On the timescales of magma accumulation and evolution at Tambora (Sumbawa, Indonesia) prior to the 1815 eruption

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The great Tambora eruption in 1815 has been one of the largest explosive eruptions in historic time. It produced extensive pyroclastic fall and density current deposits from the evacuation of a 30-33 km^3 trachyandesite to tephriphonolite magma body [1, 2]. Geochemical modelling suggests that the parental trachybasalt of the evolved 1815 magma may be produced by 2% partial melting of a garnet-free, I-MORB-like mantle source contaminated with 3% fluids from altered oceanic crust and < 1% subducted sediment, preserving the small ^{238}U excesses observed in the 1815 Tambora rocks. Magmatic differentiation from primary trachybasalt to trachyandesite and tephriphonolite occurred during two-stage, polybaric differentiation at depth(s) around the Moho and in a shallow-level crustal magma reservoir emplaced at a maximum depth of 7.5 km, but with a degassed cap possibly extending to depths as shallow as 2.3 km below the summit. This crustal reservoir grew by influx of basaltic trachyandesite magma, which is interpreted to have formed predominantly by partial crystallisation of primary trachybasalt in the inferred deep reservoir or hot zone [3]. Subsequent magmatic differentiation dominated by fractional crystallisation, magma recharge/mixing and convection over timescales of 4000-4500 years led to the trachyandesitic (and ultimately tephriphonolitic to phonolitic) melts that erupted in 1815. Highly calcic, in some cases corroded, plagioclase and other mineral phases in ^{226}Ra-^{230}Th equilibrium (> 8000 years old) provide physical evidence for incorporation of antecrystic material into the 1815 magma. Magma accumulation and differentiation at shallow depth prior to the eruption were accompanied by continuous degassing of sulphur and other volatile species, which appear not to have accumulated within or towards the top of the magma reservoir to contribute to the volatile budget of the eruption, but to have escaped to the surface passively through permeable wall rocks.

References: [1] Self et al. (2004). Geophys. Res. Lett., 31, doi:10.1029/2004GL020925; [2] Gertisser et al. (2012). J. Petrol., 53, 271-297; [3] Annen et al. (2006). J. Petrol., 47, 505-539.