Growth of diamonds in subduction zones? Evidence from zoning of nitrogen defects

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The concentration and aggregation of nitrogen (N) has been used widely to constrain the thermal history of natural diamonds. However, some diamonds do not contain N defects (type II) and it is uncertain whether i) they originally contained N, which has subsequently been lost, or ii) the diamonds were free of N during growth. As part of a study of sub-lithospheric diamonds from Machado River, Brazil, we have discovered a very unusual diamond, with high N content 98% IaB core and a type II rim, which sheds light on this problem. We have obtained detailed N zoning profiles from a polished central slice of the diamond using synchrotron FTIR spectroscopy at SRS, UK. As the boundary beween the two zones is sharp, it is implied that the type II rim was deposited on a pre-existing crystal of type IaB diamond, and that the rim was N-free from the outset. The absence of N in the type II rim cannot be explained by loss of N during plastic deformation. We therefore suggest that the presence of plastic deformation texture in the rim, but not the core, results from the decreased resistance to deformation of N-free diamond. Implications for the role of different growth media on the incorporation of N in natural diamonds will be discussed.

An olivine inclusion (Fo 93.9) in the core indicates a peridotitic lithospheric origin, but as the majority of type II diamonds from this locality contain inclusions of sub-lithospheric origin (Bulanova *et al.*, Ext Abstracts 9th IKC, 2008), we assume that the rim of diamond P16 grew at a depth of at least 410 km. Therefore our interpretation of the different stages of growth of this diamond is that it grew in subducting material.

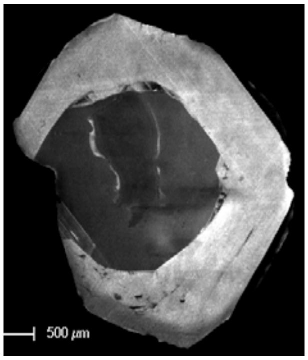

Figure 1. Cathodoluminescence image of diamond P16 showing a sharp transition between type IaB core and type II rim. Note the plastic deformation texture in rim only.

Fingerprinting sources of granitic rocks with Li isotopes

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Lithium isotope compositions are determined in a suite of granitic rocks (I-, S-, A- and S_s-type) and accompynying chemically less evolved gabbros and diorites from Western Carpathians, Slovakia, thought to have originated in the lower to middle crust. This study aims to constrain their origin and possible genetic relations. Two major granite suites (I, S) show reverse Li isotope systematics compared to that found for Australian granites [1,2]. The Carpathian I-type granites are on average isotopically lighter than the S-type granites and show little scatter consistent with a homogeneous meta-igneous source; the S-type granites on the other hand span more than 10‰ testifying to highly variable meta-sedimentary/igneous precursor rocks. Evolved, slightly mineralized (Sn, Mo, W) S_s-type granites provide evidence for lacking Li isotope fractionation during extensive magmatic fractionation. As yet uncharacterized A-type granites have systematically higher δ^7Li than the other granite types [1,2] or even the Earth's mantle [3,4]. We speculate that the sources of these anorogenic granites are affected by isotopically heavy fluids distributed from a subduction zone [5]. Eventually, mantle wedge itself enriched in δ^7Li by percolating fluids could have provided an important input to the later reactivated source of A-type granites. Alternatively, mafic mantle-derived melts generated through the magmatic underplating might have played a dominant role for Li isotope systematics. High Li abundances and uniformly light Li isotope signature of basic rocks (gabbros and diorites) require an initial loss of original Li, followed by a secondary addition of isotopically light Li by late-stage percolating fluids.

[1] Teng *et al.* (2004) *Geochim. Cosmochim. Acta* **68**, 4167; [2] Bryant *et al.* (2004) *Trans. Roy. Soc. Edinb. – Earth Sci.* **95**, 199; [3] Magna *et al.* (2006) *Earth Planet. Sci. Lett.* **243**, 336; [4] Seitz *et al.* (2007) *Earth Planet. Sci. Lett.* **260**, 582; [5] Bonin (2008) *J. Geosci.* **53**, 237