Earthquake predictions on shaky ground?

The U.S. Geological Survey (USGS) last week slightly increased its estimated probability of a major earthquake occurring in southern California within 30 years, while two new studies suggest that forecasting such an event may be even trickier than geologists think.

Representing the work of a dozen scientists over the past year, the USGS document estimates a 60 percent probability of an earthquake of at least 7.5 magnitude along the San Andreas fault near Los Angeles. A 1980 study had put the probability at 50 percent. The report also gives a 50 percent likelihood for a similar earthquake in the San Francisco Bay area during the next 30 years.

The USGS scientists calculated their estimates from the dates and sizes of previous ruptures along the San Andreas fault system. They noted that major quakes occur northeast of Los Angeles on average every 130 years, with the most recent in 1857. But in the July 8 SCIENCE, Gordon Jacoby and Paul Sheppard of Columbia University's Lamont-Doherty Geological Observatory in Palisades, N.Y., and Kerry Sieh of California Institute of Technology in Pasadena say the fault moves with such irregularity that earthquakes there remain too uncertain to forecast from historical records.

After measuring rings from 70 trees, Jacoby and his colleagues believe an earthquake occurred along the Mojave segment of the fault in 1812 — the year of a large rupture known as the San Juan Capistrano quake (SN: 4/18/87, p.255). Previously, scientists had blamed this earthquake on a coastal fault, not on the San Andreas, since historical accounts describe coastal damage. However, the researchers found that nine trees growing within 20 meters of the fault suffered a severe shock in 1812 characteristic of a large, growth-stunting earthquake. Assuming trees are accurate historians, they say, only 45 years separate the two most recent major quakes.

In a separate, still-unpublished study, Sieh dated the last 10 earthquakes along the same segment using refined radiocarbon dating methods on sediment layers snapped apart during earthquakes. Although a simple average of the more exact numbers still spaces the temblors 131 years apart, Sieh found they occurred in bursts of two or three, followed by 200 to 330 years of calm.

To increase precision, Sieh's group used larger samples of sediment and left them in a radioactivity counter two weeks, rather than the usual 17 hours or so. Although the new radiocarbon study was mentioned in the USGS report (Sieh was also one of its authors), the data were not used in the calculations.

"We need to study some other localities that can either substantiate or conflict those data," says Randy Updike, deputy director for the USGS Earthquake Hazards Office in Reston, Va. Ironically, this means the segment of the fault traced in detail leaves the most questions.

"We probably would have been more certain [of the USGS probability estimates] not having them," says Sieh of the radiocarbon dates. "But we wouldn't have been better off." He believes that to outsmart the next Los Angeles-area quake, scientists must determine whether the nearby fault is moving in one of these clusters of earthquakes. Although he thinks the Mojave segment is most likely quiet for now, given the length of time since the last rupture, he also cautions that no one can be sure how many earthquakes make up a cluster.

James Dieterich, USGS geophysicist and an author of the agency's report, says that because the USGS "doesn't regard the difference between 50 percent and 60 percent [probability] as significant," the report raises more questions about the measurement of past earthquakes than about the prediction of future ones. Comments Dieterich: "It's more of a scientific issue than a public concern." — *L. Beil*

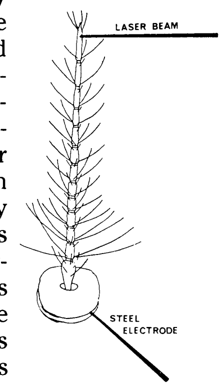
The sound of no mosquitoes biting

The search for a perfect mosquito repellent may never end, but it's been years since scientists have come up with anything even a little more effective than the old standby, N,N-diethyl-m-toluamide, or deet. "Probably the single most important reason for this failure," says Edward E. Davis of the Vector Biology Program at SRI International in Menlo Park, Calif., "is that we still don't know the site or mode of action of any currently effective [mosquito] repellent substances" — most of which have remarkably dissimilar chemical structures. Without insight into what makes a repellent repulsive, it's difficult to design a more effective version.

But in preliminary research reported last week, Davis provided new clues about deet's *modus operandi,* spurring hope that custom designed compounds someday may put an end to that summertime symphony of little whining wings. Speaking at the International Congress of Entomology in Vancouver, British Columbia, Davis described electrophysiological and behavioral experiments on mosquitoes that suggest deet specifically interferes with antenna-based receptor cells that normally bind and respond to lactic acid.

Lactic acid, which evaporates from the skin of warm-blooded animals, has long been recognized as a mosquito "host attractant" molecule. But scientists have been uncertain what step in a lactic-acid-mediated chain of events deet interrupts. Davis' experiments suggest that deet, when it evaporates from treated clothing or skin, somehow interferes with the initial molecular binding of the attractant acid to a mosquito's sensory cells.

Using tungsten microelectrodes, Davis measured microvolt "action potentials" — changes in electrical activity that initiate neuronal firing — at lactic acid receptor sites on the tiny hairs, or sensillae, of mosquito antennae. The neurons that normally fire with increased frequency in response to the specific lactic acid cue fired significantly less frequently in the presence of deet; other neurons were much less affected by deet. This suggests that more generalized theories about deet's mode of action — that it is a central nervous system blocker or that it binds to and activates its own, specific "noxious stimuli" receptors — are probably incorrect, Davis says.



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He also performed behavioral experiments, in which he tallied the number and degree of directional changes mosquitoes made in a wind tunnel when exposed to varying combinations of lactic acid and deet. He videotaped their behavior and reviewed the tapes frame by frame. The mosquitoes behaved the same in the presence of lactic acid and deet as they did in the absence of lactic acid, providing new evidence of the acid's attractant role.

In other work, Peter Belton of the Simon Fraser University in Burnaby, British Columbia, glued live mosquitoes' "chins" onto glass microscope slides. He then zapped their antennae with a laser (see diagram) and recorded vibratory resonance and the electrical activity of sensory cells at the antennal bases. His findings confirmed earlier work, done with less-sensitive instrumentation, that male mosquitoes are most sensitive to sounds in the vibratory range made by the beating of female mosquito wings — about 250 hertz. But he also found that electronic devices that purport to repel mosquitoes by emitting irritating sound waves are completely outside the hearing range of the tiny insects.

— *R. Weiss*