Geochemistry of the Chaltén Plutonic Complex (Patagonia) mafic rocks and the influence of accessory minerals on trace element signature of arc magmas

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Several studies have shown that the trace elements signature of arc magmas is conditioned by the terrigenous material introduced into the mantle wedge during sediment subduction and subduction erosion. Like arc magmas, this terrigenous material is extremely rich in lithophile elements relative to mantle rocks. The way how these lithophile elements are transferred to the mantle wedge had been traditionally modelled considering the physical features of elements, such as ionic ratio and charge, resulting in a different behaviour (incompatibility and mobility) for each group of elements (e.g. LILE and HFSE) during the dehydration and melting processes that occur in the subduction zone. However, during the last decade, different authors have emphasized the importance of accessory minerals in the petrogenesis of arc magmas (e.g. Hermann and Rubatto 2009). The crustal rocks and sediments contain accessory minerals capable of capturing elements such as REE, U, Th, Zr, Hf, among others. For example, monazite usually has high Th and U concentrations; zircon has high concentration of Zr and Hf; garnet and titanite concentrate medium to heavy rare earth elements (MREE and HREE), while allanite concentrates light REE (LREE) and Th. In continental subduction zones, during the dehydration and melting of the oceanic crust and the overlying sediments, these minerals could remain as residual phases after the melting of terrigenous material, retaining the mentioned elements. Therefore, the trace element signature of terrigenous material could not be completely transmitted to the mantle wedge and arc magmas.

We analyse next the geochemical data from a mafic unit belonging to the Chaltén Plutonic Complex (CHPC), located at the Chile-Argentina border in Patagonia formed in a context of fast subduction and high subduction erosion rates during the Miocene in the Austral Andes (Ramírez de Arellano et al. 2012). Within this complex, the Laguna Sucia mafic group ($\gamma 1$ series), unlike the others units, shows a marked depletion in U, Th, Zr and Hf, and a flat LREE pattern.

Trace element ratios such as Th/La, which is typically inherited from subducted sediments (Plank 2005) does not correlate with any of the trench sediments, nor the forearc units. Therefore, we argue that the trace element signature of these rocks is not inherited from the continental crust. The degree of differentiation and the isotopic composition of these rocks indicate that only little assimilation occurred. Moreover, fractional crystallization modelling shows that there are no phases capable to generate such anomalies (Bustamante 2017). Considering these results, we argue that the U, Th, Zr and Hf anomalies observed in the analysed samples can be attributed only to processes occurred during the contamination of the mantle wedge with a subduction component generated by the partial melting of eroded crust.

Hence, trace element signature of arc magmas is influenced by the accessory minerals contained in terrigenous material, depending on whether they are melted or not. Petrography (optical microscopy and back scattered images), EDS and X ray diffraction analyses indicate the presence of zircon, Zr-oxides, monazite and large volume of garnet in rocks from the forearc region (metamorphic complexes and Patagonian Batholith), supporting this hypothesis.

Unlike the Laguna Sucia mafic group (γ1 series), the rest of the CPCH mafic units, which do not exhibit strong U, Th, Zr and Hf negatives anomalies, represents situations in which zircon has been melted instead of remaining as residual phases after melting of terrigenous material. Thus, the melting of subducted terrigenous material (sediment or eroded crust) occurs at temperatures around of the zircon equilibrium condition (800-900°C; Watson and Harrison 1983). This is consistent with the sediment melting model proposed by Behn et al. (2011), where terrigenous material is detached from the slab and rise, forming diapirs and reaching higher temperatures in the mantle wedge.

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