

Detection of microbes in fluid inclusions in hydrothermal minerals by Raman spectroscopy

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Microbes can exist in subsurface habitats, such as sub-seafloor sediments and continental and oceanic crust under extreme conditions (i.e., wide thermal gradients, high pressures and chemical extremes). The oldest evidence of methanogens has been found in fluid inclusions in hydrothermal precipitates (Pilbara craton, Australia) from hydrothermal vents at temperatures ranging from 60 to 464 °C. This kind of fluid inclusion can also happen in the black ores and barite, which were generated from submarine volcanic activity.

In this study, to explore if "extraordinary creatures/microbes" could be included into fluid inclusion during black ores and barite formations, several rock samples were taken from the Hokuroku area, Japan; the fluid inclusion formation temperatures was measured using microthermometry method, and the organic matters in fluid inclusions found in black ore and barite were detected using a Raman spectroscopy. By making flakes of the rock samples, several fluid inclusions were found in Hokuroku black ore and barite, which have a general size of 1.5-4.5 μm . The generation temperature of black ore fluid inclusion is found to be 200-300 °C, consistent with previous studies (i.e., 150-350 °C). At a temperature of 200 °C, it is still possible to keep microbes alive, based on the protein stability test. Barite was formed above 300 °C, at which microbes are hard to survive. Raman measurement of the fluid inclusion in the black ore then suggests the presence of organic matters. For example, the presence of a small peak at 2954.47 cm^{-1} indicates the existence of C-C chemical bond.

This study first shows the possibility of the presence of organic matter in the fluid inclusions in hydrothermal minerals using a Raman spectroscopy. However, the temperature at which fluid inclusions were formed and microbes could be alive should be further confirmed, and the structure of organic matters should also be identified in future studies.

Keywords: Fluid inclusions, Hydrothermal minerals, Microbes, Raman