Prediction of Huge Peruvian Quakes Quashed

The U.S. National Earthquake Prediction Evaluation Council is "unconvinced of the scientific validity" of the prediction

Golden, Colorado. Last November, the American press gave considerable coverage to a prediction that two devastating earthquakes would occur along the coast of Peru this summer. One of them would be larger than any experienced in modern history. On 27 January, the U.S. National Earthquake Prediction Evaluation Council, meeting for the first time ever to consider a specific prediction, found the prediction to be based on "speculative and vague evidence," to be scientifically unconvincing, and to be unsubstantiated by the observations and theoretical arguments presented to the Council.

The rejection of the prediction, one of the most precise ever made by a credentialed scientist, is not simply a matter of opinion. Moderate-sized earthquakes, which were considered necessary precursors to the huge one to come and which were included in the prediction, failed to occur last fall. Brian Brady, the originator of the Peruvian prediction, received a Ph.D. from the Colorado School of Mines and has been a physicist with the U.S. Bureau of Mines since 1967. He detailed the fall 1980 foreshocks in a memo dated 1 May 1980. Brady's prediction was rather specific. He expected that foreshocks larger than magnitude 4.5 would cluster in a small area southwest of Lima beginning in mid-September. "The time duration will be approximately 328 days," he wrote. "There will be a total of twelve or more events in this series which will be temporally distributed in two active phases at the beginning and end of the series, each of whose time durations will be approximately 109 days." The first phase would have ended in early January.

"The activity Brady predicted in the May memo has never occurred," according to Robert Engdahl, chief of the global seismology branch of the U.S. Geological Survey (USGS) in Golden, Colorado, and a member of the National Earthquake Prediction Evaluation Council. If only data that the National Earthquake Information Service (NEIS) routinely acquires were to be used, Engdahl says, then the area specified by Brady would be considered to have been quiet throughout the fall of 1980. Only because Peruvian scientists made a special effort to provide data from their close-in regional detection network could NEIS list the occurrence of even small earthquakes anywhere near the area, he notes. The Peruvian network detected an event of magnitude 3.2 in September, which was well below Brady's minimum of 4.6, and an event of magnitude 4.5 on 26 December whose exact location—inside or outside the zone—remains uncertain, he says.

Brady is unperturbed. He sees the September and December events as signs of a general pickup of seismic activity. In spite of a slow start to the foreshock pattern, Brady believes that the big ones are still on the way. "I cannot withdraw this prediction," he told the Council as it met here last month, at the request of the Peruvian government, to consider the validity of his prediction.

Brady has not withdrawn his prediction, but he has altered it in recent months. In the May memorandum he predicted that a great earthquake would rupture the offshore subduction zone, where the Pacific crust dives beneath South America, in August 1981. This quake would begin near Lima and run to the south for about 1400 kilometers. Such an event would have a magnitude of 9.8 on the Kanamoori scale, which is equivalent to the Richter scale below magnitude 8 but gives a larger, more representative magnitude above 8. (The 1906 San Francisco earthquake had a Kanamoori magnitude of 8.6.) Another quake with a magnitude of 8.8 would also begin near Lima and rupture a 500-kilometer zone to the north in May 1982. By the time of the Council meeting, the second quake had been moved up to 10 August 1981 and the larger one pushed back to 15 September, thus reversing their order.

Although Council members complained to Brady that his precise predictions seemed all too flexible, Brady's means of arriving at his predictions distressed them more. One of the most serious complaints heard during the 2-day meeting was that there was no obvious observational support for Brady's theory that ties his laboratory studies of fracturing rocks to earthquakes. "It is

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my opinion," Brady told the Council, "that there is little hope of understanding earthquakes without understanding how rock breaks in the laboratory." Watching rocks under compression fail in the lab, Brady concluded that, before complete failure, small pockets of highly fractured rock form that are under tension. After further growth, the pockets, or inclusions, coalesce, the new pocket collapses, and the whole rock fails. On the larger scale of an earthquake, the inclusion collapse is the main shock. The theory's key to prediction, he says, is that once the process begins in the lab or in the earth, a "clock" begins running whose speed is steady until the final collapse. Bursts of moderate foreshocks are the ticks of the clock.

No one on the Council admitted that he believed that. James Rice of Brown University, a specialist in fracture mechanics called in by the Council, claimed that "There is no observational evidence for your theory. I don't think you have a wide enough perspective on the experimental literature." James Dieterich of the USGS, Menlo Park, also had serious reservations. He noted that the evidence is scanty for a connection between the breaking of a solid, intact rock in the lab and the rupturing of the earth's crust along a fault, which is a preexisting zone of weakness. In particular, the analogy between the noises in a rock sample that Brady recorded microseconds before failure and the moderate earthquakes that sometimes precede great earthquakes is "a very rough one at best," Dieterich says, requiring an act of faith to relate them.

Brady used the pattern formed by the timing and location of moderate quakes associated with the great 1974 quake near Lima to predict the huge Peruvian events, but no Council member said that he accepted Brady's rationale for doing so. After repeatedly pressing for an explanation, Robert Wesson, who as assistant director for research represented the USGS director at the meeting, concluded that Brady could not demonstrate any kind of theoretical relation between his proposed inclusions and the supposedly precise patterns of seismicity that he used to make the prediction. "We have to classify these arguments as assertions," he said. "We don't have an equation that we can put our hands on."

Claiming that there was no obvious theoretical basis for the prediction, the Council tried to take an empirical approach to the interpretation of Peruvian seismicity data. There, Brady leaned heavily on his interpretation, guided by his theory, of the smaller events that preceded the San Fernando (California) earthquake of 1971. That quake was indeed foreshadowed by two bursts of seismic activity that straddled a period of quiescence, according to Hiroo Kanamoori of the California Institute of Technology. But Kanamoori cautions, as did most Council members, that even if the San Fernando pattern of foreshocks could indicate something about how the rock there was going to break, a similar pattern off Peru, if it exists, probably can indicate little about when those rocks will break. "There is some similarity of patterns within the same region," he notes, "but, basically, every event has a different pattern."

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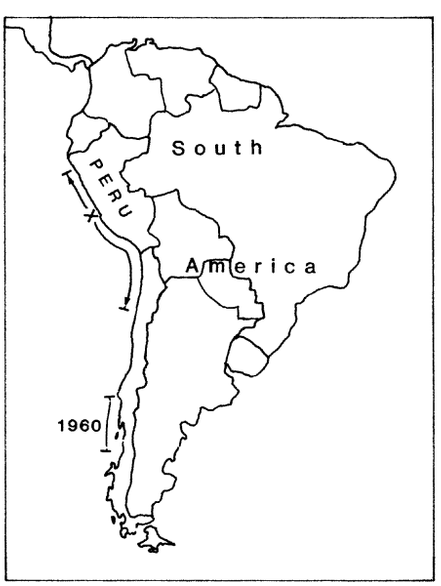
The pattern off Peru seemed particularly obscure to the Council members. In fact, they never accepted the existence of one. "If San Fernando doesn't convince you," Brady warned, "this [the Peru data] will never convince you. This is a more complicated situation. I'm sure it's very hard for others to see it because it's very model-dependent. This is obviously an interpretative process. There's a lot of engineering judgment in this method."

For the Council members, there was all too much judgment. "He [Brady] asked the Council to take too much on blind faith," Engdahl complains. "Unless there is a strong theory to support such a prediction," Wesson told Brady, "then I think it isn't scientific, it's numerological." Barry Raleigh of the USGS in Menlo Park echoed those thoughts during his closing remarks. "There is no theoretical development for clustering [of foreshocks] or cyclic activity. These patterns that you present are purely ad hoc. Major events have virtually every possible pattern. We've all been excited by patterns, only to find that other ones occurred elsewhere."

Another problem, Council members claimed, was that Brady did not follow the usual procedure for disseminating his results. According to John Filson, chief of the Office of Earthquake Studies of the USGS in Reston, Virginia, and a Council member, several informal meetings have been held specifically to consider Brady's prediction since the scientific community became aware of it in 1977. At most of these meetings, listeners remained skeptical but urged Brady to put his thinking into print and submit it to the usual publication process, Filson says. Brady never did. At the Council meeting, member James Savage of the USGS at Menlo Park, complained that the only material in writing on the prediction was a few old theoretical papers that are now outdated. None of his fellow members disputed his view.

Council members felt that they did have one satisfying achievement. When pressed, Brady promised to withdraw his prediction if at least five quakes greater than magnitude 4.5 did not occur southwest of Lima by mid-May. But the Council had already made up its mind. In a thoroughly negative final statement, which was endorsed by the USGS and conveyed to the president of Peru, the Council members declared that none of them "would have serious reservations about being present personally in Lima at the times of the predicted earthquakes."—RICHARD A. KERR



Predicted great earthquakes

The X marks where the two great earthquakes predicted for this summer by Brian Brady would start. One would propagate to the south, the other to the north. The length of fault broken by the 1960 Chilean earthquake, the largest earthquake in this century, is shown by the lower bar [Map by Eleanor Warner].