U-series histories of magmatic volatile phases and enclave development at Soufrière Hills Volcano, Montserrat

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Injection of volatile-rich mafic magma prior to an eruption may trigger episodes of volcanism and can act to transfer metals from depth. During these events, the injected mafic magmas commonly cool and crystallize, host magmas may be heated and mass may be complexly exchanged [1]. The study of mafic enclaves dispersed within felsic lavas can provide insights into the nature and timing of this interaction. Towards this end, we present major element, trace element, and $^{234.238}$U-^{230}Th-^{226}Ra-^{210}Pb isotope data across the interface of two mafic enclaves in contact with their host andesite from the last major eruption at Soufrière Hills Volcano (SHV), Montserrat. The enclave magmas were likely generated within a few thousand years before the eruption based on excesses of ^{226}Ra over ^{230}Th when they erupted. The enclaves also had ^{210}Pb excesses over ^{226}Ra when they erupted, consistent with a magmatic volatile phase input to the enclave magma within a few decades before eruption. Samples of the andesitic host, however, which make up the bulk of the eruptive products, have $(^{210}Pb/^{226}Ra)_0$ equilibrium or have small ^{210}Pb-deficits and have compositions like other SHV andesites [2]. Incompatible trace elements are enriched in the andesite immediately adjacent to the enclave, suggesting that melt was expelled from the enclave into this andesite. This includes Cu, although overall, Cu acts as a compatible element in this system as shown by the higher Cu concentrations in enclaves than in the andesites. Cl concentrations have been shown to decrease with increasing differentiation in this system [3]. Both of these observations can be explained by loss of a metal-carrying magmatic volatile phase during differentiation of magmas feeding the SHV. Our data support a role for magma influx during periods of unrest, but long-term accumulation of the andesite.

[1] Plail et al., 2014, Geol. Soc. London, Spec. Pub., 410, 343-360. [2] McGee et al., 2019, Earth Planet. Sci. Lett., 524, 115730. [3] Edmonds et al., 2014, Geol. Soc. London, Spec. Pub., 410, 95-121.