

## Restoration of the 3.2-3.1 Ga sea floor: Local analysis of S isotope of micro-scale spherical shell pyrite in DXCL core.

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In the Western Australia Pilbara coast green stone belt, low-grade metamorphic Dixon Island Formation and Cleaverville Formation of 3.2-3.0 Ga is exposed. In these sedimentary rocks, information of the earth's surface environment of Archean and a trace of the initial life which are very important to solve geological and biological evolution of the initial earth are left.

DXCL land drilling (Kiyokawa et al., 2012) was performed in 2007 and 2011 for the purpose of the high-resolution reconstruction of the change of past sedimentation environment in this area, and four rock core samples (DX, CL1, CL2, and CL3) were acquired.

S isotopic measurement is performed for DX, CL1, and CL2. Delta 34S value was very heavy (-1.9 - +26.8 permille: Sakamoto, MS2010), and this is different from the negative isotope fractionation of the creature source usually seen. Change of the value was in particular big in the DX core. As a result of microscopic observation of DX, we found the layer of tens-hundreds micrometer euhedral pyrites and the layer of the micro-scale spherical shell pyrites(=MSSPs; about 10 micrometer in diameter) which are fulfilled with silica.

In this study, we measured S isotope of these MSSPs planarly and observed micro-scale distribution of isotopic ratio for the purpose of revealing to what extent minutely the fractionation occurred and how these pyrites grew.

(Classification of the MSSPs) We measured 11 samples and classified them under 3 types: A type(1 sample) is pyrite shell whose inner side is filled with silica, B type(7 samples) is pyrite shell which has a pyrite grain in its center, and C type(3 samples) is spherical pyrite which is fulfilled with pyrite. We suppose that these pyrites grew from A type to C type, via B type, based on this morphological classification.

(Method) We buried a thin section of DX124.34 which includes MSSPs and a working standard in resin, and performed imaging analysis to this sample using NanoSIMS. A type was measured an enlarged part of the spherical shell in the area of 3x3 square micrometer. B type and C type were measured a whole particle in the area of 10x10 square micrometer. Measuring time varied according to a measuring domain, but we can compare the results with the same precision by regulating the number of pixels to show in either 4x4, 8x8, or 16x16.

(Result of a measurement) 1. Standard: in the measurement of the standard with isotopic homogeneous composition, measured value was not stable. However, dispersion of the value in one analysis domain was small; we reproduced the homogeneity. Therefore, not the absolute value but the relative value, or difference of the isotopic ratio in one analysis domain is important in our mapping data.

2. MSSPs: in A type, isotopic ratio showed patch-like distribution. In B type, the inner edge was higher than the outer edge, and concentric structure was seen. However, patch-like distribution like A type was also seen. In addition, pyrite grain in the center was heavier than spherical shell. In C type, a heavy domain was seen in the shape of a ring.

(Summary) 1. In A type, isotopic ratio showed patch-like distribution. However, this is only a result of 1 sample.

2. In B type, an inner edge was higher than outer edge. We suppose that spherical shell grew toward inner side and got heavy isotopic ratio because of further fractionation in closed environment. Moreover, heavy pyrite grain in the center can be thought to have been formed for the same reason. Because some B type pyrite had patch-like distribution, we suppose that MSSPs grew from A type to B type in generally.

3. In C type, the center and the outer edge was light and a heavy domain was seen in the shape of a ring. This is because heavy pyrite grew from both the inner edge and the center, and the heaviest pyrite filled the inner space at last. Therefore, we suppose that B type pyrites grew into C type.

From Summary1 to Sumary3, we claim that MSSPs grew from A type to C type, via B type.

Keywords: micro-scale spherical shell pyrite(=MSSP), sulfur isotope, local analysis, sulfate reduction bacteria, Archean, Pilbara