Biophile isotopic behaviors and biomarkers related with microbial activity in semi-permafrost environment

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Interest in the thermal limit of life in various temperature environments has been growing (e.g. Rothschild and Mancinelli, 2001). Many microbes and cell lines can be preserved successfully at - 196 degree-C (liquid nitrogen), but the lowest recorded temperature for active microbial communities was substantially higher, at -18 degree-C (Clark, 2003). The permafrost microbial community has been described as a community of survivors (Friedmann, 1994). Permafrost environments consist of perennially frozen ground and represent unique physical, chemical and microbiological characteristics (e.g. Rivkina et al., 2000; Rivkina et al., 2004).

This report deals with the analyses of stable isotope ratios of carbon (delta 13C) and nitrogen (delta 15N) of semi-permafrost terrestrial sediments from Rikubetsu, Hokkaido, Japan. The delta 13C and delta 15N values of organic matter ranged from -24.7 to -28.1 permil and from +2.0 to +6.5 permil, respectively. A plot of these points yielded a straight line as defined by a least-squares method and could be expressed by the equation delta 13C = 1.1 delta 15N + 33.4 ($r = 0.93$). There was a marked fluctuation in the biophile isotope ratio in the shallow depth and a similar change in the viable microbial cell density. The vertical profile of the delta 13C and delta 15N values showed a negative correlation with the total organic carbon (TOC) and the total organic nitrogen (TON), respectively. Consequently, it was determined that the biophile isotopic fluctuation in the labile organic matter (LOM) phase was significantly more dramatic than changes in the refractory organic matter (ROM).

[Reference]
Y. Takano, J. Kudo, K. Takeo, K. Kobayashi, Y. Kawasaki and Y. Ishikawa: Geochemical Journal, 38, 153-161 (2004).