

Search for Subsurface Biosphere of Submarine Hydrothermal Systems by Using Phosphatase Activities

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A wide variety of methods have been proposed to detect microbial activities, but most of them can be applied to limited categories of terrestrial organisms. We propose here to use phosphatase activity, which seems to be an essential catalytic activity for all the terrestrial organisms, and possibly for extraterrestrial organisms. We determined phosphatase activity in core samples and chimney samples obtained in submarine hydrothermal systems located at Suiyo Seamount, Izu-Bonin Arc, and South Mariana.

Core samples and chimney samples were collected as a part of the Archaean Park Project at the Suiyo Seamount, Izu-Bonin Arc, the Pacific Ocean in 2001 and 2002, and in South Mariana hydrothermal systems in the Pacific Ocean in 2003.

A 0.5-g of powdered sample was mixed with 2 mL of substrate solution 0.5 mM p-nitrophenyl phosphate in Modified Universal Buffer; pH 6.5. After incubation at 37°C, CaCl₂ NaOH solution was added to stop the enzymatic reaction. The formation rate of p-nitrophenol was monitored at 410 nm after filtration through a 0.2 µm membrane filter. Acid phosphatase activity was calculated by using the value at pH 6.5.

Some of the chimney and core samples showed much higher activities than background activities shown by montmorillonite. Vertical profiles of phosphatase activities in some Suiyo core samples showed a peak not at the surface but in the middle of the core. On the other hand, Mariana core samples showed significant level of phosphatase activities only at the surface. Hydrothermal fluid can go through Suiyo core samples, but it hardly goes through Mariana core samples, which seems to make the difference. The outer part of the chimney samples showed higher phosphatase activities than the inner part. It can be explained by the facts that the inner part faces to hot fluid, while the outer part faces to ambient sea water.

The present results of phosphatase activity assay agreed with the results of organic and microbial analyses. It was shown that phosphatase activity is one of possible biomarkers for extant life.