Geophysical Research Abstracts, Vol. 9, 11333, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-11333

Life in extreme environment: environmental stress factors and biogeochemical benefits for pioneer animals on smoker walls

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Black smoker walls are by far the most extreme habitats of the deep-sea. The outstanding short-scale thermal and chemical variability there constitutes the most important threat for life. If a wide diversity of microbes can colonize these environments, only a few highly specialized metazoans are adapted to such conditions. In this respect, the east-Pacific rise annelid *Alvinella pompejana* can be viewed as a model organism. Across the thickness their tube aggregation, temperature varies from less than 10 ˚C to over 100 ˚C, pH decreases from 8 down to 4 and the observed millimolar sulphide gradients likely combine with a transition from slightly hypoxic to fully anoxic conditions (Le Bris and Gaill, 2007).

This short-scale variability has long prevented to consider the temporal and spatial changes characterizing the environment of Alvinella colonies at larger scales. Our multi-site study along the East Pacific Rise reveals that the iron to sulphide ratio widely varies in local venting sources. The consequence of this variability in terms of chemical stresses and biogeochemical energy sources is of main importance to the communities. Not only the reduction of sulphide toxicity by formation of iron sulphide complexes (Luther et al. 2001), but also abiotic depletion of oxygen and sulphide from the medium through catalytic processes are expected. Temperature conditions at the surface of colonies also largely differ among chimneys. This was hypothesized to reflect the progressive reduction of hot fluid emission as chimney aged. Our study of thermal and chemical gradients at the interface additionally reveals that the Alvinella

colony in fact substantially contributes to the cooling process. The evolution of chemical habitat conditions over time and their biogeochemical consequence should thus be both constrained by geologically-driven changes in Fe:S ratio and colonization progress. Based on in situ characterization and geochemical modelling, we propose a scheme for the temporal evolution of these habitats from initial settlement stages on a chimney aged of only a few months, to several year old edifices where the venting activity has apparently decreased. This will provide a basis for a future experimental study of the biological adaptations of this species to the different stress factors of its extreme environment.

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