The Micro-/Macro-Diamond Relationship: A Case Study from the Artemisia Kimberlite (Northern Slave Craton, Canada)

Catherine N. Johnson*
University of Alberta, Edmonton, Alberta
cnj@ualberta.ca

and
Thomas Stachel
University of Alberta, Edmonton, Alberta

and
Karlis Muehlenbachs
University of Alberta, Edmonton, Alberta

and
John Armstrong
Stornoway Diamond Corp, Vancouver, British Columbia

The diamondiferous Artemisia kimberlite is a located within the Coronation Gulf region of Nunavut, Canada. Artemisia intrudes sediments of the Coronation Supergroup of the Bear structural province, located along the western margin of the Northern Slave Craton. A set of 961 micro- and macro-diamonds were made available for this study by Stornoway Diamond Corp.

This study investigates the geochemical signature of the diamond source beneath the Northern Slave Craton by determining the carbon stable isotopic composition and nitrogen characteristics of diamonds from the Artemisia kimberlite. Macro (>0.5mm) and micro (<0.5mm) diamond size populations were evaluated separately to clarify the nature of their genetic relationship.

Preliminary results of diamonds from Artemisia have shown that the carbon stable isotopic composition for the macro-diamond sample set (n=22) ranges between -0.2‰ and -11.1‰, with a mean of -4.9‰ and a median value of -4.8‰. The micro-diamond sample set (n=71) ranges between +1.6‰ and -9.2‰, with a mean of -3.8‰ and a median value of -3.8‰.

Slight variations in mean $\delta^{13}C$ exist when comparing sieve classes of the diamond samples. The micro-diamond sample set represents 5 sieve classes, whereby the mean $\delta^{13}C$ varies, from finest to coarsest, from -3.7‰ (0.212mm sieve class) to -4.1‰ (0.450mm sieve class). The median $\delta^{13}C$ values for the sieve classes vary from -3.4‰ (0.300mm sieve class) to -4.1‰ (0.450mm sieve class) The macro-diamond sample set analyzed thus far represents a single sieve class (0.600mm sieve), which has a mean $\delta^{13}C$ of -4.9‰.

Nitrogen is a common impurity in diamond. Its abundance depends upon the nitrogen concentration of the diamond forming fluid and its aggregation state on the temperature and time of the diamond's residence in the mantle. Preliminary results of the macro-diamond sample set (n=55) range in nitrogen abundance between 18 to 1849 at.ppm, with a mean value of 272 at. ppm. The aggregation states of the macro-diamond samples range between 2% to 100% nitrogen in the highly aggregated B-centre, with a mean value of 69%.The micro-diamond sample set (n=33) ranges in nitrogen abundance from 6 to 658 at. ppm, with a mean value of 160 at.ppm. The aggregation state of the micro-diamond set ranges between 11 and 100%B, with a mean value of 81%.

At Artemisia, it is observed that there is a broad range in $\delta^{13}C$ values for both the micro- and macro-diamond sample sets. There is slight variation in mean and median values between the

two size distinctions, whereby the micro-diamond sample set shifts to slightly heavier isotopic values. These variations, if found to be significant, could be attributed to distinct diamond forming fluids or diamond sources. At this stage, too few $\delta^{13}C$ analyzes have been completed on the macro-diamond sample set to fully constrain the variability and average carbon isotopic composition of this group. Nitrogen abundance and aggregation state for the micro-and macro-diamond sample sets both display wide variability and it cannot be concluded, at this stage, if observed differences are statistically significant.

Further analyses of carbon stable isotopic composition and nitrogen characteristics are currently being completed to clarify if the micro- and macro-diamond size populations at Artemisia kimberlite are genetically related.

Acknowledgments

We are grateful to Stornoway Diamond Corp. for providing the samples for this study. We thank John Craven and Richard Hinton from the University of Edinburgh Ion Micro-probe Facility (EIMF) for assistance with analyses and Richard Stern (University of Alberta) for help with sample preparation.