EGU2020-8591
https://doi.org/10.5194/egusphere-egu2020-8591
EGU General Assembly 2020

Petrology of the April 2015 eruption of Calbuco volcano, southern Chile

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Understanding the origin of intermediate magmas that commonly erupt from subduction zone volcanoes is important to better constrain the mechanisms of continental crust formation. We carried out a detailed mineralogical and petrological study of the eruptive products from the last eruption of Calbuco volcano, Chile. In April 2015, Calbuco produced a 3 phase sub-Plinian eruption with pyroclastic fallouts and flows of andesitic composition. Rocks from Calbuco are made up of a glass phase and a high but variable proportion of minerals dominated by plagioclase, clinopyroxene, orthopyroxene and minor olivine, amphibole and magnetite. Plagioclase is very strongly zoned with highly anorthitic cores surrounded by more albitic rims. Based on thermodynamic calculations and using published experimental data, we estimate that the anorthitic cores crystallized from a basaltic andesite containing 3.5-4.5 wt.% H_2O. Using geochemical modelling, we also estimate that the bulk-rock major and trace element variability of Calbuco is best explained by accumulation of minerals in proportion plagioclase/pyroxene 72/28 in a dacitic melt. Such minerals most likely formed in the crystal mush zone of a magma chamber which, according to pyroxene and amphibole compositions, may have formed at a pressure of 2-3 kbar, corresponding to a depth of 8-11 km. A few weeks to months before the eruption, the crystal mush disaggregated, perhaps due to magmatic underplating, and a crystal-bearing dacitic melt moved upwards into a sub-surface storage region where the anorthite-poor rims formed. The 2015 eruption was probably internally triggered by over-pressurization in the shallow magma chamber.