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Role of mafic enclaves at the Soufriere Hills volcano, Montserrat

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The presence of mafic enclaves in igneous rocks is well documented in andesitic to rhyolitic lava domes, as well as in the plutonic record. Assuming that all rock types are demonstrably comagmatic, the study of multiple texturally and compositionally diverse enclaves in a single host lava is of clear importance to 1) determine the parental magma which provides heat to the silicic body and 2) to distinguish different recharge events. For this study, we collect of suite of mafic enclaves, erupted 1996 – 2006, hosted by andesite at the Soufriere Hills volcano. We use field evidence, mineral compositions, whole rock composition and textural evidence to characterize the enclaves and model their formation. All enclaves are microphenocryst rich basaltic to basaltic – andesite in composition and divide into three groups. Type 1 is distinguished by a thick rind and comprises xenocrysts with framework minerals of plagioclase and pyroxene. Type 2 is distinguished by an angular margin and comprises phenocrysts of tschermakite and high Ca plagioclase with framework minerals of plagioclase and amphibole. Type 3 has an angular margin and comprises phenocrysts of magnesiohornblende and high Ca plagioclase with framework minerals of plagioclase and pyroxene. Type 1 and Type 2 chemically overlap in major, trace and REE elements. Type 3 overlaps with T1 and T2 in major elements, but is enriched in Y and REE relative T1, T2 and the host andesite. U shaped earth element profiles indicate the involvement of amphibole in the differentiation of all three types of enclaves. Negligible Eu anomalies indicate minor plagioclase involvement in differentiation of the T1 and T2 enclave, whereas a sharp negative anomaly for T3 indicates a strong involvement of plagioclase. We interpret the T1 and T2 enclaves as the same magma and the T3 as from the same parental source but having undergone a different fractionation history. We model the intrusion of a wet aphyric basaltic magma into the base of an andesitic reservoir. The T1 enclave forms as a lower density portion of the magma, degasses, rises and stalls at conditions where pyroxene is stable. The T2 encalve is remobilized by the intrusion from the lower portions of the magma chamber where amphibole has been crystallizing. The T3 enclave is also remobilized at the time of intrusion but has been stored in a more shallow portion of the magma reservoir.