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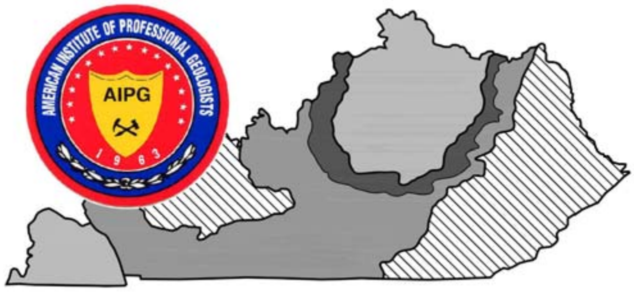

2005 Spring Field Trip and Awards Banquet

Hilton-Cincinnati Airport

Florence, Kentucky

April 23, 2005

GEOLOGY OF NORTHERN KENTUCKY AND THE OHIO RIVER VALLEY

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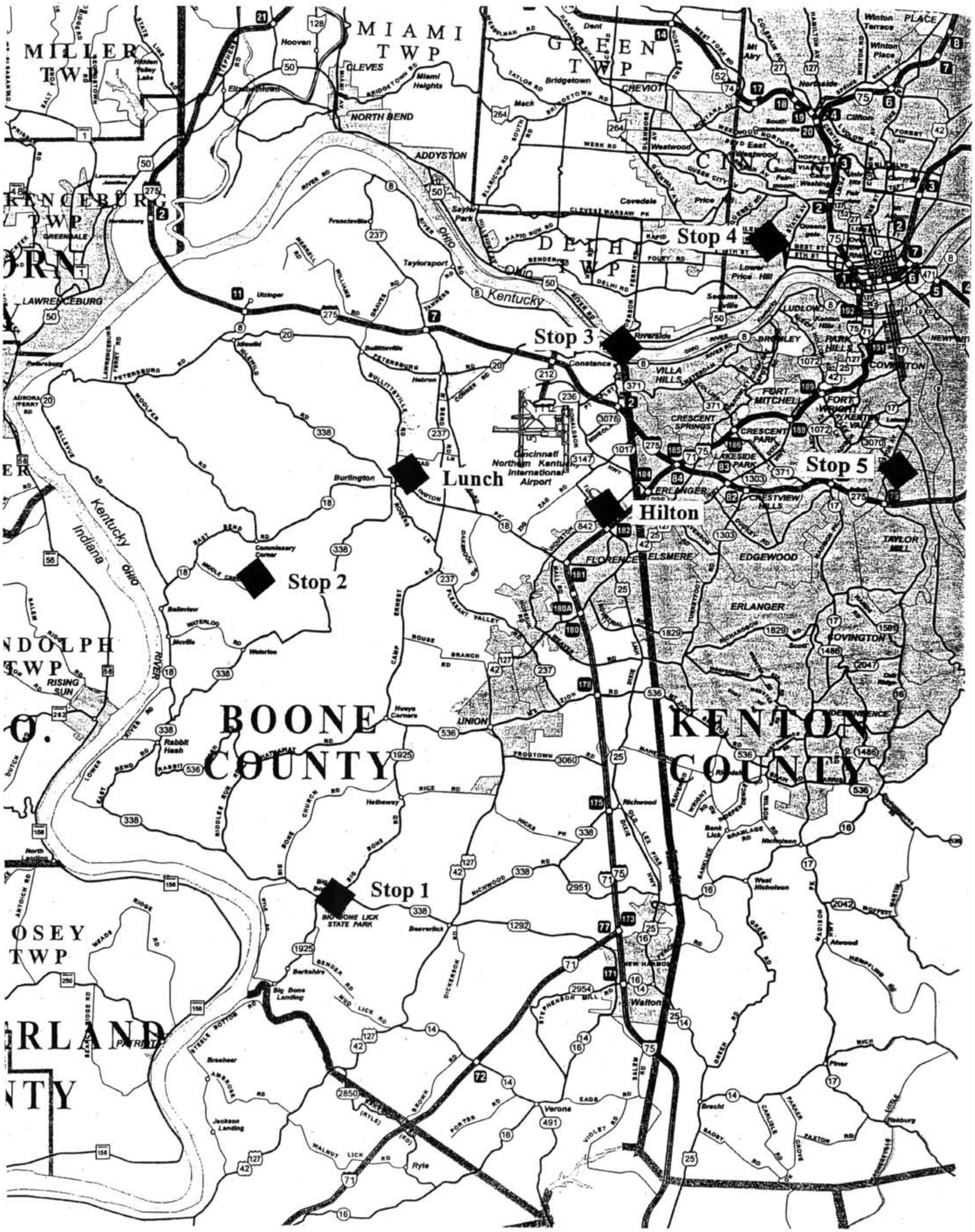


Quaternary Geology in Boone County, Northern Kentucky

Compiled by William Andrews, Jr.
Kentucky Geological Survey

Many people have assisted with data collection included in this brief guide. Special thanks are due to John Barker (Big Bone Lick State Park), Sarah Johnson (NKU), Steven L. Martin and Michael Murphy (KGS), Dr. Harry Rowe (UK), and Dr. Barry Maynard (UC).

Bedrock Geology

Upper Ordovician limestone and shale dominate the bedrock geology of the field trip area (Swadley, 1969, 1971a). In Kentucky, this sequence is divided into mapping units primarily on the basis of limestone vs. shale content (Table 1.). This thick package of shaly bedrock is relatively easily eroded compared to sequences dominated by only sandstone or limestone. Combined with the proximity of the major drainage in the Ohio River, this has led to significant incision of the area and the development of fairly rugged hills and steep-sided valleys. Upon closer inspection, however, the landscape has a more complex history than simply streams eroding their valleys down through time. Excellent overviews of the field trip area geology can be found in Ray (1974) and Potter (1996).

Age	Unit	% Limestone	Thickness
Upper Ordovician	Bull Fork Formation	~50%	>100 ft.
Upper Ordovician	Bellevue Tongue of Grant Lake Limestone	>90%	5 – 40 ft.
Upper Ordovician	Fairview Formation	~50%	90 – 120 ft.
Upper Ordovician	Kope Formation	10-20%	200 – 230 ft.
Middle Ordovician	Point Pleasant Formation	~50%	>20 ft.

Table 1. Summary of Ordovician bedrock units in the field trip area.

<u>Not-directly-represented-and-thus-speculative Mesozoic to Mid-Tertiary History</u>

The field trip area sits astride the Cincinnati Arch, a broad regional anticline separating the Appalachian Basin on the east from the Illinois Basin on the west. Based on regional stratigraphic patterns, sediments were probably deposited across this area throughout much of the Paleozoic, similar to the rocks preserved in the adjacent basins. No Triassic or Jurassic rocks have been identified in the region or adjoining basin areas. Cretaceous through mid-Tertiary coastal plain and shallow marine sediments are preserved in the Jackson Purchase of far western Kentucky (Olive, 1980). On the basis of fission track and conodont thermal maturity data (Harris and others, 1978; Roden and others, 1993), erosion of a Late Paleozoic depositional surface was apparently slow until the mid-Tertiary, and accelerated in the Miocene (Hulver, 1997). An estimated 400 to 800 m of overburden has been eroded from the crest of the Cincinnati Arch since the Mesozoic (Andrews, 2004).

<u>Teays River (Plio-Pleistocene)</u>

During the Pliocene and Early Pleistocene, meandering rivers drained central Kentucky and the highlands to the east. The Old Licking River and the Old Kentucky River flowed northward past Cincinnati to join the ancient Teays River system in central Ohio, before flowing west across central Indiana and Illinois, and turning south to follow the approximate modern path of the Mississippi River to the Gulf (Figure 1). The Old Ohio River was a much smaller stream than the modern Ohio, with its headwaters only reaching as far as Madison, Indiana. The Old Ohio River was comparable in size to the modern Salt River in central Kentucky. Remnants of these ancient river systems are apparent in abandoned high-level valleys and fluvial deposits found scattered in the uplands near master streams through central Kentucky and the field trip area (Figure 2). For the most recent review of the Teays River system and its tributaries, see Melhorn and Kempton (1991) and the articles therein. Granger and Smith (1998) and Granger (personal communication) has used cosmogenic Be^{10} dating to estimate the age of Teays River sediment at 1.1 to 1.45 My.

<u>Pleistocene Geologic History</u>

<u>Pre-Illinoisan</u>

Ray (1974) provides a comprehensive yet outdated review of Quaternary geology in the field trip area. Early workers identified four major Pleistocene glaciations in the eastern United States: the Nebraskan (oldest), Kansan, Illinoisan, and Wisconsinan (youngest). These terms were used widely in the regional literature, until subsequent work with tephra layers in the type areas of the Kansan and Nebraskan showed major complications in correlation and chronology. Numerous glaciations (over a dozen) have now been recognized in the Pleistocene of the central United States, with only the Illinoisan and Wisconsinan having reasonable chronologic or stratigraphic control; thus, the terms Kansan and Nebraskan are no longer appropriate. The USGS-KGS geologic mapping program (1960-1978) identified only one pre-Illinoisan glacial deposit in the area (Swadley, 1971b). Leighton and Ray (1965) identified two pre-Illinoisan glacial deposits in northern Kentucky in the Ohio Valley, and assigned these to the Nebraskan and Kansan. The two tills are difficult to distinguish, however, and these were considered one multi-phase glacial event by Teller (1970).

Pre-Illinoisan glacial drift has been mapped along many of the ridgetops in the study area, and rests on top of the fluvial deposits of the Old Kentucky River (Swadley, 1971b). The pre-Illinoisan glaciations impounded the Teays River and its tributaries, disrupting the regional Teays River drainage pattern and assisting in the integration of the modern Ohio River. The sudden increase of drainage area for the lower Ohio River valley, and the dramatic decrease in distance to the Gulf of Mexico for the headwater streams of the Teays River system resulted in rapid incision and down-cutting by master streams and their tributaries in Kentucky. The literature on the evolution of the Ohio River is extensive; readers are encouraged to examine Ray (1974), Potter (1996), and Melhorn and Kempton (1991) for related articles.

Deep Stage

After the pre-Illinoisan glaciations, an extended interglacial period allowed the newly arranged Ohio River system to adjust to its new course and longitudinal profile. The change in stream profile during destruction of the Teays left the Ohio River and tributaries in disequilibrium, and a period of rapid downcutting ensued. The deepest erosion of the Ohio River bedrock valley occurred during this “Deep Stage” interglacial. Nearby tributaries also deeply incised to keep pace with the master stream level in the Ohio River valley.

Illinoisan

The Illinoisan glaciation reached into northern Kentucky, but the steep “Deep Stage” topography supposedly kept the glacial ice restricted to the valley bottoms, so Illinoisan till and outwash deposits are only identified along the margins of major stream valleys, and not on the adjacent ridgetops. The Illinoisan and pre-Illinoisan deposits are be distinguished by their topographic position (Figure 2), as well as by the intensity of weathering and alteration of the sediments and matrix materials (see Potter, 1996). The Illinoisan till and outwash partially filled the Ohio River valley, and dammed up adjacent tributaries, creating valley-bound lakes in many of the tributary valleys. After retreat of the Illinoisan ice, the Ohio River began to downcut into the Illinoisan valley deposits.

Wisconsinan

The Wisconsinan glaciers did not reach into northern Kentucky, but they dumped huge quantities of sand, gravel and silt into the Ohio River valley, filling the post-Illinoisan valley (Figure 2), and forming an extensive outwash valley train. The Wisconsinan outwash is distinguishable from the Illinoisan outwash only by topographic position along valley margins. The subsurface sand and gravel deposits are virtually indistinguishable from each other. As the outwash valley trains moved down valley, winds blowing off the cold glaciers picked up the siltier material, depositing it southward as loess blankets across much of northern and central Kentucky. Particles of fine sand coalesced into dunes near valley walls. Again, the outwash deposits dammed up tributary streams and led to extensive valley lakes in tributary valleys, such as that seen at Stop 1, Big Bone Lick State Park.

Holocene

Since the retreat of the Wisconsinan glaciers, the Ohio River and tributary streams have reworked and redeposited sandier and siltier materials in the modern floodplain. This floodplain sits lower than the surface of the Wisconsinan outwash, which remains as a terrace through the area. The sand and gravel of the outwash terraces along the Ohio River is produced for road aggregate and other uses. The relatively high outwash terrace has been an attractive place for settlement and occupation for the last 12,000 years or so.

Figure 2 is a generalized profile showing the relationship of bedrock and Quaternary units in Boone County. The relative positions of our two morning stops, Big Bone Lick State Park and Boone Cliffs State Nature Preserve, are shown on the profile.

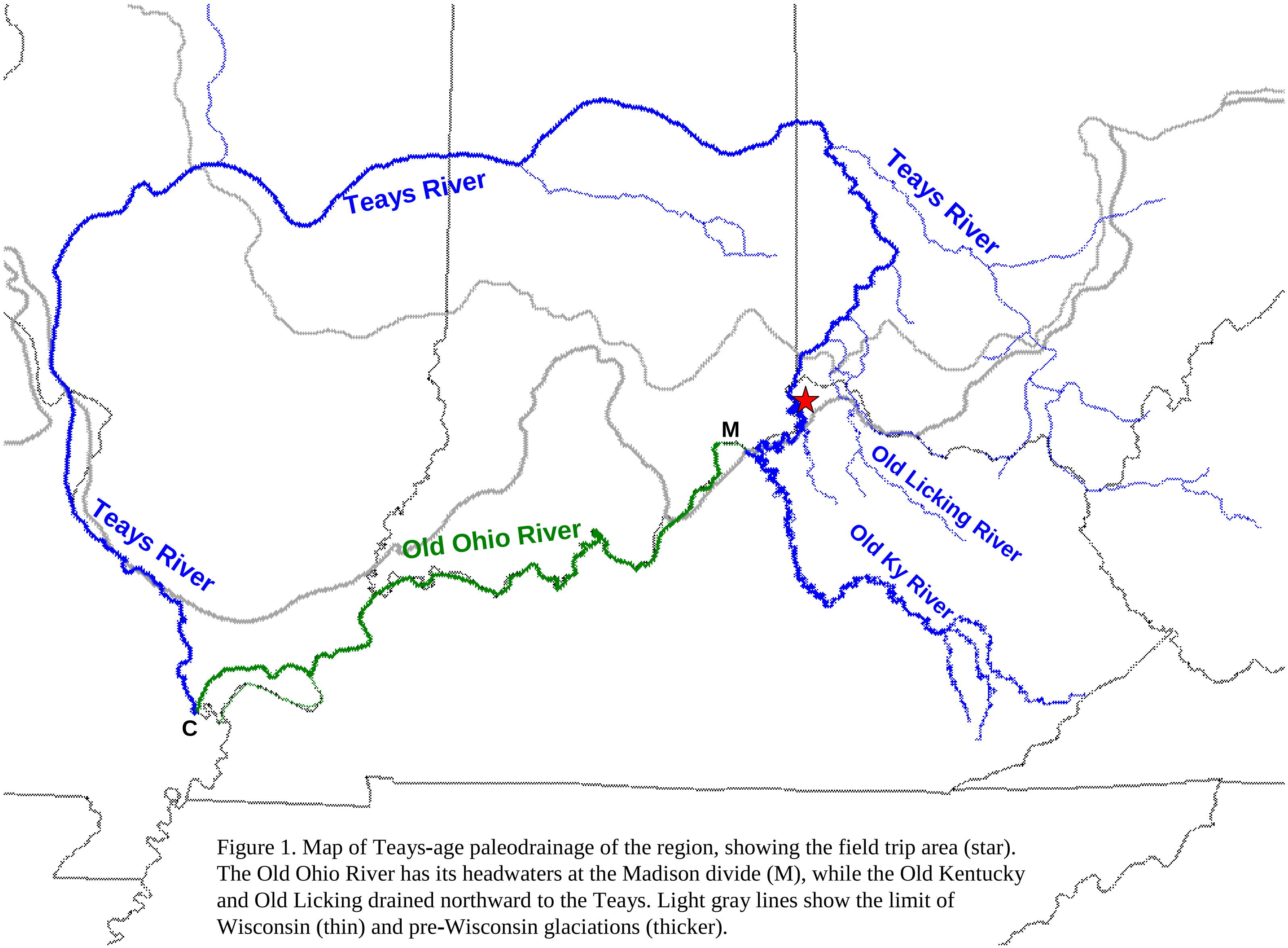
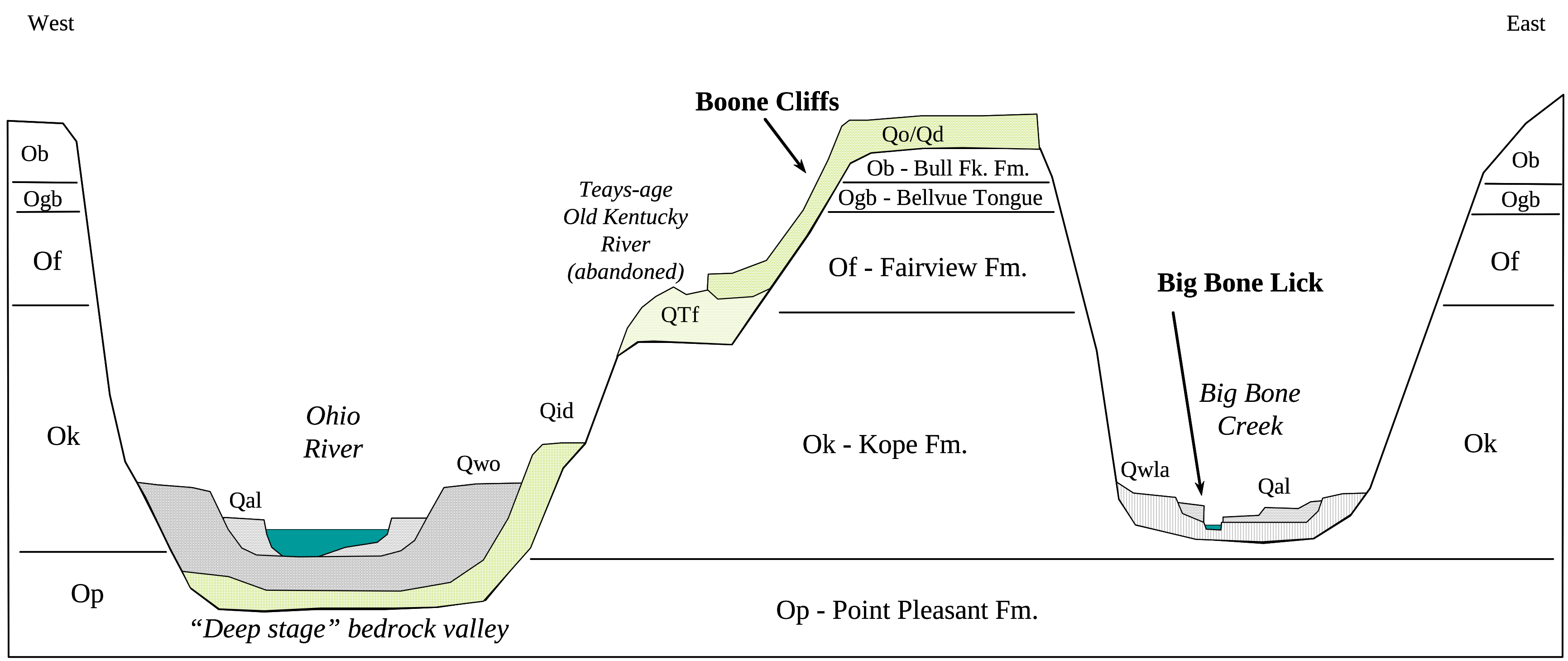


Figure 1. Map of Teays-age paleodrainage of the region, showing the field trip area (star). The Old Ohio River has its headwaters at the Madison divide (M), while the Old Kentucky and Old Licking drained northward to the Teays. Light gray lines show the limit of Wisconsin (thin) and pre-Wisconsin glaciations (thicker).



Unconsolidated Deposits

Qal	Recent alluvium
Qwla	Wisconsinan lacustrine deposits
Qwo	Wisconsinan outwash
Qid	Illinoisan drift (till? outwash?)
Qo/Qd	pre-Illinoisan drift (till? outwash?)
QTf	high-level fluvial deposits

Figure 2. Schematic cross section showing the bedrock stratigraphy and unconsolidated deposits in the field-trip area. Bedrock units are Upper Ordovician. Total relief in the area is approximately 500 feet. Adapted by Wm. Andrews from Swadley (1971a) Geologic Map of Part of the Rising Sun Quadrangle, USGS GQ-929.

STOP 1. Big Bone Lick State Park
NOTE: Stop 1 is a Kentucky State Park attracting numerous tourists and local/regional campers every year. Collecting of artifacts, etc., is prohibited in the park without prior permission of the Park Naturalist.

A cooperative study by the Kentucky Geological Survey, Northern Kentucky University, University of Kentucky, and the University of Cincinnati, supported by the U.S. Geological Survey, has been investigating the geology, geomorphology, geochemistry, and hydrology of Big Bone Lick State Park. A series of five cores and one auger hole were collected in July 2004 and examined by students and faculty at these institutions to provide background data for the geological interpretation of the park for visitor education and for site management. A groundwater monitoring well was installed in one of the core holes. Stop 1 will be in the area near the monitoring well, Big Bone Creek, and two of the active saline springs.

The floodplain of Big Bone Creek is inset into Wisconsinan lacustrine terrace deposits developed due to aggradation of Ohio River outwash episodically impounding Big Bone Creek. The lacustrine material is primarily comprised of bluish gray clayey silt and silty clay, which is locally laminated and contains sparse sandier layers. University of Nebraska paleontological excavations found preserved bones of Pleistocene mammoth, mastodon, giant ground sloth, bison, musk ox, caribou and horses on and in the lacustrine deposits (Schultz and others, 1967). The floodplain of Big Bone Creek overlies the lacustrine material and includes brown silty clay loam and silt loam up to 12 feet thick. University of Nebraska paleontological studies found historic artifacts and bones of historic domesticated and Holocene wild animals in the brown floodplain deposits (Schultz and others, 1967). The contact between the brown floodplain deposits and the underlying “blue clay” of the lacustrine deposit can be seen in the bank of Big Bone Creek at Stop 1. The 2004 drilling determined bedrock at this location to be approximately 21 feet below ground surface.

The critical geological feature of Big Bone Lick State Park is a series of saline springs flowing from the floodplain of Big Bone Creek. These springs attracted large Pleistocene and Holocene vertebrates who needed the salt as part of their diet. As the animals crossed the swampy lake flat to access the salt, many became mired in the mud and were trampled or drowned. The presence of the animals in turn attracted prehistoric peoples who hunted the animals and collected salt for their own use. Early settlers manufactured salt from the Big Bone Lick springs. In the 19^{th} century, the springs became a medicinal resort, attracting numerous travelers to consume the saline waters for their perceived health benefits. Jillson (1936) discusses the geology, paleontology and history of Big Bone Lick. According to recent analyses overseen by Dr Barry Maynard at the University of Cincinnati, the major-element chemistry of the groundwater from these springs is dominated by sodium chloride. Surface water samples from Big Bone Creek are calcium-carbonate rich. In a comparison with regional brine analyses, Dr. Maynard suggests these springs are tapping a source chemically similar to brines found in the Illinois Basin to the west.

Although they will not be viewed at this stop, Plio-Pleistocene fluvial deposits of the Old Kentucky River cap the upland where the modern Big Bone Lick campground is located. The fluvial deposits are identified mainly by the presence of pebbles of well rounded quartz, subangular brown chert, and geodes. These lithologies are derived form bedrock outcrops in east-central and south-central Kentucky and were carried to this location by a north-flowing segment of the Old Kentucky River flowing toward the Teays River system to the north. The bedrock at the park is shale and limestone of the Upper Ordovician Kope Formation.


Diorama of foundering Pleistocene mammals at the park.

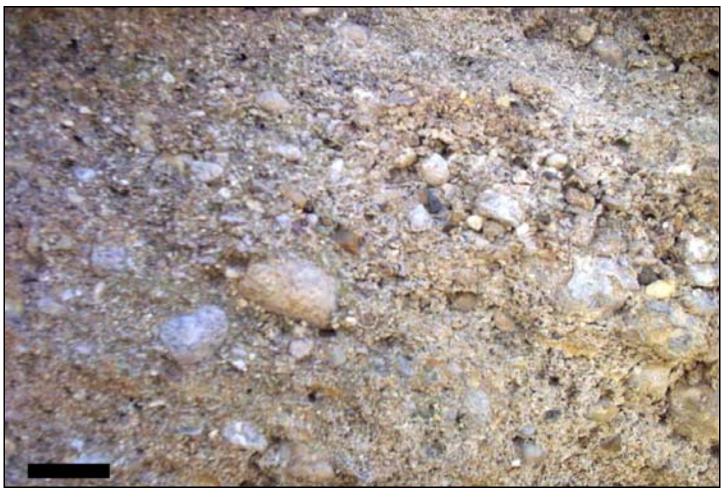
The July 2004 cooperative drilling project extracted five soft-sediment cores at Big Bone Lick State Park, and involved cooperation from the U.S. Geological Survey, Kentucky Geological Survey, University of Kentucky, Northern Kentucky University, and the University of Cincinnati.

View looking down from bank of Big Bone Creek at Stop 1, showing contact (dashed line) between lacustrine (left/below) and floodplain (right/above) sediments.

STOP 2. Boone Cliffs State Nature Preserve

NOTE: Stop 2 is a state nature preserve protecting unique and fragile natural habitats. Please stay on the trail. Collecting or disturbing plants, animals (and yes, rocks) is prohibited. At the last pre-field trip visit (April 14 2005) several native woodland plants were blooming, including common blue violet (purple), blue phlox (purple), dwarf larkspur (dark purple), sessile trillium (maroon), Dutchman's-breetches (white), ragwort (yellow), and others. Even without rock hammers, there will be plenty to see and enjoy.

Boone Cliffs is a 75-acre tract of old growth forest including distinctive cliffs of consolidated Early(?) Pleistocene glacial-outwash congolomerate overlying shale and limestone of the Kope through Bull Fork Formations. The conglomerate includes pebbles and cobbles of limestone, quartz and quartzite, sandstone and siltstone, chert, igneous/metamorphic rocks and geodes. Most pebbles are less than 4 inches (10 cm) in diameter, but some slabs of limestone range up to 18 inches (45 cm), as we will see at this stop. Crossbed orientation directions in the conglomerate range from northeast (30°) to southeast (145°) with dips as high as 20°. Overall, these outwash deposits have a southbound trend and overlie northbound fluvial sediment of the Old Kentucky River, which flowed into the Teays Valley System north of Cincinnati. Although no direct geochronologic measurements have been made, they are presumed to be pre-Illinoisan and thus would represent the glacial advance that disrupted the Plio-Pleistocene Teays River and encouraged the integration of the modern Ohio River system. Cosmogenic Be^{10} dating on northbound Old Kentucky River sediment near Carrollton suggests an age of 1.1 to 1.45 My for the Teays-age sediment (Granger and Smith, 1998; Granger, personal communication).



Crossbedded conglomerate exposed at Boone Cliffs; filled rectangle is roughly 1 inch in length.

Photograph of limestone slabs in conglomerate at Boone Cliffs

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View of the Ohio River valley from KY 18, south of McVille, looking north.

STOP 3. Anderson Ferry

This ferry crossing is located at a former divide in the pre-glacial (Illinoisan) drainage. The divide separated drainage that flowed east from that which flowed west. The east drainage joined major streams like the paleo-Licking River that flowed north to join with the Teays system. Drainage that flowed to the west joined streams like the paleo-Kentucky that flowed northward, and later, the deep-stage Ohio River that flowed to the south and west.

Evidence of the drainage reversal in this area can be seen in the barbed tributary valleys just upstream (east) from here. They enter the westward flowing Ohio River at an obtuse angle, indicating that they once were part of drainage flowing eastward. Tributary valleys that join the Ohio River at an acute angle can be found just downstream (west) from here, indicating that they were part of drainage flowing westward.

The ferry was positioned at this point because the divide formed a shallow point in the river channel. In the days before dams raised the river level, draft animals could be used to pull the boats back and forth across the shallows throughout much of the year. Such was the case in the 1830's when the ferry started.

Note the rather narrow gorge through which the river flows at this point. There is very little floodplain on either side.

STOP 4. Price Hill Incline

The view from this overlook provides a backdrop for consideration of various aspects of the geological setting of the region. The benefits and obstacles encountered as a result of this environment become a bit more apparent here. The broad basin that extends eastward from the overlook provided room for growth of both population and industry. The famous hog markets and slaughter houses that helped make Cincinnati a great city were located in this valley, together with other industries that used the by-products of the hog processing (such as Jergens, and Proctor and Gamble). The basin is the product of stream and slope processes that pre-date the Ice Age.

As the city expanded, the only space to grow was on the hilltops. This meant that the steep slopes that surrounded the basin must be overcome with reliable transportation. Several inclines served the city for many decades, with the last being closed in 1948.

Slope processes create many hazards in the region. Creep, slump, and debris slides are common, especially in the spring. The bedrock conditions set the stage for slope instability. The lower 2/5 of the slopes consists of the Kope Formation. Shale is the dominant rock type, comprising 75-80% of the formation. The upper 3/5 of the slope consists of bedrock with increasing percentages of limestone.

STOP 5. Mason Road Outcrop, Taylor Mill, KY

The Mason Road outcrop consists of the upper Kope, all of the Fairview, and the lower Bellevue. The Miamitown shale is not really present here, but is more discernable further north and west.

Cincinnatian Stratigraphy

Compiled by Rick Bullard
Northern Kentucky University

Geography

During the time that Cincinnatian rocks were deposited, 1000 km east of Cincinnati there stood the a large mountain chain called the Taconics. They ran along a line roughly parallel to the modern U.S. East Coast. Stretching westward from the mountains lay a vast sea. More than 1500km wide, the bottom of this ocean first sloped into a deep basin then, further to the west, the bottom rose near to the surface in a sort of underwater plateau. Beyond the plateau the bottom dropped back down into another basin.

What is now the Cincinnati area was atop the undersea plateau mentioned above, hundreds of miles offshore from the nearest dry land to the east. The waters in there area were quite shallow at times. This situation was the result of an anticline beneath the region that caused the seafloor to be much closer to the surface. To the east and west of this upraised section, the bottom sloped off into deep basins. Along the hinge line of the anticline, the bottom sloped from its shallowest points to the south and east of Cincinnati (near the SE Kentucky-Tennessee border) into deeper waters to the north and west of the region (NW Ohio-N Indiana). So overall then, the sea floor here formed a "ramp", sloping to the NW at an angle of about 10 or less. Although the angle was very slight, by moving in a down-ramp direction a distance of 10 - 20 km, the water depth may have increased by 30m (-100') or more. A change in depth of 30m (particularly in shallow waters) can result in a very significant change with regards to the type of habitats that existed on the sea floor and the sediments that were deposited there.

The Effects of Storms

One of the most significant factors affecting the sea bottom in shallower waters was the effect of storms (remember, in the late Ordovician, the Cincinnati region was in a position just south of the equator, in warm, tropical seas). There is evidence that frequent hurricanes swept across these seas, generating large waves and strong currents, just as they do in the tropics today.

During good weather, waves can disturb the bottom only to depths of less than -10m (referred to as fair weather wave base). During a severe hurricane, waves may reach heights of 20-30m. These can suspend and move sediments at depths of 30+m (referred to as storm wave base)! At times in the area's history, much of the sea bottom was within a depth range that was frequently affected by storm waves. Another effect of hurricanes is what is referred to as "storm surge". This is a piling up of seawater by the wind action of hurricanes, and can result in local rises in sea level of up to 1 Om or more! If such a surge is piled into shallow water, when the winds abate, the extra water then rushes back out to sea along the bottom in a strong return current" which can erode and transport sediments as they move offshore. During times of fair weather however, the seas here were warm and clear, very much like those of the modern Bahamas (but without the sand).

Sea Level Changes

Superimposed on this picture of the ancient topography of the region is the history of sea level change during the late Ordovician. During the time that the earliest layers of the Cincinnatian rocks were deposited (the Kope Fm.), sea levels were relatively high, placing the sea floor at a depth that protected it from the actions of storm generated waves. During times of higher input of fine sediments transported out from the Taconics during storms, the sea bottom was almost entirely soft mud. The mud was home to numerous burrowing organisms including worms and arthropods. During a time when the supply of mud was cut off (which was probably most of the time), the bottom hardened and organisms like crinoids and bryozoans would colonize the bottom, anchoring onto the hard substrate. The bottom began to accumulate a "hash" of bits of broken shells and other skeletal debris such as bryozoan and crinoid fragments.

Towards the close of the Ordovician, sea levels began to drop as- pulses of glaciation increased in polar regions, effectively "raising" the sea bottom above storm wave base on the Cincinnatian ramp. This change in depth had profound effects on both the nature of the sediments deposited and the types of organisms living there. The Fairview and Bellevue Formations are the result of this shallowing.

Rock Origins

There are two basic types of rock in the Cincinnatian, shale and limestone. The origins of the two rock types are very different.

Limestone in the Cincinnatian consists almost entirely of the skeletons of animals that inhabited the seas. Bryozoan colonies, brachiopod shells, and crinoids were the main sources for the CaC03 (calcium carbonate) that makes up the limestone. Some limestone may have been emplaced relatively rapidly in shallow water environments. The Kope limestones were formed slowly in deeper waters and may represent long-term accumulations of skeletal debris.

Cincinnatian shale is a mixture of siliciclastics derived from the erosion of the Taconics and extremely fine carbonates derived from biological sources (probably algae) in the ramp environment. It is thought that many of the shales were deposited quickly as mud settled from waters disturbed by storms. This rapid deposition is responsible for the fact that some of the finest Cincinnatian fossils come from the shales. Whole animals could be preserved as fossils if mud buried them rapidly to a depth where they would be unaffected by scavengers.

The Kope Formation

The Kope Formation occurs at lower elevations in the Cincinnati area, and consists of proportions of -80% shale / 20% limestone. Thick layers (1 -2 m) of shale are interbedded with limestones, 10 cm-50cm thick. The Kope was deposited during a period when transgression (sea level rise) had increased water depth until the bottom was well below storm wave base. Conditions on the bottom were generally quiet and undisturbed. Occasional episodes of storm-driven bottom currents would scour the sediments creating channels in the muddy substrate.

The shales of the Kope were probably deposited relatively quickly during periods of high turbidity resulting from storms. The ultimate source of the fine mud was far to the east in sediments washing off of the Taconics. Thick accumulations of mud resulted in a soft, fairly mobile bottom, poorly suited for the attachment of the hardground community. Instead, worms and arthropods, including trilobites extensively burrowed the muds. Mollusks and brachiopods, adapted for life on and in soft substrates, also flourished. Most of the animals living in this environment were relatively small and delicate. After sedimentation stopped, the mud would begin to compact and solidify, collecting debris on its surface and in some cases, forming extensive hardgrounds.

The limestone layers are now thought to represent accumulations of skeletal debris that collected during long periods of sediment starvation. Often the upper surfaces of these limestones show hardground characteristics such as borings and the holdfasts (basal attachments) of crinoids. The limestone is composed of brachiopods, bryozoans, crinoids, and trilobites, although these remains are highly fragmented from long exposure on the sea floor. Several of the limestone layers are quite thick and laterally extensive throughout the region.

The Fairview Formation

The Fairview Formation represents a time when regression (shallowing) of the Ordovician seas exposed the bottom to wave action during hurricane conditions. As water depth decreased, the sea floor became closer to, and ultimately above, storm wave base. The depth of the seas in which these rocks were laid down was such that the bottom was exposed to a much more active environment than during Kope times. During hurricanes, skeletal debris (brachiopod shells and bryozoans) in shallower water up-ramp was swept about by the pounding of waves. Muds were suspended and carried away, moved into deeper water. Coarser materials such as shell debris were sometimes swept into deeper water as well, where they finally came to rest. Many of the resulting beds show signs of wave action such as pinching and swelling, ripple marks and edgewise -stacked shells. These processes produce a mish-mash of rock and bedding types. The result was the removal of much of the mud from the bottom. Overall the Fairview consists of about 50% shale and 50% limestone, deposited in water above storm wave base, but below fair weather wave base.

The animals that lived in these active circumstances needed to be more durable in order to survive. Accordingly, many of the organisms that lived in the Fairview environment were larger and stronger than their counterparts in the Kope. Brachiopods became larger and more robust for additional strength. Bryozoans became much thicker and grew in plates instead of delicate branches.

The "Miamitown Shale"

The Miamitown Shale overlays the Fairview Formation throughout much of the Cincinnati area. It has not been given formation status mostly because it has not been extensively studied throughout the region. The Miamitown was deposited as a result of another episode of transgression, but the sea level did not rise as much as during Kope times. The muds in the Miamitown are siltier than those of the Kope.

The most distinctive thing about the Miamitown is its abundant molluscan fauna, consisting of large numbers of bivalves and a variety of gastropod species. In addition, trilobites and crinoids often occur in the shales and mudstones. Of course, as in all Cincinnatian rocks, brachiopods and bryozoans are quite common in the Miamitown. The Miamitown also is notable for its excellent fossil preservation.

The Bellevue Formation

The Bellevue Formation marks another episode of regression in the Cincinnatian seas. Sea level dropped even further than in the time of the Fairview. The Bellevue was deposited in very shallow water at or near fair weather wave base. Strong wave action in the shallow water winnowed out most of the muds, so very little shale is present in the Bellevue thus it has only 20% shale / 80% limestone.

Animals inhabiting the shallow, turbulent waters of the Bellevue seas had to be very robust and durable. Brachiopods become quite thick shelled and large. Some species develop heavy "plications" or ribs (like Ruffles potato chips) to increase their strength. Bryozoans also become thicker and more massive.