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U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves

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3.1 Atlantic and Pacific Basin Differences

A national comparison of tsunami hazards must account for the difference in tectonics between the Atlantic and Pacific Ocean Basins. As is well known, much of the Pacific consists of subduction zones (Appendix A, Figure A-1)—the Alaska, Cascadia, Kermadac-Tonga, and many others that are responsible for producing most of the world's great earthquakes and tsunamis (Table 2-1). The plethora of sources in the Pacific drives the number of tsunami events to the high levels seen in Hawaii. Not only are there large tsunami sources local to Hawaii, but the State is also in the crosshairs of tsunamis generated around the Pacific from South America to Alaska. To a lesser extent, other U.S. States and territories in the Pacific are subject to the dual threat posed by many distant sources and significant local sources.

The mid-Atlantic ridge, a spreading system, dominates the Atlantic Basin (Figure A-1). Unlike the subduction zone boundaries that dominate the Pacific and the Caribbean, the mid-Atlantic ridge is a passive boundary and tends to produce smaller magnitude earthquakes than those in subduction zones (Table 2-1). Generally, there is little probability of generating tsunamis along passive boundaries.

Lacking a tectonic plate boundary, the near-shore U.S. Atlantic and Gulf coasts are considered to be intraplate. This tectonic setting results in reduced expected earthquake maximum magnitudes (compared to the subduction zones in the Pacific) and greatly increased recurrence times. The USGS uses a maximum magnitude earthquake of 7.5 for all Gulf and Atlantic coastal areas (Frankel et al., 1996, 2002). Unlike the Pacific or the Caribbean where earthquakes rupture to the seafloor causing large vertical displacements, primary surface faulting and vertical displacement have a very low probability of occurrence along the Gulf and Atlantic coasts.

Complicating the assessment in the Atlantic is the uncertainty of the physics responsible for producing the largest events. The 1929 magnitude 7.3 Grand Banks, Newfoundland, earthquake is one of three known earthquakes with magnitudes of 7 or greater along the eastern coast of North America. More importantly, this event generated a tsunami that killed 29 people in Canada. Seismological studies show this was a complex earthquake with a largely horizontal slip at a depth of about 20 km (Bent, 1995). The seismological parameters rule out vertical displacement on the seafloor as the cause of the accompanying tsunami. Instead, an underwater landslide, triggered by the earthquake, caused the tsunami. In the NGDC database summarized in Table 2-1, the 1929 tsunami is the only runup listed for Maryland, Massachusetts, and New Hampshire, and is one of the two runups listed for South Carolina and Rhode Island.

The other two magnitude 7.0 or greater events along the Atlantic coast did not have destructive tsunamis. The first was the 1886 Charleston, South Carolina, earthquake. This event had an estimated magnitude of 7.3. Based on felt reports, the epicenter was estimated to be just onshore. A small, non-destructive tsunami was observed in both Florida and South Carolina. The second event occurred near Baffin Bay, Canada, in 1933. Also of magnitude 7.3, this event apparently did not cause an underwater landslide, and no tsunami was generated.