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Lava balloons – Proof of a submarine, non-emergent eruption (Serreta, 1998-2001)

U. Kueppers (1,2), M. Potuzak (3), A. Nichols (4), V. Zanon (1), and J. Pacheco (1)

(1) Centro de Vulcanologia e Avaliação de Riscos Geológicos, University of the Azores, 9501-801 Ponta Delgada, Portugal, (2) Earth & Environmental Sciences, University of Munich, 80333 Munich, Germany (present address), (3) Corning Incorporated, Corning, NY 14831, USA, (4) Institute for Research on Earth Evolution (IFREE), Japan Agency for Marine Earth Science and Technology (JAMSTEC), Kanagawa 237-0061, Japan

Most volcanic eruptions on Earth take place in submarine settings, still, only a small fraction are emergent or possibly observed at the sea surface. Between December 1998 and April 2001, a submarine eruption occurred 10 km west of Terceira Island, Azores (Portugal) and was observable at the sea surface due to the periodic occurrence of "lava balloons". The witnessed lava balloons were up to 3 m long and remained floating for several minutes.
In order to better constrain the genesis of these balloons and test models presented by Gaspar et al. (2003), we used a three-fold approach: 1) examination and understanding of the physical volcanology of the samples, 2) quantifying volatile contents of glassy matrix and melt inclusions hosted by olivine and pyroxene phenocrysts, and 3) measuring the cooling rate of glassy samples from the crust as a function of their distance from the exterior surface. The successfully collected balloons consist of a large cavity surrounded by a crust a few cm thick that shows signs of large-scale fluidal deformation and small-scale brittle cracking. The crust exhibits several different layers with varying bubble-number density, bubble size, and crystallinity. The outermost layer is glassy, golden-coloured, and highly porous. The concentration of volatiles in groundmass glass and melt inclusions was measured by micro-FTIR and indicate an efficient but incomplete degassing that started long before the magma reached the eruptive conditions. Cooling rates of glass from the different layers in the crust and the ash were determined using their cp-temperature paths, measured by differential scanning calorimetry. We discriminated values as high as 1259 K/s, the fourth fastest cooling rate known for volcanic glass.
We believe that the balloons are gas-filled cavities that formed at and detached from ponded lava by gas accumulation. Balloon formation is possibly a more common feature than previously realised. Whether they are observed at the surface depends critically on the water depth at the vent and whether there is anybody present to observe it, as their presence is ephemeral. We suggest looking carefully for balloon evidences around submarine vents during future submersible explorations.