mechanism for how the hygiene hypothesis works," says geneticist William Cookson of the Wellcome Trust Center for Human Genetics in Oxford, England. Umetsu's group has produced "interesting work, but the study needs follow-up," Cookson adds. "It would be nice to see it replicated and generalized." Of course, nobody would choose to go back to the bad old days of dubious drainage and rampant infections to fend off asthma. The Stanford team is currently testing whether vaccination will do the trick instead.

Lisa Melton is based in London.

SENSORS

Volcanic Sniffing

QUANTUM-CASCADE LASER MAY DETECT IMPENDING ERUPTIONS

BY CHARLES CHOI

In A.D. 79 Mount Vesuvius erupted, annihilating the cities of Pompeii and Herculaneum and killing thousands who did not evacuate in time. To avert a similar fate for present-day Naples, which lies six miles west of the still active Vesuvius, as well as for the cities near volatile Mount Etna in Sicily, a novel laser system could soon forecast volcanic eruptions up to months in advance.

Current methods to predict eruptions have downsides. Seismometers can monitor tremors and other ground activity that signal a volcano's awakening, but their readings can prove imprecise or complicated to interpret. Scanning for escaping gases can reveal whether magma is moving inside, but the instruments used to analyze such emissions are often too delicate and bulky for life outside a laboratory. "You have to collect samples from the volcano, bring them to a lab, and often wait through backlogs of weeks to months before analysis," explains Frank Tittel, an applied physicist at Rice University.

A more promising technique for early detection focuses on changes in carbon isotopes in carbon dioxide. The ratio between carbon 12 and carbon 13 is roughly 90 to one in the atmosphere, but it can differ appreciably in volcanic gases. A ratio change by as little as 0.1 part per million could signal an influx of carbon dioxide from magma either building under or rising up through the volcano.

Lasers can help detect this change: carbon 12 and 13 absorb light at slightly different mid-infrared wavelengths. The lasers must continuously tune across these wavelengths. Previously investigators used lead-salt lasers, which require liquid-nitrogen cooling and thus are impractical in the field. Furthermore, they are low-power devices, generating less than millionths of a watt, and can emit frequencies in an unstable manner. Other isotope scanning techniques are similarly lab-bound.

Tittel and other scientists in the U.S. and Britain, in partnership with the Italian government, have devised a volcano-monitoring system around a quantum-cascade laser. Such a semiconductor laser can produce high power across a wide frequency. Moreover, they are rugged and do not require liquid-nitrogen

MOUNT VESUVIUS, shown here in 1944, still threatens Naples.

BETTMANN/CORBIS

A WATERFALL OF ELECTRONS

Quantum-cascade lasers consist of thin, nanoscale layers of semiconducting materials that provide several energy levels to an electron. An excited electron cascades down the levels to lose energy, emitting a laser photon at each step. In this way, a single electron can emit dozens of photons, making quantum-cascade lasers more powerful than standard semiconductor lasers, in which only one photon per excited electron is emitted. Moreover, by adjusting the size of the layers during fabrication, researchers can make an electron emit photons of different frequencies. The combination of high power, wide-frequency bandwidth and compact size makes the quantum-cascade laser ideal for volcano monitoring.

cooling, making them compact enough to fit inside a shoe box.

The researchers first tried out their device on gas emissions from Nicaraguan craters in 2000. The new field tests will check its performance and accuracy in harsh volcanic locales. Dirk Richter, a research engineer at the National Center for Atmospheric Research in Boulder, Colo., says it would prove difficult to design a system "to work in one of the worst and most challenging environments possible on earth," but "if there's one group in the world that dares to do this, that's Frank Tittel's group."

If the instrument works, the plan is to deploy early-warning systems of lasers around volcanoes, with each device transmitting data in real time. False alarms should not occur, because carbon isotope ratios in magma differ significantly from those in the crust. The changes that the laser helps to detect also take place over weeks to months, providing time to compare data from other instruments, as well as ample evacuation notice. "Our system aims at avoiding a catastrophe like the Vesuvius eruption," says team member Damien Weidmann, a physicist at the Rutherford Appleton Laboratory in Oxfordshire, England. Field tests for the prototype are planned for the spring of 2005 in the volcanic Alban Hills region southeast of Rome, near the summer home of Pope John Paul II, as well as for volcanic areas near Los Alamos, N.M.

Charles Choi is a freelance writer based in New York City.

SPACE

Flawed Revelations?

CONTAMINATION MAY UNDERMINE GENESIS DATA

BY BARRY E. DiGREGORIO

After traveling 1.5 million kilometers beyond Earth to obtain bits of the solar wind, NASA's first automated sample-return mission, Genesis, ended in a crash in the Utah desert on September 8. Researchers do not know just why the parafoil failed to deploy, but they say they feel confident that they can still accomplish the major goals of the mission despite the damaged capsule. Any conclusion stemming from the mission, however, may remain dubious because of the mere possibility of contamination.

Genesis had onboard an estimated 20 micrograms of solar-wind particles

LOOK OUT BELOW: Genesis capsule lay in a shallow crater shortly after impact.

NASA/JPL; USAF 388 RANGE SQUADRON