

Small scale edifice collapse and tsunami generation at eastern Caribbean volcanoes; a standard phase of the volcanic cycle

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Since the spectacular collapse of the northern flank of Mt St Helens on 18 May 1980, volcanologists have come rapidly to the realization that sector collapse, of a variety of types and scales, plays an important part in the development of most volcanic edifices. The relatively small volcanoes of the Lesser Antilles island arc are no exception, and recent studies on land and under water have demonstrated the abundance of sub-aerial collapse-related features and sub-aqueous deposits. This recent research was prompted in part by the 26 December 1997 sector collapse at the Soufrière Hills volcano on Montserrat. That collapse produced a debris avalanche and subsequent dome disintegration generating energetic pyroclastic flows and surges. A small tsunami was generated by voluminous pyroclastic flows entering the ocean off Montserrat's southwest coast; the tsunami was witnessed and caused minor damage along the central part of the island's west coast. During the latest collapse of Montserrat's lava dome on 12 July 2003, tsunami generation again occurred when voluminous pyroclastic flows entered the ocean at the end of Tar River Valley on the east coast of the island. This tsunami was not witnessed on Montserrat but caused some damage to fishing boats in Guadeloupe. The reports of pyroclastic flow-generated tsunami during the 1902 eruptions of Mont Pelée, Martinique, and Soufrière, St Vincent, are consistent with the more recent Montserrat experience.

Given that most of the potentially active volcanoes of the eastern Caribbean are within a few km of the coast; that pyroclastic flow generation is a key aspect of most magmatic eruptions in the region; and that most of the volcanoes show both edifice collapse features onshore and debris avalanche deposits offshore, it is clear that tsunami generation should be characterized as probable rather than possible during eastern Caribbean magmatic eruptions. The limited empirical data from Montserrat suggest that pyroclastic flow and debris avalanche volumes can be treated equally in terms of tsunami generating potential and that collapse volumes of 10 to $50 \times 10^6 \text{ m}^3$ have the potential to generate 'local' tsunami (which can impact the host island's coastline) and that volumes $>50 \times 10^6 \text{ m}^3$ have the potential to threaten neighboring islands. The largest known collapse volume in the eastern Caribbean, from southern Dominica, is 10 to 20 km^3 , and this gives an upper limit on tsunami wave generation potential.

Of further note is that edifice collapse and tsunami generation is not necessarily triggered by a magmatic eruption (e.g. earthquake-triggered landslides from Nevis Peak and tsunami generation, 1690 & 1843); that collapse of sub-aqueous deposit fans or island slopes by loading or seismic shaking prior to or during an eruption can also cause tsunami generation (as was probably the case for the 7 May 1902 tsunami reported in St Lucia, Barbados and Grenada which coincides with major sea-floor cable breaks off Martinique attributed to sub-aqueous slumping); and that the eastern Caribbean also possesses an underwater volcano (Kick 'em Jenny) with known tsunamogenic potential.