Episodic diamond formation beneath the Orapa and Letlhakane mines, Botswana

S. TIMMERMAN[1*], J. M. KOORNNEEF[1], I. L. CHINN[2] AND G. R. DAVIES[1]

[1]Vrije Universiteit, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands (*correspondence: suzette.timmerman@hotmail.com)

[2]De Beers, Private Bag X01, Southdale 2135, South Africa

Determining temporal variations in the nature and timing of diamond formation is an important step in understanding the workings of the Earth's deep carbon cycle. To this end we report the first successful TIMS Sm-Nd dating study of extremely small (2-110 μg) individual silicate inclusions from diamonds. The Nd and Sm isotope ratios were analysed using Faraday cup amplifiers equipped with new 10^{13} Ω resistors that have 10 fold higher signal to noise ratios compared to conventional 10^{11} Ω amplifiers, resulting in higher precision.

20 eclogitic garnet and clinopyroxene inclusions from diamonds from Orapa and Letlhakane, Botswana, were measured for Sm-Nd and Rb-Sr isotopes. Inclusions were grouped for isochron determinations based on similar diamond growth zone morphology, nitrogen content and aggregation, inclusion trace element content and Sr isotope ratios. Nd T_{CHUR} model ages of individual inclusions gave ages of <0.2 Ga, 0.7 Ga, ~1.0 Ga, and ~1.5 Ga (Orapa) and <0.35 Ga, ~0.9 Ga, ~2.1 Ga, and 2.7 Ga (Letlhakane), showing multiple diamond growth events in both diamond mines. Isochrons give similar ages (116±85 Ma, 224±35 Ma, 987±75 Ma, 1555±320 Ma, 2144±35 Ma) with initial ratios close to CHUR (Orapa: ε_{Nd} +0.2 to +2.3; Letlhakane: ε_{Nd} -1.3 to +0.8). The older ages of 1.0, 1.5, and 2.1 Ga ages confirm Sm-Nd ages obtained on pooled silicate inclusions [1] and Re-Os ages on sulphides [2] from Botswana. These ages can be directly linked to regional tectono-magmatic events.

Three studied diamonds record episodic growth with inclusions in different growth zones. Two Orapa diamonds had age differences of 0.8 Ga and 1.45 Ga between intermediate zones and rims. A Letlhakane diamond had a larger age difference with a 2.1 Ga intermediate zone and 0.2 Ga rim. Despite large age differences, the variation in $\delta^{13}C$ of these three diamonds was limited (<1.5‰), suggesting that $\delta^{13}C$ did not change markedly over time on a local scale in the sub-continental lithospheric mantle (SCLM). This successful study demonstrates it will be possible to determine the detailed $\delta^{13}C$ history with time in the SCLM worldwide.

[1] Richardson *et al*. (1999) *Proc 7th Int Kimberlite Conf* **2**, 709-713. [2] Richardson *et al*. (2004) *Lithos* **77**, 143-154.