Geophysical Research Abstracts, Vol. 9, 02351, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02351

Submarine lava flows around the coasts of Pico Island, Azores

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Bathymetry data collected with a multibeam sonar around Pico Island reveal a remarkable series of lava flows on the island's shelf with a variety of pristine structures that suggest how lava behaves on entering water. Many flows are dendritic, some with channels and tumuli. Dendritic geometries arise from flow fronts repeatedly arrested by enhanced cooling and magma pressure subsequently causing new breakouts. Cascades of elongated flow fingers also occur. Some flows have wide transverse clefts, in some cases separating flows into segments, which are interpreted as caused by their upper surfaces having solidified, while their still-fluid cores allowed the surfaces to extend. A number of flows moved onto the shelf as large bodies, stopped, and then sourced smaller lobes forming the dendritic patterns. This two-stage evolution and the tumuli (which lie on a low gradient immediately below a steep near-shore gradient) suggest that, after initial emplacement and development of a crust by cooling, some flows pressurized. Once movements ceased and viscous stresses dissipated, magmastatic pressure developed from the weight of flow interiors passing over cliffs and near-shore submarine slopes. One group of flows traverses the island's submarine slope, so direct supply of lava to the slopes is possible, although volumetrically how important it is to the island's internal composition is difficult to tell from these data.

Based on observed strong surf erosion of historical flows, these delicate structures could not have survived passage through a moving sea level so they are not pre-Holocene subaerial flows. They were formed in the Holocene from flows penetrating sea level or possibly some from near-shore tube openings or vents. Such flows and abundant clastic deposits are ephemeral features that probably become remobilized by surf during times of lowering sea level. The shelves of active volcanic islands are therefore active geologically and are far from being simple products of erosional truncation as was once envisaged. The finding of lava extending below sea level has implications for assessing the hazards of volcanic islands, in particular for event frequency and censoring of flow length and volume statistics.