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Studying Volcanoes Under the EarthScope

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We all know the graceful and menacing shape of a volcano. But what does a volcano look like underground? Images of a volcano being fed through a simple pipeline bringing hot, molten rock from a chamber below can be found in popular literature and scientific books. It is simple and easy to understand - but that is not exactly the whole story. When lava is underground scientists call it magma, and no one really knows how magma is stored beneath volcanoes or how it reaches the surface during an eruption.

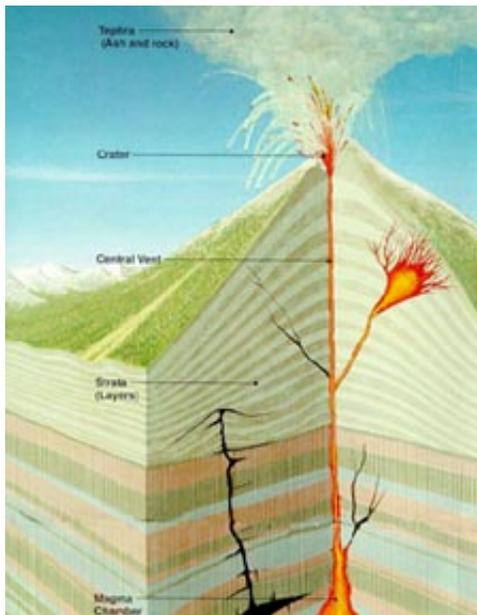


photo courtesy of USGS

This simple view of the interior of a volcano has a single pipeline bringing magma from deep in the Earth to the surface. Scientists know this model is too simple, but filling in the story will take much more data and study.

largest prehistoric eruptions, and has shown signs of renewed activity.

Much of the workshop was devoted to informal discussion of scientific issues related to the EarthScope effort. The scientists discussed the different processes that control the behavior of magmatic systems including the: 1) Structure of Magmatic Systems, 2) Dynamics of Magma Movement, and 3) Volcano and Plate Interactions.

Structure of Magmatic Systems

The Structure of Magmatic Systems discussion focused on what locations and research would best illuminate the inner "plumbing" of volcanoes. Is there really a magma chamber and pipeline to transport the magma to the surface? Or is something else going on? And are all magma systems set up the same way?

In late October, a group of leading scientists gathered to plan research that will help us better understand these magmatic systems. At the [EarthScope Workshop on Active Magmatic Systems](#) in Vancouver, Washington, these scientists discussed how to use EarthScope resources to learn about magmatic systems. EarthScope is a monumental earth science project intended to turn a "telescope" on the North American continent and its geologic processes, and is currently awaiting Congressional approval of the National Science Foundation's budget request.

At the workshop, academic and government geologists, geophysicists, and geochemists met to begin planning the magmatic systems component of the EarthScope experiment. The research will focus on four areas of the country: the Aleutian Islands in Alaska, the Cascade Mountain range in the western U.S., the Yellowstone region in Wyoming, and the Long Valley caldera in California.

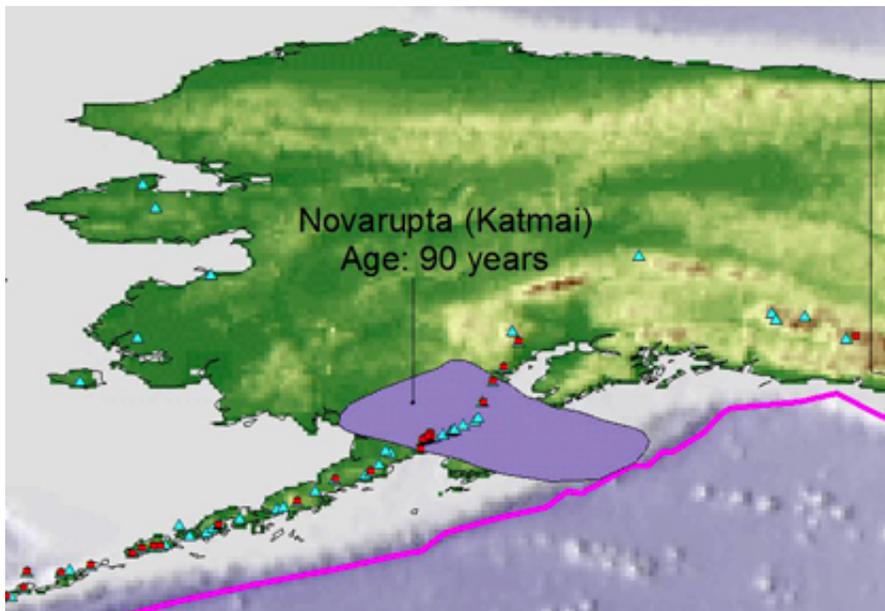
Each of these locations has active volcanic systems that are fed with magma from deep within Earth. Some are obvious volcanic systems, like the Cascades volcano Mt. St. Helens -that erupted just over 20 years ago. Other volcanic systems are not so obvious, such as the Long Valley caldera. This volcano has not erupted in human history but was the site of one of the world's

To better answer these questions, EarthScope will provide a dense network of Global Positioning System (GPS) instruments that measure millimeter- to centimeter-long movements on the surface of Earth. By concentrating these instruments on known volcanoes, scientists can piece together images of what is inside.

The scientists also recommended using seismographs to measure small and large movements of rock and magma beneath the surface of Earth. These instruments could be deployed in all four locations, with possible concentrations on volcanoes in the Aleutian Islands in Alaska, and the Cascade Mountain Range in the northwest United States.

Dynamics of Magma Movement

One application of magmatic systems research is to someday be able to predict the size and timing of large eruptions. As of today, one of the limitations of reliably predicting eruptions is incomplete knowledge of how magma moves through the system before, during, and after an eruption. The Dynamics of Magma Movement discussion focused on how and where to monitor a complete eruptive cycle.



Ash fall region for the eruption of Katmai Volcano in Alaska. (Image Courtesy of [SAGUARO Project](#))

If scientists can "catch an eruption" that is, have a volcano fully instrumented prior to and throughout an eruption, they could learn a lot about how the magmatic system behaves. Unfortunately, to instrument every volcano in the U.S. is very expensive, thus the challenge is to strategically place instruments on sites that are likely to erupt.

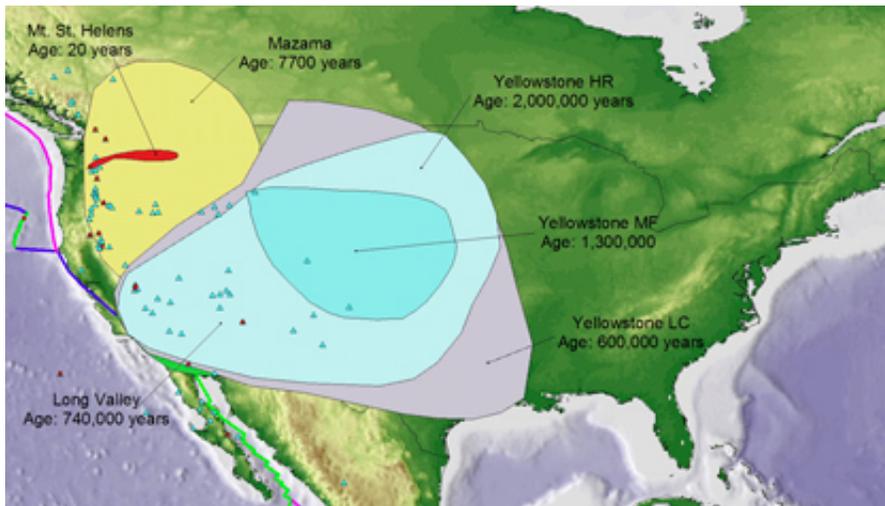
The Aleutian Islands and Cascade Mountains are the obvious candidates to monitor, as volcanoes have erupted in each of these regions in recent history at least once. Experts agreed that 5 volcanoes in the Aleutians should be outfitted

with instruments, and 2 in the Cascades. The scientists also recommended that EarthScope acquire a set of instruments that could be rapidly deployed to areas of active magmatic activity. This "Hotfoot array" could be used to catch an eruption or other magmatic process in progress.

Volcano and Plate Interactions

The Volcano and Plate Interactions discussion tackled how to use EarthScope to study the interactions between volcanoes and plate boundaries. The surface of Earth is covered with rigid plates of rock that move slowly around the globe over millions of years. The continents and ocean floor are two different types of these plates. Where two plates meet, earthquakes and volcanoes are common.

Long Valley, for example, is a volcano that sits near the North American plate boundary, better known as the San Andreas Fault. In the past, earthquakes along the San Andreas Fault have coincided with activity in Long Valley - but scientists do not know the details. Can earthquakes along the plate boundary trigger volcanic eruptions? Or can volcanic activity trigger movement along the plate boundary? In either case, EarthScope may help illuminate what is going on.



Ash fall tuffs located in the lower 48 states. (Image Courtesy of [SAGUARO Project](#))

says "the volcanology community has a wealth of geophysical and geological techniques available to study magmatic systems, but has never had the physical or human resources to investigate different systems with the level of detail needed to really see the inner workings."

EarthScope will provide the physical resources to gather the most detailed information to date on how volcanoes work. It will also bring together scientists from different fields and locations to collaborate and answer these important questions.

More information

[Cascades Volcano Observatory](#)
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[Monitoring Long Valley Caldera](#)
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