# FUTURE SHOCK

## New theory predicts a violent earthquake for Peru next August

The occasion: a dinner given by the California Institute of Technology for science reporters who had come to Pasadena in November to cover the Saturn fly-by. The speaker: Clarence Allen, a Caltech seismologist, who was to review recent developments in earthquake forecasting.

For the writers, it was a night off, a time to relax, free of deadline pressures. Then, in the middle of his talk, Allen casually mentioned a development that he incorrectly assumed was widely known: two reputable geophysicists in Denver had predicted that one of the strongest earthquakes in history would strike Peru and northern Chile next August. Startled, the reporters reached for their notebooks, and the world soon learned what, until then, had been publicly discussed only in South America.

What is remarkable about the prediction by Brian Brady, of the U.S. Bureau of Mines, and William Spence, of the U.S. Geological Survey, is that it pinpoints the time, place, and intensity of the temblor months ahead of the event. Previous long-range forecasts have been far more general. The two geophysicists predict that on August 10 or 11 an earthquake measuring more than 8.5* on the Richter scale will strike at 12.5 degrees south latitude, in the Pacific, about 40 miles off the coast of Peru. The rupture will spread more than a thousand miles south along the coastline to northern Chile. Thirty-six days later, a second quake—almost as strong—will strike under the coastal waters off Lima and travel hundreds of miles northward. Both Brady and Spence stress that they are making the prediction on their own; their federal agencies do not endorse it.

While other seismologists are also highly skeptical that so detailed a prediction can be made this far ahead, they agree that most of South America's western coastline is vulnerable to great shocks. A Peruvian quake in 1970 left 50,000 dead and 800,000 homeless.

Why that part of South America? The explanation lies in the earth's crust, which is divided into a dozen or so major, moving tectonic plates. One of these, the Nazca plate, lies under the floor of the Pacific and is inexorably being thrust under the edge of the South American plate. The trouble is that in a region off the coast of southern Peru and northern Chile, the two plates have been locked together by friction for many years, causing great stresses to build up in the rocks. When the rocks finally crack and the plates lurch into motion again, the pent-up energy will result in a quake. "The lower half of that region is one of the most likely sites for a great earthquake in the next decade," says William McCann, a seismologist with Columbia University's Lamont-Doherty Geological Observatory.

To pinpoint the moment of rupture, Brady is applying his "inclusion collapse" theory, a complex set of equations based on the physics of how materials break. His inclusion is a "soft" zone of highly fractured rock at the plate boundary, surrounded by a "hard" zone of stiffer material. Brady believes that a four-mile-thick soft zone now stretches for 140 miles off the Peruvian coastline. While the plates are locked, he says, the deeply buried inclusion expands outward and becomes more fractured; the expansion causes the hard zone to stiffen even more, increasing the stress on the rocks. Eventually, so much energy builds up in the region that the soft zone collapses, the rocks give way, and the quake occurs.

Brady maintains that his mathematical model predicts the sequence of seismic events leading up to the earthquake. "As the soft zone grows or contracts," he says, "certain seismic activity occurs around the outside boundary of the hard zone. It is the recognition of these patterns—the periods of quiet and minor tremors—that allows us to make the prediction."

Brady published the first stage of the forecast four years ago in a technical journal, and as early as three years ago he predicted privately that Peru would start experiencing low-magnitude tremors in the fall of 1980 that would lead to a major quake in the summer of 1981. Alberto Giesecke, director of the Geophysical Institute of Peru, confirms that light shocks did occur last August and October, but adds that whether this supports Brady's theory is anybody's guess, because few months pass without some seismic activity in Peru.

Brady and Spence periodically receive reports from Peruvian seismologists and admit that new data might cause them to revise or even cancel their prediction. This information includes rates of uplift of the Peruvian coastline, size and direction of minor quakes, and the sinking of the sea floor off the coast. Seismologist Allen, head of the National Earthquake Prediction Evaluation Council, has reservations about Brady's theory. "It is not necessarily wrong, but I still have to be convinced that the precursors are there." Karen McNally, another Caltech scientist, insists that seismologists are "not yet at the level to make anything more than a general forecast that far ahead." Brady takes such criticism in stride: "We're never going to convince anyone of the prediction until the future arrives."

—Marcia Bartusiak

**A Peruvian church destroyed in 1970 earthquake**

DAVID BURNETT

**Perhaps 100 times as great as the 6.8 quake that struck southern Italy in late November.*