IODP Proposal Cover Sheet

Continental Margin Methane Cycling

836 - Apl

Title	Constraining methane cycling in continental margins: a combined microbiological, geochemical, and modeling approach at DSDP Site 262
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Area	Timor Trough

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Abstract

Microbial methanogenesis in continental margin sediments, where most marine organic carbon is deposited, is a widespread, yet poorly understood process in the global carbon cycle. Open questions include the pathways and rates of microbial methanogenesis; the influence of sediment temperature and organic matter characteristics; and the relative importance of shallow versus deep methanogenesis. We propose to address these outstanding questions by linking (1) microbiological experiments done at conditions comparable to those in situ, (2) geochemical measurements, and (3) reaction-transport modeling. The proposed study directly addresses Challenge 13 (What properties and processes govern the flow and storage of carbon in the subseafloor?) and Challenge 5 (What are the origin, composition, and global significance of subseafloor communities?) in the IODP 2013-2023 science plan. A previous proposal (791-APL) was focused on IODP Site U1325 (northern Cascadia margin), a location that will not be on the JR shiptrack in the near future. The research we envision is focused on a global process and is not tied to a specific location; we propose here a similar project at DSDP Site 262 (Timor Trough), which is in the area of JR operations in the next few years. Site 262 is an apt location because existing data show the presence of methane and intense microbial activity fueled by organic matter remineralization. We propose to core two additional holes: one to the original depth of Site 262 (442 mbsf), and one reaching just below the sulfate-methane transition (9.5 mbsf at Site 262). The measurement plan consists of high-resolution sampling for microbiology and geochemistry (0.5-5 m sampling interval), ~10 pressure cores with the PCS tool, APC-T temperature measurements, infrared core imaging, and downhole logging. Methanogenesis rates will be measured in microbiological experiments where sediment samples are inoculated in biomass recycle reactors that reproduce the starved conditions experienced in situ and in separate incubation experiments done under in situ pressure. We will also conduct an extensive geochemical program for interstitial waters (including organic matter metabolites, pH, Ca, Mg, Cl, volatile fatty acids, DOC), headspace gas (including N2 and Ar to estimate in situ methane concentration and H2), in situ methane from degassing of PCS cores, and organic matter characterization. Based on Site 262 operations, the proposed program can take place in ~4 days. A companion proposal will be submitted to support the science proposed herein.

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Scientific Objectives

The overall scientific goal is to improve our understanding of biogeochemical processes fueled by organic matter degradation in continental margin sediments. We will focus on comparing methanogenesis rates derived from microbiological experiments with the rates needed for reaction-transport modeling to match the geochemical observations. If experimental rates match the modeling rates, the observations can be explained by in situ methanogenesis only; if instead the experimental rates are insufficient to generate the observed amounts of methane, the existence of an alternate, possibly deeper source is supported. The proposed study will address outstanding questions on methane cycling in continental margin sediments: we will estimate in situ methanogenesis rates by experiments and modeling, test whether the observations require a deep methane source, investigate how methanogenesis rates are related to temperature, age and composition of organic matter, and clarify the role of methane in the complex set of near-seafloor biogeochemical reactions relevant to the C cycle. The planned measurements of in situ methane concentration will provide key constraints to the modeling and the estimated methanogenesis rates will inform models that quantify methane amounts in continental margin sediments. Additional benefits include a comparison of in situ methane estimates based on N2 and Ar with PCS data and a set of combined incubation and extraction-based measurements of H2.

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	
TIMOR-1A	-10.8698, 123.8463	2298	442	0	442	APL is for a single site, see the objectives in the proposal cover sheet.

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