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Geology in and around Charleston, IL: Rocky Branch Conservation area & Charleston Quarry Field Trip

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ABSTRACT

A field trip guide for Rocky Branch Conservation area and Charleston Quarry, in and around Charleston, Illinois. This field trip occurred during the 44th Biennial Convention at Charleston, IL on September 23rd, 2017.

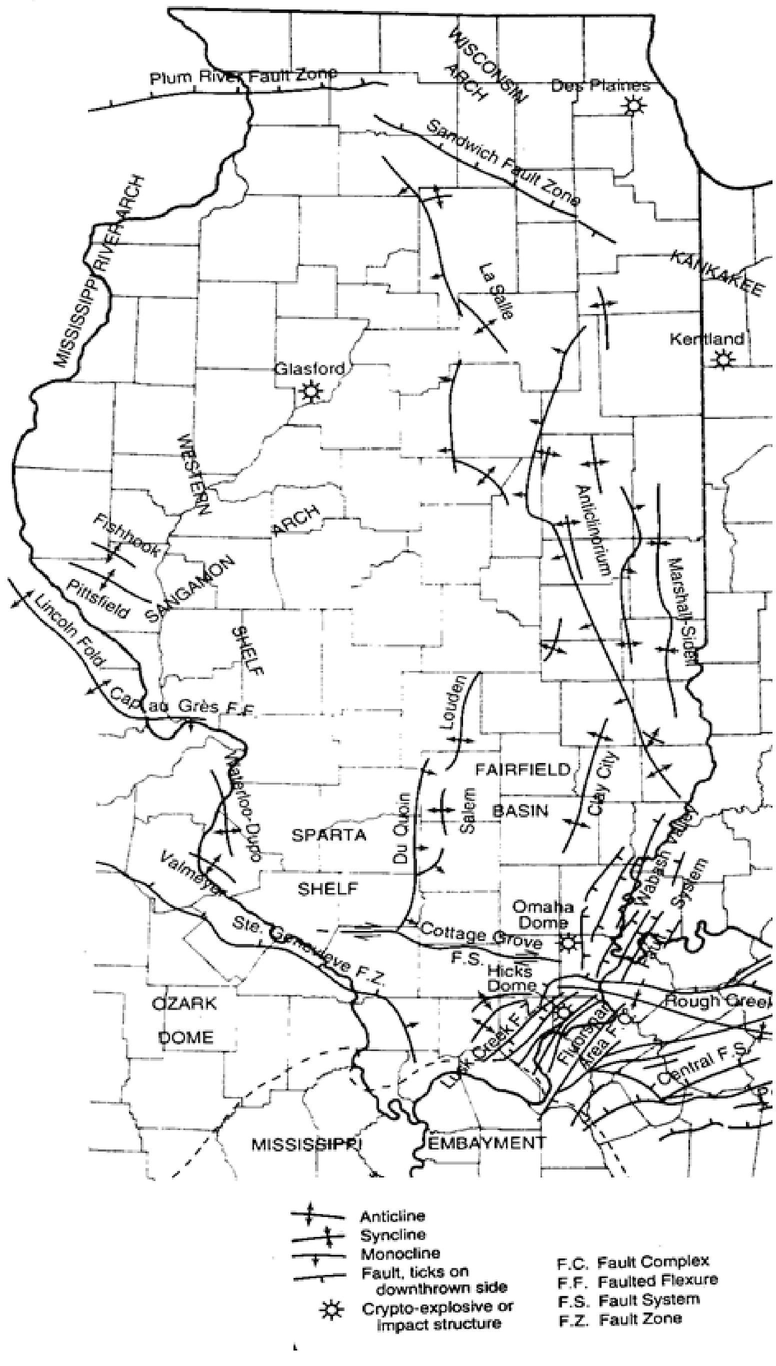
KEY WORDS: Field Trip Guide, Charleston IL, Biennial Convention

HISTORY OF THE REGION

Early Paleozoic rifting in what was then Laurentia created a broad embayment that became the depocenter for sediment accumulation from the Late Cambrian through the Middle Ordovician (Burke and Dewey, 1973; Ervin and McGinnis, 1975). This basin, later named the Illinois Basin, overlies the rift complex that includes the intersection of the Reelfoot Rift and the Rough Creek Graben.

The boundaries of the basin are the NE Missouri and Mississippi River arches to the west/northwest, the Pascola arch to the south/southwest, the Kankakee arch to the northeast, the Cincinnati arch to the southeast and the Ozark uplift to the southwest. The basin is elongate with a north-south trending axis that lies to the west of the LaSalle anticline. Over 7,000 m of sediment is preserved at the deepest point in the basin in western Kentucky near the Rough Creek graben.

Tectonic deformation from the Taconic, Acadian and Ouachita orogenies helped shaped the features and allowed for ore formation characteristic of this and adjacent basins. Deformation began in the Pennsylvanian through the Mississippian with the uplift of the LaSalle anticline, followed by extensive folding and faulting as well as igneous intrusion in the south of the basin (Nelson, 1991).



Plum River Fault Zone
WISCONSIN ARCH
Des Plaines
Sandwich Fault Zone
MISSISSIPPI RIVER ARCH
La Salle
KANKAKEE
Kentland
Glasford
WESTERN ARCH
Anticlinorium
Fishhook
Pittsfield
SANGAMON
Lincoln Fold
SHELF
Marshall-Sidell
Cap au Grès F.F.
Louden
FAIRFIELD
Clay City
Waterloo-Dupo
Salem
BASIN
Du Quoin
SPARTA
SHELF
Valmeyer
Wabash Valley
Omaha Dome
Fault System
Ste. Genevieve F.Z.
Cottage Grove F.S.
Hicks Dome
Rough Creek
OZARK DOME
Lusk Creek F.Z.
Fluorspar Area F.C.
Central F.S.
MISSISSIPPI EMBAYMENT
Anticline
Syncline
Monocline
Fault, ticks on downthrown side
Crypto-explosive or impact structure
F.C. Fault Complex
F.F. Faulted Flexure
F.S. Fault System
F.Z. Fault Zone

This later (Permian) tectonism triggered Mississippi Valley Type (MVT) mineralization in both the north and south of the basin (Plumlee, et al., 1995; Brannon, et al., 1993). Late Paleozoic uplift of the Pascola arch completed the deformation in the basin that is observable today; see Figures 1 and 2 (Kolata and Nelson, 1991).

The most prominent formation in the basin is the Ordovician St. Peter Sandstone, which spans the basin and ranges from 10 to 200 m in thickness (Willman, et al., 1975).

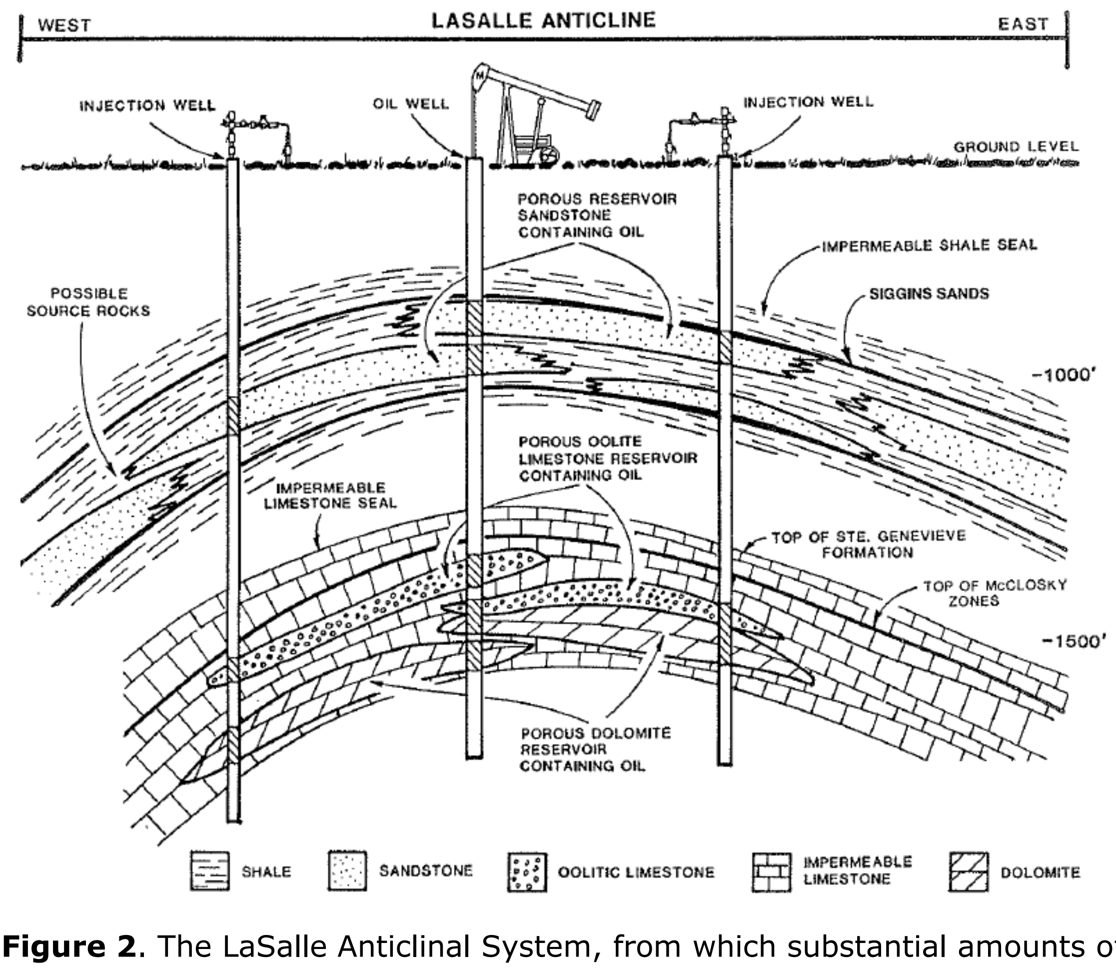


Figure 2. The LaSalle Anticlinal System, from which substantial amounts of petroleum were extracted in the mid-1900’s (from Frankie, et al., 1994).

The formation ranges from red and green shales to sandstone with local chert conglomerates, but the majority of it is composed of fine-grained, well-sorted, porous and permeable sandstone (Templeton and Wilman, 1963).

FIELD TRIP LOG

Beginning from the campus of Eastern Illinois University, travel approximately 1.6 km east on Lincoln Ave/SH 16 to the intersection with 18th Street/SH 130. Make right at intersection and travel approximately 3.9 km to the entrance to Lake Charleston. Make a left and park in first parking lot.

Stop 1 – Lake Charleston

From the vehicle(s), walk ENE along the water front/Dam A for approximately 0.5 km to a spot from which the spillway and Dam B can be seen.

Created in 1947 by damming the Embarras River, this lake serves as the sole water source for the City of Charleston, IL. The dam is constructed of two earth embankments, a 128 meter long overflow spillway and a side channel reservoir installed in 1982 to increase available water supply (Demissie, et al., 1986). In 1985, there was imminent danger of the dam failing due to breaches in the spillway because of excessive erosion brought about by high flood conditions. Initially, slopewall panels on the downstream part of the spillway were displaced and eventually moved downstream by the floodwaters (Demissie, et al., 1986). This subjected the underlying fill material to erosion and caused the failure of that part of the spillway that controlled the water level in the original lake area. This failure created large scale scouring (a "sinkhole") that proceeded to migrate upstream. This process carved out a channel substantially deeper than the original lake bottom and drained the portion of the old lake outside of the side channel reservoir, exposing the pump used to move water to the side channel. Within a week, scouring had progressed quickly and the side channel dike was in eminent danger of being breached. Engineers began construction of several finger dikes as well as a stone ledge barrier to keep the fastest moving currents away from the dike. Construction of the rock wall was completed 3 weeks after the scouring first developed and prevented further upstream movement. The dam was saved from failure; see Figure 3.

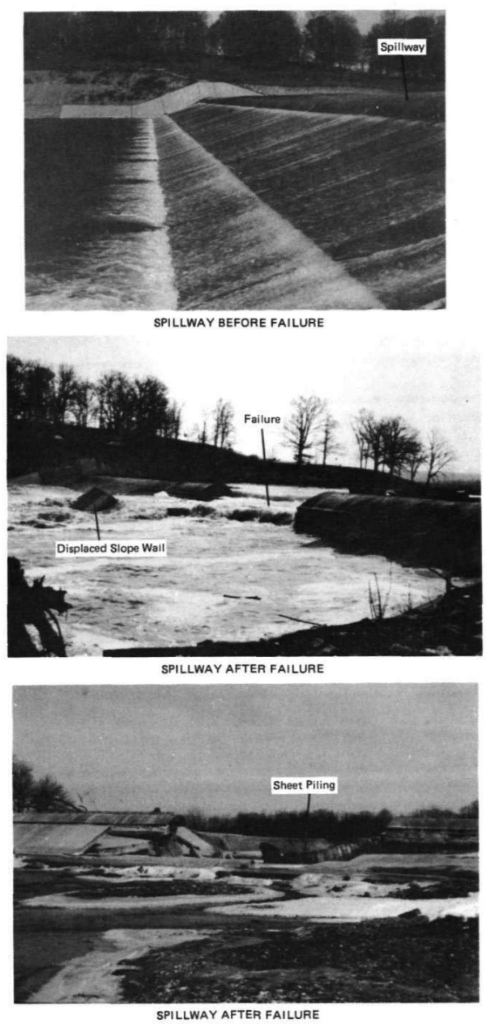


Figure 3. Archived photos showing the spillway before and after failure (from Demissie, et al., 1986).

Walk back to the parking lot but continue on past it towards a gazebo to the NNW of the red barn. From the gazebo, walk approximately 61 m to the west.

This section of the path that continues around the lake created a continuous loop trail that was completed in 2016. The land to the south of this trail is privately owned. When the slope was cut to establish the trail, the effect on the erosion of the slope was not calculated correctly and slope erosion has increased significantly. As is seen in Figures 4 and 5, the blue structure at the top of the slope is at risk of being undercut to the point of failure if remediation is not enacted.

Stop 2 – West Field/Oil Field

Exit Lake Charleston and turn left (to the SE) on Hwy 130 for approximately 2.25 km. Take a left at the historic Five Mile House onto Westfield Road. Stay on Westfield Road for approximately 12.9 km, entering the town of Westfield. Make a right onto Hwy 49 for approximately 1.3 km to the intersection of County Road 2000. Turn right and then make an immediate left into a pullout (old highway rest stop) approximately 61 m from the intersection. Exit the vehicle(s) to observe the surrounding fields without walking into the crop areas.

Figure 4. Slope erosion undercutting privately owned garage at Lake Charleston.

The Wisconsin Glaciation period, the most recent one of the Ice Age, created a landscape characterized by a series of subparallel end moraines separated by low relief till and lake plains. Formed by a series of offlapping drift sheets of mostly diamicton that pinch out towards the NNE (Hansel, et al., 1999), the configuration of these moraines reflects the glacial outflow of the Lake Michigan basin as well as the influence of bedrock topographic highs (Johnson and Hansen, 1999). Most of the moraines are true end moraines, being composed predominantly of till and formed at an ice margin during the deposition of the last glacial pulse (Mickelson, et al., 1983). The end moraines in central Illinois are either simple or superposed with little to no evidence of characteristic glacial features like hummocky topography, outwash plains, kettles, drumlins or eskers (Hansel, et al., 1999). Directly to the north of the stop, there is a line of trees that stretches for miles to the east and west. These mark the boundary of the Wisconsin Glaciation event in this area. Soils to the north of the tree line are ~10,000 years old; soils to the south are ~100,000 years old.

The LaSalle Anticlinal Belt is the most prominent structural feature in the Illinois Basin. It is a complex structure of folds, asymmetrical anticlines, and monoclines extending from Ogle County SSE to the Wabash River in Lawrence County, a distance of approximately 418 km (Frankie, et al., 1994). The system is host to one of the major oil accumulations in this country, the Southeastern Illinois Oil Field. Total production has exceeded 460,000,000 barrels of oil since the field was first heavily drilled in the early 1900s (Reinertsen, 1979). The principal yielding formations are Mississippian and Pennsylvanian in age, although small amounts of oil have been obtained from Devonian and Ordovician limestones (Bell and vandenBerg, 1963). Although the majority of petroleum has already been extracted, "mom and pop" operations continue to exploit the reserves with over 10,000 wells still producing. All of these operations have employed secondary recovery methods such as re-pressuring, hydraulic flooding and fracking. Looking to the south of the tree line, both to the east and west, numerous pump jacks can be seen in operation. Many of these have just been installed in the last several years, a result of increasing petroleum prices as well as newer, more effective methods of extraction. On most days, the smell of sulfur is strongly detected, a byproduct of the extraction process releasing gases associated with the oil.

Figure 5. Cut out toe of slope increasing erosion on trail at the lake.

Leave the Westfield/Oilfield stop and make a left from the pullout heading north on SH 49. Drive approximately 23.0 kilometers to the intersection with SH 16 and make a left, heading west. Drive approximately 20.7 kilometers to CR 2000E, which is the driveway bordering the Charleston Speedway on the west side of the property. Make a right onto CR 2000E and drive approximately 1.4 kilometers to the T intersection with CR 1000N. Make a left and follow the road approximately 1.4 kilometers to just before the metal bridge. Stop here; there is a small pull off to the left for parking. Exit the vehicle(s) and walk past the "No Trespassing" sign (prior permission from the Charleston Stone Quarry needed to access property) north until it intersects with a large haul road. Turn right and walk to where the road is adjacent to the quarry lake.

Look out over the lake towards the cliff opposite of the haul road. The exposed, tan colored material that is rilled and comprises most of the face of the hill is loess. This wind-blown, glacially derived material was deposited during the Wisconsin Episode. This material and other layers associated with the sediment succession of that time have been examined at various pits throughout the Charleston quarries over the past several decades. Evidence from other sites indicate that a forest soil (the A horizon of the Farmdale Geosol) developed in the loess, with fossil spruce tree trunks found rooted in the material (Ford 1973; Gutowski, et al. 1991; Hansel and Johnson 1996; Gutowski, et al. 1998; Johnson and Hansel, 1999). Stumps average 12 cm in diameter and have trunk lengths of up to 2 m in height. Bark, thin limbs and even needles are found to be fairly well preserved. Carbon 14 dating done by Gutowski, et al. (1998) yielded ages of approximately 20,000 years B.P.

Incision by the Embarras River cuts through sediment and rock; where the uppermost part of the LaSalle Anticline encounters the impact of the Embarras River, bedrock is exposed. This is evident at the Charleston Stone Quarry, where that limestone bedrock is quarried. This limestone layer is part of the Bond Formation that formed during the Pennsylvanian Period approximately 290 MYA. The limestone layers of this formation are the purest ones from the Pennsylvanian in IL, so they are heavily quarried throughout the state (Wilman, et al., 1975) as well as here at the Charleston Stone

Quarry. These limestone layers developed during a time of eustatic sea level rise in a shallow inland sea, home to a variety of marine fauna. Fossils found at the quarry include crinoids, horn corals, bryozoans, brachiopods and – rarely – shark's teeth. Searching the waste rock piled on either side of the large haul road may yield several specimens that are permissible to take home.

Return to vehicle(s), exit quarry via the roads to SH 16, make a right and return to EIU's campus approximately 10 km to the west.

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