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Geology 1010
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Yellowstone
The Super Volcano of North America

“America's oldest and most famous national park sits atop one of the largest, most explosive volcanoes ever to exist” (Breining 2007). For a volcano to be deemed a “super volcano,” the volcano has had to have purged at least 1,000 cubic kilometers, or 240 cubic miles of magma all at once, at one time or another. There is evidence of three major eruptions of the Yellowstone super volcano that were more powerful than any eruptions in recorded history. To put the first eruption into perspective, “The magma chamber beneath the vast area of Yellowstone emptied with the force of hundreds of thousands of bombs the size of the explosion that leveled Hiroshima” (Breining, 2007). When Yellowstone's magma chamber emptied, the surface collapsed back into the earth forming three different, giant calderas as a result of each of the three eruptions.

“Calderas are...collapsed remains of volcanic summits following explosive eruptions. What is left is a wide, steep-walled basin several miles across” (Vogt, 1989). The most recent of these eruptions was 630,000/640,000 years ago, forming the Yellowstone park caldera, the second was 1.3 million years ago, creating the Island Park, or Henry's Fork caldera, and the first, and also the largest eruption, was 2.1 million years ago. “The caldera created by [the] most recent super explosion measures 50 miles by 30 miles and sits nearly in the center of Yellowstone National Park” (Breining, 2007).

Obviously, nobody witnessed these eruptions, and we can only assume what the devastation was like by the aftermath—what is apparent geologically—in the ash beds and the welded tuffs. The three calderas overlap each other, and we can see this through the volcanic tuffs, which are the result of welded pyroclastic materials (hot ash and rock) finally coming to a resting point after an eruption. The three tuffs are so named, the Huckleberry Ridge Tuff from the first eruption, the Mesa Falls tuff from the second, and the Lava Creek Tuff from the most recent..

“During the volcanic cataclysm, hot ash and rock blew into the heavens over Yellowstone, then rained like hell from the sky” (Smith and Siegel, 2000). The heavier particles of ash and pumice welded together by heat to create the previously mentioned tuffs, however the lighter ash particles fell all over the western half of North America. The ash beds hundreds of miles around the eruption site were at least a foot deep, and were several inches further out than the hundreds of miles out. It is likely that the debris and ash expelled from these eruptions cooled earth's climate creating volcanic winters for several years following the eruptions. Along with the Mount St. Helens, and Long Valley ash fall, the diagram above and to the right, puts into perspective the the ash fall of the three major eruptions of Yellowstone.

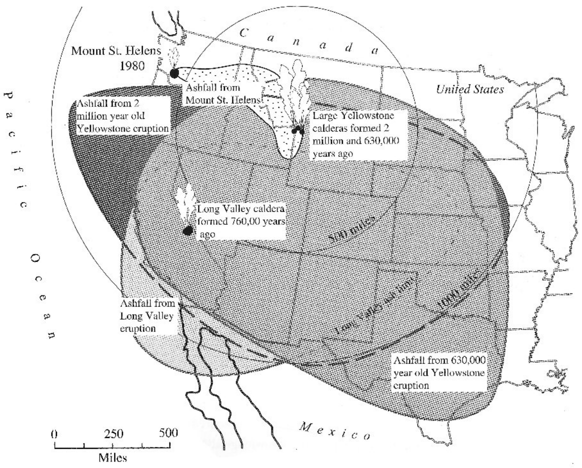

Diagram by Robert B. Smith and Lee J. Siegel (Figure 1)

According to the diagram, the ash fall from the different Yellowstone eruptions covered most of what is now the United States.

The Yellowstone super volcano has a caldera eruption style, that emits pyroclastic material when it erupts. The most recent eruption, 630,000 years ago purged approximately 250 cubic miles of ash and pumice at 1,470 degrees Fahrenheit. Yellowstone expels felsic, igneous rock, rich in the mineral silica, (70% or greater) whereas most other volcanoes expel basaltic/mafic igneous rock containing 45-50% silica. Yellowstone's eruption style is a caldera-style because of having a higher viscosity due to the high concentration of silica in its rhyolitic magma/lava.

Although Yellowstone does not expel basaltic/mafic lava, (from the research collected) there is still “...basaltic magma trapped inside the chamber by denser, overlying rhyolitic magma” (Achenbach, 2009). Because there is geological evidence that there is magma building up under Yellowstone, we see that there is definitely a possibility that Yellowstone could have a major eruption again in the future, but to have it erupt anytime soon is unlikely. However, since the major eruption that happened 630,000 years ago, there has been an estimated eighty smaller eruptions, the most recent being 70,000 years ago.

Pumice Rock... Photo by Chris Anderson (Figure 2)

Because Yellowstone has a history of a more explosive eruption style (probably the most explosive of all eruption styles) the materials produced in these eruptions are mainly hot ash and pumice. Pumice is a light, glassy rock that cools rapidly after an eruption.

Because pumice cools so rapidly, the chemicals within it are unable to unite to make an orderly crystalline structure—leaving us with a “holey” rock that is so lightweight that it can float on water. Pumice has a light color because of the felsic properties of its parent magma.

“The Yellowstone hotspot is the largest hotspot under a continent and among the largest of some thirty active hotspots on Earth” (Smith and Siegel, 2000). Although the point of origin of the hotspot is not exactly clear, there is evidence that the North American crustal plate drifts southwest over the Yellowstone hotspot approximately 1” per year. There is evidence that this particular hotspot was beneath what is now Nevada, Oregon, and Idaho about 16.5 million years ago—creating a chain of calderas that grew gradually younger, and dumping volcanic ash over half of the United States.

Presently, the ground at Yellowstone emits thirty to forty times more heat than the rest of North America. This heat from the active hotspot is displayed in Yellowstone's geysers, hot springs, mud pots, and steam vents.“Half the geysers on the planet are in Yellowstone” (Achenbach, 2009). “This 200-foot-wide,” (Figure 3) “vividly colored hot spring exemplifies Yellowstone's world-renowned geothermal features. Mineral deposits next to the spring are colored by microbes that thrive in hot water” (Smith and Siegel, 2000).

Grand Prismatic Spring Photo by David Mencin (Figure 3)

"A volcanic hot spot beneath Yellowstone is responsible for the continuous thermal activity that spawns numerous fumaroles and geysers..." (Erickson, 2000). Geysers are generally intermittent and they are also explosive. The hot water that is ejected from the geysers at Yellowstone can rise between 100 to 200 feet high. "Geysers need earthquakes" (Smith and Siegel, 2000). Small earthquakes driven by the hotspot help break up any clogging minerals by shaking the conduits within the earth at Yellowstone, resulting in a change in the over 300 geysers, the hot springs, mud pots, and steam vents behaviors.

Approximately 2,000 earthquakes shake within and around Yellowstone National Park each year (about five each day). Some of the earthquakes are too small to notice, usually under a magnitude of 5, however others have been immense, and some even devastating, reaching a magnitude of 7.5. However, the earthquakes within the park have never been recorded to exceed a magnitude of 5, the quakes within a caldera are generally weaker—it is on the outskirts of the caldera that the earthquakes are massive. In 1959, a massive 7.5 earthquake happened just outside of the park creating a landslide at "Hebgen Lake" killing 28 people.

In 1975, a 6.5 earthquake happened at the "Norris Geyser Basin." In 1983, the "Borah Peak" earthquake reached a 7.3. In 1985, an earthquake shook within the park itself, followed by several thousand earthquakes in the following months, and ten years after, another onset of earthquakes. The Yellowstone Super Volcano is far from being extinct, or even dormant, really. "Even today, the thin, heated crust of Yellowstone is heaving like the chest of a gasping man" (Breining, 2007). The majority of the millions of Yellowstone National Park visitor's are ignorant to the fact that Yellowstone is a super volcano—if not a currently active volcano, it is at the very least, an active system.

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