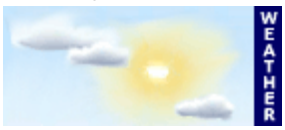

Volcanic eruptions predicted via laser

By Charles Choi
United Press International

New York, NY, Jul. 20 (UPI) -- A novel laser sensor under development could predict volcanic eruptions and earthquake activity, researchers told United Press International.

Scientists from the United States and Britain are partnering with the Italian government to design an early warning system around Naples and Sicily to predict eruptions weeks to months in advance. The research team hopes to deploy their sensors soon at volcano sites in the United States as well, and one day elsewhere along the volcano-laden Pacific Rim.

"At the moment we are developing a field-deployable prototype," said researcher Damien Weidmann, a physicist at the Council for the Central Laboratory of the Research Councils at the Rutherford Appleton Laboratory in Oxfordshire, England. "The system is now assembled and is on final testing in the lab."

The methods nations currently use to predict eruptions involve seismometers to detect tell-tale rumbles and devices that scan volcanic emissions for chemical signals. Seismometer readings can be imprecise, however, and with existing chemistry scans, researchers physically must go to the volcano and bring samples back to the lab, usually necessitating a long wait before results are available.

"Long waits are not a good thing when a volcanic crisis looms and decisions may need to be made quickly," researcher Clive Oppenheimer, a volcanologist from Cambridge University in England, told UPI.

The new laser system will scan volcanic emissions for variations in carbon dioxide by focusing on the isotopes of carbon the

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emissions possess.

Carbon-12 -- so named because it has 6 protons and 6 neutrons making up its atomic nucleus -- is stable and makes up roughly 98.9 percent of all carbon in the atmosphere. Carbon-13, with 6 protons and 7 neutrons, also is stable but makes up only about 1.1 percent. The slight remainder is carbon-14, with 8 neutrons.

The CO2 in magma from deep in the Earth can have more or less carbon-12 and carbon-13 than normal, depending on the volcano and its local geology. If the carbon-13 levels change by as little as one-tenth of a part per million, that could suggest a fresh dose of magma has entered the volcano and more is ascending toward the surface -- "both of which could lead to an eruptions," Weidmann told UPI.

Laser beams can scan which form of carbon is present in volcanic emissions with extraordinary sensitivity.

"Each molecule absorbs light differently, and the spectrum of the absorbed light provides an unambiguous signature of the molecule," Weidmann explained. "With such a technique, we are able to discriminate carbon-12 dioxide and carbon-13 dioxide and to measure their concentrations independently."

The researchers are using a quantum cascade laser -- from Alpes Lasers in Neuchatel, Switzerland, technology licensed from Lucent -- which is made with hundreds of extremely thin, semiconductor layers, each thinner than a wavelength of visible light. These delicate films each have varying electrical conductivity. When electricity charges them, electrons remain sandwiched between the more electrically resistant layers. This confinement boosts energy levels in all the layers, until, collectively they emit bright light.

Other lasers can generate infrared beams at the best wavelengths to scan for carbon isotopes, but they also require extremely cold temperature. This means cryogenic cooling with gases such as liquid nitrogen, making such lasers cumbersome and expensive.

Quantum cascade lasers, on the other hand, generate light beams without requiring cryogenics. This makes them much simpler to operate than other lasers. In addition,

unlike any other chemical-based technique to predict eruptions, the lasers are deployable in the field and can operate in real time.

"Other technologies are big boxes. Our sensor can be in a shoebox," said researcher Frank Tittel, an applied physicist at Rice University in Houston.

"So it's something you should be able to mass-produce since it's so small, and in theory can be very cost-effective," he told UPI. "You can deploy them over the whole volcano, and put antennas on them, beam to satellite, and sit anywhere in the world and monitor over the Web. It's a real advantage."

The changes in volcanic chemistry detected by the laser "typically occur on timescales of weeks to months," Weidmann said. "We have, let's say, one month to evacuate. We have time to evacuate the instrument as well."

Both active and dormant volcanoes often are located in urban or agricultural areas.

"To give an example, three active volcanic regions are in and around Naples. When they erupt, they erupt with great violence and can destroy large centers of population," Tittel said. "So having early warning of such events would help civil defense activities in securing the population. Also, usually people living downwind of volcanic emission sites can have crops, livelihood and health affected detrimentally. Being able to minimize that would have great impact."

The researchers have tested their device on volcanic gas emissions from craters in Nicaragua in 2000 to measure the link between volcanic eruptions and carbon dioxide emissions.

"Presently, we are planning a first demonstration campaign in Italy, in the neighborhood of Rome," Weidmann said. "Depending on the laser availability, this campaign will occur this year or next year."

Tittel added they also plan to study volcanic emissions in New Mexico, California and Hawaii in 2005.

The laser's results promise to provide deeper insight into the causes of volcanic eruptions, "and with that the establishment of a new kind of early warning system," said physicist

Ulrike Willer, of the Technical University of Clausthal in Germany, who is not affiliated with this work.

"This could help to evacuate inhabited regions prior to eruptions," Willer told UPI. "As always with measurements in the vicinity of volcanic gases, care must be taken to shield the equipment from the chemically very aggressive surroundings."

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