Geophysical Research Abstracts
Vol. 17, EGU2015-11291, 2015
EGU General Assembly 2015

A case study of the Streitishvarf composite dyke: Implications for magma mixing and mingling in Iceland

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We present a study carried out on the 10.7($\pm$0.2) My old Streitishvarf composite dyke in East Iceland. The 26m wide dyke features eastern (5.5 m-thick) and western (4.5 m-thick) dolerite margins and a 7.5 m thick felsic core, separated by distinct hybrid zones (3 m-thick). The dyke margins exhibits the most primitive composition: 50.7 % SiO_2, 6.1 % MgO, 12.4 % FeOt and 0.4% K_2O. It is a dolerite containing <10 modal% of plagioclase and clinopyroxene phenocrysts in a sub-ophitic groundmass of plagioclase, clinopyroxene, magnetite and interstitial (late) glass. The inner dolerite has a basaltic icelandite composition and contains resorbed quartz xenocrysts suggesting that it has been modified by mixing between the dolerite of the dyke margins and silicic magma represented by the core of the dyke. The felsic core contains <15 modal% of anhedral phenocrysts of sanidine and quartz, which commonly feature embayments, and sit in a holocrystalline groundmass of quartz and feldspar. In terms of composition the rhyolite is borderline sub-calcic (i.e. transitional) with 73-76 % SiO_2, 0.1-0.5 % MgO and 0.13-0.38 % TiO_2. It contains 10-15 modal% of up to 30 cm-long enclaves with icelandite composition. The enclaves often exhibit chilled margins. This mingling of basalt and rhyolite melts took place before dyke injection and did not modify the composition of the host rhyolite to any degree. The hybrid zones contain variable amounts of inversely zoned and embayed macrocrysts of oligoclase-andesine plagioclases and quartz sitting in mottled and devitrified groundmass. The outermost part of the hybrid zone is icelandite with 61.5 % SiO_2 and 3.6 % MgO. Inward it becomes progressively more silicic, where the innermost zone is dacite with 67.6 % SiO_2 and 1.87 % MgO. The end members and the hybrid zones define a linear geochemical trends indicating that the hybrid zones were produced by mixing of the end-member composition. Hence the formation of the hybrid zone is best described as a sequential in situ mixing, starting with the basalt and rhyolite end-member compositions to form the basaltic icelandite. This was followed by mixing of the newly formed hybrid with the silicic core; a process that was repeated in succession making each segment of mixed magma more silicic with time.

The implication of these observations is that production of icelandite by mixing of basalt and rhyolite magmas is confined to segments of flow-induced shear and is an energy consuming process. The Streitishvarf composite dyke provides a snapshot of a system in which basic and silicic magmas were mingling and mixing and thus provides an insight into processes operating immediately before silicic eruptions in Iceland.