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Reconstruction of 3.2Ga ocean floor environment from DXCL Drilling cores, Pilbara, Western Australia.

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The 3.2 Ga Dixon Island - Cleaverville Formation in the coastal Pilbara terrane, Western Australia, is one of the most complete and best preserved examples of middle Archean sedimentary sequence in the oceanic arc setting (Kiyokawa et al., 2006). In addition, we can understand the paleoenvironment with high-resolution using a non-weathered rock sample. In Dixon Island-Cleaverville drilling project (Yamaguchi et al., 2009), we gained three fresh drill cores (DX, CL2 and CL1 in ascending order). Here we describe detailed stratigraphy and stable sulfur isotope ratio of them to reconstruct the ocean floor environment.
These cores have 200 m long and totally 130 m stratigraphic thickness. We described detail about lithology and measurement of number and thickness of beds in non-deformed parts (DX: 45 m, CL 2: 23 m, CL1: 30 m).
DX core, covers the upper part of the Dixon Island Formation, is constructed by clay-sized black shale (1705 layers), laminated pyrite (1395 layers) and gray chert (298 layers) with fine laminations. CL1 and CL2 cores, cover the lower part of the Cleaverville Formation are constructed by silt-sized black shale (CL2: 219, CL1: 276 layers), laminated pyrite (CL2: 44, CL1: 137 layers), volcaniclastic sandstone (CL2: 10, CL1: 27 layers, nothing in DX). When focusing into each one layer, sedimentary characteristics follow that; 1) black shale layers are thickening upward from DX to CL1 (2.1 cm to 14.4 cm in average), 2) pyrite layers are thinning upward from the bottom to the top (10 cm to 3 cm in average) of DX and more decreased in thickness and number in CL2 to CL1 (0.6 cm to 0.3 cm in average) and 3) thin volcaniclastic layers appear in stratigraphic upper part.
Delrta ^{34}S values of 63 bulk samples are showed that -1.9 to +12.9 per mil in DX, +1.7 to +24.9 per mil in CL1 and +4.4 to +26.8 per mil in CL2. The range of value is extended and shifted to positive side in CL cores. Also, the mass-independent fractionation (MIF) of sulfur, which is occurred by photolysis of SO_2gas, is obviously founded In Archean (Farquhar et al., 2000). Capdelta ^{33}S values, which express the degree of MIF, of these samples are settled in a narrow band between -0.9 and +0.7 per mil. Consequently, mass-dependent fractionation (MDF) is dominant in whole cores.
Wide and heavy delta ^{34}S values indicate the very active microbial sulfate reduction in the area that sulfate supply is limited. It is assumed that sulfate reduction and pyrite crystallization were proceeded in the stagnant organic ocean on the sediment. Lack of MIF signature in sulfur isotope suggests that there was few MIF-affected sulfur in seawater.
In this way, the carbonaceous and anaerobic sedimentary environment of 3.2-3.0 Ga Dixon Island-Cleaverville formations shifted from calm and deeper to relatively shallower condition with weak volcanism. There was the stagnant anaerobic layer at the sea floor in that time. At first the hydrothermal sulfide layer mainly deposited in deeper part, after that many sulfate-reducing bacteria flourished to the top.

Keywords: DXCL Drilling, black shale, pyrite, sulfur isotope ratio, Archean, surface environment