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Geochemical signatures of Palaeoarchean seafloor-derived silicified lavas and sediments from the Barberton Greenstone Belt

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Palaeaorchean geological terrains preserve silica-rich stratigraphic sections representing the uppermost portion of the sub-oceanic crust. Silica-rich rocks (lavas, clastic, and orthochemical sediments) present in these sections offer a unique opportunity to determine 1) the physico-chemical properties of ancient oceans and 2) the geochemical signature of the material that was potentially recycled into the mantle and into the source of Archean granitoids. However, these silica-rich sections remain poorly studied so far.

To determine the geochemical signatures inherited from silicification, we acquired petrographic, thermometric, and geochemical data on silicified lavas and sediments from the 3.5-3.2 Ga Barberton Greenstone Belt. Analysed samples were collected from five different stratigraphic sections (Theespruit, Middle Marker, Hooggenoeg 3-4 and Mendon) and present variable SiO_2 contents (51 to 98 wt.%). The analyses of ^{138}La-^{138}Ce isotopic systematics indicate that weathering by post-Archean oxidised fluids recently modified the light REE abundances of samples displaying Ce anomalies. We further show that measured thermometric proxies (Raman spectrometry of carbonaceous material, chlorite thermometry, and oxygen isotope thermometry) were reset by regional metamorphism at temperatures > 280 °C. Yet, a temperature of ~125°C, obtained from the O isotopic composition of one quartz-carbonate assemblage, plausibly approaches the temperature of hydrothermal silicification. Despite metamorphism, archives of Archean fluid (e.g. seawater) can therefore still remain in silicified rocks. After excluding the samples affected by recent weathering, we associate the following signatures with hydrothermal silicification: 1) a decrease in absolute rare earth element (REE) concentrations (dilution effect), 2) an enrichment in alkalis, and 3) a preferential mobilisation of Eu relative to its neighbouring REE elements because it was present in its reduced form. We note that Y/Ho and Zr/Hf ratios measured in both lavas and sediments preserved chondritic values during hydrothermal alteration of the oceanic crust. A slight decrease of Sm/Nd ratios with increasing SiO_2 content associated with very variable Lu/Hf ratios are ascribed to hydrothermal silicification. These observations suggest that the Sm/Nd and Lu/Hf ratios of the Palaeoarchean silicified uppermost crust may be different from fresh mafic lavas, which may have implications when tracing recycled material into the mantle using Nd-Hf isotopic modelling.