Inverse radiometric age relationships in ^{187}Re-^{187}Os geochronology

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Inverse radiometric age relationships are a well-known peculiarity in Re-Os geochronology. An outstanding example stems from a 20 m stratigraphic column of the Archean Mount McRae Shales (Pilbara craton) in Western Australia [1]. Nine drill core samples yield a Re-Os isochron age of 2501 ± 8.2 Ma ($^{187}Os/^{188}Os_i$ = 0.04 ± 0.06). However, since the samples belong to different stratigraphic horizons, two additional isochron ages are reported [2]: an age of 2495 ± 18 Ma ($^{187}Os/^{188}Os_i$ = 0.06 ± 0.09) from five samples of the 128.71-129.85 m interval, and an age of 2464 ± 41 Ma from four samples of the 145.22-148.32 m interval ($^{187}Os/^{188}Os_i$ = 0.86 ± 0.86). Their initial isotopic dichotomy contradicts a cogenetic origin, but unfortunately, the precision of the initial ratios is poor. The same is true for the two isochron ages; they cannot be distinguished within their age uncertainties. Thus, ^{187}Re-^{187}Os nuclear geochronometry, a new dating method combining principles of geochronology and nuclear astrophysics [3,4], is applied to this problem. By means of two different nuclear Re-Os geochronometers, individual nucleogeochronometric TPI ages were calculated for all drill core samples. The results confirm the isotopic dichotomy of the two groups ($^{187}Os/^{188}Os_i$ = 0.03, n=5; $^{187}Os/^{188}Os_i$ = 1.01, n=4); besides, accuracy and precision of the initial $^{187}Os/^{188}Os_i$ ratios are now significantly improved. The inverse radiometric age relationship for the 145.22-148.32 m interval (2458 ± 4 Ma, n=4) and the 128.71-129.85 m interval (2498 ± 8 Ma, n=5) becomes definitely evident. Therefore, the Re-Os "isochron" age of 2501 ± 8.2 Ma [1] for the Mount McRae Shales is challenged, because obviously the nine samples used to derive this age were initially not isotopically homogeneous. U-Pb SHRIMP zircon age data suggest that intrusive dykes in mantle peridotites are the most promising targets to decipher the mechanism responsible for the inverse age relationship observed in the McRae Shales.

[1] Anbar *et al.* (2007), *Science* **317**, 1903. [2] Anbar *et al.* (2007), *Science* **317**, supporting online material. Material and Methods, S3. [3] Roller (2015), *Goldschmidt Conf. Abstr.* **25**, 2672. [4] Roller (2016), *Goldschmidt Conf. Abstr.* **26**, 2642.