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Understanding the evolution of the cratonic mantle: Re-Os dating on single grain sulfides in Somerset mantle xenoliths (Canadian Shield).

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Archean cratons constitute an incredible source of information on the evolution and geological processes that shaped the early Earth. Both the compositional and age structure of the cratonic mantle have been used to constrain the architecture of the lithospheric mantle underlying the cratons, and understand the geological processes leading to their creation and assembly.

Xenoliths from Somerset Island, located in the Rae craton, Canada, sample a typical archean lithospheric mantle in term of composition, thickness and age. However, the whole-rock Re-Os T_{RD} age varies with the "fertility" of the peridotites (expressed as Al_2O_3 contents) as well as with their highly siderophile element fractionations. The more depleted peridotites (i.e. low Al_2O_3 and low Pd/Ir) yield the oldest T_{RD} ages (2.7-2.8 Ga) while the more fertile peridotites extent towards younger ages (2.7-1.8 Ga), likely reflecting open-system behaviour [1].

The whole-rock PGE systematics of Somerset Island peridotites show clear signs of disturbance. To evaluate whether lithospheric formation might be older than the Neoarchean age implied by the whole-rock data, we have peformed Re-Os dating on single sulfide grains from three Somerset Island peridotites xenoliths. Sulfide samples were selected to cover the full range of whole-rock Re-Os age, composition and HSE fractionation.

Sulfides occur as interstitial grains or inclusions in silicates and are comprised mainly of pentlandite and millerite, the latter probably a by-product of serpentinisation. Single sulfide T_{RD} ages show a large isotopic range in the three samples and also within a single sample. In sample JPN-3A (group C of [1]), where 7 sulfides could be microsampled or hand-picked, T_{RD} ages range from future age to 2.80 Ga, encompassing the whole-rock T_{RD} ages (2.2 Ga). The oldest ages recorded here are in excellent agreement with the oldest whole-rock age reported for Somerset Island. In samples XO7 and JPN-11 (group A and B of [1]), the sulfides picked yield T_{RD} ages very close to the whole-rock T_{RD} ages (respectively 1.86 and 1.94 Ga for JPN-11 and 2.67 and 2.64 for XO7).

Our results confirm that the whole-rock Re-Os ages are minimum estimates of the timing of partial melting while sulfides, one of the main host minerals for Os, have the ability to preserve older partial melting age and possibly provide a more robust and better record of the partial melting event in peridotite samples that have been strongly overprinted by post-magmatic processes. In this context, the apparent composition-age co-variation observed in Somerset Island lithospheric mantle could also be interpreted as the result of different extension of post-magmatic process where the least depleted part (i.e. the youngest in age) have been rejunevated by metasomatic processes. Combining sulfide and whole-rock dating in peridotites (where sulfide is present) has the ability to extract the protracted multi-phase evolution of the lithospheric mantle.

[1] Irvine et al. (2003) *Lithos* 71, 461–488