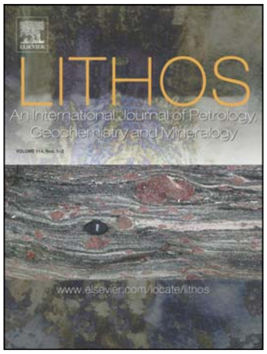

Diamond growth from C-H-N-O fluids in the lithosphere: evidence from CH4 micro-inclusions and 13C-15N-N content in Zimbabwe mixed-habit diamonds

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Diamond growth from C-H-N-O recycled fluids in the Zimbabwe lithosphere: evidence from CH_4 micro-inclusions and $\delta^{13}C$-$\delta^{15}N$-N content in Marange mixed-habit diamonds

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Abstract

Mixed-habit (octahdedral + cuboid) diamonds from the Marange alluvial deposits in the eastern Zimbabwe craton have high nitrogen and hydrogen content that provides an opportunity to evaluate diamond growth mechanisms and C-N-H-O bearing fluids in the lithospheric keel. Light grey cuboid sectors with hydrogen-containing defects, trap abundant dispersed CH_4 inclusions (Raman peaks at 2917 cm^{-1}) associated with graphite (Raman peaks at 1580 cm^{-1}). Clear octahedral sectors are richer in nitrogen and free of any such inclusions. Core to rim co-variations of $\delta^{13}C$-$\delta^{15}N$ and N content can be explained by a mixing trend between earlier fluids that are CH_4-rich and later fluids that are more CO_3- or CO_2-rich. Marange diamonds have limited overall $\delta^{13}C$ variation, but do show fractionation during growth towards higher $\delta^{13}C$ values. This trend can be explained by diamond precipitation from mixed CH_4 and CO_2 fluids, where isotopic fractionation occurs as the amount of fluid wanes. Calculated $\delta^{15}N$ values for diamond source fluids evolving in this manner are between +2.3 and +6.4 ‰. These N isotopic compositions require CH_4-rich and CO_3-/CO_2-rich 'end-member' fluids to have a recycled metasedimentary component perhaps introduced with subduction of eclogite.

Keywords: methane, diamond, non-redox growth, $\delta^{13}C$, $\delta^{15}N$, cratonic lithosphere, Zimbabwe