Uranium-series timescale constraints on recent changes in the eruptive behaviour of Merapi Volcano, Java, Indonesia

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The 2010 eruption Merapi volcano (Central Java, Indonesia) was the volcano's largest eruption in 140 years and was much more violent than expected. Prior to 2010, for example in 2006, volcanic activity at Merapi was characterised by several months of slow dome growth punctuated by gravitational dome failures, generating small-volume pyroclastic density currents. We present new uranium-series (U-Th-Ra-Pb) isotope data for the volcanic products of both the 2006 and 2010 eruptions at Merapi to investigate the driving forces behind the recent unusual explosive behaviour and their timescales. The 2006 and 2010 volcanic rocks display ^{238}U excess and suggest variable enrichment by a U-rich fluid or melt (e.g., subducted slab or crustal assimilant) within the last 380 kyr. The 2010 deposits display a slightly wider range in (^{238}U/^{232}Th) (0.671 to 0.723) compared to those of 2006 (0.702 to 0.720). A negative correlation is observed between (^{226}Ra/^{230}Th) and Th (as index of differentiation). Assuming that the degree of disequilibria in the sample with the highest (^{226}Ra/^{230}Th) (3.28) represents that at the onset of differentiation, ^{226}Ra excesses implicate short timescales for magmatic differentiation at Merapi of < 750 years for the 2006 and < 300 years for the 2010 volcanic rocks, noting that apart from one 2006 sample, the volcanic rocks of both eruptions have similar (^{226}Ra/^{230}Th) activity ratios. However, it is unlikely that the U-series data at Merapi can be interpreted within the context of simple closed-system evolution due to the previous recognition of open-system processes, such as magma recharge, magma mixing and mingling processes and assimilation of crustal carbonates. The 2006 and 2010 volcanic rocks have initial (^{210}Pb) values of 2.66 to 3.04 dpm/g and 2.22 to 3.08 dpm/g and (^{210}Pb/^{226}Ra)$_0$ ratios of 0.81 to 0.95 and 0.72 to 0.96, respectively and may suggest persistent and complete ^{222}Rn degassing over a few years to a decade prior to eruption possibly related to the time for magma ascent from a deeper crustal reservoir. The 2010 volcanic rocks show the largest ^{210}Pb deficits suggesting longer timescales of degassing prior to eruption compared to the 2006 eruption. However, volcanic rocks of both eruptions display relatively similar range in (^{210}Pb/^{226}Ra)$_0$ ratios.