SCIENCE NEWS of the week

Beneath California's Hills, Another Earthquake Hazard

The gentle hills that trend along California's coast ranges may mask faults that pose a major, and so far unpredictable, earthquake hazard. Scientists trying to reconstruct the puzzling events that led on May 2 to a Richter magnitude 6.5 earthquake at Coalinga, Calif., combed the area for signs that an unknown fault had split the earth's surface (SN: 5/21/83, p. 329). No surface rupture was found, but the researchers did find that a hill became higher and a valley dropped. The finding—that movement of the earth caused by the sizable quake followed the topography of the area—raises the possibility that similar lines of hills through the state also may conceal buried faults capable of causing considerable surface damage.

"Generally, buried faults take us by surprise," says Ross Stein of the United States Geological Survey (USGS) in Menlo Park, Calif. "Most of our tools fail us when we're trying to find faults beneath the surface." Nonetheless, he adds, once there is a large earthquake followed by aftershocks, it supports a conclusion that a fault exists.

At the meeting last week in San Francisco of the American Geophysical Union, seismologists compared preliminary data gathered in the aftermath of the Coalinga quake. The details still are sketchy, but even in the midst of their debate, the scientists concur that some of the hills are folds created by movement of the earth's crust along deeply buried faults. Seismic data suggest that the main shock occurred 10 kilometers beneath the surface, while the thousands of aftershocks that followed the quake occurred anywhere from 13 km deep to the surface. The one aftershock that did cause surface rupture happened on June 11 along the Nunez fault about 12 to 14 km northwest of Coalinga. The fault is a buried structure that has not moved for millions of years.

The existence of such deep, buried faults has long been known, but without the earthquake data, one cannot prove how large they are, says Jerry Eaton, also at the Menlo Park research station. He says hills formed by compression of the earth's crust perpendicular to the San Andreas fault, about 30 km west of Coalinga, can be seen along the entire length of California's Great Valley. On the western side of the coast range, earthquakes with magnitudes of 5.0 and 5.5 have been recorded in the last few years, also indicating movement underground as one layer of crust is thrust over another. At depths of 15 km, Eaton explains, such movement can occur without earthquakes, as rocks are peeled off the lower layer, folded, and shoved aside. Along the coast ranges away from the San Andreas, it appears that this zone of slippage may cut up toward the surface. In these regions, he says, substantial earthquakes are more likely.

At Coalinga, this folding process is revealed in the relative movements of Anticline Ridge, a hill that extends for 15 or 20 km, and the valley in which the town of Coalinga nestles. Over the site of the deep-seated quake, the ridge rose as much as half a meter, while the valley dropped two-tenths of a meter, Stein reports. From his measurements, he infers about two meters of slip along the fault. Stein says this suggests that some hills may form in jumps rather than in gradual increments.

As Eaton examines the seismic events that preceded Coalinga, he sees a pattern of moderate quakes beginning in 1974 that circled the Coalinga area, forming a seismic gap. Such rings are sometimes believed to precede a larger quake in the ring's center, and may prove useful in identifying sites where quakes are likely. Still, many questions remain about buried faults. How large are these structures? How big a piece might break at one time? How large an earthquake might be produced? In the next few years, Eaton says, researchers will try to map the deep features in the region adjacent to the San Andreas fault, and "to be sure to include such features in the set of structures that might produce big earthquakes." —*C. Simon*

Long Valley: More eruptions in shorter time

Anxiety that an eruption is imminent at Long Valley caldera in central eastern California has abated for now, but residents and scientists working in the area have some new, and disquieting, information to consider. Researchers compiling chronologies of eruptions at two chains of volcanic craters just north of Long Valley find that the eruptions within each chain have not occurred separately, as has been widely believed. Instead, analyses of volcanic debris at the Mono and Inyo craters show that when the systems become active, eruptions occur not from one volcanic vent, but from many, and within a period that may be shorter than 20 years.

The findings were presented last week at the meeting in San Francisco of the American Geophysical Union. They are especially notable because in the last three years, swarms of thousands of small earthquakes and increasing northeast/southwest stretching across the floor of Long Valley indicate that an 8-kilometer-long dike of molten rock, or magma, has been injected into fissures beneath the caldera (SN: 7/16/83, p. 40). The caldera, a sunken crater, marks the site of a colossal eruption that leveled the mountains there 700,000 years ago.

The histories of the two chains raise the possibility that an eruption at Long Valley could take place along the whole 8-km expanse rather than from a single location. The scientists don't know when or if such an event will occur, but Dan Miller of the United States Geological Survey in Denver says, "I don't think whatever is going on is over." Such an eruption might also stimulate related volcanic systems to the north.

Miller and Kerry Sieh of the California Institute of Technology in Pasadena suggest, based on separate research, that the record of activity at the Mono and Inyo craters provides an analogy for what may occur at Long Valley if the stirrings within the system persist. The Inyo craters, the younger of the two volcanic chains, lie just south of the Mono craters chain, 29 km north of Long Valley, and extend into the northern part of Long Valley caldera. Miller finds that eruptions there occurred more than several thousands of years ago; 1,200 to 1,350 years ago; and most recently, about 550 years ago. In at least the last two instances, steam blasts and explosions of magma propelled a searing mixture of gas, ash and solid and molten rock from many vents along an 11-km stretch.

Further to the north, Sieh and colleagues find evidence that the 20 or so eruption episodes known to have occurred at the Mono craters over the last 2,000 years were not isolated events, but occurred in clusters. Studies of rock layers and sediments show that the craters erupted about 1,280 years ago. The most recent eruptions, about 580 years ago, emanated from a string of vents along the northernmost 6 km of the crater chain.

"At least six separate craters went all at once," Sieh says. "I can't see any significant time between eruptions—it could have been 20 days or 20 years, but my guess is that the first few went off in a couple of days or a couple of hours."

The events can be used as a model for what could happen at Long Valley, Miller says. At the times of the most recent eruptions at Mono and Inyo craters, the area apparently was affected by tectonic, or crustal, movements that allowed magma to work its way toward the surface. At Long Valley a similar period of crustal unrest may well be underway.

—*C. Simon*