been hauled in too had he not been on Nyiragongo at the time. The others are now free, nursing injuries. But visiting volcanologist Jean-Christophe Komorowski of IPGP says that armed men visit the observatory every few days demanding donations to buy beer. Grimmer threats aren't far away: In the chaotic countryside beyond Goma, the U.N. has confirmed reports of mass executions, rapes, and torture. Kasereka's new house is filled with relatives who have fled the violence.

All this is too much for some. Jean-Baptiste Katabarwa, a former dean at the National University of Rwanda and once Rwanda's only volcanologist, lost 12 family members in the 1994 genocide, and if he had not been working in Nepal at the time, he probably would be dead too. His wife and two children survived, and he bribed a diplomat to get them out. Now Rwanda—vulnerable to the Congo volcanoes along its border, and having five of its own—has no volcanologist. Katabarwa is a consultant in Sherbrooke, Quebec, currently working on a technique for turning volcanic ash into cheap, strong bricks, a resource that could help rebuild his country. "Maybe I'll go back some day," he says.

Aka Tongwa is not going anywhere. Yes, life would be easier with a phone or even just a rock crusher—luxuries within reach if only he would emigrate. "I want to work at home, where I can serve my country," he says. "I was born here. In New York or Tokyo, I can make a lot of money. But at home, the negatives I see, I can help to improve."

–KEVIN KRAJICK

Kevin Krajick is the author of *Barren Lands: An Epic Search for Diamonds in the North American Arctic.*

NEWS

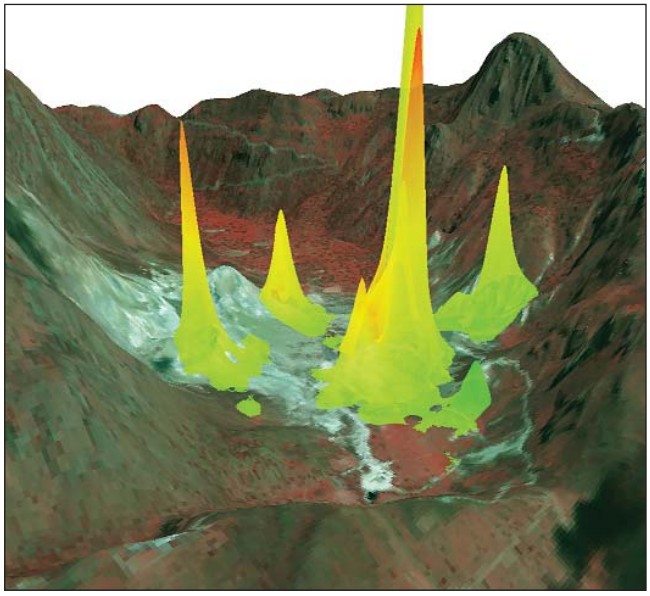
Seeing Volcanoes in a New Light

Two new software packages merge data ranging from seismic patterns to escaping gases into a unified view of a volcano's behavior; the hope is that this bigger picture will improve eruption predictions

CAMBRIDGE, U.K.—For scientists at the Hawaiian Volcano Observatory (HVO), the spectacle of lava gushing from Mount Kilauea in late January—a major eruption in which the summit throbbed like a pair of lungs inflating and deflating—was a familiar thrill, yet one experienced from a totally new vantage point. The researchers had watched this constantly active volcano go full throttle dozens of times in recent years, but the latest flare-up was the first in which a new monitoring system merged data on Kilauea's land heaves, gas emissions, and seismic rumblings into a single picture, in real time. "It made the observation much more dynamic," says Donald Swanson, scientist-in-charge at HVO. "People were gathering around monitors and watching things happening, and that created a sense of excitement."

HVO is the first observatory in the world to have wrapped all these kinds of monitoring data together onto one computer screen, in real time. The rationale behind the newly developed Volcano Analysis and Visualization Environment (VALVE) is for scientists to "come up with a kind of unified understanding of what's going on," says Peter Cervelli, a geophysicist at HVO.

That is an idea that volcano observatories around the world are starting to pick up on. Another major attempt to compile monitoring data into a bigger picture is now under way in Europe. Scientists from Germany, Greece, Italy, and Switzerland are using the Greek island of Nisyros in the southeastern Aegean Sea as a natural laboratory to develop a software package called Geowarn. Much like VALVE, Geowarn unifies various monitoring data in a common time frame. But Geowarn goes a step further, presenting them in a three-dimensional map of the volcano that dominates the tiny island.



Seeing with new eyes. Geowarn software depicts, in 3D, CO_2 rising from a modified satellite picture of the Nisyros volcano. Peak sizes indicate CO_2 volume, and colors indicate temperature variations.

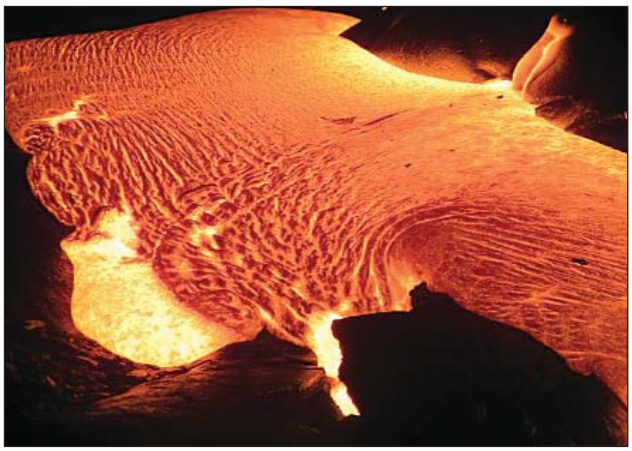
CREDIT: INSTITUTE OF CARTOGRAPHY/ETH ZURICH

Geowarn is meant to serve as an early warning system to catch the first signs of unrest. "We try to grasp a volcanic system in its entirety before it reawakens and threatens to erupt," says Volker Dietrich, a volcanologist at the Swiss Federal Institute of Technology in Zurich. In this sense, Nisyros is an ideal testing ground. Although it has not had a major eruption in 20,000 years, several small hydrothermal blasts from the central crater in the 19th century, and a spate of earthquakes underneath the island between 1996 and 1998, suggest that the volcano may be slowly emerging from hibernation.

Over the past 2 years, the Geowarn team has been using state-of-the-art monitoring equipment to scrutinize Nisyros from every possible angle. Global Positioning Systems and satellite radar interferometry—a new technique that clocks the travel time of microwave signals beamed from a satellite—have measured ground deformations on the island on the order of a few millimeters, from which scientists can infer alterations in the magma chamber that feeds Nisyros. They glean information on the magma's behavior from the composition of gases wafting from the mountain, the temperature and electrical conductivity of the island's hot springs, and the pattern of seismic activity beneath the volcano. The data suggest that during the latest tremblings, magma welled up but is now shedding heat, so Nisyros is unlikely to erupt any time soon.

Many observatories gather these sorts of data, but what is about to change is the way the data are analyzed. At many places, the routine is for various experts to sit around a table with printouts of their data and discuss what it all means. "That sort of works. But it isn't anywhere near as clever as it could be," says Christopher Newhall, a volcanologist at the University of Washington, Seattle.

In contrast, "Geowarn brings data together in a unique way," says Lorenz Hurni, head of the Institute of Cartography at the Swiss Federal Institute of Technology in Zurich.



Show time. Thanks to VALVE, scientists were able to observe various facets of Kilauea's latest flare-up in a single picture.

Hurni and his colleagues are the architects of Geowarn's visualization software. His team has combined digital three-dimensional maps with the powerful data-processing tools of Geographic Information Systems used by surveyors and other field specialists to create a template that monitoring data can be fed into and displayed. Experts find the approach intriguing. The system, says Newhall, gives "an unusually good integration of different kinds of data and an ability to look at them together in space and time." Moreover, Geowarn and VALVE, both of which could be adapted to use on any volcano, promise to fundamentally alter how scientists who study volcanoes interact, says William Rose, a volcanologist at Michigan Technological University, Houghton. "We are all specialists trapped in disciplinary holes unless we … put our observations together," he says.

One caveat, of course, is that the new systems are blind to instinct. Volcanologists standing on a fuming mountain must have "a gut feeling for how the activity is going," says geophysicist Paul Segall of Stanford University—something that today's computers, at least, cannot possibly register.

Volcanologists hope that Geowarn or VALVE will help them refine their predictions of when a mountain might erupt, but they would be even more pleased if the new systems could aid in getting the message out to the public. "You could be scientifically superb at predicting something, but unless you can communicate that to the people who might be affected, it doesn't do any good," says David Hill, scientist-in-charge at the Long Valley Observatory in Menlo Park, California. Geowarn's backers say that scientists outlining hazard zones to elected officials and the public will be able to do so more effectively with three-dimensional, interactive maps. Newhall agrees: "This is absolutely the way to go." Indeed, plans are already afoot to hook up other volcanoes: VALVE at Long Valley, and Geowarn at Vesuvius.

–DANIEL BACHTOLD

NEWS

Bracing for the Big One on Montserrat

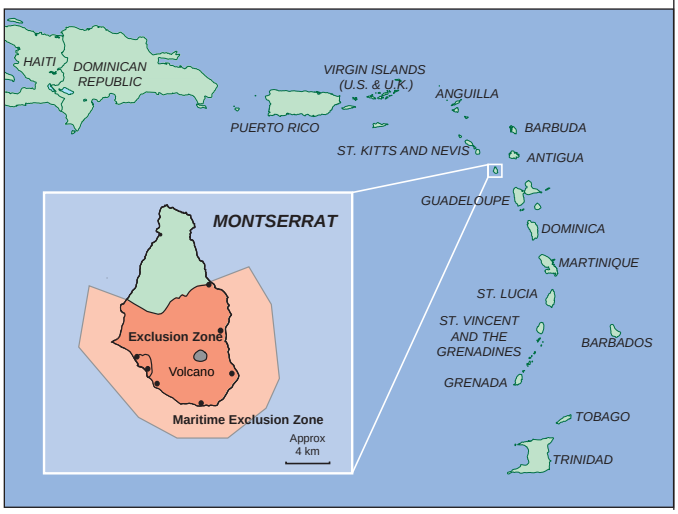
The Soufrière Hills volcano destroyed the capital and much of the rest of this island's southern half in the mid-1990s, and it may not be done yet: Its massive and still-growing lava dome has begun to threaten communities in the north, raising the stakes for the scientists who are keeping watch

MONTSERRAT—Some of the hottest pop songs of the 1980s came to life here, in a pale beige ranch-style house perched on a bluff. Elton John, Paul McCartney, and Stevie Wonder, among others, made the pilgrimage to this recording studio on the "Emerald Isle" of the Caribbean. Perhaps they drew inspiration from the shimmering turquoise waters, or maybe their muse was the mountain looming in the southeast: the Soufrière Hills volcano.

The vista is as entrancing as ever, long after the music died. AIR Studios, part of the vast Montserrat estate of Beatles producer George Martin, sits abandoned on a swath of land evacuated by authorities last October. The only sounds on a sunny afternoon last month were the sloshing of a cement mixer and the banter of volcanologist Barry Voight and his colleagues as they yanked yard after yard of plastic piping, conduit for the fresh cement, from a borehole near the studio. If a siren had blared, Voight's team members would have dropped what they were doing and hauled out of the exclusion zone as fast as they could have: The lava dome of Soufrière Hills is bigger than ever since the volcano roared back to life in the mid-1990s, and it could collapse at any time, in any direction.

Today, the volcano is calm, a taupe ash cloud drifting lazily out to sea. The researchers have just about finished installing two devices—a meter-long steel-sheathed seismometer that resembles an artillery rocket and a smaller, more cylindrical tiltmeter—near the bottom of the borehole, one of four drilled around the volcano. The sensors sit atop a strainmeter so sensitive that it can detect motions in the rock of the dimensions of an atom. The recordings from these instruments may not rival the sounds that once filled AIR Studios, but they will be music to the ears of scientists: They are expected to be the most precise readings yet of the mountain's inner stirrings.

"We're hoping to get a feel for what's happening deep in the system," says Voight, who is from Pennsylvania State University, University Park. "This volcano is a unique natural laboratory." The mountain's often enigmatic convulsions have been a boon to modelers, who are starting to put together a coherent picture of the relation between magma movements and the varying seismic signals they trigger. "The models are starting to give us some power to explain the phenomena we've seen in this eruption"—insights that can be



Hot zone. Growth of the lava dome toward the north forced the island's governor last October to evacuate another swath of Montserrat's dwindling inhabitable territory.

CREDIT: (TOP) USGS