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Modeling the crystallization and emplacement conditions of a basaltic trachyandesitic sill at Mt. Etna volcano

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This study documents the compositional variations of phenocrysts from a basaltic trachyandesitic sill emplaced in the Valle del Bove at Mt. Etna volcano (Sicily, Italy). The physicochemical conditions driving the crystallization and emplacement conditions of the sill magma have been reconstructed by barometers, oxygen barometers, thermometers and hygrometers based on clinopyroxene, feldspar (plagioclase and K-feldspar) and titanomagnetite. Clinopyroxene is the liquidus phase, recording decompression and cooling paths decreasing from 200 to 0.1 MPa and from 1050 to 940 ˚C, respectively. Plagioclase and K-feldspar cosaturate the melt in a lower temperature interval of 870-1006 ˚C. Cation exchanges in clinopyroxene (Mg-Fe) and feldspar (Ca-Na) indicate that magma ascent is accompanied by progressive H_2O exsolution (up to $\sim$2.2 wt.%) under more oxidizing conditions (up to ΔNNO+0.5). Geospeedometric constraints provided by Ti–Al–Mg cation redistributions in titanomagnetite indicate that the travel time (up to 23 h) and accent velocity of magma (up to 0.78 m/s) are consistent with those measured for other eruptions at Mt. Etna volcano. These kinetic effects are addressed to a degassing-induced undercooling path caused principally by H_2O loss at shallow crustal conditions. REE modeling based on the lattice strain theory support the hypothesis that the sill magma formed from primitive basaltic compositions after clinopyroxene ($\leq$41%) and plagioclase ($\leq$12%) fractionation. Early formation of clinopyroxene at depth is the main controlling factor for the REE signature of basaltic products, whereas subsequent degassing at low pressure conditions enlarges the stability field of plagioclase, causing trace element enrichments in the more evolved trachyandesitic eruptions.