Forecast of Mexican Quake Accurate, but Ignored

A major earthquake—one of the four or five largest anywhere in a quarter century—struck southern Mexico Nov. 29, within a mile of where University of Texas scientists last year predicted the epicenter would be. The quake's magnitude, 7.9 on the Richter scale, was also very close to the strength expected. The warnings, however, were virtually ignored.

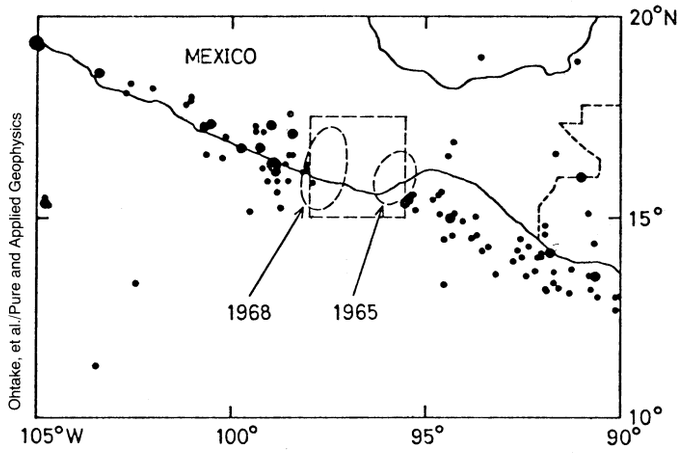
In a paper published in the 1977 PURE AND APPLIED GEOPHYSICS, Masakazu Ohtake, Tosimatu Matumoto and Gary V. Latham used seismic history data to forecast an impending quake near the coast of Oaxaca state. At the time, all three were working at the Geophysics Laboratory, Marine Science Institute of the University of Texas at Galveston. Ohtake has now returned to the Japanese National Research Center for Disaster Prevention, where he and others have used similar methods to forecast a major quake in the Tokai region of Honshu Island (SN: 4/29/78, p. 282).

The success of this forecast is likely to give new impetus to efforts aimed at combining various approaches to earthquake prediction. The method used by the University of Texas team involved a search for a "seismicity gap" along an active fault. As giant land masses on either side of a fault slide past one another, tension builds up irregularly along their common boundary. Some regions along the fault may slip rather smoothly in a series of minor tremors; others may "lock" and then release suddenly in a major earthquake.

Where a region becomes locked, two distinct stages of seismic activity may appear prior to a quake. In the "alpha stage," the normal series of small (and usually unnoticed) tremors in a region may cease altogether, even though such activity continues along parts of the fault on either side of the region. A "gap" is then said to exist in the seismicity of the fault, and the region of the gap is considered a prime location for a major quake. If quakes have occurred along neighboring parts of the fault, these can be used to estimate the strength of the impending quake.

But such data are not sufficient to predict *when* an expected quake will occur. Sometimes, just before the quake, a second "beta" stage of activity has been noticed. This stage signals a return of minor tremors to the locked area, just as a piece of wood under pressure will begin to crack before it finally snaps. To detect the beginning of the beta stage, and thus provide a warning of an impending major shock, careful monitoring of activity along a seismic gap becomes extremely important.

The Oaxaca case provided a classic example of a seismicity gap. Along a coastal region near the town of Puerto Angel, two major quakes had occurred, separated by a hundred-mile stretch of fault that had recently displayed the suspicious decline of seismic activity characteristic of alpha stage. For both prior quakes, which occurred in 1965 and 1968, the beginning of alpha stage quiescence came about 1.5 to 2.0 years before the major shock. Beta stage activity was less evident because of inadequate local monitoring. The Texas team thus ended their 1977 paper with a call for immediate, detailed measurements around Puerto Angel.



A gap (enclosed by square) appears in a plot of seismic activity (tremors shown by dots) in region of Oaxaca, Mexico, where a major quake just occurred. Previous quakes and aftershocks along the same fault line are shown by ellipses.

Their plea was virtually ignored. Excitement caused by subsequent amateur predictions that a quake would occur last April soured the Mexican government on further study of the area. The University of Texas team applied for U.S. government funding to monitor seismic activity along the gap and were initially told they could go ahead. Then, only a month before the quake, their request was rejected. With some restraint Latham told SCIENCE NEWS, "I think they missed a good bet."

He was more sanguine, however, about the impact this solid success is likely to have on the increasingly fragmented field of quake prediction. At the end of a recent meeting that produced no consensus, he says, "all of us left in despair. What we've done now is give people a new hope that we may one day predict earthquakes." (Although the terminology is not universal, a "prediction" must include place, magnitude *and* time of quake; hence the more restrained claim that the Oaxaca quake was only "forecast.")

Future earthquake prediction scenarios, then, may run something like this: Searches are made to identify seismicity gaps and then instrumentation to detect other precursory phenomena are concentrated in the area of the gap. In areas such as California where background activity is not as great as in southern Mexico, the search for such gaps may require studying smaller, previously ignored tremors.

And uncertainties about the two stages of quiescence and renewal must also be ironed out. For example, it is not clear that beta stage activity occurs in all cases or whether such activity is confined to just the region close to a potential epicenter. Latham admits that "such a remarkable case as this one may not happen again in my lifetime."

One way or the other, forecasts based on seismicity gaps are likely to be taken much more seriously in the future. Already a team of scientists from Scripps Institute of Geophysics and Planetary Physics have left for Oaxaca to measure after-shock activity in the area. But that such measurements were not made before the recent quake, possibly allowing detection of beta stage activity and prediction of the quake's time of arrival, says Latham, was "a major tragedy." □

Desegregation: Things get worse first

Social science studies of the effects of school desegregation upon students have been anything but encouraging. The most positive of such studies have shown little improvement in interracial attitudes and contact while the least positive have shown an apparent worsening of attitudes and behaviors. A number of these studies have been criticized, however, for examining just one effect of desegregation or for failing to relate other variables to such effects.

Now, researchers Walter G. Stephan of New Mexico State University and David Rosenfield of Southern Methodist University say they have included such factors in their study of fifth and sixth graders in a "medium sized southwestern city." The methodological improvements, however,

brought little change in results: Most of the students — black, white and Mexican American — exhibited either no change in interracial attitudes and contact or more negativism than before integration.

"The results ... indicate that desegregation had little effect on self-esteem and interethnic contact, but it did cause blacks and whites who had previously attended segregated schools to evaluate both in-group [members of their own ethnic group] and out-group members more negatively," the researchers report in the October JOURNAL OF EDUCATIONAL PSYCHOLOGY.

The "most important" aspect of the results, Stephan told SCIENCE NEWS, is that the attitudes triggered by desegregation are not necessarily aimed solely at other ethnic groups. "There are negative *interpersonal* attitudes during the first year of desegregation — they do not seem to like *people* as much," he said. The psychologist attributes much of the phenomenon to the "fallout of a tense, hostile ... situation."

Still, the data — drawn from a total sample of 309 blacks, 487 Mexican Americans and 528 whites — "show that each ethnic group had much more contact with members of their own group than with out-group members," say Stephan and Rosenfield. "Clearly, the minority students in this study have more positive attitudes toward in-group than out-group members."

The negativism was more pronounced among blacks and whites from segregated backgrounds than among those from previously more integrated backgrounds. (Mexican interethnic attitudes did not change appreciably, perhaps because those students underwent "limited" desegregation.) The researchers theorize that integration was more stressful for such youngsters. This idea seems to be supported by a recent Illinois study indicating that children who start out in integrated schools develop more positive attitudes than do those who switch from segregated schools (SN: 8/27/77, p. 133).

In personal self-esteem (which may not necessarily be related to in-group attitudes) blacks ranked the highest and Mexican Americans the lowest. This, along with similar findings in several other studies, suggests that "if it were ever true that blacks had negative self-images ... it is probably not currently the case," say the investigators.

Stephan suspects that the negativism apparent during the first year of desegregation may yield to positive changes once the school system has become stabilized — a contention that he says is consistent with the results of a six-year follow-up study of desegregation efforts in Riverside, Calif. However, because of the "sensitive" nature of Stephan's study, he says school officials in the city he examined have refused to allow him to pursue a follow-up.

"If desegregation has positive effects," he says, "it is probable that it takes more than a year or two for them to evolve." □

Not with a bang, but a twist

The discovery that there is a dynamic operating in the history of the universe, that it had a beginning and that it may have an end is one of the two or three most significant scientific developments of recent decades. As Robert Jastrow has pointed out in more than one recent writing, it is a revolution that overthrows astronomers' almost universal preference for a static, unchanging, nonexpanding universe, and it makes them unhappy.

Unhappy though they be, astronomers now mostly agree that the universe began in the explosion of a tiny, unimaginably dense bundle of energy, the event called the big bang. There is less agreement as to how it will end. Will the expansion that the big bang started stop, and will a recollapse lead to another bang? Or will the expansion go on forever? John D. Barrow of the University of Oxford and the University of California at Berkeley and Frank J. Tipler of the University of California at Berkeley have done a study of the future of possible open, endlessly expanding universes, and, in the Nov. 30 NATURE, they conclude that the fate of such universes is a new version of the "heat death" propounded by 19th century natural philosophers, to which is added a new twist, a vorticity that alters the shape of the universe, turning it from a sphere to a cigar or pancake shape. (All this is in four dimensions, of course, and trying to imagine the shapes could bring heat death to the mind. Cosmologists don't. They derive numbers from equations and say "such a number means a spherical shape," "such a number means a cigar shape," and so on.)

The universe as we have it now seems to be spherical and isotropic; that is, the same in all directions. Putting it another way, the equations used to describe the relationships of things don't have to take account of the direction one looks; one can use the same relation for any direction. That is a convenient universe to live and work in, and, because it seems a highly special case, a lot of ingenuity has been devoted to demonstrating that it could come about.

Even if isotropy can come about, Barrow and Tipler show that the class of universes in which it can appear are unstable with regard to their future, and lose it as they age. As the universe gets older, matter gradually falls into black holes. Over eons of time, black holes evaporate, releasing swarms of subatomic particles. But there is no bar in general relativity against these particles forming mini black holes of their own. If a proton and an electron form a hydrogen atom, this can collapse to a black hole of its own, and, when it evaporates, two photons come out.

Ultimately everything becomes photons and neutrinos, a universe made only of radiation. This is the point of "death" where the entropy is a maximum, and the possibility of further change is at an end. The 19th century natural philosophers had come to the conclusion that this would happen by considering the second law of thermodynamics. Barrow and Tipler use the laws of gravity and speak of the "entropy of the gravitational field." They compare their picture to Eddington's view of an ever-expanding ball of dead radiation.

But with a twist. The very process of black hole evaporation introduces a vortical instability into space and time — the intimate connections among space-time, matter and the gravitational field make such things possible — and the universe twists out of sphericity and isotropy, endlessly.

How long will it take? Bismarck is supposed to have said that if he heard the world was about to end, he would go to Mecklenburg because everything happens 50 years later there. Time depends on where you are and how you are looking. In the proper time of these universes, the time built into them and represented in their equations, the future expansion seems to go on infinitely. But if you measure time extrinsically, if you choose a "physical time" that is tied to the sequence of physical changes that take place, you can get a finite answer. Physical time may slow down with respect to proper time in the future.

One way to measure physical time is called York time, and Barrow and Tipler point out that "If York time measures physical time in the far future, then an ever-expanding universe, which exists forever in the future proper time, will continue to exist for only a finite physical time. Vaguely speaking, only a finite number of changes will occur in the future...." □

Levich gets out

Benjamin Levich, a physical chemist who for many years symbolized the plight of outspoken Soviet scientists and dissidents, left Moscow for Vienna with his wife on November 30 — six years after they first applied for exit visas. In September, Senator Edward Kennedy met in Russia with officials to discuss the emigration of 17 "refuseniks" (Jews refused emigration) and their families. At that time, Soviet President Brezhnev promised all 17 cases would be reviewed. To date, only the Leviches, who will settle in Israel, and the Katses — now in Boston — have been allowed to leave.

Levich was told by Soviet officials only a few years ago that he could "never" leave. Robert Adelstein, a cochairman of the Committee of Concerned Scientists, credited his release to the vigilant campaign by outside scientists on his behalf. CCS is a New York-based human-rights group. □