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Tracking crustal contamination in arc batholiths: the Adamello case study

MANUEL PIMENTA SILVA[1], ANDREA GIULIANI[1], PROF. URS SCHALTEGGER, PHD[2], BLAIR SCHOENE[3], PETER ULMER[1] AND OTHMAR MÜNTENER[4]

[1]ETH Zürich
[2]University of Geneva
[3]Princeton University
[4]University of Lausanne

Presenting Author: manuel.dossantos@erdw.ethz.ch

The build-up of magmatic systems in continental arcs is accompanied by interactions between magma and various crustal reservoirs, modulating the geochemical and isotopic composition of the newly formed crust. To gain new insights into such interaction processes, we analysed bulk and in-situ isotopic systems in samples previously characterised by U-Pb dating on zircon (LA-ICP-MS and CA-ID-TIMS) and εHf [1,2,3] in the 42-30 Ma Adamello batholith (Northern Italy), the largest Tertiary magmatic complex in the Alps. We measured in-situ plagioclase Sr isotopes (LA-MC-ICP-MS) in samples from the first 1 Myr of magmatic activity [1,2] and bulk Sr-Nd isotopic ratios (TIMS) in samples covering the 12 Myr of igneous crystallisation of the batholith [3].

We performed Sr-Nd isotope binary mixing models between mantle-derived magma and a metapelitic contaminant representative of the Southern Alpine Basement. This model shows that the isotopic evolution of the Adamello batholith can be explained by increasing metapelitic contamination over time, which is consistent with previous studies [3,4]. We identify a decrease in contamination at the end of the batholith lifetime, which was previously not possible due to the higher uncertainty of in-situ zircon Hf isotope analysis.

Our in-situ Sr isotope data in plagioclase from felsic units show similar $^{87}Sr/^{86}Sr$ ratios for anorthite contents ranging from 20 to 90, indicating that crustal contamination preceded significant differentiation. This is further substantiated by compiled bulk rock SiO_2-$^{87}Sr/^{86}Sr$ data supporting the hypothesis that there is no statistically significant increase in Sr isotopes (i.e., a crustal contamination proxy) with increasing differentiation. This indicates that crustal contamination predominantly occurs below the emplacement level of Adamello magmas, consistent with enthalpic constraints [e.g., 5].

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