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New evidence of oxygenic photosynthesizing bacteria in 2.7 Ga oceans and their connection to hydrothermal vent communities

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It has been debated if oxygenic photosynthesizing bacteria were already flourished in middle to late Archean oceans. Here we report new evidence of oxygenic photosynthesizing bacteria in 2.7 Ga oceans. The examined samples were collected from the Munro Township in Abitibi Greenstone Belt, Canada. Black cherts are widespread in the Munro area. They contain 0.1 to 0.2 wt % C of organic carbon. Carbon isotope compositions of kerogens in black cherts were ranging from -33 and -25 per mil. Nitrogen isotope composition of kerogen was determined by the step-wise heating method, yielding around +14 per mil. Raman spectroscopic analyses of kerogens indicate that the metamorphic temperature was less than 300 C. This further suggests that the metamorphic alteration was not responsible for 15N-enrichment of kerogen, and, therefore, the 15N-enriched nitrogen reservoir was present in the Munro ocean. The nano-sized carbon-Mo complex was found in graphite structures by HR-TEM/STEM observation. Presence of such Mo compounds implies that oxidized Mo were present in the Munro ocean, and such dissolved Mo was incorporated into photosynthesizing bacteria as a part of the nitrogen-fixing enzyme. Those all new findings study indicate that the presence of oxygenic water column at the 2.7 Ga Munro ocean and therefore oxygenic photosynthesizing bacteria were already flourished by this time.

The submarine hydrothermal sulfide deposits are present at the Munro area, accompanied with organic-rich sedimentary rocks containing traces of vent microbial communities. Detailed geological survey with petrographic studies indicates that organic matter from photosynthesizing bacteria were sedimented around the recharge zone of the hydrothermal system. Sedimentary organic matter were incorporated into descending hydrothermal fluids, and then, converted into petroleum and other hydrocarbons. Carbon isotope studies indicate that those thermally altered carbon species were discharged through the vents and used by the benthic hydrothermal vent communities. This further implies that Archean hydrothermal vent communities were not independent and had a connection with photosynthesizing communities.