The lateral change of sea-floor hydrothermal system; The Dixon Island Formation in the coastal Pilbara terrane, Australia

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The 3.2 Ga Dixon Island Formation in the coastal Pilbara terrane, Western Australia, is one of the most complete and best-preserved examples of Mesoarchean submarine hydrothermal sedimentary sequence. Its continuous section is well exposed along the northern coastline of the Dixon Island. Based on our detailed geological mapping, the 6km-wide outcrop is subdivided into six blocks, namely DX-A to DX-F, which was defined by strike-slip faults. The 400m-thick Dixon Island Formation is composed of, in an ascending order, Komatiite-Rhyolite Tuff, Black Chert, and Varicolored Chert members. To explore lateral variations of potential microbial activity in submarine hydrothermal system and depositional environments, we focused on the organic carbon (Corg)-bearing black chert in the Black Chert Member and performed petrographic investigation of thin sections under microscope and measured the Corg contents, Corg isotope compositions, and rare earth elements (REEs) abundance.

The massive and laminated black cherts in DX-B are thicker than those in other area. The amount of massive dark green chert laterally increases from DX-B to DX-F. The shale-normalized REE+Y patterns of both massive and laminated cherts similarly show overall enrichment of heavy REEs and positive Eu anomalies. The Corg contents are generally very low (less than 0.05 wt.%) throughout the area. Those of massive black chert in the Black Chert Member slightly decrease laterally from west to east (DX-B to DX-F), ranging from 0.18 wt.% to 0.02 wt.%. Moreover, their Corg isotopic compositions show somewhat different ranges; -28 to -40permill (DX-B), -27 to -35permill (DX-C), -20 to -35permill (DX-E), and -22 to -33permill (DX-F), respectively. The Corg isotopic compositions of the black chert vein range from -25permill to -35permill.

Based on our field observation and obtained geochemical data set, we suggest that the massive black chert and black chert vein have the same source material, which was supplied from the low-temperature (silica-rich) hydrothermal system. We tentatively conclude that such lateral variations in the Corg contents and isotopic compositions of chert, with similar REE+Y signatures, may reflect differences not in physicochemical environments but in the diversity (e.g., extent and community structure) of microbial activity near/on/in the 3.2Ga seafloor.