Manganese Deposits within the Cape Supergroup and their Relation to Thermal Springs

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The mechanisms controlling the formation of manganese deposits within the ~300 Ma Cape Supergroup (South Africa) are not well constrained. Manganese is a critical element not only in steelmaking, but in the production of batteries which are vital to the rapidly growing electric vehicle industry. Much work has been done on the mineralisation seen in the western portions of the Cape Fold Belt (CFB), however the same is not true for that of the central and eastern portions of the CFB. This study looks at the CFB in its entirety and serves to determine the mode of precipitation of manganese. In an effort to reach this goal, a model involving thermal springs was investigated with springs being described in terms of their physiochemical, chemical, isotopic and microbiological characteristics. Two Mn deposit classes exist within the CFB: vein hosted, cryptomelane-goethite dominated mineralisation and pyrolusite-goethite surficial deposits intimately associated with thermal spring activity. Manganiferous springs are shown to have significantly higher salinities (> 95 ppm) than non-manganiferous springs (< 70 ppm) and this is intrinsically linked to manganese concentration as chloride acts as a transport ligand for Mn. PHREEQC modelling software was utilized to show that mixing between warm, fossil spring water and cool, modern groundwater is a viable means for the precipitation of manganese oxides. Microbial communities were classified to determine whether biomineralization may have contributed to oxide precipitation. The presence of multiple different species of manganese oxidising bacteria indicates that this process is biologically-mediated. Burkholderiales bacteria which are associated with manganiferous springs was identified as a biomarker and has potential to be used as an exploration tool. This work shows that there is an intimate relationship between thermal springs and manganese mineralisation within the CFB, and has implications for our understanding of vein-hosted and surficial Mn deposits located elsewhere globally.