Significance of Cr-rich sedimentary rocks in 3.2 Ga Fig Tree Group, Barberton Greenstone Belt, S. Africa

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Geological and geochemical studies were performed on sedimentary rocks of Fig Tree Group in Jesefsdal and Waggon Road Mine (WR) areas. Black shale and sandstone are dominant at the base of Fig Tree Group in WR. These are correlated to conglomerate and sandstone units at Jesefsdal. In particular, WR samples are often rich in chalcopyrite and spharelite, which are not associated with later Au mineralization. Such lithological and mineral differences suggest that clastic sedimentary rocks in WR deposited in deep water envrionments influenced by submarine hydrothermal activities, while Jesefsdal samples represents shallow and high energy sedimentation environments. Shale and sandstone in both areas contain appreciable amounts of organic carbon, up to 0.6 wt % C. Raman spectroscopic analyses suggest less metamorphosed nature of organic carbon. Most clastic sedimentary rocks are found to be rich in Cr (up to 900 ppm in black shale). Detrital chromite, derived from Onverwacht Group, is often found in matrix of conglomerates. On the other hand, some chromite crystals in sandstone have distinct chemistry (very low Mg#) and morphology compared to detrital chromite (high Mg#). This suggests that a part of chromite were chemically precipitated from 3.2 Ga ocean water. This further implies presence of oxidized aqueous Cr species (e.g., Cr^{6+}) in 3.2 Ga shallow ocean water. In bothe areas, clastic sedimentary rocks are overlaid by banded iron formations (BIFs) concordantly. It is found that a part of BIFs are also rich in Cr. BIFs in WR are uniquely interbeded with black cherts. Those black chert contains appreciable amounts of organic carbon, up to 0.3 wt % C. Carbon and nitrogen isotope compositions of extracted kerogens are surprisingly constant (at around -25 per mil for $\delta^{13}C$ and +2 per mil for $\delta^{15}N$) from early clastic sedimentary rocks to black cherts in banded iron formations, although their sedimentary environments and ages were different. Such homogheneous carbon and nitrogen isotope compositions require common primary producer, during sedimentation of Fig Tree Group. Oxygenic photosynthesizing microbes were likable primary producers in 3.2 Ga oceans to explain Cr oxidation and high biological primary production.