Redox trace element and organic carbon geochemistry of the Neoarchean Campbellrand carbonates, South Africa

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Drill cores through the Campbellrand-Malmani carbonate platform (~2.64 to 2.50 Ga, Transvaal Supergroup) provide a platform-to-basin transect to study dynamics of redox-sensitive trace elements, organic matter and organic carbon isotopes before the early Paleoproterozoic increase of atmospheric oxygen levels. Cores represent proximal slope and distal slope/basin environments. They record flooding of the Kaapvaal Craton, establishment and aggradation of an extensive carbonate platform, and platform drowning, followed by deposition of shales, iron formation and chert across former platform environments. Correlation between concentrations of Al and Th, and redox-sensitive trace elements indicate a dominantly detrital source of these elements in the studied section, consistent with low oxygen concentrations in the environment. Elements Fe and Mn were effectively separated during deposition and/or diagenesis by incorporation into pyrite, siderite and carbonate, respectively. Carbonates have organic carbon contents of ≤ 2 wt.% TOC, whereas up to 7 wt.% TOC were observed in shale lithologies. Organic carbon is broadly correlated with total sulfur concentrations, indicating coupled C and S cycles. Significant spread and little systematic stratigraphic variation characterize △13Corg and the isotopic difference between organic and carbonate carbon (△), which could reflect some thermal overprint. However, △13Corg values between -29 ‰ PDB and -44 ‰ PDB are considered to be close to the original signature. The isotopic difference △ varies between -36 ‰ PDB and -28 ‰ PDB. The more 13C-enriched values likely reflect photoautotrophic carbon fixation as the main process of primary productivity. On the other hand, the very depleted values suggest a contribution from secondary reworking of organic matter under anoxic conditions.