

## TRACE-ELEMENT PATTERNS OF DIAMOND: CLUES TO MANTLE PROCESSES

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### Abstract

Quantitative trace-element analyses of > 40 elements in diamonds have been carried out by LAM-ICPMS, using a multi-element doped-cellulose standard; detection limits range to low-ppb levels for many elements [1]. This new type of data offers new insights into metasomatic processes in the SCLM.

The trace-element patterns of polycrystalline (framesite, diamondite) and fibrous diamonds are consistent with crystallisation from kimberlitic-carbonatitic melts. However, some fibrous diamonds show an abrupt change in trace-element patterns as crystallisation proceeds. Contents of LREE, Sr and Ba decrease sharply, accompanied by decreases in Nb/Ta and Zr/Hf from chondritic to 0.1-0.01 x Chondrites. The fractionation of these pairs of geochemically similar elements is hard to explain by fractional crystallisation, because  $D(\text{solid/melt})$  for these elements are very similar. However, such fractionations can be the result of liquid immiscibility: a separation into broadly (?hydrous)-silicate and carbonatite fluids. The ubiquitous development of pronounced negative Y anomalies (relative to Ho-Dy) during the crystallisation of some fibrous diamonds may reflect the separation of fluoride phases or immiscible fluoride melts; microinclusions with positive Y ( $\pm\text{Yb}$ ) anomalies are observed during ablation of diamondites.

Nearly all monocrystalline diamonds show low LREE/HREE, Ba/MREE and Sr/MREE, as well as low Nb/Ta and Zr/Hf, suggesting that they have crystallised from the hydrous-silicate member of the proposed immiscible-liquid couple. Oscillatory zoning of composition in some diamonds suggests that both fluids were circulating in the system. Preliminary studies show little difference in the trace-element patterns of peridotitic and eclogitic diamonds from single localities. This implies limited interaction between the fluid(s) and wall rocks, which in turn suggests high fluid/rock ratios during diamond crystallisation. Further work is required to reconcile the model described here with the data from single-inclusion studies of fibrous diamonds, which suggest immiscibility between a hydrous fluid (brine) and a continuum of carbonatite-silicate melts. However, it is consistent with observations of carbonate-silicate immiscibility in melt inclusions trapped in Cr-diopside derived from ca 180 km beneath the Slave craton [2].

Modelling of the Mg-rich carbonatitic fluid that develops in the diamond-forming system shows it would have extremely high LREE/HREE, Ba and Sr; similar patterns are observed in secondary coats on monocrystalline diamonds from some localities. The reaction of this fractionated carbonatitic fluid with chromite + olivine + opx can produce subcalcic Cr-pyrope garnets with "sinuous" REE patterns and high Sr contents, which are a characteristic inclusion in diamonds of the peridotitic paragenesis [3]. We therefore suggest that the development of immiscibility during the evolution of methane-rich low-volume melts of the kimberlite-carbonatite spectrum produces conjugate fluids, one of which crystallises most monocrystalline diamonds, and the other of which interacts with mantle harzburgites to produce the most ubiquitous

inclusions in peridotitic diamonds. This model provides a genetic link between the diamonds and their most distinctive indicator minerals.

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