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187Re - 187Os Nuclear Geochronometry: A New Dating Method Applied to Old Ores

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^{187}Re - ^{187}Os nuclear geochronometry is a newly developed dating method especially (but not only) for PGE hosting magmatic ore deposits. It combines ideas of nuclear astrophysics with geochronology. For this, the concept of sudden nucleosynthesis [1-3] is used to calculate so-called nucleogeochronometric Rhenium-Osmium two-point-isochrone (TPI) ages. Here, the method is applied to the Sudbury Igneous Complex (SIC) and the Stillwater Complex (SC), using a set of two nuclear geochronometers. They are named the BARBERTON (Re/Os = 0.849, ^{187}Os/^{186}Os = 10.04 $\pm$ 0.015 [4]) and the IVREA (Re/Os = 0.951, ^{187}Os/^{186}Os = 1.9360 $\pm$ 0.0015 [5]) nuclear geochronometer. Calculated TPI ages are consistent with results from Sm-Nd geochronology, a previously published Re-Os Molybdenum age of 2740 $\pm$ 80 Ma for the G-chromitite of the SC [6] and a Re-Os isochrone age of 1689 $\pm$ 160 Ma for the Strathcona ores of the SIC [7]. This leads to an alternative explanation of the peculiar and enigmatic ^{187}Os/^{186}Os$_i$ isotopic signatures reported from both ore deposits. For example, for a TPI age of 2717 $\pm$ 100 Ma the Ultramafic Series of the SC contains both extremely low (subchrondritic) ^{187}Os/^{186}Os$_i$ ratios (^{187}Os/^{186}Os$_i$ = 0.125 $\pm$ 0.067) and extremely radiogenic isotopic signatures (^{187}Os/^{186}Os$_i$ = 6.55 $\pm$ 1.7, [6]) in mineral separates (chromites) and whole rock samples, respectively. Within the Strathcona ores of the SIC, even more pronounced radiogenic ^{187}Os/^{186}Os initial ratios can be calculated for TPI ages between 1586 $\pm$ 63 Ma (^{187}Os/^{186}Os$_i$ = 8.998 $\pm$ 0.045) and 1733 $\pm$ 84 Ma (^{187}Os/^{186}Os$_i$ = 8.901 $\pm$ 0.059). These results are in line with the recalculated Re-Os isochrone age of 1689 $\pm$ 160 Ma (^{187}Os/^{186}Os$_i$ = 8.8 $\pm$ 2.3 [7]). In the light of nuclear geochronometry, the occurrence of such peculiar isotopic ^{187}Os/^{186}Os$_i$ signatures within one and the same lithological horizon are plausible if explained by mingling of the two nucleogeochronometric (BARBERTON and IVREA) reservoirs containing very old rapid (r) neutron-capture process signatures from (at least) two different events. In this scenario, intermediate ^{187}Os/^{186}Os$_i$ ratios are due to mixing, resulting from the interaction of the two ancient components. Since there is a striking agreement between the nucleogeochronometric TPI ages and the conventional isochrone and mineral ages for the SC and SIC, respectively, nuclear geochronometry may offer an enormous potential for exploration purposes in mining industry, especially if additional geochemical and petrologic cross-correlations are taken into account. Furthermore, there might be now a new and promising opportunity to understand the link between magmatic ore forming processes and global geodynamics.

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