Diamond-destroying metasomatism under the central Slave craton: constraints from diamond morphology in Ekati mine, Northwest Territory, Canada

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Volatiles are important agents of mantle metasomatism, which control geophysical and geochemical properties of the mantle. Volatile-induced resorption features are documented on natural diamonds and produced in experiments. We investigated mantle-derived dissolution morphology on diamonds from kimberlite pipes in the central Slave craton in order to better understand the conditions of diamond-destroying metasomatism under the Slave craton. The study focused on finding a relationship between the diamond resorption morphology and the internal proerties of diamond crystals including the internal growth patterns revealed on cathodoluminescece images, carbon isotopic content ($\delta^{13}C$), N content and aggregation state. The study used of 82 octahedral diamonds selected from 603 stones from Grizzly, Misery, Leslie, and Koala kimberlites in Ekati Diamond Property, Canada. Zoning patterns on cathodoluminescence images helped to distinguish between growth and resorption for step-faced morphologies. Nitrogen content varies from 13 to 2128 ppm, and δ13C values analyzed range from −6.4 ‰ to −2.3 ‰, which accounts for -5‰ of the mantle C isotopic range. Nitrogen contents and aggregation state determined by infrared spectroscopy form two clusters: (1) total nitrogen above ~ 400 ppm and lower state of aggregation; and (2) total nitrogen < 1000 ppm and higher state of aggregation. The limited variability of C isotopic compositions for the diamonds analyzed cannot distinguish mantle derived from recycled crustal carbon or peridotitic from eclogitic diamond reservoirs. Correlations between diamond morphologies and nitrogen aggregation, however, are apparent. Comparison of our results with the existing experimental data on diamond dissolution at high pressure and with the published datasets of diamonds recovered from eclogitic and peridotitic xenoliths shows that, in the Slave craton, metasomatism in peridotite develops complex resorption features (CM-1) perhaps in the presence of CO_{2-} or carbonate rich media and step-faced (SM-2) diamonds in the presence of H_2O fluid; whereas metasomatic fluid in eclogite is likely H_2O-bearing.