United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

OFFICE OF THE DIRECTOR

In Reply Refer To:
EGS-Mail Stop 106

December 30, 1980

Dr. Robert E. Jackson
Chief, Geosciences Branch
Division of Engineering
U.S. Nuclear Regulatory Commission
M.S. P-314
Washington, D.C. 20555

Dear Bob:

This is in response to your request for an update on our information concerning the occurrence of earthquakes similar to the Charleston, S.C., event of August 31, 1886. That earthquake is rated as a Modified Mercalli intensity IX-X and, as such, is the principal controlling event for the determination of engineering design of nuclear power plants and processing facilities in the southeastern United States. In the past, the seismic engineering input has been based upon an earthquake of similar intensity occurring in the vicinity of Charleston, S.C., but not occurring randomly throughout the entire Coastal Plain province.

During the past decade, there has been considerable research by the geologic community directed toward a better understanding of seismicity in the southeast and, in particular, toward identification of the structure that generated the 1886 earthquake. The spring 1978 regional meeting of the Geological Society of America in Chattanooga, Tennessee, devoted a half-day symposium to the discussion of recent investigations in the Charleston area. The USGS has published (1978) Professional Paper 1028, and is planning a second one, which describes the progress of its research at Charleston. In addition, new ideas about southeastern U.S. seismicity are being presented at meetings of geologic and seismologic societies and are being discussed in the various geological journals. As a result, several new working hypotheses have been presented. However, although geologic mapping, stratigraphic drilling, seismic reflection profiling, and gravity and magnetic surveys have been underway for several years, no direct correlation between structures and earthquakes has been possible. The only significant structure recognized in the 1886 earthquake meisoseismal area is a northeast-trending reverse fault called the Cooke Fault. This feature has been interpreted primarily from seismic reflection surveys as there is no surface expression at all. To date, however, no evidence has been presented that associates the Cooke Fault directly with the 1886 earthquake. In fact, the length of the fault, as presently known (15 km), does not appear sufficient for generating an earthquake of intensity MM-IX-X, if standard fault length-earthquake size relationships are used. However, until further research

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provides more definitive concepts of southeastern U.S. seismicity and of its fault length and history of movement, the Cooke Fault by virtue of its coincidence of location with the Charleston earthquake should remain as a candidate structure to associate with that earthquake. Consequently, it should be considered as having a potential for generating similar events in the future.

Recently, several other faults have been recognized in the Charleston-Summerville areas, but none appear to have the potential of generating the higher intensity earthquakes. Individual faults recognized in the area appear to have responded to stress fields of different orientation (compressional or extensional) rather than reverse movement, and have inferred slip movements either in a normal or reverse sense depending upon the direction of stress of a given time. Other faults mapped throughout the eastern Coastal Plain and Piedmont provinces have had similar histories but none have been proven to be active at the present time, particularly in context of capability according to NRC criteria.

During the course of recent investigations, various additional hypotheses on the probable causative mechanism of the 1886 earthquake have included models of association with mafic plutons, stress concentration along block interface, and projection of the Blake Spur Fracture Zone at depth (basement structure).

Currently, there is much discussion of an interpretation of structure that hypothesizes a large east dipping decollement extending from Georgia northeastward to New England (Harris, L. D., et al, 1979) (Cook, F. A., et al, 1979). The decollement has been interpreted primarily from deep seismic reflection surveys done by COCORP (Schilt, F. S., et al, in prep.). Whether the decollement extends under the Charleston region is controversial (Hamilton, R. M., et al, in prep.). Present day seismicity ranges in depth from 3 to 13 km, with two-thirds of the events in the 5-8 km range. Composite focal mechanism solutions indicate sub-horizontal nodal planes as one of the possible orientations. However, there is no evidence which suggests that the generation of the present low-magnitude seismicity is related to the larger magnitude earthquakes such as the 1886 event. A structure such as the hypothesized decollement, however, should it exist and still be undergoing sufficient stresses to cause continued movement, may be capable of generating a large earthquake.

However, where the hypothesized decollement projects to the surface along the western margin of the valley and ridge province, there has been no recognition of quaternary surface rupture. In addition, this zone is characterized by a relatively low level of seismicity.

The problem regarding identification of specific tectonic structures capable of generating large earthquakes in the east is far from resolution. Local structures near Charleston are incompletely known at present and the larger structural element, the decollement, is as yet hypothetical. However, the concentration of seismicity in the Charleston earthquake epicenter both before and after the August 31, 1886, event and the lack of post Miocene faulting in the Coastal Plain or any evidence for localizing large earthquakes indicate that the likelihood of a Charleston sized event in other parts of the Coastal

Plain and Piedmont is very low. Consequently, earthquakes similar to the 1886 event should be considered as having the potential to occur in the vicinity of Charleston and seismic engineering parameters should be determined on that basis.

The research on the causative mechanism of the Charleston and other east coast earthquakes must continue if a more definitive resolution of this problem is to be obtained.

Sincerely yours,

James F. Devine

James F. Devine
Assistant Director for
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Enclosure