Microbial activity below Archean seafloor constrained by quadruple sulfur isotopes of pyrite within ca. 3.5 Ga basalts from North Pole area, western Australia

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Microbial sulfate reduction (MSR) is one of the most ubiquitous metabolisms on Earth [Canfield, 1998]. Aoyama *et al*. (2014) showed MSR takes place not only in quiescent seafloor (i.e. non-hydrothermal), but also in active hydrothermal system. On the other hand, the oldest evidence of MSR has been reported from ca. 3.5 Ga Dresser Formation, Western Australia by using quadruple sulfur isotopes of sulfate and sulfide minerals related to hydrothermal environment [Ueno *et al*., 2008]. The activity of MSR below seafloor is, however, still poorly understood. Here, we report quadruple sulfur isotopic compositions of small pyrite grains (<40 μg) within seafloor basalts by using newly developed micro-fluorination technique. The observed variations within each hand specimen have positive correlations between the $\delta^{34}S$ and $\Delta^{33}S$ and negative correlations between the $\delta^{34}S$ and $\Delta^{36}S$. Sulfides within adjacent viens penetrating into the basalts show distinctive isotopic compositions and thus cannot be an end-member mixing component of the pyrites in the basalts. Based on the $\Delta^{36}S/\Delta^{33}S$ ratio and large $\delta^{34}S$ variations within small volume rocks (~10‰) suggest MSR took place in Archean hydrothermal systems.