

**KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 2001-39**

Geology of South-central Kansas
KGS Staff Field Trip, September 27, 2001

by

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Introduction

On this field trip we will be looking at the same Pennsylvanian rocks that crop out in the Eudora, Lawrence, and Topeka areas, but we'll be seeing what they look like about 80 miles southwest of Lawrence, in Greenwood and Woodson counties. In addition, we will be looking at something rare in Kansas, intrusive igneous rocks. Once we get to south-central Kansas, we will be traveling in the Osage Cuestas and the Chautauqua Hills physiographic regions (see attached fact sheets). Note: for information about rock units discussed on this trip, see stratigraphic column (p. 7).

From KGS to STOP 1

From the Survey, head north to 15th Street, then west to Wakarusa Drive, then north to 6th Street / U.S. 40. Continue west to K-10 and then head north to the Kansas Turnpike. The interchange of K-10 and U.S. 40 is located in an area where the Kanwaka Shale crops out at the surface. The hills east and west of here are capped by the Lecompton Limestone. We will be examining the Kanwaka Shale, which occurs just below the Lecompton Limestone, at Stop 2, where we will be collecting numerous invertebrate fossils.

Take the Kansas Turnpike west and southward to Emporia. About 3 miles southwest of the South Topeka interchange, the road climbs a hill capped by the Bern Limestone; the slopes below are developed on the Scranton Shale. These are the two formations we will see at Stop 1.

Get off the Kansas Turnpike at Emporia and proceed east on U.S. 50 about 2 miles to Prairie Street and turn right (south). Go south 0.5 mile to South Street and turn left (east). Prairie Street passes the IBP beef processing plant. IBP is just one of the big beef packing company operating in Kansas. In fact, Kansas leads the nation in the number of cattle slaughtered. Last year, 8.21 million head of beef were killed in Kansas packing plants. This figures out to a little more than three head of

beef killed for every resident of the state: "Beef, it's what's for dinner!"

Proceed east on South Street 1.5 miles to Commerical Street, which is also K-99, and turn right (south). Continue south on K-99, passing through the towns of Olpe, Madison, and Hamilton, and traveling over uplands formed on the Emporia and Bern Limestones. About 4 miles south of Hamilton, turn right (west) on a gravel road and travel west 6 miles to a crossroad and turn left (south). The last half mile of this stretch passes a large grove of catalpa trees on the south side of the road. This grove occupies much of the northwest quarter of the section. Catalpas were often planted on Kansas ranches and farms for fence posts and other uses. Catalpa wood is durable and makes long-lasting posts. After turning south at the catalpa grove, go a little less than 2 miles to a parklike area near the north end of the dam at Eureka City Lake. This lake was built in the 1930's as a Works Progress Administration (WPA) project and is a water-supply lake for Eureka, about 5 miles to the south. The WPA built numerous reservoirs and other projects in Kansas, including Lone Star Lake, located southwest of Lawrence.

We will walk a short distance south to the floodway at the south end of the dam. This is Stop 1.

STOP 1—Eureka City Lake

Overflow from Eureka City Lake has created a waterfall over limestone members of the Bern Limestone. The upper limestone is the Wakarusa Limestone Member; the lower one is the Burlingame Limestone Member. Both members are named for outcrops near towns south of Topeka. They are separated by the Soldier Creek Shale. Below the limestone is a thick sequence of gray shale and sandstone in the upper part of the Scranton Shale. A thin coal layer can also be found in the Scranton.

The sandstones contain mica flakes and woody fragments and also display various sedimentary structures, including ripple marks. These ripple marks are asymmetrical in that one side of each

ripple is steeper than the other. This indicates formation by a current rather than wave action, which tends to form symmetrical ripples. The steeper side of the ripple is in the direction of the current.

The diverse sedimentary rocks that crop out here at the spillway indicate changing environments of deposition. The coal and ripple-marked sandstone were formed slightly above sea-level, perhaps in a swampy delta. The shale most likely was deposited as sea level rose slightly, in shallow waters near the shore. As water got deeper and the shoreline was farther away, the influx of sediment decreased. The water cleared up enough for various invertebrate animals to flourish. The calcium carbonate shells these animals formed were the raw materials for the limestones we see at the top of the outcrop. This sequence of events recurred hundreds of times here in Kansas during Pennsylvanian and early Permian times (about 300 million years ago), creating the repetitive sequence of limestones and shales that make up the Flint Hills and Osage Cuestas (fig. 1).

STOP 1 to STOP 2

Proceed south about 5.5 miles, passing through the city of Eureka and reaching U.S. 54. Turn left (east) and go about 11 miles to the small town of Neal. Follow the main gravel road south out of town in a stair step fashion, south and east, about 3 miles to an isolated hill, which is Round Mound, our next stop (Stop 2).

STOP 2—Round Mound

The rocks that crop out at this stop are in the Kanwaka Shale. This unit lies above the Oread Formation, upon which the University of Kansas sits. The type locality of the Kanwaka Shale is along Stull Road, just west of the community of Kanwaka, just west of Lawrence.

Numerous invertebrate fossils have weathered out of the shale and thin limestones at this site. Fossils are the ancient remains or evidence of once-living plants and animals, and invertebrates are animals

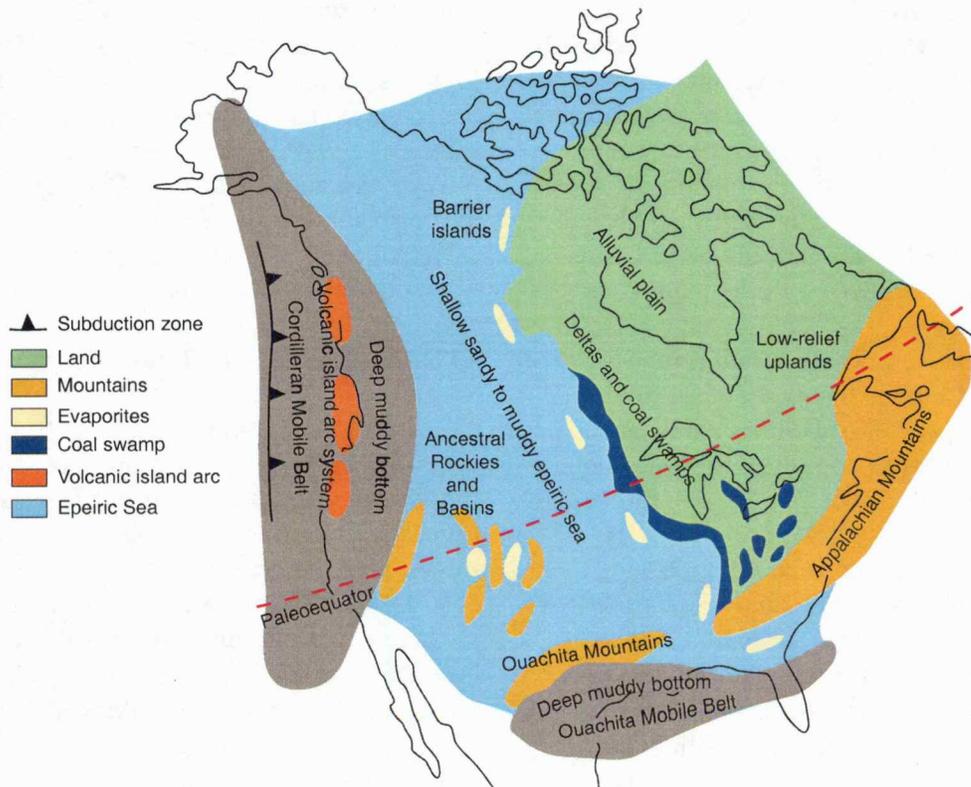


Fig. 1—Geography of North America during the Pennsylvanian Period, about 300 million years ago. Present-day Kansas was near the shore of the shallow sea (from Wicander and Monroe, 1989).

without backbones. In Kansas, invertebrate fossils are much more common than vertebrate fossils. Even so, they represent only a tiny sampling of the animals that once inhabited this area, most of which lived and died without leaving a trace. The fossils here give an idea of the variety of animals that lived in the Pennsylvanian seas, roughly 300 million years ago. Among the fossils found at this site are brachiopods, bryozoans, bivalves (oysters, clams, scallops), corals, fusulinids, and trilobites. These are described in more detail below.

Bryozoans are some of the most abundant fossils found in sedimentary rocks, and they are also widespread today, both in marine and freshwater environments. Bryozoans are small animals (just large enough to be seen with the naked eye) that live exclusively in colonies. Bryozoans are sometimes called moss animals—the name comes from two Greek words, *bryon* (moss) and *zoon* (animal)—because some bryozoans form colonies of bushy tufts that resemble mosses. Bryozoan colonies can also resemble colonies of some corals. Like corals, most bryozoans secrete external skeletons made of calcium carbonate, but unlike corals, bryozoans generally don't build reefs. Each bryozoan colony starts out with a single individual, called a zooid. Each zooid is essentially cylindrical and has a ring of tentacles that it uses to feed, drawing tiny plants and animals towards its mouth. As the first zooid begins feeding, it buds to form additional zooids, each of which has its own feeding tentacles. The new zooids also bud, forming the colony. Large colonies may consist of hundreds of thousands or even millions of zooids. Fossil bryozoan colonies come in a variety of shapes (figs. 2, 3). Some bryozoans built colonies that grew from the seafloor in branching structures; these fossils look like something like twigs. Other species erected netlike frameworks, while still other spread like a crust on

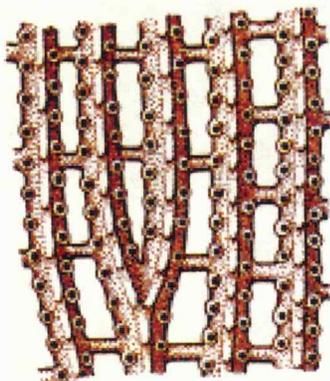


Fig. 2—*Fenestella* is one bryozoan found in Kansas rocks; its colonies had a netlike structure.

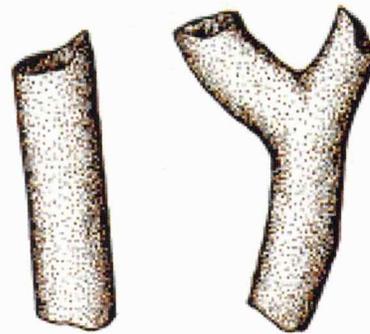


Fig. 3—*Rhombopora*, another bryozoan found in Kansas rocks, is characterized by upright, slender, branching stems.

shells, rocks, plants, and even other bryozoan colonies.

Brachiopods secrete a shell consisting of two parts called valves. Their fossils are common in the Pennsylvanian and Permian limestones of eastern Kansas. Brachiopods have an extensive fossil record. They first appear in rocks dating back to the early part of the Cambrian Period, about 545 million years ago, and were extremely abundant until the end of the Permian Period, about 250 million years ago, when they were decimated in the mass extinction that killed more than 90 percent of all living species and was the largest of all extinction events (larger than the major extinction at the end of the Cretaceous that killed off the dinosaurs). A distinctive feature of all brachiopods is that their valves are bilaterally symmetrical—that is, the right half is a mirror image of the left half. (Humans are also bilaterally symmetrical.) The bilateral symmetry of the individual valves differentiates brachiopods from clams and other bivalved mollusks, with which they are sometimes confused. Unlike brachiopods, clam valves are not bilaterally symmetrical; instead, the



Fig. 4—Fossil brachiopods common in Kansas rocks.

right and left valves are mirror images of each other. Brachiopod shells come in a variety of shapes and sizes (fig. 4). The outer surface of the valves may be marked by concentric wrinkles or radial ribs. Some brachiopods have prominent spines, but these are generally broken off and incorporated separately in the sediment.

Clams and other bivalves. Fossil clams are generally easy to recognize because they look a lot like the shells scattered along modern seashores. Clams and their relatives (oysters, scallops, mussels) are often called bivalves (or bivalved mollusks) because their shell is composed of two parts called valves. Like their living relatives, fossil bivalves come in many different shapes and sizes. Typically the right and left valves are symmetrical (in contrast to the bilateral symmetry of individual brachiopod valves), though some bivalves, such as oysters, have valves that are not symmetrical. In western Kansas, fossil clams found in younger rocks from the Cretaceous Period are even more common. Some of these—the inoceramid clams from western Kansas—are huge, as much as 6 feet in diameter.

Corals are close relatives of sea anemones and jellyfish and are the main reef builders in modern oceans. Corals can be either colonial or solitary. As fossils, corals are found worldwide in sedimentary rocks; the oldest are from rocks deposited during the Middle Cambrian, over 525 million years ago. Corals are among the simplest multicellular animals and are characterized by their radial symmetry and lack of well-developed organs. Corals live attached to the seafloor and feed by trapping small animals with their tentacles. Two groups of corals were

important inhabitants of the Pennsylvanian and Permian seas—tabulate and rugose corals (fig. 5). Tabulate corals were exclusively colonial and produced calcium carbonate skeletons in a variety of shapes (moundlike, sheetlike, chainlike, or branching). A common characteristic of rugose corals, from which they get their name, is the wrinkled appearance of their outer surface. (Rugose comes from the Latin word for wrinkled.) Rugose corals may be either solitary or colonial. Because solitary rugose corals are commonly shaped like a horn, these fossils are sometimes called horn corals. Both tabulate and rugose corals died out in the major extinction that occurred at the end of the Permian Period, roughly 250 million years ago. The corals that inhabited the post-Paleozoic seas differ significantly from the earlier corals. Because of this, many specialists argue that these later corals may not be closely related to the Paleozoic corals.

Trilobites are an extinct group of arthropods, relatives of insects, spiders, ticks, crabs, shrimp, lobsters, and numerous other organisms. They were exclusively marine organisms. Trilobites first appear in the fossil record in rocks deposited during the Lower Cambrian, about 540 million years ago. Although they were extremely abundant during their first 100 million years or so, by the Pennsylvanian and Permian Periods (when the surface rocks in eastern Kansas were deposited), trilobites were much less dominant. They became extinct, along with many other species, at the end of the Permian. The bodies of trilobites, like insects, have three parts: the head (or cephalon), the thorax, and the tail (or pygidium). Leg-like appendages attached to all

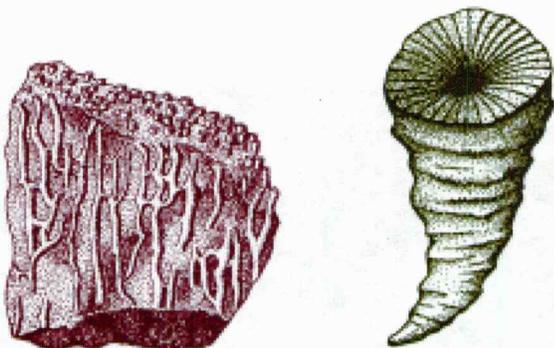


Fig. 5—The colonial tabulate coral *Syringopora* (on the left) shows the structure of the hard parts that protected the polyps and formed the framework of the colony. Note the pores on the surface of the colony, from which the polyps extended their tentacles to feed. The solitary rugose coral *Caninia* (on the right) is common in eastern Kansas.



Fig. 6—This tail, or pygidium, of the trilobite *Ameura*, came from the Pennsylvanian Drum Limestone, near Independence, Kansas. Most trilobites in Kansas are members of the genus *Ameura* or *Ditomopyge*.

three parts, but these are rarely preserved. Because of this, and the fact that trilobites have no living counterpart, paleontologists are hesitant to speculate about how trilobites lived. Trilobite pygidia are sometimes found in rocks in eastern Kansas (fig. 6).

STOP 2 to STOP 3

From Round Mound, proceed a short distance east and turn left (north), passing Rocky Ford Cemetery. About half a mile north of the cemetery is Rocky Ford (Stop 3), a natural crossing of Walnut Creek.

STOP 3—Rocky Ford

The rock forming Rocky Ford is the Leavenworth Limestone Member of the Oread Limestone. The black platy Heebner Shale Member can be found in the north bank of the creek. Where it crops out in eastern Kansas and southeastern Nebraska, the Leavenworth Limestone Member maintains a uniform thickness of about one foot or so; this indicates that the environment in the ancient sea that covered this area at that time was the same over a wide area and the ocean depth was also widely uniform. The Leavenworth shows a slight southerly dip in this area, and its upper surface is scarred by numerous joints of various directions. Some of these joints are more prominent than others and may have preferred orientations. These are essentially fractures in the rock that are the result of various geologic strains exerted in this area during millions of years when the North American Plate was drifting over the globe.

STOP 3 to Lunch (Yates Center)

Leaving Rocky Ford, continue north, make a short jog to the east, and then continue north again to U.S. 54, a total of roughly 1.5 miles. Turn right (east) on U.S. 54 and proceed to Yates Center, about 18 miles.

LUNCH

Yates Center has three restaurants fairly close together. The Tip-Top Café is west along U.S. 54; it has burgers, etc., as well as a daily special. Just east is Smoky Bens, which serves barbecue and other sandwiches, and occasionally has brisket. On the east side of U.S. 75 is another restaurant, Woody's, that features classic American cuisine from the Eisenhower era; smoking is encouraged.

Yates Center to STOP 4

After lunch, proceed south on U.S. 75, about 13 miles to the small town of Buffalo. As we leave Yates Center, we enter the Chautauqua Hills, a region of sandstone hills formed on thick sandstones in the Lawrence and Stranger Formations. These sandstones were deposited in deep, alluvial valleys during the Pennsylvanian Period, at a time when the area was above sea level. A patchwork of oak woodlands and tallgrass prairie cover the hills in this region; as a result, they are sometimes known as the Cross Timbers, a vegetative complex that extends southward into Oklahoma and central Texas.

On the way to Buffalo, the highway makes a jog and passes over Rose Dome—a broad, gentle uplift formed by an igneous intrusion below the surface. This has brought limestone in the Stanton Formation to the surface, and it is quarried near the highway. The Stanton is exposed in numerous outcrops along K-10 between Eudora and DeSoto. In this quarry, gentle dips can be seen in the limestone beds, reflecting the arching of the bedrock. In Buffalo, proceed to the west side of town, about 1 mile from U.S. 75 to the Micro-Lite plant (Stop 4).

STOP 4—Micro-Lite Plant

At the Micro-Lite plant we will learn about the history of mining at the Micro-Lite quarry and the uses of the lamproite that is extracted there.

STOP 4 to STOP 5

From the Micro-Lite plant, head west about 4 miles and turn right (north), passing the Wildcat Ranch. Proceed 1.25 miles and then turn left (west) and go 0.5 mile and turn right (north) at the entrance to the mine and proceed about 0.75 miles to the loading area, where we will park the vehicles and then walk into the quarry area (Stop 5).

STOP 5—Micro-Lite Quarry/Silver City Dome

Most of the rocks at the surface of Kansas (limestone, sandstone, shale) are sedimentary in nature—that is, they are made up of sediments usually deposited at the bottom of an ocean or by a stream. In general, you have to drill hundreds or thousands of feet below the land's surface in Kansas to find igneous rocks, those once-molten rocks, such as granite. In a few places, however, you can see

igneous rocks at the surface, and two of those locations are in Woodson County.

The igneous rocks here are called lamproites. About 90 million years ago, these igneous rocks rose from great depths and exploded to the surface, producing volcano-like features. Lamproites are pipes of igneous rock, which was highly charged with gas and pushed its way up through faults, fractures, and zones of crustal weakness. They are similar to kimberlites, another type of igneous rock in Kansas, found at 13 locations in Riley and Marshall counties, west of Tuttle Creek Reservoir. Lamproites have a different chemical composition than kimberlites, but both have produced diamonds (although not in Kansas). In fact, the world's largest diamond mine is at a lamproite at Argyle in north-western Australia.

Because the landscape has endured millions of years of erosion since the lamproites here erupted, relatively little evidence of these features is visible at the land's surface. At Rose Dome, about five miles south of Yates Center, the intrusion of the lamproite created a broad dome that is apparent at the land's surface and on topographic maps. In addition to the pipe of molten rock that blew to the surface, other lamproite intruded itself into the underground rock (because lamproite and kimberlite intrude themselves into rock that is already in place, they are sometimes referred to as "intrusives"). Arms branch off of the main pipe like branches off of a tree. These branches, or sills, extend away from the main pipe and have been encountered at depths of about 1,300 feet during core drilling, and drilling for oil and gas, in the area around the dome.

The lamproite itself is not visible at the surface of Rose Dome, but a number of granite boulders litter a pasture west of U.S. Highway 75. These granite boulders, which are generally surrounded by trees that have grown up around them, probably came along for the ride with the lamproite when it exploded to the surface. The granite was probably originally part of the crystalline basement rock that is about 2,500 feet deep here, and lies beneath the overlying sedimentary rocks. These granites are about 1.2 billion years old, formed during ancient Precambrian times. Geologists use the term "xenolith" for rock fragments, such as these chunks of granite, that are "foreign rocks," or not part of the intrusive but mixed in with the lamproite, like chocolate chips in cookie dough. These granites seem so out-of-place here that early geologists thought they might have been carried in by glaciers,

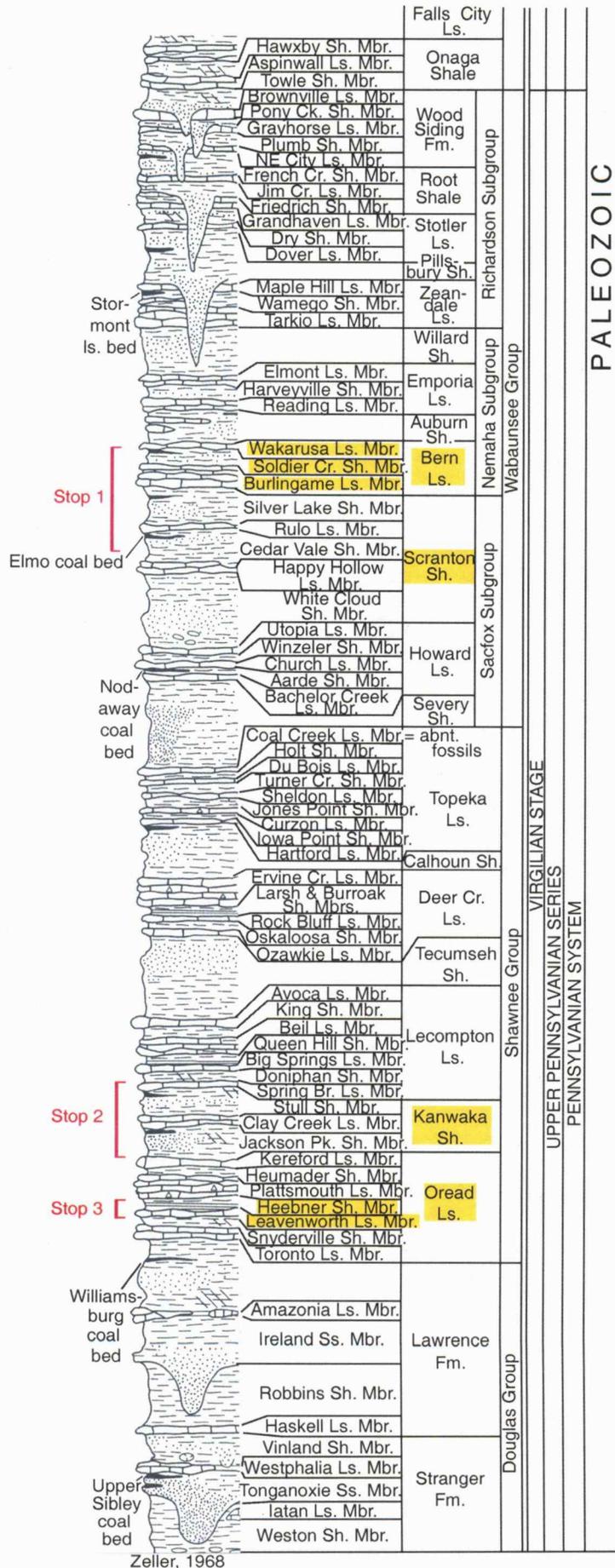
though we now know that glaciers did not extend this far south in Kansas.

The lamproite we will visit today is at the Silver City Dome, southwest of Rose Dome (fig. 8). The Silver City lamproite is very similar to the Rose Dome. The actual topographic dome at Silver City is more subtle and a little more difficult to visualize than at Rose Dome; however, the lamproite itself is exposed at Silver City. The lamproite contains shiny flakes of mica; that led to early reports that the rock contained silver and a short burst of mining in the 1870's that produced a settlement called Silver City. While there is no silver here, the lamproite has been mined intermittently since then, and steadily since 1982 when Micro-Lite began quarrying the lamproite. The lamproite is quarried and hauled to the nearby town of Buffalo, where it is bagged and eventually used as a mineral supplement for cattle feed. The rock contains small amounts of the essential minerals magnesium, potassium, and iron. In 1996, Micro-Lite mined about 70,000 tons of lamproite.

While most igneous rocks are very hard, the lamproite exposed at the surface here is soft and powdery, weathering to an olive brown. The rock itself is called peridotite (pronounced pah-RID-oh-tight); it is coarse grained and high in the minerals olivine and pyroxene. Surrounding the lamproite are sedimentary rocks that were deposited in Pennsylvanian times, about 330 million years ago, before the lamproite came to the surface. When the lamproite exploded to the surface, it was extremely hot, as much as 800 degrees Celsius, cooking the limestones and shales that it contacted. This process is called "contact metamorphism"—the high heat of the molten rock cooks and changes the existing sedimentary rocks (these previously in-place sedimentary rocks are sometimes referred to as "country rock" a term that, in this context, has nothing to do with music). Thus, some of these limestones and shales are now extremely hard and have a far different character than the much softer limestones and shales that we have seen in the other stops on this field trip.

STOP 5 to KGS

Proceed back to Buffalo and U.S. 75. Head north on U.S. 75 through Yates Center and Burlington to BETO Junction, where we will take I-35 north to Ottawa and U.S. 59, which we will take north to Lawrence.



PALEOZOIC

VIRGILIAN STAGE

UPPER PENNSYLVANIAN SERIES

PENNSYLVANIAN SYSTEM

Stratigraphic classification of Upper Pennsylvanian rocks in Kansas (from Zeller, 1968).