Geophysical Research Abstracts
Vol. 16, EGU2014-4898, 2014
EGU General Assembly 2014

Bulk rock and melt inclusion analyses indicate bimodal distribution in Calbuco volcano (Chile)

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Calbuco is an active stratovolcano situated in the central SVZ (Southern Volcanic Zone) of the Andes at 41.2°S. The dominant rock-type is basaltic andesite containing macrocrysts of plagioclase (An57-91), olivine (Fo60-81), clinopyroxene (Mg# 74-85), orthopyroxene (Mg# 66-75) and rare amphibole (mostly pargasitic) in a microcrystalline matrix. Orthopyroxene frequently occurs as a reaction rim surrounding olivine suggestive of a peritectic reaction. The oldest lava unit (Calbuco 1) contains basaltic andesites that are notably lower in MgO and higher in $Al2O_3$ than the other samples. Some dacitic compositions have also been identified. Bulk rock analyses define a low-K calc-alkaline trend with however two basalts plotting in the tholeiite field in the AFM diagram. Bulk rocks display a differentiation trend of decreasing CaO, FeOt and MgO and increasing K2O and P2O5 with increasing SiO_2. Typical negative anomalies in Nb, Ta and Th are shown in spiderdiagrams whereas there is no Eu anomaly in REE patterns. In variation diagrams, a clear compositional gap occurs between 61 and 65 wt. % SiO_2. Investigation of melt inclusions was performed on homogenized and naturally quenched inclusions hosted in olivine and clinopyroxene crystals. Their composition mimics the differentiation trend observed in the bulk samples, including a bimodal distribution. The melt inclusions analyzed in olivine range in composition from 45 to 58 wt. % SiO_2 whereas those occurring in clinopyroxene range from 70 and 76 wt. % SiO_2. The compositional gap of the melt inclusions thus overlaps that of the whole rocks. The observed differentiation trend from basalt to basaltic andesite (49 to 58 wt. % SiO_2) perfectly fits published experimental trends acquired on hydrous basalts at different crustal pressures, water concentrations and oxygen fugacities at subduction zones and can be accounted for by a fractional crystallization process where a bulk cumulate made of plagioclase, olivine, clinopyroxene and magnetite of intermediate compositions is subtracted from the least differentiated basaltic andesite to drive the melt composition up to 58 wt. % SiO_2. The origin of the compositional gap (immiscibility, density filter, rapid evolution of the liquid composition at intermediate SiO_2 contents, critical crystallinity) at Calbuco has still to be resolved.