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A deep-sea scoria cone at Lo‘ihi Seamount, Hawai‘i: the product of “volatile-coupled, water-assisted” (VOCWA) eruption

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A wide variety of submarine eruption styles are possible, ranging from lava effusion to explosive caldera-formation. Submarine explosive eruptions have been somewhat inappropriately described according to subaerial classifications originally based on dispersal, but now somewhat modified to reflect ascent and degassing systematics- influential factors determining how a given magma batch will erupt. The common inference is that deep-sea pyroclastic eruptions are “Strombolian,” with magmatic volatiles mechanically decoupling from melt as buoyant slugs or collapsing foams to vigorously drive eruptions under high hydrostatic pressure. Fully submarine eruptions have been characterised based on relatively sparse samples- almost exclusively of fine material- that are often of unknown or poorly-constrained origin. Here we present a first-of-its-kind dataset, integrating: quantified vesicle textures in scoriaceous lapilli; volatile (H2O+CO2) contents of matrix glasses and olivine-hosted glass inclusions; and morphological features of fine ash particles, to demonstrate that a small pyroclastic cone at Ĩ km depth on Lo‘ihi Seamount was formed by an eruption in which exsolved volatiles remained coupled to magma during ascent. Volatile-coupled ascent was accompanied by vesiculation that imparted explosive potential to the magma, but was insufficient to fully fragment the melt. Interaction with seawater provided the extra energy required for wholesale magma fragmentation. This texturally and analytically-defined eruption style, here termed “volatile-coupled, water-assisted” (VOCWA), is specific to deep subaqueous settings. VOCWA eruptions are partially analogous to subaerial “Hawaiian” eruptions, but contrast markedly with the “Strombolian” eruptions widely inferred to be an appropriate analogue for submarine explosive eruptions.