Group 4
Selena Adams
Ben Corby
Belinda Gosnell
Mike Needham

The history of Yellowstone National Park is a long and eclectic one. It may come as a surprise that Yellowstone has many non-volcanic rocks in addition to the basaltic and andesitic rocks left from its volcanic activity. Mount Everts, found east of Mammoth Springs, contains a rock layer with many oceanic fossils, such as trilobites. Oceans covered most of Yellowstone for much of the past 400 million years. The sea receded around 65 million years ago, near the end of the dinosaur age. Other fossils that have been found are the bones of a plesiosaur (a giant marine reptile) and fossil clams, both found on Mount Everts. On top of the layer of marine deposits rests another sedimentary layer that is darker, coarser, and thinner. This layer is formed from material that was deposited in a river delta. It includes fragments of dinosaur eggs and freshwater plants.

Now, the question is, why was there an oceanic environment covering Yellowstone in the first place? Scientists have theorized that the Yellowstone area was once on the western end of the North American continental shelf. The subduction of the Pacific plate took place because the North American plate, being a continental plate, was less dense than the oceanic Pacific plate. The stress and high temperatures caused at the subduction zone formed magma chambers in the depths. These chambers led to massive volcanic activity.

This volcanic activity began in early Eocene time, between 50 and 55 million years ago. The several active volcanoes are now collectively called the Absaroka volcanoes. The Absarokas were andesitic and basaltic stratovolcanoes that were categorized by long vent eruptions with lots of breccias. The magma entered existing Paleozoic and Mesozoic rocks as dikes and other intrusions. Additionally, the forests that grew at the base of the volcanoes were buried by subsequent reactions, which lead to the existence of fossil forests. The temperate and subtropical vegetation in the warm valleys below was petrified, including the redwood, breadfruit, avocado, dogwood, sycamore, and hickory trees that grew there.

Harold Prostka and some others have divided the Absaroka rocks into 3 groups. The Washburn group, including Mount Washburn, is the northernmost and oldest volcanic pile. The Sunlight group is in the middle and is the most mafic group. The Thorofare group is the southernmost group. These groups do run from north to south, but there is a fair amount of overlap between them. After the Absaroka volcanism, the Yellowstone area was quiet for a while, with not much activity in the Oligocene and Miocene epochs. The Pliocene time, however, was marked by lots of uplift activity. The existing landforms were raised several thousand feet above their previous positions (Keefer).

About 30 million years ago, a plume of magma started rising to the surface at about 6 inches per year (Wallace). Around 15 million years ago, it neared the crust and became a "hot spot". One can see how crust continued to move over the hot spot by looking across the west Great Basin's chain of calderas. The track of this one hot spot runs from eastern Nevada to southern Idaho, with the calderas getting successively younger. Around 2 million years ago, the hot spot was in the Yellowstone area, preparing the way for some of the largest volcanic activity ever known.

Approximately 650,000 years ago, Yellowstone National Park was far different than it appears today. The entire area had been a 50-mile wide powderkeg for almost 1.5 million years. Whereas most volcanoes form when a column of magma seeps up to the surface, the Yellowstone Caldera, dubbed a "supervolcano" by the BBC program Horizons in the year 2000, had a much more unstable formation ("Super Volcano Yellowstone"). Rather than a column seeping up to the surface, a wide batholith of magma had risen into the crust and began baking the surface. Eventually, the pressure became so immense that the entire area exploded in one of the most violent eruptions ever.

Six hundred fifty thousand years ago, the pressure finally reached the breaking point. An eruption roughly 2,000 times as powerful as the 1980 Mt. St. Helens blast caused the entire 53 by 28 mile caldera to explode and collapse in on itself ("Super Volcano Yellowstone"). The collapse shot volcanic gases and pyroclastic flows along ground level for 3,000 miles, devastating much of North America. The volume of debris released at ground level was roughly 240 cubic miles, or enough to cover the entire United States with a layer of ash five inches thick ("Super Volcano Yellowstone").

The supervolcano also released a massive cloud of ash into the atmosphere that made the Krakatoa cloud pale in comparison. This cloud circled the earth several times, and caused extinction of thousands of species worldwide. Needless to say, Yellowstone itself was a wasteland, as was much of the North American continent, but layers of ash deposited by this cloud are still being found in core samples as far away as the Gulf of Mexico ("Super Volcano Yellowstone").

What makes the Yellowstone Caldera all the more amazing is the fact that plate tectonics play no role in its formation or eruptions. The Yellowstone Caldera is "merely" a hot spot, like the one forming the docile (by comparison) Hawaiian Islands ("Yellowstone National Park: Yellowstone Volcano Observatory"). An enormous flow of magma collected at that particular spot and, due to weaknesses in the rock rather than plate movement, worked its way to the surface. It was slowed and forced to spread by thicker rock encountered closer to the surface, forming the massive batholith that eventually exploded. The eruption 650,000 years ago was not the first, either. The initial eruption of the Yellowstone Caldera is dated to roughly 2 million years ago ("Super Volcano Yellowstone"). Another one, more intense, followed at roughly 1.3 million years ago. The one 650,000 years ago was by far the most intense, and it's not over yet ("Yellowstone Volcano: Is 'the Beast' Building to a Violent Tantrum?").

A lengthy quiet period followed, with only occasional small eruptions of lava flows. The most recent lava flow has been dated to roughly 75,000 years ago. Since then, geysers and occasional earthquakes have been the only real evidence of seismic activity. Within the past 50 to 100 years, parts of Yellowstone have risen as much as a meter or more ("Yellowstone Volcano: Is 'the Beast' Building to a Violent Tantrum?"). Various explanations for this have all given way to one—the batholith is reloading for another explosion ("Yellowstone Volcano: Is 'the Beast' Building to a Violent Tantrum?").

Geologically, it makes sense. The eruptions have all happened at a spacing of 600,000-700,000 years, and we're right in the time frame for another one ("Yellowstone National Park: Yellowstone Volcano Observatory"). Signs are all pointing to Yellowstone, which is currently in a quiet period, erupting sooner rather than later

("Yellowstone Volcano: Is 'the Beast' Building to a Violent Tantrum?"). If and when the Yellowstone Caldera erupts, the blast would be even more intense than the last one, with some estimates making it 2,500 times as powerful as the Mount St. Helens eruption ("Super Volcano Yellowstone"). An eruption of that magnitude would basically end life on Earth as we now know it. Fortunately, any massive eruption would probably be preceded by a number of smaller blasts, with researcher Robert Christiansen of the U.S. Geological Survey saying that "a blowout on the scale of Mount St. Helens is conceivable" ("Yellowstone Volcano: Is 'The Beast' Building to a Violent Tantrum?"). Though Yellowstone is unlikely to explode on the scale of the blast 650,000 years ago, researchers generally agree that another explosion is in our future. When an explosion happens, it will spell doom for the majority of Earth's life.

Today, Yellowstone and all 2,221,766 acres, is covered with forests, mountains, geysers, hot springs, fumaroles, mudpots, and a variety of wildlife. Much of Yellowstone sits in the caldera of the super volcano which erupted 650,000 years ago. Yellowstone has long been an area of study due to its volcanic activity and its landscape which supports these varieties of geothermal activity, wildlife and vegetation.

Yellowstone is an area known for its volcanic activity, past and present. The present volcanic activity is in the form of geysers, hot springs, pools, fumaroles and mudpots. There are over 10,000 thermal features in Yellowstone. Magma beneath the 40 miles thick crust controls these activities long with some earthquake activity due to faults located in Yellowstone. Lava sits as close as 4-10 miles below the surface in some areas. Ground temperature is extremely high at very low depths in certain areas of Yellowstone. However there are rocks containing hard minerals, such as rhyolite, volcanic ash and tuff, which withstand the heat. Most of these rocks contain silica, which is a hard mineral. When the silica erupts and accumulates on the surface near the geyser, it forms geyserite or sinter. The water released by geysers contains dissolved minerals and gases and are classified into 4 groups: alkali chloride; acid sulfate; acid sulfate-chloride and bicarbonate. These four groups determine the water's pH. Some geothermal activity releases gases into the air including: carbon dioxide; hydrogen; hydrogen sulfide; methane; oxygen; nitrogen; ammonia; argon; radon; helium; neon; krypton and xenon.

Geothermal activity also releases travertine and calcium carbonate into the environment (Schreier).

The park contains half of the world's know geothermal active features including the largest concentration of geysers. There are some large geysers in Yellowstone. These are the geysers that erupt over 100 feet and are rather predictable. The geysers erupt when water seeps through the ground and gets warmed and then released by great pressure through the geysers. The geysers must have a vertical chamber that narrows as it gets closer to the surface. The narrowing acts as a valve, which controls the pressure and the release of the eruption (Schreier). The well known geysers in Yellowstone include Old Faithful, Giantess, Castle, Beehive, Grand, Plume and Lone Star.

Another geothermal feature of Yellowstone is hot springs. In hot springs, water oozes from vents. Hot springs are like geysers in that they let off steam, but do not erupt. The major hot springs include Mammoth Hot Springs, Heart Spring, Chromatic Spring and Emerald Spring. Hot springs in Yellowstone are all many different colors due to the bacteria, algae, and different temperatures. These colors range from red, orange, yellow,and green. Yellowstone's geothermal activity also includes some other small attractions such as pools, mudpots and fumaroles. Pools are small pond-like features containing water and minerals. Pools in Yellowstone range from green to blue in color. This changes due to the amount of light each pool receives and to the amount of rock particles and minerals in the water. Some well known pools are Doublet Pool, Beauty Pool, Morning Glory Pool and Crested Pool. There are also fumaroles located in Yellowstone. These are also called steam vents. Fumaroles release steam into the atmosphere. Sometimes when the steam is released it makes noises like hisses and roars. Another geothermal feature of Yellowstone is mudpots. Mudpots occur when steam from groundwater dissolves surrounding rock into clay creating a large "mudhole". These mudpots vary in color due to minerals. The water released from mudpots is also very acidic which makes dissolving surrounding rock easier ("Four Types"). Heat from volcanic activity makes its presence known by heating ground water to create the thermal features we see on the surface.

The rock in the Yellowstone area is mostly felsic along with some sedimentary rock and oceanic rock. The most common rock is rhyolite. In the mountains of the

Washburn range, dark breccia with angular volcanic stones embedded in a fine angular matrix can be found ("Geology"). This breccia is dated to 50 million years ago and is thought to be formed from ash and rocks from a volcanic eruption. There is also obsidian(black volcanic glass) which can be found in Canyon Village.

There is much vegetation in Yellowstone including forests, wildflowers and exotic plant species. Vast forests can be found in Yellowstone. Lodgepines cover 80 percent of these forests. However, Yellowstone has recently been victim to wildfires that have destroyed some forest land in the park including pine and fir trees ("Wildland"). These forests of pines were set out after the wildfires. Wildfires are not viewed as bad for Yellowstone. The wildfires help the spreading of pine seedlings. Wildfires also stimulate the regeneration of sagebrush, aspen and willows. Wildfires also increase productivity of some plants and grasses.

Living in the mountains, forests and near the lake are many abundant and diverse forms of wildlife. These include bears, bighorn sheep, bison, coyote, elk, foxes, moose, wolves, falcons, bald eagles, lynxes, bobcats, mountain goats and mountain lions ("Wildlife"). In Yellowstone park is also a large lake. Yellowstone Lake is thought to be formed in a caldera basin. The basin was formed when the large volcanic eruption occurred 650,000 years ago. Recently, Studies show that the uplift of surrounding areas is causing Yellowstone Lake to "tilt" ("Geological"). The lake is now tilting to the north more and extending to the south. The area surrounding the lake supports much geothermal activity, is home to many forms of wildlife and supports much vegetation.

With all the present volcanic activity many scientists have tried to predict the future of Yellowstone and its features. Scientists are hoping to apply knowledge from the past and present conditions of Yellowstone to determine what will occur in the years tocome. As time continues to go by, our dynamic earth will continue to change, and these changes will affect Yellowstone and the area around it. The North American Plate will continue to push westward for the foreseeable future causing more stress and tension in the crustal boundary area. The hotspot that is responsible for the Yellowstone supervolcano will continue to brew, and the magma beneath Yellowstone will continue to run its course.

The situation of the Yellowstone magmatic activity is not entirely discernable. It could be that the area is in stage 6 or 7 of a resurgent cauldron cycle (Christiansen, 19.16:729). This would mean that there is a high heat flow which we can see evidence of in the hydrothermal system of Yellowstone, most notably in the geysers. This fact along with the geologic, gravity, aeromagnetic, geodetic, and seismic evidence supports the hypothesis that there probably is rhyolitic magma still crystallizing below the plateau region (Christiansen, 19.16:729). This is significant because the volcanic cycle in Yellowstone begins with a new insurgence of rhyolitic magma, a feat that could have been underway for the last 160,000 years. While the volcano is more than likely to be in the closing stages of the rhyolitic cycle, a volcanic eruption is very possible. In fact, it is almost definite that further eruptions will occur in Yellowstone National Park (Christiansen, 19.16:729).

There have been three major eruptions in the history of the Yellowstone supervolcano. Between the first and second, there were 700,000 years, between the second and third there were 650,000 years, and it has been 640,000 years since the third volcano erupted (Christiansen, 19.16:729). So logically, we can assume that there will be another large scale volcanic basaltic eruption in the next 50,000 years. The location of this eruption will probably be in one of the regions with a relatively young rhyolitic lava flow. The potential locations for this massive basaltic eruption include the Norris Geyser Basin, and the Mallard Lake Central Plateau. Rhyolitic lavas have preceded each major ash flow and caldera episode, and these two locations are the youngest rhyolitic lava flows (Christiansen, 19.16:729).

Until the massive eruption takes place and severely alters the landscape, terrain, and geology of the area, less significant changes will continue to take place. Chemical weathering by acidic alteration of rhyolite at the old Grand Canyon of Yellowstone will continue to take place. Evidence of this is found in the many thermal springs and gas vents between the Lower Falls and Inspiration Point. Other acid alteration of the bedrock is associated with hot springs and fumaroles, especially in Sulphur Hills, north of Sour Creek and the south slope of the Canyon (Hutchinson).

The dynamic earth and the moving plates will continue to cause a change in the landscape and geography of the area. Over the last 600,000 years the Teton fault has been moving at a rate of 0.4 mm a year. Dip Projections indicate that the structural relief of the Teton fault could have been altered more than 1,400 meters over the last 4.3 million years. This fault movement is responsible for forming the area known as Jackson Hole (Christiansen, 19.16:729).

Few things about the future can ever be certain. However, we can use the present to understand the past, and the past to understand the future. By doing this, we assume that at some point in the future Yellowstone will experience a significant volcanic eruption. We assume that chemical and physical weathering will continue to change the landscape of the Yellowstone area. More than likely this is exactly what will happen, we just cannot predict exactly when, but we know that as James Hutton said, the present is the key to the past, and the past is the key to the future.

Sources

Christainsen, "Quarternary and Pliocene Yellowstone Plateau Volcanic Field of Wyoming Idaho and Montana." U.S. Geological Survey Professional Paper 729. Washington, D.C.: U.S. Government Printing Office, 2001

Christianson, Robert L., Robert O. Fournier, Roderick A. Hutchinson, and Ken L. Piene. A Field-Trip Guide to Yellowstone National Park, Wyoming, Montana, and Idaho – Volcanic, Hydrothermal, and Glacial Activity in the Region (U.S. Geological Survey Bulletin 2099). Washington DC: U.S. Government Printing Office,1994.

Four Types Of Thermal Features. 2003. Yellowstone Association 29 Oct. 2003 www.Yellowstonenationalpark.com/geology.htm

Geological Overview of the Lake, Bridge Bay & Fishing Bridge Areas. 07 Aug. 2003. National Park Service 29 Oct. 2003
www.nps.gov/yell/nature/geology/geolake.htm

Geology. 2003. Grand Teton Historical Society. Yellowstone Media Group, Inc. 29 Oct. 2003 www.Yellowstonenationalpark.com/geology.htm

Hutchinson, R.A., T.E.C. Keith, and Donald E. White. "The Geology and Remarkable Thermal Activity of Norris Geyser Basin, Yellowstone National Park, Wyoming." U.S. Geological Survey Professional Paper 1456. Washington DC: U.S. Government Printing Office, 1988.

Keefer, William R. The Geologic Story of Yellowstone National Park (U.S. Geologic Survey Bulletin 1347). Washington DC: U.S. Government Printing Office, 1972.

Prostka, Harold J., and Harry W. Smedes. “Stratigraphic Framework of the Absaroka Volcanic Supergroup in the Yellowstone National Park Region.” U.S. Geological Survey Professional Paper 729-C. Washington DC: U.S. Government Printing Office, 1972.
Schreier, Carl. A Field Guide to Yellowstone’s Geysers Hot Springs and Fumaroles. 2003. Yellowstone Media Group, Inc. 29 Oct. 2003
www.Yellowstonenationalpark.com/geysers.htm

Super Volcano Yellowstone
http://www.solcomhouse.com/yellowstone.htm
Wallace, David Rains. Yellowstone: A Natural and Human History of Yellowstone National Park, Idaho, Montana, and Wyoming. Washington DC: U.S. Government Printing Office, 2001.
Wildland Fire. 20 Oct. 2003. National Park Service 29 Oct. 2003
www.nps.gov/yell/nature/fire/index.htm

Wildlife. 2002. Yellowstone Media Group, Inc. 29 Oct. 2003
www.Yellowstonenationalpark.com/wildlife.html
Yellowstone Volcano: Is ‘the Beast’ Building to a Violent Tantrum?
http://news.nationalgeographic.com/news/2001/08/0828 wireyellowstone.html

Yellowstone National Park: Yellowstone Volcano Observatory
http://nps.gov/yell/technical/geology