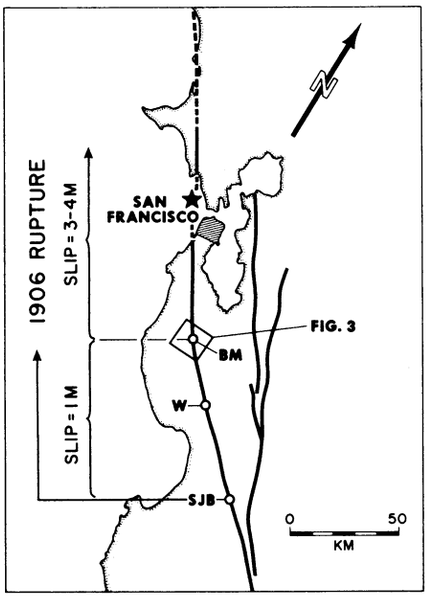
Seismic risk in Silicon Valley

In the latest James Bond movie, the villain schemes to make a killing in integrated circuits by eliminating the competition clustered in northern California's Silicon Valley. His plan is to trigger a series of devastating earthquakes along the San Andreas fault, the sliding boundary between the American and Pacific plates that slices through the San Francisco peninsula.

Bond, of course, foils the plan. But had Agent 007 been reading the seismic literature he would have realized that he would be up against a more formidable foe: Mother Nature. In the last three years, seismologists have tagged a section of the San Andreas fault near Silicon Valley as the likely site of a moderate earthquake in the near future. And now, in the October GEOPHYSICAL RESEARCH LETTERS, Christopher H. Scholz argues that the magnitude and rupture length of this quake could be greater than has been previously suggested.

Scholz, a seismologist at the Lamont-Doherty Geological Observatory (LDGO) in Palisades, N.Y., focused his study on the region of Black Mountain, an 860-meter-high formation located southwest of Palo Alto, Calif. Near Black Mountain, the San Andreas fault abruptly bends so that the 100-kilometer-long fault segment to the south of the mountain trends 9° more toward an east-west direction than do the segments lying to the north and south. Scholz believes that when the great 1906 earthquake struck San Francisco, the rupture propagated down the fault, crashed into this bend and dissipated much of its energy into Black Mountain. "The whole Black Mountain was uplifted and shattered during the earthquake," he says. As a result, the fault along the segment to the south of Black Mountain slipped only about 1 to 1.4 meters, while the rupture caused a typical slippage of 2.5 to 4 meters on the fault to the north.



This map shows part of the San Andreas fault that slipped during the 1906 earthquake centered near San Francisco. Scholz thinks that the segment due soon for another earthquake extends from San Juan Bautista (SJB) through Wright (W) and up to Black Mountain (BM), where the fault makes an abrupt bend.

This difference in slippage over the two general regions has prompted a number of researchers to suggest that the southern segment is due for a quake. For example, Lynn R. Sykes, also at LDGO, and Stuart T. Nishenko at the U.S. Geological Survey (USGS) in Denver, Colo., last year estimated a 60 percent chance that a rupture would occur in the next 20 years. In another study, Allan Lindh at USGS in Menlo Park, Calif., looked at changes in the geologic structure of the region in order to pinpoint the rupture area. He suggested that the next earthquake with a magnitude of 6.5 would rupture a 45-kilometer-long segment between San Juan Bautista and Wright, 30 kilometers to the south of Black Mountain.

But now, based on the way Black Mountain shattered and on one measurement of 1-meter slippage just to the north of the mountain, Scholz proposes to extend this rupture length north all the way to Black Mountain. He estimates that the resulting 75-kilometer-long rupture segment would result in a magnitude 6.9 earthquake.

In his paper, Scholz also notes recent geodetic measurements for the area in which strain is accumulating at a rate of about 15 millimeters per year. This means that it should take between 60 and 110 years from 1906 for the strain to regain the level that resulted in the 1906 slippage of 1 to 1.4 meters, he says. "North of the bend, we wouldn't expect an earthquake to recur on the fault until sometime in the middle of the 21st century," he adds. "But to the south of the bend it can essentially occur anytime." —*S. Weisburd*

Apple SOS: New York and the 'big one'?

Worry over when *the* big earthquake will strike would appear to be part of the California lifestyle — not something found on a New Yorker's list of anxieties. But if measurements by a team of California scientists are correct, the New York City area may someday be the center of a destructive earthquake.

Localized strain in rocks near the earth's surface apparently is accumulating at rates comparable to those observed near the notoriously active San Andreas fault in California, according to a report in the Oct. 24 NATURE. "Such rates could probably not be sustained in the lower crust for more than several hundred years without a major earthquake occurring," write coauthors Mark Zoback of Stanford University, William Prescott of the U.S. Geological Survey in Menlo Park, Calif., and Scot Krueger of the University of California at Berkeley. But how movement on the earth's surface relates to deformation deeper in the crust, where earthquakes originate, is uncertain.

Their conclusions are based on analyses of National Geodetic Survey (NGS) records from 1872 to 1973 for northeastern New Jersey and southeastern New York, where they found slight movement of surface survey markers in western Long Island and along a 60-kilometer stretch of the Hudson River's eastern shore. Amid the continuing controversy that clouds earthquake prediction, the study raises some new points for geophysicists to ponder.

Geological differences between New York and California make interpretation of the data all the more interesting. Subsurface rocks in California are weaker and less dense than their eastern counterparts, which contain no known large, active faults. But the principal dissimilarity may be that California sits on the unstable edge of a massive plate of rock, while the "edge" nearest New York lies in the middle of the Atlantic Ocean. "More important than what we found in New York was the underlying concept of intraplate seismicity," Zoback told SCIENCE NEWS. "We're looking at a phenomenon that's never been observed before."

The findings don't guarantee a large quake will occur, but Zoback says the region's series of smaller quakes is consistent with the data. The Oct. 19 shaker centered in Ardsley — the area's 16th in the last 250 years estimated at magnitude 3.5 or greater — occurred next to the region assayed by Zoback's group.

Also located nearby is the Lamont-Doherty Geological Observatory (LDGO) in Palisades, where some are taking a "wait and see" approach to the new data. One LDGO seismologist, who asked not to be identified, called the strain rates "just absolutely astonishing" because of their intraplate location. But unpublished data from an LDGO bore hole experiment and a similar NGS analysis of marker movement appear to corroborate the high strain rates. As LDGO geophysicist Dan Moos told SCIENCE NEWS: "The big unanswered question ... is how much stress is necessary before an earthquake will happen." So no one can say whether the unsettling rates in New York will cause a quake as large as that said to threaten California.

—*D.D. Edwards*