A Late Ordovician U-Pb age for HP metamorphism of the Tromsdalstind eclogite in the Uppermost Allochthon of the Scandinavian Caledonides

FERNANDO CORFU[1], ERLING KROGH RAVNA[2] AND KÅRE KULLERUD[2]

[1] University of Oslo, Oslo, Norway (fernando.corfu@nhm.uio.no)
[2] University of Tromsø, Tromsø, Norway (erlingr@ibg.uit.no; Kare.Kullerud@ibg.uit.no)

High pressure (HP) rocks found at different tecto-nic levels of the Scandinavian Caledonides record different stages in a protracted history of aggregation and colli-sion. So far all know eclogite ages have fallen into two distinct groups: (1) the Late Cambrian Early Ordovician generation present in the Upper Allochthon (Seve Nappe Complex), and (2) the Late Silurian-Early Devonian suite of the Western Gneiss Region recor-ding the Scandian collision. Evidence from the Bergen Arcs (Middle Allochthon) for a third, Late Ordovician HP event remains controversial and is not supported by the most recent studies. In the present investigation we have now found firm evidence for a Late Ordovician metamorphic event within the Uppermost Allochthon, which is of exotic origin with respect to Baltica. The dated rocks are part of the Tromsdalstind complex, a very large 0.4 km^3 eclogite body with smaller satellites, all associated with a supracrustal succession. A U-Pb age of 493 +5/-2 Ma, provided by zircon in an eclogi-tized trondhjemitic gneiss within the large eclogite body, indicates an origin of these rocks in a Late Cambrian arc outboard of Baltica. Metamorphic zircons from an eclogite, on the other hand, define an age of 452 ± 2 Ma for the HP event. A slightly younger age of 450 ± 2 Ma age was measured for titanite in an amphibole bearing plagioclase pegmatite within the eclogite, whereas a 1-2 cm large rutile porphyroblast defines an age of 449 ± 2 Ma. Both the pegmatite and the rutile are associated with retrogression of the eclo-gite, thus, the whole process of eclogitization and subsequent exhumation spanned just a few million years. Matrix rutile in the eclogite and the gneiss yield ages in the range 440-420 Ma, similar to published Ar -Ar and Rb-Sr ages, probably reflecting resetting during the younger Scandian thrusting.

Constraints on gross mantle differentiation from perovskite-melt partitioning of trace elements

A. CORGNE AND B. J. WOOD

CETSEI, University of Bristol, United Kingdom (alexandre.corgne@bris.ac.uk; b.j.wood@bris.ac.uk)

During its early history of bombardment and core segregation, the Earth almost certainly underwent a period of extensive melting. Under such conditions, crystallisation of the deep mantle minerals $CaSiO_3$ perovskite, $MgSiO_3$ perovskite and (Mg,Fe)O magnesio-wüstite could have resulted in extensive differentiation of the bulk silicate Earth (BSE). This process would explain the primitive upper mantle (PUM) depletion in silica if large amounts of Si-rich perovskite were fractionated from the residual PUM. Experimental studies of trace element partitioning have however led to the conclusion that the amounts of perovskite crystallising during a magma ocean stage must be very small in order to match the PUM composition. These results were used to argue against the magma ocean theory by Ringwood et al. (1987). Because of the uncertainty in partition coefficients, however and the non-consideration of $CaSiO_3$ perovskite, the statement that only modest amounts of perovskite could fractionate has not been clearly demonstrated.

We reexamined this issue by performing partitioning experiments between perovskites and melt at pressures and temperatures relevant to the uppermost lower mantle using a multi-anvil apparatus. Our results show that the chondritic refractory lithophile element ratios of PUM could only be compatible with a surviving perovskitic layer less than 15% the BSE volume. If composed of 30% $CaSiO_3$ perovskite and 70% $MgSiO_3$ perovskite, such a reservoir could balance the Earth's heat budget together with the crust and the upper mantle. However, this reservoir cannot explain the Si and Nb depletion of the primitive upper mantle and the imbalance between BSE and the terrestrial Hf-Nd array. From the point of view of crystal chemistry, our results show that Al likely enters the Si-site of $MgSiO_3$ perovskite and that highly charged elements such as U^{4+} and Nb^{5+} enter $CaSiO_3$ perovskite with a different charge-balancing mechanisms from that arising in $MgSiO_3$ perovskite.

References

Ringwood A.E., Kato T. and Irifune T. (1987) *EOS, Trans. Amer. Geophys. Union* **68**, 1548.