

IODP Expedition 370: Temperature Limit of the Deep Biosphere off Muroto

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International Ocean Discovery Program (IODP) Expedition 370 aimed to explore the limits of life in the deep seafloor biosphere at a location where temperature increases with depth at an intermediate rate and exceeds the known temperature maximum of microbial life ($\sim 120^{\circ}\text{C}$) at the sediment/basement interface ~ 1.2 km below the seafloor. Drilling Site C0023 is located in the vicinity of Ocean Drilling Program (ODP) Sites 808 and 1174 at the protothrust zone in the Nankai Trough off Cape Muroto at a water depth of 4776 m. ODP Leg 190 in 2000, revealed the presence of microbial cells at Site 1174 to a depth of ~ 600 meters below seafloor (mbsf), which corresponds to an estimated temperature of $\sim 70^{\circ}\text{C}$, and reliably identified a single zone of higher cell concentrations just above the décollement at around 800 mbsf, where temperature presumably reached 90°C ; no cell count data was reported for other sediment layers in the 70° – 120°C range, because the limit of sensitivity in cell counting for low-biomass samples was not high enough. With the establishment of Site C0023, we aimed to detect and investigate the presence or absence of life and biological processes at the biotic–abiotic transition with unprecedented analytical sensitivity and precision. Expedition 370 was the first expedition dedicated to seafloor microbiology that achieved time-critical processing and analyses of deep biosphere samples by simultaneous shipboard and shore-based investigations.

Our primary objectives during Expedition 370 were to study the relationship between the deep seafloor biosphere and temperature. We aimed to comprehensively study the factors that control biomass, activity, and diversity of microbial communities in a seafloor environment where temperatures increase from $\sim 2^{\circ}\text{C}$ at the seafloor to $\sim 120^{\circ}\text{C}$ at the sediment/basement interface and thus likely encompasses the biotic–abiotic transition zone. We also aimed to determine geochemical, geophysical, and hydrogeological characteristics in sediment and the underlying basaltic basement and elucidate if the supply of fluids containing thermogenic and/or geogenic nutrient and energy substrates may support seafloor microbial communities in the Nankai accretionary complex.

To address these primary scientific objectives and questions, we penetrated 1180 m and recovered 112 cores across the sediment/basalt interface. More than 13,000 samples were collected. Ensuring minimal contamination of potentially extremely low biomass core samples was of highest priority for the research objectives of Expedition 370. Therefore, rigorous quality assurance and quality control (QA/QC) efforts and super-clean technologies were implemented, including helicopter transport of freshly taken core samples to the onshore super-clean room facility at Kochi Core Center (KCC).

Keywords: IODP, Deep Biosphere