The redox state of diamond-forming fluids: Constraints from Fe^{3+}/Fe^{2+} of garnets

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Inclusions in diamonds afford unique glimpses of deep lithospheric and asthenospheric minerals, allowing the thermal and chemical state of the mantle to be characterised. In the host diamonds, the concentration of N, $^{15}N/^{14}N$ and $^{13}C/^{12}C$ all give information about the origin of fluids in the mantle. The speciation in these fluids is uncertain in many cases, with considerable debate as to whether CH_4 or CO_2 is the predominant component in the transport of C [1,2]. As methane and carbon dioxide (or carbonate) represent reduced and oxidised C respectively, this redox signature should also be reflected in other mantle minerals.

Redox conditions of diamond-forming regions in the mantle can be found from the Fe^{3+}/Fe^{2+} ratio of garnets as determined by X-ray absorption near edge structure (XANES) spectroscopy [3]. We present Fe^{3+}/Fe^{2+} data for several suites of diamonds: Argyle, Western Australia; Juina, Brazil; Diavik, Canada; Udachnaya, Russia; Murowa, Zimbabwe. For the first three sets of diamonds, both eclogitic and peridotitic garnets were analysed, allowing the two distinct diamond-forming events to be contrasted.

For suites in which olivine and orthopyroxene coexist with garnet, the fO_2 of the diamondiferous paragenesis was calculated following [2].

Our work aims to couple the fO_2 information obtained from garnets to trace element data and (for the eclogitic samples) their oxygen isotope ratios, allowing the geochemical evolution of the slab during subduction to be robustly constrained.

[1] Thomassot *et al*. (2007) *EPSL* **257**, 362-371. [2] Stagno *et al*. (2013) *Nature* **493**, 84-88. [3] Berry *et al*. (2010) *Chem. Geol*. **278**, 31-37.

Patterning in stress: A new insight into the development of phase separation in metamorphic rocks

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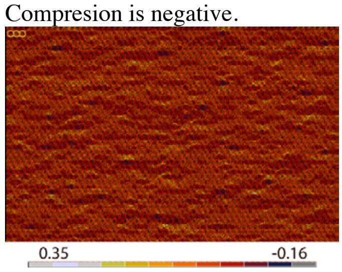
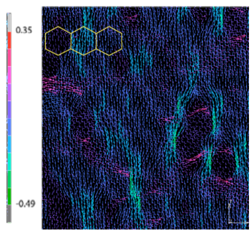
The development of slatey cleavage, foliation and compositional banding in metamorphic rocks is understood to result from mass transport by either dissolution or diffusion under the influence of a non-hydrostatic stress field. Explanations for how compositional differentiation initiates generally rely on high shear strains to orient pre-existing features or folding of a pre-existing foliation to form a pattern of fold noses and limbs that lead to preferential dissolution. Based on 2D plane-strain finite element models, I propose a new low-strain mechanism for the formation of compositional banding based on mass transport between local regions experiencing varying levels of differential stress caused by the variations in the single crystal elastic properties of the constituent minerals in the rock. Models were constructed of 2574 hexagonal grains each containing 48 elements. Grains were assigned elastic properties appropriate for crystals of quartz, feldspar and mica in a variety of crystallographic orientations. Compression results in local variations in the differential stress that are ~ 30% of the total load and a pattern minimum stresses that mimics foliation. This pattern could serve as a template for mass transport of the most mobile chemical components leading to phase separation.

Figure 1: Model is shortened by 0.2% vertically. The size of grains in each view is given by the yellow hexagons. Compresion is negative.



a) Pattern in minimum stress.



b) Direction and magnitude of minimum and maximum stress.

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