

DANGERS OF VOLCANIC ACTIVITY IN ECUADOR

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Abstract

While starting a life out on your own can be stressful, so is picking the spot to where you would like to start. Living in areas with Volcanic activity can be stressful to many communities as they think daily on when the next eruption might take place. When deciding on where you want to live is important but so is learning about what might impact your capabilities of living comfortably are. Volcanoes can be found along fault lines and over periods of time can grow to become larger in size and become dangerous, while others can remain small and not cause much concern at all. Geologists study everyday on when the next eruptions might take place. Planning these predictions and eruptions can be unpredictable, while taking precaution can be taught to many about what to do when this catastrophe takes place.

Volcanic activity was a concern while travelling over there and was talked about and pointed out daily. In this paper you will learn about the three different kinds of volcanoes that were visited while on my trip in Ecuador, volcanic formation, impacts on communities and the health effects that take place after these eruptions. The seismic activity increases and the volcanic eruptions are creating panic amongst the local communities and causing health problems amongst them as well. Respiratory problems, labored breathing, burns, ash cover, asthma and more are showing up in the people that are around this activity. We can not stop volcanic eruptions but we can be more aware of what can happen when someone lives nearby one and the damages that will be caused after the eruption takes place.

Keywords: Ecuador, Volcanoes, Geologist, Health, Communities, Eruptions, Predictions

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Introduction to Volcanic Formation

Volcanic formation begins along the boundaries of the Earth's tectonic plates. They create massive expanses of our planet's lithosphere that continually shift and bump into each other (Wei-Haas, September, 2019). Many volcanoes form on fault lines, and in Ecuador around the coast, there are multiple faults everywhere. Seismic activity occurs all the time in Ecuador, causing the shift of the tectonic plates creating the formation (Wei-Haas, September, 2019). There are three different kinds of volcano formations that can occur. Stratovolcanoes, cinder cone volcanoes, shield volcanoes. When the tectonic plates collide, and one often plunges deep below the surface, which is known as the subduction zone (Oregon State, 2014). A subduction zone forms when continental crust and oceanic crust collide. As the plates sink deeper below the surface where it is too hot, the crust will release fluids that are trapped inside caused by the heat (Oregon State, 2014). The descending landmass sinks deep into the earth; the temperatures and pressures climb, releasing water from the rocks. Subduction zones produce volcanic arcs, curving chains, or steep-sided volcanoes (Oregon State, 2014).

Not all volcanoes are related to subduction; other volcanoes can form by what is known as hotspot volcanism (Wei-Hass, September 2019). A zone of magmatic activity in the middle of a tectonic plate can push up through the crust to form a volcano. Erupting volcanoes near or under the surface of the water may produce towering steam eruptions when the super-hot lava contacts the cold water (Wei-Hass, September 2019). The water temperature on the surface will help reduce the melting point of the magma, creating overlying rock (Wei-Hass, September 2019). Volcanic eruptions pile on top of previously occurring eruptions over some time until the

volcanic earth is pushed to the surface to create islands. An example to demonstrate this picture that everyone is more familiar with is the Hawaii volcanic chains and recently, from my trip to the Galapagos Islands (Wei-Hass, September 2019).

Volcanic eruptions can be deadly and cause mass destruction in nearby areas as well as hundreds of miles away from the eruption (Wei-Hass, September 2019). Volcanoes can be monitored and studied to determine the amount of time before the eruption, this can not always be predicted correctly or 100% accurate. Geologists are continuing to explore old and new volcanoes that form and give updates on their findings and their predictions (Wei-Hass, September 2019). Volcanoes when they erupt spew hot lava, ash, dangerous gases, and rock that are powerfully destructive (Water Encyclopedia). It is essential to know how they form and how dangerous they can become. Health concerns arise from these eruptions and cause respiratory illnesses, burns, injuries from falls, and vehicle accidents related to the slippery hazy conditions caused by ash (Geology and human health, November 2016). Air quality becomes a problem after an eruption causing not only issues to people but many of the species that live on the Island but also throughout Ecuador (Geology and human health, November 2016).

The Galapagos Island Formation

The Galapagos Islands were formed 3 million to 5 million years ago. Geologists describe the Islands as being the Islands on fire. There have been about 50 plus eruptions that have occurred on the Islands in the last 200 years (Geology of the Galapagos Island, 2020). Current active volcanoes on the Islands continue to show productive activity that Geologists continue to keep a close eye on for research as well as safety for the people living on these Islands (Geology of the Galapagos Islands, 2020) Only four islands are inhabited by humans: Santa Cruz, San

Cristobal, Isabela, and Florena. The islands typically form from a single shield volcano's eruptions of basaltic lava flows, expanding its shores (Geology of the Galapagos Islands, 2020). However, the largest island, Isabela, is made up of six volcanoes that have flowed into each other, filling the Pacific gap between them. This process of island formation is from the Volcanic eruptions piling on top of previously occurring eruptions (Geology of the Galapagos Islands, 2020).

There are multiple islands in the Galapagos Islands and many active volcanoes currently. We visited the Island of Santa Cruz as well as the Island of Isabela. These islands are young in geological time, according to a former geologist Theo Toulkeridis that we had the pleasure of meeting on our trip. He informed us that the best way to study volcanic history is by looking at its past. The Islands are known to have high biodiversity; some of these eruptions have threatened the flora and fauna that exist (Kurz, M., & Harpp, K. November,2010). Some eruptions have created new islands, including the new pahoehoe lava flow Santiago Island. This Island did not exist when Charles Darwin made his discovery of the Galapagos Islands in 1835 (Galapagos Conservancy, 2020)

Introduction of Santa Cruz Island

The Island of Santa Cruz was one of the islands that we traveled to when we visited the Galapagos. When we landed, we were on the island of Baltra, which is a small barren island that not many people live on considering how little the Island is. The island is a fault delimited Island. Many people land at Baltra, take a bus, and then a small boat to the Island of Santa Cruz (Volcanic Discovery, n.d). The highlands of the broad Santa Cruz shield volcano(Crater Gemelos) rises above the north above the renowned Charles Darwin research station at academy

bay (Volcanic Discovery, n.d). The volcano is a large depression of volcanic material formed by a long process of slow subsidence of the earth. In this depression, shrubs and plants and mosses are growing along the rocks, and many bird species live here (Volcanic Discovery, n.d).

The new morphology and some sparsely vegetated surfaces indicate that this volcano is not old and is about 1000 years of age (Volcanic Discovery, n.d) Ages of volcanoes can not be determined precisely, geologists use the positioning of rock layers to decide which one was older. The old method that geologists would use to determine the age would be older on the top and newer on the bottom. This method does not work anymore, considering how easy it is for rock layers to manipulate themselves when they are adjusting over time. We did not get a chance to visit this Crater, but our tour guide Johnathan escorted us around the Island once we arrived.

Sierra Negra on the Island of Isabela

Sierra Negra is a volcano located on the southern part of Isabela Island in the Galapagos National Park. Sierra Negra is a shield volcano on the Galapagos Islands, and it has erupted six times since 1948. The volcano is 3,688ft. The most recent eruption was in August of 2018. The eruption began on June 26th and divided into two main phases (Global Volcanism Program, February,2020). The first and most energetic phase lasted about one day, and this process breaks up into openings of five fissures. When we hiked the volcano to see the caldera, we were told by our tour guide Johnathan that where the lava had spewed out, the surrounding area is still hot even after a year has passed. The geophysical institute installed a device that detects seismic activity below the surface of the volcano. The equipment showed little evidence of seismic activity over 12 years, but then in July of 2017, seismic activity started to display on the monitor(

Global Volcanism Program, August 2018). Earthquakes began to occur, and then multiples began to take place at the same time.

The increase of seismic activity started to show in December of 2017. Three earthquakes greater than three on the GPS receivers showed the movement of the Caldera floor between 2013-2017(Global Volcanism Program, September 2018). This level of seismic activity and the progress of the caldera floor preceded much higher than the eruption in 2005. Elevated seismic continued into 2018 with a magnitude 3.8 event recorded on January 6th, 2018, that tourists, guides, and National park officials felt (Global Volcanism Program, September 2018). In 2018 when Sierra Negra Park staff reported the sounds as bellowing coming from the Volcán Chico fissure vent. The volcano has currently not shown dangerous activity since its eruption in 2018, geologists have stated (Global Volcanism Program, September 2018). Sierra Negra is one of the most active volcanoes on the Island to this day.

Quilotoa in Cotopaxi Province

Quilotoa is a water-filled caldera and the most western volcano in the Ecuadorian Andes. The word Quilotoa comes from the local Quechua language. The 3-kilometer wide caldera formed by collapse due to the eruption that was about 600 years ago (Atlas Obscura, July,2016). The last eruption for this volcano was in 1280, and it left this gaping caldera filled with beautiful turquoise water. This eruption was one of the most massive explosives in the world during the past 1000 years (Atlas Obscura, July, 2016) Geological studies have shown that Quilotoa has produced at least eight significant explosive eruptions during the past 200,000 years(Volcanic Discovery,n.d). The volcano is around 3,800-3,900 meters in elevation; there are well-worked

hiking trails all along this caldera leading you down to the lake back up to the surface(Atlas Obscura, July, 2016).

The caldera is the remnant of a dacitic stratovolcano. The inner walls are 400m high, and the lake is 240m deep(Volcanic Discovery, n.d) In the nearby area are indigenous tribes who survive off the land by farming and harvesting their goods. You can meet some of these people on the trails wearing their traditional Andean clothing. The hike down to the bottom of the caldera is about 4.7 miles(Atlas Obscura, July, 2016). Erosion on the paths is becoming noticeable from all the foot traffic that takes place to see this beautiful site. Some days you can walk the entire circumference of the caldera and not come in contact with a single person. There is vegetation growth in this caldera. Shrubs, trees, and wildflowers are growing along the edges, and on the side of the caldera, there is grass. Geologists monitor the caldera, and there have been no signs of the current activity of the volcano erupting. Many tourists visit this national park daily and travel the path down to the lake to either take kayaks on the lake and to take scenic pictures as well. The hike is about 18.7 miles going both directions(Atlas Obscura,July,2016). Dr. Theofilos that was with us this day while we were visiting the volcano, did state that the one danger about this volcano is that it will not produce lava, but CO₂ gases will erupt. A considerably large gas bubble will form, causing the air to become toxic and suffocating anyone in a close area of the volcano(Gunkel, G., Beulker, C., Grupe, B., & Viteri, F, January,2008)

Cotopaxi in Quito

Cotopaxi is in the cordillera of the Andes in central Ecuador. The volcano rises to a height of 19,393 feet and is among the world's highest volcanoes. This volcano has a long record of violent eruptions; the most significant eruption took place in 1904, killing approximately 500

people(Encyclopaedia Britannica,September, 2016). Cotopaxi is one of the most famous volcanoes in South America and is the most active one. There is snow that covers the top of the stratovolcano that, during the day, melts slightly and at night refreezes, causing a thick layer. Cotopaxi has often produced lahars, which is a destructive mudflow on the slopes of a volcano(Hansen, K. September,2015). A lahar can be very dangerous since it does not need a volcanic eruption to occur. Lahars commonly occur more after a landscape has formed over time by loose volcanic material. Cotopaxi's steep cone has nested summit craters, the outer of which measures 550 by 800 m in diameter. Cotopaxi has erupted more than 50 times since 1738 (Freeman, K. August,2015). The volcano has produced violent eruptions with pyroclastic lava flows and destructive mudflows (Freeman, K. August ,2015). While on the bus to the national park, you can see through the windows the mudflows that once were hot magma. There are no signs of plant life growing through the lava flows but there are signs of life everywhere in the national park. There is a rare altitude hummingbird that has been discovered to live on the slopes of Cotopaxi between 13,000 and 15,000 feet where it nests on protective cliffs(Freeman,K. August,2015). Many people live near the active volcano, and the problem with living near an active volcano is you never really know when it's going to blow. Geologists can predict when a volcano might erupt, but it is never 100% accurate. The guide in the state park said that geologists had made predictions that Cotopaxi will erupt in 5-10 years.

Effects of these Volcanic Eruptions

On June 26th, 2016, an increase in seismic activity near the Sierra Negra volcano within the Galapagos National Park. An orange alert was issued, evacuating 50 people being evacuated from their homes and in the area. In 2018 the site for the park was closed off to visitors until

further notice that it was safe to occupy the space(Global Volcanism Program,2018). Potential changes in the ecosystem could occur and are monitored by the GNPD, four potential populations of Giant tortoises, and Land Iguanas so far none of the lava flows have affected these populations. The impacts of a significant eruption by Sierra Negra can impact the biodiversity surrounding the area and potentially cause a fire from the intense heat from the lava flows and their travels(Global Volcanism Program,2018). The volcano is massive in size and can erupt from multiple spots at a time. Keeping a close eye on the volcano is detrimental, considering its recent activity in 2018.

Quilotoa is a massive Caldera that contains an abundance of gasses below the lake's surface. Investigations to evaluate the hazards of the lake have been carried out. In the caldera lakes, there is CO₂ gas as well as acidic and toxic water due to the emissions of volcanic gases as HF, SO₂, HCl, and gaseous boron, which is taken into consideration(Gunkel, G., Beulker, C., Grupe, B., & Viteri, F, January,2008).

If an eruption does retake place in Quilotoa, everyone in the area and close proximity will suffocate from the gas cloud covering the entire city. CO₂ gas is the leading cause of climate change, they cause climate change by trapping heat, and they also contribute to respiratory diseases from smog and air pollution(Nunez, C.May,2019). The first phase of the eruption produced one the northern Andes air fall pumice and ash layer. The following phases generated large pyroclastic flows and lahars that reached the pacific ocean(USGS Science for a changing world,October,2017). The eruption follows the formation of the caldera, which ended with the lava dome that is there today.

Cotopaxi is a significant concern right now with it showing recent activity, and the people around the surrounding area are panicking due to the signs of eruption that might take place in the coming years. There are fears that the pyroclastic rock and gas flows could melt the ice on the glacier caps and flood nearby towns with volcanic mud. In 1877 this was the last time that this happened, and fatal results took place in the neighboring communities(Kitson, M.,September 2015). In August of 2015, Cotopaxi, one of the world's most dangerous volcanoes, continued to show signs of eruptions and releasing little miny flares throughout the week.

Cotopaxi is considered one of the world's most dangerous volcanoes due to its proximity to populations and very explosive activity(Kitson, M. September2015).

About 200,000 people are living along the lahar channels, and most of the living conditions are just tiny houses with just enough land for them to survive. In August of 2015, The National Park declared a state of emergency and that 325,000 people were at risk of being in danger(Freeman, K. August,2015). Some people said that they feel abandoned by the government. They issue a state of emergency and then evacuate the people, and then no further information was given to them by the government(Freeman, K. August,2015).

The communities listen to the newscasters and are told that there are no signs of eruption, but stand in their town and see that the volcano is erupting before their eyes. In Latacunga, there has been panic of an eruption, and many people were evacuated, but no further information was followed up just causing panic(Freeman, K. August,2015). In the town Romerillo, the people are struggling with the fallout from Cotopaxi's eruptions. Small eruptions can be very harmful to many; one small eruption can lead to multiple eruptions causing multiple pyroclastic flows to form(Freeman, K. August,2015).. Many people of the communities are sad about the volcano

erupting and creating fright amongst them. They used to live happy and free, and now they live in fear and sadness.

Cotopaxi National Park attracts more than 200,000 tourists a year. Many tourists travel for sightseeing as well as touring the slopes and climbing one of the world's highest volcanoes peaks(Freeman, K.August, 2015). A Lot of the families in the area live off of tourism. The money that is brought in by the tourist feeds the families of the communities, and they sell their goods to the tourist to provide money for their families as well(Freeman, K. August, 2015). In August of 2015, when the volcano erupted, no one was found to be in the hotel rooms or the restaurants. The area was quiet for three days, and they struggled in those three days(Freeman, K. August,2015).

Health concerns with volcanic eruptions

Major health concerns rise to the surface when it comes to volcanic eruptions. Volcanic eruptions cause fear and panic in surrounding areas in which the volcano is causing health impacts on people and even livestock that is nearby. Periods of inactivity of volcanoes can generate a wrong perception of risk. Not knowing the characteristics of this threat can increase vulnerability, especially in communities nearby along the lahar of the volcano. Many people in certain areas do not have tv or radios to listen to the news of volcanic eruptions and rely on the Geologist or the Park rangers to let them know about the current activity and what might take place in the upcoming years. The most common effects on health concerns with volcanic eruptions are Traumatic injuries, traumatic injuries, burns, suffocation, skin diseases, eye injuries, respiratory problems, conjunctivitis, and even death. Health measures must be available for any type of eruption that takes place(PAHO/WHO Health Emergencies,February,2020)

Plans to prevent loss in homes and properties manifest when eruptions take place. There are certain types of eruptive events that take place: Explosions, Hot ash release, Melted ice/snow, and simultaneous rain accompanying eruption, Lava, and Gas emissions(PAHO/WHO Health Emergencies, February,2020). When a Volcano is predicted to erupt or is showing signs of seismic activity, the national park constructs and implements evacuation methods. Explosions cause the impact of flights not being able to see through the smoke stopping all access to and from the country due to hazardous conditions. Many eruptions when they happen can be seen from outer space and captured by the satellite. Melted ice/snow and rain caused flooding impacting the nearby communities that are near the impact zone(PAHO/WHO Health Emergencies, February,2020). Magmatic eruptions create lava flows and forest fires by the intense heat coming from the lava. The route of lava flows are predictable, and they move relatively slowly. The use of evacuation methods prevent anyone from being impacted by these lava flows(PAHO/WHO Health Emergencies,February,2020).

Conclusion

Those living in areas where there is volcanic activity must take precautions and know the risk of living in an area with volcanic activity or even dormant activity. Researchers predict when a volcano will erupt; volcanic activity changes every day, and so does the prediction date. When a volcano erupts, it causes a lot of panic and much damage to nearby areas or even miles away. Volcanoes are not always steep slopes and conical, they also tend to be Calderas and lakes. Ecuador is a country known for its volcanic activity and its seismic activity as well. When moving to Ecuador, the country addresses the risk, and a homeowner should consider the placement of their home as well. Homeowners live near volcanoes because the volcanoes entrap

geothermal energy producing efficient, environmentally-friendly electricity for their homes. This stream is used to power and drive turbines in geothermal power stations to generate electricity for domestic and industrial use.

When I was in Ecuador for our study abroad program, Volcanic activity was discussed every day. The fears arise in your body, and you think to yourself: what would they do for you if this were to happen? The people that live here in Ecuador think the same things. What would they do for them if this were to take place? Evacuation is the primary method that they all decide to use when volcanic activity might happen but: what happens when they all lose their homes and goods due to this disaster? Living in areas that have Volcanoes and Volcanic activity requires one to be aware of the damage that can take place physically and mentally.

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