Rapid formation and exhumation of eclogites in the Eastern Alps

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High-pressure metamorphic rocks are a ubiquitous feature of Phanerozoic tectonics, yet the mechanisms by which the terranes are exhumed from mantle depths at rates sufficient to preserve high *P*–low *T* assemblages are not understood [1].

Despite the Eastern Alps being one of Earth's best studied orogens, the age and evolution of its *HP* units are poorly constrained. The Tauern Window eclogites (south-central Austria) are exposed as a 2 km thick tectonic sliver (the Eclogite Zone), between the European crystalline basement complex and an incomplete ophiolite suite. Eclogite Zone metasediments and *senso stricto* eclogites experienced peak metamorphism between 20-25 kbar and 550-600 °C prior to a regionally penetrative greenschist facies overprint at 7 kbar and 500-570 °C.

We present results of a combined thermobarometric and U–Pb geochronological study of an allanite-bearing, eclogite facies metapelite collected from the central Eclogite Zone. Pseudosection modeling in the MnNCKFMASHO system provides prograde and retrograde constraints on the evolution of the observed *HP* garnet-chloritoid-kyanite assemblage. REE spectra from zoned allanitic-epidotes, observed as both a matrix and inclusion phase within garnet, exhibit a LREE-enriched profile and lack a significant Eu anomaly. Together, these data suggest that allanite grew on the subduction related prograde *P-T* path, prior to garnet growth. Allanite grains were dated *in situ* via LA-ICP-MC-MS and ID-TIMS by laser-milled extraction of individual grains. An ID-TIMS crystallisation age of 34 ± 3 Ma, combined with pre-existing multi-mineral Rb-Sr geochronology [2], shows that *HP* metamorphism in the Eastern Alps was short-lived – approximately 3 Ma in duration. These data confirm that exhumation of the Eclogite Zone occurred at plate tectonic rates and provide a first order constraint on Alpine tectonics.

[1] Ernst (2006) *Lithos* **92**(3–4), 321–335 [2] Glodny, Ring, Kühn, Gleissner & Franz (2005) *Contributions to Mineralogy & Petrology* **149**, 699–712.

Ce speciation in silicate melts

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Speciation calculations using the standard-state free energies of the component oxides indicate that both Ce^{3+} and Ce^{4+} are possible melt species at terrestrial magmatic conditions. This is confirmed by the common occurrence of Ce anomalies in zircon, owing to the preferential uptake of Ce^{4+}. To quantify the speciation of Ce as a dissolved component, and better understand mineral-melt partitioning of this element, we are undertaking an experimental investigation of the speciation of Ce in silicate melts. A series of glasses ranging in composition from dacite to basalt were synthesized in a piston cylinder at 1 GPa and at 1 atm in a vertical tube furnace under varying temperature and fO_2. For experiments run at 1 atm fO_2 was controlled using gas-mixing. At 1 GPa fO_2 was internally buffered.

The Ce^{4+}/Ce^{3+} ratio in our experiments is determined by Ce $M_{4,5}$-edge X-ray absorption near-edge structure (XANES) spectroscopy collected in the region of 870 to 920 eV on the SGM beamline at the Canadian Light Source. Data reduction and background corrections to the spectra were done using standard techniques [1].

The collected $M_{4,5}$-edge XANES spectra show an increasing proportion of Ce^{4+} at higher fO_2 imposed during synthesis of the silicate glasses, with variation in Ce^{4+}/Ce^{3+} in agreement with theoretical expectations. We have also observed a significant dependence of the Ce^{4+}/Ce^{3+} ratio with melt composition, with a greater proportion of Ce^{4+} being stabilized with increasing melt polymerization. Experiments run at 1 GPa show a systematic shift to lower concentrations of Ce^{4+}, however, as these contained ~6 wt.% H_2O this can also be attributed to decreased melt polymerization. This has been attributed to structural controls within the melt and may account for the presence of Ce anomalies in some igneous systems where, from previous work [2], only Ce^{3+} would be expected. If partitioning behaviour is understood, this will allow for determination of fO_2 from phases with a stronger affinity for Ce^{4+} where the parent melt composition is known.

[1] Gunnarsson & Schönhammer (1983) *Phys. Rev. B* **28**, 4315–4341. [2] Schreiber *et al.* (1980) *Geochim. Cosmochim. Acta* **44**, 1599–1612.