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Cratonic origin of Type Ib diamonds: age constraints from Re-Os analyses of sulphide inclusions

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Type Ib diamonds preserve nitrogen as single unaggregated atoms, known as C-centres. These C-centres are only rarely preserved in the lithospheric mantle ($<0.1\%$ of natural diamonds), as they require short mantle residency times of a few million years and/or cool storage temperatures below 850 ˚C (using isotherms for Ib-IaA aggregation of Taylor et al., 1996).

Sulphide-inclusion bearing Ib diamonds from the West African craton provide the opportunity to determine the age of these enigmatic diamonds for the first time, along with their mantle storage conditions. Major element and Re-Os analyses of these sulphide inclusions are ongoing. Age results will allow us to distinguish between two distinct origins for Type Ib diamonds from the West African craton:

1.) These are ‘old’ Archaean-Proterozoic diamonds that resided along an extremely cool geotherm. Crustal geophysical studies indicate that the West African craton has a low surface heat flow of 33 ± 8 mW/m^2 (Lesquer and Vasseur, 1992), compared to a ‘typical’ cratonic heat flow of around 40 mW/m^2. Major element analyses of clinopyroxene xenocrysts from Koidu are underway to determine a geotherm for this part of the West African craton. If it is as cool as the geophysical studies suggest, it could explain why this craton provides the optimal conditions for Type Ib diamond preservation. Along such a cool geotherm, diamonds would already become stable at temperatures around 650 ˚C and diamonds residing at these temperatures would preserve their C-centres.

2.) These are ‘young ‘diamonds that only resided in the lithosphere for a few million years. Diamond formation could predate or postdate magmatic activity of the Central Atlantic Magmatic Province (CAMP $\sim$200 Ma; Blackburn et al., 2013), which led to rifting of the West African craton from the Amazonia craton in South America and the ultimate opening of the Atlantic Ocean. Although these Ib diamonds are alluvial, most of the potential source kimberlites in this area are between 150 and 140 Ma. This would give these Ib diamonds a maximum mantle residency time of $\sim$50 Myr – perhaps sufficiently short to prohibit complete aggregation to A centres. Flood basalt magmatism and subsequent continental break-up are traditionally considered to be diamond-unfriendly processes. If these rare diamonds are indeed young and related to continental rifting, it will allow us to understand whether diamond-hosting portions of the mantle keel can survive rifting.

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