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Petrogenesis and hydrothermal alteration of 3.48 Ga oceanic crust in the Dresser Formation, Pilbara Craton

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The ca. 3481 Ma Dresser Formation of the Warrawoona Group, exposes in the North Pole Dome, and unconformably overlays the North Star Basalt. Previous studies suggested the Warrawoona Group formed as an oceanic plateau complex. Yet the Dresser Formation was formed during ~10 – 20 Ma hiatus between two major volcanic cycles of the Warrawoona Group. The Dresser Formation thus may not be directly comparable to the major volcanic cycles as an oceanic plateau complex. Here we examined the geochemical features, including whole-rock major and trace elements, nitrogen (N) content, oxygen isotopes ($\delta^{18}O$), and Sr-Nd-Hf-Pb isotopes of pillow basalts from the middle member of the Dresser Formation. Studied samples are fine to medium grained, and have a mineral assemblage of chlorite + plagioclase + magnetite + microcrystalline quartz ± calcite ± epidote ± goethite/ilmenite ± pyrite. No foliation and recrystallization of secondary minerals were observed in the samples, excluding later metamorphic effect. The pillow basalts show elevated contents of LOI (7.1 – 16.8 wt.%), K_2O (0.1 – 1.0 wt.%), $Fe_2O_3^T$ (9.7 – 18.5 wt.%) and N (2.8 – 11.6 ppm), as well as $\delta^{18}O$ values (8.4 – 11.3‰), indicating low-temperature seawater-rock interaction. Fluid mobile element enrichments and slightly positive Eu anomaly (Eu/Eu* = 0.88 – 1.87) are consistent with low-temperature alteration. No significant negative Ce anomaly (Ce/Ce* = 0.84 – 1.04) is observed, excluding involvement of oxic fluid. Chondrite- and NMORB-normalized REE patterns show MORB-like affinity of the basalts. Batch melting calculations reveal that these samples were derived from the depleted mantle through shallow melting, which is validated by their Hf isotope signature. In contrast, their Sr, Pb, and Nd isotope compositions show large variations that deviate from their depleted mantle ranges, consistent with variable overprinting by seafloor alteration. Taken together, our results indicate that the pillow basalts in the Dresser Formation record depleted mantle signature and Archean seawater alteration following their emplacement on seafloor. Accordingly, the oceanic-plateau model of the Warrawoona Group cannot be directly extrapolated to the Dresser Formation. The Warrawoona Group likely records more diverse magmatic sources than previously assumed.