California issues first quake prediction

In a drama that could have come from a Hollywood script, the San Andreas fault started showing signs of seismic activity beneath the tiny town of Parkfield, Calif., just in the nick of time. The moderate earthquakes that occurred there last week have raised scientists' hopes that a major jolt will shake this rural region before time runs out on the only long-term quake prediction ever sanctioned by the U.S. seismic community.

Located midway between Los Angeles and San Francisco, the town of Parkfield has suffered strong earthquakes on a remarkably regular schedule almost every 21 years. The small patch of the San Andreas running through this town produced jolts between magnitude 5.5 and 6.0 in 1857, 1881, 1901, 1922, 1934, and 1966. Recognition of this regularity led scientists with the U.S. Geological Survey to predict in 1985 that a magnitude 6.0 earthquake would occur along the 25-kilometer-long Parkfield segment of the San Andreas fault by the end of 1992. The USGS and the State of California funded a multimillion-dollar experiment to monitor the fault in hopes of issuing a short-term prediction hours to days before the actual quake hit.

In recent years, some seismologists have criticized the original prediction and the decision to pour what has amounted to $19 million into the Parkfield experiment while restricting funds for other earthquake research. This year, with time on the prediction running out, the Parkfield segment of the San Andreas has remained particularly quiet, adding to the feeling that the original prediction had overestimated the quake's chances.

In early October, though, the Parkfield region started popping with a series of three small earthquakes, the largest of which reached magnitude 3.1, says John O. Langbein of the USGS in Menlo Park, Calif., who heads the Parkfield experiment. The three tremors emanated from the San Andreas near Middle Mountain — a region where past Parkfield earthquakes have started. That activity triggered a C-level alert on a five-level rating system.

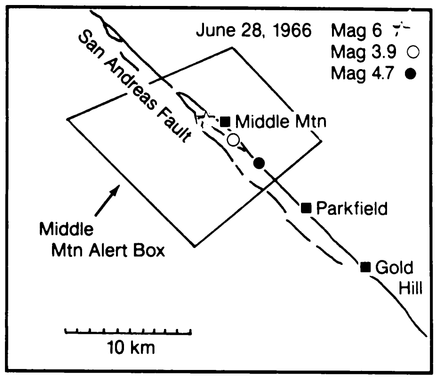
On Oct. 19, the same area of the fault produced a much larger jolt, measuring magnitude 4.7, which set off an A-level alert, the highest possible. This was the first A-level alert in the seven-year-long experiment.

As part of the prearranged Parkfield plan, the California Office of Emergency Services issued a public earthquake prediction — the first of its kind in state history. Officials announced there was a 33 percent chance that a magnitude 6 quake would come within three days, a statement that turned out to be a false alarm.

Scientists with the USGS say they are surprised the program went so long without an A-level alert. "We expected maybe two or three by this time," says William Bakun, one of the people who set up the Parkfield experiment.

The magnitude 4.7 tremor caused a stir because past Parkfield earthquakes have been preceded by similar or slightly larger shocks near Middle Mountain. But researchers last week did not see any of the other activity expected before a major quake. In 1966, the San Andreas fault began to creep several hours before the main shock, breaking an irrigation pipeline and producing cracks in the ground. The USGS has installed sensitive creepmeters along the fault, but they did not detect any abnormal activity last week.

After the A-level alert, the fault quieted down for several days. It reawoke on Oct. 25, producing several earthquakes near Middle Mountain, the strongest of which reached magnitude 3.9. This jolt triggered a B-level alert, signifying a 10 percent chance that the expected earthquake would come in 72 hours.



Last week's jolts occurred within the Middle Mountain alert box.

If the quake does not occur by the end of the year, the original Parkfield prediction will be judged a failure. The experiment will continue, but as the years pass it will be harder to keep equipment operating, says Langbein. "Scientifically, though, if the earthquake doesn't come now, but in three years, we'd be pretty happy with the results." — *R. Monastersky*

New twist in the old search for dark matter

For two decades, astronomers have inferred the presence of galactic dark matter by measuring the velocities of gas and stars orbiting near the visible edge of galaxies. The farther any orbiting material lies outside a known concentration of mass, the slower its velocity. Yet researchers have repeatedly found that the rotational velocity of material at the visible outskirts of galaxies doesn't slow down. Instead, it levels off, indicating that a halo of unseen matter — perhaps black holes or some other type of exotic, invisible mass — extends beyond the visible edge of galaxies, providing the extra gravitational tug needed to keep material orbiting at a constant, high speed.

Kormendy

Dust lanes of the galaxy NGC 4753 indicate it harbors a twisted disk.

But such evidence of dark matter says little about its shape or about the overall distribution of mass in galaxies. Now, a group of astronomers reports that the presence of a twisted disk of material, sticking out of the plane of a galaxy, has revealed the shape of dark matter in that galaxy.

Thomas Y. Steiman-Cameron of NASA's Ames Research Center in Mountain View, Calif., and Richard H. Durisen of Indiana University in Bloomington began their study about 10 years ago, using a computer to simulate the evolution of a tilted disk of matter, formed when a galaxy's gravity grabs a nearby blob of material. Over time, the inclined disk would become twisted or warped, depending on the overall distribution of mass in the galaxy — both visible and dark matter. The flatter, or less spherical, the galaxy, the more rapid the twisting.

Steiman-Cameron adds that a disk lying flat in the plane of a visible galaxy can't become twisted and thus can't help define the full three-dimensional structure of the galaxy in which it lies.

While such a model suggested that a study of galaxies with twisted, inclined disks could reveal the shape of dark matter, the researchers hadn't applied the results of their study to any particular galaxy. That state of affairs changed dramatically when a colleague showed them a picture of the galaxy NGC 4753. The unusual pattern of dust lanes in the galaxy, imaged by John Kormendy of the University of Hawaii in Honolulu, matched the dust pattern the researchers had predicted would be produced by their model of a twisted disk, inclined about 15 degrees toward the plane of the visible galaxy.

Though NGC 4753 — twisted disk and all — appears nearly as flat as a slightly