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Exploring the driving mechanisms of the Havre 2012 eruption – a case study for deep submarine explosive eruptions

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Havre volcano situated at a depth of 1100m in the Kermadec arc, north of New Zealand erupted in 2012 and produced the largest explosive deep sea submarine eruption ever observed, featuring a $\sim$400km^2 pumice raft, and a $\sim$80km long vapor plume at the sea surface, indicating focused heat delivery to the surface and hence requiring some form of narrow thermal plume. Three years after the eruption, a US-funded research cruise used deep submergence vehicles to provide a 1m-resolution topographic map of the volcano, observations and systematically sampling of eruptive products from the sea-floor.

Determining the driving mechanisms for an explosive submarine eruption requires understanding how particles are generated and their heat transferred to the ocean. These two aspects are interconnected, since fragmentation costs process-specific energy and newly produced fresh surfaces form additional effective interfaces for heat transfer. In subaerial eruptions, ash production strongly controls generation of buoyant plumes. In order to explore in detail how the Havre eruption operated in the deep sea, heat-transfer and fragmentation experiments have been conducted by remelting both pumice and dense rock from seafloor-collected Havre samples. The resulting experimental data in combination with 2D and 3D shape analyses comparing lab-generated volcanic particles with natural volcanic ash will reveal the dominant ash generation mechanisms involved in the 2012 Havre eruption. Experimental setups and applied analyzing techniques are presented, and, based on first results, the most likely eruptive scenarios are discussed.