# Awaiting the Next Mexico City Earthquake

*All eyes are on the Guerrero seismic gap off Mexico where the next great earthquake to shake Mexico City may be building*

THERE are few certainties in the science of predicting earthquakes, but one of them is that the slow sinking of Pacific Ocean crust beneath coastal Mexico will sooner or later generate earthquakes that will shake Mexico City. According to the latest thinking, the impending shaking could come as a series of two or three large, moderately damaging shocks or as a single great earthquake of the magnitude that killed more than 10,000 and left 250,000 homeless in 1985. Whatever its nature, the seismic activity could start any time and has a 50:50 chance of striking by 1991.

Researchers have no doubts about the best place to look along the subduction zone for the next damaging Mexico City earthquake. It is a 130-kilometer strip of sea floor off the middle of the Mexican state of Guerrero, 325 kilometers southwest of Mexico City. On the principle that the longer the time since the previous large earthquake on a given segment of fault the sooner the next will strike, the central Guerrero segment should be primed to fail in the near future. The last major events there occurred in 1899, 1907, and 1909, but the average time between recurrences on the Mexican coast is only about 30 to 50 years.

"The Guerrero segment is one of the hottest places we know of right now," says Stuart Nishenko of the U.S. Geological Survey in Golden, Colorado. "We all have a gut feeling that it will be the next one to rupture, but putting a number on it is difficult. The problem is that the last sequence happened at the turn of the century and we have no historical observations before that, so there is no evidence for a recurrence time."

In the absence of a track record for the central Guerrero segment itself, Nishenko and Krishna Singh of the National Autonomous University of Mexico looked to other segments of the Mexican subduction zone that had broken more than once in recent decades. In this record they found that recurrence times are proportional to magnitudes—the longer the recurrence time the larger the earthquake.

Assuming that major earthquakes on the central Guerrero segment behave as they do nearby, Nishenko and Singh calculated from their recurrence-magnitude relation that a repeat of the magnitude 7.5 earthquake of 1909 has a 54% chance of recurring between 1986 and 1991. The other, larger events in the sequence have lower probabilities of recurring during the next 5 years, but all are almost certain to strike again within the next 20 years, according to these calculations. The uncertainty of these probabilities is still considerable, the 54% probability representing a range of 31% to 75%.

***There is some hope of pinning down the timing of ruptures in the Guerrero segment.***

A similar approach was taken by Luciana Astiz, Hiroo Kanamori, and Holly Eissler of the California Institute of Technology. In their calculation they used a recurrence-magnitude relation developed in 1984 by Astiz and Kanamori in which earthquakes occurring within 3 years of each other were lumped together as one earthquake. Applied to the segment that produced the Mexico City earthquake, their empirical relation predicts that a 1985 earthquake would have had a magnitude of 8.0. The actual Mexico City earthquake had a magnitude of 8.1.

The same relation predicts that a single earthquake breaking the entire central Guerrero segment this year would have a magnitude of 8.1. Alternatively, the same energy could be released by a sequence of three events of magnitude 7.8. As the Caltech researchers note in their paper, "Both scenarios have serious implications for damage in Mexico City." They do not specify recurrence probabilities, but, because the largest earthquakes in Mexican history were magnitude 8.1, the next Guerrero earthquake could be assumed to be imminent.

The factor of 3 uncertainty in this forecast of the size of the next Guerrero earthquake runs counter to an increasingly popular concept among seismologists called the characteristic earthquake. The same fault segment rupturing time and again after accumulating the same amount of strain each time produces identical earthquakes, the fault's characteristic earthquake. The concept can hold elsewhere, but Kanamori for one argues that it is unworkable along the Mexican coast. The segments are certainly there, he says. In his model, strong spots on the fault called asperities divide it into segments of varying size depending on the strength of the asperities. The larger the asperity, the stronger the segment, the longer the time to accumulate enough strain to break the segment, and the larger the earthquake. That is what makes the recurrence-magnitude relation work, he says.

The problem with this segmentation, Kanamori notes, is that there is no obvious way to tell when the failure of one asperity will trigger the failure of another. Kanamori cites as an example the 600 kilometers of subduction zone along coastal Colombia that ruptured in a single event in 1906 but in a sequence of three events in 1942, 1958, and 1979. The great 1985 Mexico City shock was actually two identical events, one 100 kilometers to the south of the first following it by 26 seconds. Jaime González-Ruiz and Karen McNally of the University of California at Santa Cruz built on the idea of triggering between segments when they recently suggested that both the central and the southern Guerrero segments "will most likely rupture in a sequence of large earthquakes and/or a great earthquake" composed of more than one segment failure.

McNally sees some hope of pinning down the timing of ruptures in the Guerrero segment by closely watching the seismic activity there. Although the central Guerrero segment has always been relatively quiet, the southern segment, called the Acapulco–San Marcos region, became unusually quiet in 1977. That attracted attention because several years of such quiescence had apparently preceded major earthquakes nearby. McNally reports that after a 3-year surge of activity the quiescence resumed in 1985. Possible signs that stress is building to near the failure point include continuation of the quiescence and upward migration of deeper activity, she says. In any case, all eyes will be on Guerrero. ■ **RICHARD A. KERR**


ADDITIONAL READING

L. Astiz, H. Kanamori, H. Eissler, "Source characteristics of earthquakes in the Michoacan seismic gap in Mexico," *Bull. Seismol. Soc. Am.* 77, 1326 (1987).

J. R. González-Ruiz and K. C. McNally, "Seismic slip gap and potential for a large multiple-shock earthquake sequence in Guerrero, Mexico," *Eos* 67, 1115 (1986).

S. P. Nishenko and S. K. Singh, "Conditional probabilities for the recurrence of large and great intraplate earthquakes along the Mexican subduction zone," *Bull. Seismol. Soc. Am.*, in press.