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Volatile constraints on the magma supply, dynamics and plumbing system of a top-ranking basaltic gas emitter: Ambrym volcano, Vanuatu Arc

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Ambrym basaltic volcano (central Vanuatu arc) is one of the most active volcanic systems of the Southwest Pacific region, where recurrent lava lake activity sustains voluminous gas release from two main cones, Benbow and Marum, in a 12 km-wide summit caldera. In 2007-2008 we could perform the first detailed investigations of gas emissions from this very active but remote and hardly accessible intra-oceanic arc volcano, combining ground-based and airborne measurements and using both in situ and remote sensing tools. The degassing budget of major, minor, trace and radioactive volatile species reveals that Ambrym ranks amongst the three most powerful persistent emitters of magmatic volatiles at global scale [1]. Coupled with the analysis of dissolved volatiles in the feeding basalt (olivine-hosted melt inclusions), the gas emission rates imply a very high average magma supply/degassing rate of 25 m^3/s – 6 times the rate at Mount Etna - from a reservoir emplaced at about 4 km depth beneath the caldera floor. The chemical composition of emitted volcanic gases is compatible with dominant closed-system ascent and degassing of the basalt, followed by open degassing at shallow depth as water exsolution becomes extensive. The modest time-averaged extrusion rate, estimated from caldera infilling over the past 2 ka, requires convective downward recycling of the denser degassed magma in conduits with diameter of order 10 m. High resolution OP-FTIR remote sensing of hot volcanic gases from Benbow lava lake reveals short-term oscillations of basalt degassing and convective overturn in these conduits [2]. The ratios and fluxes of short-lived radioactive daughters of radon-222 (^{210}Po, ^{210}Bi, and ^{210}Pb) in the volcanic gases and the ^{210}Pb activity in the basalt lead us to estimate a volume of 0.5 km^3 for the magma reservoir, a renewal rate of only 240 days, and a bubble transfer time of a few (<10) days from the reservoir to the surface. Further refinement of these preliminary estimates will require additional studies of Ambrym.

[1] Allard et al., JVGR. 2015, dx.doi.org/10.1016/j.jvolgeores.2015.08.022; [2] Allard et al., EPSL, in revision.

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