

Assessment of Seismic and Volcanic Tsunami Generating Source Mechanisms in the Caribbean Region

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Earthquakes, volcanic eruptions and volcanic island slope failures have generated destructive tsunamis in the Caribbean region. Seismic and volcanic tsunami generation mechanisms in this region are complex and often anomalous. Convergent, compressional and collisional tectonic activity - caused primarily from the eastward movement of the Caribbean Plate in relation to the North American and South American Plates - is responsible for zones of subduction and the formation of volcanic island arcs on the overlying plate. The inter-plate tectonic interaction near or along these marginal boundaries results in moderate seismic activity. Along the northern margin, including areas in the vicinities of Jamaica and the Virgin Islands, moderate, potentially-tsunamigenic, earthquakes of shallow depth occur. Tectonic deformation caused by active geo-dynamic processes in the vicinity of the Lesser Antilles Arc can result in potential tsunami sources with unique seismic and volcanic generative mechanisms.

Superimposed on inter-plate tectonic interaction in the Caribbean is a pattern of intra-plate activity - which is more pronounced in the Leeward Islands region where subduction by the Barracuda Rise adds additional strain on both the "subducted" North American Plate and the overlying Caribbean Plate. In this region earthquakes are generally shallow and potentially tsunamigenic. Also, moderate, deeper, non-tsunamigenic, intra-plate earthquakes occur in the Northern Caribbean. These are caused primarily by internal deformation in a slab of the North American Plate. Another region of concentrated seismic activity is northwest of Trinidad where the strike of the plate boundary changes direction. However most of the earthquakes in this area are of intermediate depth and therefore less tsunamigenic.

Generally, active seismic tsunamigenic source mechanisms in regions of subduction of the Caribbean involve relatively small crustal blocks. The dimensions of the source area, the extent of vertical crustal displacements and collateral events - such as landslides - determine the source characteristics of the tsunami, such as its energy, the period of its waves, and thus near and far-field effects and potential for destructiveness. Volcanic tsunami source mechanisms in the intra-plate regions vary in complexity and can result in different types of local tsunami generation from lateral, direct or channelized volcanic blast mechanisms as well as from other mechanisms of volcanic edifice mass failure.