Fracture formula yields volcanic forecasts

The equation $\dot{\Omega}^{-\alpha}\ddot{\Omega} - A = 0$ won't win any awards for easy reading, but it just might save some lives. New research suggests that this mathematical expression can help experts predict when a restless volcano will blow its top.

The equation represents a general law describing how various materials — ranging from metal to plastic to ice — fracture under stress. But it also appears to have promise for indicating when an imminent volcanic eruption will occur, report Barry Voight and Reinold R. Cornelius of Penn State University in University Park.

Before volcanoes blow their tops, they generally offer some sort of geophysical clues, such as earthquakes and bulging of the land surface. Voight and Cornelius demonstrate how volcanologists can predict the timing of an eruption by feeding a particular type of earthquake information into the fracturing equation.

In the April 25 NATURE, they apply their technique to four case studies: two small, nonexplosive eruptions from Mount St. Helens in 1985 and 1986, and two explosive bursts from Alaska's Mount Redoubt in 1989 and 1990. In their analysis, Ω stands for average seismic ground movement; A and α represent empirical constants. By plugging in data on earthquake activity preceding the four eruptions, Voight and Cornelius demonstrate that this method could have predicted a narrow "window" for eruption time several days in advance. In the case of Mount Redoubt's violent eruption on Jan. 2, 1990, the technique showed predictive skill with information available a full week before the eruption, they report.

Some volcano experts remain skeptical of the method's usefulness, noting that Voight and Cornelius have tested it only by "hindcasting" past events, and have yet to demonstrate its accuracy before an eruption has occurred. "I think the jury's still out on whether we can use it as a predictive tool," says Alaska State Seismologist John Davies in Fairbanks.

But if it does work, the technique promises to make eruption predictions much more rigorous and more accurate, says Stephen D. Malone, a seismologist at the University of Washington in Seattle. Scientists currently use less objective tests for forecasting. "It's a lot of judgment calls — the seat-of-your pants sort of stuff," Malone says. He adds that he plans to incorporate the new method in his analyses of seismic information for Mount St. Helens.

Voight and Cornelius stress that their approach will not work for all volcanoes under all circumstances, and that researchers will obtain the best predictions by using several different techniques together.

For instance, this particular mathematical method could not have predicted the devastating May 18, 1980, eruption of Mount St. Helens. The blast started after an earthquake triggered a landslide, uncorking the pressure building within a bulging flank of the volcano. Because the landslide short-circuited the normal eruptive process, the volcano didn't provide any of the seismic clues normally used in predicting eruptions—and Voight and Cornelius' method hinges on many of those same seismic changes.

— R. Monastersky

Quirk in antibody action yields cheap assay

A new sensing device that can detect cocaine quickly and cheaply may prove a time-saver for scientists, a cost-saver for the U.S. military and a life-saver for patients, as well as a roadside drug detector.

The new approach could radically broaden the commercial potential for screening technology, says Ralph O. Mumma, an environmental chemist at Penn State University in University Park. For example, it might make possible portable, easy-to-use sensors.

Developed at the Naval Research Laboratory (NRL) in Washington, D.C., the "flow immunosensor" was described last week by Frances S. Ligler at the American Chemical Society meeting in Atlanta. The device's high efficiency took its inventors and other researchers by surprise, the NRL chemist says, because according to conventional wisdom, it shouldn't have worked at all.

Today, laboratories typically screen for drugs with devices that use molecules labeled with radioactive tags or fluorescent dyes. Many of these screening techniques harness antibodies, molecules that recognize specific substances—even when those substances exist in minute amounts. Because each assay consumes a little of the costly labeled material — whether or not screened-for material is detected — even a simple urine test for cocaine can cost as much as $4. For the U.S. Navy, such tests now add up to $10 million a year, Ligler notes.

Though the immunosensor she helped develop borrows from that antibody approach, "the way we're using the antibody is different," Ligler explains. The Navy scientists pack tiny beads coated with cocaine-sensitive antibodies into a cylinder slightly bigger than a pencil's eraser, then add a fluorescent label to the cocaine molecules, which bind to the antibodies.

As urine flows through the cylinder, any cocaine molecules in the sample will kick their fluorescent counterparts off the antibodies, and these tagged molecules will register a positive result as they exit past a fluorimeter. But if the sample contains no drug, no expensive tagged material is consumed, Ligler says — and therein lies a substantial savings.

Ligler says she doubted this approach would work because the labeled cocaine should bind to these immobilized antibodies and never come off. Instead, it comes off in seconds — much faster than in other screening tests, which take at least 20 minutes. Moreover, she notes, this sensor costs much less to build than comparable assaying equipment and requires less training and labor to operate. "You can use it in the workplace or in a police station," she says.

With different antibodies, she expects researchers can adapt the flow immunosensor for monitoring pollutants in water, drug levels and blood chemistry in patients, and elusive substances sought by scientists in their research. Though antibodies exist for some of these substances, sensors for many other compounds will require the development of new antibodies. The technique "needs more development to see how versatile it will be," says Mumma. *— E. Pennisi*

Colds may thwart vaccines

In recent years, physicians have observed an increase in the number of children who develop measles despite vaccination against the disease. Three Army pediatricians now offer a possible explanation for some of these vaccination failures: cold-like infections in the children when they were immunized.

Marvin S. Krober of the Madigan Army Medical Center in Tacoma, Wash., and his co-workers studied 98 infants who received a measles-mumps-rubella vaccination at 15 to 18 months of age. Of the 47 fever-free children who had cold-like symptoms at the time of vaccination, 10 (21 percent) failed to develop measles antibodies, they report in the April 24 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. In contrast, only one (2 percent) of the 51 healthy infants never developed the beneficial antibodies.

Such failures may result from the body's attempt to battle existing infections by producing virus-fighting proteins called interferons, the researchers suggest. In an accompanying editorial, Georges Peter of Brown University in Providence, R.I., notes that other studies support this idea, but he argues against delaying immunizations in children with minor upper-respiratory infections. Too few children receive immunizations as it is, he says, and even in this study, the vast majority of cold sufferers developed protective antibodies. □