Discovery of living microbes from the ancient subseafloor sediment up to 101.5 million years old: How is it possible for microbes to survive for such a geological timescale?

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Marine subseafloor harbors a remarkable microbial population that comprises 12-45% of total microbial biomass or ~0.6-2% of total living biomass on Earth (1-3). Recent findings also demonstrated the large diversity of the subseafloor microbial population that matches marine or soil microbiome (4). However, the rate at which they use energy is reported to be extremely low, at energy fluxes lower than previously shown to support life (5).
In 2009, we obtained subseafloor sediment samples at an ultraoligotrophic oceanic region of South Pacific Gyre (SPG) during the Integrated Ocean Drilling Program (IODP) Expedition 329. Incubation experiments conducted using old (4.3-101.5 Ma) sediments showed that diverse aerobic members of communities in SPG sediments could readily incorporate carbon and nitrogen substrates and dividing(6). In contrast, anaerobic microbes were only minimally revived from this oxic sediment. These results suggested that microbial communities distributed in organic-poor abyssal sediment consist mainly of aerobes that retain their metabolic potential under extremely low-energy conditions for up to 101.5 Ma. Still, the mechanism that enabled microbes to survive is uncertain. The constraints in nutrient, energy, and spatial structure will be discussed in the context of microbial survival in the subseafloor sedimentary environment.

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