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Magma evolution as seen through zircon geochemistry: an example from the Southern Adamello Batholith, N. Italy

C. Broderick (1), U. Schaltegger (1), A. Gerdes (2), D. Frick (3), D. Guenther (3), and P. Brack (4)

(1) University of Geneva, Earth Sciences, Geneva, Switzerland, (2) Goethe-University Frankfurt, Institute of Geosciences, Frankfurt, Germany, (3) ETH Zürich, D-CHAB, Lab of Inorg Chem, Zürich, Switzerland, (4) ETH Zürich, Earth Sciences, Zürich, Switzerland

Zircon is an ubiquitous accessory mineral often used for U-Pb geochronology but is also an important recorder of geochemical information. The trace element and isotopic characteristics of zircon yield potential for tracking changes in an evolving magma through time. With recent advances in U-Pb zircon geochronology, 10-100 ka to Ma timescales are observed for incremental pluton construction (Michel et al., 2008, Schaltegger et al., 2009). In observed 100 ka timescales of zircon crystallization, can zircon record the processes that produce trace element variations in a magma?

This study focuses on the Val Fredda Complex (VFC) in the southern tip of the 43 to 33 Ma Adamello batholith, N. Italy. The VFC displays complex relationships among mafic melts that were injected into solidifying felsic magmas. Single zircon crystals were dated using CA-ID-TIMS. With permil uncertainties on 206Pb/238U zircon dates, zircons reveal complexities within single populations. The mafic units crystallized potential autocrystic zircons over a duration of 100 - 150ka, whereas the felsic units record up to 200ka of zircon crystallization. In order to understand these complex zircon populations, we analyzed Hf isotopes and trace elements, on the same volume of zircon used for U-Pb dating, following the TIMS-TEA method (Schoene et al., 2010). This detailed zircon study will allow us to look at how magmas are evolving with time.

Hf isotopes of VFC mafic zircons reveal distinct εHf values between the three mafic units and their εHf values remain consistent through time, whereas the VFC felsic units record more complexity in their εHf values. We observe changes such as increasing and slight decreases in εHf with time which suggest different processes are occurring to produce the different felsic units. Trace element ratios in zircon reveal differences which allow us to make distinctions between felsic and mafic units (e.g. Th/U, (Lu/Gd)N, REEs).

The VFC records 200 ka of zircon crystallization and our data suggests that zircons do in fact reflect changes in isotopic and in trace element signatures on 100 ka timescales. Although we observe changes in our trace elements, the TIMS-TEA method provides an average of trace element concentrations from a zircon volume, dominated by more marginal growth zones. Therefore we will compare our data with in situ methods to determine how our trace element data compares with trace elements across zircon profiles.

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Michel et al., 2008, Geol. 36 : 459-462 ; Schaltegger et al., 2009, Earth Planet. Sci.Lett. 286: 208-218; Schoene et al., 2010, Geochim. Cosmochim. Acta 74, 7144-7159.