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Habitability of Mars (F34)

HABITABILITY OF MARS: HYPERTHERMOPHILES IN PERMAFROST

David Gilichinsky, gilichin@online.stack.net
Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Russia
Elizaveta Rivkina, elizaveta.rivkina@gmail.com
Institute of physicochemical & biological problems in Soil Science, Russian Academy of Sciences, Pushchino, Russia
Tatiana Vishnivetskaya, vishnivetsta@ornl.gov
Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States
Gomez Felipe, gomezgf@inta.es
Centro de Astrobiolog, Spain
Vasilii Mironov, gambrinus.soil@gmail.com
Institute of Physicochemical and Biological Problems of Soil Science, Russian Academy of Sciences, Pushchino, Russia
Jenny Blamey, jblamey@bioscience.cl
Fundacion Bdiociencia, Chile
Miguel Ramos, miguel.ramos@uah.es
University of Alcala, Spain
Miguel Ángel De Pablo, miguelangel.depablo@uah.es
Dpto. de Geología. Universidad de Alcalá, Alcalá De Henares, Spain
Miguel Castro, orickmer@bioscience.cl
Fundacion Biociencia, Chile
Freddy Boehmwald, orickmer@bioscience.cl
Fundacion Biociencia, Chile

This is a first microbiological study of volcanic permafrost carried out on Kluchevskaya volcano group (Kamchatka Peninsula) and Deception Island (Antarctica). By culture- and culture-independent methods we showed the presence of viable hyper(thermophilic) microorganisms and their genes within volcanic permafrost. The optimal temperature for sulfide producing bacteria was 65, whereas acetogens and methanogens were able to produce acetate and methane at temperatures up to 75^{o}C, while sulphur-reducers showed optimal growth at 85-92^{o}C. Hyper(thermophiles) were never found in permafrost outside the volcanic areas before. The only way they are to appear within a frozen material is a concurrent deposition during the eruption, together with products associated with volcano heated subsurface geothermal oases. The eloquent evidence to the hypothesis is the presence among clones of the sequences affiliated with

(hyper)thermophilic bacteria, both, aerobic and anaerobic, in the environmental DNA derived from ashes freshly deposited on snow in close proximity to volcano Shiveluch (Kamchatka) and aerobic bacteria incubated at 80°C from ashes freshly deposited on the top of Llaima Volcano glacier (Andes). Thus, in the areas of active volcanism the catastrophic geological events transports the life from the depths to the surface and this life from high-temperature ecological niches might survive in permafrost over a long period of time. The results obtained give insights for habitability of Mars. Terrestrial permafrost represents a possible ecosystem for Mars as an Earth-like cryogenic planet. But permafrost on Earth and Mars vary in age, from a few million years on Earth to a few billion years on Mars. Because such difference in age, the longevity of life forms preserved within terrestrial permafrost may only serve as an approximate model for Mars. On the other hand, numerous ancient extinct volcanoes are known on Mars. Their past eruptions periodically burn-through the frozen strata by magma fluxes and formed the thermal and water oases. Simultaneously, products of eruptions (lava, rock debris, scoria, ash) lift from the depths to the surface and freeze. The age of these permanently frozen volcanic deposits is much younger than the age of surrounding permafrost, and the age of youngest volcanoes date back to few million - few dozen million years. It is reasonable to expect to find here the youngest permafrost of the age close to that one on Earth, and analogously to the Earth (even if the recent Mars is a sterile planet), inhabited by viable life forms coming from the depths. This is why the terrestrial hyper(thermophilic) psychrotolerant microbial inhabitants of the volcanic permafrost might serve as a model for hypothesis of existing microorganisms, that may probably be found in permafrost around young Martian volcanoes. For free of oxygen Martian subsurface with inaccessible organic matter these microorganisms should be chemolithotrophic anaerobes with mechanisms to assimilate CO_2.