Kobe in California
By Keay Davidson (from *Earth* magazine, 1995)

The recent catastrophic earthquake in Kobe, Japan, gave Northern Californians a sneak peak of what may be their own future disaster, one that could strike in a few decades—or tomorrow.

The San Francisco Bay Area shares haunting similarities with the now-ruined city of Kobe, Japan. Both are densely populated. Both have many buildings, highways and bridges that were built before the modern era of quake resistant construction codes. And, both are gashed by a major fault that runs through landslide-prone hills and waterfronts with unstable soils that can liquefy into quicksand during a quake.

Of course, one major difference between the Japanese city and the Bay Area is that the fault near Kobe has just unleashed a magnitude 6.8 temblor, killing more than 5,450 people as it released stress that had been accumulating on it for years. In contrast, the Hayward Fault, which runs through the East Bay and cities such as Oakland and Berkeley, has not produced a big quake for at least 159 years. Because the 30-mile long northern segment of the Hayward Fault is roughly the same length as the fault under Kobe, it might release about the same amount of energy during a quake. Thus, many seismologists believe the Hayward Fault is a Kobe disaster waiting to happen.

Seismologists and engineers gathered at a recent meeting of the Earthquake Engineering Research Institute in San Francisco to discuss what might happen if a magnitude 7.0 quake struck the northern part of the Hayward Fault. The damage, they agreed, would be more akin to the damage caused in Kobe than to that following the 1989 Loma Prieta earthquake, which occurred on the San Andreas Fault some 60 miles to the south of the Bay Area. The Loma Prieta quake claimed 62 lives and caused six billion dollars in damage. But a large temblor on the Hayward Fault is likely to kill thousands and cause tens of billions of dollars in damage.

Is the Bay Area prepared for a Kobe-like disaster? Not nearly well enough, according to the recent gathering of engineers. A magnitude 7 earthquake could devastate the East Bay and the entire region, seismologist David Schwarz of the United States Geological Survey in Menlo Park, California, told his colleagues at the meeting.

The researchers envision a scenario–a realistic one, they stressed–that describes the rupture of the entire northern segment of the Hayward Fault, which stretches from Lake Chabot to the northern part of San Pablo Bay. They estimate the quake would last 22 seconds, causing the earth to shift as much as ten feet (3 meters).

The anticipated results are that there could be as many as 4,500 deaths, 20,000 injuries, and 57,000 buildings "red-tagged" as unsafe or uninhabitable (11 times as many as after the Loma Prieta quake). Fires would rage out of control as hundreds of gas and water mains burst. Firefighters would be unable to get to blazes because many fire trucks could be trapped in collapsed stations. Anywhere from 75,000 to 200,000 people would need emergency shelter. The higher figure isn't unreasonable: 300,000 people were left homeless after the Kobe quake.

"You can expect ghost towns throughout the East Bay," said Mary Comerio of the University of California, Berkeley, an expert on post-disaster rebuilding of residential areas.

When people think of California quakes, they tend to think of the San Andreas Fault, along which the Pacific and North American tectonic plates grind past each other in the sideways motions known as strike-slip faulting. But in recent years, seismologists have realized that the direct threats to California's urban centers aren't posed by the San Andreas. In Southern California, disaster looms instead in the form of blind or "invisible" thrust faults beneath the Los Angeles basin. In Northern California, the greatest threat comes from the Hayward Fault, which lies on the opposite side of San Francisco Bay.

The fault that shook Kobe in January was a heretofore quiescent branch of a major strike-slip fault that marks the boundary between the Philippine and Eurasian plates. The Hayward is a similar branch of the San Andreas. In both locations, stress between the crustal plates builds. As the plates grind against each other, the stress causes each side of the fault to "creep," or move slowly. The two

sides of the Hayward Faults are creeping past each other at a rate of about one-third of an inch (8.5 millimeters) per year. This motion accounts for about one-quarter of all movement between the Pacific and North American plates.

The Hayward cuts right across the football stadium at the University of California, Berkeley. As a result of the creeping movement along the fault, the stadium is "unobtrusively and almost uneventfully being torn in two," seismologist Bruce Bolt has written.

On occasion, steady creep is replaced by sudden catastrophic movements, such as a fault ruptures. After the 7.1 magnitude Loma Prieta quake, the U.S. Geological Survey studied the state of crustal strain in Northern California to estimate the odds of future quakes. The agency calculated that the northern segment of the Hayward Fault had a 28 percent chance of generating another large earthquake by the year 2020.

Geologic evidence suggests that the northern segment of the Hayward Fault may undergo a big quake on average of once every 150 to 250 years, Schwartz says. Unfortunately, no one is sure when the last big quake on the northern part of the Hayward occurred because the Bay Area was sparsely populated until well into the 19th century. Shaky evidence suggests that the last northern Hayward quake occurred in 1836. So another major Hayward quake becomes more likely every year.

Such a jolt could be much worse than the 1994 Northridge quake in Los Angeles. Much of the seismic energy of the Northridge shock was absorbed by a nearby mountain range. A quake on the northern segment of the Hayward Fault would release its energy directly underneath some of the most densely urbanized real estate in California – just as the Kobe quake went off right underneath the feet of 4 million Japanese. Also, the Hayward is a strike-slip fault, which means that it breaks the surface and thus might cause even more surface damage than the buried fault under Northridge and Loma Prieta epicenters, says seismologist William Lettis. Finally, buildings in the East Bay are generally older than those in the Northridge area and thus are less likely to meet the tough state building standards adopted after the 1971 San Fernando Valley quake north of Los Angeles.

"Kobe told us how vulnerable our urban systems are, " Rich Eisner of the Governor's Office of Emergency Services said at the earthquake conference. In Kobe, modern buildings generally fared much better than older, pre-code structures. "The single most important thing to do is to strengthen the buildings," Eisner said. "Delaying is going to cost lives." Meeting attendees agreed that retrofitting buildings in the East Bay may not prevent all deaths but will almost certainly mitigate the damage.

The hypothetical Hayward quake is a grim scenario. But reality may prove even worse. Conceivably, a northern Hayward rupture could trigger secondary ruptures on adjacent faults–either the southern part of the Hayward or the Rodgers Creek Fault to the north. Since the amount of energy released by a quake generally increases with rupture length, the possibility of the quakes breaking beyond the northern segment is "very sobering," Schwarz says.

In Kobe, earthquake preparedness drills were sparsely attended because residents believed Tokyo would be the next city to be hit by a major quake. In the Bay Area, few people seem ready for such a disaster. After the Northridge quake near Los Angeles, a poll found that over two thirds of all Northern Californians had not considered taking action to protect against earthquake damage. Another ten percent said they had thought about preparing for a quake but probably would not take any protective measures. And, one third did not believe that a big quake would happen near enough to affect them.

This lack of earthquake planning has at least one historical precedent. In October 1868, after a major quake on the southern end of the Hayward Fault, the San Francisco Daily Examiner cheerfully assured its readers that such events were too rare to worry about: "The plausibility, therefore, is that in 80 years more, a like shock will not occur, if ever…It is a foolish imagination, therefore that will take a gloomy view of the future of [this] great commercial emporium of the Pacific." Thirty-eight years later, San Francisco was reduced to flaming ruins by one of the worst earthquakes in history.