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ORIGINAL PAPER

Deep sourced magma and ore-metal mobility in the D. João de Castro submarine volcano (Azores): a mineral chemistry and melt inclusion study

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Abstract

The D. João de Castro is a submarine volcano with known hydrothermal activity located in the Terceira ultra-slow spreading rift within the Azores triple junction (ATJ). Several well-known mafic and ultramafic rock-hosted seafloor hydrothermal systems lay along the Mid-Atlantic Ridge, to the north and to the south of the Azores platform, yet little is known about seafloor hydrothermal activity, ore-metal availability, and magmatic–hydrothermal interactions within the ATJ. Here, we investigate multi-phase melt inclusions hosted in early formed phenocrysts (olivine, clinopyroxene and plagioclase), and metallic precipitates found in groundmass vesicles. Combining detailed petrographic observations with geochemical data and thermobarometry calculations, we assess P–T conditions of early formed phenocrysts, melt pathways towards surface, timing of sulfide saturation and composition of immiscible sulfide melts. Results show that D. João de Castro is characterized by a multi-level magmatic system where primary melt segregated from the upper mantle and moved up through the oceanic crust with little residence time. Sulfide saturation with the formation of immiscible magmatic sulfide liquid (Fe–Ni–Cu) occurred early in primitive magmas with clinopyroxene and olivine crystallization and continued during plagioclase crystallization. At shallower levels, the magmatic degassing of volatiles carrying base metals (Cu–Zn–Pb–Co) and Ba have contributed to the element budget of the D. João de Castro hydrothermal system. The study of multi-phase melt inclusions and vesicles at D. João de Castro submarine volcano contributes to the understanding of source to surface magmatic processes at the Terceira Rift and underline the importance of magmatic degassing into seafloor hydrothermal systems.

Keywords Melt inclusions · Azores · Terceira rift · Submarine volcano

Introduction

Most seafloor hydrothermal systems are genetically linked with mantle-derived magmas and whilst there is consensus that magmatic heat drives seafloor hydrothermal systems, the extent of water, metals and ligands contributing from magmas into the hydrothermal ore-forming systems is still under debate. Notwithstanding, it is recognized that during magma ascent to surface, magmas may exsolve single-phase fluids or co-existing vapor and liquid phases due to decompression and crystallization, with implications on the transport of ore metals into shallower levels of hydrothermal systems (*e.g.*, Hedenquist and Lowenstern 1994; Audétat et al. 1998; Heinrich et al. 1999; Candela 2003; Heinrich 2005; Williams-Jones and Heinrich 2005; Zajacz et al. 2008, 2017; Zajacz and Halter 2009; Kamenetsky and Kamenetsky 2010; Brugger et al. 2016; Keith et al. 2018). Moreover, studies on melt inclusions and vesicles in volcanic rocks

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