In the wake of the July 21 quake — David L. Durham '51 checks vertical displacement on a hill outside Tehachapi.

EARTHQUAKE REPORT

AT 4:52 A.M. on Monday, July 21, 1952, southern California experienced a strong earthquake, felt from San Francisco to Mexico. Once again, Californians were rudely reminded that they live in a seismologically active belt of geologically young, developing mountain ranges and valleys.

Principal damage to buildings, pipelines, irrigation systems, and to the large Paloma petroleum refinery, centered around Arvin, a few miles south of Bakersfield; the towns of Arvin and Tehachapi suffered most.

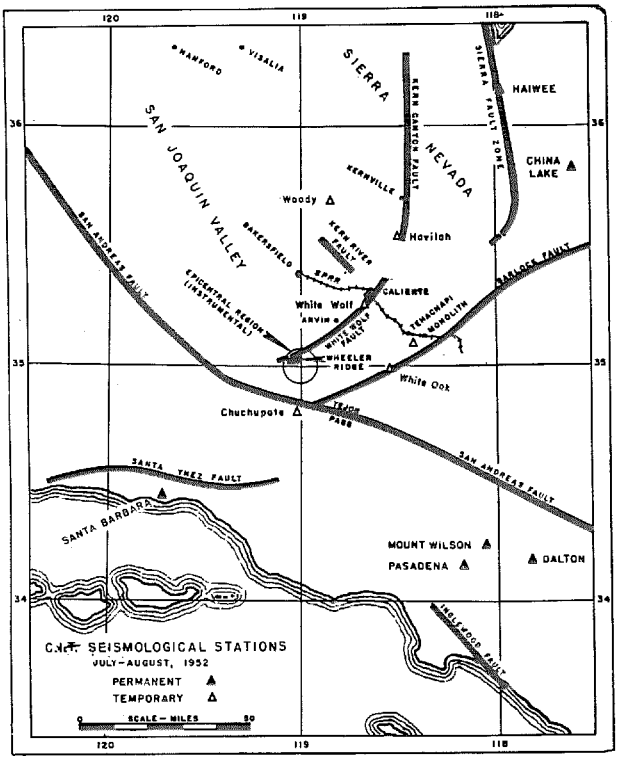
Intermediate in magnitude and intensity between the Long Beach shock of 1933 and the San Francisco earthquake of 1906, the Arvin disturbance took at least 14 lives and resulted in damage which presumably aggregates several tens of millions of dollars. Fortunately the area most strongly affected is one of relatively sparse population; had this shock occurred in a densely settled portion of the country the loss of life and property destruction would almost certainly have been very large.

Shortly after the initial shock the entire staff showed up for work at the Caltech Seismological Laboratory in Pasadena. Some of the staff went on telephone duty; others developed and studied seismograms. Emergency preliminary statements were given out to the press. Field parties were organized. For days—and to some extent for weeks—the Laboratory was like an engine house after a three-alarm fire has started.

At Pasadena, most of the sixteen instruments recorded the beginning of the main shock, plus an uncountable number of aftershocks. One torsion instrument had its suspension broken — which is something that hasn't happened before in all the Lab's 25 years. The Laboratory's strong-motion instruments were the only ones in California to write complete records of the big shock; their light-spots were deflected about two and a half inches, corresponding to actual ground motion of over half an inch.

All records of the start of the shock were good at the Lab's auxiliary stations at Mount Wilson, Santa Barbara, China Lake, Haiwee, Tinemaha, Barrett, and Big Bear. At Riverside the drum recording the vertical component had stopped; at La Jolla records had not been changed over the weekend, so that the main shock was missed; at Dalton the clock had unfortunately stopped the day before; and at China Lake the vertical pendulum was slammed against the stop by the main shock so hard that it froze until freed three weeks later.

A field party, headed by Dr. Charles Richter and carrying recording equipment, left Pasadena at 7:15 a.m., two hours and odd minutes after the first shock on July 21. A continuously-recording temporary station was established that afternoon at the Chuchupate Ranger Station in the Frazier Mountain area. Other temporary stations were set up to record aftershocks at the Havilah



Map shows the location of the Seismological Laboratory's auxiliary recording stations, as well as the principal faults, in the region of the Arvin earthquake.

Ranger Station in the Kern River country (on July 26), and at Woody, northeast of Bakersfield (on August 5). Short runs were recorded at nine other locations.

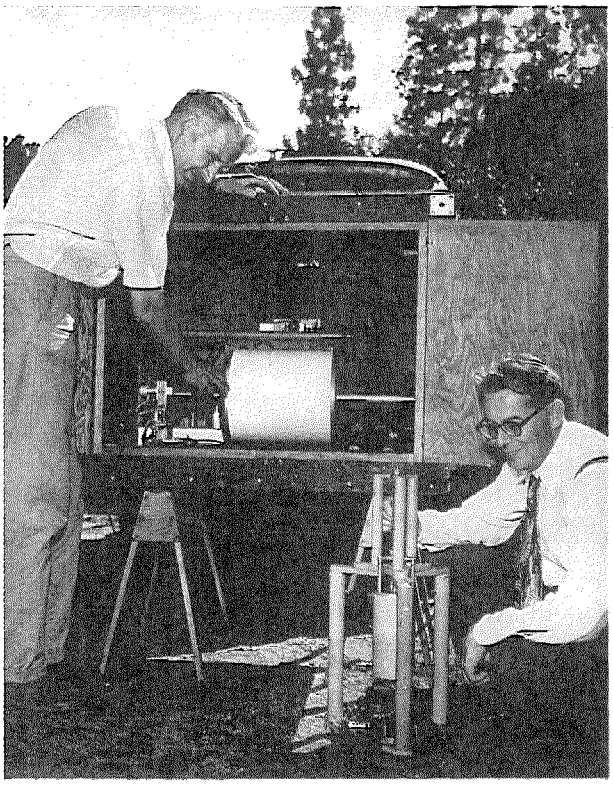
All field parties kept in touch with Pasadena headquarters, where Dr. Beno Gutenberg, director of the Lab, was in charge. In the first few days, at the Pasadena Lab, Dr. Hugo Benioff, as the most available of the staff, spent much of his time on the telephone. The Lab secretaries, along with the regular Caltech switchboard, tried to handle or detour the less important incoming calls—which wasn't easy to do. Too many people telephoned on the excuse of asking for information—but actually to tie up the line by *telling* the Lab about the earthquake. It was a sizable job to make way for legitimate inquiries from the press and radio news services, officials, or persons with valuable information.

Some of the staff had to work odd hours or away from the Lab in order to dodge the flood of inquiries. It was most urgent to analyze the first records brought in from the field stations, so as to use the results for further planning. The natural eagerness of the press — and the public — for every crumb of news sometimes interfered with the very work that produces news. The staff had to repeat over and over that it was unable to stop to count the hundreds of small shocks being recorded, or to work out exact times and magnitudes for any but the largest. By August 25, a little more than a month after the main shock, there had been about 188 shocks of magnitude 4 or over — and the Pasadena Lab was still recording over 40 small shocks a day!

In describing this group of earthquakes the Laboratory and the press have used the magnitude scale developed here about 20 years ago. This scale proves to give the best answer to "How big was the earthquake?" Seismologists contrast the magnitude scale with the intensity scale, which is older.

An earthquake intensity number is just a horseback rating of the amount of shaking at a given place, judged by effects on buildings, crockery, windows, women and children, dogs, horses, herds of elephants or whatever. II means that few people felt the shake; IV that it rattled windows; VII that there was slight damage; X that it was destructive; XII (the highest rating) that it razed almost all structures to the ground, threw stones into the air, and shot posts out of postholes (believe it or not!). On July 21, intensities around Arvin and Tehachapi were VII to VIII; at Bakersfield, about VII; at Pasadena and Los Angeles, V to VI. These intensities vary with distance and the nature of the ground.

Magnitude, on the other hand, is a rating of the whole earthquake. It is calculated from the size of the seismogram written by a standard type of instrument (the horizontal short-period torsion seismometer operating at many of the Lab's stations) at a standard distance of 100 kilometers (62 miles). If the recording station is at some other distance from the epicenter, its records are reduced to 100 kilometers by means of tables or charts. Magnitudes calculated for the same earthquake from different stations usually agree closely.



Dr. C. F. Richter, right, and John Nordquist check portable recording equipment after Tehachapi field trip.

Here are some typical magnitudes (note that the magnitude numbers have nothing to do with intensity at the places named, which are mentioned only to help identify the earthquake).

Bakersfield	Aug. 22, 1952	6
Santa Barbara	June 29, 1925	6.3
Long Beach	March 10, 1933	6.3
Kern County	July 29, 1952	6.5
Imperial Valley	May 18, 1940	6.8
Kern County	July 21, 1952	7 ½
Nevada	Oct. 2, 1915	7 ¾
San Francisco	April 8, 1906	8 ¼
Tibet	Aug. 15, 1950	8.6
South America	Jan. 31, 1906	8.6

The last two in the list are the largest known earthquakes. The smallest shocks recorded by instruments are about magnitude 1; the smallest which cause a little damage, about 4½.

The magnitude scale is logarithmic. That means that every step up of one unit on the magnitude ladder multiplies the size of the seismogram by 10. Seismograms of the San Francisco earthquake were about 100 times as large as those of the Long Beach earthquake at the same distance. If the largest and smallest earthquakes could be recorded by the same seismograph, one record would be over ten million times as large as the other.

Seismograms for the main shock of the July 21 quake led to an epicenter near the Wheeler Ridge oil field, at the south end of San Joaquin Valley west of U. S. Highway 99. Here the rupture of the rocks started probably at a depth of about 10 miles. It traveled northeastward under the valley, passing east of Arvin along the west front of Bear Mountain, following the White Wolf fault. Where the disturbance crossed the Southern Pacific line near Bealville and Caliente, it wrecked three tunnels, putting the track out of service for weeks.

Weak brick and concrete buildings fared badly in the recent quakes. Cracks in this hotel front in Santa Barbara are the result of improper design or construction.

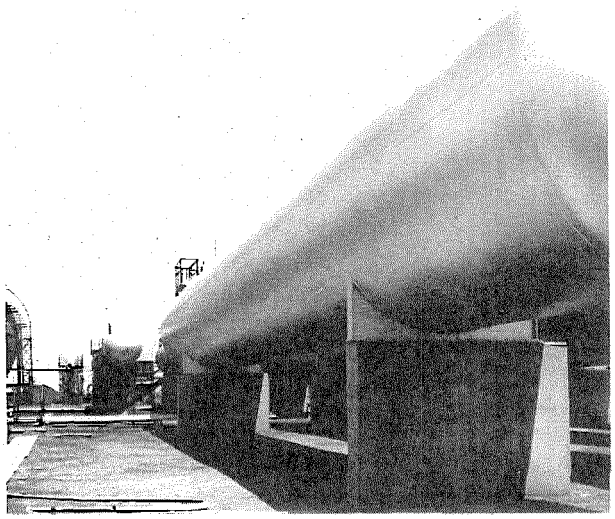
Extensive building damage in Tehachapi was not so much due to violent shaking as to the fact that it was an old town, with a good many old brick structures.

What happened at the surface is not exactly what happened to the rocks a few miles down. Some of our California earthquakes, as in 1906 and 1940, have broken the ground with a continuous offset of fences and roads. The 1952 earthquake produced long zones of cracks and even long ridges like the one east of Arvin that looks like a road embankment — but most of these are due to shaking. The cracks are due to opening and closing of the ground and lurching from side to side during the shaking; the ridges, very likely, to sliding on the slopes.

Dr. John Buwalda, Professor of Geology, has been investigating these effects for weeks; and he has serious doubts whether there is anywhere a true fault trace like that of 1906. Such conclusions as that "Bear Mountain has risen three feet" go a long way past the known facts.

The epicenter of most, but not all, the shocks have been on or near the White Wolf fault. Those of magnitude 6 and over (to date) are:

			Mag.	
July	21	4:52 a.m.	7½	Main Shock
	21	5:05 a.m.	6	Unlocated
	22	5:38 p.m.	6	North of Caliente
	25	12:10 p.m.	6¼	East of Caliente
	25	12:43 p.m.	6	East of Caliente
	29	12:04 a.m.	6½	East of Bakersfield
	31	5:09 a.m.	6	Near Caliente
Aug.	22	3:41 p.m.	6	Near Bakersfield



Paloma Oil Refinery was hard hit in July 21 quake. Note how oil tank has moved relative to concrete pier above.

The earthquake on July 29, although part of the aftershock group, was on a different fault system, known as the Kern River fault, which runs across the mouth of Kern River canyon and cuts through the foothills not far from Bakersfield. The one on August 22 presumably originated even closer to that city; at least, so says Dr. Richter, who had been running the portable seismometer in the hills and sleeping in a pasture, but turned up at Bakersfield that evening, disheveled, unshaven, and with hay in his hair, to look over the damage and broadcast a statement.

Everyone asks how long this will last. We can only judge by past experience, which is confirmed now by Dr. Benioff's method of plotting a curve of aftershocks. Shocks of this group down to magnitude 4 are usually noticeable in the Los Angeles area. These may be expected to go on at the rate of one or two a day for some months. Minor shocks may continue for two or three years.

The future?

An occasional shock stronger than usual is to be expected from time to time. An aftershock of magnitude 6 may well happen a year from now; but the intervals between such shocks will be longer and longer. Moreover, there is no reason now to expect another shock in the same region equal to the first major earthquake of July 21. Of course, there is always the possibility of a really great earthquake (magnitude 8 or over) in California.

Secular strains have been building up along the northern portion of the great San Andreas Fault since the 1906 San Francisco quake, and along the southern portion since the quake of 1857. (The latter produced damage for at least 100 miles to each side of the town of Gorman).

It is these strains, accumulating for nearly 50 years on the northern San Andreas, and for almost a century on its southern portion, that lead Caltech seismologists to expect a great rift to slip again some day in the indeterminate future. The Kern County shocks have probably not done much either to delay the big one or speed it up.

Above — all that was left of a new Ford, after the July 21 quake hit Tehachapi. An entire building front fell on it.