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Membrane lipid adaptation of microorganisms to "extreme" environmental conditions

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Adaptation to “extreme” environmental conditions is an essential process for microorganisms to survive in deep subsurface environments e.g. in the so called Deep Biosphere (e.g. Parkes et al., 2000). The microorganisms existing in such subsurface habitats comprise archaea and bacteria, and their occurrence is most probably highly dependent on the ambient conditions. Consequently, effects of temperature, pressure, or nutrient changes on microorganisms have been frequently studied.

Within our current studies the focus is on the cellular lipid composition of microorganisms, especially on the membrane phospholipid constituents, which have been observed to show systematic structural variations within their fatty acyl side-chains and also their head groups as response to either pressure (LT25: 99 % similarity to *Vibrio diazotrophicus*; hyperthermophilic *Pyrococcus furiosus* and *P. glycovorans*) or substrate changes (ß-proteobacterium EbN1). Strains were sampled from deep subsurface sediments (LT25), from coast (*P. furiosus*) and deep sea (*P. glycovorans*) or are laboratory cultures (EbN1). Pressure experiments were carried out under atmospheric and high (25-26 MPa) pressure. EbN1 was cultivated under different alkylbenzene concentrations, from standard to sublethal with regard to different degrees of hydro-

carbon biodegradation. For investigation of the microbial lipid distributions we use an HPLC-ESI-MS/MS method allowing structural elucidation and quantification of individual phospholipids (PLs).

Both bacterial and archaeal strains show significant changes in the composition of their cell membrane lipid composition under higher pressure: preferential incorporation of extended head groups and/or double bonds. These changes are interpreted as an adaptation in response to increasing growth pressure to maintain the cell membrane fluidity. The effect of different alkylbenzene concentrations on EbN1 on the PL composition is more complex but at the same time clearly reflects restructuring processes to improve cell membrane stability by enhanced proportions of PLs with larger head groups and less double bonds, which counterbalance the maceration of the membrane after dissolution of hydrocarbons within the lipid bilayer.

References

Parkes, R.J., Cragg, B.A., Wellsbury, P., 2000. Hydrogeology Journal 8, 11-28.