

Diamond growth beneath Letlhakane established by Re-Os and Sm-Nd systematics of individual eclogitic sulphide, garnet and clinopyroxene inclusions

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The diamondiferous Letlhakane kimberlites are part of the Orapa kimberlite cluster (~ 93.1 Ma) in north-eastern Botswana, located on the edge of the Zimbabwe Craton, close to the Proterozoic Magondi Mobile Belt. Here we report the first Re-Os ages of six individual eclogitic sulphide inclusions (3.0 to 35.7 μg) from Letlhakane diamonds along with their rhenium, osmium, iridium and platinum concentrations, and carbon isotope, nitrogen content and N-aggregation data from the corresponding growth zones of the host diamonds. For the first time, Re-Os data will be compared to Sm-Nd ages of individual eclogitic silicate inclusions recovered from the same diamonds using a Triton Plus equipped with four $10^{13}\Omega$ amplifiers.

The analysed inclusion set currently encompasses pairs of individual sulphides from two diamonds (LK040 sf4 & 5, LK113 sf1 & 2) and two sulphide inclusions from separate diamonds (LK048, LK362). Ongoing work will determine the Sm-Nd ages and element composition of multiple individual eclogitic garnets (LK113/LK362, n=4) and an eclogitic clinopyroxene (LK040) inclusion.

T_{MA} ages of the six sulphides range from 1.06 to 2.38 Ga (± 0.1 to 0.54 Ga) with Re and Os contents between 7 and 68 ppb and 0.03 and 0.3 ppb, respectively. The host diamond growth zones have low nitrogen abundances (21 to 43 ppm N) and high N-aggregation (53 to 90% IaB). Carbon isotope data suggests the involvement of crustal carbon ($\delta^{13}\text{C}$ between -19.3 to -22.7 ± 0.2 per mill) during diamond precipitation.

Cathodoluminescence imaging of central plates from LK040 and LK113 displays homogenous internal structure with no distinct zonation. The two sulphide inclusions from LK040 define an 'isochron' of 0.92 ± 0.23 Ga (2SD) with initial $^{187}\text{Os}/^{188}\text{Os} = 1.31 \pm 0.24$. Sulphides from LK113 have clear imposed diamond morphology and indicate diamond formation at 0.93 ± 0.36 Ga (2SD) with initial $^{187}\text{Os}/^{188}\text{Os} = 0.69 \pm 0.44$. The variation in the initial $^{187}\text{Os}/^{188}\text{Os}$ does not justify including these inclusions (or any from other diamonds) on the same isochron and implies an extremely heterogeneous diamond crystallisation environment that incorporated recycled Os. C1-normalized osmium, iridium and platinum (PGE) compositions from the analysed sulphide inclusions display enrichment in Ir (3.4 to 33) and Pt (2.3 to 28.1) in comparison to eclogitic xenolith data from Orapa that are depleted relative to chondrite.

The Re-Os isochrons determined in this study are within error of previously reported ages from the adjacent (~ 40 km) Orapa diamond mine (1.0 to 2.9 Ga) based on sulphide inclusions and a multi-point 990 ± 50 Ma (2SD) isochron for composite (n=730) silicate inclusions. Together with additional new Sm-Nd isochron age determinations from individual silicate inclusions from Letlhakane (2.3 ± 0.02 (n = 3); 1.0 ± 0.14 (n = 4) and 0.25 ± 0.04 Ga (n = 3), all 2SE) these data suggest a phase of Mesoproterozoic diamond formation as well as Neoproterozoic/Paleoproterozoic and Mesozoic diamond growth, in punctuated events spanning >2.0 Ga.