

Rockford Fossil and Prairie Park

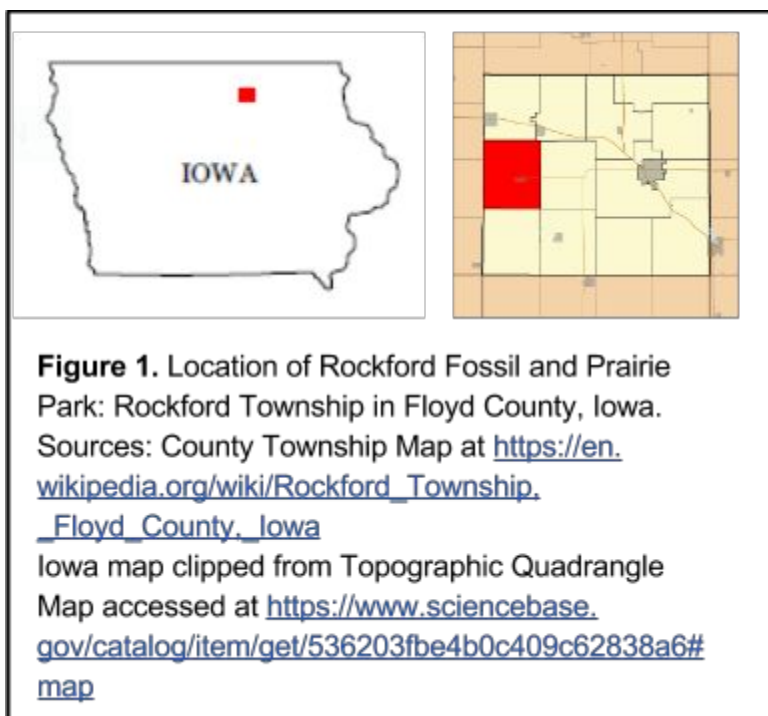
Final Project - Iowa's Geologic Resources

Summer 2015

Laura Walter

A: Site Identification

Rockford Fossil and Prairie Park (RFPP) is a county park located in Rockford Township, Floyd County (Figure 1), in northeastern Iowa. It includes retired clay pits surrounded by restored tallgrass prairie and wetlands, and is bordered to the north by lowland forest along the banks of the Winnebago River. At the time of settlement, the name in use for this river was Lime Creek, and the bedrock units at RFPP are known as the Lime Creek Formation (Biggs, ed. 1987).



Site Identification Data (Sources are included as links)

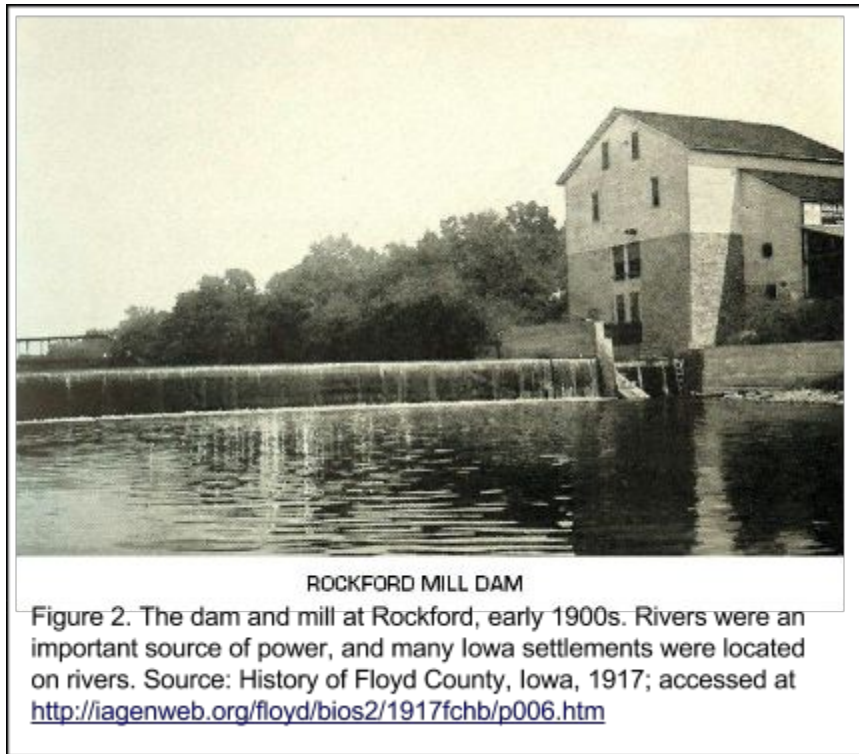
1. Primary 7.5' USGS topographic quadrangle: [Rockford Quadrangle, Iowa](#)
 - a. created 1972
 - b. photo revised 2013
2. Public Land Survey System ([USGS Mineral Resources](#))
 - a. 5th Principal Meridian
 - b. Township: 095 N
 - c. Range: 018 W
 - d. Section: 16
3. Latitude and Longitude: -92.976, 43.0481 (WGS84) ([USGS Mineral Resources](#))

B: Historical Record

Settlement History

Floyd County, Iowa was settled during the early 1850s and named by an act of the Territorial Legislature in 1851. Early settlers were drawn to the area because of its highly productive organic-rich soils and abundant water. The 1882 *History of Floyd County, Iowa* states that the grain elevator in the town of Rockford in Floyd County stored and sold crops of mostly corn, but also oats, flax, and wheat. Hogs and cattle were the main livestock.

The town of Rockford was built at the confluence of the Winnebago and Shell Rock Rivers. The rivers supplied not only water but, when dammed, provided power to drive flour mills and sawmills (Figure 2). Several of the earliest settlers came from Rockford, Illinois, and decided to name their new Iowa town Rockford, noting that the name fit because the new town was also sited at a place where the river was shallow and rocky and could be forded. Fording the rivers was still a significant hazard, and the *History of Floyd County* (1882) describes numerous deaths from drowning, especially near dams. One of the main tasks of the county government in the first few decades was to fund the construction of bridges to make river crossings safer and more convenient.



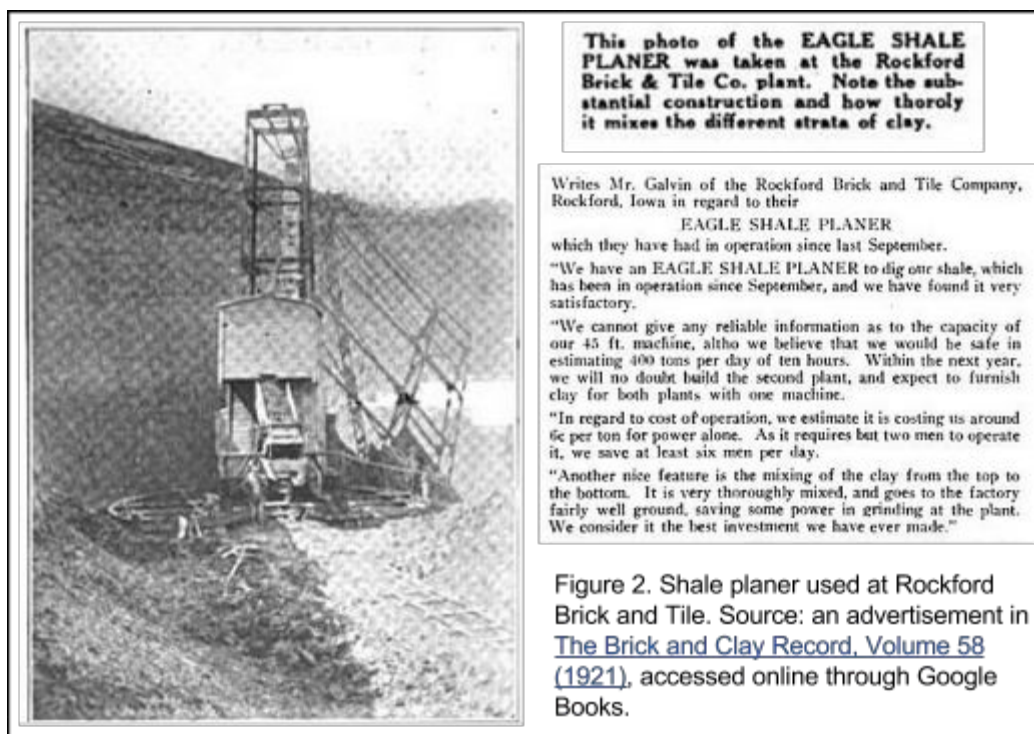
Before transportation networks, especially railroads, expanded into the area, houses, schools, churches, and businesses were constructed of local materials: timber, stone, or brick. There was no such thing as Home Depot! Knowledge of the local mineral resources was therefore of great importance. For example, the first county courthouse, in Charles City, was built of limestone. After it was destroyed in a fire in 1881, it was replaced with a brick building.

Clay Mining

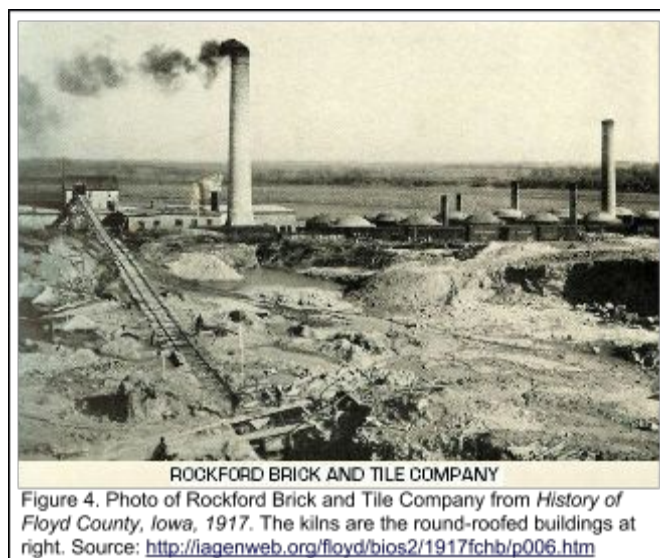
For Iowa settlers, clay was an important natural resource for producing essential materials including pottery, brick, sewer pipe, and drainage tile. A *History of Floyd County, Iowa*, 1882 lists a brickmaker, L.M. Harris, among the business owners of Rockford Township. Mr. Harris's brickworks supplied local builders but his business suffered and eventually shut down in 1899, because he could not convince the railroad to build a track to his yard (Anderson, W.I., in Bunker, et al., 1995). Early settlers found that Floyd County had accessible clay deposits, along with plentiful timber that provided the fuel for kiln-firing of bricks and tile. The importance of clay was even greater in local areas where there were no good stone quarries, and using brick for construction was seen as a way to reduce the pressure on timber resources for lumber (Anderson, W.I., in Bunker, et al., 1995). The clay resources of Rock Grove Township, just north of Rockford Township, were described thus:

“It has a deep rich soil under laid with a sub-soil of clay, and from this clay a superior quality of brick has been made for years--specimens of which can be seen pointing their red fingers through the roofs of numerous dwellings for a region of twenty miles around..” (History of Floyd County, Iowa, 1882)

Clay was found as surface deposits along streams and rivers (“drift” clay) or could be mined and processed from bedrock shales. RFPP is at the site of a retired clay quarry where bedrock shale was mined for eight decades, beginning in 1910 (Groves, 2008). The shale had to be crushed, ground, mixed, and screened to produce a uniform consistency. By 1921, Rockford Brick and Tile Company had an Eagle Shale Planer that was, at least theoretically, capable of digging, grinding, and mixing up to 400 tons of shale in a 10-hour day (Figure 3).



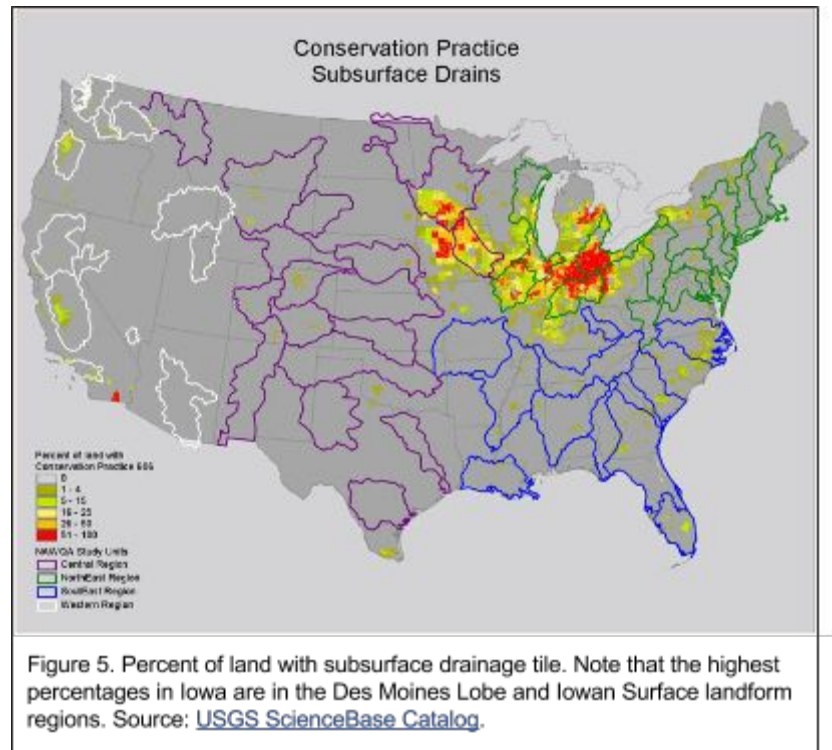
Dry powdered clay was mixed with water and pressed into molds. The dried but still “green” forms were fired kilns to drive off remaining water and cause physical and chemical changes that made for stronger and more durable products. The earliest kilns used wood for fuel. Edson Gaylord, a brick maker in Rock Grove Township, was known to have used the timber from 40 acres of land to fire around



in

200,000 bricks during a period of twenty years starting in 1860 (History of Floyd County, Iowa, 1882). At its peak, the Rockford Brick and Tile Company operated 16 “beehive” kilns (Figure 4). In more recent times, oil and natural gas were used to fuel the kilns (Garvin, 1998).

By 1920, Iowa was the nation’s leading producer of drain tile (Garvin, 1998), and after World War II, the production of agricultural drain tile became the main focus for Rockford Brick and Tile Company (Anderson, W.I., in Bunker, et al., 1995). Sections of clay pipe were laid in trenches dug in poorly drained fields. The drain tiles provided a “path of least resistance” for excess water to drain from fields to ditches and then into streams and rivers. Crop yields improved, and drainage brought otherwise marginal cropland into production. The use of subsurface drainage is related to the landform region. It was most necessary in the Des Moines Lobe, which lacks an integrated drainage network, and the Iowan Surface, where the water table is high and fens also occur (Figure 5). Plastics have since replaced clay for use as drain tile, and asphalt and concrete have replaced bricks for paving. The Rockford Brick and Tile quarry was purchased by the Floyd County Conservation Board in 1990 and opened as a county park in 1991 (Groves, et al., 2008).



Rockford in the History of Geology

During the first state geological survey, geologists Edward Hungerford and J.D. Whitney investigated the Lime Creek Formation west of Rockford and collected species of brachiopods new to science. Iowa’s first State Geologist, James Hall, illustrated and published the names and description of these species, including *Theodossia hungerfordi* and *Spirifer whitneyi* in 1858 (Figure 6; Biggs, 1987; Anderson 1998). Since that time, Rockford has become well known internationally as a source of invertebrate fossils.

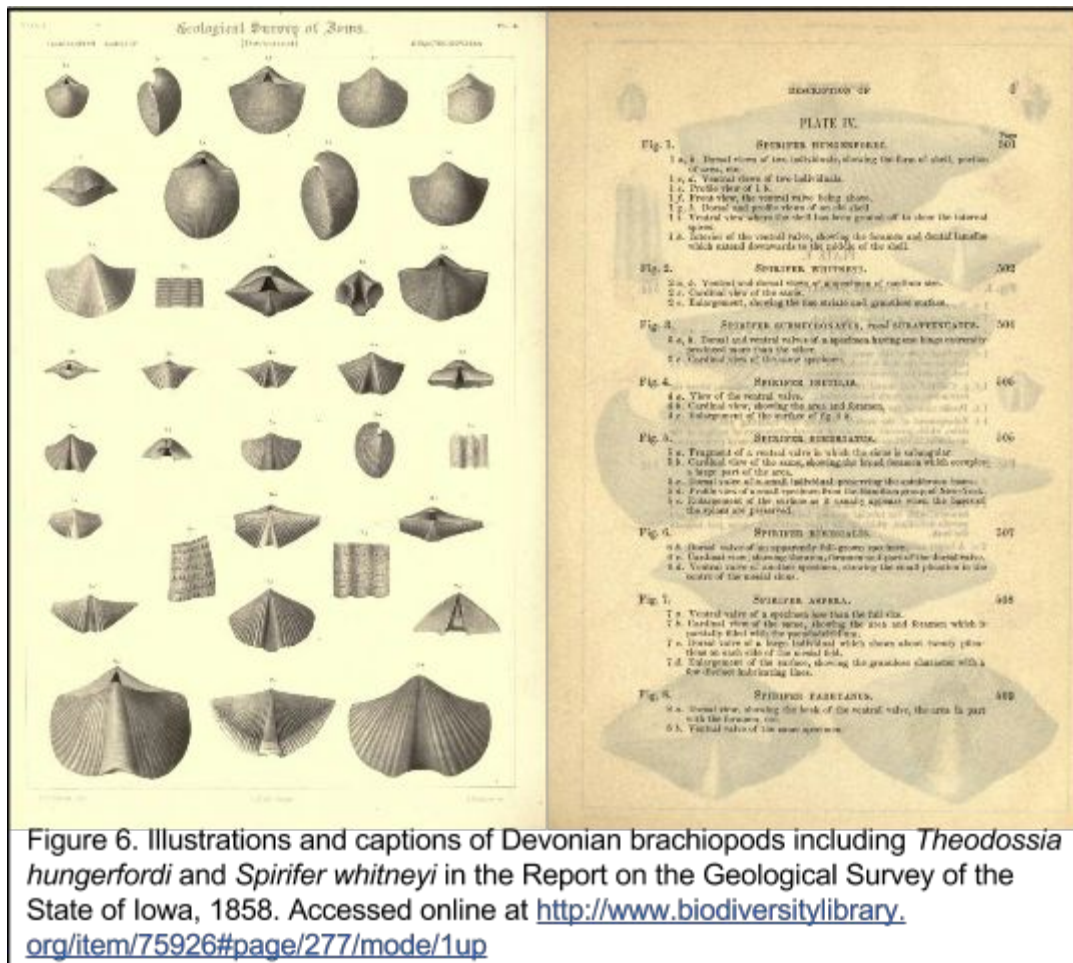
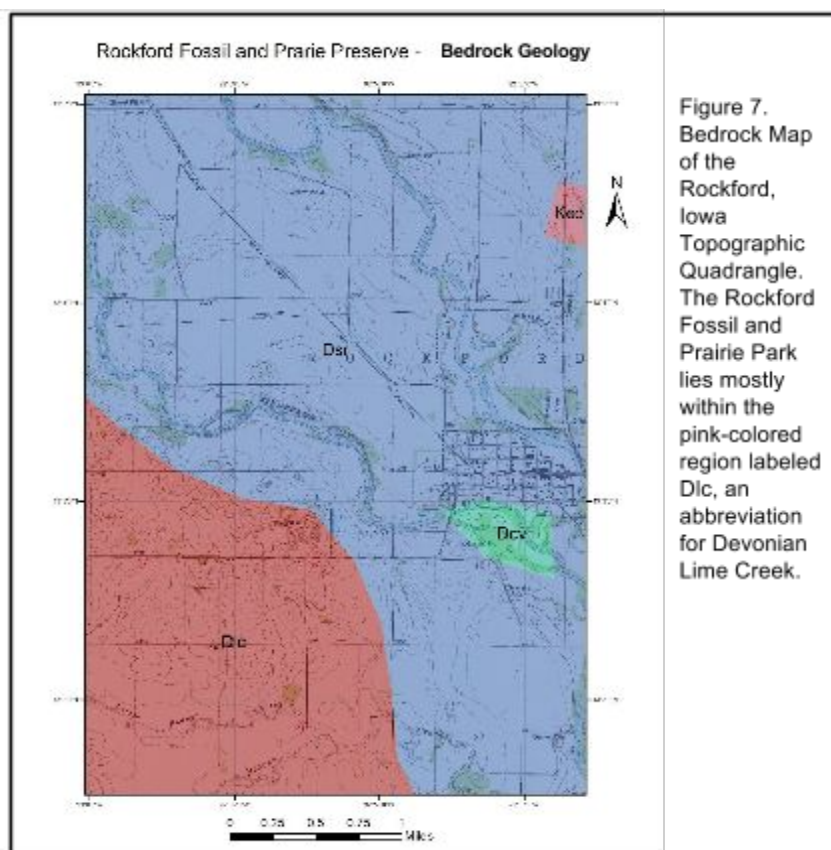


Figure 6. Illustrations and captions of Devonian brachiopods including *Theodossia hungerfordi* and *Spirifer whitneyi* in the Report on the Geological Survey of the State of Iowa, 1858. Accessed online at <http://www.biodiversitylibrary.org/item/75926#page/277/mode/1up>

The first chapter of the 1958 classic *The Fossil Book* begins with a description of the Rockford fossils. In vivid and imaginative detail, the geologist/authors, Carroll and Mildred Fenton, describe the seafloor environment and its diverse inhabitants as they were when the sediments that formed the bedrock were fresh. The Fentons were native Iowans who met while studying geology in college. Carroll Fenton spent much of his childhood in Floyd County, and the Rockford fossils stimulated his early interest in paleontology and provided material for his later research. In 1920, while he was a twenty-year-old undergraduate student, Carroll Fenton authored a faunal list of the "Hackberry Stage," now referred to as the Owen and Cerro Gordo Members of the Lime Creek Formation (Biggs, 1987). He reported 143 taxa from the Cerro Gordo Member, the most fossiliferous unit at Rockford Fossil and Prairie Park. In 1924, the Fentons illustrated and published the "Stratigraphy and Fauna of the Hackberry Stage of the Upper Devonian." Besides working as professional geologists, the couple authored and illustrated books for a wider audience, helping to popularize geology and its ability to "reconstruct the story of life" (Carroll Lane Fenton And Mildred Adams Fenton Manuscripts - Special Collections - The University of Iowa Libraries).

C: Bedrock Geology

Clay was produced at the Rockford Brick and Tile Company through open pit mining because the bedrock units that produced the clay are located near the surface. The total depth of the pit is about 20 meters, and it exposes two members of the middle Lime Creek Formation of the upper Devonian. In other sites in north-central Iowa, layers of limestone and dolostone mark the upper part of the Lime Creek Formation, known as the Owen Member. These younger layers are absent at the RFPP due to erosion (Groves, et al., 2008). The Lime Creek Formation, and especially its Cerro Gordo Member, is notable for the preservation and diversity of its fossil fauna; nearly 200 species have been collected and described from this formation (Anderson, 1998; Bunker, 1995; Groves, 2008). Northeast of the RFPP, the bedrock is the somewhat older (though still considered Upper Devonian) Shell Rock Formation (labeled Dsr on the map in Figure 7), which is comprised mostly of carbonate rocks. There is also a localized exposure of the Middle Devonian Coralville Formation (Dcv) in the valley of the Winnebago River just south of the town of Rockford.



The Cerro Gordo Member from the middle of the Lime Creek is the uppermost layer exposed at the quarry (Figure 8, Figure 10, Wicander and Playford, 1985). It is made up of three intervals of shale with different colors, quantities of limestone beds, and fossil content with a total depth of 12.8 m. The lower 9.7 m of the Cerro Gordo are made up of shales with

interbedded argillaceous (clay-containing) limestone units. Invertebrate macrofossils are generally abundant at Rockford, but the top 3.1 m layer of the Cerro Gordo member is a pale

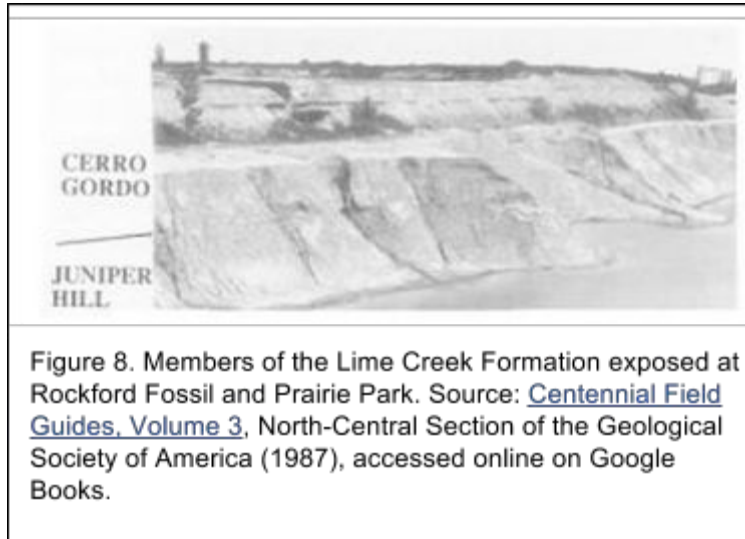


Figure 8. Members of the Lime Creek Formation exposed at Rockford Fossil and Prairie Park. Source: [Centennial Field Guides, Volume 3](#), North-Central Section of the Geological Society of America (1987), accessed online on Google Books.

yellowish calcareous shale or “marl” that is “extremely fossiliferous,” containing numerous, well-preserved fossils of shelly invertebrates such as brachiopods (Figure 9), gastropods, and bivalves (Wicander and Playford, 1985). Colonial and solitary corals, bryozoans, and fragments of crinoids also occur. Less commonly found are nautiloid and ammonoid cephalopods (Anderson, 1998). Many of these macrofossils show evidence of epibionts, animals such as worms, bryozoans, and sponges

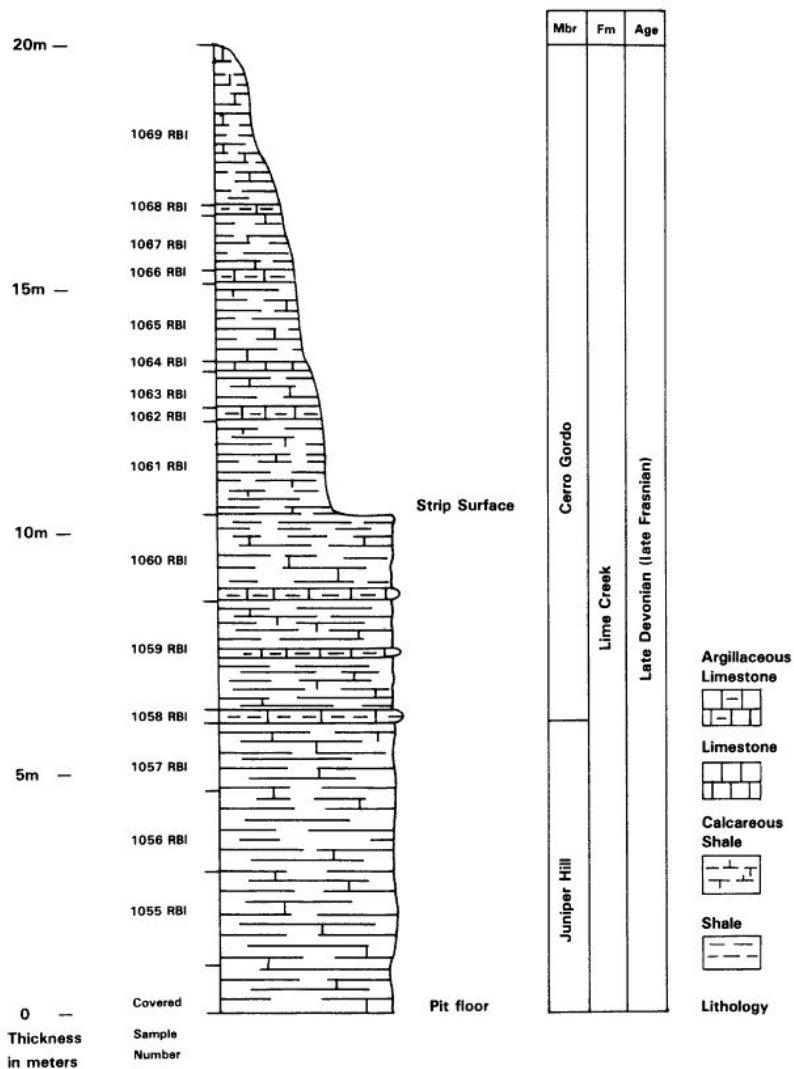
that anchored themselves to and grew on brachiopods, corals, and gastropods (Biggs, ed. 1987).

Lying conformably beneath the Cerro Gordo is the Juniper Hill Member. This is a layer of medium-gray calcareous shale and mudstone with a depth of 5.5 m, containing a less abundant and diverse fossil fauna than the Cerro Gordo Member (Groves, et al. 2008). Primarily brachiopods and pyritized plant remains can be found in the Juniper Hill shales at RFPP (Groves, et al. 2008). I have personally found a few unusual specimens that were tentatively identified several years ago by IGS staff as Devonian shark or ray teeth.

Evidence from invertebrate macrofossils (cephalopods) and microfossils (conodonts) has been used to place the Lime Creek Formation within the upper Frasnian Age of the Late Devonian Epoch, 381-373 Mya (Wicander and Playford, 1985). The shale of the Juniper Hill and Cerro Gordo Members at Rockford is soft and friable, making it easy for amateurs to collect fossils without tools. The fossils are well-known to amateur and professional collectors and paleontologists for their abundance, diversity, and excellent preservation.



Figure 9. Brachiopods collected from the Lime Creek Formation by a Waverly-Shell Rock High School student, September 2015. Source: L.Walter



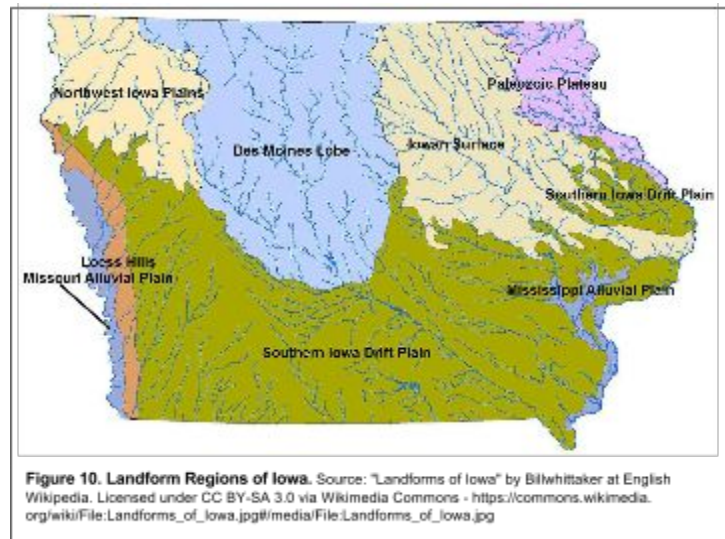
TEXT-FIGURE 3
Stratigraphic section of Upper Devonian Juniper Hill and Cerro Gordo members of Lime Creek Formation, showing lithofacies and palynologic sample locations.

Figure 9. Stratigraphic section showing Juniper Hill and Cerro Gordo Members of the Lime Creek Formation. (Source: Wicander and Playford, 1985)

D: Quaternary Geology and Topography

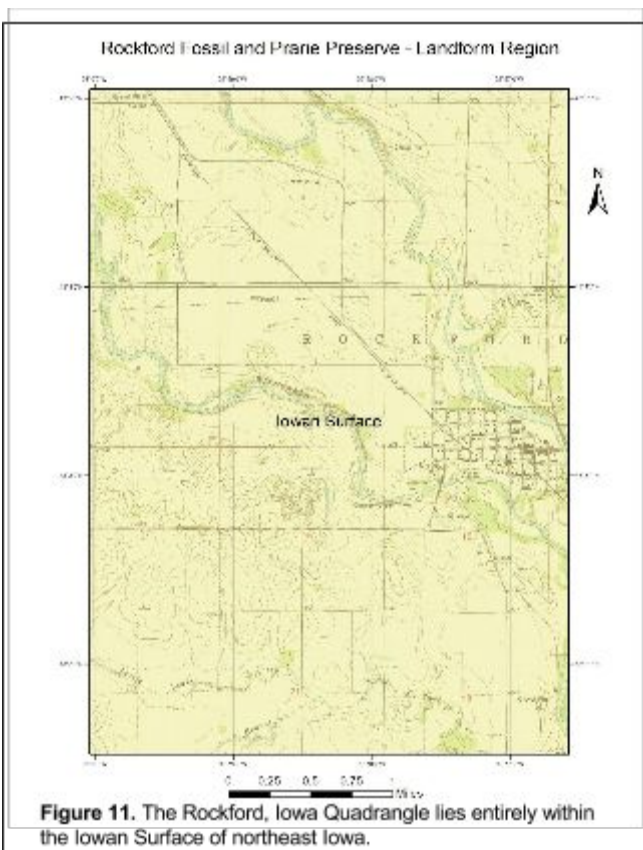
Landform Region - The Iowan Surface

Seven landform regions with differing history, topography, and surface characteristics have been characterized for the State of Iowa (Prior, 1991, Figure 10). Rockford Fossil and Prairie Park is located within the landform region known as the Iowan Surface (Figure 11).



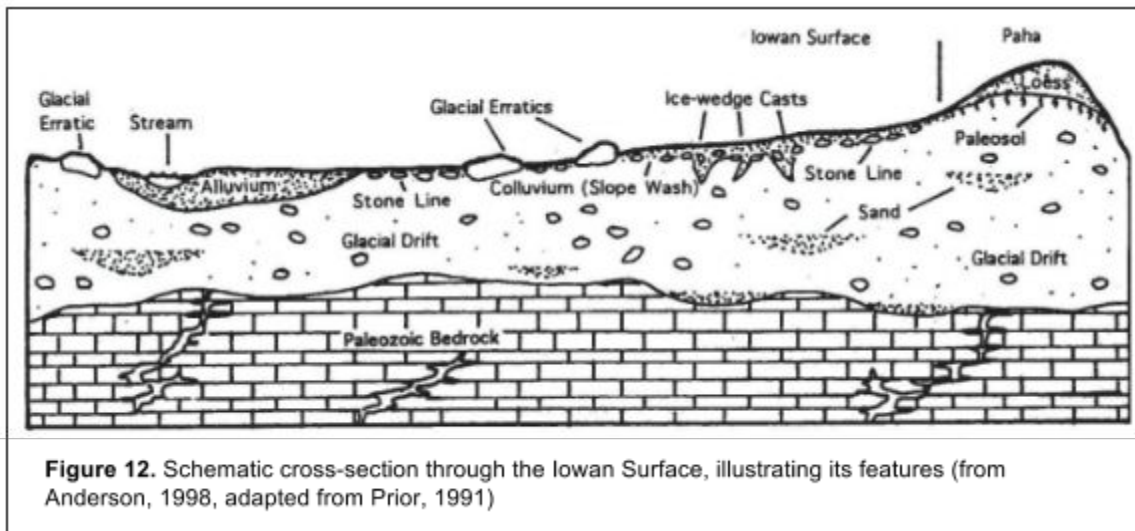
The Iowan Surface is a slightly inclined to gently rolling landscape with well-established drainage network that flows into three main rivers: the Cedar, Wapsipinicon, and Maquoketa Rivers. In this low relief landscape there are also some areas of poor drainage where wetlands, including some fens, occur (Prior, 1991). The Iowan Surface is also known for a peculiar kind of hill known as "paha" (Figure 12). Pahas developed from wind-blown (eolian) loess that collected along vegetated ridges during dry, cold

climatic conditions, and these hills are oriented in a northwest to southeast direction, marking the prevailing wind direction during their formation (Prior, 1991).

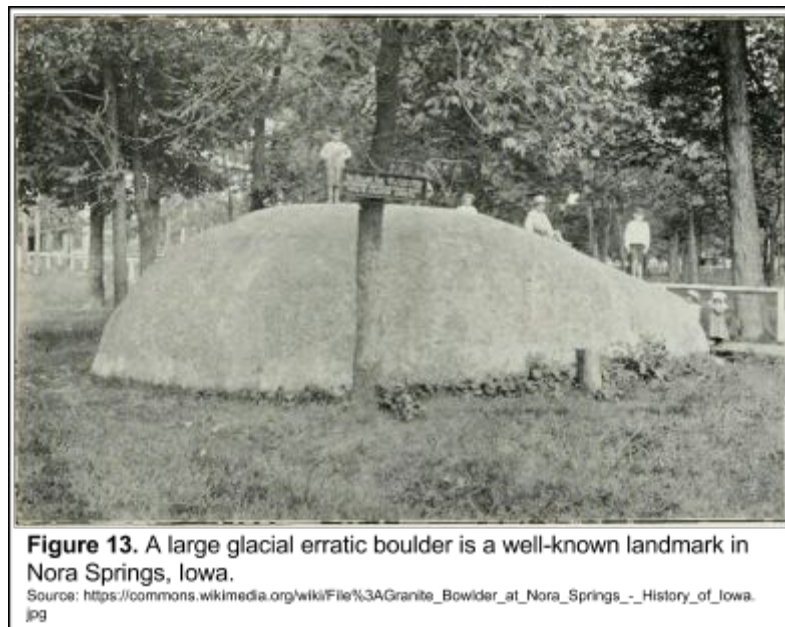


The bedrock foundations of this landform are Paleozoic (primarily Devonian and Silurian) strata (Figure 12). There are a few locations in the Iowan Surface where the bedrock is visible in outcrops, but mostly it is buried under glacial till, which is itself overlain by soil. In the northern part of the Iowan Surface, which includes Floyd County, the glacial till is quite thin, especially in uplands and on side slopes, and karstification of the shallow bedrock

has produced some sinkholes (Prior, 1991).



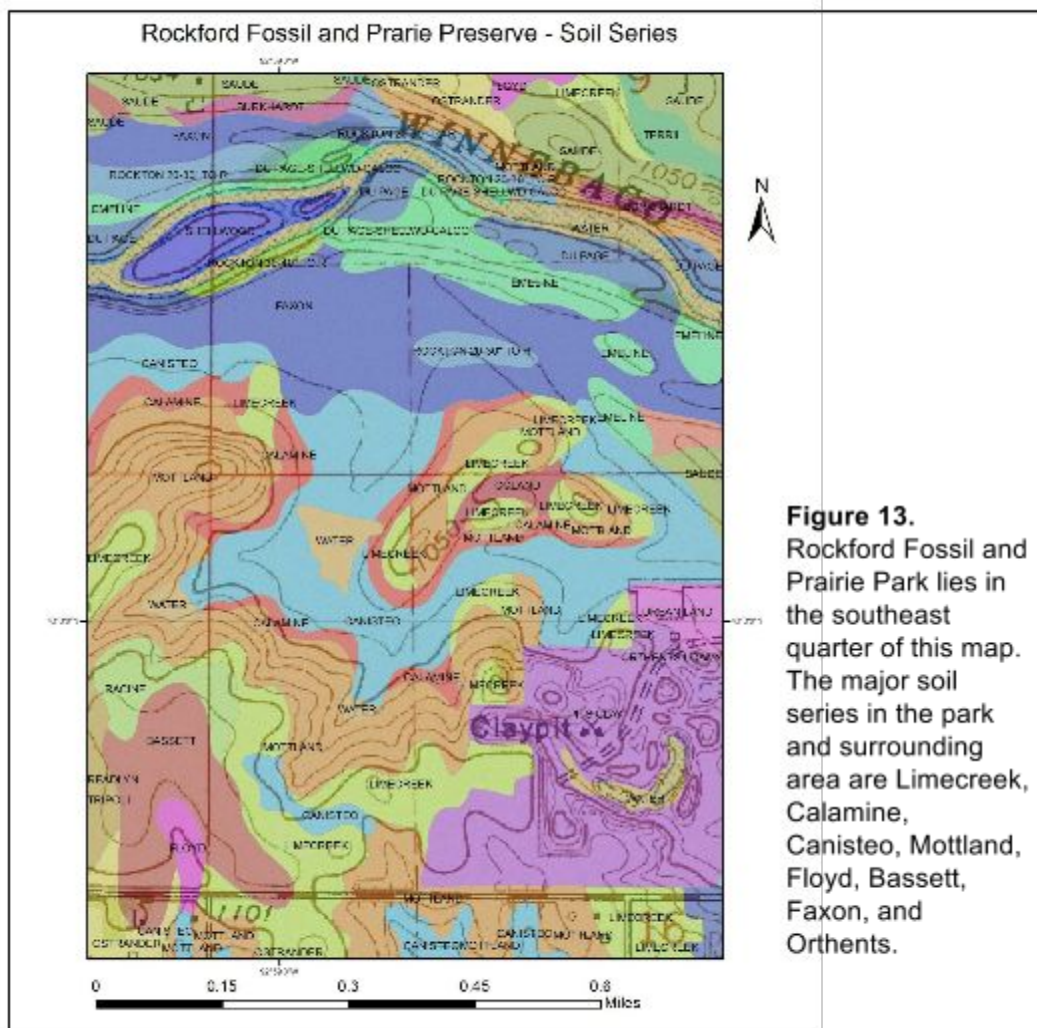
Igneous rocks within the Pre-Illinoian till resisted the erosional scrubbing and were left behind. They appear as a stone line within exposed drift, pop up in tilled fields, and occur as prominent large boulders in some valleys (Figure 12). In Floyd County's Rock Grove township, just north of Rockford, a huge glacial erratic boulder is a well-known landmark in the town of Nora Springs (Figure 13).



Soils

Productive soils were the major reason why Iowa was attractive to settlers, and they remain the literal basis of our economy. Soil characteristics that affect their usefulness include texture (proportion of different particle sizes), parent material, depth, drainage, and native vegetation.

There are several prominent soil series around the clay pits of the RFPP (Figure 13) that vary in their characteristics and uses (Figure 14).



Figure

14. Major soil series in the RFPP area and their characteristics. The name of each series is linked to its official description from the USDA, with the exception of Orthents.

Soil Series	Texture	Parent material	Depth	Slope and setting	Drainage Class	Use and Vegetation
Lime Creek	silty clay loam	carbonate rock: siltstone/shaley limestone	very deep, combined thickness of A and B horizons (solum) is 20-40 inches	0-9 percent (level to gently sloping, on/near ridge crests)	moderately well drained	cropland; native vegetation was prairie grasses

Calamine	silt loam	carbonate rock: siltstone/ shaley limestone	deep, solum thickness 25 to 50 inches	0-3 percent (level uplands, depressions, and seeps)	poorly drained to ponded	most remains in grassland; native vegetation is marsh grasses and sedges
Canisteo	clay loam	calcareous, loamy till	deep (solum thickness measure not given)	0-2 percent (level to convex slope, rims of depressions)	poorly to very poorly drained	artificially drained and cultivated; native vegetation is wet tallgrass prairie
Mottland	loam	weathered limestone	deep (A horizon 7-9 inches, no B horizon)	2-40 percent (ridge crests, convex sideslopes)	well drained	gently to moderately sloped areas used for row crops; steeper slopes in pasture; native vegetation was prairie
Floyd	loam	glacial till (containing 0-3% boulders)	very deep (depth to till is 30 - 60 inches)	0-5 percent (concave foot slopes)	somewhat poorly drained	cultivated; native vegetation was tallgrass prairie
Bassett	loam	glacial till	very deep (depth to till 15 - 30 inches)	2-35 percent (on sideslopes of ridges between streams)	moderately well drained	cultivated; native vegetation was tallgrass prairie and deciduous trees
Faxon	clay loam	glacial drift over limestone bedrock	moderately deep (20-40 inches depth to bedrock)	0-2 percent (often in shallow depression on a rock-cored terrace)	poorly to very poorly drained	mostly in pasture; some cultivated; native veg. was wet prairie

Orthents (links to Wikipedia page; not officially listed as a soil series on USDA site)		weathered shale and limestone (in this specific case)	extremely shallow; lacks soil horizon development	steep slopes, areas where soil was removed for clay mining	drainage (?); highly susceptible to erosion, which releases fossils for easy collection	some areas restored to prairie
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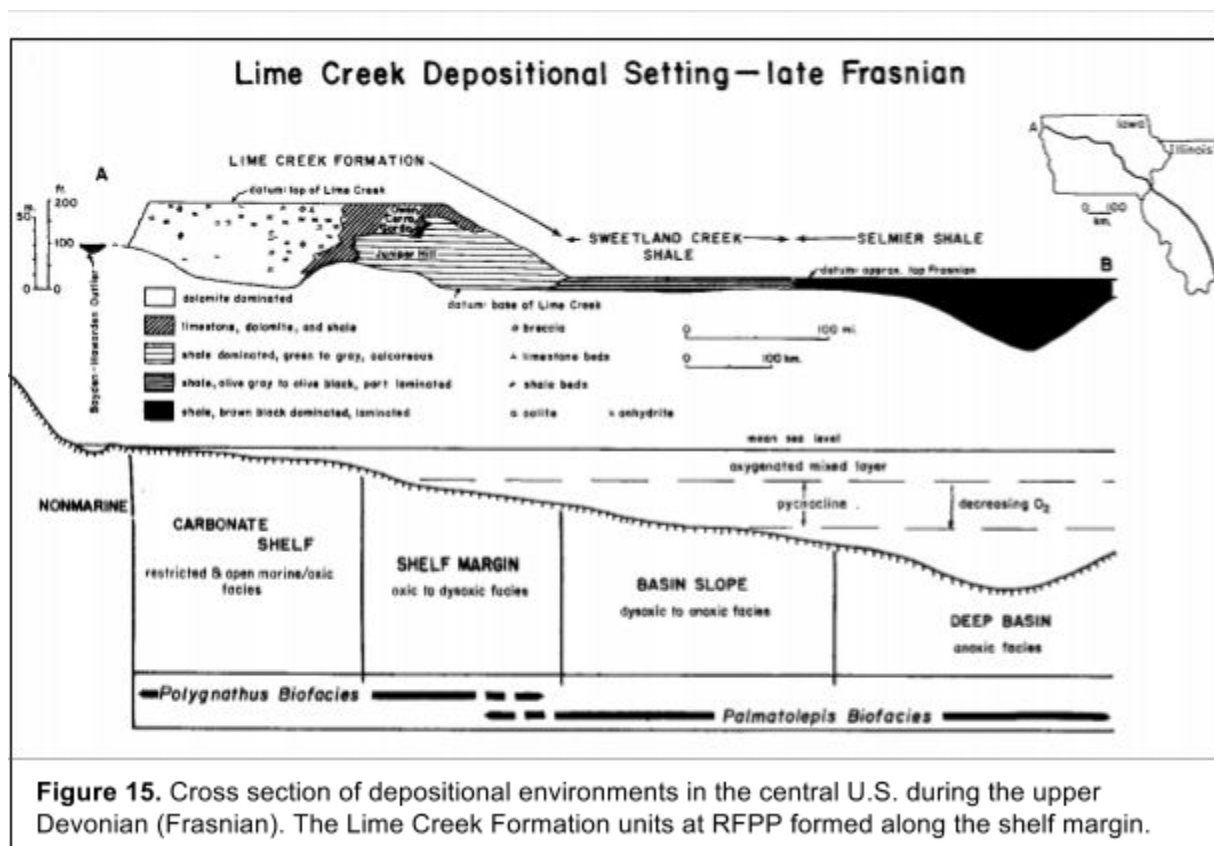
E: Geologic Evolution/Local Earth History

The ultimate source of the sediment that formed the rock units at RFPP was transport and deposition of mud that was produced by weathering and erosion of rocks on the land surface, including those of the Acadian Mountains (Anderson, 1998). These sediments were deposited during one of seven cycles of transgression and regression during the Devonian. During this time, approximately 375 Mya, there were shallow tropical seas across central North America which deepened in a gradient from the north-central Iowa to the southeast across Illinois. Along this gradient, the depositional environments were different, and the resulting rock formations provide evidence for the changes (Figure 15; Anderson, 1998; Bunker, ed., 1995). To the northwest of Rockford, the Lime Creek formation contains more limestone, indicative of a carbonate platform environment. The shales at RFPP formed from muddy seafloor sediments, showing that they were in deeper water, likely on the margin of the carbonate shelf. This was a low to moderate energy environment where fine sediment could build up in the absence of frequent wave action. It was also a zone where the water was adequately oxygenated to support an abundant fauna, which is certainly evident in the fossils at RFPP. In even deeper water, such as that found to the southeast in the Illinois Basin at that time, fewer fossils are found, and the build-up of organic matter in this poorly oxygenated environment resulted in the formation of darker-colored shales (Bunker, ed., 1995).

The particular makeup of the fossil fauna of RFPP also provides clues to the depositional environment. The conodont fauna of the Lime Creek Formation at RFPP supports the conclusion that this was a relatively shallow shelf-margin environment (Anderson, 1998). Wicander and Playford (1985) examined the acritarch and spore microfossils of the RFPP shales and concluded that the assemblage was indicative of a “normal nearshore, open marine environment.” A couple of different pieces of faunal evidence point to a muddy seafloor: 1) the absence of stromatoporoids (Bunker, ed., 1995) and 2) the abundance of epibionts, animals which use other fauna as substrates as (Biggs, ed., 1987; Bunker, ed., 1995). There were probably few hard surfaces that a small suspension feeder could attach to. Therefore, many brachiopods, gastropods, and even horn corals found at RFPP have encrustations of epibiotic organisms (Bunker, ed., 1995).

Following their deposition, the sediments that formed the Lime Creek Formation must have been buried, compressed, and cemented to become the layers of sedimentary rock we

observe today. Following the last T-R cycle of the Devonian, seas again advanced and retreated from the North American craton ten times during the Mississippian Period (Anderson, 1998), producing extensive limestone deposits along with some shales and sandstones. At the site of the RFPP, these later formations were removed by warping, uplift, weathering, and erosion.



Quaternary geologic evolution

The Paleozoic seas had long since retreated, and the bedrock had been subjected to many millions of years of weathering and erosion before Pleistocene glaciations added the next layer of sediment and shaped it into the outlines of today's landscape. As the ice sheets advanced, they ground down the rocks in their path and carried the resulting mixture of boulder-to-clay-sized particles with them. When the glaciers melted, this material was deposited without sorting to form thick layers (up to 600 feet thick in the southwestern part of the state) of glacial till (Prior, 1991).

Glacial till on the Iowan Surface was deposited during the Pre-Illinoian glaciation, at least 500,000 years ago. Since then, the Iowan surface has not itself been ice-covered. Weathering, erosion, deposition, and soil development that were influenced by the climate during more recent episodes of glaciation helped to shape this landform. During the coldest part of the last glaciation, about 16,500 to 21,000 years ago, which created the Des Moines Lobe, the Iowan Surface was subjected to cold-climate processes of intense weathering and erosion. The

combination of freeze-thaw action and mass wasting acted to level the contours of the landscape, a process referred to as “erosional scrubbing” (Prior, 1991). It thinned the cover of glacial till, especially on uplands and slopes, in the northwestern part of lowan Surface, including the site of the RFPP. Episodes of cold, dry weather promoted wind erosion. Smaller particles (loess) that could be carried on the wind accumulated in elevated areas where the vegetation had protected the underlying till and paleosols from erosional scrubbing. The resulting accumulations of loess are oriented in a northwest to southeast direction, following the prevailing winds, and form the distinctive hills called “paha.” One analogy for this process is the way a snowfence allows drifts to form in alignment with the wind direction.

Meltwater from retreating Wisconsin ice sheets cut through the leveled landscape and formed interconnected stream and river channels, which transported and re-deposited glacial sediment as alluvium. The sand and gravel found along Iowa river channels and extinct oxbows are evidence of this process and are a valuable natural resource (Figure 16). As a runner, I have a deeply experiential connection to this landscape. The hills I run were carved into the lowan Surface by flowing

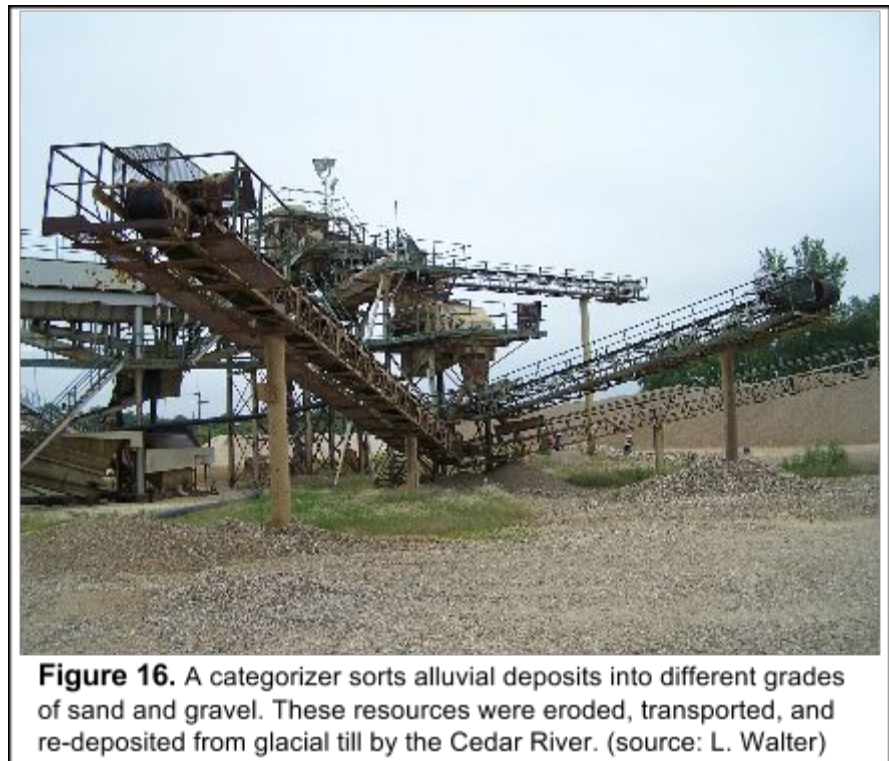


Figure 16. A categorizer sorts alluvial deposits into different grades of sand and gravel. These resources were eroded, transported, and re-deposited from glacial till by the Cedar River. (source: L. Walter)

water. When I want a steeper hills workout, I pick routes that run parallel to the river and cross the ravines of its tributary streams. When I want an easier run, I stay along the ridges that mark watershed boundaries and run mostly perpendicular to the river’s course or keep to the floodplain.

Soil Formation

Glacial till, like soil, contains a mixture of particle sizes, but it is not soil. Soil forms through weathering and leaching of the parent material, in this case glacial till, in place. The soils of this area are a good example to illustrate all of the factors in the formation of soil. The initials CLORPT are helpful in remembering these factors (Smithsonian, 2015):

CL stands for climate, especially temperature and precipitation. Several soil-forming processes are affected by climate. The weathering of rocks and minerals, erosion of

soil-forming sediment, leaching of mineral nutrients, and the accumulation of organic matter over time are all strongly dependent upon the combination of temperature and precipitation. For the past several thousand years (the Holocene), the climate in our region has been temperate and humid, with some longer-term warmer and drier periods. Seasonal differences in temperature promote freeze-thaw action (increasing weathering) and warm summers increase the rate of chemical weathering. The level of precipitation is high enough to promote chemical weathering, some leaching of minerals and clays, and the formation of soil horizons.

O stands for organisms. During the Holocene, the vegetation of our area changed from a tundra-like system, to coniferous forests, deciduous forests, and finally, tallgrass prairie with forested river valleys. The root systems of plants help to stabilize sediment, allowing it to resist erosion, giving it more time to develop into soil. The plants' roots also add organic matter to the developing soil, and help to support a diverse micro- and macro-fauna. The soil fauna aid in the decomposition of plant remains, producing humic acids that, in turn, increase the rate of chemical weathering. Certain soil microorganisms (cyanobacteria) and microbial symbionts of some plant species (notably legumes) are capable of fixing nitrogen from the air, increasing the concentration of this important soil nutrient and promoting the growth of vegetation.

R stands for relief. Sediments must remain in place in order for soil-forming processes to work. Erosion and mass wasting move sediments downslope under the influence of water and gravity. Therefore, soils are thicker on level land or in valleys than on steep slopes. The low topographic relief on the lowan Surface promotes soil formation and stability, and it is true that our area is known for its highly productive soils. Even so, there are different soil series and characteristics associated with different portions of slopes even in the relatively low relief landscape around RFPP (Figures 13 and 14). Uplands and the slopes near ridge crests have soils that formed on calcareous bedrock, the older glacial till having been stripped away during Wisconsinan times, while lowland soils have a base of till. Soils in depressions are more poorly drained than soils on convex slopes. Soils on steeper slopes have less well-developed horizons than those that formed on level or gently sloping land.

P stands for parent material. Over most of the state of Iowa, the parent material is glacial till overlain by loess. It contains the particle sizes - clays, silts, and sands - that make up a soil's texture. The till is derived from mostly igneous and metamorphic rocks (from source areas in Minnesota and Canada) that were crushed, ground, transported, and deposited by the glaciers and then transported further by wind and water. This material is rich in mineral nutrients that can be released through weathering. At RFPP, erosion removed much of the Pre-Illinoian till from uplands, so that the soil series on uplands and slopes have calcareous (limestone and shale) parent material, while lowland soils formed on a base of glacial till (Figure 14).

T stands for time. It takes a long time (on the order of hundreds of years) for weathering, leaching, and organisms to produce soil from the parent material. This depends greatly upon the type of parent material, climate, and organisms. Some interesting early studies into the weathering rates of different parent materials come from investigations of old

buildings in Europe (Factors, 1994, accessed online at <http://www.soilandhealth.org/01aglibrary/010159.jenny.pdf>).

F: Projects for Students

Our entire unit on Rocks and Earth's Story will be building toward our field trip to Rockford. Then, we will use macro- and/or microfossil collections to apply the broad-scale understanding to analysis of our local/regional Earth history. I have outlined the activities and resources for the unit in the section below. I have gathered resources from a variety of online sources to supplement materials my colleagues and I have developed.

My aim is to have a well-sequenced series of lessons and activities that incorporate complete learning cycles (exploration, concept development, application). Some of the "exploration" activities are relatively simple for the grade level. My intention is to use them to quickly review concepts students should have been exposed to in elementary and middle school and to assess students' level of prior knowledge. I consider this section a "work in progress" and will be reworking it prior to the start of the school year.

Pre-Field Trip Activities:

(Full-fledged unit I am planning to investigate as an alternative or to supplement the materials I have planned below: Schoolyard Geology Unit from USGS:

<http://education.usgs.gov/lessons/schoolyard/index.html>)

1. Nature of Science Intro Activity (paper/pencil) Fossils: Keys to the Past
<http://www.nps.gov/flfo/learn/education/upload/Unit1Lesson6.pdf>
2. Rocks and the Rock Cycle
 - a. Info and online activity
http://www.windows2universe.org/earth/geology/rocks_intro.html
 - b. Activity (hands on exploration): Rock Cycle Lab
https://higherlogicdownload.s3.amazonaws.com/GEOSOCIETY/a2a49183-ba2a-469c-9d3b-68daf22c94bd/UploadedImages/TAP%20Photos/Lesson%20Plans/Rocks.%20Minerals%20and%20Mining/RockCycleLab_k-12.pdf
 - c. Lab (Concept Development): [How do Sedimentary Rocks Form?](#) Source: http://learningcenter.nsta.org/discuss/default.aspx?tid=nnUkOiNadME_E
 - d. Activity (Application) [Rocks and Environments Group Presentation](#):
3. "Core Ideas" of Stratigraphy
 - a. Info: http://www.geologyclass.org/evolution_concepts2.htm
 - b. Activity (conceptual exploration): [Geosleuth Murder Mystery](#)
 - c. Activities (hands on exploration): Cake Core Drilling ("Core Your Cake and Eat it Too") http://www.womeninmining.org/activities/Cake_Core_Drilling.pdf
<http://www.earthsciweek.org/classroom-activities/core-sampling>

- d. Activity (concept development, pencil/paper) Relative Dating
https://higherlogicdownload.s3.amazonaws.com/GEOSOCIETY/a2a49183-ba2a-469c-9d3b-68daf22c94bd/UploadedImages/TAP%20Photos/Lesson%20Plans/Geology%20&%20Geologic%20Time/Relative_Age_7-14.pdf
- e. Activity (application) Research well-drilling records???
- 4. Fossilization
 - a. Info: <http://www.fossilmuseum.net/fossilrecord/fossilization/fossilization.htm>
 - b. Activities and Role-Playing Game:
<http://www.ucmp.berkeley.edu/fosrec/Breithaupt2.html>
 - c. Role-Playing Game:
<http://www.museumoftherockies.org/LinkClick.aspx?fileticket=8oDRXhWVHx8%3D&tabid=106&mid=568>
 - d. Online Game: Fossil Fabricator: <http://www.wonderville.ca/asset/fossil-fabricator>

Field Trip and Post-Field Trip Activities:

- 1. Fossil Collection ([LINK to student instructions](#))
- 2. Fossil ID and Data Analysis ([LINK to student instructions](#))
- 3. Fossil Research ([LINK to student instructions](#))
- 4. Fossil Story ([LINK to student instructions](#))
- 5. Extensions:
 - e. Microfossil Preparation and Observations ([LINK to lesson plan](#))
 - f. Art with Clay?
 - g. [Write the Wikipedia Page](#) for Rockford Fossil and Prairie Park

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