Geochemistry of a Palaeoarchean shallow shelf environment: Unravelling sediment provenance, alteration history and redox tracers

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Scientific drilling was recently completed by the ICDP-sponsored Barberton Greenstone Belt Drilling Project and has provided well-preserved volcanic and sedimentary rocks of Palaeoarchean age. Siliclastic and felsic volcaniclastic rocks of the 3.26- 3.23 Ga Middle Mapepe Formation in the Fig Tree Group were intersected by the BARB5 core. In this study, we use a chemostratigraphic approach to identify the nature of sedimentation, sediment sources and redox conditions for this core which traverses a 400m stratigraphic section from deeper water to a shallow nearshore environment. Lithologies include mudstone, sandstone and conglomerate together with chert, carbonate, barite, iron formation and volcaniclastic ash. Silification is minor at most depths and cherts occur as distinctive layers in shale and ash horizons. A distinctive layer of detrital heavy minerals including diverse sulfides indicates weathering of prexisting mineralized crust. Bulk rock analysis of mudstones and sandstones shows overall depletions in TiO_2, K_2O, P_2O_5, Al_2O_3, Na_2O and enrichment in Fe_2O_3, MnO, CaO and MgO relative to PAAS. Th/Sc and Cr/Th ratios reveal variable proportions of source material weathered from high-Mg basalt mixed with dacitic ash. Carbonate chemistry links fine grained bedded carbonate to late stage carbonate veining. Cryptic alteration has affected only the most highly mobile elements including alkali metals, Sr and Ba. Many other elements including redox sensitive tracers such as Fe, Mo, V and U appear immune to alteration and are consistent with fully anoxic conditions in the Palaeoarchean. The wealth of information provided here will provide a critical framework for the interpretation of sedimentary, geochemical and microbiological processes in early Archean basins.