Vesiculation and Fragmentation of Silicic Magma in Subaqueous Environments

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The past decade has seen many advances in our understanding of explosive volcanism. Among these are numerous experiments on nucleation and bubble growth in rhyolitic melts, and quantitative studies of the textures of silicic pyroclasts. Experiments have shown that rates of homogeneous bubble nucleation are sensitive to the pressure drop imposed, and that high rates of bubble nucleation can only be achieved at very large overpressures (> 120 MPa). Silicic pumice clasts have high bubble number densities, in addition to vesicularities that are high but not sufficient to allow closed system degassing to low pressures, variable degress of coalescence, and high interconnected porosities and permeabilities. Together these characteristics suggest that bubbles form rapidly, in response to rapid decompression, and that permeability develops sufficiently fast to allow gas escape (open system degassing) during fragmentation. Is the same true of vesiculation of silicic magmas in subaqueous environments? While limited, available data suggest that the answer is yes. A survey of pumice samples from the Izena cauldron, the Izu-Ogasawara arc, Kikai caldera and Myojin Knoll caldera shows pumice clasts that are highly vesicular (63-86%) and permeable (~ 5-10 e-13 m2) with thin bubble walls, extensive evidence of bubble coalescence, and heterogeneous deformation. The only well constrained samples are those from the crater wall of Myojin Knoll caldera; these show no obvious change in vesicularity with either sampling depth or estimated eruption depth, at least to eruption depths approaching 1 km. Taken as a whole, these observations suggest that processes of vesiculation, and probably also of fragmentation, are similar in subaerial and submarine environments. However, this picture may change with more detailed sampling and analysis of the products of deep submarine eruptions.