6.7.P02

Dating method of the martian permafrost and ice using isotopic ratios of dissolved gases

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We propose a new method to determine the timing when the water on Mars was frozen. The method is based on measurements of isotopic ratios of gases dissolved and (trapped) in ice.

Mars-Odyssey mission discovered ice and/or permafrost with high ice content under Martian surface. During water-freezing events dissolved atmospheric gases could be "trapped" in ice. Abundance of the dissolved gases depend on their chemical composition and atmospheric partial pressure. However, the composition of the Martian atmosphere was changing in time. Therefore, by measuring dissolved gases we can reconstruct the age and conditions when the freezing took place.

The most promising ratios to measure are $^{15}N/^{14}N$, $^{36}Ar/^{38}Ar$,$^{40}Ar/^{36}Ar$. They do not depend on chemical processes on the planetary surface. These ratios are set by the rate of non-thermal escape and the rate of outgassing . At present, isotopic ratios of $^{15}N/^{14}N$, $^{36}Ar/^{38}Ar$ in the Martian atmosphere are 1.6 and 1.3 times higher than the terrestrial ones although the isotopic compositions of sources of these gases should have been similar on both planets. Our estimations show that we can determine the age of the last contact of the liquid water with the Martian atmosphere with the accuracy of 10–100 Myr.

^3He accumulated in the Martian ice is another potential candidate for the age determination of the freezing events. ^3He is produced by the intensive flux of the cosmic rays at the Martian surface. To implement this tracer in the Martian missions we propose an effective method of gas-extraction from ice (including selective extraction of He) followed by mass-spectrometric analysis. We estimate the range of ^3He dating method as 10^5-10^8 yr

Using the proposed method, we can also reveal the imprints of ancient biological activity by measuring biogenic gases like NH_3, CH_4, H_2S, which are virtually absent in the modern Martian atmosphere. Those gases are subject to quick oxidation in the Martian soil. However, ice and permafrost are good environments for the preservation of these gases.

6.7.P03

Probing life's upper temperature limits using parallel microscopic and biochemical approaches

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Low biomass, extreme environments on Earth are a challenging milieu in which to explore geomicrobiological processes. Investigation of these systems requires stringent criteria to confirm the origin and identity of putative microbial structures prior to studying their ecology. Deep-sea hydrothermal vents harbor liquid water at temperatures above 300ºC and yield organisms which consistently test the known upper temperature limits to microbial life, currently 121ºC [1]. Observations of deep-sea hydrothermal chimneys suggest the occurrence of organisms beyond this boundary in situ [2]. To build such a case (based upon in situ observations), however, requires a rigorous co-registered approach to confirm the biogenicity of the structures observed and probe their identities and activities. We have developed one such approach, using multiple fluorescent stains targeting specific biochemical entities to detect and characterize microbial structures within natural geological matrices.

Hyperthermophilic cultures incubated under varying conditions were used to develop and validate the described method. Samples were characterized by epifluorescence microscopy prior to and following application of nucleic acid- and membrane-specific stains. Subsequently, the targeted molecules were enzymatically degraded and the disappearance of fluorescent signal was observed. In the cultures, intact, ribosome-containing cells could be distinguished from inactive and membrane-compromised cells, which were more abundant during sub-optimal conditions. Analysis of mineral surfaces within thermal-chemical gradients at deep-sea vents documented abundant and active microbial communities in moderate temperature environments and the absence of cells within extremely high-temperature environments. The described approach provides a means to confirm the biological nature of putative microbial structures and offers insight into their structural integrity and activity. In combination with detailed phylogenetic and geochemical analyses this approach can elucidate the processes occuring near and above the known upper temperature limits to life.

References

[1] Kashefi K and Lovley D.R. (2003) *Science* **301,** 934.
[2] Schrenk M.O., Kelley D.S., Delaney J.R., and Baross J.A. (2003) *Appl. Environ. Microbiol.* **69,** 3580-3592.