Tracing episodic magma accretion by zircon $^{18}O/^{16}O$ isotopes and U-Pb dating in the Adamello batholith, Italy

A. SKOPELITIS[1]*, I. BINDEMAN[2], A. ULIANOV[3], P. BRACK[4] AND U. SCHALTEGGER[1]

[1]University of Geneva, 1205 Geneva, Switzerland (*correspondence: Alexandra.Nowak@unige.ch)
[2]University of Oregon, OR 97403, USA
[3]University of Lausanne, 1015 Lausanne, Switzerland
[4]ETH, 8092 Zürich, Switzerland

Styles and timescales of batholith formation still remain a matter of debate. There is growing evidence that batholiths are not formed by a single ascent of magma but by accretion of multiple batches. In the latter case, are they derived from the same source or different ones, and do they suffer similar degrees of contamination?

In order to answer these questions, we study tonalites from the Adamello batholith (33-43 Ma) localized in the northern Italian Alps. Previous studies mainly based on cooling ages highlighted a younging of magmatic activity towards the north [1, 2, 3], which is confirmed by our new U-Pb zircon LA-ICP-MS dating. Isotopic compositions of both Sr and O indicated increased contribution from higher $\delta^{18}O$, more radiogenic supracrustal sources in the same direction [4]. We present new data from a $^{18}O/^{16}O$ isotope study on small quantities of freshest and refractory separates of quartz, amphibole, titanite and zircon, and best estimate $\delta^{18}O$ magma values [5]. The data confirm increasing crustal contamination towards the north indicated by elevated $\delta^{18}O$ values up to 7‰ in zircon. H isotope ratio is strongly negative (-97‰) for the amphibole in the most northerly sample suggesting an assimilation of hydrothermally-altered rocks or an assimilation of marine sediment. We will quantify the contamination by AFC modelling using geochemistry, whole rock and mineral isotopes. As a preliminary conclusion, the Adamello batholith was formed by different pulses over ca 10 m. y. coming from different in $\delta^{18}O$ magma reservoirs with contrasting oxygen isotope compositions, due to their different depth in a $^{18}O/^{16}O$ zoned crust.

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Melting of carbonaceous sediments in subduction zones

S. SKORA* AND J. BLUNDY

Dept of Earth Sciences, University of Bristol, BS8 1RJ, UK (*correspondence: Susanne.Skora@bristol.ac.uk, Jon.Blundy@bristol.ac.uk)

The terrestrial carbon cycle is of immense interest to geoscientists as it has important consequences for, inter alia, Earth's climate, diamond formation, carbonatite volcanism and mantle metasomatism. Subduction zones provide the major geotectonic settings where surficial carbon can enter the Earth, and potentially return via arc volcanism. To date, experimental phase equilibria studies as well as thermodynamic calculations suggest that carbonates behave in a refractory manner under most subduction zone conditions in the slab. This stands in contrast to observations from nature, namely that CO_2 is released in arc volcanoes. Stable isotopic characteristics further suggest that most arc carbon is sediment-derived.

The suggested limited release of CO_2 at sub-arc depths, either by melting or by decarbonation, poses a great challenge to explain the high arc-flux of CO_2. This study aims to test the hypothesis that calcareous lithologies melt more readily at sub-arc conditions in the presence of external water, similarly to the melting behaviour of non-calcareous lithologies.

Two different calcareous lithologies were picked from the southern Lesser Antilles arc – one containing approx. 5% and one with approx. 35% carbonate. Initial experiments at 900°C, 3 GPa, 10% added water have yielded very high degrees of silicate melts, despite the fact that previous experimental studies have placed the solidus at temperatures >900°C at 3 GPa (fluid-absent conditions). This suggests that the fluid-saturated solidus in carbonaceous sediments has not been adequately constrained by the available fluid-absent experiments. In addition to glass, experimental run products contain either garnet + phengite + rutile + carbonate (5% carbonate lithology) or zoisite + quartz + rutile + carbonate (35% carbonate lithology). We will further investigate under which conditions CO_2 can be transported into the overlying mantle wedge.