Magmatic plumbing system of a complex ocean island volcano, Ascension Island, south Atlantic

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Ascension Island, 7˚56’ S, is an isolated composite volcano in the south Atlantic, lying 90km west of the Mid Atlantic Ridge. Even though Ascension Island is small –only 12 km in subaerial diameter –it has produced a wide variety of eruptive products in its 1-million-year subaerial eruptive history. Volcanic rock compositions range from basalt to rhyolite, following a silica-undersaturated subalkaline evolutionary trend. Yet, while a huge variation in magmatic compositions have been erupted across a limited spatial extent, there is little evidence for magma mixing preserved in erupted deposits.

Here we present extensive whole rock XRF data coupled with EPMA and LA-ICPMS analyses of glass and crystals of samples which span the entire range in compositions erupted throughout Ascension Island’s subaerial history. These new geochemical data are coupled with detailed field observations and targeted $^{40}Ar/^{39}Ar$ dating, which reveal more than 70 explosive pumice-producing eruptions, and more than 40 mafic effusive eruptions have occurred in the last 1-million years. We use these data to construct a robust volcanic history for Ascension Island, including dating its most recent activity, and build a detailed petrological model for the magmatic plumbing system underlying Ascension. These data highlight the role of fractional crystallisation in the production of the range of magmatic compositions found on Ascension Island, and reveals the closed-system nature of the magmatic plumbing system, unlike many other ocean islands, such as Tenerife or Iceland. SIMS-measurements of volatiles in melt inclusions in two zoned fall deposits appear to show this closed-system evolution occurs at depths between 7 and 11 km, i.e. the lower crust. The closed-system and relatively deep nature of magmatic evolution, and the relatively small volumes erupted in single events means that any explosive future activity is unlikely to preceded by significant precursory signals.

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