

**Geologic History of Johnson County,
Iowa:
An Emphasis on the Devonian Fossil Gorge**

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Abstract

This following paper summarizes the geological history of Iowa and in particular Johnson County. Details can be found on the types of bedrock found in Iowa and common fossils found in Johnson County. Specific attention is given to the Coralville Lake area in Coralville, Iowa and the Devonian Fossil Gorge. The Devonian Fossil Gorge is an impressive formation displaying several fossils preserved in Devonian rock and gives an unique insight into what the ecosystem of that time period was like. The fossil gorge is later included as part of a middle school science lesson on geology, classification and ecology.

Introduction - Statement of purpose

The central focus of this paper is on the Devonian Fossil Gorge in Coralville, Iowa. The main focus of the student project will be identification of fossils found in the Devonian Fossil Gorge and making ecological connections between the organisms and their environment. Students will need to understand the geologic history of the Johnson County, historical flooding events that have helped to uncover the Devonian Fossil Gorge, and the organisms that existed during the Devonian Time Period.

Geography

Johnson County is located in Southeast Iowa (see Figure 1) and was settled in 1836. According to the United Census Bureau, the most recent estimated population of Johnson County, Iowa is 144,251 people (U.S. Census, 2015) and the population density is 213.1 people per square mile (U.S. Census, 2010). The prominent watersheds in Johnson County are The Lower Cedar Watershed, the Middle Iowa Watershed and the Lower Iowa Watershed. The Lower Cedar Watershed contains the cities of Marion, Cedar Rapids and Tipton. The Middle Iowa Watershed contains the cities of Tama, Marshalltown and Belle Plaine. The Lower Iowa Watershed contains the cities of Iowa City and Coralville and is the watershed that contains the Devonian Fossil Gorge (United States Environmental Protection Agency, 2016). Major streams and rivers of Johnson County include The Iowa River, Turkey Creek, Rapid Creek, Clear Creek, Ralston Creek, and Old Mans Creek. The source of water flowing into the Coralville Lake (which contains the Devonian Fossil Gorge) is the Iowa River.

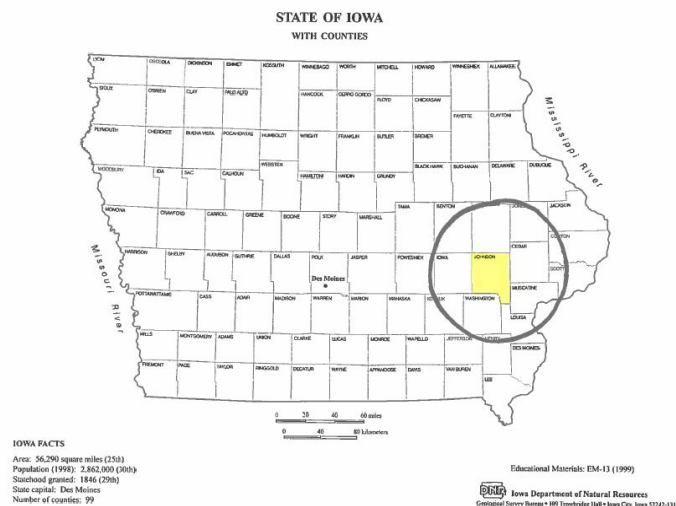


Figure 1: Map displaying the counties of Iowa. Johnson County is marked in yellow and circled. (Iowa Department of Natural Resources, 1999).

Johnson County is characterized by several soil types (see Figure 2 below), some of the most prevalent being Colo-Ely complex (6.5% of Johnson County), eroded Ladoga silt loam (6.6%), Clinton silt loam (3.1%), Muscatine silt loam (2.0%), Tama silt loam (7.2%), Fayette silt loam (10.9%) (United States Department of Agriculture, 2015).

Soil Types in Johnson County

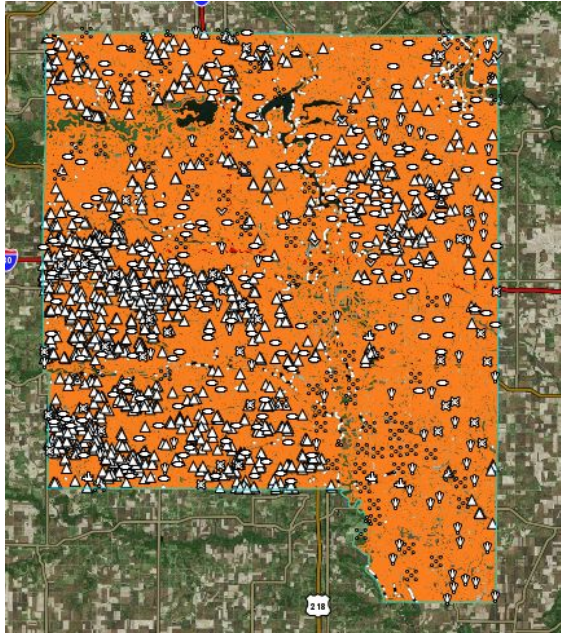


Figure 2: Map displaying various soil types throughout Johnson County. (United States Department of Agriculture, 2015).

Johnson County Iowa was settled in 1836 and named after Colonel Richard Mentor Johnson (Johnson County Iowa Website). It was initially settled as farmland when the country was expanding westward. Until recently much of the county was dedicated to small family farms which have converted to large-scale operations run by corporations. The development of larger cities within the county also created an urban sprawl effect which limited the available amount of farmland left.

Iowa City, the largest town in Johnson County, served as Iowa's capital until 1840-1857 (The Goldfinch, 1984) and is currently the home of the University of Iowa. The University largely contributes to the growing population of Johnson County. Because of the growing population and the fact that the 20.4% of the population is represented by those under 18 years of age (United States Census Bureau, 2014), the school districts are growing. The largest school district in Johnson County (Iowa City Community School District) is responsible for 13,000 students and encompasses roughly 133 square miles (Iowa City Community School District Website, 2014). Such a large population requires city upkeep including maintaining roadways. Johnson County is responsible for over 900 miles of paved, gravel and dirt roads (Johnson County Iowa Website).

There are a wide variety of businesses that are economically valuable to Johnson County, not limited to but including farming, retail, manufacturing and academics (Johnson County Iowa Website).

Johnson County is home to several natural resources, the most economically valuable for the state being limestone, sand and gravel. The quarries in Johnson County, Iowa outsource their products for use in construction and road fill. As with all forms of strip mining, quarrying for

limestone comes with some environmental concerns. Since limestone is a high porosity rock, there is a higher potential for water carrying contaminants from the quarrying process to travel through the rock and into water sources (Bliss et. al., 2008).

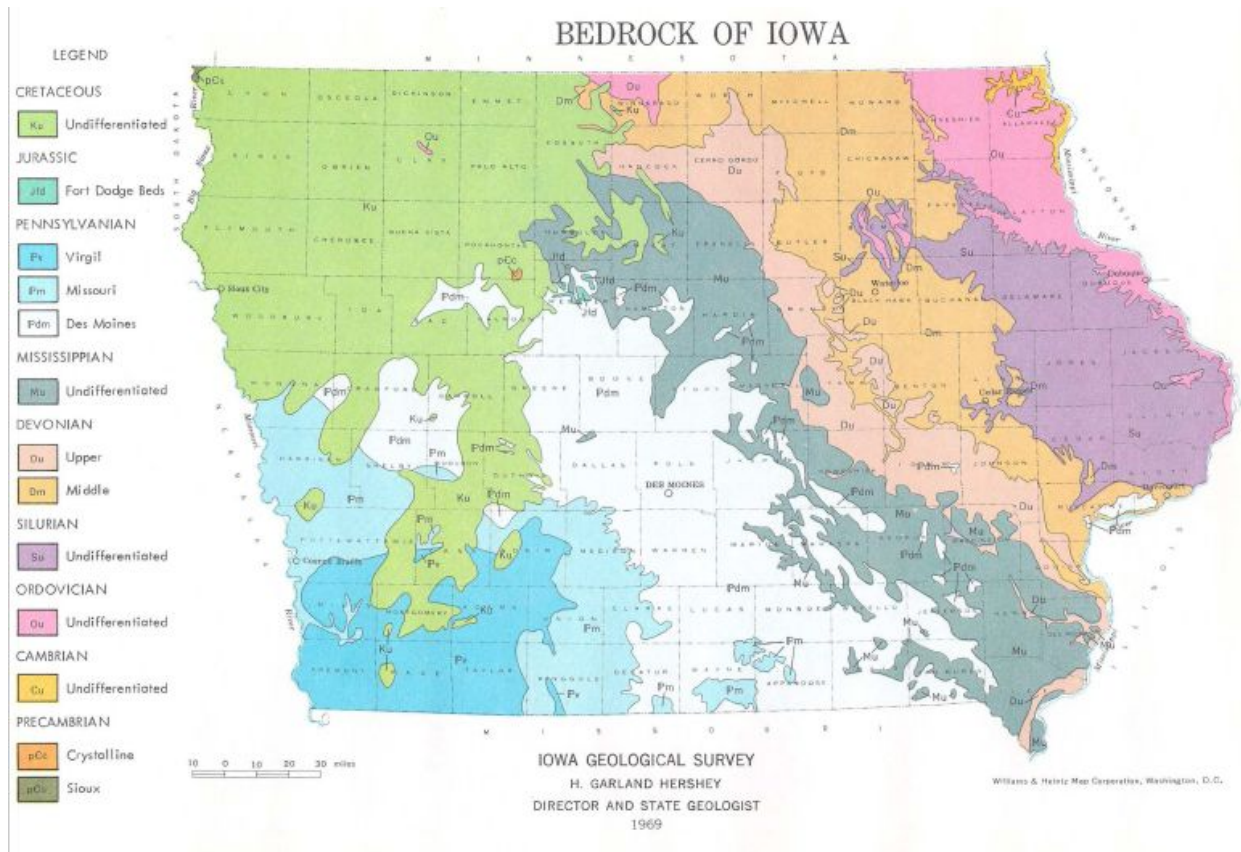


Figure 4: State of Iowa Bedrock Map (Iowa Geological Survey, 1969).

According to the bedrock map of Iowa (see figure 4), in the Northwest quarter of the state, there is a large bedrock formation that is undifferentiated. This was developed during the Cretaceous period. The Cretaceous period was the longest part of the Mesozoic Era. There was an extinction after the Jurassic period. The Southwest corner of the state has Virgil and Missouri bedrock. These were both created during the Pennsylvanian period. The Pennsylvanian period was in the Paleozoic Era. It is sometimes referred to as two different sub periods. In the middle of the state there are several different types of bedrock. These types of bedrock are called the undifferentiated, middle, upper and Des Moines bedrock. These different types of bedrock were created over several different time periods and include the Ordovician, Devonian, Mississippian and then the Pennsylvanian again. The Ordovician period takes place within the Paleozoic Era. This time period is characterized by significant seafloor spreading which in turn caused the temperatures of the seas and oceans to increase. During this time, North America was almost completely underwater and the sediment deposited trapped the dead sea life to form fossils. There was also a huge boom in the diversity of organisms during the Ordovician time period. Some of the species of this time period include brachiopods, trilobites, and graptolites. These organisms and several others can be found in the Devonian Fossil Gorge. The Silurian, Cambrian and Precambrian areas of bedrock can also be found in Iowa. These can all be found in the Northeast part of Iowa (Holland, 2016). The Silurian time period is characterized by rising sea levels due to glacier melt. This rise in sea level contributed to a more stable climate on Earth. This stability allowed coral reefs to form in the seas and is responsible for the large

diversity of ocean species of this time period. A notable development during this time period was the first vascular plant. This had huge implications for life on land (University of California Museum of Paleontology, 2009). The Cambrian Era is known for fastest growth in the number of major new animal groups which happened over the course of 40 million years (University of California Museum of Paleontology, 2009). The rocks near Dubuque were formed in the Precambrian Era. The Precambrian Era covers 90% of the history of the Earth which is everything before 600 million years ago. There isn't a record of life form, but even if there was life form during the Precambrian time, it probably would not have left trace fossils. It is typically divided into three different eras, the Hadean Era (which is the first one), the Archeon Era, and the Proterozoic Era.(Schaezel) The Stratigraphic Column of Iowa is another way to look at the bedrock of Iowa. It not only gives the different time periods in which the rock was created, but it also gives an estimate as to how deep that section of rock might be. (See figure 5).

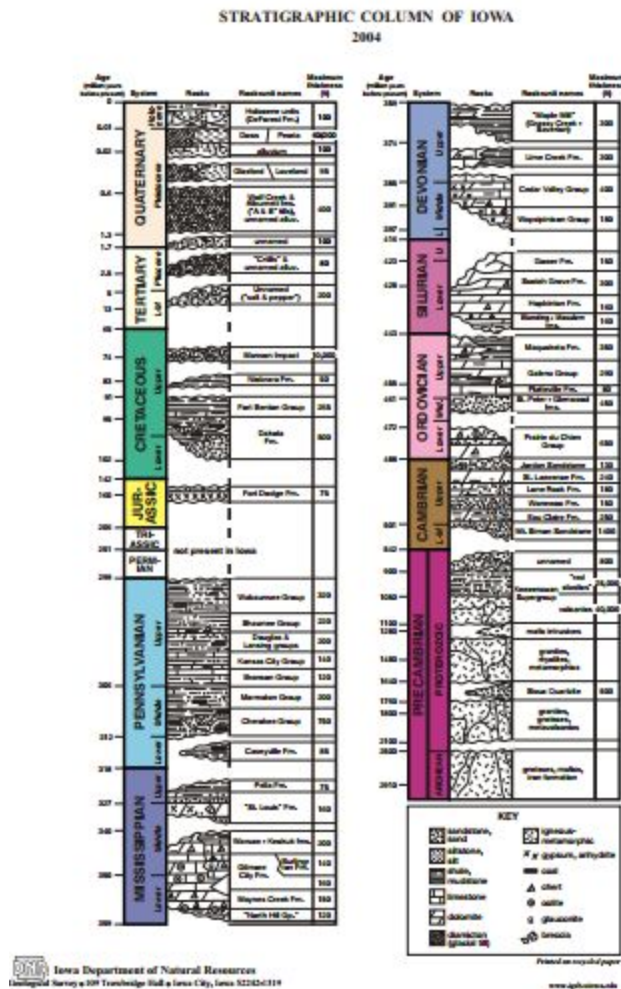


Figure 5: Stratigraphic Column of Iowa (Iowa Department of Natural Resources, 2004)

Today, Iowa is a prairie state having gradual relief and gentle slopes. In some places the floodplain is easily seen. The Mississippi and the Missouri River's help the state to be well drained. There are some parts of the state that show extensive erosion and other parts that have little erosion (Physiography of Iowa). Surficial formations are present in Allamakee County due to this area remaining untouched when the last glacier passed over Iowa creating glacial till and flatten the rest of Iowa (Northeast Iowa Resource Conservation and Development).

The primary bedrock of Johnson County dates back to the Mississippian and Devonian Time Period during the Paleozoic Era, a time period that lasted nearly 40 million years. The rock type of this period is mainly limestones, but there is also some shale found in the region. The limestone is thought to have formed while Iowa was covered by warm, shallow seas. This time period is characterized by both vertebrate and invertebrate life forms (Rose, 1967). Several Mississippian rock formations can be seen at the Coralville Reservoir in Coralville, IA. Limestone outcrops line the shores of the man-made lake. While the primary bedrock in Johnson County is Mississippian in nature, the boundary between Devonian and Mississippian bedrock is sometimes difficult to determine. The Coralville Lake area exhibits exposed rocks and sediments from three different geologic systems: Devonian Limestone (370-380 million years old), Pennsylvanian deposits (310-320 million years old) and more recent Quaternary aged glacial and wind-blown deposits (1.5 million years old). The oldest exposed rock in the Coralville Lake area can be found north of Lake MacBride and the youngest exposures are found southwest of the old State Quarry (Witzke, 1994).

There is an excellent exposed Devonian formation in Coralville known as the Devonian Fossil Gorge. The fossils that are present in Johnson County, and which can all be found in the Devonian Fossil Gorge are brachiopods, gastropods, crinoids, cephalopods, colonial corals and solitary corals. The crinoids are also called “Sea Lilies” and are made up of a stem of at least 100 “cheerios” that form a plant “backbone.” The top of the sea lily is called the calyx. There is abundance of crinoid pieces at the Devonian Fossil Gorge. There are also colonial coral and solitary coral exposed. (Geologic Survey Bureau, 2001). While early fish species evolved during the Devonian time period, there are no complete fossils of any in the Coralville Lake area. Species have been identified largely by individual bones and teeth and compared to complete Devonian fossils found elsewhere. The most common fish fossils found in the Coralville lake area are from placoderm fish, a fish with jaws. One type of placoderm fish (see Figure 6), the arthrodires, is commonly found in Johnson County. These fish are thought to be the largest animals in the shallow seas covering Iowa, reaching up to 2-3 meters in length (Witzke, 1994).

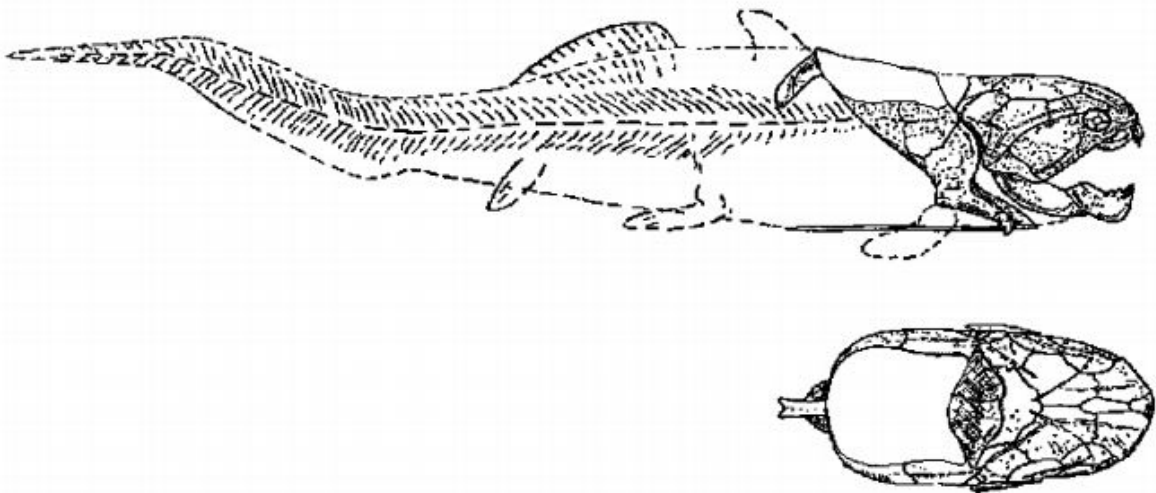


Figure 6: Sketch of giant arthrodire (placoderm fish) found at the Devonian Fossil Gorge in Coralville, IA (Witzke, 1994).

The land surface during the Devonian time period included early vascular plants like lycopods, sphenopsids and ferns. There were also some early species of insects and other arthropods that were beginning to evolve within the newly forming land ecosystems. Some land vertebrates began to evolve from their early amphibian ancestors during the Devonian as well (Witzke, 1994).



Figure 7: City Park flooded photo taken by Alan Reinier during the Flood of 2013

Johnson County has experienced a significant flood twice in the history of the county. The first one was during 1993. During this flood, the Coralville Reservoir which is the watershed for the area exceeded the emergency spillway that serves as a safety device to control the water levels on the Coralville Lake. Coralville Lake is fed by the Iowa River which starts in the North Central part of the state and is a tributary to the Mississippi River. During this flood that topped the spillway, the campground that was close to the spillway was destroyed, but in that process the Devonian Fossil Gorge was exposed. (Geologic and Water Survey, 2010) This is an area of limestone which was from the Devonian Era. There was a vast array of organisms in this limestone as fossils since this part of Iowa had once been covered by a shallow sea. This was only the first of the two floods. The flood of 2008 actually started in December of 2007. The United States Geologic Survey(USGS) has recorded that December was the second wettest December in 135 years. There was also major precipitation in February on all but 8 days that month. March was fairly normal, but then April turned into the second wettest April in 136 years. May and June also experience heavy precipitations and in July of 2008 the Coralville Reservoir topped the spillway again and caused severe flooding downstream. (Buchmiller and Eash, 2008) The flood of 2008 may have been devastating to the people living downstream from the spillway but the flood was beneficial to the Devonian Fossil Gorge. It was able to be widened and the water swept away loose rocks and vegetation that had began growing in the gorge. The was also exposed new rocks and fossils that hadn't previously been seen. (Geologic and Water Survey, 2008).

Economic Resources of Johnson County

A variety of rocks and minerals can be found within Johnson County, the most common of which are limestone, gypsum, sand and gravel, clay, coal, lead and zinc however, the most profitable rock of the area is limestone (see Figure 3). The limestone industry in Iowa on average, produces between 25 and 30 million tons of limestone a year (Economic Geology of Iowa's Rock Materials, 2016). Limestone and dolomite have been mined in Iowa since the 1800's for building stone and is still actively quarried as sand and gravel primarily for concrete, roadstone, agricultural lime, construction fill, and ballast (Iowa Geological Survey, 2015). While limestone is a type of rock that has several industrial uses, it is most notably used for cement which continues to be a highly demanded resource. Crushed limestone was 68% of all crushed rock that had been produced in the United States in 2007. Some of the lesser known uses of limestone include material source for marble countertops and other decorative stone work, to remove impurities from steel and other metals, and removing toxic compounds found in the exhaust of coal-burning power plants. Limestone can also be used as a filler for several textiles and even used in foods and medicines. Lime has been used to make lime (CaO) which can be used to treat soil, clean water and smelt copper.

Klein Quarry in Iowa City, Iowa



Figure 3: Ongoing operations at Klein Quarry in Iowa City, Iowa. Klein Quarry has produced crushed limestone, sand and gravel since 1920 (River Products Company, 2016).

The total annual U.S. limestone production has steadily increased throughout the early 2000's however, since limestone is such a versatile substance it is often in high demand. Several shortages in limestone have occurred in the past due to increasing urban growth of land that has mineable limestone bedrock. The increase in limestone production is product of larger quarries and more modern methods of mining. The increased production in limestone is environmentally concerning as limestone aggregates are also often aquifers. There is concern that in these circumstances, contamination from the quarrying process may enter groundwater that is used for wells. There is also an increased risk that limestone aquifers that have formed cave systems can transport contaminants from quarrying much more quickly. Caves and other karst formations are very common in areas of where limestone is found (see Figure 4) (Bliss et. al., 2008).

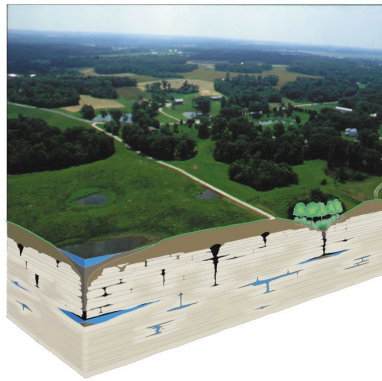


Figure 4: A cross section of land exhibiting karst topography in Southwestern Illinois (Berg, 2016).

Geology and Theme

The chosen theme for this project centers around the identification of fossils and reproducing a model of a Devonian age ecosystem. The project will be geared toward 8th grade students in an Earth and Physical Science classroom. The project serves both as an introduction to geology and also as a bridge between the 7th grade Life Science Curriculum and 8th grade Earth and Physical Science Curriculum. In 7th grade, students learn how to classify organisms and use a dichotomous key to identify unknown species. They are also introduced to concepts of ecosystems. We will use the principle of uniformitarianism to build on the student's knowledge of the current ecosystem and to that of what once was at the Devonian Fossil Gorge. The students will be able to use fossil evidence examined at the gorge to determine the ecosystem of the past. With this knowledge, the students will create a model of the relationships within the ecosystem. This could include: food webs, food chains, predator/prey relationships, and symbiotic relationships.

The project will take place over the course of two weeks at the beginning of students' 8th grade year. The field trip to the Devonian Fossil Gorge will ideally take place during the second week of the project. The first week will be dedicated to a quick review of ecosystems learned in 7th grade and preparing the students for the trip to the Gorge.

Summative assessments will informally take place each day up until the due date for the project. The formative assessment will be to share their findings with classmates. Students will be expected to create a visual to aid their presentation. Both the presentation and the visual will be graded formally.

References

- Bedrock of Iowa Map. (1969). Iowa Geological Society. Retrieved June 11, 2016, from http://s-iihr34.iihr.uiowa.edu/publications/uploads/2015-12-17_15-12-30
- Berg, Richard C. (2016) *Karst Landscapes of Illinois: Dissolving Bedrock and Collapsing Soil*. Illinois State Geological Institute.
- Bliss, James D., Hayes, Timothy S., Orris, Greta J.. *United States Geological Survey. Limestone - A Crucial and Versatile Industrial Mineral Commodity*. 2008.
- Buchmiller, R. and Eash, D. (2008) *Floods of May and June 2008 in Iowa*. United States Department of the Interior U.S. Geological Survey.
<http://s-iihr34.iihr.uiowa.edu/publications/uploads/EM-42.pdf>
- Bunker, B., Witzke, B. (1994). Classic Geological Exposures old and new Coralville Lake and Spillway: Devonian Fossil Gorge, Merril A. Stainbrook Preserve & Old State Quarry Preserve. Geological Society of Iowa. p. 2-11.
- Devonian Fossil Gorge Brochure*. (2010). Iowa Department of Natural Resources Geologic Land and Water Survey. <http://s-iihr34.iihr.uiowa.edu/publications/uploads/EM-42.pdf>
- Driftless Area Scenic Byway*. Northeastern Iowa Resource and Conservation Board.
<http://northeastiowarcd.org/driftless-area-scenic-byway/>
- Flood Photograph (2013). Johnson County Metro Dive Team and Alan Reinier JCSO Photographer. http://www.johnson-county.com/dept_emergency.aspx?id=13265
- Fossils of Iowa Brochure. (2001). Iowa Department of Natural Resources Geologic Survey Bureau. <http://s-iihr34.iihr.uiowa.edu/publications/uploads/EM-26.pdf>.
- The Goldfinch* 5, No. 4 (April 1984). Iowa City: State Historical Society of Iowa. Retrieved June 11, 2016.
- History Of Johnson County Iowa (Book) Iowa City, Iowa. (1883) Retrieved June 9, 2016, from https://books.google.com/books?id=BfIN2L5htEwC&printsec=frontcover&dq=editions:027YRuZ Nbn6_UiaQl8SshD8#v=onepage&q&f=false
- Iowa Geological Survey Minerals and Resources. (July 1, 2015). Retrieved June 10, 2016, from <http://www.iihr.uiowa.edu/igs/mineral-resources/>
- Johnson County Website. (n.d.). Retrieved June 10, 2016, from http://www.johnson-county.com/dept_about.aspx?id=5725
- Johnson County Streams and Rivers Map. (n.d.). Retrieved June 9, 2016, from http://www.johnson-county.com/dept_blank.aspx?id=9701
- Ordovician Period. (2016). In *Encyclopædia Britannica*. Retrieved from <https://www.britannica.com/science/Ordovician-Period>

Physiography of Iowa. <http://s-iihr34.iihr.uiowa.edu/publications/uploads/Em-02.pdf>

Picture of Klein Quarry: <http://www.riverproducts.com/>

Population estimates, July 1, 2015, (V2015). (n.d.). Retrieved June 10, 2016, from <http://www.census.gov/quickfacts/table/PST045215/19103>

The Precambrian Era. (1964). Retrieved June 12, 2016, from <http://geo.msu.edu/extra/geogmich/precambrian.html>

Publications - IGS Publications. (n.d.). Retrieved June 9, 2016, from <http://s-iihr34.iihr.uiowa.edu/publications/publications>

Rose, J.N. (1967). Fossils and Rocks of Eastern Iowa: a half-billion years of Iowa history. (17,18). http://s-iihr34.iihr.uiowa.edu/publications/uploads/2015-12-17_15-22-29_es-1.pdf

Soil Map. United States Department of Agriculture (n.d.). Retrieved June 10, 2016, from <http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Stratigraphic Column of Iowa. (2004). Retrieved June 12, 2016, from <http://s-iihr34.iihr.uiowa.edu/publications/uploads/Em-40.pdf>

Surf Your Watershed. (n.d.). Retrieved June 9, 2016, from https://cfpub.epa.gov/surf/county.cfm?fips_code=19103

University of California Museum of Paleontology: The Silurian Period. (2009). Retrieved June 10, 2016. <http://www.ucmp.berkeley.edu/silurian/silurian.php>.

