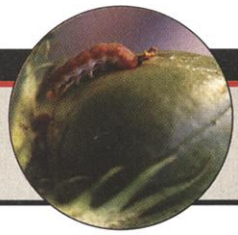
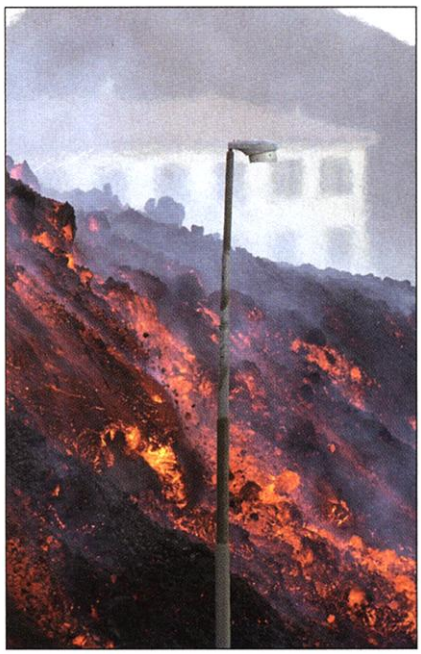


VOLCANOLOGY

Etna Eruption Puts Volcano Monitoring to the Test

MOUNT ETNA, SICILY—It's well past midnight, but Patrick Allard has no desire to knock off for the night. He fiddles with a computer in the back of a Land Cruiser parked on hardened lava 2600 meters up Etna's south flank, watching the raw data from a Doppler radar feed onto the screen. Fighting hunger and fatigue—Allard has been at this for 4 weeks—the research director at CNRS, France's basic research agency, gestures at the breathtaking sight rising, unnervingly, just half a kilometer away. "Ten days ago, there was nothing there," he says. Now, in the early morning of 30 July, a volcanic cone already 150 meters tall and growing is shooting magma and gas high into the sky. Every few seconds, hundreds of bombs burst like fireworks from Etna's newest "parasitic" cone, falling in a graceful arc and landing on the steep slope with the rhythmic sound of a breaking wave. The glowing lava blobs tumble in chaotic, seemingly slow-motion patterns resembling the movements of swarms of fireflies.



Hot science. Volcanologists are monitoring the eruption with an array of instruments.

Allard, who collaborates with the Catania section of the National Institute of Geophysics and Volcanology (INGV) in Sicily, Italy, is bouncing radio waves off the erupting magma blocks to measure their velocity and volume and thus get a handle on the amount of energy streaming from the cone. Set incongruously against the lights of Catania at Etna's foot, the cone seems to pause and catch its breath for several seconds. "Get ready," Allard says with evident glee, as acrid sulfur dioxide gas drifts down from the main crater. Suddenly, a supersonic magma jet tears from the cone with a thunderous clap, disgorging car-sized bombs and unleashing a shock wave that presses clothes against body. "Wow," Allard says. "That was off the scale." Little wonder he doesn't want to pack up. One of the world's most active volcanoes is on fire—and the science is pretty hot, too.

Etna's latest eruptions began on 17 July, and they have attracted scores of volcanologists like Allard eager to use the latest technologies to study this awesome display. So far, Etna's pyrotechnics show no signs of abating. As *Science* went to press, the half-million-year-old volcano's activity posed little threat to surrounding villages or to individuals who stay off the mountain. Lava flows freely from its vents, as its magma is not as viscous as that in volcanoes such as Mount St. Helens that build lava domes and blow their tops in violent, explosive eruptions.

But Etna is not a simple volcano, and INGV scientists are vigilant for signs that it may be entering a more dangerous phase. Researchers are keeping a 24-hour watch on the volcano, monitoring seismic activity, ground deformations, gas emissions, and gravity changes that track magma upwelling. If Doppler radar and other new techniques prove themselves during this eruption, they could sharpen monitoring and prediction at other hot spots around the world. The stakes are high. Nine times out of ten, says Clive Oppenheimer of the University of Cambridge, U.K., apparent signs of an imminent eruption are red herrings. "You can't evacuate people and get it wrong," he says, as many people would inevitably ignore the next evacuation order.

Earth tremors and ground deformations are the key observations that help emergency management authorities predict when a volcano may blow and, often just as critically, when it should begin to simmer down. Although volcanologists have long wanted to expand their monitoring toolkit, the need to do so was brought into sharp relief by Montserrat, where volcanic eruptions in 1997 obliterated the tiny Caribbean island's capital. When the eruptions ceased in March 1998, seismic and deformation measurements pointed to the volcano entering a quiescent mode. "It looked like there would be a period where people would be able to move back in," says Oppenheimer. Offering contrary evidence, however, were analyses of venting gases suggesting that magma remained in the volcano's upper reservoir. In November 1999, Montserrat erupted anew; its violent activity continues to this day.

Sniffing venting gases could improve the forecasting abilities of volcano oracles. Toward this end, the young discipline of volcanic geochemistry is the beneficiary of a military spin-off: portable Fourier transform infrared (FTIR) spectrometers developed for detecting chemical weapons on a battlefield. INGV's Mike Burton is pioneering the use of FTIR spectrometry in monitoring a dynamic volcano such as Etna. "No one's been able to do this before," says Oppenheimer, who with the late Peter Francis helped develop the technique, which allows scientists to analyze gas clouds rapidly at a safe distance.

Burton put the machine through its paces one recent blistering afternoon near Catania.

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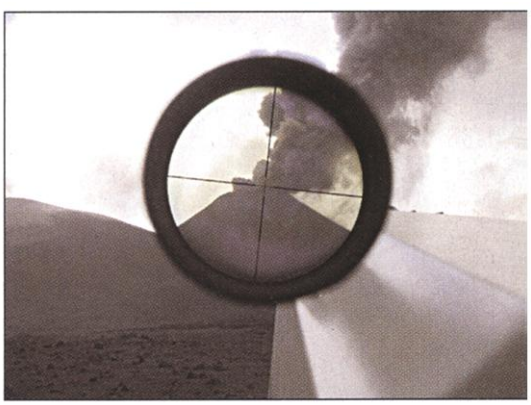


Gas attack. INGV's infrared spectrometer draws a bead on Etna.

Working in a fine rain of black ash perceptible only from a rustling in the foliage and the way it faintly pricks the skin, Burton measured the absorption of the sun's rays passing through the volcano's gas cloud. From this he could decipher the relative amounts of gases—such as sulfur dioxide, hydrogen chloride, and hydrogen fluoride—venting from the volcano.

Sifting through earlier gas data, Burton has found an intriguing correlation. Just 4 days before the eruption began, the ratio of sulfur dioxide to hydrogen chloride rose more than twofold. It remains to be seen whether such a sign will presage future eruptions.

More pressingly, the gas ratios should help researchers gauge the stamina of each of Etna's now five active vents by determining which are drawing from the main magma reservoir. "It's difficult to tell if the main central system is feeding all these vents," says geologist Renato Cristofolini of the University of Catania. Ebbing sulfur dioxide might suggest less welling up and degassing of magma—and the eruption tapering off. A lengthy eruption—such as Etna's last major one, which lasted from December 1991 to March 1993—would be cause for concern, as it would increase the likelihood of lava tube formation. These hardened lava conduits would funnel molten lava faster and farther down the mountain, perhaps threatening towns. So far, however, all signs point to ample magma—and no end in sight to Etna's latest outburst. Although monitoring tools are getting better, says Oppenheimer, "no one could give you reliable odds on how long the eruption will go." **–RICHARD STONE**

STEM CELLS

Japan Readies Rules That Allow Research

TOKYO—Japanese scientists would be allowed to derive and conduct research on human embryonic stem cells under guidelines expected to be approved this week by a top-level advisory body. Researchers say they are satisfied with the guidelines, which have been drawn up with little of the rancor that has characterized the debate in the United States.

A committee working under Japan's highest science advisory body was set to finalize its recommended guidelines at a meeting scheduled for 1 August. Ultimately the guidelines will have to be approved by the education minister, whose concurrence is widely expected. Barring unforeseen glitches, the guidelines could be put into practice as early as this fall, clearing the way for any researcher in Japan to establish human embryonic stem cell lines and start using them for research. "We can now go ahead in making plans for research in this very exciting field," says Norio Nakatsuji, a developmental biologist at Kyoto University who is likely to be one of the first in Japan to establish such cell lines.

Green light. Norio Nakatsuji is looking forward to creating cell lines under new guidelines.

Human embryonic stem cells, which theoretically can develop into any of the body's cells, may ultimately provide laboratory-grown replacement organs and treatments for such diseases as Parkinson's and Alzheimer's. But embryos are destroyed when stem cells are harvested, making their use ethically controversial. Unlike in the United States, there has been no organized lobbying against their use in Japan, and few politicians have addressed the issue. However, public concern over the possible commercialization of human embryos and potential misuse of the cells has led the panel to recommend tough guidelines. "Strict regulation is necessary to obtain public support," agrees Nakatsuji.

Under the proposed guidelines, all plans to establish embryonic stem cell lines and all research using the cells will have to be approved and monitored by each institution's ethical review board and by a newly established review board under the Ministry of Education, Science, Technology, Sports, and Culture. Researchers must have demonstrated an ability to handle stem cells through prior work with animal stem cells. Stem cells may only be harvested from "spare" embryos resulting from in vitro fertilization. The embryos must be donated, with donors giving written informed consent for their use. Clinics or hospitals planning to gather embryos for the isolation of stem cells must have their own review boards.

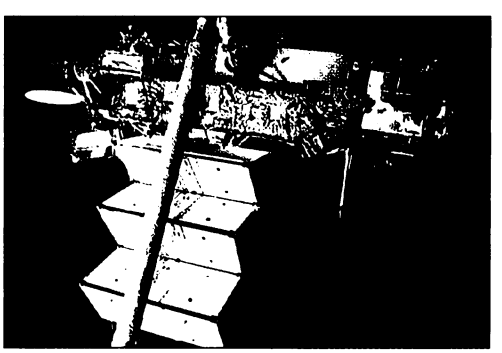
The resulting cell lines are to be used only for basic research. Use of the cells for reproductive purposes, cloning, medical treatment, or drug screening is expressly prohibited. The guidelines apply to both public and private sector research. Public sector violators could lose their funding. Although the guidelines don't carry the force of law, private firms are unlikely to risk the bad publicity that would come with flaunting public policy. As yet, however, the private sector has shown little interest in the field. **–DENNIS NORMILE**

EARTH SCIENCES

Satellite Shutdown Stirs Controversy

NASA last week abruptly decided to shut down a venerable research satellite that has been gathering critical global climate change data for a decade. The decision, made for fiscal reasons, surprised and angered atmospheric researchers, who were planning a festive 10th anniversary celebration next month for the Upper Atmosphere Research Satellite (UARS).

NASA officials say it's probably only the first in a series of similar shutdowns resulting from a decision several years ago to put industry in charge of satellite operations. The planned cost savings never materialized, however, forcing project scientists to make some tough decisions. "It's not a pleasant situation," says Paul Ondrus, project manager for operational missions at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Now, NASA managers are faced with another



Heads up. The massive UARS satellite, here being placed in orbit, must either be brought back by the shuttle or be left to an uncontrolled descent.

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