Geophysical Research Abstracts
Vol. 13, EGU2011-14145, 2011
EGU General Assembly 2011

Microbial Induced Mineral Formation in the Deep-Subsurface Biosphere

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Prokaryotes, in general, have been dubbed "The Unseen Majority" and those living in the deep subsurface have been estimated to represent approximately 30% of the Earth's total living biomass (Whitman et al., 1998). In fact, over a surprisingly broad range of depths, temperatures and pressures, the deep subsurface, in both marine and continental realms, hosts an extensive microbial population comprising the deep biosphere. Geochemists studying cored material have long recognized that the deep-sea subsurface cannot be barren of life because the buried sediments and rocks contain distinctive geochemical signals in the associated pore waters and in situ mineral deposits, which are indicative of microbial activity.

Promoted by international research drilling programs, such as IODP and ICDP, a new understanding of this deep microbial activity is evolving with the application of microbiologic and molecular techniques to samples cored from various depositional environments. Biogeochemical studies clearly show fluxes of metabolic reactants and products demonstrating that a very diverse microbial activity exists at depth. These metabolic processes with associated reactions impact the microenvironments leading to microbial induced mineral formation or dissolution. Although the metabolic processes employed by the subsurface microorganisms may be similar to those of surface species, they function under uniquely different environmental conditions. For example, the lack of light at depth excludes photosynthesis. Thus, the subsurface microbial life is dependent on buried energy sources or influxes of dissolved components with circulating fluids. Also, because oxygen is rapidly depleted with depth, anaerobic processes must dominate.

Although we are only beginning to comprehend the nature and importance of this subsurface biosphere, it will undoubtedly be an important factor to consider when evaluating any carbon capture and storage (CCS) program utilizing subsurface formations. Determining how microbial communities respond to perturbations induced by the injection of CO_2 in a gaseous to supercritical state will continue to be a challenging research topic of the future.

Whitman, W.B., D.C. Coleman, and W.J. Wiebe. 1998. Prokaryotes: The unseen majority. *Proceedings of the National Academy of Sciences of the United States of America* 95:6,578–6,583.