Geophysical Institute Quarterly
Volume 24, No. 1, 2011

Christopher Bruton photo

# Inflating volcanoes of South America: Scientists ponder what fuels a super eruption

High in the Andes Mountains, a few volcanoes have been inflating for decades despite not having erupted in hundreds of thousands of years. Geophysical Institute scientists are leading a South American-based project to study the world's largest body of magma and its implications in a land of super eruptions.

In the next five years, Research Professor Steve McNutt, Assistant Research Professor Mike West, and Professor Doug Christensen will deploy seismometers and GPS equipment on the volcanic flanks of the 6,008-meter Uturuncu in Bolivia, and in a region called Lazufre that is composed of two mountains in a complex of high volcanoes on the border between Chile and Argentina.

The GI professors have partnered with Matt Pritchard of Cornell University, researchers from Montana State University, the University of California Santa Cruz, Oregon State University, and the University of Alberta, as well as colleagues from Bolivia, Chile and Argentina.

Geologists were more interested in other Andes volcanoes until Pritchard analyzed a wide swath of the world's longest mountain range with interferometric synthetic aperture radar (InSAR). Using technology that allows researchers to see subtle changes in surface elevation, Pritchard noticed that four volcanoes were deforming at a rapid rate. The most active volcano, Uturuncu, had been inflating one to two centimeters per year since the InSAR technique was first applied in the 1990s. Scientists contend a massive pool of magma about 17-20 kilometers beneath the surface is responsible for the volcanoes' swelling.

Pritchard shared his discovery with McNutt in 2003. Once in the region, McNutt carried a portable seismometer to the specific area in the Andes and recorded 29 earthquakes in the first two hours.

"Twenty-seven of those were similar, which tells us they were all coming from the same spot," McNutt said. "We were right on the flank (of Uturuncu), close to the deformation center."

This special section of the Andes will teach volcanologists about conditions that give birth to super eruptions, which, lucky for humanity, only occur about once every 10,000 years.

"They are kinds of eruptions that when they happen, 'massive' doesn't really describe it," West said. "They are larger than what we've seen in recorded history. The sort of comparison most people make is about 100 times the volume of Mount St. Helens."

Steve Sparks photo

***LISTENING TO VOLCANOES*** *– Above, Matt Pritchard helps install a seismometer to observe earthquakes in the Andes. Scientists use seismic data to help locate areas of volcanic unrest. At top is a view of Uturuncu Volcano from the north shore of Laguna Colorada, a nearby shallow salt lake.*

# Volcanic ash monitoring goes three-dimensional

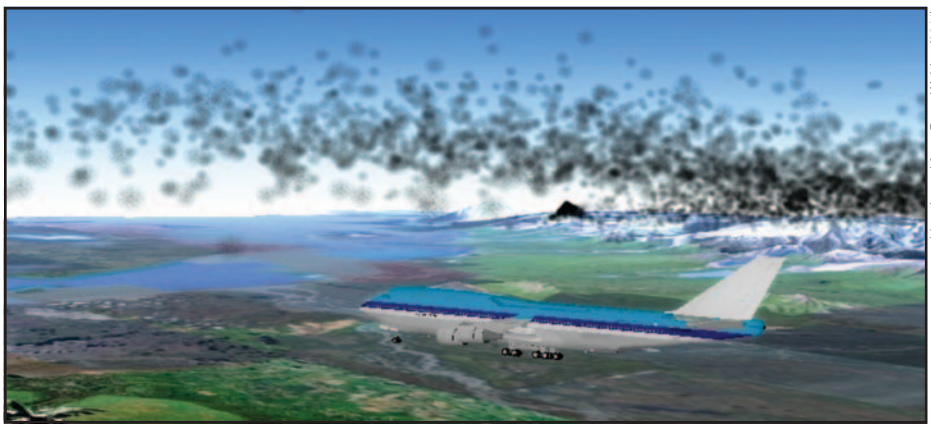
When Research Assistant Professor Peter Webley arrived at the Geophysical Institute in 2005, he wondered why volcanological data was plotted in two dimensions when it was being computed in three dimensions. At a point when virtual globes were gaining mainstream momentum through programs like Google Earth, it seemed logical to use real-time imaging to display volcanic activity rather than static graphs.

Webley's question led to action. He developed a way to integrate a computerized volcanic ash dispersal model named Puff with Google Earth.

"Plug it all in and press play," Webley said. "It doesn't require you to plot data yourself."

By using the three-dimensional geographical program Google Earth, Webley was able to combine different data streams to create an all-inclusive display of a volcanic event on a virtual globe.

To demonstrate the benefit of merging the two programs, Webley used the well-documented 1989 KLM airliner encounter with a volcanic ash cloud spewed from Alaska's Redoubt Volcano. The result is a spatial and temporal understanding of where the Boeing 747 began to malfunction in the ash cloud. This information helps scientists establish an idea of how thick ash concentration must be in order to impact an airliner.



graphic adapted from Peter Webley (2011)

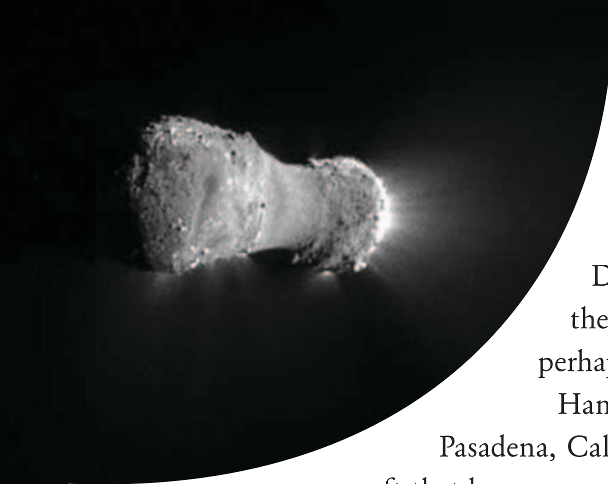
***LEARNING FROM THE PAST*** *– Scientists are using three-dimensional models to explore volcanic ash dispersal. The example above is from a reconstruction of the encounter between a KLM Boeing 747 aircraft and an ash cloud spewed from Redoubt Volcano in December 1989.*

This vein of research is tremendously helpful to the aviation community, as well as state and federal officials, as it will improve predictions and help mitigate volcanic hazards. The eruption of Eyjafjallajökull Volcano in early 2010 is a stark reminder of how broad the impacts can be when a large span of airspace is shut down. Eruption of the Icelandic volcano and the resulting ash cloud impacted an entire continent, spurring days of cancelled flights and socio-economic upheaval throughout Europe.

While scientists like Webley have a new tool to assist their research, the general public benefits from this program as well. Anywhere there is an Internet connection, people can log on and view a volcanic eruption to see how an ash cloud travels above the landscape. This ability, enhanced by the popularity of Google Earth, may elicit interest in geophysics among gamers and computer-savvy youth.

"My hope is that interest in this program will feed down to the (K-12) school level," Webley said.

photo by Cyrus Read
courtesy AVO/USGS



NASA/JPL-Caltech/UMD image

# Close encounter with a comet

A telescopic imager that Poker Flat Research Range Optical Science Manager Don Hampton helped design more than a decade ago has captured images of the glowing knuckles and smooth waistline of the comet Hartley 2, which is perhaps a fragment from the formation of the solar system 4.5 billion years ago.

Hampton joined the ground control team at the Jet Propulsion Laboratory in Pasadena, Calif., to participate in the continued operation of a pickup-truck-sized spacecraft that became a celebrity five years ago when it slung a copper bullet into the heart of comet Tempel 1. At that time, Hampton was working at Ball Aerospace & Technologies Corp. in Boulder, Colo., as part of the team that designed the electronic eyes for a craft launched into space for the Deep Impact mission.

After the success of Deep Impact, "we still had half of our propellant left," Hampton said. The instruments on board the spacecraft were still working, and NASA agreed to fund another comet chase.

Hartley 2 is a dirty snowball of ice and gases that were a fuzzy dot more than 11 million miles from Earth when astronomer Malcolm Hartley first saw it back in 1986. With much foresight, researchers fired the rocket motors on the Deep Impact spacecraft five years ago to position its orbit around the sun for a close pass with Hartley 2.

"It's not often you get to use spacecraft for a second purpose," said Hampton.

In early November 2010, the countdown was on. Hampton manned a seat in the Control Room; his job was to make sure the instruments aboard the spacecraft were working, and to come up with a plan if they weren't.

Hampton pulled long shifts in the Control Room as the spacecraft neared Hartley 2. Since the ship's original configuration was for a different comet in a different location, its communication antennas couldn't always be aimed at Earth when its imagers were locked on the comet.

"We did the do-si-do for a while, moving the spacecraft to point its instruments at the comet, then shifting back to point the antenna here," Hampton said.

As the spacecraft neared its closest approach, 434 miles from the comet, the team halted the dance and turned the ship's two visible-light and single infrared imagers at Hartley 2. After the close pass, it still took a few hours to receive the data from space that would become a new portrait of a comet.

"We've seen five comet nuclei now, and they're all different," Hampton said from JPL a day after the comet images were released. "The big thing is how active this one is. There's no doubt about where the source of the jets (that give the comet a fuzzy appearance) are coming from – the really rough two ends of it. We're going to learn a lot more about comets from this."

Among the discoveries from the mission, scientists have found a cloud around Hartley 2 that is comprised of little dirty snowflakes, no more than 1 mm across, which is something not seen in previous comet encounters.


NASA photo

*__VIEWING A COMET__ – Above is an image of Hartley 2 taken on November 4, 2010. The comet is 1.4-miles-long and is composed of water ice, carbon dioxide ice and silicate dust. At right, NASA's Deep Impact spacecraft lifts off on Jan. 12, 2005. The rocket carried an instrument scientists recently used to capture unprecedented images of a comet.*

GEOPHYSICAL INSTITUTE
University of Alaska Fairbanks
903 Koyukuk Drive
P.O. Box 757320
Fairbanks, AK 99775-7320

Address Service Requested

Nonprofit Organization
U.S. Postage
**PAID**
Permit No. 2
Fairbanks, Alaska

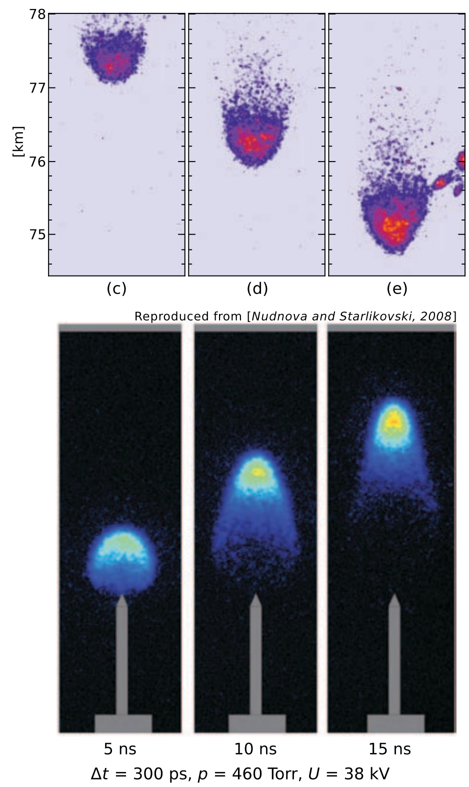
The Geophysical Institute Quarterly is published as a public service by the UAF Geophysical Institute Outreach Office: **Kathryn Bertram**, director; **Amy Hartley**, editor and writer; **Vicki Daniels**, designer and editor; **Ned Rozell**, writer; and **Stevie Seibert**, writer. Free subscriptions to the Quarterly are available by e-mail at info@gi.alaska.edu, by phone at (907) 474-7558; by fax at (907) 474-7290, from the address above, or online at http://www.gi.alaska.edu. UAF is an AA/EO employer and educational institution.

# On the forefront of sprite research

Only a few scientists across the globe spend their time scanning the skies to research the nature of sprites. The Geophysical Institute, along with Penn State, Stanford, Duke and the Florida Institute of Technology, comprise a small community of U.S.-based academic facilities that aim to understand sprites – short-lived electrical discharges that occur at altitudes 70-90 km above thunderclouds.

The first organized sprite research was conducted in the late 1980s by GI Professor Davis Sentman and Emeritus Professor Eugene Wescott. Researchers now aspire to understand large-scale impacts, if any, resulting from these hard-to-capture phenomena. Recent findings revealed similarities between streamers – sprite tendrils that can travel both upward and downward – and laboratory-created electro-discharges. The discovery merits further investigation.

Since 2003, Emeritus Professor of Geophysics Hans Nielsen and doctoral candidate Takeshi Kammae have partnered with UAF alumnus Matthew McHarg at the U.S. Air Force Academy to collect sprite data. The group relies on auroral research techniques pioneered at the GI. The scientists use powerful Phantom-7 CMOS cameras, which can capture up to 100,000 frames-per-second while observing from laboratories high in the mountains of New Mexico and Wyoming. In 2009, Nielsen and Kammae used the cameras on an aircraft flying at 46,000 feet altitude, parallel to thunderclouds in the American West, to gather better spectra of sprites.




***SIMILARITIES*** *– Shown at top is a sprite streamer observed with a Phantom camera. The bottom image of a laboratory generated electro-discharge reflects a similar structure.*