'Clockwork' quakes may not keep good time

Parkfield, Calif., has a reputation for moderate earthquakes that strike with clock-like regularity. Expecting the next such quake by 1993, the U.S. Geological Survey (USGS) has installed millions of dollars' worth of quake-monitoring equipment there. This week, however, two groups of geoscientists reported evidence suggesting Parkfield's quakes are less regular than believed, raising doubts about whether the forecast will hold.

"I'm a little less optimistic [than I used to be] for it happening in the next several years," says USGS geophysicist Paul Segall of Menlo Park, Calif., who led one of the new studies.

In 1985, two USGS scientists gave 20-to-1 odds that a magnitude 6 shock would occur before 1993 on the San Andreas fault in Parkfield, a sparsely populated farming town about halfway between Los Angeles and San Francisco. The prediction stemmed from the theory that some portions of the San Andreas rupture repeatedly in "characteristic" earthquakes. In Parkfield, earthquakes of magnitude 5.5 or 6 were known to have struck in 1857, 1881, 1901, 1922, 1934 and 1966. Aside from the 1934 event, this shock sequence suggested an apparently regular period of 21 or 22 years. The 1934 and 1966 quakes had the same epicenter and magnitude, adding weight to the notion of Parkfield's characteristic quakes.

Believing another shock was due soon, the USGS in 1985 set up its Parkfield Prediction Experiment in an attempt to study the earthquake process in unprecedented detail and to issue a prediction days or hours before the quake.

Now, evidence culled from thousands of old newspapers, diaries and letters challenges the assumption that Parkfield quakes occur regularly. Tousson R. Toppozada and his colleagues at the California Division of Mines and Geology in Sacramento say their historical search has uncovered earthquakes in 1877 and 1908 that apparently originated in Parkfield and measured magnitude 5.5. These two quakes clearly do not fit in the presumed 21-year cycle, Toppozada notes. The historical records also suggest that a magnitude 5.5 aftershock followed each of the previously known earthquakes in 1901 and 1922.

Toppozada's group estimates the epicenter and size of quakes described in old documents by comparing the descriptions with well-known modern quakes. They presented their results in Santa Cruz, Calif., at a meeting of the Seismological Society of America.

The new finds suggest that Parkfield's seismic activity has diminished dramatically in recent decades, Toppozada says. If the newly described shocks did in fact originate in Parkfield and were as strong as estimated — assertions debated by some geoscientists — then the area experienced seven shocks of magnitude 5.5 or greater between 1870 and 1930, but only two such quakes between 1930 and 1990.

In a separate presentation, Segall and colleagues from the USGS and Stanford University described old geodetic surveys across the fault in Parkfield. The data suggest that the 1934 and 1966 ruptures didn't break identical parts of the fault — a finding that makes Segall wonder how "characteristic" the Parkfield quakes really are.

Nonetheless, Segall maintains there is a "reasonable chance" that the forecasted earthquake will occur by 1993, and he says the need to concentrate limited equipment makes Parkfield the best place for the experiment.

But as the end of the forecast period draws closer, many observers, including some scientists, have started grumbling that Parkfield has diverted equipment and attention from more dangerous parts of the San Andreas, says Evelyn A. Roeloffs, chief scientist of the Parkfield Prediction Experiment.

In a broader sense, the new evidence "raises questions of whether the concept of characteristic earthquakes is a useful one," Roeloffs says. "If not, then it's going to be very hard to issue earthquake forecasts." — *R. Monastersky*

Panel finds fluoride-cancer link 'equivocal'

A review panel of nongovernment scientists last week affirmed the findings of a recent federal study that weakly links sodium fluoride — a compound widely used in public drinking water to discourage tooth decay — to bone cancer in male rats. Both the panel and the study's authors caution, however, that the results are "equivocal," meaning the excess bone cancers have only marginal statistical significance and might have occurred even in the absence of fluoride.

No excess bone cancers appeared in groups of female rats and in mice of both sexes, notes study director John R. Bucher of the Public Health Service's National Toxicology Program (NTP) in Research Triangle Park, N.C. The NTP, which commissioned the review panel, released the research results on April 2.

"The findings are much ado about nothing," asserts Joseph A. Cotruvo of EPA's office of toxicology. EPA is required by law to review fluoridation safety every three years, and Cotruvo estimates it will complete its current review sometime next year. "There is an extremely minimal amount of information [in the NTP study] to apply to human health considerations," he says.

Pathologist John A. Yiamouyiannis of Delaware, Ohio, strongly disagrees. A longtime opponent of water fluoridation, Yiamouyiannis coauthored a controversial epidemiologic report in 1977 that claimed a yearly excess of 10,000 human cancer deaths due to U.S. water fluoridation, prompting Congress to request the NTP animal tests. Yiamouyiannis calls for an immediate halt to fluoride use, citing the NTP tests and other reports, which he contends "provide clear evidence that fluoride is a carcinogen."

Still other researchers see no evidence at all in the two-year NTP study. John W. Stamm of the University of North Carolina at Chapel Hill, a dental epidemiologist and spokesman for the American Dental Association, maintains that NTP and the review panel took an overly cautious route by labeling the findings equivocal rather than statistically insignificant. Stamm notes that NTP scientists who conducted a similar animal study eight years ago, examining the toxicity of stannous chloride in drinking water, found a cancer incidence slightly higher than that of the recent fluoride study, yet they concluded there was no statistically significant cancer association. NTP's Bucher responds, "That was in 1982. We're allowed to change our thinking."

The disagreement centers on NTP's recent finding of a small excess rate of bone cancer among 180 male rats given sodium fluoride in their drinking water. Three cancer cases appeared among the 80 males receiving the study's highest fluoride dose — 79 parts per million (ppm), or about 80 times the usual concentration in fluoridated drinking water — and one cancer arose among the 50 rats exposed to a 45-ppm concentration. In contrast, no bone cancers developed in a group of 50 males receiving a dose of 11 ppm or in a control group of 50 males drinking fluoride-free water.

Bucher and his colleagues performed two types of analyses. Simple comparisons between the control group and each group with excess bone cancer indicated the cancers have no statistical significance. But a more sensitive analysis known as the trend test, which accounts for varying disease rates among animals exposed to different doses of a chemical, indicated the excess cancers have marginal statistical significance, Bucher says.

While emphasizing that the data are far from conclusive, Bucher maintains that a link between fluoride and the excess bone cancers "is plausible." He notes that fluoride binds to bone and can stimulate the proliferation and activity of osteoblasts, cells that increase bone mass.

A Public Health Service subcommittee is now comparing the NTP findings with other animal and human studies, and will likely issue its recommendations on fluoridation in July. — *R. Cowen*