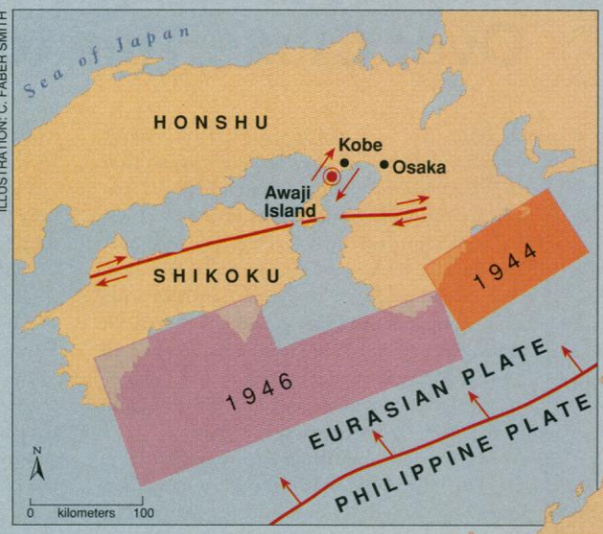
An Unnerving Preview of a Northern California Quake?

Almost 9000 kilometers separate the quake that struck Kobe, Japan, last week and San Francisco's East Bay region. But the parallels between the Japanese disaster and what the future almost surely holds for the East Bay are unsettling U.S. seismologists, engineers, and emergency response experts. An East Bay earthquake will bear a striking resemblance to the one that just devastated Kobe, from its ultimate driving force to its location practically under the feet of a dense population. "It will be a real mess," says geologist Lloyd Cluff of Pacific Gas and Electric (PG&E) in San Francisco. "A lot of things we see at Kobe we expect in the East Bay; we're going to have localized devastation."



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A seismic sideshow. Great quakes in 1944 and '46 relieved stress deep offshore, but the Kobe quake broke the surface on a branch of a San Andreas–like fault.

The fault that has Cluff and many others so worried isn't the notorious San Andreas; it passes 30 kilometers to the southwest. Their focus is the Hayward fault, which slices right through the East Bay from just east of San Jose through cities including Oakland and Berkeley. Concern about that fault was already running high enough that the Earthquake Engineering Research Institute (EERI) planned to devote a session at its meeting next month in San Francisco to a hypothetical magnitude 7 Hayward quake. Now Kobe's misfortune has given the engineers and hazard experts an early look at the kind of disaster that might strike the East Bay.

The ultimate driving force for earthquakes in Kobe and the East Bay is the same: the jostling of the tectonic plates around the Pacific. The great Pacific plate slides by North America along the San Andreas fault, snagging and triggering quakes as it goes; some of that slip is diverted onto branch faults, such as the Hayward. Likewise, the collision of the Philippine Sea plate with the Eurasian plate east of Japan drives slip along a San Andreas–like fault that passes south of Kobe. A smaller, usually quiescent branch fault much like the Hayward extends northeast toward the city.

It was a short segment of that branch fault that ruptured last week near Kobe, producing an earthquake bearing an uncanny resemblance to the hypothetical Hayward quake that experts on quake damage and disaster response will be considering at next month's EERI meeting. Program chair William Savage of PG&E and his colleagues had come up with this quake based on what is known of the last big quake on the Hayward fault in 1868. In 1990 the Working Group on California Earthquake Probabilities put the odds of another large Hayward quake by 2018 at 28%.

The event in the Hayward scenario has a magnitude of 7.0; seismologist Hiroo Kanamori of the California Institute of Technology puts the Kobe quake at magnitude 6.9 ± 0.1. The hypothetical Hayward rupture extends for 50 kilometers; at Kobe the fault ruptured along 25 to 50 kilometers, according to Masayuki Kikuchi of Yokohama City University. But the most unnerving similarity of all is the proximity of fault and people.

A quake rupture on the northern half of the Hayward fault would rip directly through the densely populated region just to the east of San Francisco Bay. The Kobe rupture began under the 3-kilometer-wide Akashi Strait between Awaji Island and the mainland, 20 kilometers from central Kobe. The rupture's northeast-southwest orientation put the Kobe metropolitan area smack in the path of the rupture to the northeast. No surface rupture has yet been found in Kobe proper, but Kikuchi thinks a line of especially heavy damage may trace the path of the rupture into the city. Alternatively, he says, the swath of heavy damage might be the result of the pulse of concentrated seismic energy that travels ahead of a fault rupture (*Science*, 13 January, p. 176).

Either way, the strong shaking was inflicted on a stock of older structures not designed to today's standards and built on soft, unstable bay muds. That deadly combination is yet another of the unsettling parallels that Kobe shares with the cities along the Hayward fault, and it made disaster inevitable.

–Richard A. Kerr

loads, allowing the building to absorb the earthquake's energy but not collapse. The idea was to save lives during a quake by keeping a building standing, even if it was so damaged during the quake that it had to be torn down afterward.

But codes usually apply only to new construction. Communities also face the problem of what to do about buildings designed under older, weaker codes. Otani says that massive retrofitting programs have been carried out in other parts of the country, particularly in Shizuoka Prefecture, 60 kilometers west of Tokyo, where seismologists convinced local and national government officials that the area was overdue for a magnitude 8+ quake. But officials in the Osaka-Kobe region apparently grew complacent about earthquakes because they hadn't had one in more than 75 years.

Hideki Kaji, a civil engineer now with the United Nations Centre for Regional Development, says the lack of awareness was evident in many ways. On 1 September, there are earthquake preparedness drills throughout the country to mark the anniversary of the 1923 Tokyo earthquake. "The participation in Tokyo is less than 30%, but in Kobe it is even less than 10%," he says.

Seismologists had recognized that major quakes could strike the Osaka-Kobe area. The area is crisscrossed by active faults, and an adjacent section of the same fault that ruptured last week saw a magnitude 6.1 rupture in 1916. Although that's a short period geologically, it's a lifetime for human memory. Masayuki Watanabe, a civil engineer who headed Kobe's office of disaster prevention in the 1960s, says that the disasters Kobe has faced in the past half-century have been floods and mud slides triggered by torrential rains. "Kobe has been focused on other kinds of disasters," he admits.

For structural engineers and seismologists, questions of retrofitting and prepared-