

## Fluids role in formation of microdiamonds from ultrahigh pressure metamorphic terranes

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### Methods and Results

Metamorphic microdiamonds are known within six orogenic belts related to Paleozoic continent-continent collisions [1]. Our studies with a synchrotron infra-red (IR) spectroscopy and a transmission electron microscopy show that the diamonds contain nanometric fluid and crystalline inclusions of varying compositions including K, P, S, Cl, Si, Al, Ca, Mg, Fe and O. In the Kokchetav massif, the diversity of Si-, Al- and Fe- oxide nano-inclusions in diamonds correlates with the bulk chemistry of their host rocks (quartz-feldspathic gneisses, quartzite), whereas Ca- and Ca-Mg- carbonate inclusions mostly occur in diamonds from marbles. The fluid inclusions of the Erzgebirge diamonds contain Mg and Ca, but more often Si, Al and Ti. Other elements such as K, P, S and Cl occur in all fluid inclusions we have observed in any metamorphic diamonds regardless of their locations. Presence of OH-stretching bonds of molecular H<sub>2</sub>O and CO<sub>3</sub><sup>2-</sup> radicals were confirmed by synchrotron IR spectroscopy in both Kokchetav and Erzgebirge diamonds. Most diamonds are skeletal; if they are cubes or octahedra, a resorption is observed on their faces. The resorption is due to aqueous fluid interaction with the diamond faces; this retrograded fluid triggers diamond transformation to graphite.

### Discussion

Diamond-forming medium was suggested to be an ultrapotassic melt [2], or carbon-rich silicate melt [3]. Our results indicate that the diamonds originate from a supercritical COH fluid of crustal origin. The enrichment of such a fluid with K, P, S and Cl has no direct connection to any ultra-potassic intrusions, or Si-melts, but it reflects high solubility of these elements in a COH fluid at high pressures. Later aqueous fluid promotes diamond-to-graphite reactions or/and causes the resorption of diamond crystals surface.

[1] Dobrzhinetskaya *et al.* (2007) *Proc. Natl. Acad. Sci. U. S. A.* **104**, 9128-9132. [2] Hwang *et al.* (2006) *EPSL* **243**, 94-106. [3] Massonne (2003) *EPSL* **216**, 347-364.

## Boron and Nitrogen in ultrahigh-pressure terrestrial rocks

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### Methods and Results

Nitrogen is a well known constituent of diamonds from both kimberlitic sources and ultrahigh-pressure metamorphic terranes related to continent-continent collisions. It was also described in ilmenite xenocrysts from African kimberlites. We have recently discovered nanometric inclusions of Boron Nitride and TiN – osbornite – in coesite associated with kyanite, FeTi alloy and OsIr alloy containing microdiamond inclusion; all are from massive chromitite of the mantle section of the Tibetan ophiolite. Both TiN and BN form bright-contrast particles in secondary-electron SEM images. Because EDS spectra of boron and nitrogen have severe overlaps with Ti L-lines, we have used EELS to confirm the presence of boron and nitrogen K-edges and to separate them from Ti L-lines. Electron diffraction data (TEM) identify the cubic boron nitride (c-BN) structure. TiN is stoichiometric (Ti=77.20wt%; N=22.80wt%) and has cubic symmetry, NaCl structure. NanoSIMS studies of osbornite show that its  $\delta^{15}\text{N} = -10.4 \pm 3 \text{‰}$ , what is a characteristic of mantle nitrogen known in many kimberlitic diamonds.

### Discussion

Because both nitrides are inclusions in coesite, high-PT conditions are required for their formation. We offer two hypotheses to explain their origin—astroblyme versus a mantle convection model. Astroblyme hypothesis is less favorable because there is not any evidence of impact microstructures in the host coesite and in the surrounding phases. We hypothesize that a small fragment of boron-rich Si-Al metasediments was subducted to mantle depth and due to mantle convection was brought to the middle-oceanic ridge to be trapped by chromitite at the bottom of lower horizons of the Tibetan ophiolite formation. This is unexpected occurrence for B-bearing metasediments.