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Havre 2012 Pink Pumice is Evidence of a Short-lived, Deep-Sea, Magnetite Nanolite-driven Explosive Eruption

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The Havre 2012 deep-sea eruption produced a massive pumice raft (~1.2 km^3) at the sea surface from a volcano that sits 900 mbsl (~9.6 MPa) in the Kermadec Arc. Lava flows/domes and a field of sunken seafloor pumice were also emplaced across the summit during the eruption. Havre raft and seafloor pumice are considered to have erupted contemporaneously and as part of an effusive eruption due their similarity in appearance and bulk chemistry. A distinctive feature of the raft is the common occurrence of pink pumice. Pink pumice has been reported from subaerial explosive eruptions, and results from high-temperature atmospheric iron-oxidation (> 700 °C). The pink raft pumice therefore poses problems given the deep water setting that is assumed to prevent eruption explosivity and the effusive eruption model for the 2012 eruption. Here, pink pumice is experimentally produced by heating white Havre raft pumice for several minutes in air at temperatures between 675-900°C (Fig. 1). The degree of reddening in experimental pumices increases with increased temperatures and times, resulting in a similar spectrum of colouration observed in natural pink raft pumice. The origin of the pink colouration was then investigated using several microanalytical techniques including X-ray Fluorescence Microscopy (XFM), Fe X-ray Absorption Near Edge structures (Fe-XANES), EPMA, rock magnetics, and TEM imaging. We found that white and pink raft pumice contain abundant magnetite nanolites/microlites and higher amounts of hematite in the pink pumice. In contrast, no magnetite nanolites or hematite occurs in the seafloor pumice. Magnetite nanolites line vesicle walls of pink raft pumice where the colour is microscopically localized. This provides evidence the magnetite nanolites are oxidizing to hematite and also acted as nucleation sites for enhanced volatile exsolution. Our results demonstrate a short-lived but powerful explosive eruption phase occurred during the 2012 eruption that penetrated the water column allowing hot pyroclasts to oxidize in air (Fig. 2). In light of these results the known depth limits for explosive eruptions (~10 MPa) in the marine realm need to be reassessed and we suggest pink pumice can be an indicator of magnetite nanolite-driven explosive eruptions.

Figure 1. Experimental Pink Pumice

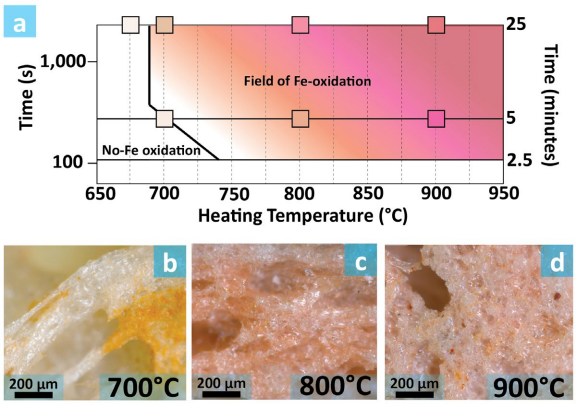

Figure 2. Havre 2012 Explosive Eruption Model