A new technique for chemolithoautotrophic activity under piezophilic fluid conditions and its successful application

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Microbial activities and their fluid-mineral-rock interactions under extreme habitats such as deep-sea hydrothermal environments and deep subsurface biosphere are controlled primarily by physico-chemical state of the habitats. Signatures and phenomena of such biogeochemical processes and geomicrobiological interactions have been, in most cases, observed, detected and analyzed in the natural samples recovered, and have been explained and understood in the light of results, rules and theories deduced from the experiments. Experimental approach could be generally conducted under the naturally occurring environments or under the similar conditions in the laboratories. Unfortunately, however, deep-sea hydrothermal vents and deep subsurface are quite hard to access and resistant to investigation by in-situ observation and experiments. Thus, we have to design the experiments in laboratory under the same physico-chemical conditions as the deep-sea hydrothermal vents and deep subsurface. Among a variety of physical and chemical factors, hydrostatic pressure has always escaped from the experimental strategy. The hydrostatic pressure is an important physical factor but also may be a more important factor to control the energy and carbon metabolisms of the microbial ecosystem by increasing solubility of gas components into water.

In this study, we have successfully established a new technique for cultivation of chemolithoautotrophic microorganisms under piezophilic fluid conditions. This is the first report of successful cultivation of various deep-sea chemolithoautotrophs such as sulfur-oxidizing and hydrogenotrophic nitrate-reducers, hydrogenotrophic sulfate-reducers and hydrogenotrophic methanogens. This technique could be applied not only to cultivation of microorganisms but also to experiments for microbial activities and their fluid-mineral-rock interactions under extreme habitats. We show you the great potential of this technique with several outstanding examples.