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The 1998–2001 submarine lava balloon eruption at the Serreta ridge (Azores archipelago): Constraints from volcanic facies architecture, isotope geochemistry and magnetic data

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ABSTRACT

The most recent submarine eruption observed offshore the Azores archipelago occurred between 1998 and 2001 along the submarine Serreta ridge (SSR), ~4–5 nautical miles WNW of Terceira Island. This submarine eruption delivered abundant basaltic lava balloons floating at the sea surface and significantly changed the bathymetry around the eruption area. Our work combines bathymetry, volcanic facies cartography, petrography, rock magnetism and geochemistry in order to (1) track the possible vent source at seabed, (2) better constrain the Azores magma source(s) sampled through the Serreta submarine volcanic event, and (3) interpret the data within the small-scale mantle source heterogeneity framework that has been demonstrated for the Azores archipelago. Lava balloons sampled at sea surface display a radiogenic signature, which is also correlated with relatively primitive (low) $^{4}He/^{3}He$ isotopic ratios. Conversely, SSR lavas are characterized by significantly lower radiogenic $^{87}Sr/^{86}Sr$, $^{206}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios than the lava balloons and the onshore lavas from the Terceira Island. SSR lavas are primitive, but incompatible trace-enriched. Apparent decoupling between the enriched incompatible trace element abundances and depleted radiogenic isotope ratios is best explained by binary mixing of a depleted MORB source and a HIMU-type component into magma batches that evolved by similar shallower processes in their travel to the surface.
The collected data suggest that the freshest samples collected in the SSR may correspond to volcanic products of an unnoticed and more recent eruption than the 1998–2001 episode.

1. Introduction

Understanding the spatial and temporal evolution of volcanic systems is essential to raise volcano-hazard awareness. The volcanic islands of the Azores archipelago (North Atlantic Ocean, Fig. 1) have been largely studied and monitored during the last decades through rock and fluid sampling (e.g. Flower et al., 1976; White et al., 1979; Davies et al., 1989; Turner et al., 1997; Moreira et al., 1999; Beier et al., 2008; Jean-Baptiste et al., 2009), seismic and GPS networks and geophysical surveys (both onshore and offshore; e.g., Miranda et al., 1991, 1998; Lourenço et al., 1998; Fernandes et al., 2006).

Several onshore and offshore volcanic eruptions have been reported in the Azores since the beginning of the colonization by the Portuguese in the 15th century (as described in Machado, 1959a, Zbyszewski, 1963 and Weston, 1964). Nonetheless, in the last two centuries the most prominent volcanic events occurred offshore. Several submarine eruptions lead to the formation of temporary islands (e.g. D. João de Castro Bank, 1720; Sabrina Island, 1811) or increased island areas with strong impact in the life of the local population (e.g. surtseyan Capelinhos eruption in 1957–58, Faial Island). The most recently observed submarine eruption (1998–2001) occurred along the submarine Serreta ridge, ~4–5 nautical miles WNW of Terceira Island (Fig. 2), in accordance with the age migration of the Terceira Island central volcanoes

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