

## **Trace elements in Gem-Quality Diamonds – Origin and evolution of diamond-forming fluid inclusions**

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In the same way that melt inclusions in phenocrysts have expanded our idea of melt formation and evolution in basalts, studying fluids trapped in diamonds is providing important new constraints on the nature of diamond-forming fluids. Fibrous and cloudy diamonds trap a high but variable density of fluid inclusions and so have been extensively studied using major and trace element compositions. In contrast, constraining the nature of the diamond-forming fluid for high purity gem-quality diamonds has been restricted by the rarity of available high quality trace element data. This is due to the extremely low concentrations of impurities that gem diamonds contain – often in the ppt range. The recent discovery of fluids in gem diamonds showing similar major element chemistry to fluid-rich diamonds suggest that many diamonds may share a common spectrum of parental fluids. Here we test this idea further.

Recent advances in analytical techniques, in particular the development of the “off-line” laser ablation pre-concentration approach, have allowed fully quantitative trace element data to be recovered from “fluid-poor”, high quality gem diamonds. We present trace element data for gem diamonds from a variety of locations from Canada, S. Africa and Russia, containing either silicate or sulphide inclusions to examine possible paragenetic or genetic differences between fluids.

REE abundance in the “gem” diamonds vary from 0.1 to 0.0001 x chondrite. To a first order, we observe the same spectrum of trace element compositions in the gem diamonds as that seen in fluid-rich “fibrous” diamonds, supporting a common origin for the fluids. REE patterns range from extremely flat ( $Ce/Yb)_n \sim 2.5$  to 5 (commonly in sulphide-bearing diamonds) to  $>70$ , the latter having significantly greater inter-element HFSE/LILE fractionation. In general, the fluids from the sulphide-bearing diamonds are less REE-enriched than the silicate-bearing diamonds, but the ranges overlap significantly. The very large range in REE fractionation mimics very closely that produced in high pressure (5-6 GPa) experimental melts of  $CO_2$ - $H_2O$  fluxed peridotite. Hence, the elemental characteristics of the fluids could be reconciled by the diamonds growing from such melts over a range of T and hence F, with the sulphide-bearing diamonds generally being produced by larger fraction (higher T) melts that have reacted less with their wall rocks. It is also possible that the less REE enriched fluids are consistent with derivation from more reduced  $CH_4$ -bearing fluids that have lower solute capacity than oxidised fluids. This option is being evaluated.