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GEOLOGIC HAZARDS of the South Carolina Coastal Plain 2012

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Train washed from tracks by a four-foot high wall of water when the Charleston earthquake burst the mill dam at Langley Pond near Aiken, SC.

MAP DISCUSSION

Introduction

This map has been designed as a planning tool for use by emergency managers for the response to and recovery from a hazardous geologic event, such as a large magnitude earthquake or a smaller occurrence such as a sinkhole formation. It also may be useful to land-use planners and regulators as a generalized guide to regional hazard mitigation actions. This deterministic map assumes that the occurrence of geologic hazards in the Coastal Plain region of South Carolina is related to the underlying geologic conditions.

The South Carolina Geological Survey (SCGS) used several data sets to construct this map including known and geophysically inferred faults, epicenters and magnitudes of earthquakes, areas susceptible to liquefaction including sites of known liquefaction, a GIS analysis of landsliding potential, and areas of sinkhole and karst occurrence. All data sets have been assembled using GIS technology and are available digitally. The primary data sources used to compile this map include 7.5-minute topographic maps of the Coastal Plain, existing geologic maps at various scales, United States Geologic Survey (USGS) earthquake database, field records and maps showing locations of paleoliquefaction features, a map of the liquefaction features created by the 1886 Charleston earthquake, and various published reports on geologic hazards in the Coastal Plain. The quality and accuracy of the data varies according to the type of data, date of development, and original map scale. Therefore, for best results, this map should be used at the scale of construction, 1:600,000.

Liquefaction Areas

Liquefaction is the transformation of loosely packed sediment or cohesionless soil to a liquid state as a result of increased pore-fluid pressure and reduced effective stress. It is caused by the ground shaking during an earthquake. Soil-liquefaction potential is based on the interpretation of thick, cohesionless material (mostly sand) combined with a high water table. Two areas of liquefaction potential are delineated on this map. The area of highest potential consists of surficial Coastal Plain sediments younger than 400,000 years including the sediment in adjacent modern alluvial valleys. This area also corresponds with the greatest occurrence of known liquefaction and paleoliquefaction sites, and it is similar to the delineation of Obermeier and others (1987; 1990). They field checked the area of predominantly marine sediments younger than 240,000 years for pre-1886 sand blows. Therefore, the new high liquefaction-potential area sets its northwestern-most boundary at the farthest inland occurrence of liquefaction sites, which corresponds with the Betheria Scarp physiographic feature (Doar and Willoughby, 2006). The high liquefaction-potential area includes the flood plains of modern rivers and streams. The second liquefaction area consists of the upstream extensions of stream valleys and is given a lower potential for liquefaction. The absence of evidence for liquefaction features is the basis for assigning a lower potential. Few, if any, liquefaction sites are found in stream valleys probably owing to the dynamic nature of the stream system; but because these areas contain water-saturated, unconsolidated sediments, they have a potential to liquefy.

Paleoliquefaction features shown on the map were transferred from maps and reports prepared by Dr. Pradeep Talwani and his students at the University of South Carolina (Talwani and Cox, 1985; Amick, 1990; and Schaeffer, 1995), and from Obermeier and others (1987; 1990) of the USGS. The liquefaction features formed by the 1886 Charleston earthquake were transferred from Earle Sloan's map presented in Dutton (1889, plate 28).

Collapse Potential

Two different areas of collapse potential are shown on the map. The first and larger area is taken from a USGS report on potentially karstic rocks in southeastern United States (Weary, 2008). This map area indicates where near-surface



An example of a sand blow, generally referred to as liquefaction, associated with the 1886 Charleston earthquake.

sediments are either carbonate rock or contain carbonate sediment. The area lies inland of the zone of liquefaction and consists almost entirely of the middle Coastal Plain. Additionally, a few areas with known sinkhole potential are delineated in the potential-liquefaction zones. They are mapped on the basis of karstic features (e.g. sinkholes, caves, and losing streams). Two areas north of Myrtle Beach are delineated from sinkhole studies by Hockensmith and Pelletier (1987). A large area is found around the town of Beaufort. The data for this area comes from geologic mapping by Doar (2003).

Another area of potential collapse occurs east of Lake Moultrie along the Santee River, and recent sinkhole activity in Georgetown is shown. There is field evidence for significantly more karstic features in the lower Coastal Plain, but because of map scale sinkhole potential is generalized.

Landslide Potential

Areas of potential landsliding have been delineated using GIS analysis. A slope-stability model was developed to identify hill slopes sensitive to potential landslide hazard. Modeling was done in ArcGIS 9.3 and resulted in areas with a slope surface equal to and greater than 10 percent. These areas were generalized for this map. Additional information on this process is available from the South Carolina Geological Survey.

Areas with landslide potential consist of steep slopes and thick, cohesionless materials. The cohesionless materials include thick and thin units that mainly consist of sand with some clay beds. Areas with landslide potential were recognized using a known landslide occurrence in Lexington County as the type example (Howard, 2010). The landslide occurred on a 12 percent slope surface. Using this information, it was determined that a slope surface of 10 percent or greater was appropriate for representing areas sensitive to potential landslide hazard. Two major areas of landslide potential are recognized. First are oversteepened banks of major rivers, such as the bluffs of the Congaree and Wateree Rivers, and some of their minor stream tributaries. These areas lie adjacent to large stream alluvial valleys. The second area consists of areas adjacent to Fall zone, which is that area of the Coastal Plain immediately southeast of the Piedmont and exhibits high relief particularly in incised stream valleys.

Known Faults

The Earthquake History and Fault Structures map (inset) is a derivative of the Structural Features Map of South Carolina (Maybin, 1998) and includes new faults that are interpreted to be responsible for the 1886 Charleston earthquake (cf. Dura-Gomez and Talwani, 2009). The Interpreted Isoseismals from the Charleston Earthquake map (inset) for the 1886 Charleston earthquake was developed by Bollinger (1977), and it shows the extent of shaking intensity associated with this event relative to today's infrastructure.

Because faults are buried structures with no surficial expression, their presence is inferred from secondary lines of evidence. They are inferred from geophysical data. There are two designations of faults on the structural features map. The first set of faults consists of features inferred from aeromagnetic anomaly data. The interpretation source



Sinkhole in Horry County. This cover-collapse sinkhole is the most common type forming depressions on the landscape.



Sinkhole created by the collapse of limestone material just below the surface.

Sinkhole created by the collapse of limestone material just below the surface.

for these structures is the Structural Features of South Carolina (Maybin, 1998). The second set of faults called “new” is inferred from seismicity and first-motion studies of earthquakes in the vicinity of the 1886 Charleston epicenter. These faults were interpreted by Dura-Gomez and Talwani (2009) to be the causal faults of the 1886 Charleston earthquake.

Recent Seismicity

The Earthquake History and Fault Structures map (inset) also shows epicenters of 650 earthquakes in and closely adjacent to South Carolina. The earthquakes are separated into three categories by their magnitude. Major cluster sites are: the Summerville area, site of the 1886 earthquake; Lakes Monticello and Jocassee, sites of reservoir induced seismicity; and the Eastern Piedmont fault system, the northeastern trending faulted area between Savannah River and the North Carolina border with Columbia along its axis. Several counties have no record of any significant seismic events including Horry, Marion, Dillon, Williamsburg, Jasper, and Hampton Counties.

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* Modified Mercalli Intensity Scale (MMI), for scale description please visit <http://earthquake.usgs.gov/learn/topics/mercalli.php>

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Paint store at the corner of East Bay and Cumberland Streets in downtown Charleston. Damage is result of the 1886 earthquake.

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SC Department of Natural Resources, Geological Survey
and
SC Emergency Management Division, Office of the Adjutant General



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MAP DISCLAIMER
This map and accompanying data have been prepared by the South Carolina Department of Natural Resources – Geological Survey. The information presented includes subjective assumptions developed on the basis of standard geologic principles. This map has been designed as a generalized guide to regional hazard potential. The map also may be useful to planners and regulators as a tool in the response and recovery from significant geologic hazards in the Coastal Plain. However, information should not be used for land-use zoning, building-code requirements, or defining insurance rate zones. The relative hazard zones also are not intended to replace site-specific evaluations, such as engineering analysis or design. Hazard potential should be evaluated through site-specific geotechnical investigation by qualified practitioners. Not intended for use at scale greater than presented here.

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