Microbial communities around ca. 2.7 Ga submarine hydrothermal fields at the Potterdoal deposit in Abitibi Greenstone Belt, Canada

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The Archean submarine hydrothermal environment is often considered as a cradle of early life. Large uncertainties still exist as to which microorganisms were active around Archean submarine hydrothermal systems and if hydrothermal communities could be the primary producers for the global biosphere. To approach this problem, we studied ca. 2.7 Ga volcanogenic massive sulfides (VMSs) and associated sedimentary rocks at the Potterdoal deposit in Abitibi Greenstone Belt, Canada. Purposes of the present study are (1) to evaluate which type of microorganisms were active in 2.7 Ga submarine hydrothermal environments, and (2) to find new biosignature in nanoscale analysis of organic matter (OM).
VMS ores were mainly composed of chalcopyrite, sphalerite, pyrrhotite and pyrite, mostly showing layered and sorting textures. They often contained brecciated shale or actinolite or chlorite. Chert and sandstone appeared in the distal area from the VMSs. Most examined VMSs did not have OM, but some samples had up to 0.5 wt.% of carbon concentration. Those OM were found together with actinolite or chlorite or shale fragments trapped in VMSs. Carbon concentration in sedimentary rocks were moderate in general, ranging from 0.0 to 0.9 wt.%C. The thermal alteration temperature was estimated as below 300 ˚C based on the full widths of half maximum of the D1 band in the Raman spectra of kerogen, indicating that less altered features. Overall carbon isotope compositions of kerogen were ranging from -44.6 to -23.6 ‰ (PDB). These values suggest that the presence of contrast microbial ecosystems at this region, utilizing either hydrothermal CH_4 or atmospheric CO_2. Transmitted electron microscope analysis revealed that examined kerogen were mainly composed of immature OM with minor graphene layers. Novel nanostructures of Mo-sulfides stacked with graphene or Fe-sulfides were newly found in immature kerogen structures.These nano-sulfides associated with kerogen may suggest incorporation of biological sulfides in OM during the early diagenesis, possibly giving new evidence of sulfur metabolisms for the early life.

