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Microbial survival through high metabolic rates in a deep and hot subseafloor environment

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A fourth of the global seabed sediment volume is buried at depths where temperatures exceed 80 °C, a previously proposed thermal barrier for life in the subsurface. Here, we demonstrate, utilizing an extensive suite of radiotracer experiments, the prevalence of active methanogenic and sulfate-reducing populations in deeply buried marine sediment from the Nankai Trough subduction zone, heated to extreme temperature (up to ~120 °C). Sediment cores were recovered during International Ocean Discovery Program (IODP) Expedition 370 to Nankai Trough, off the cost of Moroto, Japan. The steep geothermal gradient of ~100 °C km^{-1} allowed for the exploration of most of the known temperature range for life over just 1 km of drill core. Despite the high temperatures, microbial cells were detected almost throughout the entire sediment column, albeit at extremely low concentration of <500 cells per cm^3 in sediment above ~50 °C. In millions of years old sediment a small microbial community subsisted with high potential cell-specific rates of energy metabolism, which approach the rates of active surface sediments and laboratory cultures. Even under the most conservative assumptions, potential biomass turnover times for the recovered sediment ranges from days to years and therefore many orders of magnitude faster than in colder deep sediment.

Our discovery is in stark contrast to the extremely low metabolic rates otherwise observed in the deep subseafloor. As cells appear to invest most of their energy to repair thermal cell damage in

the hot sediment, they are forced to balance delicately between subsistence near the upper temperature limit for life and a rich supply of substrates and energy from thermally driven reactions of the sediment organic matter.