Environments of Archean Ocean floor: 3.2 Ga Dixon Island Formation vs. 3.5Ga Marble bar chert

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The 3.2-Ga Dixon Island Formation in the coastal Pilbara terrane and the 3.5 Ga Marble Bar Chert in the Warrawoona Group in Pilbara Craton of western Australia, are well preserved an Archean hydrothermal stratigraphic sequence containing organic black chert and Fe rich iron chert or BIF. We did detail mapping (1/500 and 1/100 scales) to recognize previous ocean floor environments. Especially the Dixon Island Formation is exposed excellent preservation along the coast (7 km long) which is only location of the greenstone belt in the Pilbara.

The stratigraphy of these sequences preserved quite resembles. They form volcanics (rhyolite tuff, pillow basalt), highly altered zone with hydrothermal black chert vein, black chert, varicolored (black and white) chert and red chert or BIF from bottom to top. Many black-chert vein swarms imply intensive low-temperature hydrothermal activity during deposition of black chert above the basement volcanics. These resemble stratigraphy, which is called Black chert-BIF (BCB) sequence indicate the one of the standard sedimentary sequence of Archean oceanic hydrothermal environments.

Metamorphic grade and structural deformation is different. The Dixon Island Formation is situated less than prehnite-pumpellyite facies with D2 left-lateral strike-slip deformation (Kiyokawa et al., 2002). It contains many previous sedimentary structures. On the other hand, the Marble Bar Chert is affected NNW compressional deformation and lower greenschist facies metamorphic grade and most carbonaceous materials are decomposed.

In detail, absence of detrital sediments of continental origin in the Dixon Island formation implies that this sedimentary facies represents a hydrothermal environment at about 500-2000 m in paleo-depth. Microbial material has been preserved well in the black chert bed, which is composed of massive black chert and laminated black chert. The massive black chert has carbonaceous peloids (0.3 mm-2 mm in diameter) similar to those in the black chert veins. The massive black chert of the Dixon Island Formation contains wriggle-, rod- and dendrite-shaped bacterial-shape material. The black chert of the Marble Bar Chert, however, preserved more deformed black carbonate materials and poor rod-shape matarials. Geochemical data of the Dixon Island Formation as follows: total organic carbon (TOC) in the black chert and black chert veins varies within 0.05-0.16 par cent (average 0.1par cent) and the carbon isotope (delta 13C) values of these rocks are -35- -27 per mil (average 30 per mill). Sulfur isotope (delta 34S and delta 33S) values of the pyrite in black chert rocks are -1- -9.9 per mil and -1.3-5.6 per mil. This evidence suggests that the carbonaceous grains and bacteria-shaped material in the black cherts in the Dixon Island Formation are biogenic and formed close to a hydrothermal vent system.

Based on the field observations and geochemical evidences suggest that the Dixon Island Formation and Marble Bar Chert are quite resemble sedimentary environments on the ocean floor with biogenic microbial colony near hydrothermal vents in the Archean. The black carbon materials in the Marble Bar Chert may be decomposed by diagenesis and metamorphism.