example, there are two other large groups: those who calculate the electronic structure of molecules and those who simulate collisions between molecules. But, as Donald Secrest of the University of Illinois points out, the situation of these quantum chemists differs considerably from that of crystallographers. Crystallography is a mature science for which today's computers are adequately powerful and pretty well worked out. Some quantum chemistry calculations are routine; but at the forefront of research existing computers are only powerful enough to handle simple molecules in detailed, first-principles calculations. Moreover, programs are continually being improved to squeeze more performance from the machines or to try a new computational method. George Jeffrey of the University of Pittsburgh estimates that the situation of quantum chemists is somewhat akin to that of crystallographers 15 years ago, when all computers were very much slower.

For these reasons, quantum chemists do not seem to feel the sense of urgency about portable programs that crystallographers do. Frank Harris of the University of Utah thinks that the failure to appreciate the need for portability is, however, having its effect on quantum chemists in that new theoretical ideas do not circulate through the community as fast as they should because researchers cannot easily reproduce one another's programs. Thus, even though their situations differ, the need of quantum chemists for portable programs is as great as that of crystallographers. Nonetheless, it seems unlikely quantum chemists (or anybody else) will adopt the crystallographers' solutions without modifying them to fit their own circumstances.

It would be a feather in the NRCC's cap if the portable program experiment does turn out to be successful. One of the major reasons portable programs are only now being constructed has to do with the way in which federal agencies support research. In chemistry, for example, most computer programs have been developed by scientists as part of their ongoing research projects, with funding provided for the overall project but not specifically for program development. In the past, says Edward Hayes of NSF, proposals to develop new computer codes generally have not been well received by peer reviewers. Since acceptance or renewal of proposals has depended primarily on new chemistry results, investigators understandably have not placed a high priority on refinements of computer programs such as portability. In some cases, such work may be "bootlegged" on grants not intended for the purpose. The NRCC, which is barely 2 years old and is still seeking its niche, is perhaps filling a gap in its sponsorship of such efforts as the portable program workshop.—ARTHUR L. ROBINSON

Concern Rising About the Next Big Quake

"Interesting" phenomena in southern California are giving the new Earthquake Prediction Evaluation Council something to ponder

The earthquake that struck last month east of San Francisco near Livermore—the second moderate quake in the Bay Area in 5 months—raised familiar questions. Does that mean that the Big One is coming? Is California finally going to slip into the ocean? Other than assuring everyone that California will never slip into the ocean, scientists cannot say what, if anything, the Livermore quakes or the larger Imperial Valley earthquake of last October imply about the expected great earthquake, which would be ten thousand times more powerful than these moderate ones.

The Livermore quake appears to say little about future earthquakes, but researchers have observed unusual phenomena in southern California that, they admit, would have already prompted an official prediction of some sort if a more empirical approach were taken here, as it is in the People's Republic of China. Americans familiar with the situation are expressing a "heightened concern," but, having been burned before by phenomena that are poorly understood, they remain wary of drawing any conclusions. The data from southern California will be closely examined by the new National Earthquake Prediction Evaluation Council that will aid the director of the U.S. Geological Survey in issuing any formal predictions, but no action is expected to be taken by it soon.

What has happened is that the San Andreas fault, with Los Angeles on one side and the Mojave Desert on the other, began to be pulled apart in 1979 instead of being increasingly squeezed together, as it had been in the past. At the same time, the strain that tends to force the two sides to slip past one another continues to build.

Although it is "definitely not a good sign," the expansion in southern California comes as almost a relief to researchers because it has some predictable consequences. Studying it "is so much better," says one specialist, "than chasing precursors"—those poorly understood phenomena such as barking dogs, bubbling springs, or bulges in the crust.

Researchers are taking the abrupt change in the behavior of the San Andreas fault seriously because it appears to be undeniably real and widespread. Two groups of researchers have detected the expansion using two methods that could hardly be more unlike. James Savage's group at the U.S. Geological Survey at Menlo Park measured the lengths of 20- to 30-kilometer long survey lines across and along the San Andreas fault to an accuracy of 1 centimeter with a portable laser device called a geodolite. A. E. Neill and his colleagues at the Jet Propulsion Laboratory measured the distance between two radiotelescopes 190 kilometers apart on either side of the fault with an accuracy of 5 centimeters. They determined the distance between the two by comparing the precisely measured arrival times of radio noise from a quasar millions of light years away.

Both methods showed about the same change at about the same time. The geodolite first detected the switch from compression of the fault to an expansion in January 1979 near the Salton Sea southeast of Los Angeles, or about 30 kilometers from the center of October's Imperial Valley earthquake. A similar expansion was also detected on the San Andreas due north of Los Angeles, and an even larger one was observed near Palmdale, which is northeast of the city.

Although the next large earthquake on the San Andreas fault would arrive sooner if the present expansion contin-

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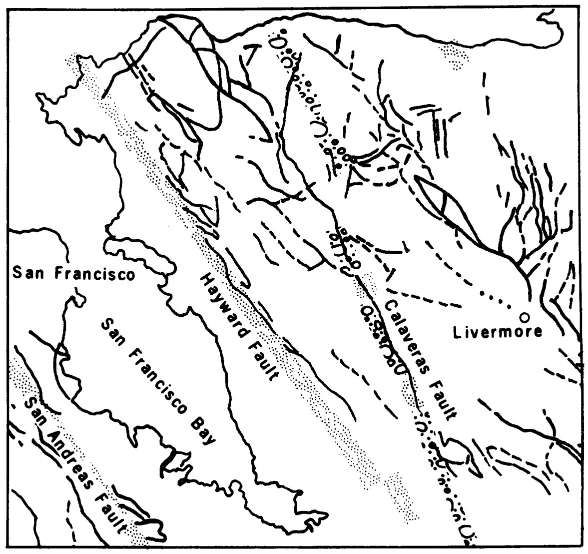

Faults in the San Francisco Bay area that are thought to have slipped during earthquakes in the last 200 years (stippled band), in the last 2 million years (mottled band), and before 2 million years ago. The recent Livermore quakes appear to have occurred on the fault system to the north of Livermore.

ues, a specific prediction is still impossible, according to Barry Raleigh of the USGS at Menlo Park. Researchers know that the less the fault is compressed, the easier it would be for the two sides of the fault to slip past each other; that is, to cause an earthquake. But this knowledge alone cannot lead to a prediction. For one thing, no one knows if the expansion will continue. Because extensive survey measurements have been made for less than 10 years, it could be only a part of a long-term cycle of alternating expansions and contractions. Also, these measurements reveal only the changes in the strain felt by the fault, not the total strain. It is now known that the San Andreas fault is getting less help, for the moment, in resisting the strain tending to make it slip, but how much strain it is carrying and how much it can carry before slipping remain unknown.

Other possible clues to what is happening in southern California have turned up, but they tend to fall in the "peculiar but inexplicable" category, according to Raleigh. Similar phenomena play a central role in the prediction system of the People's Republic of China, but Americans would prefer to understand some of the underlying causes of the phenomena before they are used for prediction (*Science*, 2 November 1979, p. 542). Nonetheless, these possible precursors of earthquakes are receiving considerable attention.

Studies to detect some possible precursors in southern California have been under way for only a few years. The concentration of radon (a radioactive gas produced in rock) in groundwater at sites in the Transverse Range (northeast of Los Angeles) has been followed by Mark Shapiro of the California Institute of Technology and by Harmon Craig of the University of California at San Diego for several years, but the high radon concentration observed at three of the sites in mid-1979 had never been seen before. Unusual water levels in wells nearby in the area of Palmdale have also been recorded. They have been behaving strangely since 1977 and stayed at their high winter levels during the summer of 1979. As is often the case with these sorts of observations, other radon sites and water wells in the same area have not followed the same trends.

Small and moderate earthquake activity has also been peculiar. Karen McNally of Caltech found that most of the microearthquake activity on a 200-kilometer section of the San Andreas fault centered at Palmdale ceased at the end of 1978. Moderate earthquake activity, on the other hand, has increased throughout California within the past year, according to Charles Bufee of the USGS at Menlo Park, but is similar to the activities prior to 25 years ago. The aftershocks of moderate quakes have also been unusual. Carl Johnson of the USGS at Caltech reports that the last three moderate earthquakes in the area of the Transverse Range, all of which struck in the past year, had sequences of aftershocks that were more energetic than had been noted in the last 35 years.

Even if taken together, these observations would not normally generate the interest they have. Other peculiar events, such as the crustal uplift of the Palmdale Bulge, have occurred without any concomitant large earthquakes. But the current crop of poorly understood phenomena have occurred at the same time as the more readily interpretable easing of the squeeze on the southern San Andreas fault, so researchers have taken more note. "Maybe they're all coincidences," says Robert Wesson, head of the USGS Office of Earthquake Studies. "We haven't been looking all that long, so we're not sure what's 'normal,' but there is a tendency among geophysicists to think that all of these things are effects of the same tectonic event"—a relatively sudden deformation of the earth's crust that is part of the mountain-building process. Whether a large earthquake could be a product this particular event, if that is what it is, may not be known except in hindsight. In the meantime, the new National Earthquake Prediction Evaluation Council may provide a much-needed focus for the sorting out of perplexing data.

—RICHARD A. KERR

A crew measuring a survey line in southern California with a laser ranging device called a geodolite. Instruments on the helicopter measure temperature, humidity, and pressure along the path of the laser beam so that the velocity of light can be calculated between the known markers. [Source: Earthquake Information Bulletin]