

Geology of Northeastern Kansas Field Trip

Public Field Trip in Celebration of Earth Science Week

October 7, 2000

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Introduction

This field trip will introduce participants to the geology of northeastern Kansas, highlighting rocks and fossils in the vicinity of Lawrence and Topeka (see map). The stops are located in Douglas, Shawnee, and Wabaunsee counties, and, with the exception of Stop 2, lie within the physiographic province called the Glaciated Region.

The field trip is part of the Survey's participation in Earth Science Week (October 8–14), a national celebration of the earth sciences, established in 1998 by the American Geological Institute, based in Alexandria, Virginia. Earth Science Week is a time to increase public awareness and understanding of the earth sciences. Since 1998, Earth Science Week activities have taken place in every U.S. state and in several countries around the world. For more information about Earth Science Week, visit the Earth Science Week Web Site at www.earthscienceworld.org.

Between the KGS and Clinton Lake

Moore Hall, the home of the Kansas Geological Survey, sits on the slope of Daisy Hill, a southwest extension of Mount Oread, the site of the University of Kansas. Mount Oread lends its name to the Oread Limestone, the limestone and shale rocks that help form this prominent topographic feature. The Oread Limestone also caps the prominent bluffs to the north of Clinton Parkway and to the south across the Wakarusa valley.

Stop 1—Clinton Lake Spillway

The spillway at Clinton Lake provides an excellent introduction to the geology of eastern Kansas. The dam here was constructed on the Wakarusa River in the 1970's. The spillway is a

means by which water can move out of the lake during times of extremely high water levels (though the water has never been that high). The bike path along the floor of the spillway was added in the 1990's as part of the construction of the South Lawrence Trafficway.

The spillway is a good place to view a cross section of the rock layers that are typical of this area. These interbedded limestones and shales were deposited during the Pennsylvanian Period of geologic history (also known as the Coal Age), about 300 million years ago. At that time, Kansas was near the equator, the climate was warmer, and a shallow sea advanced and retreated repeatedly across eastern Kansas (figs. 1, 2).

At times the sea left behind minerals that eventually became limestone, the brown and tan rocks in the spillway. Limestone is made up of calcium carbonate, debris composed of sea shells and other marine life, and minerals that were deposited onto the shallow ocean floor. Some of those limestones contain fossils of the invertebrate animals that were common during the Pennsylvanian, such as corals, sponges, and crinoids. These creatures secreted calcium carbonate to form shells and other hard body parts that make up these limestones.

At other times, rivers deposited mud into the oceans; these muds eventually formed shales, the softer, thinly layered rocks in between the limestones. Occasionally, this area was at or slightly above sea level and sandstone was deposited by rivers into estuaries and deltas.

Although each rock layer here is only a few feet thick, these formations extend vast distances across Kansas and adjacent states. Geologists have given each of these rock layers a name, based on the location where it was first described (fig. 3). The limestones and shales here are part of two formations, the Oread Limestone and the Lawrence

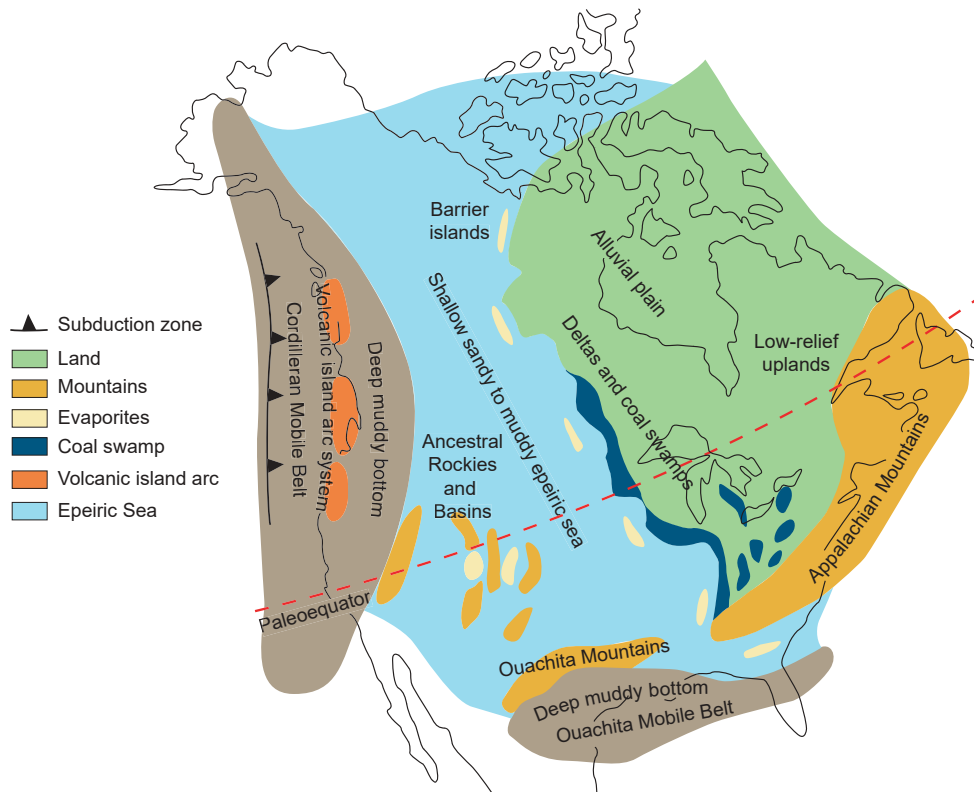


Fig. 1—Geography of North America during the Pennsylvanian Period, about 300 million years ago. Present-day Kansas was near the shore of the shallow sea (from Wicander and Monroe, 1989).

Formation. The Oread Limestone is named after nearby Mount Oread, home of the University of Kansas, where the formation was first described by geologist Erasmus Haworth in 1894. In spite of its name, the Oread Limestone, like many other formations, contains rocks other than limestones. The Lawrence Formation, which lies below the Oread (and is thus older), is named for the city of Lawrence.

Geologists have divided the rock layers in the Oread and the Lawrence down into smaller units called members, much the way that biologists divide a genus into smaller groups called species. The rock layer at the bottom of the spillway is called the Amazonia Limestone Member, named for the small town of Amazonia, north of St. Joseph in Andrew County, Missouri. Above the Amazonia are shales that are also part of the Lawrence Formation. This part of the Lawrence Formation includes a thin coal layer called the Williamsburg coal bed, named for

the small town of Williamsburg, Kansas. This coal layer is barely visible at the spillway, but it is exposed in a roadcut south of the dam. This part of the Lawrence Formation may have been deposited on the plain of an ancient delta, where local swamps had formed.

Above the Lawrence Formation is the Toronto Limestone Member of the Oread Limestone. The Toronto is a thick, light-gray to brown limestone that contains a few fossils. Above the Toronto is the Snyderville Shale Member, which is gray, and above that is the Leavenworth Limestone. The Leavenworth is a thin layer of gray to brown limestone that was first described from exposures near the town of Leavenworth.

The next unit up is the Heebner Shale Member, one of the most recognizable rock layers in the spillway. The Heebner is very different from the Snyderville Shale and shales in the Lawrence Formation. The Heebner is very dark—black, in

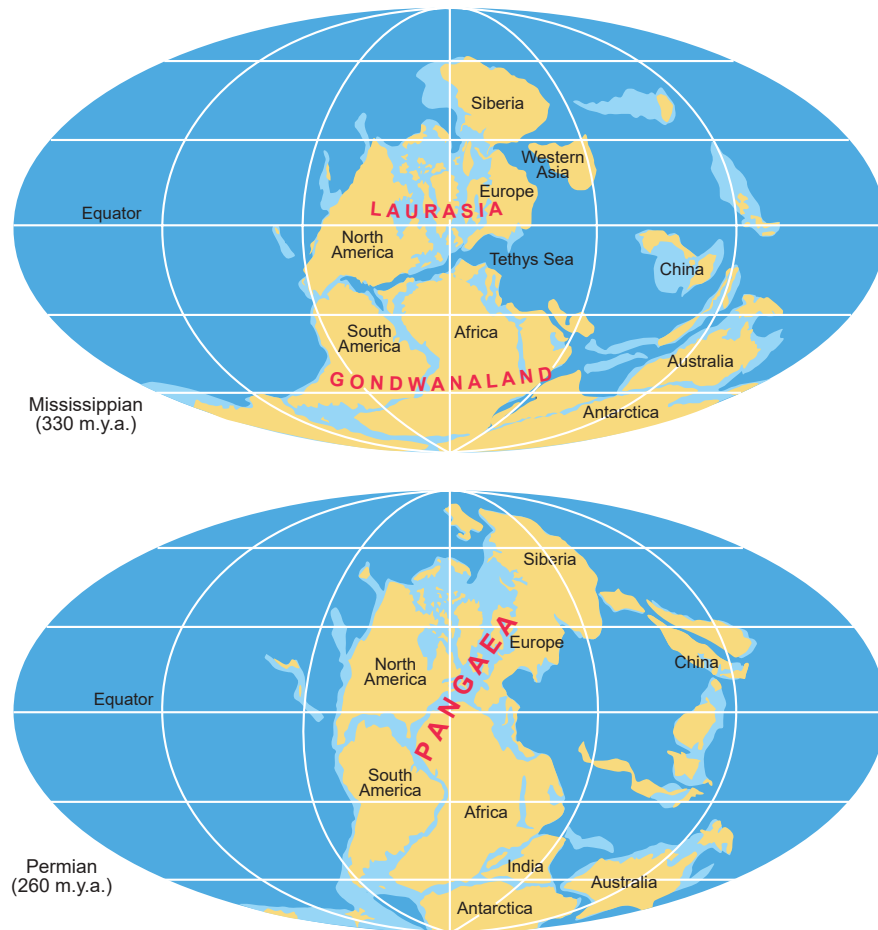


Fig. 2—Positions of the plates during the Mississippian and Permian periods, the two periods bracketting the Pennsylvanian Period. During the Pennsylvanian, Kansas lay near the equator (from Tarbuck and Lutgens, 2000).

fact. It is fragile and thinly bedded, deposited in layers so thin that they resemble pages in a book. In places, the Heebner contains phosphate nodules, marble-sized rocks that are high in phosphate and are slightly radioactive. Geologists disagree about the conditions under which the Heebner was deposited. Some regard it as the kind of rock that was deposited where the Pennsylvanian sea was its deepest. Other geologists are less sure.

Above the Heebner Shale is the Plattsmouth Limestone Member of the Oread Limestone. The Plattsmouth is a wavy-bedded, gray to brown limestone. In places it contains chert (or flint) and fossils such as crinoids, corals, or single-celled, wheat-grain-shaped animals called fusulinids.

One obvious characteristic of these rock layers, as they are exposed here at the spillway, is their cyclicity. That is, the rocks here are deposited in a regular vertical sequence of limestone, shale, limestone, shale, etc. This sequence of rocks, which geologists call a “cyclothem,” is found not only in the Oread Limestone and Lawrence Formation, but is repeated in Pennsylvanian rocks above and below these formations. Geologists believe that this regular sequence of deposition is probably the result of fluctuations in sea level. As the sea levels deepened (in the range of tens of feet deep), limestone was deposited. As the seas shallowed, shale was deposited (except, perhaps, in the case of the Heebner, which some geologists believe

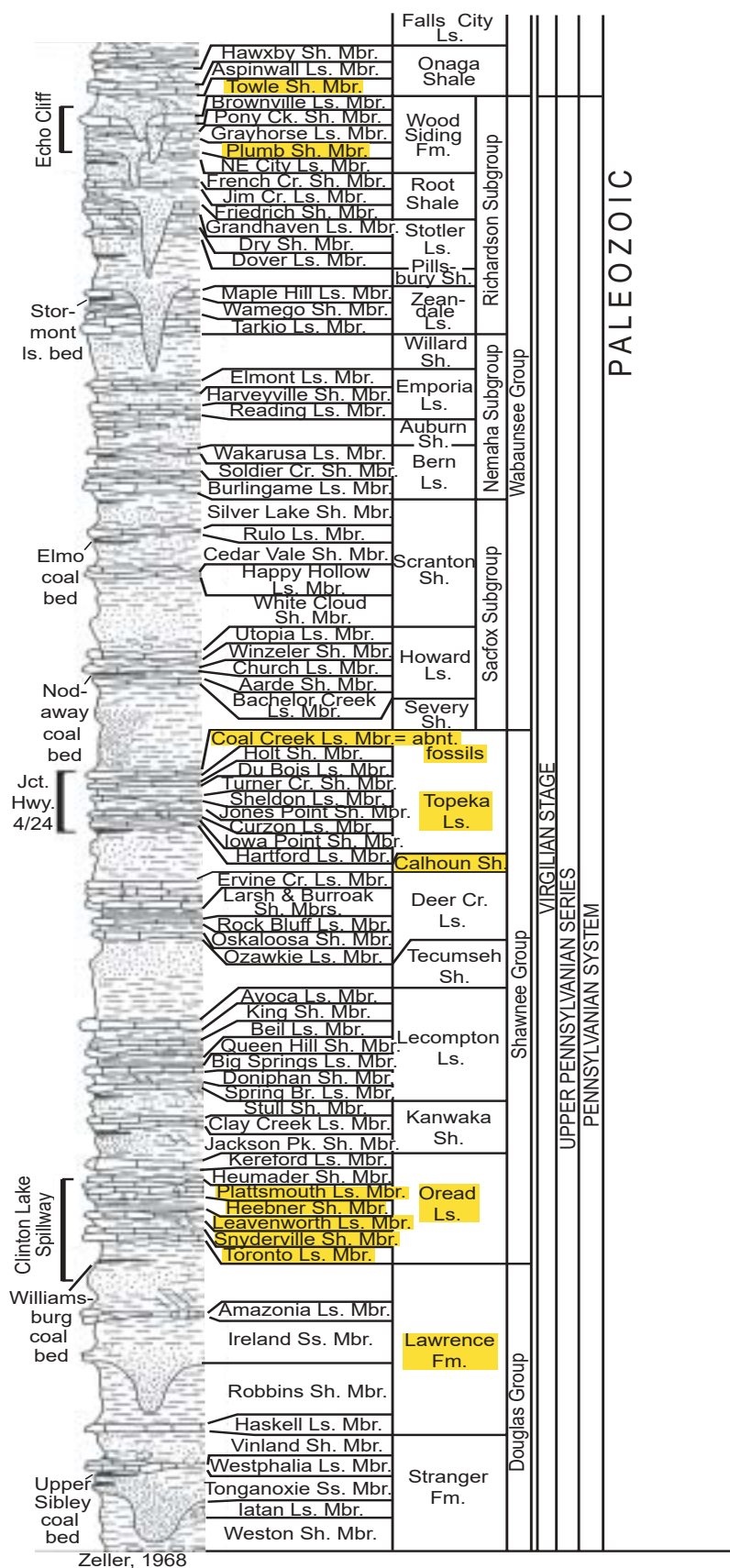


Fig. 3—Stratigraphic classification of Upper Pennsylvanian rocks in Kansas (from Zeller, 1968).

represents the time when the ocean was at its deepest).

Geologists disagree, however, about the reasons for the change in those Pennsylvanian sea levels. The changing sea levels may represent times when polar ice caps were shrinking or growing. When the ice caps melted, sea levels rose, resulting in limestone deposition. At other times, when ice caps grew, sea levels went down and shale was deposited. There are other theories about the reasons behind the sea level change. Still, it is possible to look at the rock layers in the spillway as hard evidence of sea-level fluctuations in this long-ago ocean.

Directions to Stop 1—From the junction of Clinton Parkway (23rd Street) and Kansas Highway 10 on the west edge of Lawrence, drive west a short distance to Douglas County Road 458 (this is the road that crosses Clinton Lake Dam). Turn south (left). The spillway is about 1,000 feet from the intersection, but there is a small parking area on the east side of the road just 300 feet south. This parking area allows safer access to the bike path that leads to the spillway. Follow the bike path that leads into the spillway and provides access to the rocks exposed on the north side.

Stop 1 to Stop 2

The first part of the route between Stop 1 and Stop 2 (see map), heading north on the South Lawrence Trafficway, is in the gently rolling upland formed on the Oread Limestone (see fig. 3). As the road goes under U.S. 40, it cuts through a ridge capped by the next younger limestone formation, the Lecompton Limestone. The slopes of this ridge are formed on the Kanwaka Shale, the rock unit that lies between the Oread and Lecompton Limestones. Just before the road reaches the turnpike (I-70), the Oread surfaces again east of the trafficway. In this area, the Oread is about 80 feet lower in elevation than it is 5 miles to the east at the crest of Mount Oread. This reflects the slight regional dip to the west of rocks in this part of Kansas.

The next leg of the route, heading west on the Kansas Turnpike (I-70), climbs onto a gently dipping plateau formed on the Lecompton Limestone. These gently dipping plateaus are known as *cuestas*, a Spanish word that means slope. Proceeding west to Topeka, the turnpike climbs onto *cuestas* formed by a series of successively younger limestones—namely, the Deek Creek Limestone, the Topeka Limestone, and the Howard Limestone (see fig. 3).

In south Topeka, the route continues west on I-470 and passes Burnett Mound, part of a prominent escarpment marking the east margin of a *cuesta* formed on the Bern Limestone, the next younger limestone formation. As the route continues west on 21st Street, it crests a ridge supported by the Emporia Limestone. The route then heads south and west on Kansas Highway 4, passing by prominent outcrops of the Tarkio Member of the Zeandale Limestone.

Stop 2—Echo Cliff

Echo Cliff, which stands about 75 feet above the stream, is an excellent example of ancient river-channel deposits. Cycles of submergence and emergence, caused by changes in sea level, occurred many times during the Pennsylvanian here in the Midcontinent. When sea level fell, streams cut deep channels into previously deposited layers of limestone and shale. As channels meandered across the landscape, sand, silt, and clay-sized sediments were deposited, removed, and redeposited again and again, much as they are in a modern river like the Kansas River. Evidence indicates that channel cutting occurred in a freshwater environment when the ground was above sea level, and in most cases, the channels filled with nonmarine sandstones and shales. Some channel filling, however, may have taken place in a transitional setting, where marine and nonmarine environments met and tides affected sediment deposition. Much of the material filling the channel probably came from the uplands to the north and northwest.

The channel deposits at Echo Cliff probably represent two separate channels (fig. 4). The first river channel, which developed about the same time the Plumb Shale was being deposited, cut down into rocks below the Plumb Shale. Later, a second river channel started in the Towle Shale and cut into the older Plumb Shale channel. A prominent layer of conglomerate (a rock composed of pebbles and rock fragments that have been naturally cemented together) can be seen about two-thirds of the way up from the base of the cliff; this marks the base of the Towle Shale channel.

Plumb Shale Channel—About 48 feet of the Plumb Shale channel is exposed at Echo Cliff. The Plumb channel fill is alternating layers of very fine grained micaceous (containing flakes of the mineral mica) sandstone, and micaceous siltstone and claystone. The entire deposit exhibits large-scale

crossbedding. Crossbedding is a series of thin, inclined layers in a large bed of rock (usually sandstone) that is inclined at a distinct angle to the typically horizontal bedding surface. Formed by currents of water or wind, crossbedding is found in dune, stream channel, or delta deposits. The direction in which the beds are inclined usually indicates the direction the current of water or air was flowing at the time of deposition. In this case, the crossbedding was formed by water. Some sandstone crossbeds fill small channels cut into more massive beds. Carbonized leaf and wood fragments are common on bedding planes, giving the outcrop a streaked or banded appearance. Limonite (iron oxide) nodules are abundant, and the entire outcrop is stained with iron oxide. Calcium carbonate, iron oxide, and locally, barite cement the sand grains together.

Normally, the Plumb Shale is about 10 feet thick, but where deep channels develop, it can be up to 105 feet thick. The Plumb Shale channel at Echo Cliff trends east to southeast and is probably not more than 1.5 miles wide.

Towle Shale Channel—The Plumb Shale channel is separated from the overlying Towle Shale channel by a limestone conglomerate. The conglomerate commonly forms a prominent ledge and breaks into large slabs. This conglomerate is 2–3 feet thick and consists of angular to subrounded fragments of local limestone and shale. Many of the limestone fragments are from the Brownville Limestone and Grayhorse Limestone Members of the Wood Siding Formation; this is evidence the channel is younger than these units. In other words, sometime when the Towle was being deposited, channel downcutting eroded through the limestone layers in the Brownville and Grayhorse, and fragments of these limestones were broken off and carried downstream to be deposited within the conglomerate at a level lower than where they initially occurred. This dates the Towle channel as younger than the Brownville. It also shows the channel cannot be the same age as the Plumb because the Brownville and Grayhorse, which occur above the Plumb, hadn't been deposited when the Plumb channel was active.

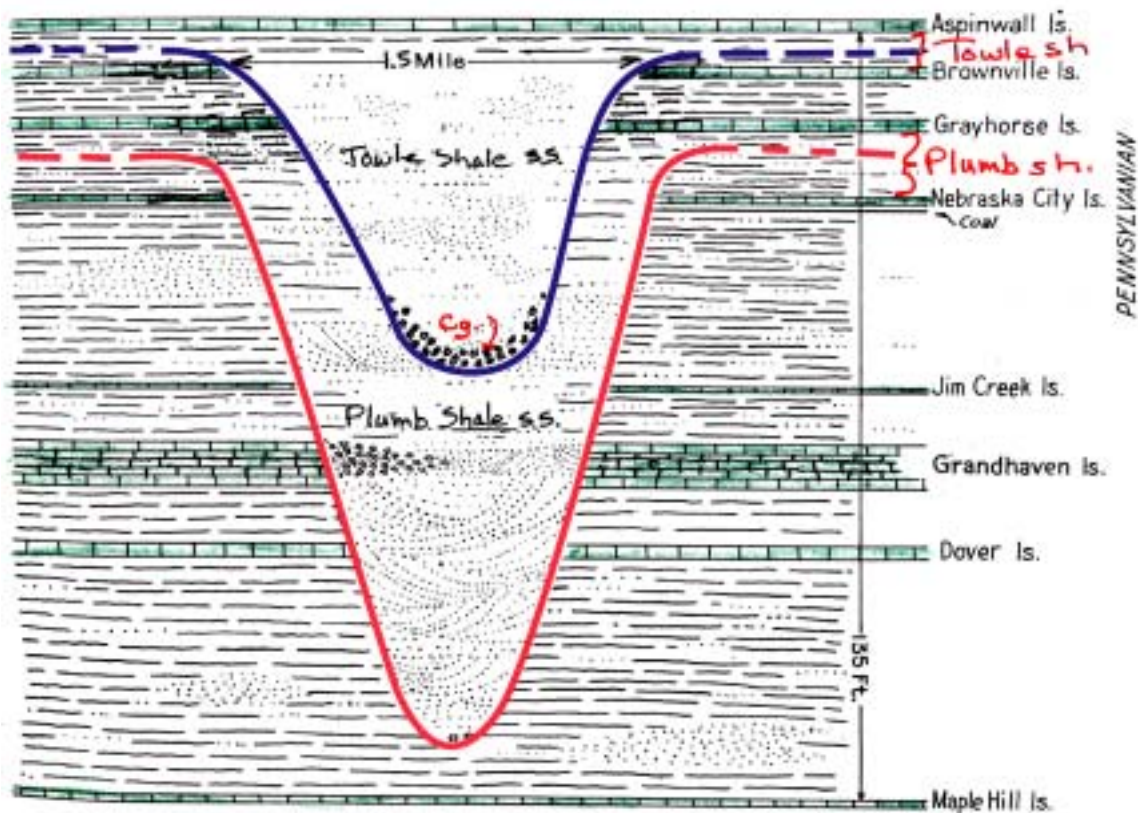


Fig. 4—Channel deposits exposed at Echo Cliff (cg = conglomerate, ss = sandstone, ls = limestone, sh = shale).

At Echo Cliff, the conglomerate is overlain by about 23 feet of very fine-grained micaceous sandstone that is interbedded with sandy siltstone. The Towle channel trends west to southwest. The channel is less than a mile wide and is about 85 feet deep. Normally, the Towle is only 10-20 feet thick in Wabaunsee County.

The channel sandstone in the Towle Shale Member is informally called the Indian Cave sandstone, referring to sandstone bluffs, locally called the “Indian Caves,” on the Missouri River in southeast Nebraska where this unit was first described.

Pennsylvanian-Permian Boundary. At this location we are very close to the Flint Hills. The eastern boundary of the Flint Hills can be defined by rocks deposited during the Permian Period (about 290 million years ago), which are slightly younger than the Pennsylvanian rocks at Echo Cliff. The Pennsylvanian and Permian rocks were deposited under similar conditions—that is, in shallow seas that fluctuated in depth. Because the rocks left behind by the Permian seas are similar to those deposited during the Pennsylvanian (alternating beds of limestone and shale), geologists have a difficult time deciding where the Pennsylvanian ends and the Permian begins. At one time, the boundary was placed at the base of the conglomerate in the Towle shale, so that everything above would have been considered Permian and everything below Pennsylvanian. In 1994, however, the Pennsylvanian-Permian boundary was moved, based on fossil evidence, much higher up in the geologic rock section. This means that all the rocks at Echo Cliff are now considered Pennsylvanian, and you don’t encounter Permian rocks (and thus the edge of the Flint Hills) until you go several miles west of here.

Directions to Stop 2—From Dover (a small town about 10 miles southwest of Topeka on Kansas Highway 4), drive 1.5 miles west on Kansas Highway 4. Turn south (left) and follow the gravel road one mile. Just before crossing the bridge over Mission Creek, turn east (left) into the Echo Cliff picnic area.

Stop 2—Stop 3

From Stop 2, the route backtracks on K-4 towards Dover and then heads north on Carlson Road, along the Wabaunsee-Shawnee county line. Just a little over a mile north of K-4, hard, pink boulders of

Sioux quartzite can be seen in the pastures on either side of the road.

Stop 3—Glacial Boulders

The glacial boulders that litter the pastures along this road, called Sioux quartzite, are evidence of glaciation. Sioux quartzite occurs near Sioux Falls, South Dakota, and derives from ancient sandstone that was fused into blocks of solid quartz over a billion years ago. These boulders were carried into Kansas by a glacier about 600,000 to 700,000 years ago.

These foreign boulders, called erratics by geologists, are tell-tale markers of the presence of glacial ice during the Pleistocene and can be used to mark the extent of the glaciation because only the immense force of moving ice is capable of carrying rocks this big any appreciable distance. Glacial deposits are not found a short distance south of here, so we are very near the terminus of the Kansan glacier.

Also in this area are other glacial deposits, including a former gravel pit, which operated until 1952. The rocks at the gravel pit are composed of rounded gravel, pebbles, cobbles, and boulders of limestone, chert, quartzite, and granites. These rocks are poorly sorted and some layers are naturally cemented by calcium carbonate. The rounded nature of these rocks and their large size indicates that they traveled some distance in a strongly flowing river, yet the site is five miles south and more than 150 feet above the nearest large river, the Kansas. The presence of relatively soft limestone pebbles and cobbles suggests that this material didn’t travel very far. Geologists refer to such deposits as glacial drift, and, like the boulders of Sioux quartzite, this deposit was left behind by the glacier that entered Kansas roughly 700,000 years ago. *Drift* is a term that originated in Britain to describe the diverse mixture of rock and clay that covers much of that island. Early beliefs were that this material “drifted” in during the Great Flood of the Old Testament. We now know that continental glaciation formed these deposits, yet the name drift persists. *Drift* is a general term for deposits associated with glacial ice and includes river and lake deposits formed by the melting glacial waters. A deposit formed directly by glacial ice is known by a Scottish word, *till*.

This deposit most likely formed when the glacier occupied the Kansas River valley, damming its

southern tributaries, creating a temporary lake and diverting the drainage to upland areas such as this. Meltwater from the glacier carried part of the huge, diverse sedimentary load from the glacier across present drainage divides and deposited it locally on some of the uplands, as at the former gravel pit and in terrace deposits along some of the larger streams such as Shunganunga Creek and the Wakarusa River. Glacial drift covers a large part of northeastern Kansas, north of the Kansas River and east of the Big Blue River. Deposits of sand and gravel such as this make excellent aquifers because of the porosity and permeability provided by the coarse grain sizes. These deposits feed small springs that drain into Vassar Creek just down the hill, and drift-related aquifers are important groundwater resources in the glaciated region of Kansas. The gravel itself is an aggregate resource and this pit was operated to provide gravel for county roads.

Directions to Stop 3—From Dover, Kansas, drive one-half mile west on Kansas Highway 4 to Carlson Road. Turn north (right). About 1.25 miles north, glacial boulders (some up to four feet in diameter) can be seen in the pastures to the west. For the next mile or two, boulders are scattered across pastures, found along fence lines, and stacked around mail-boxes on both sides of the road. Carlson Road meets I-70 at Exit 346, about 6.5 miles north of its intersection with K-4.

Stop 3 to Stop 4

From Stop 3, the route continues north on the county line road. This upland area is underlain by Pennsylvanian limestones and shales, but is mantled by glacial deposits. The use of center pivot irrigation systems along this road shows that, locally, this glacial material is an aquifer (a water-bearing rock formation). Generally, the bedrock in this part of the state does not provide enough water to allow crop irrigation.

Heading east along I-70, the route travels down section—in other words, it moves from younger to older bedrock. As the route passes through Topeka, between Shunganunga Creek and Deer Creek, it passes through roadcuts in the Topeka Limestone (see fig. 3), rocks that also crop out at Stop 4.

As the route follows U.S. 40 and K-4, it follows Deer Creek to the north (the Deer Creek Limestone that crops out along the turnpike in western Douglas County is named for exposures along this creek). As

K-4 turns to the north, the route crosses the floodplain of the Kansas River. Alluvial deposits in the Kansas River valley are up to 80 feet thick in this area and saturated with water. The Kansas River is an important source of surface water in northeast Kansas, and its saturated alluvium is a major aquifer as well. After crossing the Kansas River, the highway climbs onto Calhoun Bluff, the namesake of the Calhoun Shale. The upper part of the Calhoun Shale crops out at Stop 4.

Stop 4—Fossils at the K-4 and U.S. 24 Interchange

The new interchange at the junction of K-4 and U.S. Highway 24 is an easy place to see and collect invertebrate fossils. Fossils are the ancient remains or evidence of once-living plants and animals, and invertebrates are animals 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 part of the earth, most of which lived and died leaving no visible 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, crinoids, gastropods (snails), bivalves (oysters, clams, scallops), and trilobites. The less familiar of these are described in more detail below.

Two rock units here, the Holt Shale and Coal Creek Limestone Members of the Topeka Limestone, are particularly fossiliferous. The Holt Shale Member is a dark-gray, layered siltstone, about 2 feet thick. Fossils of brachiopods and bryozoans (see description below) are common in this member. The Coal Creek Limestone Member, which sits directly above the Holt Shale Member, is a light-gray or olive, silty limestone, about four feet thick.

In addition to the fossils at this site, you can see coal, exposed at the surface in the Calhoun Shale, the formation just below the Topeka Limestone. Pyritized wood is also found in the same vicinity as the coal, just above the coal layer in the Calhoun Shale.

Bryozoans—Bryozoans are some of the most abundant fossils 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. 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 shells, rocks, plants, and even other bryozoan colonies. All of these types of bryozoan colonies can be seen at this site.

Brachiopods—Brachiopods are marine animals that 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 right and left valves are mirror images of each other. Brachiopod shells come in a variety of shapes and sizes. 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—are huge, as much as 6 feet in diameter.

Crinoids—Crinoids are another animal that lived in the Pennsylvanian seas. Because they resemble plants, with feathery arms set atop a long stem, crinoids are sometimes called sea lilies. But they are definitely animals—relatives of starfish, sand dollars, and sea urchins. Crinoids appeared in the fossil record about 500 million years ago and still inhabit the world's oceans. Well-preserved fossils of entire crinoids have been found in the chalk of western Kansas (and are on display in museums around the country). Usually, people find only pieces of the crinoid stem, which are shaped like little buttons and were used by Native Americans as beads. At this site, you might also find the crinoid calyx, the cup-like part that sat on top of the stem.

Trilobites—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 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 at this site.

Directions to Stop 4—To get to the new interchange at the junction of K-4 and U.S.-24 northeast of Topeka, approach the interchange from the south on K-4. As you are driving north, pull off to the right side of the road immediately past the first exit ramp, but before you come to the overpass. If the ground is dry, there is a dirt road that will get you safely off the highway. Park near the underpass. The rocks exposed immediately to the east are easily accessed by walking north down to the end of the exposure and then walking back on the flat bench that has been excavated into the cut. The fossils occur in the 6 or 7 feet of rock above this bench.

From Stop 4 to KGS

From stop 4, the route continues east on U.S. 24 to Perry, Kansas, mostly travelling in the Kansas River floodplain. The route heads south from Perry and crosses the Kansas River at Lecompton. Here, on the south bank of the Kansas River, just above

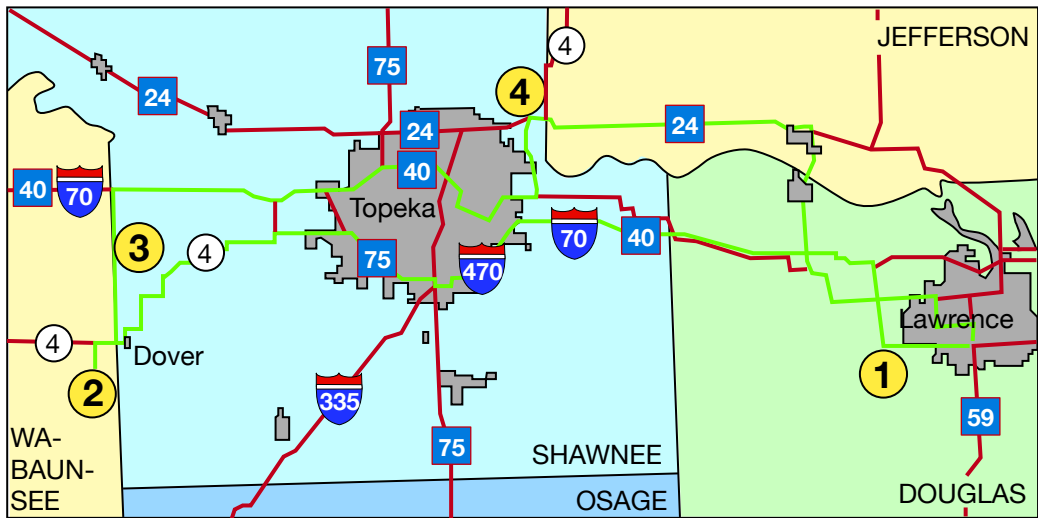
river level, members of the Oread Limestone are visible. A short distance upstream the Oread disappears from view, dipping below the alluvium of the Kansas River. The route joins U.S. 40, just below the escarpment of the Deer Creek Limestone, and heads east to Lawrence, crossing the Lecompton cuesta and returning to the Oread Limestone and the Kansas Geological Survey.

Acknowledgments

The map showing the field trip route was prepared by Liz Crouse, State of Kansas Data Access and Support Center.

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- 1** Stops described in guidebook
- Field trip route

