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Petrogenesis and Differentiation of Potassic Rear-Arc Magmas at Tambora Volcano, Eastern Sunda Arc, Indonesia

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The cataclysmic eruption of Tambora volcano, Sumbawa, Indonesia in 1815, has long been recognised as one of the largest explosive eruptions in recorded history. It yielded some 30-33 km3 (DRE) of trachyandesitic/tephriphonolitic magmas, which are among the most evolved compositions erupted throughout the history of the volcano. Here, we present a conceptual model of the processes and timescales involved in the generation of the 1815 Tambora magma body with the aid of new major element, trace element, volatile and isotopic data (Sr, Nd, Hf, U, Th, Ra) obtained for the 1815 eruptive products. The parental trachybasalt magmas can be modelled by $\sim$2% partial melting of a garnet-free, I-MORB-like mantle source contaminated with $\sim$3% fluids from altered oceanic crust and < 1% sedimentary material. These factors contributed to preserve the effects of fluid addition to the mantle source in the Tambora rocks, which must have occurred less than 350,000 years ago. Ra excesses may indicate that at least some fluid components were added to the mantle wedge less than 8,000 years ago. Magmatic differentiation from primary trachybasalt to trachyandesite/tephriphonolite occurred during two-stage, polybaric differentiation at depth around the Moho and in a shallow ($\sim$1.5-2.0 km deep) crustal reservoir that grew incrementally by recharge of hotter, less evolved magmas formed by partial crystallisation in a deep crustal 'hot zone'. Repeated additions of these magmas and subsequent fractional crystallisation, magma mixing and convection led to the development of a well-stirred, homogenous magma body at Tambora prior to 1815. These processes occurred over timescales of less than 8,000 years. Highly calcic, corroded plagioclase and crystals in Ra-Th equilibrium (> 8,000 years old) provide physical evidence for the incorporation of 'xenocrystic' material into the 1815 Tambora magma. Volatile concentrations in plagioclase-hosted melt inclusions indicate that magma accumulation and differentiation within the shallow crust prior to the cataclysmic eruption in 1815 were accompanied by continuous degassing of sulphur (and other volatile species), which did not accumulate within or towards the top of the magma reservoir to contribute to the volatile budget of the eruption, but escaped passively through permeable wall rocks to the surface.