Distribution of aerobic microbial activities in ultra-oligotrophic sediments of the South Pacific Gyre

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During the Integrated Ocean Drilling Program (IODP) Expedition 329, we observed the presence of aerobic microbial communities and dissolved oxygen throughout the sedimentary sequence from the seafloor to the sediment-basement interface at all sites we explored in the South Pacific Gyre (SPG) [1]. This finding indicated that the sedimentary biosphere in the oligotrophic ocean region has no depth limit and continues down to the basement. However, the physiology of these aerobic microbial communities, including substrate metabolism remains poorly constrained.
In this study, we studied substrate assimilation activities of aerobic microbial cells in SPG sediment samples by ^{13}C- and ^{15}N-stable isotope incubation followed by Nano-scale Secondary Ion Mass Spectroscopy (NanoSIMS) isotope imaging. We incubated subsampled mini-cores (15 cm^3) with various carbon substrates and ammonia for 1.5 years. Assimilation activities, as well as increase in cell abundance on various heterotrophic conditions (e.g., ^{13}C-labeled glucose, acetate, and pyruvate, and ^{13}C- and ^{15}N-labeled amino acids) were seen at even oldest (around 100 Ma) sediment sample examined. Anaerobic incubation for the sample obtained from almost anoxic condition resulted in the observation of a lower number of substrate-incorporating cells, indicating oxic biosphere still present in such oxygen minimum horizon. Our results demonstrate that living microbial communities distribute in the ultra-oligotrophic SPG sedimentary biosphere and are mainly consisted of the aerobic microbial ecosystem. The microbes retain their metabolic potentials under the most energetically challenging conditions up to hundred million years.

[1] D'Hondt, S. et al., Nature Geoscience, 8(4), 299-304, 2015.

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