IODP Proposal Cover Sheet

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South Atlantic Transect

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Title	Full Proposal for Multidisciplinary IODP Investigations along a Crustal Flow-line across the Western Flank of the Southern Mid-Atlantic Ridge: The South Atlantic Transect
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Keywords	MOR, Hydrothermal, Biosphere, Climate, Thermohaline
Area	Mid-Atlanic Ridge - Western flank

Proponent Information

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Abstract

DSDP Leg 3 drilled a transect of sediment holes across the western flank of the southern Mid-Atlantic Ridge to demonstrate that the basal sediment age increased with distance from the ridge, proving the theories of seafloor spreading and plate tectonics. During Leg 3 the sediments were only spot-cored, but revealed moderate to excellent preservation of the CaCO3 microfossils required to generate high-fidelity proxy data for paleoceanographic reconstructions. Given dramatic advances in drilling technology and analytical capabilities since Leg 3, many high priority scientific objectives could be addressed by revisiting the Leg 3 transect. We therefore propose a multidisciplinary IODP transect through the Leg 3 area at ~31 °S, to recover complete sediment sections and the upper 150-250 m of 7, 15, 31, 48 and 63 Ma ocean crust. This transect will simultaneously address multiple IODP Science Plan Challenges, maximizing the scientific output of the drilling effort.

The proposed transect, which follows a crustal flow-line from the slow/intermediate-spreading Mid-Atlantic Ridge, will fill critical gaps in our sampling of intact in-situ ocean crust with regards crustal age, spreading rate, and sediment thickness. These sections are required to investigate the history of the low-temperature hydrothermal interactions between the aging ocean crust and the evolving South Atlantic Ocean, and quantify past hydrothermal contributions to global geochemical cycles (Challenge 10). The transect traverses the hitherto unexplored sediment- and basalt-hosted deep biosphere beneath the South Atlantic gyre, samples of which are essential to refine global biomass estimates and investigate microbial ecosystems'responses to variable conditions in a low energy gyre and aging ocean crust (Challenges 5 and 7). The transect is also located near World Ocean Circulation Experiment (WOCE) line A10, providing access to records of carbonate chemistry and deep-water mass properties (e.g., temperature and composition) across the western South Atlantic through key Cenozoic intervals of elevated atmospheric CO2 and rapid climate change. Reconstruction of the history of the deep western boundary current and deep-water formation in the Atlantic basins will yield crucial data to test hypotheses regarding the role of evolving thermohaline circulation patterns in climate change, and the effects of tectonic gateways and climate on ocean acidification (Challenges 1, 2 and 4 of the Science Plan).

We propose two operational plans: Plan A can be accomplished in a single expedition; our preferred Plan B includes the installation of re-entry cones at each site to establish legacy boreholes for future basement hydrothermal and microbiological experiments.

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Scientific Objectives

The proposed drilling strategy exploits drilling targets that can simultaneously address multiple objectives of the IODP Science Plan, specifically:

PRIMARY OBJECTIVES:
1.EARTH CONNECTIONS THEME: Quantify the timing, duration and extent of ridge flank hydrothermal exchange, to: evaluate the effect of past changes in global spreading rates and the age-area distribution of the seafloor on hydrothermal contributions to global geochemical cycles; investigate signatures of changing ocean chemistry in the hydrothermal record; and develop medium resolution records of past ocean chemistry using hydrothermal minerals (Challenge 10).

2.BIOSPHERE FRONTIERS THEME: Investigate sediment and basement-hosted microbial community variation with substrate age, to: evaluate cell abundance and community activity in the low energy South Atlantic Gyre subseafloor biosphere to refine estimates of global biomass; investigate how the aging ocean crust influences the crustal biosphere structure; and evaluate the role of subseafloor microbes in sediment and basement alteration, and hence global biogeochemical cycles (Challenges 5 and 7).

SECONDARY OBJECTIVES:
3.CLIMATE AND OCEAN CHANGE THEME: Investigate the responses of Atlantic Ocean circulation patterns and the Earth's climate system to rapid climate change, including Cenozoic elevated atmospheric CO2. Paleoceanographic and paleoclimate reconstructions across the transect will allow us to: monitor past ocean circulation in the core of the global conveyor; document the opening of the Drake Passage and its influence on deep water circulation through the South Atlantic; reconstruct the history of the South Atlantic subtropical gyre; and evaluate the response of subtropical biota to changing environmental conditions (Challenges 1, 2, and 4).

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

We will use perfluorocarbon tracers to monitor potential contamination, as is standard during microbiological sampling. A purpose built clean room area, similar to that provided for IODP Expedition 360, is requested for handling basement microbiological samples for which the risk of contamination is greatest.

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Proposed Sites (Total proposed sites: 6; pri: 5; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SATL-13A (Primary)	-30.26056 -15.03490	3047	70	150	220	Multidisciplinary science at 7 Ma crust and overlying sediment.
SATL-24A (Primary)	-30.40021 -16.93053	3676	125	150	275	Multidisciplinary science at 15 Ma crust and overlying sediment.
SATL-33A (Primary)	-30.70173 -20.43413	4194	125	150	275	Multidisciplinary science at 31 Ma crust and overlying sediment.
SATL-43A (Primary)	-30.89618 -24.84162	4323	165	150	315	Multidisciplinary science at 48 Ma crust and overlying sediment.
SATL-53A (Primary)	-30.94242 -26.72188	4996	150	150	300	Multidisciplinary science at 63 Ma crust and overlying sediment.
SATL-54A (Alternate)	-30.94204 -26.69710	4991	700	150	850	Multidisciplinary science at 63 Ma crust and overlying sediment.