Sub-aerial rock-inhabiting communities: Role in land colonization and contribution to biogeochemistry of rock surfaces

ANNA A. GORBUSHINA

Geomicrobiology, ICBM, Carl von Ossietzky University Oldenburg, P.O. Box 2503, 26111 Oldenburg, Germany (a.gorbushina@uni-oldenburg.de)

Throughout a remarkably long period the biosphere on planet Earth consisted not of multi-cellular macro-organisms, but of mono-layered microbial communities termed biofilms. In the absence of macroorganisms land colonisation has been proceeding by biofilm growth on bare rock surfaces. The very long history of sub-aerial biofilm existence and development resulted in a high degree of their specialisation in different environmental conditions including desert rocks and high mountain altitudes. Presently the interface between the rock substrate and the atmosphere is inhabited by a complex microbial community of chemoorganotrophic and phototrophic microorganisms metabolising under limited water availability and high sun irradiation. Chemoorganotrophic fungi are related to the amount of organic energy-rich compounds contained in the surrounding atmosphere and are the most enduring and important sub-aerial rock dwellers.

It should be pointed out, that (1) these biofilm communities cannot be considered as "primitive" ones regarding the very long history of their development and high degree of their specialized organisation; and (2) bacterial and fungal biofilms cannot be compared to lichen communities, evolving much later than biofilm ecosystems. Our experimental evidence confirms the hypothesis that the colonization of land by eukaryotes was facilitated by a symbiosis between a photosynthesizing organism and a fungus that were equipped to cope with the problems associated with terrestrial existence. Another important issue in studies of sub-aerial epi- and endolithic biofilms is their ability to create and maintain biologically modified environments where mineral solubility and dissolution rates are significantly altered and new metabolic products are deposited on the rock surface. The diverse spectrum of fungal activities on the formation and transformation of minerals will be presented. Further geomicrobiological and biogeochemical role and modifications of biofilm metabolic products on rock surfaces will be discussed.

High resolution structural and chemical characterisation of framboidal pyrite formed within a bacterial biofilm

L.C.W. MACLEAN[1], T.J. PRAY[2], T.C. ONSTOTT[2] AND G. SOUTHAM[1]

[1]Dept. of Earth Sciences, The University of Western Ontario, London, ON Canada N6A5B7 (lmaclea@uwo.ca, gsoutham@uwo.ca)

[2]Dept. of Geosciences, Princeton University, Princeton, NJ USA 08544 (tpray@Princeton.edu, tullis@Princeton.edu)

A novel, anaerobically growing microbial biofilm, scraped from the inner surface of a borehole, 1,474 m below land surface within a Witwatersrand gold mine (Republic of South Africa) was found to possess framboidal pyrite. The water flowing from the borehole was measured to be at 30.9°C, pH 7.4, with an Eh = –250 mV.

Focused ion beam sectioning, field emission gun scanning electron microscopy (FIBS/FEG-SEM) of framboids from within the biofilm (Figure 1) supports early theories of framboidal pyrite formation via an organic matrix (e.g., Love, 1957) in this low temperature diagenetic environment.

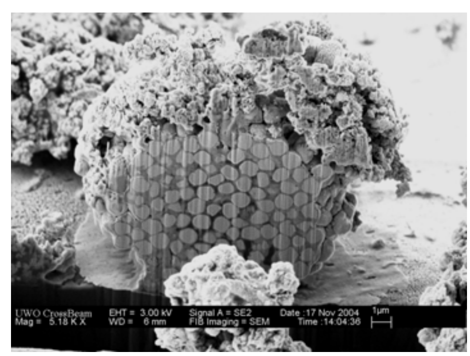

Figure 1: FEG-SEM of a FIB sectioned framboid observed within a microbial biofilm.

Elemental x-ray analysis via energy dispersive spectroscopy (EDS) revealed an extensive carbon matrix encasing individual pyrite crystals within the framboidal structure. While vegetative and fossilized bacterial cells are present throughout the biofilm, no bacterial fossils have been identified within the framboids.

Reference

Love, L.G., (1957), Geol. Soc. [Lond.] Quart. J. **291**, 55-89.