Engineers Map Volcanic Lightning *By Prachi Patel*

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Lightning sensors could leadto better eruption warnings

Photo: CARLOS GUTIERREZ/UPI/Landov
Flash, Crackle, Pop!: Lightning might warn of imminent eruptions.

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Volcanic eruptions are often accompanied by spectacular bursts of lightning—Krakatoa, Mount St. Helens, and Vesuvius have provided some relatively recent examples—and yet these breathtaking bolts are not well understood. Obtaining insight into volcanic lightning, besides being of considerable scientific interest, could make it possible to get earlier warnings of eruptions and might even yield clues to the origins of life. With those ends in mind, electrical engineers at the New Mexico Institute of Mining and Technology, in Socorro, have installed compact sensing stations of their own design at Mount Redoubt in Alaska.

Ronald Thomas, professor of electrical engineering at the institute, and his colleagues plan to map the lightning from that volcano's eruption in three dimensions, hoping to illuminate what causes electrification during some eruptions and how volcanic lightning compares with thunderstorm lightning, which itself is not fully understood.

The sensors, boxed in modified picnic coolers, record the time and magnitude of the radio-frequency impulses that lightning creates. Correlating the time that the waves hit each receiver, the researchers triangulate the position of the radiation source in the sky to within 12 meters. They can then reconstruct the charge structure inside storm clouds, helping them understand what causes lightning and when and how it touches the ground.

To study volcanic lightning, the researchers pack the sensors—along with 160 gigabytes of memory,

worth three months of recording time—into 20-kilogram boxes. Then the researchers must get the sensors to the right place at the right time. On the first two occasions they tried this, they didn't quite make it in time to get all the data they wanted.

During the January 2006 eruption of Alaska's Mount Augustine, the team arrived after the eruption had started and were able to set up only two sensors. The data was not enough to generate three-dimensional images, but it revealed a new type of lightning. Until then, lightning in volcano plumes was known to resemble thunderstorm lightning—highly branched flashes that last about half a second. But at Mount Augustine the researchers also found continuous, explosive sparks that lasted only a few milliseconds, which appeared at the mouth of the volcano just when it started erupting. This indicated that the eruption itself, not just the ejected ash and rock, had created a large amount of charge. Thomas is not sure how the charge is generated, something he hopes the Redoubt experiment will reveal.

When the Chaitén volcano erupted in Chile in May 2008, Thomas's team also arrived later than was ideal, but this time they were able to get four sensors in place, giving them their first 3-D maps. Preliminary analysis showed horizontal lightning up to 8 kilometers long.

At Redoubt, which began erupting on 26 March, they had a head start and for the first time recorded data right at the first eruption. Thomas's hopes are high: "We'll get a lot better estimate of what's going on inside the volcanic cloud."

In the kind of storm clouds that generate conventional lightning, ice particles and soft hail collide, building up positive and negative charges, respectively. They separate into layers, and the charge builds up until the electric field is high enough to trigger lightning. The conventional wisdom has been that in volcanic eruptions, charged ash and rock debris produce lightning by analogous processes. From what Thomas and his team have already learned, volcanic lightning might be more complex than that.

If they are successful in developing a mapping system, it could provide useful warning that an eruption has actually begun. "Just because a volcano is rumbling and making lots of seismic noise, you can't tell whether it erupted," Thomas says. Tamsin Mather, a volcano researcher at the University of Oxford, in England, adds that the sensors could be a handy warning system especially for "remote volcanoes in Alaska or Kamchatka that don't have people watching them all the time but have plenty of planes that fly in the vicinity." Airplanes have unknowingly flown into ash, which has sometimes choked their engines.

Volcanic lightning could also yield clues about Earth's geological past, Mather says. And it could answer questions about the beginning of life on our planet. Scientists suspect that volcanoes on a primeval, sweltering Earth could have been the cradle of life. They had the right ingredients: water, hydrogen, ammonia, and methane. Lightning would have been the essential spark that converted these molecules into amino acids, the building blocks of protein.

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