Magma storage conditions and processes at Calbuco volcano (Central Southern Volcanic Zone, Chile)

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Despite the hazardous character of Calbuco stratovolcano, evidenced by the April 2015 eruption, its differentiation processes have not yet been investigated in detail. A series of 155 samples were collected in the different units of the volcano and analyzed for mineral and bulk rock composition. The macrocrysts are usually abundant (26-47 %) and comprise olivine (Fo_{56-88}) usually with a peritectical reaction rim of orthopyroxene, plagioclase (An_{43-94}), clinopyroxene (Mg#59-81), orthopyroxene (Mg#52-75), amphibole (Mg#59-75) locally with a dehydration rim due to decompression and titanomagnetite with rare exsolution lamellae of ilmenite.

In a TAS diagram, the samples range from basalts to andesites with a marked predominance of basaltic andesites. The differentiation trend is mainly calc-alkaline except for the basalts that plot in the tholeiitic field. In variation diagrams, CaO, MgO, FeO_t, Sc, Ni decrease with increasing SiO_2 whereas K_2O, Rb, Zr increase. A few samples are significantly lower in MgO and FeO and higher in Al_2O_3 and CaO (Low-MgO samples) than the samples of the main differentiation trend (High-MgO samples). This is interpreted as resulting from a higher degree of plagioclase accumulation in the former. Chondrite-normalized spiderdiagrams show enrichment in LILE and negative anomalies in Nb-Ta.

The combination of compatible and incompatible elements in appropriate equations shows that fractional crystallization is the dominant differentiation process. A three steps least square regression model indicates that the most evolved andesitic composition is reached after 43 % crystallization. Several geothermobarometers and the plagioclase hygrometer respectively constrain the depth of the main magma storage at 3-4 kb and the H_2O content of 3-4 wt.%. This high water content is supported by the appearance of amphibole as a liquidus phase after about 40 % fractionation.