Amino acids and phosphatase activity in Antarctic soil samples near Showa base

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Antarctic soil samples were collected near Showa Station during the 47th and 49th Japanese Antarctic exploration mission in 2004-5 and 2006-7. Reference samples used were surface soil collected in the campus of Yokohama National University and carbonaceous chondrite (Murchison meteorite). Blank run was performed by using sea sand after heated at 773 K.

Amino acids were extracted with hot water at 373 K for 24 h, and by digestion at 383 K for 24 h in a Teflon vessel with mixed acid of 5 M HF and 0.1 M HCl. Both extract was then acid hydrolyzed and desalted with AG-50 resin. Amino acids were determined by HPLC (Shimadzu LC-10 Amino Acid Analyzer). D/L ratio was measured by GC/MS method after derivatization with chloroformate.

Phosphatase activity was directly measured spectrometrically at 410 nm after mixing the soil samples and p-nitrophenyl phosphate (substrate). Phosphatases were characterized after extraction with Tris buffer, where activity was assayed with 4-methylumberyferryl phosphate as a substrate. Radio tolerance was evaluated by irradiation of heavy ions (He, Ne, C beams) from HIMAC (NIRS, Japan).

Glycine was predominant among amino acids. Glycine concentration of Antarctic soil (Site 5; low biological activity) was 39.3 nmol/g (HF digestion) and 9.44 nmol/g (hot water extraction), respectively. The same tendency was observed in the case of meteorite analysis. It is suggested that most of amino acids in soils and meteorites are strongly bound to mineral matrix, and HF digestion was useful to evaluate total amino acids in these samples. Glycine concentration in Antarctic soil (Site 8; near Adelie penguin rookery) showed as high as 6090 nmol/g (HF digestion) that is close to that of campus soil. D/L ratio of alanine was 0.18 (Site 5) and 0.09 (Site 8); negative correlation was found between the D/L value and biological activity.

Phosphatase activity in soils with high biological activity (e.g., Site 8) was higher than that with low biological activity (e.g., Site 5). Phosphatase in Antarctic soil showed lower optimum temperature than that in campus soil and that of E. coli. Phosphatase in Antarctic soil showed stronger radio tolerance than that in campus soil.

Present results showed that amino acids and phosphatases are good indicators of biological activity in extreme environments.