Trace elements of rare CH_4-bearing fluids in Zimbabwe diamonds

KAREN V. SMIT[1], D. GRAHAM PEARSON[2], MANDY Y. KREBS[2,3], SARAH WOODLAND[2]

[1]Gemological Institute of America, 50 west 47th Street, New York City, 10036, NY, USA (ksmit@gia.edu).
[2]Arctic Resources Laboratory, University of Alberta, Edmonton, AB T6G 2E3, Canada.
[3]School of Earth and Sustainability, Northern Arizona University, Flagstaff, AZ 86011, USA.

Marange diamonds (Zimbabwe) contain both fluid-poor (gem-quality) and fluid-bearing growth zones with abundant CH_4. As such, they provide the unique opportunity to compare trace element compositions of CH_4-bearing diamonds with those of carbonatitic and saline high density fluid (HDF)-bearing diamonds (gem-quality and fibrous) to obtain an overview of mantle source fluids for diamond growth. HDF's in fibrous diamonds and some gem-quality diamonds have been linked to subduction of surficial material, consistent with the global link between diamond age and collisional tectonic events. Even though Marange diamonds have $+\delta^{15}N$ indicative of surficial recycling, they do not display the expected Eu or Sr anomalies.

Fibrous diamonds have the most fractionated REE patterns, with negligible HREE and high $(La/Yb)_N \approx 100$-10000. Gem-quality diamonds have highly variable $(La/Yb)_N$; the most unfractionated HDF's are in Victor and Cullinan diamonds with low $(La/Yb)_N$ <76. HDF's in Marange diamonds are intermediate between these two extremes, with $(La/Yb)_N = 23$-240. Differences in $(La/Yb)_N$ between different diamond suites relate either to varying initial compositions (where low $(La/Yb)_N$ reflects derivation during higher degrees of melting) or to the increasing interaction of HDF's in fibrous diamonds with mantle rocks during fluid infiltration.

Marange diamonds have rare +Ce anomalies, that have so far only been reported for Victor and Brazil (sub-lithospheric) gem-quality diamonds. The oxidation state of Ce (Ce^{4+} vs Ce^{3+}) and development of Ce anomalies could be attributed to fO_2, melt/fluid composition, and PT conditions. In Marange, Victor and Brazil diamonds, Ce^{4+} substitution for Zr^{4+} does not appear to be a factor since we find no correlation between Zr content and Ce anomalies. However, in Marange diamonds, CH_4-bearing zones have less variable Ce anomalies compared to the CH_4-free zones, which may suggest Ce anomalies are indicative of fluid oxidation state.