shale Member
Towanda Ls. Mbr.
Holmesville Sh. Mbr.
Doyle Shale
Fort Riley Ls. Mbr.
Oketo Shale Member
Florence Ls. Mbr.
Barneston Limestone
Blue Springs Sh. Mbr.
Kinney Ls. Mbr.
Wymore Sh. Mbr.
Matfield Shale
Schroyer Ls. Mbr.
Havensville Sh. Mbr.
Three Mile Ls. Mbr
Wreford Limestone
Chase Group
Speiser Shale
Funston Limestone
Blue Rapids Shale
Crouse Limestone
Easly Creek Shale
Middleburg Ls. Mbr.
Hooser Shale Member
Eiss Limestone Mbr.
Bader Limestone
Stearns Shale
Morrill Limestone Mbr.
Florena Shale Member
Cottonwood Ls. Mbr.
Beattie Limestone
Eskridge Shale
Neva Limestone
Council Grove Group
Salem Point Sh. Mbr.
Burr Limestone Mbr.
Legion Shale Member
Saliyards Ls. Mbr.
Grenola Limestone
Roca Shale
Howe Ls. Mbr.
Bennett Shale Member
Glenrock Ls. Mbr.
Red Eagle Limestone
Johnson Shale
Long Creek Ls. Mbr.
Hughes Creek Sh. Mbr.
Amencus Ls. Mbr.
Foraker Limestone
Hamlin Shale Member
Five Point Ls. Mbr.
West Branch Sh. Mbr.
Janesville Shale
Falls City Limestone
Hawxby Shale Member
Aspinwall Ls. Mbr.
Towle Shale Member
Onaga Shale
Admire Group
Brownville Ls. Mbr.
Pony Creek Sh. Mbr.
Grayhorse Ls. Mbr.
Plumb Shale Member
Nebraska City Ls. Mbr.
Wood Siding Formation
Lorton coal
French Creek Sh. Mbr.
Jim Creek Ls. Mbr.
Friedrich Shale Mbr.
Root Shale
Grandhaven Ls. Mbr.
Dry Shale Member
Dover Ls. Mbr.
Stotler Limestone
Nyman coal
Pillsbury Sh.
Maple Hill Ls. Mbr.
Wamego Sh. Mbr.
Tarkio Ls. Mbr.
Zeandale Limestone
Richardson Subgroup
WOLFCAMPIAN SERIES
L O
E O Z I C E R A T H E M



FLINT HILLS FIELD TRIP
KGS 1994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Emporia Ls.
Harveyville Sh. Mbr.
Reading Ls.
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Bern Limestone
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Burlingame Ls. Mbr.
Nemaha Subgroup
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Cedar Vale Sh. Mbr.
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Howard Limestone
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Wabaunsee Group
Coal Creek Ls. Mbr.
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Avoca Ls. Mbr.
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coal(s)
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UPPER PENNSYLVANIAN
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Council Grove Group
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LO
FOZIC FRATHEM

Paleozoic

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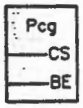

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Lawrence Formation (base LA) and Stranger Formation