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Occurrence of different Fe minerals in a same ferruginous section in the 3.2Ga Moodies Group, Barberton Greenstone Belt.

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Sedimentary rocks deposited in shallow ocean environments may preserve key information on the evolution of life and Earth's surface environments. The Barberton Archean Surface Environments (BASE) project recovered well-preserved Paleoarchean sedimentary strata in the Moodies Group, Barberton Greenstone Belt, South Africa[1]. This study primarily focused on examining Fe partitioning in a ferruginous section of the MdS1 unit, a siliciclastic unit deposited in a delta-front to offshore setting. Samples were obtained from drill cores from two different sites BASE-1 (southern part of Eureka Syncline) and BASE-5A (Stolzburg Syncline), and compared with our previous study, which examined depositional processes of Fe in the MdS1 unit in the northern part of Eureka Syncline at the Sheba mine. Petrographic and electron microscope observation revealed that hematite, magnetite, pyrite, siderite, ankerite, chlorite, and biotite were the major Fe-bearing phases. Hematite and magnetite, which were more commonly found in the Sheba mine samples, were only found in some BASE-5A samples together with chemically precipitated microcrystalline quartz. Carbonate minerals, particularly siderite dominate in most BASE-5A samples, contrasting to ankerite which is more prevalent in samples from BASE-1 core and in the Sheba mine [2]. Pyrite is not abundant (S content =<1.1 wt%) but is widely distributed in both sites. Geochemical analyses show that BASE-1 samples (n=10) have relatively higher organic C (Corg = 0.1–0.3 wt%), lower carbonate C (Ccarb = <0.1–2.3 wt%) and lower Fe contents (Fe_2O_3 = 6.1–22.5 wt%) while BASE-5A samples (n=20) have lower organic C (<0.1–0.2 wt%), higher carbonate C (1.8–7.6 wt%), and higher Fe contents (8.0–46.1 wt%). These results demonstrate that heterogeneous depositional environments for Fe in shallow ocean settings occurred in the same MdS1 unit. Assuming C in the carbonate minerals derived from decomposition of organic matters [2], a high abundance of siderite in both sandy and silty layers of BASE-5A samples may suggest the high primary productivity and earlier timing of Fe reduction during diagenesis, possibly involving biological activity.

[1] Heubeck, C. et al. (2024) *Scientific Drilling, 33,* 129–172.

[2] Suzumeji, R. et al. (2024) *Precambrian Research, 413*, 107574.