Life on the edges of the global biosphere

T. NAGANUMA

School of Biosphere Sciences, Hiroshima University, Higashi-hiroshima, Japan (takn@hiroshima-u.ac.jp)

The search for life on the edge of global biosphere is a frontier to bridge conventional bio/ecology and exo/astrobiology. This presentation reviews the foci of microbiological studies on the inhabitants of the selected "edges", i.e., deep-sea, deep subsurface and Antarctic habitats. The “salty” edges such as sub-hydrothermal vents, sub-seafloor gas hydrates, deserts, and Antarctic dry terrains, are newly added to the study target.

The deep-sea is characterized as the no-light (non-photosynthetic) habitat, and the primary production is mostly due to the chemosynthetic autotrophy at the hydrothermal vents and methane-rich seeps. Formation of the chemosynthesis-dependent animal communities in the deep leads to the idea that such communities may be found in "ocean" of the Jovian satellite, Europa. The oxygen minimal layer (OML) in mid-water provides another field of deep-sea research. Modern OML is a relatively thin layer, found between the water depth of 200 and 1000 m, but was much thicker during the periods of oceanic anoxia events (OAEs) in the past. The history of oceanic biosphere is regarded as the cycle of OAE and non-OAE periods, and the remnants of the past OAEs may be seen in the modern OML. Anoxic (no-O_2) condition is also characteristic of deep subsurface biosphere. Microorganisms in deep subsurface biosphere exploit every available oxidant, or terminal electron acceptor (TEA), for anaerobic respiration. Sulfate, nitrate, iron (III) and CO_2 are the representative TEAs in the deep subsurface. Subsurface of hydrothermal vents, or sub-vent biosphere, may house brine (high salt) habitats and halophilic microorganisms. Some sub-vent halophiles were phylogenetically closely similar to the ones found in the Antarctic habitats which are extremely dry by the lyophilizing climate. Below the 3000-4000 m-thick glacier on Antarctica, there have been >70 lakes with liquid water located. One of such sub-glacial lakes, Lake Vostok, has been a target of "life in extreme environments" and is about to be drill-penetrated for microbiological studies. These 'microbiological platforms' will provide new knowledge about the diversity and potential of the Earth's life and facilitate the capability of astrobiologial exploration.

Noble gases in Yamato 000749 nakhlite by laser microprobe analysis

K. NAGAO[1], R. OKAZAKI[1], N. IMAE[2] AND H. KOJIMA[2]

[1] Laboratory for Earthquake Chemistry, Graduate School of Science, University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan (nagao@eqchem.s.u-tokyo.ac.jp)

[2] Antarctic Meteorite Research Center, National Institute of Polar Research, Kaga, Itabashi-ku, Tokyo 173-8515, Japan

Three nakhlites, Y000593 (13.7kg), Y000749 (1.3kg) and Y000802 (22g), have been discovered at the Yamato meteorite field by Japanese Antarctic Research Expedition in 2000 [1]. Their noble gas compositions [2] show that; 1) similar noble gas compositions among them support the pairing as proporsed by mineralogical and petrological investigation and field recognition, 2) average cosmic-ray exposure age of 12.1±0.7 Ma agrees with those of other three nakhlites, 3) K-Ar age of ≤1.2Ga also in the range of nakhlites, and 4) high $^{129}Xe/^{132}Xe$ and low $^{84}Kr/^{132}Xe$ ratios are characteristic for nakhlites. These results indicate that the Yamato nakhlites were ejected from Mars with other nakhlites, Nakhla, Lafayette and Governador Valadares, by a single impact event.

It has been reported that the characteristic noble gases noted in 4) are trapped in iddingsite [3], while others [4, 5] reported a mesostasis as the host phase of the noble gases We are conducting an experiment to measure noble gases in various minerals in the Y000749 nakhlite using laser microprobe for noble gas ectraction. A thick plate (300μm in thickness) with polished surface prepared from the meteorite was set in an ultra-high vacuum chamber. Selected portion of the plate was irradiated by a Nd-YAG laser (1064nm in wavelength) to fuse 50-100 μm area. Released noble gases from the melted material (1-10 μg in weight) were measured on a modified VG5400(MS-II) mass spectrometer.

Mesostasis was abundant in the sample plate, while iddingsite was minor phase. Olivine and pyroxene crystals were clearly observed. High concentrations of noble gases are detected in mesostasis, while the concentrations are very low in olivine and pyroxene. Radiogenic ^{4}He and ^{40}Ar are abundant in mesostasis, which might be attributed to in situ produced nuclides from U, Th and ^{40}K. However, Xe with ^{129}Xe excess and low $^{84}Kr/^{132}Xe$ ratios are also observed in the mesostasis. The results imply that the main trapping site of the fractionated martian atomsphere is mesostasis in the Yamato nakhlite, though radioacitve nuclides (U, Th and ^{40}K) likely be concentrated in mesostasis. Hence, the mesostasis formation would be closely related with trapping mechanism of elementally fractionated martian atmosphere.

References

[1] Imae et al. (2002) LPS #1483; [2] Okazaki et al. (2003) Antarct. Meteorite Res., NIPR Japan (in press); [3] Drake et al. (1994) Meteoritics **29**, 854-859; [4] Gilmour et al. (1999) EPSL.**166**, 139-147: [5] Bart et al. (2001) LPS #1363.