Major and trace element composition of diamond-forming fluids: what do they tell us?

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The metasomatic medium in which fibrous diamonds grew is usually preserved in the form of high-density fluids (HDFs) trapped in sub-micrometer inclusions. Major and trace elements, and the volatile content of these fluids sheds light on the mantle sources and processes which promote diamond genesis. The major-element compositions of the HDFs span two arrays: (a) between a high-Mg carbonatitic end-member and a saline one and (b) between a low-Mg carbonatitic and a hydrous silicic end-member [1]. All four end-members are rich in K. In line with this enrichment, all are highly enriched in incompatible elements compared to primitive mantle. Their REEs are fractionated with $La/Dy_{(PM\ normalized)}$ varying from 6 in the silicic HDFs to 430 in the saline compositions; Sr, Ti, Zr, Hf and Y show variable negative anomalies relative to the REEs. The highly incompatible elements, Cs – La, exhibit two patterns. One is mostly flat and has moderate decrease of concentrations with decreasing ionic radius (this pattern is designated "Bench"); the other (designated "Table") has elevated Ba, U, Th and LREE, depleted Nb and Ta and in most cases, highly depleted alkalis (K, Rb and Cs). Both patterns were found in HDFs of either major element arrays.

The appearance of similar trace elements patterns in fluids of such diverse major element compositions suggest that major and trace elements are decoupled and that they are controlled by different sources or processes. Based on the similarity of the major-element composition of the HDFs to experimental near-solidus melts of carbonated/hydrous peridotites and eclogites, we suggest that the source-rock for the high-Mg carbonatitic HDFs is peridotitic, while the one for the low-Mg carbonatitic to hydrous-silicic compositions is eclogitic. The clear array between the saline and the high-Mg carbonatitic compositions suggests the involvement of saline fluids in the generation of the high-Mg carbonatitic HDFs. Saline fluids may be the metasomatic agent that triggers the formation of the silicic to carbonatitic fluids in the eclogitic case. However, melting of carbonates or K-bearing phases in the source-rock or interaction of such sources with carbonatitic and potassic melts/fluids may also generate similar compositions. Either way, potassium and carbonate should be available during HDF generation.

The trace element abundance patterns of the high-Mg carbonatitic HDFs resemble those of kimberlites. The huge variation in Th/Nb and La/Nb in carbonatitic-silicic and carbonatitic-saline HDFs suggests the involvement of rutile or a similar phase during HDF evolution. Similar arguments, based on major and trace element patterns, may be made for the involvement of other phases, such as zircon, apatite, mica and carbonates. Rocks rich in the above phases are known from xenoliths in kimberlites (e.g., MARID, PIC and glimmerites) and in many cases show the complementary anomalies to the "Table" pattern. On a K/Rb vs Cs/Rb diagram, HDFs with "Table" patterns fall on or very close to an array forms by Rayleigh fractionation of phlogopite from a MARID-like melt. These features indicate the importance of phlogopite in the formation and evolution of diamond forming fluids.

[1] Weiss, Y. et al. (2009) *Lithos*, **112**, 660-674.