Habitability of serpentinizng systems for methanogenic microorganisms: An energy balance model

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Serpentinizing systems can produce highly H_2-enriched fluids and thereby offer a potentially excellent habitat for hydrogen-consuming organisms, including CO_2-reducing methanogens. However, highly alkaline conditions may severely limit the supply of CO_2 to such organisms, thereby limiting the potential energy intake. Likewise, maintenance of clement intracellular pH under such conditions requires significant energy expenditure by the cell, and elevated temperatures are also expected to increase cellular energy demands. Habitability of such environments with respect to methanogenesis therefore depends largely on a balance between cellular energy demands and environmental energy availability, which is strongly influenced by local physico-chemical conditions. Using a cell-scale reaction-diffusion model, this energy balance can be characterized as a function of pH, temperature, and H_2 activity in the surrounding fluids. The boundaries of habitability for methanogens are mapped via this model, with initial application to vent fluid-like conditions. Model results also demonstrate the relative contributions to energy balance of passive vs. active transport strategies for carbon uptake, with the upper range of pH values accessible to methanogens only through adoption of the latter.

Antarctic Circumpolar Current Nd isotope variability recorded in Amundsen Sea deep sea corals

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The Antarctic Circumpolar Current (ACC) is volumetrically the largest ocean current and the most important pathway for the transfer of water between the major ocean basins. As it passes through the Drake Passage at present-day, the ACC has a homogenous Nd isotopic composition of ~-8.5 ε_{Nd} [1]. In simple terms this composition is a result of mixing between Atlantic, Indian and Pacific water masses as the ACC circulates around Antarctica. We have obtained calendar ages for a set of deep sea scleraxonian octocorals from the Amundsen Sea sector of the Southern Ocean employing the ^{230}Th/U-dating method, as well as Nd isotope data. Most corals are of Holocene age, but several deglacial and fully glacial samples have also been dated. The Holocene corals analysed here have ε_{Nd} in very good agreement with direct seawater measurements presented by Piepgras & Wasserburg [1] from the Drake Passage. Our data indicate that the ACC Nd isotopic composition remained fairly constant for most of the Holocene. Deep sea coral specimens pre-dating the Holocene, however, are systematically more radiogenic. The most radiogenic composition was found for a coral dated to Marine Isotope Stage 3 and dredged from ~2500 m water depth, yielding an ε_{Nd} of -6.8 ± 0.3. This composition is in excellent agreement with the Nd isotopic compositions reported by Albarede *et al.* [2] (□$_{Nd}$ ~ -6.9 ± 0.4) for surface scrapings from ferro-manganese crusts at 4987 m water depth at nearby sampling locations. Given the trends observed in the high-resolution Nd isotope record in Fe-Mn oxyhydroxides from the Cape Basin [3], the shift towards more radiogenic compositions seen here is most likely a function of reduced North Atlantic Deep Water contributions to the ACC during the last glacial cycle, unless the NADW end-member compositions was different at any stage preceding the Holocene.

[1] Piepgras & Wasserburg (1982) *Science* **217**, 207-214. [2] Albarède *et al.* (1997) *GCA* **61**, 1277-1291. [3] Piotrowski *et al.* (2005) *Science* **307**, 1933-1937.