Experimental constraints on the storage conditions and evolution of alkaline lavas at Erebus volcano, Antarctica: A case for CO_2-dominated volcanism

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We present new phase equilibria experiments on natural basanite and phonotephrite lavas, which elucidate the magma evolution and storage conditions beneath Erebus volcano, Antarctica with respect to H_2O and CO_2 contents, pressure, temperature, and crystallisation process occurring in the crust. Despite its remote location, Erebus volcano on Ross Island, Antarctica is very well monitored. It has an active phonolite lava lake, two complete compositional lineages of silica-undersaturated alkalic lavas, and a remarkably stable volcanic behaviour. Thanks to these features, Erebus is a wonderful natural laboratory to understand volcanic degassing trends, lava lake dynamics and shallow magmatic processes, and eruptive behaviour. The deep magma plumbing system, however, is not well known due to a lack of relevant experimental data for Erebus's silica-undersaturated basanite, phonotephrite, tephriphonolite, and phonolite lavas. The resulting glasses from experiments reported here span the compositional range from basanite to phonolite and track the compositional evolution of Erebus magmas at various stages in the crust. In addition, our results reveal how very minor changes in the initial conditions of the same parent basanite melt can evolve into the two separate lava lineages observed on Ross Island. Experiments were performed in internally heated pressure vessels (IHPVs) between 1000-1150 ℃ and 200-400 MPa at NNO+1, with XH_2O of the H_2O-CO_2 fluid varying between 0-1. Fe-Ti spinel is on the liquidus for both compositions, the growth of which is likely facilitated by the oxidizing experimental conditions. In the basanite, spinel is followed by olivine and clinopyroxene. In the phonotephrite, the first silicate phase is kaersutite (even for H_2O-poor conditions). Only in the most CO_2-rich experiments (XH_2O approaching 0) could the natural phase assemblages be reproduced. Our results, when combined with those from recent volatile solubility, melt inclusion, and in-situ gas measurement studies, make a strong case for volcanic processes at Erebus volcano and the surrounding volcanic centres being strongly influenced by the storage and exsolution of mantle-sourced carbon.