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Reconstructing the plumbing system of Krakatau volcano

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Crustal contamination of ascending arc magmas is generally thought to be significant at lower- to mid-crustal magma storage levels where magmas inherit their chemical and isotopic character by blending, assimilation and differentiation [1]. Anak Krakatau, like many other volcanoes, erupts shallow-level crustal xenoliths [2], indicating a potential role for upper crustal modification and hence late-stage changes to magma rheology and thus eruptive behaviour. Distinguishing deep vs. shallow crustal assimilation processes at Krakatau, and elsewhere, is therefore crucial to understand and assess pre-eruptive magmatic conditions and their associated hazard potential. Here we report on a multi-disciplinary approach to unravel the crustal plumbing system of the persistently-active and dominantly explosive Anak Krakatau volcano [2, 3]. We employ rock-, mineral- and gas-isotope geochemistry and link these results with seismic tomography [4]. We show that pyroxene crystals formed at mid- and lower-crustal levels (9-11 km) and carry almost mantle-like isotope signatures (O, Sr, Nd, He), while feldspar crystals formed dominantly at shallow levels (< 5km) and display unequivocal isotopic evidence for late stage contamination (O, Sr, Nd). Coupled with tomographic evidence, the petrological and geochemical data place a significant element of magma-crust interaction (and hence magma storage) into the uppermost, sediment-rich crust beneath the volcano. Magma – sediment interaction in the uppermost crust offers a likely explanation for the compositional variations in recent Krakatau magmas and most probably provides extra impetus to increased explosivity at Anak Krakatau.

[1] Annen, et al., 2006. J. Petrol. 47, 505-539. [2] Gardner, et al., 2013. J. Petrol. 54, 149-182. [3] Dahren, et al., 2012. Contrib. Mineral. Petrol. 163, 631-651. [4] Jaxybulatov, et al., 2011. J. Volcanol. Geoth. Res. 206, 96-105.