

Evaluation of biological activity in extreme environments by phosphatase activity

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Terrestrial organisms are widely distributed even in extreme environments such as submarine hydrothermal systems and Antarctica soils. In order to evaluate biological activities in such extreme environments, we analyzed phosphatase activity and amino acids in soils and rocks in extreme environments.

Antarctic soil samples were collected near Showa Station during the 49th Japanese Antarctic exploration mission in 2006-7. Reference samples used were surface soil collected in the campus of Yokohama National University. Sea sand after heated at 773 K was used as blank. Chimney samples were collected in South Mariana hydrothermal systems, the Pacific Ocean in 2003 in a part of the Archaean Park Project.

Phosphatase was extracted from solid samples with Tris buffer solution, and the enzymatic activity in the extract was fluorometrically assayed with 4-methylumbonylferyl phosphate as a substrate. Thermal stability and temperature-dependence of phosphatase were examined. Amino acid concentration in the same sample was also determined.

Outer part of the chimney samples faced to cold seawater, while inner part of them faced to superheated hydrothermal fluid. The former showed phosphatase activity, but the latter did not. Phosphatase extracted from the outer chimney, however, showed higher optimum temperature than E. coli. Thus, it is suggested that phosphatase found in the inner chimney was of thermophiles origin. Some Antarctica soils showed phosphatase activity, and some of them showed poorer thermal stability than E. coli alkaline phosphatase. Soil sampled at Langhovde penguins rookeries showed high phosphatase activity, and their thermal stability was close to E. coli's. This suggested that major source of phosphatase found in the soil was of microorganisms living in penguins' bodies.

Various enzymes have been detected in extreme environments. Characterization of such enzymes would give us further information on organisms living there. It can be said that phosphatase activity is a good biosignature for extant life in extreme environments.

Keywords: phosphatase activity, biological activity, extreme environments, amino acids, Antarctica, submarine hydrothermal systems