reported that chemists in the laboratory of Makoto Sasaki at Tohoku University in Sendai, Japan, have synthesized brevenal from cheap starting materials. Dubbed ME-1, the synthetic agent performs as well as natural brevenal in receptor-binding assays and in preventing bronchoconstriction and clearing lung mucus in sheep, Baden reported.

Promises of new therapies for CF surface regularly, but many fizzle out. And in spite of its early promise, brevenal still has a long way to go. Steve Fontana, vice president of legal affairs at AAI Pharma, says the company's scientists are evaluating brevenal and its derivatives for safety and biological activity. Once they find the best drug candidate, the company will file an Investigational New Drug application with the U.S. Food and Drug Administration (FDA), but clinical trials are several years out.

In fact, humans may not be the first test subjects for brevenal's therapeutic potential. That honor may go to Florida's endangered manatees.

"A red tide event spreads like a wildfire and poisons birds, fish, sea turtles, manatees, and dolphins," says Andrew Stamper, a veterinarian at Disney's Animal Programs in Lake Buena Vista, Florida. In March and April of this year, about 30 manatees died following a red tide spike, and 150 died in 1996 from red tide poisoning. Only 3000 of the mammals are estimated to live along Florida's coast.

In February, Stamper received a "compassionate use" permit from FDA to evaluate the safety and effectiveness of brevenal in manatees. Stamper's colleague, veterinarian David Murphy of Lowry Park Zoo in Tampa, Florida, will test brevenal on rescued manatees brought to the zoo's rehabilitation center. When poisoned by brevetoxins, manatees become paralyzed and drown because they cannot hold their head above water to breathe. Murphy straps lifejackets underneath rescued manatees and supports their half-ton bodies in shallow tanks. Normal breathing resumes in a few days, but full recovery takes months. Brevenal "will add a new weapon in our arsenal," Murphy says. The next time a red tide hits, "we'll be ready to go," says Stamper.

–CAROL POTERA

Carol Potera is a science writer in Great Falls, Montana.

GEOPHYSICS

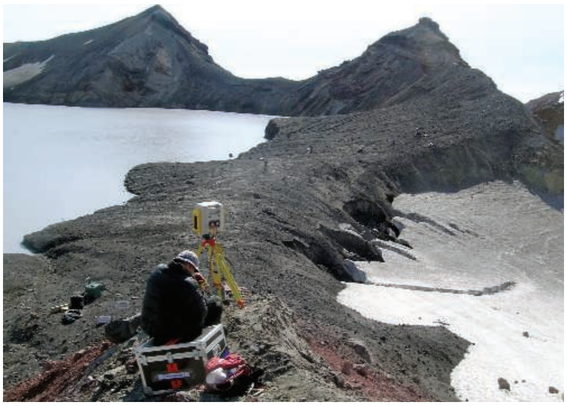
Stalking a Volcanic Torrent

The setting of the climax of the *Lord of the Rings*, New Zealand's Mount Ruapehu is earning a second reputation as a laboratory for understanding killer mudslides

MOUNT RUAPEHU, NEW ZEALAND—From a helicopter, the steaming lake nestled in the snowy crater below looks inviting, like a giant Jacuzzi for Maori gods. But taking a dip would be a bad idea: Mount Ruapehu's rocky chalice burbles with scalding sulfuric acid. The otherworldly volcano was used for scenes of the hobbit Frodo ascending perilous Mount Doom in the *Lord of the Rings*. But the real Mount Doom is a killer, too. Cradling a deep lake between its 2500-meter peaks, Ruapehu is prone to lahar flows, one of the most dangerous—and least understood—volcanic hazards. In 1953, a lahar (an Indonesian word meaning mudslide) here knocked out a train bridge; 5 minutes later, a passenger train plummeted into a gorge, killing 151 people.

Earlier this year, Ruapehu's acidic lake was unleashed again. Noxious waters blasted down the slopes, picking up rocks as big as cars along the way. But this time, not a single person was hurt.

Not only was the lahar predicted by an early warning system, but the event also generated "orders of magnitude more data than for any other lahar event anywhere in the world," says Vernon Manville, a volcanologist at the Institute of Geological and Nuclear Sciences (GNS) in Taupo, New Zealand. "This has been a 10-year experiment in the making." The information mother lode should help scientists better protect the millions of people who live in the path of lahar-generating volcanoes around the world.



Bracing for the big one. Readying for a world first: recording data from a volcanic lahar in action.

CREDIT: GNS SCIENCES

Wiring up Mount Doom

In 1995, Ruapehu's roughly 50-year cycle of eruptions kicked in again. Gobs of lava burped up from the bottom of the crater, adding 7 meters of loose ash and stones, called tephra, to the rim. The deepened crater soon filled with snowmelt from above and sulfuric acid and other material from fumaroles below. One of Ruapehu's grumbles late last year triggered an earthquake that whipped the lake into a frenzy, slamming the crater walls with 6-meter waves. "It was clear that it was only a matter of time" before the tephra rim failed and caused a lahar, says Manville.

But exactly when the big one would strike was unknown. The inherent unpredictability of lahars is what makes them so dangerous, says Cynthia Gardner, a geologist at the Cascades Volcano Observatory in Vancouver, Washington. Most eruptions are preceded by a telltale increase in underground vibrations, swelling of the slopes, and changes in the composition of vented gases. But a lahar "can occur without warning," Gardner says. Besides eruptions and earthquakes, even a heavy rain can be enough to loosen unstable material at the top of many steep volcanoes. Gravity does the rest.

Another deadly aspect of lahars is the great distances they can travel down river valleys, sometimes hundreds of kilometers from a volcano. "Imagine," says Gardner, "a rushing surge of water coming toward you that's tens of meters thick" and carrying boulders, trees, and even houses. The best chance of survival is to get out of the way—only lahars are too fast to outrun. The deadliest lahar in recent history occurred in 1985, when an eruption of the Nevado del Ruiz volcano in Columbia triggered mudslides 50 meters thick that buried a town 70 kilometers away, killing 23,000 people.

To warn of an impending lahar at Ruapehu, a team led by Harry Keys, an engineer at the New Zealand Department of Conservation, wired up the mountain. His group installed underground microphones, called geophones, at the lake's rim to record

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Mount Doom, brooding. Data from Ruapehu's lahar flow will help better protect millions of people living near other volcanoes.

vibrations. A buried wire was set to trip if the tephra dam broke, and a depth meter was deployed in the lake to record sudden drops. Geophones on the slopes listened for approaching flows. When any signal leaped above the background noise, an alarm message was sent automatically to scientists, police, and the highway authorities.

Scientists thought this would give a good idea of when a Ruapehu lahar would strike; where was another question. "What we're learning is that lahars evolve," says Sarah Fagents, a geophysicist at the University of Hawaii, Manoa. Although a lahar may start as a liquid with the low viscosity of water, it quickly becomes as thick as wet concrete as it picks up fine sediment, then morphs back into a less-viscous flow as it sheds particulates down the slope. As if that weren't already hard enough to simulate on a computer, as a lahar rips up material here and dumps it there, the changing terrain steers the flow.

"A whole lot of footwork" was required to record how Ruapehu's slopes looked before a lahar struck, says Alison Graettinger, a graduate student at the University of Waikato in nearby Hamilton. The grunt work included taking samples and Global Positioning System measurements to map out the composition and distribution of material on the slopes. The researchers also used light detection and ranging (LIDAR) technology to build three-dimensional models of land features by firing laser pulses and measuring the delay of the reflection.

By early 2007, all that remained on the scientists' to-do list was to install the last lahar-weighing sensor and a camera. Before the team could finish, nature intervened.

CREDIT: GNS SCIENCES

Chronicling its wrath

At 11:21 a.m. on 18 March, a 20-meter-wide section of the tephra dam crumbled. The breach trebled in size in 10 minutes. At its peak, the lake discharged the equivalent of an Olympic swimming pool of water every 4 seconds. By the time the flow ended a couple of hours later, 1.3 million cubic meters had drained.

For the first time ever, researchers knew a lahar was on the way and watched the event unfold.

The ultimate cause of the dam's failure was 5 days of heavy rain that nudged up the water level inside the crater by a half-meter. However, signs of trouble had begun appearing months earlier. In January, the team found that the dam was becoming more electrically conductive—an indicator that water was infiltrating the dam's porous matrix—and that tephra sediment was trickling down its outer surface. The major collapse was preceded by several smaller ones starting more than an hour before—all captured on camera. These early tremors were also picked up by the geophones and set off the alarm system.

It was clear this was no false alarm when a "landslide-type failure" cut the trip wire. Layers began sloughing from the dam's outer surface inward until erosion reached "a critical point" and rapidly accelerated about 15 minutes later, says Chris Massey, a GNS geological engineer in Wellington. The lahar traveled 155 kilometers along river paths until it reached the ocean at 3 a.m. the next morning. The damage was minor—a small bridge, a block of toilets, and a farmer's pump shed were destroyed—and the alarm system allowed authorities to close highways well in advance to clear the way.

Since that day, a team led by Manville and Shane Cronin, a volcanologist at Massey University, has worked nonstop to gather data from Ruapehu before wind and rain erase the evidence. The techniques used to establish the "before" picture—such as LIDAR scans and field sampling—are being repeated to get the "after." Data analysis is just beginning, but it is already providing "a unique insight into how natural dams fail," Massey says. For example, he says, it is clear that the dam's stability "was highly sensitive to relatively minor changes in lake water level."

Down the mountain, other data revealed that as the lahar surged along a riverbed, it may have created a soliton, a standing wave that can propagate over great distances without losing energy or changing shape. Photographs of the lahar's leading edge seem to show such a wave, and analysis of water samples indicates that the lahar was pushing a huge swell of fresh river water ahead of it. Solitons have been observed in canals, says GNS geophysicist Desmond Darby, but this is the first evidence of one generated by a volcano. Although the soliton didn't make the lahar any more vicious, it's "an interesting phenomenon," Manville says. The Ruapehu researchers will present findings next month at a meeting of the International Union of Geodesy and Geophysics in Perugia, Italy.

The ongoing scrutiny of Ruapehu's latest lahar could save lives elsewhere. Probably the biggest threat is in Ecuador, where some 100,000 people live in the direct path of potential lahars from Mount Cotopaxi, says Patricia Mothes, a volcanologist at the Geophysical Institute in Quito. The data coming out of New Zealand get at "some of the questions that I always have" about how to assess lahar risk, she says, such as which conditions are more likely to spawn sediment-laden lahars capable of "transporting huge boulders very long distances."

Someday, Mount Doom may become more famous for saving lives than for menacing hobbits. **–JOHN BOHANNON**