Inclusion and host studies of diamonds from Gahcho Kué

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Mineral inclusions within diamonds represent pristine and unaltered samples of mantle material that form before, during, and/or after diamond formation. Analysis of inclusions can inform on the chemistry, composition and processes experienced in the diamond window of the mantle beneath the Slave craton, whilst analysis of "host" diamonds can inform on the processes and conditions that led to the formation of the diamond. Eighty-eight diamonds from the Gahcho Kué mine in the Northwest Territories (Canada) had any extracted inclusions analysed by EMPA for major element chemistry, and in the case of the olivines extracted, they were also measured for their trace Al content. The trace element chemistry of associated garnets was analysed by LA-ICP-MS. The major data enable use of geothermobarometry to quantify pressure-temperature conditions in the diamond window beneath the Southern slave, and assessment of the extent of melt depletion within the mantle source, whilst trace element analyses provide information on metasomatic processes that have occurred within the mantle system. Host diamonds were analysed for their N content and aggregation state by FTIR spectroscopy, to help quantify the mantle residence conditions within the area.

The 171 mineral inclusions extracted indicate a largely peridotitic source for the diamonds (76%), with notable eclogitic (21%), and minor websteritic (3%) components. Data obtained from these inclusions are similar to other diamond-bearing localities within the Slave craton, albeit with higher Mg number olivines (89% between 92-94.5), suggesting a more depleted mantle source. Analysis also led to the observation of a new mineral; identified as the K-bearing form of loparite. Trace element patterns for peridotitic garnets show typical sinusoidal patterns (enriched $LREE_N$ with $MREE_N$-$HREE_N$-depletions), whilst eclogitic garnets are typical of worldwide patterns. Geothermometry conducted on co-existing olivine-garnet pairs using the Fe-Mg exchange thermometer, and the Al-in-Olivine thermometer suggest diamond formation in the ranges of 1180-1370^oC, and 1020-1160^oC, respectively. N contents range from 12 to 1416ppm, with aggregation states mainly in the IaAB state (78.4%), with few IaA (19.6%) and a single IaB (2%). Aggregation temperatures range from 821-1192^oC, with some samples showing positive and negative T discrepancies with included mineral thermometers (negative temperature differences are notably larger).

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