Casey's Paha in
Hickory Hills State Park
Tama County, Iowa

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EARTHSCI 6233

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Abstract

Tama County, Iowa is in the central portion of Iowa and is separated by the Iowan Surface to the north and the Southern Iowan Drift Plain to the south. The two landform regions make the county interesting because to the north is gently sloping areas with a more rugged wooded area lies to the south. Within the county, there is a glacial feature called a paha. My project is to take my high school Earth Science students to Casey's Paha at Hickory Hills Park in the northeast corner of the county to do a geocache.

Introduction

Tama county has an excellent example of a unique feature called a paha. Pahas are isolated oblong hills that rise 30 to 100 feet above the surround area and are formed of sand and silt and are concentrated at the southern border of the Iowan Surface. (Prior, 1991) The word paha means hill or ridge in the Dakota Sioux dialect. These hills are oriented in a northwest-to-southeast direction because of the prevailing northwest wind that scoured the Iowan surface while the glaciers were present. (Prior, 1991) Casey's Paha is a part of Hickory Hills Park found in the northeast portion of Tama County. My project is to explore Casey's Paha with my high school Earth Science class and learn about the concept of geocaching.

Tama County is the fifth county from the north, south and east borders of the state of Iowa see Figure 1. (Tama County, 2016) Tama County was named after the wife of Poweshiek who was a chief of the Sac and Fox Tribes. The word Tama also means beautiful or lovely in the native language of the Indians who lived in the area. (Chapman, 1879) "Nowhere within the limits of the State could it be surpassed for beautiful scenery, groves, prairies, meandering streams and carpets of flowers and verdure." (Chapman, 1879, p. 13)

The population of Tama County is 17,451 people with Tama housing 4,445 and Toledo 3,231. Other towns in the county are Traer, Dysart, Gladbrook, Garwin, Montour, Clutier and Elberon. The land covers is 6,738 square miles and 721 square miles are covered by water. (Tama County, 2016) The prominent streams are Wolf Creek, Sugar Creek, Deer Creek, Salt Creek, Richland Creek, and Otter Creek. All of these streams empty into the Iowa River which is in the southern portion of the county.

Tama County drains into two watersheds as you can see in Figure 2. The north portion of the country drains into the Middle Cedar Watershed which drains into Wolf Creek near Dysart. The southern portion of the county drains into the Middle Iowa Watershed which has four points of drainage which are Iowa River at County Highway E49 near Tama, Richland Creek near Haven, Stein Creek near Clutier, and Salt Creek near Elberon. (Surf Your Watershed, 2016)

Soils are characterized by composition of the parent material, climate, plant and animal life near the soil, the lay of the land and the time that forces have been acting on the material. (Wisner, 1995) Tama County has a number of soil types, including the Tama Soil which is the state soil for Iowa. Tama soil is classified as a fine-silty, mixed, super-active, mesic. It is a highly productive soil that can give 10 to 11 inches of moisture to plants. (Iowa State Soil, 2016)

In the spring of 1849, the first settler, Isaac Asher with his wife and eight children, came to Tama county. Early settlers found a land that was prairie to the north and wooded with oak, elm and hickory trees to

the south. (Chapman, 1879) Asher was a farmer and broke ground that spring to put in a crop of corn. The main natural resource in Tama County is the soil that can be used to grow many crops including corn, apples, peaches, grapes, cherries and other small fruit. (Chapman, 1879) There is also limestone that was easily accessible and it still quarried today to make aggregate and lime. Coal was not found in Tama county, but was mined in other parts of central Iowa from 1870 to 1920. (Coal Mining, 2016)

The old State Road a connection between Marengo and Fort Dodge was constructed in July 1853 and ran along the south side of the Iowa River. (Chapman, 1879) Construction of roadways continued to expand from that point. The most famous road to travel through Tama County is the Lincoln Highway. The Lincoln Highway was a direct route from New York to San Francisco. The Lincoln Highway Association was created in 1913 to help fundraise and make the road a reality. (Lincoln Highway, 2016) In Tama, there is a bridge from the original road built in 1915 that shows the amazing workmanship of a bygone era. (Figure 3) The county is now full of county road and is bisected by state Highway 30 running east to west and Highway 63 going north to south shown in Figure 4.

Summary of Bedrock Geology of Iowa

The bedrock of Iowa is diverse and comes from all of the following time periods. (Figure 5) Here is a brief summary of the bedrock of the entire state of Iowa. In the next section, the geology of Tama County will be discussed to explain the formation of Casey's Paha which is found in the northeast corner of the county.

Precambrian (541 Million Years Ago to 4.6 Billion Years Ago)

The earliest bedrock in Iowa is not found in Tama county. Precambrian rock is found in the northwest corner of the state of Iowa. These rocks are exposed in the Sioux quartzite which have a dense, nonporous texture. (Anderson, 1998) Most of these rocks in the Iowa were covered with deposits from a shallow inland sea that covered most of the state during later geologic periods. This layer is sometimes referred to as the Bedrock Basement. The other interesting fact about this time period is between 1.0 and 1.1 billion years ago a mid continental rift system nearly ripped North America apart from Southern Kansas to the eastern shore of Lake Superior. (Anderson, 1998)

Cambrian (485 Million Years Ago to 541 Million Years Ago)

Cambrian time brings a huge change to Iowa. The area is inundated with shallow inland seas. The precambrian rocks were weathered into small pieces that collected into sandstones with small quartz pieces. The Jordan Sandstone is an example of the a rock layer from this time period. It is primarily found in Northeast Iowa near the Yellow River. (Anderson, 1998) Cambrian Explosion refers to this rapid evolution of many species on Earth. Trilobites, anthropoids and many reef-building animals are found in this fossil record. The end of the Cambrian unfortunately also showed an extinction event. (Bagley, 2016)

Ordovician (443 Million Years Ago to 485 Million Years Ago)

"Ordovician rocks are well exposed in northeastern Iowa and indicated that the state was under the sea for much of Ordovician time." (Anderson, 1998, p. 65) The rocks of the Ordovician are separated into the lower, middle and upper. The early rocks are in the Lower Ordovician layer and limestone is

becoming the dominate rock being produced. There was a major sea transgression at the end of the early Ordovician. The Middle and Upper Ordovician have a more muddy shale created from ash from the Taconic Mountains in the Eastern part of the United States. (Anderson, 1998) The fossil record of this time period includes abundant and diverse invertebrates as well as shells from sea life. Rocks from the Ordovician era also have deposits of zinc and lead that were mined near the Dubuque area starting in 1788 by Julien Dubuque. (Anderson, 1998)

Silurian (419 Million Years Ago to 443 Million Years Ago)

During the Silurian time period Iowa was located south of the equator and was again an inland sea. The rocks of this time period are recognizable for their durability to erosion. They are exposed in many places in the state including the Maquoketa Caves, Backbone and White Pine Hollow and have become State Parks. Silurian bedrock is composed primarily of dolomite or dolostone. This is created when magnesium replaces the calcium in calcium carbonate in limestone. Dolostone preserves less detail in the fossils, but colonial corals, solitary corals, brachiopods, crinoids abound in this rock layer. Dolostone also has more porosity that limestone because the magnesium has a larger mass which makes the density of the stone larger leaving spaces for molds to form in the rock. (Anderson, 1998)

Devonian (358 Million Years Ago to 419 Million Years Ago)

Seas withdrew from the area during the late Silurian and didn't return until the Middle Devonian. This allowed for a great deal of weathering a much of the rock record during this time is missing. "The Devonian System is one of the state's most fossiliferous units." (Anderson, 1998, p. 136) Devonian Gorge near Iowa City is a wonderful example of exposed Devonian bedrock. A number of transgressions and regressions of the sea during this time period affect the rocks left behind. The water depth changed from coastal to about 200 feet and the rocks reflect this change. Gypsum was created as an evaporite rock when the seas were briny or in arid tidal flats. Bedrock from the Devonian period is economically important because it's used for aggregate and gypsum resource. (Anderson, 1998)

Mississippian (323 Million Years Ago to 358 Million Years Ago)

The last major seas over Iowa happened during the Carboniferous period. The Carboniferous period is split into There are ten recorded transgression-regression cycles recorded during the Mississippian time. Limestone is the primary deposit with sand-sized fossil fragments are abundant. Fossils of a plethora of sea-life are part of the Mississippian bedrock layer including crinoidal debris. Geodes were formed during this time period and were later named the state rock of Iowa. (Anderson, 1998)

Pennsylvanian (232 Million Years Ago to 298 Million Years Ago)

Pennsylvanian rocks show an alternating between marine and non marine environments. During the non marine periods, Iowa would have been swampy coastal areas that later created coal deposits. These beds can now be seen as cliffs of sandstone such as that found in Dolliver Memorial, Ledges and

Wildcat Den state parks. (Anderson, 1998) Coal was mined in Iowa from 1870 to 1920 especially in central Iowa. Iowa coal mining stopped as other sources of coal were found to be more economical and other energy sources such as natural gas and fuel oil. (Coal Mining, 2016)

Mesozoic (66 Million Years Ago to 232 Million Years Ago)

Iowa's Mesozoic period was a time of erosion. Much of the rock record from this period is missing. Some of the rocks that were formed in the period are gypsum which is an evaporite in the Fort Dodge formation, and a sandstone/mudstone in the Dakota Formation in western and northwestern Iowa. (Anderson, 1998) Dinosaurs lived during this time period, but Iowa's rock do not have many examples. The glaciers that came later moved and eroded the deposits from the Mesozoic period.(Witzke, 2014) Another investing feature of the Mesozoic periods is the Manson Impact crater which has been dated to approximately 74 million years ago. (United States Meteorite Impact Craters, 2016)

Cenozoic (Present to 66 Million Years Ago)

The Cenozoic period in Iowa was a time of erosion and weathering. Especially in the last 2.5 million years when a number of glaciers covered the state of Iowa. The ice sheets left behind sorted and stratified glacial outwash from meltwater and fine-grained sediments were deposited by the wind in the form of loess. Together glacial drift, loess and alluvium have developed into a fertile soil. (Anderson, 1998) Fossil remains reveal a large number of animals and track human inhabitation to approximately 9500 to 7500 years B.C. (Anderson, 1998) Seven principal landforms are found in the surficial geology of Iowa. They include the Des Moines Lobe, Alluvial Plains, Loess Hills, Southern Iowa Drift Plain, Iowan Surface, Northwest Iowa Plains and Paleozoic Plateau as shown in Figure 6. (Landform Regions, 2016)

Specific Geology of Tama County

The bedrock of Tama County is primarily limestone as you find in most of the state of Iowa. (Figure 7) Over seventy-five percent of the county had Devonian bedrock underneath the surface. Devonian bedrock contains limestone, dolostone and shale from the transgression and regression of the inland seas that covered Iowa during much of this time period. (Anderson, 1998) The Mississippian bedrock is found at the west side of the county. This layer is mainly formed of limestone and dolostone. (Fisher, 2014)

These layers of bedrock cannot be seen in most places on the surface because of the build up of glacial deposits left from the various glacial events in Iowa's history. Tama County had a prairie in the north and a more wooded area to the south when the first settlers explored the area. (Chapman, 1879) The difference in appearance of the county can be related back to the landform regions map of Iowa. (Figure 6) The north portion of the county is a part of the Iowan Surface and the south portion is part of the Southern Iowa Drift Plain. The Iowan Surface is characterized by low relief with long, gently rolling hills. It was predominantly prairie before it was settled by man. (Landform Regions, 2016) The Southern Iowa Drift Plain is composed of glacial till from the Pre-Illinoisan glaciers which are much older than those that covered the northern portion of the state. This area contains an integrated drainage system with bedrock exposed in deeper valleys. (Landform Regions, 2016)

The feature that my project is centered around is a unique feature called a paha in the northeast corner of the county. These pahas are concentrated along the southern border of the Iowan Surface within 20-50 miles of the edge. (Prior, 1991) There are 116 pahas mapped in Iowa with prominent ones including Casey's Paha at Hickory Hills Park in Tama County, and the campuses of Cornell College in Mount Vernon and Kirkwood Community College in Cedar Rapids. (Prior, 1991) Pahas are thought to be "erosional remnants of Pre-Illinoian drift preserved by thick, wind-blown deposits." (Anderson, 1998, p. 333) These landforms are often wooded including Casey's Paha in Tama County. The soil that has developed on top of these wooded pahas are more like a forest than a prairie and that shows they have been covered with trees for a long time. (Anderson, 1998) Figure 8 shows the cross section of a paha and is relationship to the edge of the Iowan Surface. (Anderson, 1998, p. 335)

Fossils in Tama County are generally buried under the soil and glacial till. There are Devonian fossils such as trilobites, corals, Dunkleosteus, and other aquatic life, but they are buried in the limestone The dolostone that is in the bedrock would make it harder to find the detailed fossil that you can find in a limestone made of calcium carbonate. (Anderson, 1998) Animal bones and early human remains do exist in the soil, but they are not readily found. My brother-in-law found some buffalo bones near a spring on his farm near Gladbrook.

Natural Resources of Tama County

Soil and land are Tama County's greatest natural resource. Ninety-three percent of the county is used for agriculture for both crops and animals. Over twenty-five percent of people in the county are employed in these agricultural pursuits which brought in over $270 million in 2009. (Tama County Agriculture, 2009) This resource will continue to be useful as long as farmers use good conservation practices such as creating terraces and establishing waterways to decrease erosion.

Tama County does have one working rock quarry near Montour, Iowa. This quarry produces crushed and broken limestone, concrete stone and ag-lime. The limestone is of Devonian age in that location. Montour is located near Highway 30 which would allow stone to be moved across the area quickly. (Montour Quarry, 2016) The quarry will continue to run as long as it has the land to expand.

Wind energy is being used in Tama County. The Vienna project put 45 wind turbines in Tama and Marshall Counties in 2012. The new Siemens generators that were installed have increased the energy being produced over earlier models. The turbines can make approximately 103.5 Megawatts of power. (Wind, 2016) Wind energy is a renewable resource that is readily available in this portion of the state. The turbines will run for many years if maintained.

Geology and Geocaching

Geocaching is a scavenger hunt that can be found all over the country. There are over 2 million caches waiting to be found. When you find the cache you sign in or log it on the phone app to show that you have been there and then you can swap knick knacks with the ones inside the box. (Geocaching Guide, 2016) The theme of my project is to do a geocache at Hickory Hill Park which is located on the border between Tama and Blackhawk County. Figure 9 is a aerial picture of the park and paha. There are two appropriate projects on the geocaching website and I would like to try to do them both in the time that the class has at the park.

Before the field trip the students in my high school Earth Science class will have studied glaciers. The geology of Iowa is so dependent on these structures that I believe all students should have a basic understanding of the anatomy of a glacier and the effects it has on the surface geology of the area that it covers. The National Parks Service has a great website that I use to show the students what a glacier is and what they do to the land around them. (Views of the National Parks, 2016)

The other topic that would be covered is the landforms of Iowa that were discussed in the earlier section. Students need to have a better understanding of what Iowa looks like and why it looks that way. It's not just corn and soybeans.

Before the field trip day, I would hand out the worksheet that I've created and have the students complete the pre-trip questions. On the day of the trip, we would use the GPS units from the Area Education Agency to find the appropriate waypoints. I've listed them on the worksheet. We would then follow the directions of the two geocaches. The first one is an Earthcache and only asks for a picture of the Paha from a specific location (Hickory Hills Paha, 2016) and the second is to find an actual cache, which is the size of a matchbox, and sign the logbook. (Another at Hickory Hills, 2016)

After the field trip, as a class we will make a geocache to put one of the local parks. The students will have to find the location and decide what should be put inside. I think this will give them some understanding of the process of geocaching and hopefully give them an idea of a new hobby. There are geocaches all over the place if you are watching the app for them. We found a few on vacation, but didn't have time to go into the wooded areas to find the exact spots.

Student Worksheet for Field Trip

Name _____

Casey's Paha at Hickory Hills State Park

Pre-field trip questions

1. What is a glacier?

2. Explain what the glacial balance refers to. Make sure to mention the zones of the glacier.

3. What is permafrost?

4. Where do we find the Iowan Surface and the Southern Drift Plain in Tama and Blackhawk Counties?

Field Trip Directions

First Geocache

Find the location using the GPS or your cell phone.

N 42° 15.991 W 092° 18.983

UTM: 15T E 556378 N 4679594

Then follow the directions made by joestephkids. (Hickory Hills Paha, 2016)

1 From the waypoint you are standing at can you tell the height of the surrounding hills to the south. "If you have a gps like Colorado with Topo maps you tell how height the hills are." But if you don't have a GPs like that you can give your best guess. The waypoint is at 862 feet.

2 You know the there is old glacial materials under the hill can you tell what kind they are?

3 Now got to Waypoint # 2 N42 16.012 W92 18.839 Read the sign and tell me what the first two sentences say.

4 At waypoint #1 you will need your photo with GPS in hand with hills to the south in the Photo!

Second Geocache (Another at Hickory Hills, 2016)

Find this location and sign the log book.

N 42° 16.333 W 092° 19.001

UTM: 15T E 556348 N 4680226

Post Field Trip Questions

1. What is a paha? How are they related to glaciers and the Iowan Surface?

2. Design a geocache that could be put somewhere here in Reinbeck.

Figures

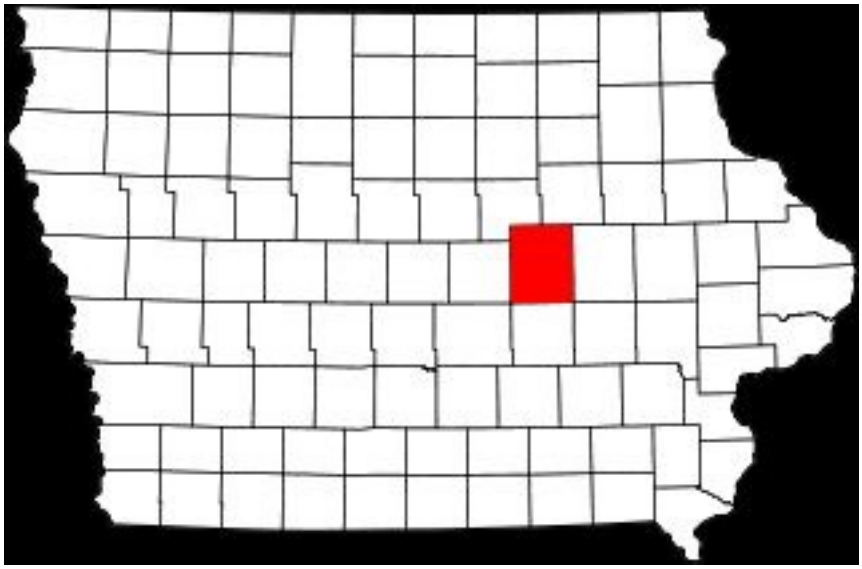


Figure 1 - Location of Tama County within the state of Iowa. (Tama County, 2016)

Figure 2 - Watershed of Tama County, Iowa. (Surf Your Watershed, 2016)

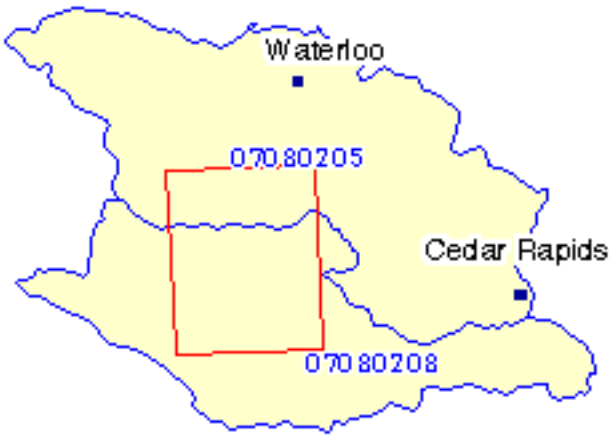


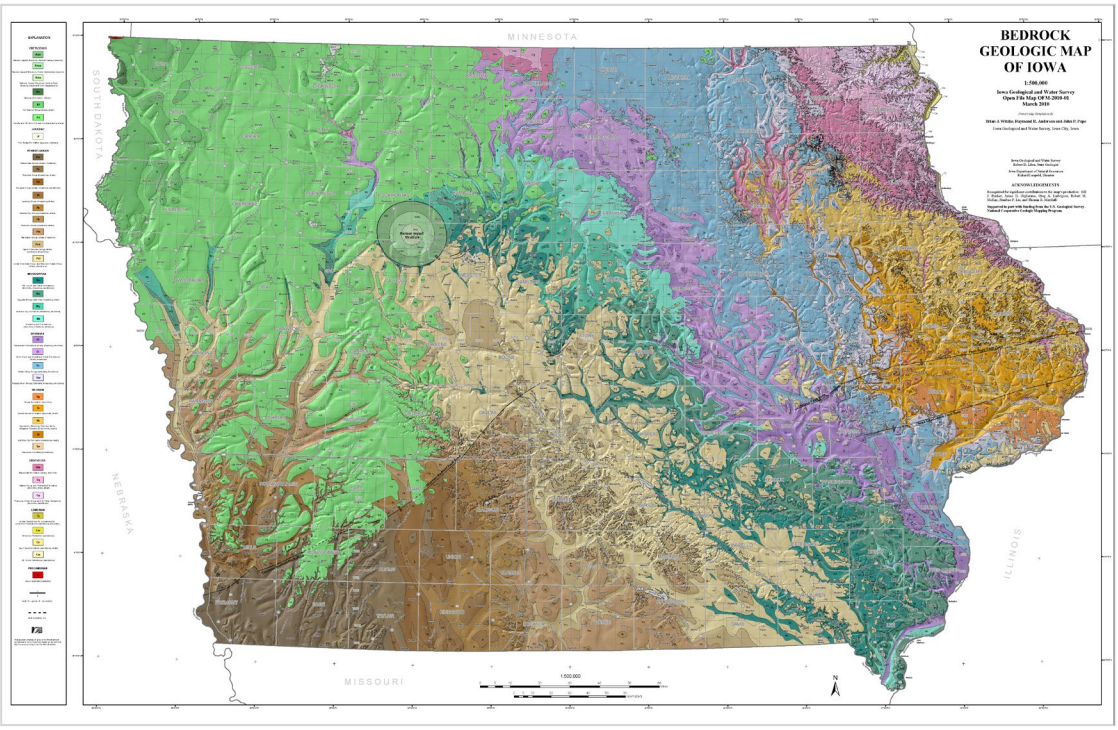
Figure 3 - Lincoln Highway Bridge located in Tama, Iowa believed to be from 1915 right after the bridge

was completed. (Tama: Lincoln Highway Bridge, 2016)

Figure 4 - Highway of Tama County, Iowa. (Highway in Tama County, 2010)

Figure 5 - Bedrock map of Iowa (Fisher, 2016)

Figure 6 - Landform regions of Iowa as shown by the Department of Natural Resources. (Landform



Regions, 2016)

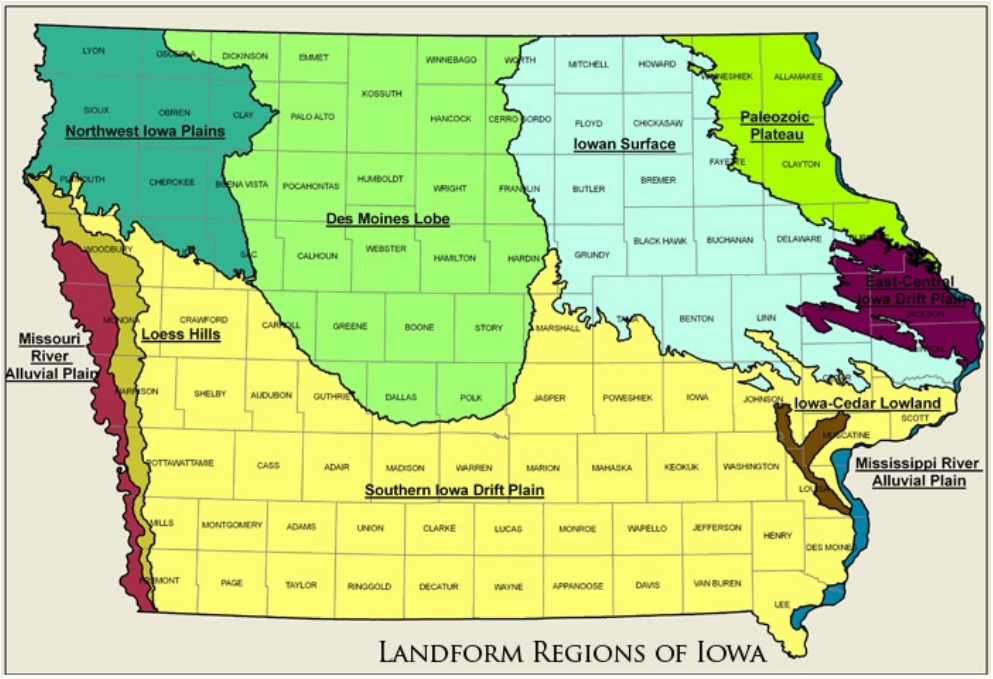


Figure 7 - Bedrock of Tama County. This is a screen shot of Tama County from the bedrock map. (Fisher, 2014) The blue and purple shading represents Devonian Bedrock and the light green shade is Mississippian in origin.

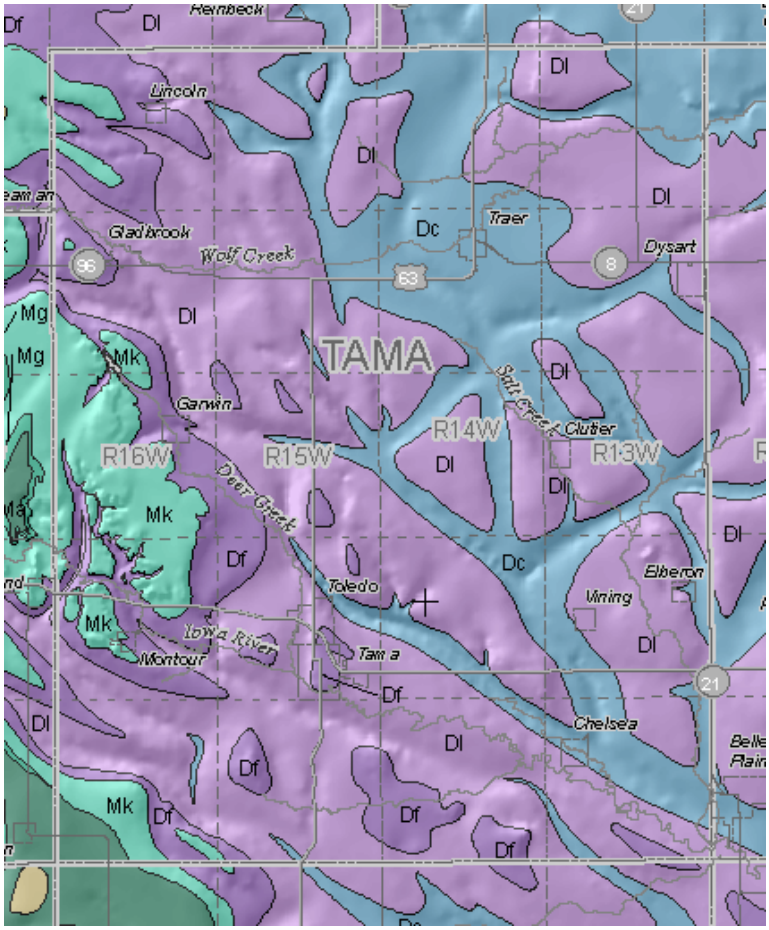
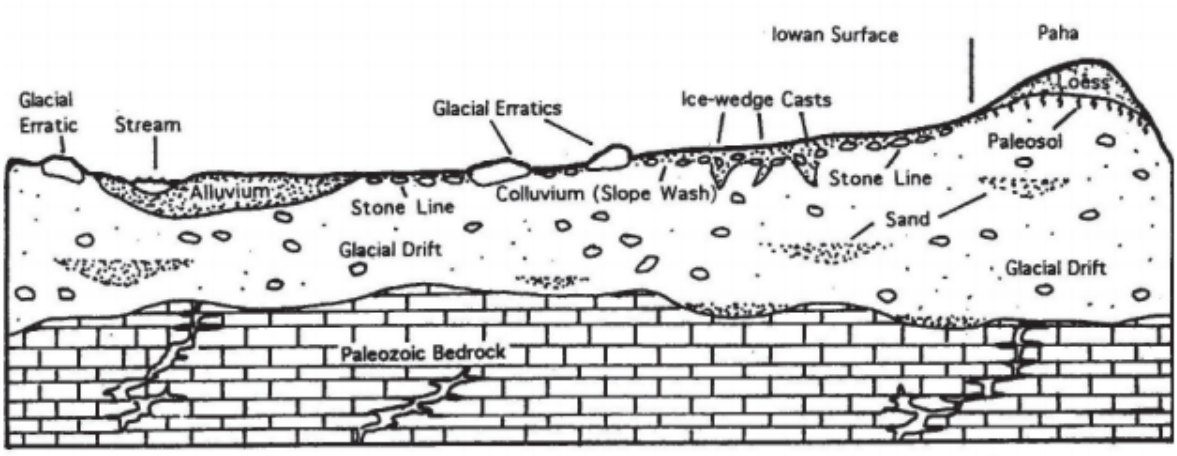
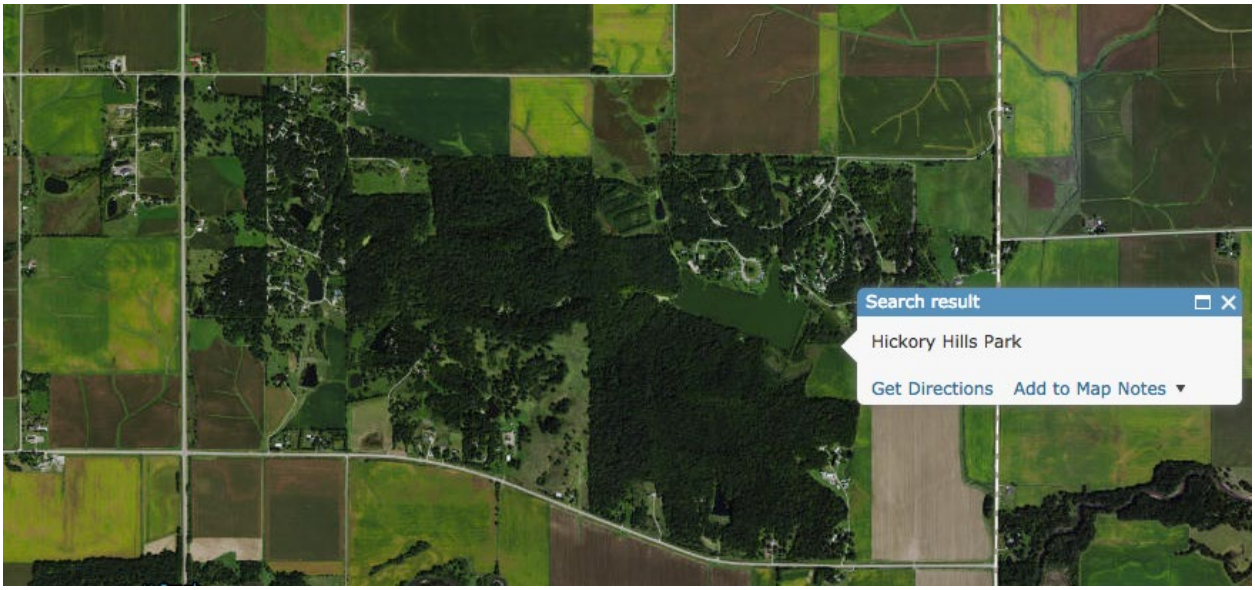


Figure 8 - A schematic cross-sectional view of the Iowan Surface showing its characteristic features



(fromAnderson, 1998, p. 335 [adapted from Prior, 1991 and Walters, 1994].

Figure 9 - Aerial Map of Casey's Paha and Hickory Hills State Park. Created on ARCGis.



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