A century after the Charleston quake

In spite of intense research over the last 15 years, seismologists are still debating whether or not they have identified the buried faults that caused the 1886 Charleston, S.C., earthquake, which killed at least 60 people and caused several million dollars' damage. A multitude of models continue to emerge about not only Charleston earthquakes but seismicity throughout the eastern half of the United States. Eastern U.S. quakes are much harder to study than their western cousins because they occur less frequently and take place in an intraplate region, far from any obvious, surface-breaking plate boundary like the San Andreas fault in California.

In honor of the centennial of the Charleston earthquake, which was estimated at magnintude 7, the eastern section of the Seismological Society of America held its annual meeting in Charleston this week. Seismologists presented several new findings and ideas on earthquakes in Charleston and other eastern U.S. regions.

One recent contribution to the understanding of Charleston seismicity has been the study of "sand blows," which were created when the strong shaking of earthquakes caused geysers of wet sand to spew out of the ground. Stephen F. Obermeier, Gregory S. Gohn and their colleagues at the U.S. Geological Survey (USGS) in Reston, Va., and Pradeep Talwani and his co-workers at the University of South Carolina in Columbia, recently used the craters left by sand blows to show that a few large earthquakes shook Charleston long before 1886 (SN: 2/2/85, p. 78). On the basis of his field work and a more recent statistical study, Talwani and his colleagues have estimated that large quakes recur every 1,500 years or so.

Now Obermeier's group has found that the older sand blows are distributed over a much larger area than the sand blows associated with the 1886 Charleston quake. According to Gohn, this suggests either that the faults that produced the 1886 quake had previously generated much larger earthquakes, or that there is more than one fault system in the Charleston region capable of producing destructive earthquakes.

In their hunt for the buried faults that generate Charleston earthquakes, seismologists have collected a variety of data — including measurements of variations in the magnetic and gravitational fields over the earth's crust, seismic reflection profiles, stratigraphic information from bore holes, and the locations of earthquakes — to probe the structure of the crust. Talwani thinks that with the addition of new gravity and bore hole data collected by him and Donald J. Colquhoun, also at the University of South Carolina, there is sufficient crustal information to identify the structures responsible for seismicity in the Charleston region.

In particular, the researchers believe that Charleston earthquakes are generated by two faults in two steps. First, at about 9 kilometers depth, a northeast-trending fault, called the Woodstock fault, slides in a horizontal plane due to northeast-southwest-trending stresses that compress the crust throughout the eastern United States. This movement then causes the overlying Ashley River fault, which trends northwest, to slip primarily in a vertical direction.

However, Roger M. Stewart at USGS, Gohn and others have been skeptical of Talwani's conclusions. They say that seismic reflection profiles and drill holes have failed to find the proposed faults (although Talwani says that profiles have not been conducted in the right places). In general, "the problem is that the data we have are so permissive," says Stewart. "There are many interpretations within the constraints of the data that can't be demonstrated one way or another."

This may explain the diversity of models being proposed for Charleston and other intraplate earthquakes. For example, some researchers have suggested that the flow of water through a crust laced with faults triggers earthquakes (SN: 3/15/86, p. 165). Others suspect that the extra weight of mountains and other surface features controls the stresses, and hence the seismic patterns, in the crust. Talwani and others, extending the Charleston model to other seismically active regions, including Anna, Ohio, New Madrid, Mo., and Tangshan, China, think that intersecting features and other structures in the crust localize stresses and hence quakes.

Most of the proposed models assume that the intraplate earthquakes occur where there are weak structures, such as Talwani's intersections, in the brittle upper crust as it is uniformly stressed. Now Mark Zoback at Stanford University and Mary Lou Zoback at USGS in Menlo Park, Calif., suggest instead that earthquake location is determined primarily by the lower, ductile crust, which controls the distribution of stress applied to the upper layers. According to the researchers, this model, which is supported in part by recent geodetic measurements in the New York City region (SN: 11/2/85, p. 277), is similar to theories explaining how earthquakes are generated along the San Andreas fault.


USGS

Aftermath of a violent quake that rocked Charleston, S.C., on Aug. 31, 1886.

All of these different models make for interesting science, but for regulators trying to assess earthquake hazards, the diversity of ideas is a nightmare. Ironically, the most scientifically useful — and perhaps the only — data that could pin down the intraplate earthquake mechanisms may very well be those gleaned from another large earthquake. Observes Stewart: "It's really too bad that the Charleston earthquake didn't happen 75 years later than it did, at a time when we'd have had better instrumental arrays around."

— *S. Weisburd*