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Magma crust interaction at Merapi volcano, Java Indonesia: insights from crystal isotope stratigraphy

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It is now emerging that whole rock isotope analyses of phenocryst-rich rocks, although useful in their own right, often show a blurred picture of magmatic evolution representing only the average of the magma's component parts. Strontium isotope profiles measured from core to rim across a phenocryst may be used to monitor changes in the isotope composition of the magma from which that crystal grew and may record, on a mineral scale, mixing or contamination events that are masked in the whole rock isotope ratios. Samples from recent eruptive products of Merapi volcano contain abundant complexly zoned plagioclase phenocrysts. These phenocrysts were analysed with respect to petrographic textures, major element composition and Sr isotope composition. Electron microprobe traverses of these crystals have revealed both normally and reversely zoned crystals with variations in An content ranging from 50-90 mol%. Transitions between zones that are separated by resorption surfaces are often marked by shifts in An content of up to 40 mol %. In addition, there appears to be little correlation between An content and other indicators of magmatic evolution i.e. MgO, FeO. In-situ Sr isotope analyses (via micro-drilling) of these samples has shown that magmatic evolution at this volcano is complex. $^{87}Sr/^{86}Sr$ ranges from 0.705682 to 0.705992 ($\pm$ 0.000032) for the discrete zones in plagioclase phenocrysts. This range notably exceeds that seen in the recent host basaltic andesite whole rocks, ($<$ 0.705737, Gertisser and Keller, 2003). Often zones with the highest An content also have the highest $^{87}Sr/^{86}Sr$ values, indicative of a Ca-rich high radiogenic Sr contaminant. In turn, recent Merapi deposits contain numerous xenoliths of metamorphosed

limestone (calc-silicates) with $^{87}Sr/^{86}Sr$ values of 0.7058421-0.7078656 ($\pm$ 0.00002). Coupled with the $^{87}Sr/^{86}Sr$ ratios observed in the crystal zones of plagioclase crystals, these inclusions suggest that magma crust interaction, previously regarded as a minor process at Merapi, may be far more significant and may pose consequences for eruptive behaviour, mass-balance calculations, and hazard assessment.