Erosion of archean continents: The Nd-Hf isotopic record of Barberton sedimentary rocks

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Archean sedimentary rocks have amalgamated the erosion products of large continental areas and provide a more comprehensive view of the composition of Archean continents than the igneous rock record. Here we present new trace element data as well as ^{147}Sm-^{143}Nd and ^{176}Lu-^{177}Hf isotopic compositions for 3.23-3.26 Ga sedimentary rocks - shale, siltstone and sandstone - drilled in the Barberton greenstone belt, South Africa. Principal component analysis (PCA) of major and trace elements reveals that the sediment geochemistry is controlled by three main endmembers: (1) a detrital source enriched in Al_2O_3, K_2O, TiO_2, REE and HFSE, that is a mixture of felsic and mafic erosion products, (2) a Si-rich component related to chert clasts and/or the silification of the sediments, (3) a Ca- and Fe-rich component associated with pyrite, Fe-oxides and carbonate.

Most detrital samples define a linear array on a Lu-Hf isochron diagram whose slope corresponds to an age of 3365 ± 370 Ma; within error of both the accepted deposition age of the sediments (3.23-3.26 Ga) and the U-Pb ages of detrital zircons (peaks at 3.25 Ga and 3.45 Ga). At the sediment deposition age, Nd-Hf isotopic compositions lie along the Terrestrial Array ($\varepsilon_{Nd(T)}$ = -1.4 to +0.1, $\varepsilon_{Hf(T)}$ = -0.8 to +3.3), suggesting that the eroded Archean crust was, on average, not more than 300 Ma older than the sediment deposition age. The Si-rich samples show scattered Hf isotopic compositions but define a linear Sm-Nd array with an age of 3818 ± 410 Ma. At the sediment deposition age, Si-rich samples have negative ε_{Nd} ($\varepsilon_{Nd(T)}$ = -2.0 to -0.5) but extremely radiogenic ε_{Hf} ($\varepsilon_{Hf(T)}$ = +1.4 to +13.1). This unusually strong isotopic decoupling may reflect either the contribution of chert clasts having low Hf contents but very high $^{176}Lu/^{177}Hf$ ratios (up to 0.9), or significant loss of Lu (20 to 90%) after sediment deposition that did not affect the Sm-Nd system. Some of the Ca- and Fe-rich samples show typical seawater REE patterns but no ε_{Nd}-ε_{Hf} isotopic decoupling at the sediment deposition age, as observed in modern seawater precipitates. These results are in line with erosion of a relatively young crust and confirm the lack of significantly old continental crust in the Barberton area at ~ 3.2Ga.