A comparison of mineral and whole rock approaches to Re-Os dating of the Kaapvaal lithospheric mantle

BENJAMIN P. GARDEN[1], RICHARD W. CARLSON[2], D. GRAHAM PEARSON[3], STEVEN B. SHIREY[2] AND STEPHEN H. RICHARDSON[1]

[1]Department of Geological Sciences, University of Cape Town, Rondebosch 7701, South Africa (garden@dtm.ciw.edu, shr@geology.uct.ac.za)
[2]Carnegie Institution of Washington, DTM, 5241 Broad Branch Road NW, Washington, DC, 20015, USA (carlson@dtm.ciw.edu, shirey@dtm.ciw.edu)
[3]Earth Sciences, Durham University, South Road, Durham (d.g.pearson@durham.ac.uk), Great Britain

Re and Os are concentrated into trace Fe-Ni-Cu-sulfide and/or PGE-alloys in peridotite. Sulfide is largely removed during the high degrees of melt extraction experienced by many Archean cratonic peridotites. Whether or not metasomatically introduced sulfides influence whole rock peridotite Re-Os results can be evaluated by examination of the data set for mantle samples from southern Africa's Kaapvaal craton. Comparison of whole rocks with very low Re/Os (< 0.016), as expected for residues of melting, with simlarly low Re/Os sulfides, shows that Re-Os model ages agree well, revealing a circa 300 Myr age difference between the lithospheric mantles of the Kaapvaal's eastern and western blocks, consistent with crustal age differences. Whole rock peridotites with higher Re/Os show little correlation between Os isotopic composition and Re/Os, implying that the range in Re/Os is caused by infiltration of the xenolith by the Re-rich host kimberlite. Sulfides in Kaapvaal peridotites [1] range from unradiogenic Os isotopic compositions typical of whole rock peridotites, to more radiogenic values that, along with Kaapvaal eclogite xenoliths, scatter about well-defined 2.9 Ga Re-Os isochrons with radiogenic initial Os (~0.155) defined by diamond inclusion sulfides from Kimberley and Bobbejaan. Similar Re-Os systematics in eclogite, eclogite-paragenesis sulfides in diamonds, and some peridotite sulfides are consistent with introduction of radiogenic Os from subducting crust into the lithospheric mantle during the 2.9 Ga assembly of the western and eastern Kaapvaal blocks. "Crustal" Os is now best preserved in Kaapvaal eclogites and eclogitic sulfide inclusions in diamond, wheras sulfides in peridotite range in Re-Os characteristics depending on the degree to which fluids/melts carrying crustal Os have interacted with depleted peridotite.

Reference

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Archean mantle beneath the Halls Creek Mobile Zone, W. Australia revealed by Re-Os isotopes

A. LUGUET[1], D.G. PEARSON[1], A.L. JAQUES[2], G.P. BULANOVA[1], C.B. SMITH[3], S. ROFFEY[4] AND M.J. RAYNER[5]

[1]Department of Earth Sciences, University of Durham, UK. (ambre.luguet@durham.ac.uk)
[2]Geoscience Australia, Canberra ACT, Australia.
[3]Rio Tinto Mining and Exploration Ltd., Bristol, UK
[4]Rio Tinto Exploration Pty. Ltd., Perth, Australia
[5]Argyle Diamond Mines Ltd, West Perth, Australia.

The high-grade Argyle lamproite-hosted diamond deposit lies within the Palaeoproterozoic Halls Creek orogenic belt. The age of the lithospheric mantle beneath both the orogenic belt and adjacent Kimberley Craton has been a matter of debate since discovery of the deposit and resolution of this issue has important implications for diamond genesis and exploration models. During recent mining a xenolith-rich portion of the lamproite was discovered. We have selected a suite of the least altered peridotites from newly sampled xenoliths, together with 4 samples from an earlier xenolith petrology study [1] for Re-Os dating. A previous study [2] reported TRD ages of 1.6 and 1.4 Ga for 2 Argyle peridotites, with TMA ages of 2.6 to 3.3 Ga. All peridotites from the new study are heavily weathered and contain no primary sulfides, requiring us to use a whole rock dating approach. Rare secondary sulfides have been identified along grain boundaries. Whole rocks analysed so far have measured $^{187}Os/^{188}Os$ ratios ranging from 0.111 to 0.117. When corrected for Re in-growth since the 1200 Ma eruption age, Re-depletion ages vary from 2.3 to 3.0 Ga, clearly indicating the presence of Archean mantle beneath this region. The combined PGE and Re-Os systematics of our samples show that the peridotites have experienced metasomatic siderophile element addition, making TMA model ages [2] unreliable. Our data are hence the first reliable indication of Archean lithospheric mantle beneath this area. The Archean Re depletion ages are significantly older than the circa 1.8 to 1.9 Ga crustal basement age or the Sm-Nd ages for inclusions in Argyle diamonds which are predominantly of eclogitic paragenesis [3]. Our results are consistent with origin as refractory Archean mantle.

References

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