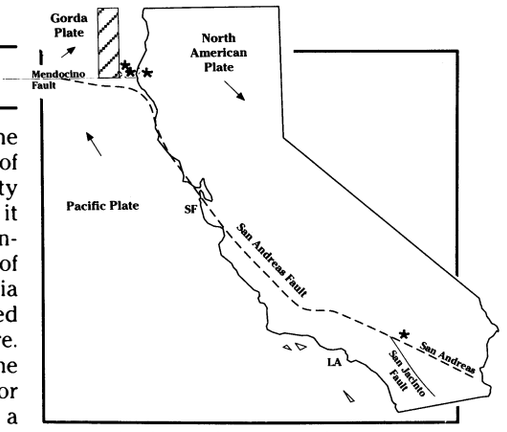
California faults unleash week of turmoil



Asterisks denote locations of last week's earthquakes in California. Hatched area at top represents zone where Gorda plate dives underneath North American plate.

Unlike microbiologists or physicists, seismologists cannot plan their experiments. They must wait for an earthquake to strike and then scramble to harvest as much data as possible during a few short minutes. Given such limitations, last week's bumper crop of quakes at either end of California should provide research fodder for years to come.

The southern jolt, centered in the Joshua Tree National Monument, may just save the lives of many Californians when the much-feared Big One finally strikes that part of the state. And the series of northern quakes offers a look inside the plate tectonic puzzle that may generate huge earthquakes in the Pacific Northwest.

Measuring magnitude 6.1, the Joshua Tree quake occurred on an unnamed fault only 9 kilometers off the San Andreas fault, says seismologist Lucile Jones of the U.S. Geological Survey (USGS) in Pasadena. This southernmost segment of the San Andreas has seismologists worried because it has remained locked, storing up energy for 300 years. A federal panel in 1988 estimated a 40 percent chance that this patch of fault would generate a shock of magnitude 7.5 by the year 2018.

Seismologists cannot predict when or where that Big One will occur. But they may be able to offer some warning of the impending disaster if a foreshock precedes it, a trait of many, but not all, strong shocks. The USGS last year installed a procedure for estimating the chances that any quake near the southern end of the San Andreas could be followed by the expected great quake.

The system's first test came at 7:25 p.m. local time on April 22, when a magnitude 4.6 shock occurred near the town of Desert Hot Springs. Because of its size and proximity to a normally quiet section of the San Andreas, the quake triggered a level C hazard state, representing a 1 to 5 percent chance that the great quake would follow in the next 72 hours.

As Jones called state and federal officials to notify them, the main Joshua Tree jolt struck at 9:50 p.m. in the same area. This much stronger quake boosted the hazard status to level B, corresponding to a 10 to 25 percent chance a magnitude 7.5 would follow within three days.

The USGS designed the hazard rating system to help inform state and local officials quickly of the potential for a killer quake. But last week's activity came before state personnel had decided how to use the information, says Tom Heaton of the USGS in Pasadena. "The state people at first were a little taken aback," he says.

The California Office of Emergency Services (OES) issued an advisory, warning counties of an increased likelihood of seismic activity for three days after the quake, but the OES made no mention of the USGS hazard level or its probability estimates. OES' Nancy Hardaker says it appears the office received more inquiries than normal about the safety of Los Angeles. She suggests the media reports of the USGS hazard levels scared people who did not know what they were.

Because of the quake's proximity to the San Andreas, it can provide a trial run for engineers seeking to understand how a major San Andreas quake would shake buildings in the Los Angeles basin, the San Gabriel Valley and other nearby areas. As seismic waves travel through the Earth, rock and sediments along the way can weaken or intensify the shaking—a lesson brought home in 1989, when water-saturated landfill in San Francisco's marina district amplified a distant quake's effect, causing severe damage.

Because earthquakes rarely occur on the section of the San Andreas near the Joshua Tree quake, engineers have not been able to determine how seismic energy radiating from there will shake various regions of southern California. "If we can see what a magnitude 6 does to the L.A. basin, we should be able to scale, to a first approximation, to what the magnitude 8 is going to do," Jones says.

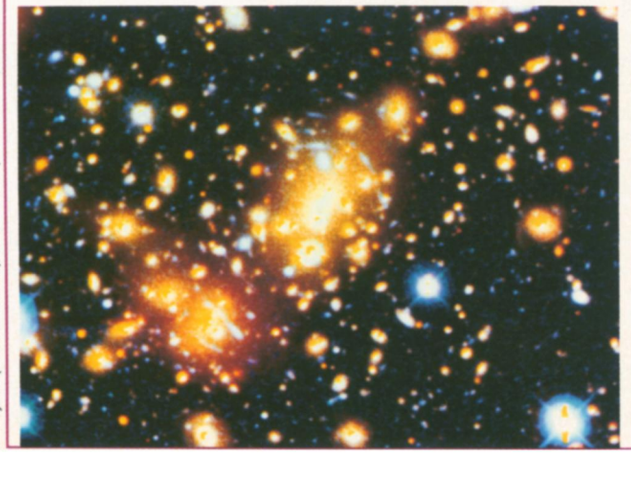
Just three days after the Joshua Tree quake, an unrelated shock measuring magnitude 6.9 occurred near the town of Petrolia in northern California. The next day, two large aftershocks, measuring 6.0 and 6.5, rattled the region. The second aftershock may have shaken buildings harder than the larger mainshock, because the aftershock radiated much of its energy in damaging high-frequency waves, says David Oppenheimer of the USGS in Menlo Park.

The quakes struck near the junction of three of the major plates that cover Earth's surface. There, a patch of the Pacific seafloor called the Gorda plate dives underneath the North American plate in an act called subduction. Immediately to the south, the large Pacific plate rams into the Gorda plate along the Mendocino fault.

Seismologists are not yet sure how last week's quakes fit into the complex jostling among the three plates. The temblors apparently stem from the subduction of the Gorda plate; however, it is not clear which fault produced them, says Oppenheimer. In the last few years, earth scientists have detected evidence that subduction of the Gorda plate and its neighbors to the north has caused giant quakes in the past, raising concern about future megashocks. — *R. Monastersky*

Gravity lenses for peering into darkness

Astronomers believe the universe contains far more dark (nonluminous) matter than is apparent in visibly glowing galaxies, stars and gas. By studying how foreground concentrations of dark matter gravitationally warp the light coming from more distant, background galaxies, researchers can map the distribution of this invisible cosmic material (SN: 1/27/90, p.52). This photo, taken with the 4-meter telescope at Kitt Peak National Observatory near Tucson, Ariz., shows a giant cluster of galaxies (yellow) about 2 billion light-years away. It also reveals images of at least 30 faint background galaxies (mostly blue), which appear distorted into short arcs by foreground dark matter. Such photos suggest that dark matter makes up at least 90 percent of the mass in giant clusters of galaxies.



J.A. Tyson (AT&T Bell Labs), G. Bernstein (Univ. of Ariz.), NOAO