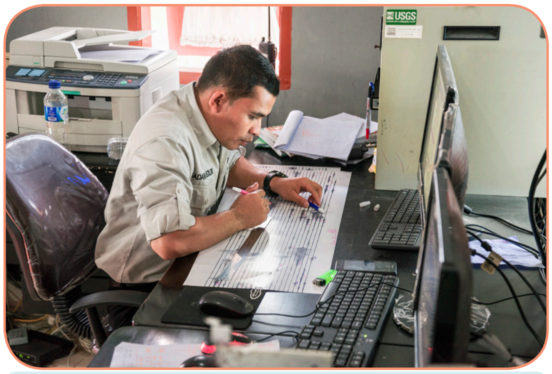
Using and Positioning a Seismograph

Posted at 9:42 am on August 8, 2019

To understand how volcanic eruptions happen, we have to start underground. We use a *seismometer*, an instrument that measures vibrations in the ground. But not just any vibrations! Seismometers can detect tiny *volcanic earthquakes* that are trembling beneath the volcano's surface.



Seismometers record seismograms, which we analyze

Volcanic earthquakes are triggered by the movement of magma within a volcano's magma chamber. The magma rises, creating pressure as it pushes through fractures in the rock. The rock then cracks and breaks, creating a vibration—an earthquake! We can't feel these earthquakes under our feet due to how small they are, but they can happen at any time. A single volcanic earthquake doesn't indicate an oncoming eruption of a volcano. However, a significantly large swarm of volcanic earthquakes—known as a *volcanic tremor*—is enough to signal that a volcano is on the verge of shooting some hot lava and rock into the air. Pretty cool, huh?

Seismograms help us see if a volcano is showing signs it will erupt

To detect these earthquakes, we bury these seismometers one meter in the ground, surrounding the volcano from 20 kilometers away. To get a simple reading, we place six to eight seismometers in the ground. If the volcano is located close to a nearby town or city, it poses a greater risk of harming the community if it erupts. We then double the number of seismometers we place. The vibrations picked up by the seismometer are then recorded as *seismograms*, or digital renderings of seismic waves, which are transmitted to our laboratory for analysis.

Reading seismograms lets us see when a volcano could potentially erupt. We can then share this information with the local authorities, who can warn people about the oncoming danger and potentially save lives.

Latest Posts

- Blog Post 1
- Blog Post 2
- Blog Post 3
- Blog Post 4
- Blog Post 5
- Blog Post 6

Using and Positioning GPS

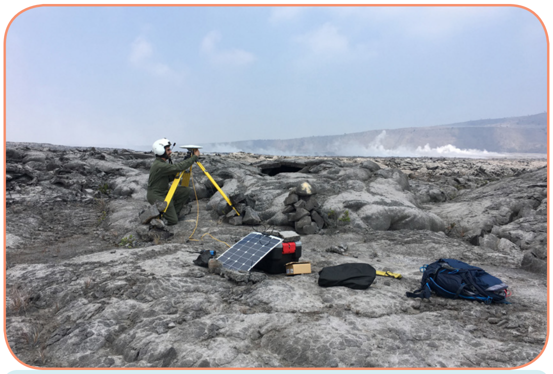
Posted at 10:37 am on August 15, 2019

Volcanic eruptions aren't hard to miss. Their chaotic eruptions hurtle lava, rock, and ash clouds hundreds of meters into the air, and they can be seen from a great distance. But the human eye can't see what's going on inside of a volcano before it erupts. Otherwise, we would be out of a job!

We use GPS to monitor and measure the surface activity on a volcano—this image shows a volcanologist recording a fumarole's position

We use *Global Positioning System* (*GPS*) monitoring, which allows us to monitor and measure any movement on the surface of the volcano. This movement is called *deformation*. It happens when magma, gases and other fluids move under the ground, causing the surface of the volcano to swell, sink and crack. These changes in the volcano's shape are a sign of earthquake activity beneath the volcano's surface, and can increase in size immediately before an eruption takes place.

To track deformation, we place multiple GPS receivers into the ground around the volcano. They're connected to satellites that orbit the Earth twice a day and continuously transmit data to our receivers. We then use this data to calculate the exact location of the receiver at any specific point in time.



The GPS are placed at multiple sites around the volcano—here, one of our team members is installing a GPS to monitor further eruptions at Kilauea

By looking at data from a single GPS receiver over a period of time, we can see whether the surface of the volcano has moved, and at what speed and direction. The data from the GPS receivers creates a larger picture of the active state of the volcano, and whether what's happening underground will eventually turn into a volcanic eruption.

Latest Posts

- Blog Post 1
- Blog Post 2
- Blog Post 3
- Blog Post 4
- Blog Post 5
- Blog Post 6

Using and Taking Rock Core Samples to Determine How Regularly Eruptions Happen

One way we collect rock samples is by breaking a piece of rock off and examining it

Posted at 12:03 pm on August 21, 2019

As we set up our monitoring equipment to take seismic and deformation readings, we also head out closer to the volcano, taking direct samples of the volcanic rock for further study. This is called taking a *rock core sample*. It allows us to identify the different types of ash, igneous, or sedimentary rock that have been deposited, or formed, by volcanic eruption. We can then examine the rock to understand how regularly the volcano has erupted.

Another way to take rock core samples is by drilling into the ground surrounding the volcano. We use hollow steel pipes with a length of two meters—these are driven into the ground using large weights. The pipes then fill with earth and rocks from the volcano. We remove the pipes, extract the rock samples, and divide them into sections. We then repeat the process multiple times, drilling the pipe 2 meters deeper into the volcano each time.

Not only do these samples detail the different layers of rock the volcano is made up of, but they can tell us more about how the volcano formed over thousands or even millions of years, as each layer of rock reveals a different time period.

Huge drills bore into the ground, removing rock core samples like these

For example, say our rock core sample contains three layers. The first layer contains light-colored rock, known as tephra, which is what is expelled by a volcano during an eruption. This reveals to us that an eruption has recently taken place. The second layer contains different types of sedimentary rock, indicating a time period where our volcano did not erupt and when rock formed through natural processes like weathering and erosion. The third and final layer contains basalt, which is rock formed as the lava erupted by the volcano cools. If there are more layers of basalt, then we can determine how frequently the volcano has erupted and whether it is likely to erupt in the future.

Latest Posts

Temperature Monitoring

Posted at 11:56 am on August 27, 2019

Fumaroles are just one of the volcanic features that we monitor

As we know, volcanoes are very hot rock formations. However, lava is not the only thing that gives off heat in a volcano. Other volcanic features such as steaming vents, geysers, hot springs, and lava domes all give off an incredible amount of heat. Before a volcano erupts, the temperature of the volcano rises due to an increase in the volcano's magma activity.

We have to continuously monitor the volcano to recognize when its temperature starts to change. There are three different types of volcanic features that need to be monitored for temperature change:

1. Steam or vapor dominated features, such as gas vents, fumaroles, and mud pots
2. Water dominated features, such as geysers, hot springs or pools, and crater lakes
3. Lava dominated features such as lava lakes, lava flows, lava domes, and pyroclastic flows

We use tools like thermocouples to record the temperature of volcanic features

Recording the temperature of these volcanic features must be done carefully, as dealing directly with lava and hot steam can cause dangerous burns and injuries.

There are multiple ways we can record temperature at a volcano. We can use *thermocouples*, which are sensors that record temperature. We place these directly onto the surface of the volcanic feature we are monitoring. This kind of measurement is only taken if the area is safe to be in for at least several minutes. These direct measurements are precise but limiting, as they only cover specific areas of the volcano.

Temperature measurements can also be made at some distance from the volcano. We use cameras that measure thermal *infrared radiation (TIR)*, which is released from a heated surface. These cameras produce an image using a color spectrum that correlates with detected temperature.

Infrared satellite sensors can also detect the temperature from a volcano. This is an important tool that allows us to monitor remote volcanoes that we can't cover with ground-based equipment. These sensors can record images of larger areas of the volcano that hold higher temperatures.

Latest Posts

- Blog Post 1
- Blog Post 2
- Blog Post 3
- Blog Post 4
- Blog Post 5
- Blog Post 6

Gas Emissions

Posted at 3:24 pm on September 4, 2019

Ash plumes, like the one seen here at Agung on the Indonesian island of Bali, help us understand how and why volcanoes erupt

We can analyze gas emissions data in real time at volcano observatories—this observatory, in Naples, Italy, monitors Vesuvius

Not only do volcanoes erupt fiery lava, but they emit gas plumes high into the air, hidden in ash clouds. These gas plumes are an important means of understanding how and why volcanoes erupt, as the gas in a volcano is released by magma that is stored in a magma chamber.

As the magma begins to rise to the volcano's surface, the gases in the magma create tiny bubbles. These bubbles grow as the magma continues to rise, turning into a magmatic foam. When the pressure in the magma is greater than the rock that surrounds it, it explodes, producing a volcanic eruption.

The different gases that are emitted by volcanoes include sulfur dioxide, carbon dioxide, and hydrogen sulfide. Keeping a close watch on gas emissions can alert volcanologists when the magma has changed inside of a volcano, triggering a potential eruption.

There are two ways we can monitor gas that is released from a volcano: *direct sampling* and *indirect sampling*.

Direct sampling is one of the easiest methods of collecting a gas sample. We do this by using a *MultiGAS spectrometer*. This monitors several gases at once, creating a detailed chemical analysis of all the gases that are detected in one area. We install these spectrometers right on the edge of a volcanic crater, within close proximity of a gas plume. The collected data is then transmitted by radio waves to a volcano observatory, providing minute-by-minute updates in changes in gas concentrations.

Remote sensing is when we use a piece of equipment called a *correlation spectrometer (COSPEC)* which is designed to measure the concentration of sulfur dioxide in a gas plume that is emitted from a volcano. This is important, as changes in sulfur dioxide emissions can signal a change in the magma beneath a volcano. We take multiple measurements, as they are needed to create reliable results. The spectrometer can be used on the ground or attached to a drone, which can be flown over a gas plume as it scans and detect the gases it contains.

3-D Mapping

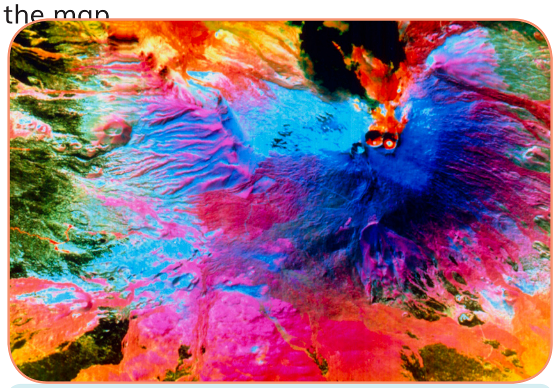
Posted at 11:33 am on September 13, 2019

Digital elevation models can show details of the volcano's surface—this one shows Cotopaxi in Ecuador, with blue and green representing the lowest elevations and beige, orange, red, and white representing the highest

To try to forecast the likelihood of an eruption, we can combine drone technology and design software to create a 3-D map of the volcano. Our drone is equipped with a digital camera and GPS monitoring, allowing us to take photos of the volcano's surface from high above. There are different kinds of maps we can create. One type of 3-D map is known as a *digital elevation model* (*DEM*) which can show details of the land surface. Another type of map is a *thermal map*, which captures the temperature of the volcano's surface by recording wavelengths using a thermal camera attached to the drone.

Before we fly the drone around the volcano, a flight plan has to be devised to make sure there are no hazardous obstacles the drone will collide with. This is done by directly monitoring the volcano to see if there is an increase in volcanic activity. We also check if the weather conditions are suitable for the drone to fly in. A flight route is then created, where we consider the drone's flying height, flight path (the route it will take), and the design software that will help create the map.

As the drone takes flight, we track the status of the drone, its GPS position, and battery life. A successful flight mission is dependent on the success of the flight plan and route that is devised—so it's very important that these are well prepared and thought-out before the drone is set to fly.



Thermal maps capture the temperature of the volcano's surface—in this map of Etna, the orange areas show recent lava flows, while violent and pink areas show older lava flows

By using drones to create 3-D maps of the volcano, we can see dangerous volcanic areas or changes in the volcano's temperature. We can then use this information to alert local authorities of potential eruptions or dangers to the community.

Latest Posts

- Blog Post 1
- Blog Post 2
- Blog Post 3
- Blog Post 4
- Blog Post 5
- Blog Post 6