Elemental distributions in zircons from diamondiferous UHPM rocks from the Greek Rhodope: A TOF-SIMS study

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The Rhodope Massif in N. Greece is a newly established ultrahigh-pressure metamorphic (UHPM) province in the world (Mposkos & Kostopoulos, 2001). Microscopic observations on zircons separated from a garnet gneiss revealed a simple zoned structure consisting of a somewhat rounded detrital core and a metamorphic overgrowth rim. Microdiamonds were identified only in the rim area.

We carried out a detailed TOF-SIMS study of both zircon domains and produced several elemental distribution maps (Chatzitheodoridis *et al*., 2005). The most prominent features are the distributions of Y, Yb and Li. Yttrium and Yb show high concentrations in the detrital core and low ones in the metamorphic rim. This is ascribed to zircon growth in the presence of garnet under UHP conditions. By contrast, Li shows the reverse distribution pattern being negligible in the core and enriched in the rim domain. This suggests a significant input of Li at subduction depths well in excess of 100 km. It is well established that phengite can host significant amounts of Li and that it is an important phase stable during subduction of crustal material to pressures up to 10 GPa. Since the peak PT conditions of the Rhodope UHP rocks have been estimated at 7 GPa / 1000°C, we favour the interpretation of phengite breakdown along its dehydration solidus during diamond formation. Sulphur, Cl and H distribution maps display high concentrations of these elements in the vicinity of diamonds strongly implying diamond precipitation from supercritical C-O-H-S-Cl fluids.

References

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Recycled oceanic crust and sediments control the Hf-Nd mantle array

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Hafnium and neodymium isotopes measured on ocean island basalts and mid-ocean ridges define a linear array, the “Mantle array” that passes above the Bulk Silicate Earth value (BSE). No convincing explanation of the origin of the discrepancy has yet been suggested. Patchett *et al* (EPSL, 2004) argue that with a slightly more radiogenic Hf isotopic composition for a similar Nd isotopic composition, the BSE value would lie in the OIB array. Alternatively, the mantle array could lie above BSE, suggesting that plume sources are different from primitive mantle: either lower mantle is not primitive or plumes do not sample lower mantle. In both cases, a reservoir with a low Hf isotopic ratio is required to balance the OIB-MORB mantle source. Continental crust, as compiled by Vervoort *et al*. (EPSL, 1999), is not a good candidate for this low Hf reservoir. As an alternative, kimberlites or a deep-mantle reservoir have been suggested, with important implications for mantle structure and dynamics. Here, we propose that the reservoir could be created by sedimentary processes.

We determined the average Hf isotopic composition of a representative section of old, altered Pacific oceanic crust and overlying oceanic sediments sampled during ODP Leg 185. The average basaltic crust composition is similar to that of present-day MORB while the average sediment composition falls in the field of Fe-Mn crusts and nodules with an elevated ε_{Hf} (+4.5) relative to ε_{Nd} (-6). We use these ε_{Hf} values combined with the average composition given by Su (2002) for average MORB, and Plank & Langmuir (Chem. Geol. 1998) for global subducted sediment (GLOSS) to evaluate the effect of recycling in the past of similar materials into the convecting mantle and its influence on the composition of the mantle. Over Earth history, such recycling had a marked effect on the mantle and would have shifted its composition towards higher Hf isotopic ratios. This process could explain the position of the mantle array above BSE. Using a Monte Carlo simulation of reasonable mixtures of sediment and basalt with surrounding mantle, we can reproduce the compositions of OIB and MORB and their position above BSE.

The high ε_{Hf} relative to ε_{Nd} typical of deep-sea sediments could have its complement in another sedimentary reservoir. We suggest it might be sand rich in heavy minerals which are present in large quantities along continental margins. Given that the “crustal array” of Vervoort is mainly based on fine grained sediments it might not be representative of the continental crust as a whole. The continental crust could contain a higher proportion of the coarser grained sediments with low ε_{Hf} than previously thought. The “crustal array” could therefore lie below the “mantle array” in ε_{Hf} versus ε_{Nd}, and a deep-seated mantle reservoir would not be necessary.