IODP Proposal Cover Sheet

Nankai Microbial Temperature Limit

865 - Full

Title	Constraining the temperature limit of the microbial deep biosphere in the Nankai Trough subseafloor
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Keywords	deep biosphere, limit of life
Area	Nankai Trough

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Abstract

We propose to drill and core new boreholes in the immediate vicinity of ODP Sites 1173 and 1174, in the central Nankai Trough off Japan. Anomalously high heat flow regimes at both sites result in temperatures of about 110 to 140°C at the sediment/basement interface (724 and 1194 mbsf, respectively), and make these sites ideal targets for an in-depth examination of subseafloor microbial life close its upper temperature limit. While the upper temperature limit appears well constrained at relatively energy-rich hydrothermal vent systems at just above 120°C, it is unknown in energy-starved sedimentary subseafloor settings but is generally presumed to be lower, and thus expected to be covered by our target sites. We thus propose to comprehensively study (1) the factors that control biomass, activity and diversity of microbial life in a temperature window that likely encompasses the biotic/abiotic transition, the so-called 'biotic fringe', (2) the relationship between thermogenic release of potential substrates and microbial life, and (3) to characterize the chemical and physical environment in sediments and basement rock at the biotic fringe. Our objectives are congruent with Challenge 6 in IODP's New Science Plan 'What are the limits of life in the subseafloor"and contribute to Challenge 5 'What are the origin, composition, and global significance of subseafloor communities?"

Due to their location in the trench (Site 1173) and landward protothrust zone of the Nankai Trough accretionary prism (Site 1174), the sites have different geotectonic and thermal histories which resulted in contrasting (bio)geochemical modes of hydrocarbon gas production and consumption. Together, they form an ideal natural laboratory for examining biotic vs. abiotic mechanisms of hydrocarbon production and consumption. Our program will benefit from the availability of an excellent pool of geological, geophysical, geochemical and geomicrobial data from ODP Legs 190 and 196 that set the stage for a highly focused, hypothesis-driven initiative that will take advantage of the enormous advances in microbiological and biogeochemical approaches since these sites were first sampled in 2000. We aim to drill and core both sites with non-riser technology down to the sediment/basement interface and ideally 20 to 120 m into the oceanic crust within 40 days of ship time (including logging operations and port-call). In order to maximize the probability of success, we have assembled an international, multidisciplinary team of proponents, including leading members from the continental drilling community and the Deep Carbon Observatory.

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Scientific Objectives

1 - We aim to study subseafloor sedimentary microbial communities situated in temperature ranges that cover the putative temperature limit of microbial life in anoxic sedimentary systems

We hypothesize that temperature increases with depth will be accompanied by substantial changes in the composition, function, and activity of microbial communities and that their population density decreases gradually rather than abruptly as suggested by previous preliminary examination of these sites.
State-of-the art cell quantification assays, molecular-biological and molecular-geochemical techniques set the stage for obtaining a comprehensive view of the relationship between microbial communities and temperature; expected results will go far beyond the initial observations made during Leg 190.

2 - We aim to examine the relationship between thermogenic release of potential substrates and microbial life

We will test existing hypotheses that predict stimulation of microbial activity by thermal decomposition of organic matter. To that end, we will conduct studies of genes, their expression, culture-dependent assays, biogeochemical activity measurements, advanced organic geochemical analyses and thermodynamic/kinetic models that specifically target potential substrates for microbial life, as well as document structural modifications of macromolecular organic matter induced by their release.

3 - We aim to characterize the chemical and physical environment in sediments and basement rock at the biotic fringe

Non-standard measurements technology needed to achieve the proposed scientific objectives.

Proposed Sites

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ODP11-73A	32.2444, 135.0251	4790	725	20	745	Is the temperature increase with depth accompanied by substantial changes in the composition, function, and activity of microbial communities? Does the population density of microbial communities decrease gradually or abruptly with temperature? How is the transition from predominantly biogenic (Site 1173) to predominantly thermogenic (Site 1174) gas formation related to the early thermal alteration of kerogen? What is the chemical and physical environment in sediments and basement rock at the biotic fringe? Which microorganisms inhabit the extended sulfate-methane transition

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-	-	-	-	-	-	zone in the depth interval of ~200-300 mbsf (~50 C) at Site 1173?
ODP11-74A	32.3423, 134.9565	4750	1194	120	1314	Is the temperature increase with depth accompanied by changes in the composition, function, and activity of microbial communities? Does the population density of microbial communities decrease gradually or abruptly with temperature? How is the transition from predominantly biogenic (Site 1173) to predominantly thermogenic (Site 1174) gas formation related to the early thermal alteration of kerogen? What is the chemical and physical environment in sediments and basement rock at the biotic fringe? Is microbial activity stimulated by fluid flow along the décollement? What is the history of fluid flow the uppermost oceanic crust and how does it stimulate microbial activity?