BIOGEOCHEMISTRY OF BASEMENT FLUIDS FROM THE SEDIMENT-BURIED JUAN de FUCA RIDGE FLANKS

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ABSTRACT

The most in depth examination to date of the biogeochemistry of oceanic basement fluids is provided for the sediment-buried Juan de Fuca Ridge flank with a crustal age of 3.5 Ma. The overall goals of this study are to understand the available nutrients, substrates and geochemical energy for the sediment-buried ridge-flank basement biosphere and to evaluate the impact that the ridge-flank hydrothermal system may have on the global ocean organic carbon cycle. Tremendous efforts were made to obtain high quality ridge-flank basement fluid samples by developing a novel clean sampling system to obtain fluids via delivery lines associated with Circulation Obviation Retrofit Kit (CORK) observatories installed in Integrated Ocean Drilling Program (IODP) boreholes 1301A, 1362A and 1362B.

The low phosphate concentrations (0.06-0.1 μM) in ridge-flank basement fluids, relative to dissolved inorganic carbon (0.46-0.59 mM) and ammonium (99-102 μM) suggest that phosphate could be a limiting major nutrient in the basement biosphere. Both methane (1.5-13μM) and hydrogen (0.05-2 μM) are present at significantly higher concentrations in ridge-flank basement fluids than in background seawater (0.0002 and 0.0004 μM, respectively), providing energy for methanotrophs and hydrogenotrophic microorganisms. The $\delta^{13}C\text{-}CH_4$ values for CORK 1301A fluids (-42±2 ‰, n=4) fall within the range of isotopic values for thermogenic (-20‰ to -62‰) and near the ^{13}C enriched compositions of biogenic (-110‰ to -45‰) methane. The low dissolved organic carbon (DOC) concentrations in the ridge-flank basement fluids (11-16 μM) confirm that the basement is a net sink for deep seawater DOC (~40 μM). However, the elevated dissolved amino acids concentrations (53-89 nM) suggest that ridge-flank basement fluid is a net source

for deep seawater amino acids (~50 nM) and that amino acids may be utilized by heterotrophic microorganisms in the basement environment. In addition, significant differences in concentrations of dissolved methane, hydrogen and amino acids in basement fluids collected from the three study sites indicate that the aquifer is heterogeneous on at the scale of hundreds of meters, suggesting that variable microbial community compositions and/or different microbial activities may be found at the three sites.