A New Method for Determining Quake Odds

Scientists can best determine earthquake probabilities for a fault once they know when it had last ruptured, the sizes of possible earthquakes, and the rates of plate motions. For example, if plate motions are loading a fault at 1 inch per year, the fault will accumulate 100 inches of strain in 100 years. If each earthquake on that fault releases 100 inches of slip and there is no aseismic creep, then one earthquake can be expected every 100 years. If the occurrence of that earthquake is equally likely at any time, the odds of it striking would be 1% in any given year. However, many earthquake experts believe that once a fault slips, plate motions must load strain back onto that fault before the next earthquake can occur. If earthquakes occurred with perfect regularity, then in this example they would occur exactly 100 years apart, and the odds of a quake would be 0% for the first 99 years and 100% for the final year.

Earthquakes however are not that predictable. WG99 working group of scientists have therefore developed a new set of models that use both physics and statistics. In these models, earthquakes are caused by a combination of constant plate motions and a random process that accounts for variations in earthquake sizes and occurrence. These models closely mimic the occurrence of quakes around the world.

Because every earthquake changes strain on nearby faults, continuous studying is ongoing and methods for figuring out earthquake probabilities involves making many decisions, such as defining fault segments. Every such decision is uncertain, but by using these methods it will also allow the USGS to update these probabilities as new insights are gained.

The Parkfield, California, Earthquake Prediction Experiment

Summary

Five moderate (magnitude 6) earthquakes with similar features have occurred on the Parkfield section of the San Andreas fault in central California since 1857. The Parkfield prediction experiment is designed to monitor the details of the final stages of the earthquake preparation process, observations and reports of seismicity and aseismic slip associated with the last moderate Parkfield earthquake in 1966 constitute much of the basis of the design of the experiment.

Certain sections of the San Andreas fault system in central California tend to fail in recurring, moderate-sized (magnitude 5 to 7), characteristic earthquakes. Characteristic earthquakes are repeat earthquakes that have the same faulting mechanism, magnitude, rupture length, location, and, in some cases, the same epicenter and direction of rupture propagation as earlier shocks. The case for characteristic earthquakes on the Parkfield section of the San Andreas fault is more complete than other segments, at least in part because the interval between events at Parkfield is shorter at (21 to 22 years) than the interval (70 to 85 years) that is apparently appropriate for the southern Calaveras fault in Northern California which is aseismic or creeping.
In recent years, earthquakes near Parkfield have occurred either on the San Andreas fault or in distinct clusters of activity near the western edge of the San Joaquin Valley. Northwest of the Parkfield section, slip on the San Andreas fault occurs predominantly as aseismic fault creep. Although small shocks (magnitude <4) occur here frequently, shocks of magnitude 6 and larger are unknown and little if any strain is accumulating. In contrast, very few microearthquakes and no aseismic slip have been observed on the fault south-east of Cholame, this locked section apparently ruptures exclusively in large earthquakes (magnitude > 7) , most recently during the great Fort Tejon earthquake of 1857. Parkfield earthquakes occur within the transition zone between these contrasting modes of fault failure. The regular nature of Parkfield seismicity since 1857 may be due to the nearly constant slip rate pattern on the adjoining sections of fault. Until recently the Parkfield section had been relatively free of significant perturbations in stress caused by nearby shocks; the effect of the 2 May 1983 Coalinga earthquake [local magnitude (*M*L) 6.7], 40 km northeast of Parkfield, on the timing of the next Parkfield shock is not known.

Finding New Faults In addition to identifying fault segments, transform "strike-slip" motion faults, like the San Andreas Fault, in which the two sides of the fault slip horizontally past each are easier to see by their offsets. In contrast, ramp-like "thrust" faults have vertical motion and often do not reach the Earth's surface, making them difficult to find. The importance of locating these hidden faults was underscored by the devastating 1994 Northridge earthquake in southern California, which occurred on a previously unknown thrust fault.