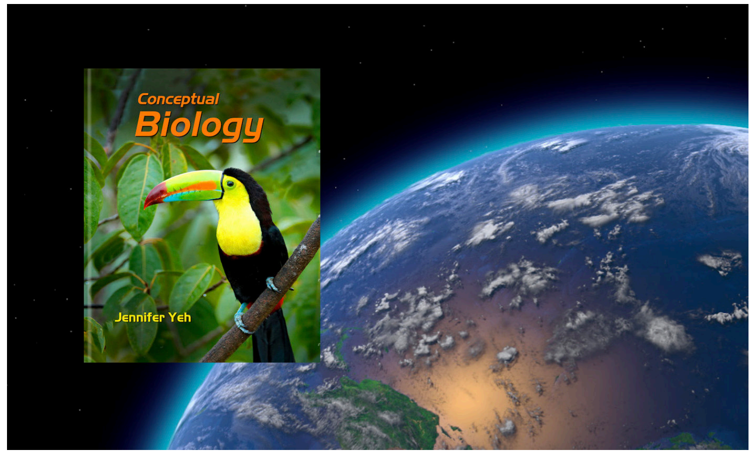
Chapter 11

Diversity of Life 2

Living Earth



11.7 The Impact of Natural Hazards

The Yellowstone Supervolcano

In 1971, the young geologist Mike Voorhies and his wife, Jane, were strolling along a gully on the edge of a farm in northeast Nebraska not far from where they lived. Since he was a little kid, Mike had been fascinated by fossils, having found his first ancient camel tooth at the age of 8. On that day by the gully, he happened to notice what looked like an animal skull protruding from the eroding edges. Within minutes, he and Jane unearthed not just the skull but the entire skeletal remains of a 12 million year old rhinoceros. They had discovered what has since become known as the Ashfall Fossil Beds of Nebraska.

Figure A Mike Voorhies discovered the Ashfall Fossil Beds of Nebraska.

Further explorations revealed the remains of hundreds of large vertebrate animals who, around a water hole, had died together upon being buried by a meters thick layer of ash. The source of this ash? A supervolcano 1000 miles to the west—an earlier version of the very same supervolcano that now resides beneath Yellowstone National Park in northwest Wyoming.

Recall that the outer layers of Earth are made up of a series of tectonic plates, looking much like a cracked hard-boiled egg. About 95% of Earth's volcanoes arise along these cracks. These volcanoes are certainly destructive, but they pale in comparison to the fewer "supervolcanoes" found on Earth.

Figure B The Grand Prismatic Spring of Yellowstone is one of many bodies of water in the area heated by an underlying pool of magma.

Supervolcanoes tend to form over a "hot spot", which is where there is a direct line between Earth's molten mantle and the surface. These hot spots tend to occur in the middle of a tectonic plate rather than along the edge of the plate. Yellowstone resides over just such a hot spot, which explains its many natural hot springs along with frequent earthquake activity (Figure C).

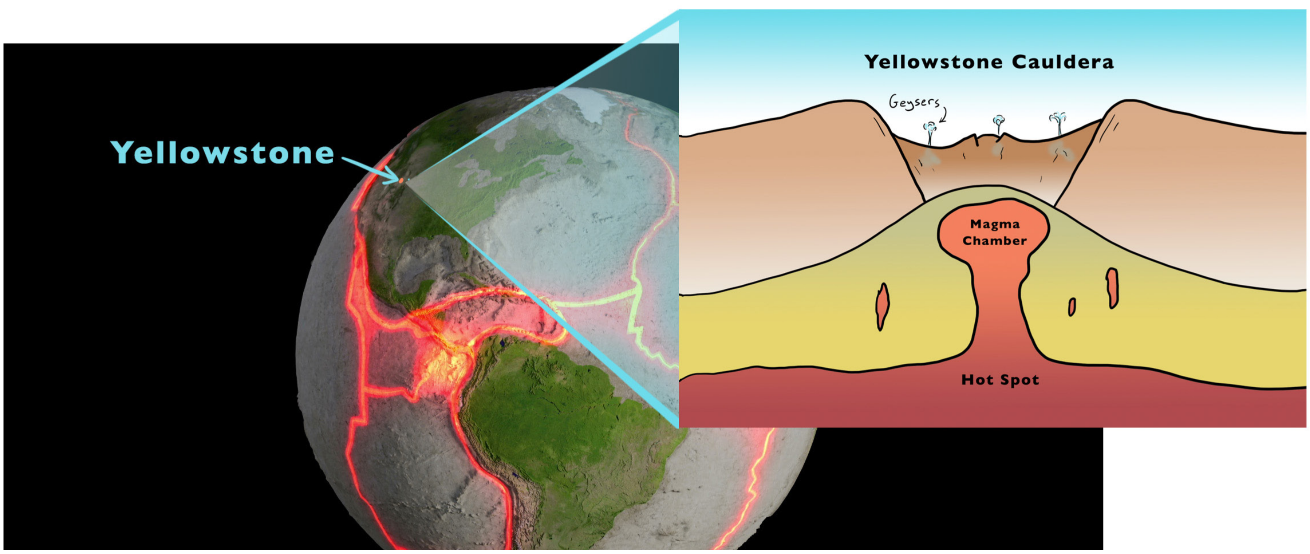


Figure C Yellowstone is found over a hot spot within the North American tectonic plate.

The Yellowstone supervolcano has a history of blowing up once every 600,000 years or so. Notably, the last mega-explosion occurred about 630,000 years ago, which means that we are due for another mega-explosion at any time. Yellowstone, however, is one of the most closely studied and monitored volcanoes around the planet. As of this writing, the Yellowstone supervolcano is showing no unusual signs of impending doom.

But that doesn't stop scientists from wanting to learn as much as they can about this volcanic system. For example, geology graduate student Hannah Shamloo, and her advisor, Christy Till, from Arizona State University, published research showing that the build-up to the last major eruption of Yellowstone may have occurred over a matter of only years or decades, as opposed to thousands of years. But how exactly did they come to this conclusion? After all, we're talking about a supervolcano that erupted some 630,000 years ago.

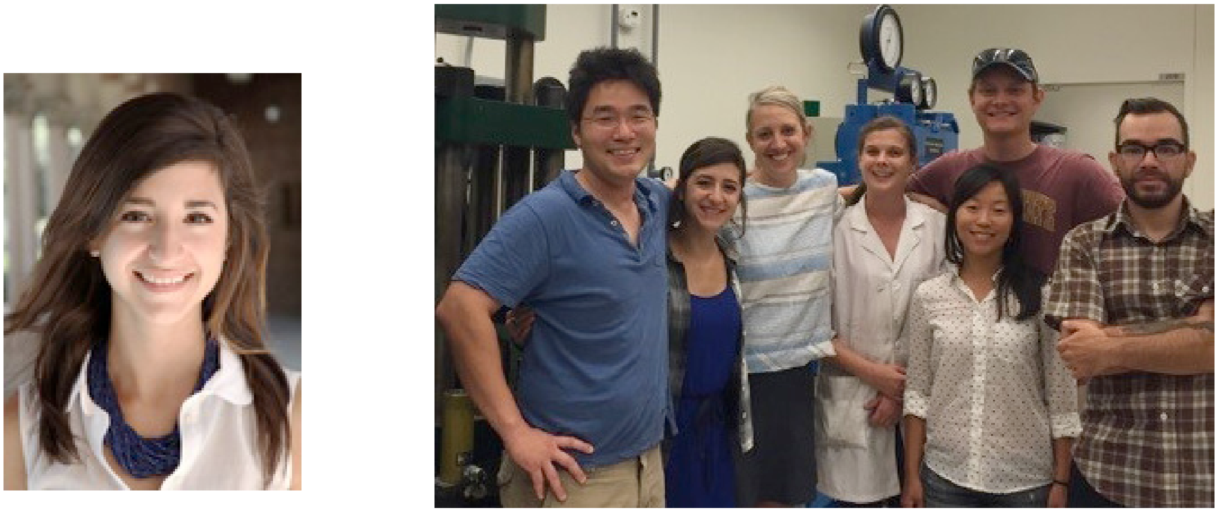


Figure D Hannah Shamloo and her team looked at how crystals formed within Yellowstone's magma formed just prior to the last eruption. The chemical composition of these crystals held important clues to how this eruption unfolded.

Hannah and her team traveled to Yellowstone to collect samples of ash from the layer corresponding to the last mega-explosion (Figure D). Back in the laboratory, she used instruments to measure the chemical composition of micro-crystals known as phenocrysts—tiny crystals that form as magma cools as it slowly rises toward the surface. She had learned that as the crystal grows, trace elements, such as barium, Ba, get embedded within the crystal. The gradient from the center of the crystal to the outer edges, thus provides a storyline of the changing conditions beneath the volcano prior to eruption.

If there were no changes at all in the conditions of the magma over time, then the chemical composition would be the same throughout the crystal. What she found instead were chemical changes that showed two things: a rapid increase in the temperature of the surrounding magma and an increasing amount of crystallized barium (Figure E).

The problem with this is that with increasing temperatures, barium tends to stay out of the crystal and within the molten magma—yet with higher temperatures, they found the barium content of the crystals actually increasing! Further analysis also showed a relatively low content of water within the crystals. This was telling because a major mechanism for volcanic explosions is the presence of large amounts of water, which helps in the building of pressure.

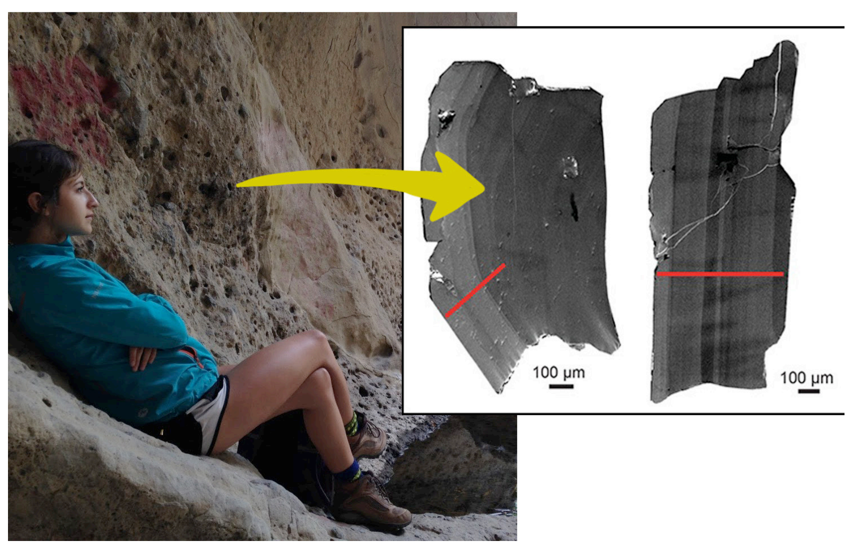


Figure E Hannah Shamloo by the area in Yellowstone where samples containing the phenocrysts were collected.

Here was important evidence within these tiny phenocryst crystals. And like a thoughtful Sherlock Holmes, Shamloo and Till realized this pointed to a likely alternate mechanism of the last mega-explosion. Their observations could be explained by the rapid influx of a large quantity of magma from deep below over not thousands of years, by potentially only decades. If true, this means that present-day Yellowstone could go from its current conditions to a major explosion within this century.

As Hannah and her advisor are quick to point out, much more research is required to support or refute these conclusions. Further, the subterranean magma chambers, as far as scientists can track, are currently not undergoing major movements. Thus, geologists estimate that the chances of a mega-explosion occurring within a year to be about 1 in 760,000. The slow release of lava, which would devastate only the area around the national park, has a greater chance of occurring at about 1 in 10,000.

The main point to all of this is that we live on a planet that is very much alive. When it comes to volcanoes, earthquakes, tsunamis, wild fires, tornados, hurricanes, and other destructive forces, the more we can learn about these systems, the better we are able to prepare ourselves. Learning more about these natural hazards also helps us to respect the wonders and powers of this living planet upon which we live.

Figure F The Pinatubo volcanic eruption of 1991 within the Philippines.

READING CHECK

If the chemical composition of phenocrysts are uniform throughout the crystal, then what does this say about the condition in which the phenocrysts formed?

CHECK YOUR ANSWER

A uniform chemical composition indicates little changes in conditions within which the phenocryst formed.

Follow this link to learn more about the Yellowstone supervolcano:

https://www.usgs.gov/observatories/yellowstone-volcano-observatory