

Geologic Resources of Iowa Final Project

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## **Abstract**

Buena Vista County has a recent past, geologically speaking, of erosional and depositional geologic events that has given it a varied landscape of rolling hills, flat plain, lakes, kames, and ponds. High school students will research Iowa's geologic past to gain understanding of how Iowa was geologically developed, but spend more time investigating a specific chosen landform in Buena Vista County. The student will visit the sight of the landform, take at least one photo of which they must be in, research, and write an article as to how the landform was produced. Any history, lore, economic benefit or disadvantage surrounding the landform must be addressed in the article. The article must be published on Geocaching.com as either an Earth-cache or a Geo-cache. The capstone activity is a field trip to a number of the geo- and earth-caches students have published. All students must visit, record his/her experience in a meaningful way at each cache site, and publish it on Geocaching.com website.

## **Introduction**

Based on current geological evidence, it is widely believed that Earth's surface began as large body of water and a supercontinent (Pangea). Over the last 4.6 billion years crustal stresses pushed and pulled the continent causing the crust to snap, deforming and tilting Earth's crust. Land masses separated, volcanoes erupted spewing ash and magmatic debris, and winds blew creating sand and dust storms. Seas transgressed and regressed leaving layers of mineral deposits, or eroding land masses entire geological evidence of what happened over millions of years. Huge sheets of ice transgressed and receded over thousands of years reshaping Earth's crust. Even extraterrestrial impacts have left scars on the surface and punching holes in the bedrock. While Earth's physical features were undergoing a change, so was life on the planet. Trapped in Earth's layers is a record of plant and animal life. By carefully examining the sediment strata and the fossils trapped in sediment, we can begin to unravel how the land area now known as Iowa, and particularly Buena Vista County, came to be a rich farmland strewn with rocks of all types, shapes, and sizes.

## Buena Vista County Location, Demographics, and Terrain

Buena Vista County is located in the northwest portion of Iowa (Fig 1). The county is approximately 70 miles east-northeast from Sioux City, Iowa, and 80 miles west-northwest from Fort Dodge, Iowa. The communities of Buena Vista County are Albert City, Alta, Lakeside, Linn Grove, Marathon, Newell, Rembrandt, Sioux Rapids, Storm Lake, and Truesdale (Fig 2).

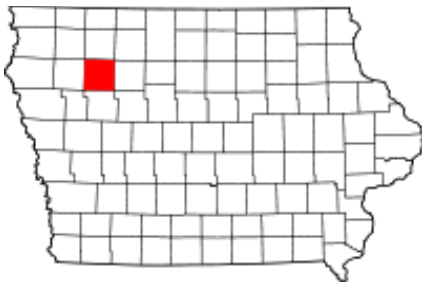


Fig. 1 Buena Vista County, Iowa

The coordinates for Storm Lake, the county seat, are 42.6430° N, 95.2019° W. It is a rural community of approximately 11000 people accounting for more than 50% of the county population. The racial makeup of the city is

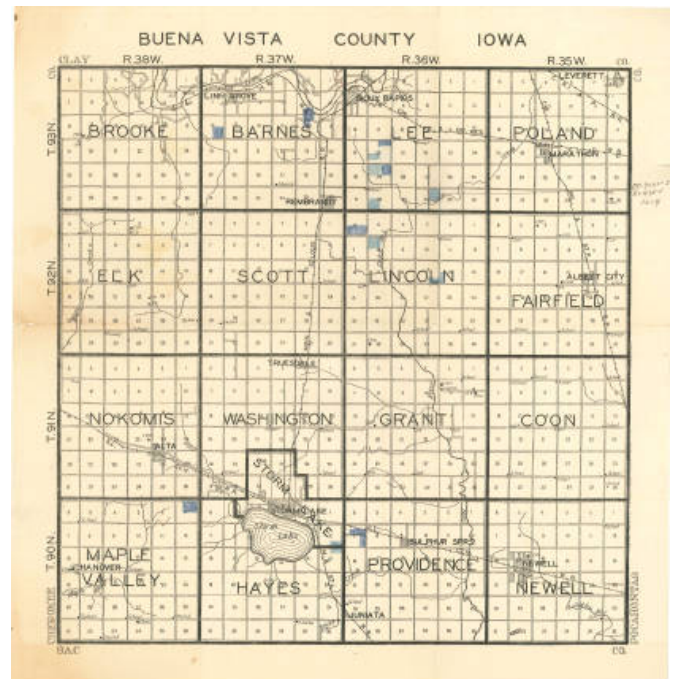


Figure 2

68.4% White, 4.4% African American, 0.4% Native American, 9.8% Asian, 0.9% Pacific Islander, 13.6% from other races, and 2.4% from two or more races. Hispanic or Latino of any race is 36.1% of the population. It has a population density of approximately 2600 people per square mile while the county's population density is 35 people per square mile.

Buena Vista County is mostly agricultural and the major industries reflect that. Land is used mostly for growing crops, such as corn (chief crop), soy beans, hay, and oats. Some is also used for pasture simply because it is too steep, rocky, or both. There are also large pork, beef, and poultry industries located within the county.

Since most of the land in Buena Vista County is agricultural, it is very important to the economy, local and national, to maintain its unpaved roads in so farm equipment has access to the land so farmers can plant, maintain, and harvest the crops. All of Iowa's secondary roads are maintained using aggregates found locally. Buena Vista County is blessed with large amounts of aggregate in the form of glacial till, and there are several gravel, sand, and clay deposits in Buena Vista County that are currently being mined. Mining of aggregate in Buena Vista County for road maintenance is a multi-million dollar industry.

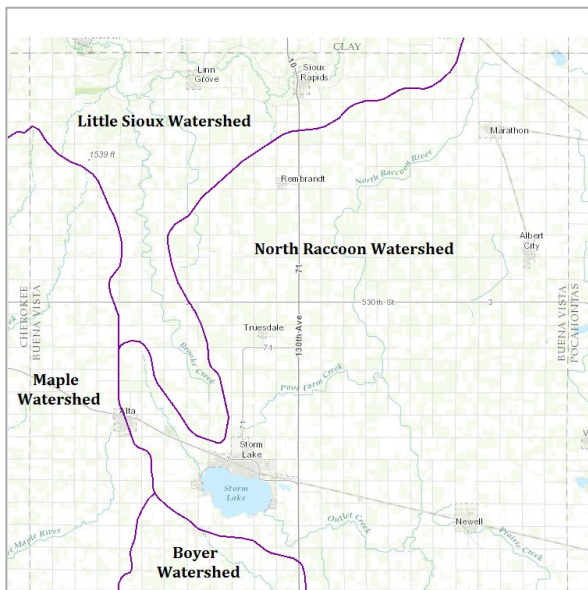
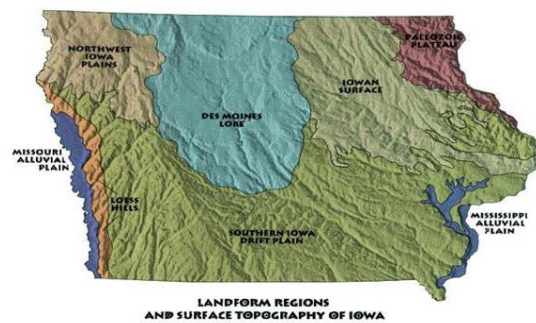


Figure 3

Buena Vista County has 4 sub-major watersheds (Fig. 3). The Little Sioux, Maple, and Boyer watersheds are a part of the Missouri watershed, while the North Raccoon watershed is part of the Mississippi watershed. Geologists believe, however, that the Little Sioux watershed was part of the Mississippi

watershed. Evidence suggests that Wisconsinan age glaciation caused a blockage of the waterways in the area of Spencer causing water to backup into a low lying area but then eventually overflowed causing the Little Sioux watershed to double in size and change direction and drain to the Missouri River (Landforms of Iowa, 1991, Jean C. Pryor) Buena Vista County is very unique in that it has a ridge line caused by glaciation



that separates the Missouri and Mississippi watersheds. Comparing Fig. 5 to Fig. 6, one can see that the dividing line between the two watersheds is in the same position as the west margin of the Des Moines Lobe. Furthermore, close examination of a topographical map of northwest Iowa (eastern Buena Vista) reveals that the area where the last glacial episode affected Iowa is relatively flatter than the portion of Iowa last glaciated during the Pre-Illinoian age (western Buena Vista). The map (Fig. 5) shows how eastern

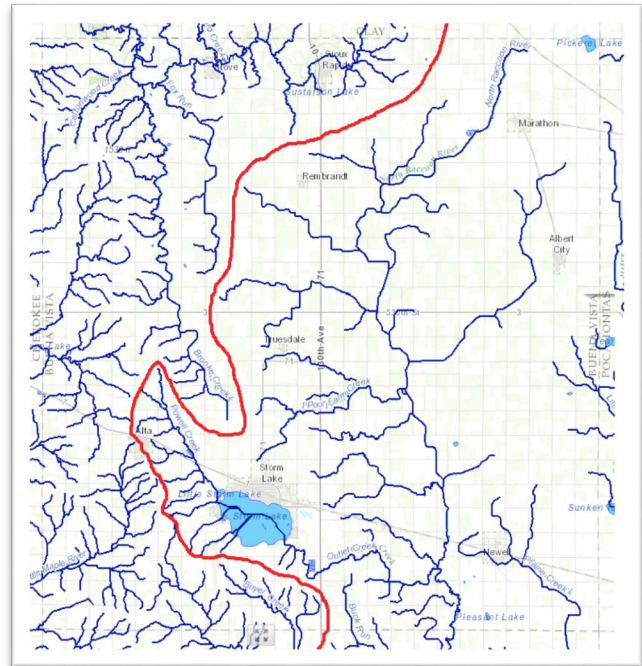


Figure 5

Buena Vista has few small streams causing poor drainage while western Buena Vista is well drained with many streams. The differences in drainage are a result of the different glaciers.

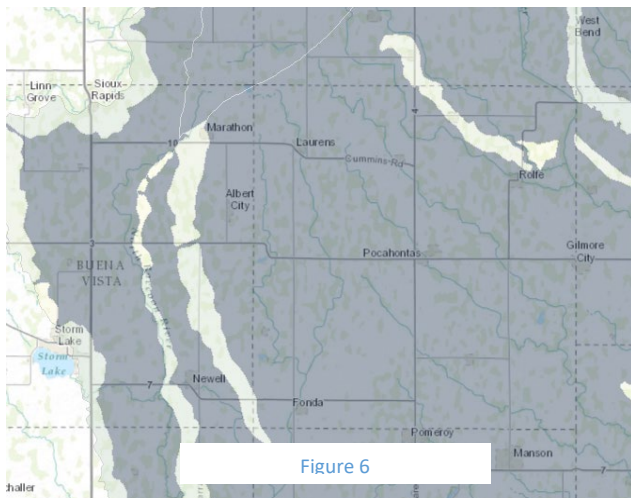


Figure 6

Buena Vista county has two lakes created by glaciation. The largest is Storm Lake in the southern portion of the county. The other is Lake Pickerell. It is a swampy low lying lake with poor drainage in the extreme northeastern corner of the county.



## **Anthropological History of Buena Vista County**

Evidence of the earliest people, known as the Mill Creek culture, is found in Buena Vista County at a village archeological dig site near Linn Grove called the Chan-Ya-Ta Site. The evidence suggests that this tribe or population hunted, fished, grew crops, and built extended family villages in a manner that provided defense against weather and enemies. (Alex, Lynn Iowa's Archaeological Past, 2000, Lynn Alex). The disappearance of this culture from Buena Vista County about 900 years ago remains a mystery. Archeologists speculate that a change in climate may have affected crop and animal population forcing them to seek subsistence elsewhere. Some archeologists believe that they may have been assimilated by other cultures similar to their own. (Mill Creek by Rich Fishel, <http://archaeology.uiowa.edu/mill-creek>)

The northern most area now known as Buena Vista County was first settled by trappers, fur traders, and farmers in the 1820's. A trading post was established and it served as waypoint for the established trade route between Mankato, MN and St. Louis, MO. While there were families scattered throughout the region living in sod homes and some wood cabins, the first permanent settlement was established in May of 1856. (A.T. Andreas Illustrated Historical Atlas of the State of Iowa, 1875). The community grew on the south side of the Little Sioux River and is known as Sioux Rapids. The county's first flour and timber mills, both powered by the flow of the Little Sioux River, were established in the community. (BV County Historical Society, Storm Lake, IA, 2016) The timber along the Little Sioux River was a valuable resource and the saw mill was built to take advantage of that. Most homes in northwest Iowa had to be built from sod because of the lack of trees, except those found along rivers. (History of Iowa by Dorothy Schwieder, 1999)



Beginning in the winter of 1856 and extending into the spring of 1857, a band of renegade Indians, led by Chief Inkpaduta traveled upstream from Smithland to the Lake Okoboji. The band stopped at nearly every cabin and community on their journey northward. They gained access to cabins by appearing non-belligerent so they were usually asked to dine or offered a share of the settlers' supplies. After being treated hospitably, the Indians became threatening and aggressive, taking what they wanted, by force if necessary. As they traveled northward up the Little Sioux River, their brutish behavior escalated to violence. They began to beat the settlers and their children, kidnap and rape women, and steal or kill the livestock. The people of Sioux Rapids were subjected to these brutalities, but no one was killed. However, a few days later the Indians began to brutally kill white settlers in the Iowa Great Lakes region. This has since been known as the Inkpaduta's Raid.(History of Emmett County and Dickinson County Iowa,1917). Inkpaduta and his followers avoided capture by fleeing into Minnesota, and then the Dakota Territory. He fought in the Battle of Little Bighorn and fled to Canada, where he remained until his death (<https://www.nps.gov/resources/person.htm?id=77>, 2016).

### **Transportation in Iowa**

Most early settlers came to northwest Iowa to trap and trade the skins of the abundance of fur-bearing animals, or to raise and support a family through farming. They made their own way overland through the prairie with direct reckoning, or following the occasional animal path. Boats and keels, however, were used on navigable rivers. The first Iowa road was authorized and made in 1835 by the military Dragoons. The road was nothing more than a trail that had navigated the best path from Des Moines to Fort Dodge along the Des Moines River.

In 1838 the first military road was built from Dubuque to Iowa City. It was nothing more than a furrow plowed by a farmer contracted to do the job.

By 1900, there were 104,000 miles of road and all of it was dirt. However, the larger cities of Iowa were using brick to pave some of their streets since the materials were readily available in Iowa. (Historic Iowa



US Hwy 30 during rains before aggregates were used to maintain the roads.

Transportation Milestones Booklet, 1999)

Around 1916, communities began to sponsor a “Gravel Bee” where each able bodied man would help maintain the streets using gravel purchased by the community. With this new use for Iowa aggregate came an abundance of jobs mining sand and gravel. Farmers who had been hit hard by the Depression were glad to have these jobs. Aggregate continued to be in demand up to when the United States joined in World War II. (Historic Iowa Transportation Milestones Booklet, 1999)

## **Geologic History of Iowa and Buena Vista County**

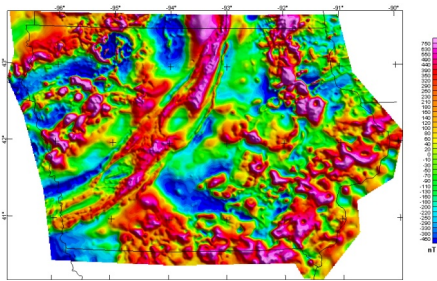
### Precambrian Period

Iowa lies in a position of the continent known as the Stable Interior where the countryside looks mostly flat. However, the underlying bedrock is not! There are uplifts, slopes, and even a dome buried deep beneath Iowan soil and late bedrock layers. Iowa's oldest Precambrian rock, thus far, was formed approximately 2.9 billion years ago and its history is hidden under significantly younger rocks. The only visible outcropping of the Precambrian is a formation (1.5 b.y.a) of Sioux Quartzite found in the Gitche Manitou State Preserve located in the extreme northwest corner of Iowa. Sioux Quartzite is a metamorphic rock comprised of fine-to-medium sand sized quartz grain with superior resistance to erosion so it was heavily mined and used in the construction of buildings in Iowa (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City). This Precambrian outcropping is 100 miles northwest of Buena Vista County.

Since Iowa's Precambrian layer is only visible in one location, scientists had to find ways to determine what is thousands of feet under the soil. Scientists have drilled wells and examined core samples using radiometric dating, depth, magnetic and gravitational anomalies, and mineralogy, and ultimately mapped the results. Further drilling will reveal more about Iowa's Precambrian layer (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

If the Precambrian layer of Iowa could be exposed, we would find that from Iowa's northern border the Precambrian layer slopes its greatest, descending nearly 2500 feet within 50 miles (50 ft/mi), and begins a much more gradual slope descending 1500 feet over the next

100 miles descending 1500 feet (15 ft/mi). Over the next 40 miles basin floor remains relatively level and then begins a final ascent of 2000 feet over the last 70 (30 ft/mi). This formed a basin in which water and sediment could collect (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).



The Midcontinent Rift System can be seen from the north central border curving to the southwest border

Constructive forces were not the only influence on the development of the Iowa Precambrian. About 1.1 bya, destructive forces pulled the continent apart creating a rift. This is known as the Midcontinent Rift System. Lava rose from the mantle into the rift creating new crust. The rift suddenly closed about 1 mya. This rift formed what is called

the Iowa Horst. The horst is 20 to 40 miles wide and was uplifted more than 30,000 feet over the course of its development. Over time, the sediments eroded and were deposited on the sides of the uplift (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

### The Paleozoic Era

Early in the Cambrian period (545 – 510 mya), Iowa was above water and no deposition occurred, but by late Cambrian and into the early Ordovician period all of Iowa had become covered in a shallow sea (sandy marine shelf), that covered most of what is now considered the North American continent. A record is left behind as beaches and (Sauk) sequence deposits. Iowa's Cambrian rock formations (Jordan, Lone Rock, Wonewoc, St. Lawrence) are exposed in eastern part of the state along the Mississippi river in Allamakee County (Iowa's Geological Past:

Three Billion Years of Change, by Wayne I. Anderson. Iowa City). This is located 210 miles from Buena Vista County.

During the early Ordovician period the shallow warm sea completely withdrew from Iowa and the rest of the continent. Earliest bedrock now exposed to the elements eroded and was deposited as sediment to form the Middle Ordovician rocks and sediment. During the middle Ordovician, water again covered Iowa and developed a shelf of quartz sand. Over time, the seafloor became a muddy, carbonate shelf. As a result, the bottom waters were oxygen deficient during the Late Ordovician and organic material developed into shale. During this time the animal and plant life became more diverse. Trilobites, cephalopods, gastropods, and brachiopods can be found in the fossil record of the Maquoketa and Dubuque formations of eastern Iowa. The sea had retreated from Iowa by the end of the Ordovician period leaving the Upper Ordovician rocks exposed to erosional forces (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

The Silurian Period (439 – 409 mya) finds Iowa still south of the equator. The climate in Iowa changed drastically during this period from dry to a warm tropical climate, and became a shallow and warm sea. The sea withdrew during the Late Silurian exposing formations of mostly dolomite, and some limestone, which are heavily mined in central and eastern Iowa for building materials. They are found as outcroppings in a number of locations in Iowa, such as the Hopkinton Formation in Backbone State Park, Delaware County. The fossil record of the Silurian Period is extensive and varied. It includes algae, brachiopods, corals, crinoids, gastropods, graptolites, nautiloids, stromatoporids, and trilobites (Iowa's Geological Past: Three

Billion Years of Change, by Wayne I. Anderson. Iowa City). The closest surface outcrop to Buena Vista County is located in Blackhawk County at a distance of 140 miles.

The sea did not return to Iowa until the Middle Devonian (about 385 mya). The sea bed was exposed for about 30 million years so there is no record of the Lower Devonian strata in Iowa. However, an unconformable layer of Devonian rock now lies on top of Ordovician and Silurian rock. The seas returned, however, retreating and advancing throughout the Middle and Late Devonian. Mud was cyclically deposited on the sea floor, along with carbonate due to sea transgression and regression for approximately 3 million years and can now be seen as 13 Devonian formations in Iowa. These layers of rock contain an important fossil record of brachiopods, bryozoans, corals, stromatoporoids, echinoderms, mollusks, worms, arthropods, sponges, spores, conodonts, and fish (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

Throughout most of the Mississippian Period (360-320 mya) carbonate-producing tropical seas continued to advance and retreat numerous times in Iowa. Limestone is the predominant deposit during this period, but other rocks, such as dolomites, gypsum, shale, quartz, and sandstone can be found as well. Iowa's state rock, the geode, was produced during this period. Iowa has at least 10 Mississippian formations that extend from north central to southeastern Iowa with several exposed areas along the Mississippi River. The fossil record of this period includes echinoderms, brachiopods, mollusks, corals, foraminifera, conodonts, and amphibians. The sea water withdrew from Iowa in the Late Mississippian period, possibly due to warping of the bedrock, exposing the sea floor to weathering and erosion (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

During the Pennsylvanian Period (320 -299 mya), Iowa shorelines shifted back and forth across Iowa a number of times. These shifts caused the environment to change from marine to non-marine. Thus, Iowa's rock contains a cyclical record of those environments. With the underlying bedrock eroded, new sediments were deposited unconformably. Iowa became a swampland, filled with trees, plants, and other vegetation. Over millions of years this plant and animal decayed and settled on the sea bottom leaving layers of carboniferous material. This material eventually became shale and coal in Iowa. Sandstone is found in other Pennsylvanian strata and a fossil record of marine invertebrates, calcareous algae, fish remains and microfossils can be found. The closest outcropping to Buena Vista County is the sandstone layers south of Boone in Ledges State Park at a distance of 130 miles. (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City)

### The Mesozoic Era

The Mesozoic Era (245 -65 mya) consists of the Triassic, Jurassic, and Cretaceous periods. There is no rock record of the Triassic in Iowa, and only a small record of the Jurassic found in Fort Dodge. During this period, Iowa drifted northward to about 25 degrees north latitude. The area was most likely covered with a carbonate water solution and when the water evaporated, it left behind dense layers that formed gypsum, found and mined near Fort Dodge, which is 86 miles from Buena Vista County. Gypsum is used in drywall, cement, and plaster. Iowa's Cretaceous rock record indicates that waters again covered Iowa as it continued to drift northward to about 40 degrees north latitude (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City).

There is evidence that an extraterrestrial impact occurred during the Tertiary Period (73.8 mya) in northwest Iowa and punched a hole approximately 20 miles in diameter through all layers including the oldest Precambrian basement. This is known as the Manson Impact structure. The Precambrian layer has been uplifted to about 100 feet under the glacial till. Some of the minerals have been melted into glass and other rocks appear to have been heated severely. There is also an ejecta pattern around the structure that indicates it was a result of impact rather than that of volcanic uplift. (Iowa's Geological Past: Three Billion Years of Change, by Wayne I. Anderson. Iowa City). This structure is 56 miles from Buena Vista County.

By the end of the Mesozoic Era, Buena Vista County looked much like the rest of Iowa except the few places where there were exposed pre-Cretaceous bedrock, but the next 2 to 3 million years changed the surface of Iowa numerous times due to at least four glacial periods that chewed up the bedrock over which it slid, and deposited glacial till.

The Late Pliocene age was the first to bring glaciations to Buena Vista County as the Additional Pre-Illinoian Glacial and Interglacial Stages which occurred 2.5 mya to 1.65 mya. . Evidence of this stage include unnamed glacial and interglacial mixed with volcanic ash. (Iowa's Geologic Past: 3 Billion Years of Change by W. Anderson) It extended as far south as the location of the Missouri River from Kansas City to St. Louis, so it covered all of Iowa leaving a till of depths between 100 to 150 feet thick. The glacier receded, leaving scars and a troublesome layer of till that was mostly clay in southern Iowa and Missouri. As all of the glacial till weathered, soil was spurring the development of plant life (From Rift to Drift: Iowa's Story in Stone, 1983, J. Troeger).



The Pre-Illinoian Glacial and Interglacial Stages occurred during the Pleistocene Epoch, 1.65 mya to .72 mya. Just like the Additional Pre-Illinoian Glacial and Interglacial Stages, this ice sheet covered entire state of Iowa and moved just as far south. (From Rift to Drift: Iowa's Story in Stone, 1983, J. Troeger). Evidence of this glacial event is the glacial drift of the Wolf Creek Formation, volcanic ash, and glacial drift of the Alburnett Formation (Iowa's Geologic Past: 3 Billion Years of Change by W. Anderson).

The Yarmouthian Interglacial age followed ( .5 mya to .3 mya). It was during this time that the major streams of southern Iowa developed. Evidence of this is the Yarmouth Soil (paleosol) and alluvium (Iowa's Geologic Past: 3 Billion Years of Change by W. Anderson).

The Illinoian glacier was next but evidence in Iowa contains only a partial (.16 mya to .14 mya) record of this age. (Iowa's Geologic Past: 3 Billion Years of Change by W. Anderson). Buena Vista county was undisturbed by this glacier as it only affected the southeastern tip of Iowa about. This glacier caused the Mississippi River to be moved to the west a few miles. During this period there were severe dust storms in western Iowa that impacted the area greatly. These dust storms left huge hills, over 300 feet in places, of loess soil. It deposited mostly in western Iowa on the Missouri River valley because of the tall walls of the river bank slowed the wind and gradually disappears 50 to 75 miles east. Finally the Illinoian glacier receded but the winds in western Iowa continued for about 15000 years (From Rift to Drift: Iowa's Story in Stone, 1983, J. Troeger). During this time loess soil was being deposited on Buena Vista County also.

About 125000 years ago, the Sangamonian Interglacial age began and paleosols developed in southeastern Iowa and in Loveland Loess on the other side of the state.

Quantities of gravel and sand were deposited at this time as well. This period ended approximately 55000 years ago and there was limited amount of change in Buena Vista County (Iowa's Geologic Past: 3 Billion Years of Change by W. Anderson).

The Wisconsinan Glacial Stage began about 55000 years ago and made its way south from Minnesota and into Iowa as far as Des Moines. This glacier, known as the Des Moines Lobe, slid across the eastern half of Buena Vista County (as well as much of northern and central Iowa) changing the Pre-Illinoian landscape. Eventually, the glacier began to melt and left deep depressions in places causing lakes to form. The land was left relatively flat and drainage was poor causing lakes to develop. Near Spencer, Iowa (Lake Spencer), the glacier stalled and copious amounts of ice melt cut a channel to the southwest changing the direction and flow of the Little Sioux River from the Mississippi watershed to the Missouri watershed.

## **IOWA / BUENA VISTA COUNTY GEOLOGIC HISTORY PROJECT**

### **Overview:**

This will be a semester long project. Don't procrastinate. This is your semester final and will be 20 percent of your overall grade.

You are going to research Iowa's geologic past to gain understanding of how Iowa was geologically developed, but spend more time investigating a specific chosen geologic landform in Buena Vista County. You will visit the sight of the landform, take at least one photo of which you must be in (selfie), research, and write an article as to how the landform was produced. Any history, lore, economic benefit or disadvantage surrounding the landform must be addressed in the article.

You will then visit three sites that other students have published in the Google Doc as long as they are not the same site as yours. For each site visited you must write a paragraph about your experience. Include any notable geographic features and include a photo at the site. You must be in the photo (selfie). The site must be recognizable by your teacher.

### **Scoring:**

Geologic History of Iowa	35 pts	
Time frame		5
General position in relation to N/S latitude		5
Climate		5
Life		5
Changes in surface / bedrock		5
Events		5
References		5
Earthcache:		
Essay	35 pts	
Landform description and location		5
Formation of cache		10
History /Lore		5
Economic benefit / detriment		10
Quality of writing		5
Publish on Google Doc	15 pts	
Worksheet questions on		10
Photo of feature with you or a placard taken at the site.		5
3 site visits	15 pts	
You must visit site, take a 'selfie' at site. (Note: I must be able to recognize you and the site.) Then write a paragraph about your visit and PUBLISH it online.		5 pts each

DUE DATE: \_\_\_\_\_