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The old central igneous complexes of Sal, Boa Vista and Maio islands: Implications for 17 Ma of isotopic evolution of the Cape Verde archipelago

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ABSTRACT

The central igneous complexes of the easternmost islands (Sal, Boa Vista and Maio) preserve some of the most ancient outcropping rocks of the Cape Verde (CV) archipelago. These Early to Middle Miocene (about 25 to 12 Ma) complexes show marked isotopic differences between mafic rocks from the northern (Sal and Boa Vista) and the southern Maio Island, the latter showing lower $^{143}Nd/^{144}Nd$, $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and higher $^{87}Sr/^{86}Sr$ ratios. The main mantle plume composition beneath Cape Verde is here considered to be dominated by the FOZO component. Our data supports previous models suggesting the incorporation to plume components of minor DMM mantle sources in the northern CV island alignment, whereas mixing with the EM1 pole is prevalent on the southern CV islands. These isotopic differences are evident since the early stages of Cape Verde magmatism. The Late Miocene to Holocene time period (7 to 1.7 Ma) is characterized by the irruption of silica-undersaturated and carbonatite magmas with a relatively homogeneous isotopic composition and highly radiogenic Pb signatures ($^{206}Pb/^{204}Pb$ up to 20.6 in carbonatitic rocks and 20.2 in silicate rocks) throughout most of the Cape Verde archipelago. During this transitional stage, the input of this new HIMU mantle component overprinted the previous mixing of the main FOZO plume component with shallow mantle members (DMM, EM1) of minor contribution.

1. Introduction

The Cape Verde (CV) archipelago is a volcanically active ocean island group formed by alkaline intraplate magmatism. Successive plutonic and volcanic events built a complex rock association within each island generating a diverse and wide compositional range of eruptive products. This archipelago is located around 450 km off the west African coast and consists of ten major islands arranged in a semicircle forming two alignments of islands in the north and south, closed to the east by the N-S aligned Sal-Boa Vista-Maio ridge, which is formed by the oldest islands of the archipelago (Fig. 1).

The islands stand on top of the Cape Verde rise, one of the highest oceanic plateaux, rising 2 km above oceanic floor (Crough, 1982; Gerlach et al., 1988). These islands are underlain by a Cretaceous (120 to 145 Ma) ocean crust with a Moho depth decreasing westward from >20 km beneath Maio to 10–14 km beneath the westernmost islands of Fogo and Santo Antão, whereas the oceanic lithosphere reaches around 100 km of thickness beneath Sal (Lodge and Helffrich, 2006). This uplifted plateau and the extremely varied strongly silica-undersaturated CV magmatism is considered to be associated to a hotspot swell produced by ascending thermochemical plumes, as deduced from anomalous heat flow and geoid data (e.g., Carvalho et al., 2019; Pim et al., 2008).

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