IODP Proposal Cover Sheet

800 - Full

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Received for:

Title	Nature of the Lower Crust and Moho at Slower-spreading Ridges
Proponents	Henry Dick, James Natland, Shoji Arai, Paul Robinson, Christopher MacLeoc, Maurice Tivey, Ildefonse Benoit, Georges Ceuleneer, Damon Teagle, Kazuhito Ozawa, Marguerite Godard, Jay Miller, Ricardo Tribuzio, Hidenori Kumagai, Mark Kurz, Juergen Koepke, Sumio Miyashita, Jinichiro Maeda, Rolf Pedersen, Juan Pablo Canales, Greg Hirth, Johan Lisenberg, Aaron Yoshinobu, Huaiyang Zhou, Wofgang Bach, Jonathan Snow, Katrina Edwards, Virginia Edgecomb, Yaoling NIu, Alessio Sanfilippo, Lydéric France, Frieder Klein, Masako tominaga, Tim Schroeder, Natsue Abe, Betchaida Payot, Marie Python, Yumiko Harigane, Veronique LeRoux
Keywords	Moho, Crust, Mantle, Ridge
Area	Southwest Indian Ridge

Proponent Information

Proponent	Henry Dick
Affiliation	Woods Hole Oceanographic Institution
Country	United States

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Abstract

This multi-phase drilling proposal is to drill through the Atlantis Bank gabbroic massif into mantle 2.2 km NE of 1.5-km deep Hole 735B to 500-m below Moho. There are 2 major objectives. First to recover the lowermost gabbros and crust-mantle transition to understand the processes creating Mid-Ocean Ridge Basalt – the most abundant magma type on Earth, and second, resolve the controversy as to whether the Moho at slow spreading ridges can be a serpentinization front. Based on geologic mapping, geochemistry, and seismic refraction the igneous crust-mantle boundary below Atlantis Bank is believed ~2.5 km above Moho. This is an ideal location, then, to test the serpentinization front hypothesis for Moho. If successful in penetrating serpentinized mantle, the drilling may not only extend the limits for life, but also document an entire new planetary biosphere below the ocean crust.

The drill site is at the center of the 700-km2-gabbro massif where the crust-mantle transition is most fully developed at the likely point of focused melt delivery from the mantle. This will test competing hypotheses for MORB petrogenesis: one supported by experimental petrology that it segregates at depths of 10 to 30 km where MORB melts would be last in equilibrium with the olivine and two pyroxene mantle assemblage, and then transported to the crust with little additional mantle interaction. The alternative hypothesis is that MORB aggregates and pools in the mantle at the base of the crust, where melt-rock reaction with the mantle and lower crust, significantly modifies the melt composition prior to intrusion to higher levels and eruption to the seafloor. The latter process has two major implications: 1) the assumed composition of primary magmas, based on compositions calculated assuming that MORB is produced by simple fractional crystallization of a parental melt is incorrect, and that 30 years of experimental petrology has used the wrong composition and model in predicting mantle-melt equilibrium, and 2) that mantle hybridized by melt-rock reaction at the base of the crust contributes significantly to the bulk composition of the crust. The results will profoundly affect understanding of magma generation and the linkages between the mantle, melt, and crust.

Combined with the existing holes the drilling will produce a transit spaced at ~ 1-km intervals to look at lateral heterogeneity of the crust, test the nature of magnetic reversals in plutonic rock, and document the stress-strain evolution of a plate boundary undergoing asymmetric seafloor spreading.

Scientific Objectives

There are two principle objectives:
I. Test the hypothesis that the Moho beneath Atlantis Bank is a serpentinization front.
II. Recover the igneous lower crust and the crust-mantle transition at an average melt flux for slow and ultraslow-spreading ridges.
From this we seek to understand:

- The igneous stratigraphy of the lower crust
- How much mantle material is incorporated into the lower crust.
- How melt is transported through and emplaced into the lower crust
- How the lower crust and shallow mantle shapes the composition of mid-ocean ridge basalt, the most abundant magma on Earth?
- The primary modes of accretion of the lower crust.
- Lateral heterogeneity of the lower crust at magmatic time scales.
- The distribution of strain in the lower crust and shallow mantle in the shallow lithosphere during asymmetric seafloor spreading.
- The nature of magnetic anomaly transitions in the lower crust.
- The role of the lower crust and shallow mantle in the global carbon cycle.
- Life in the lower crust and hydrated mantle.

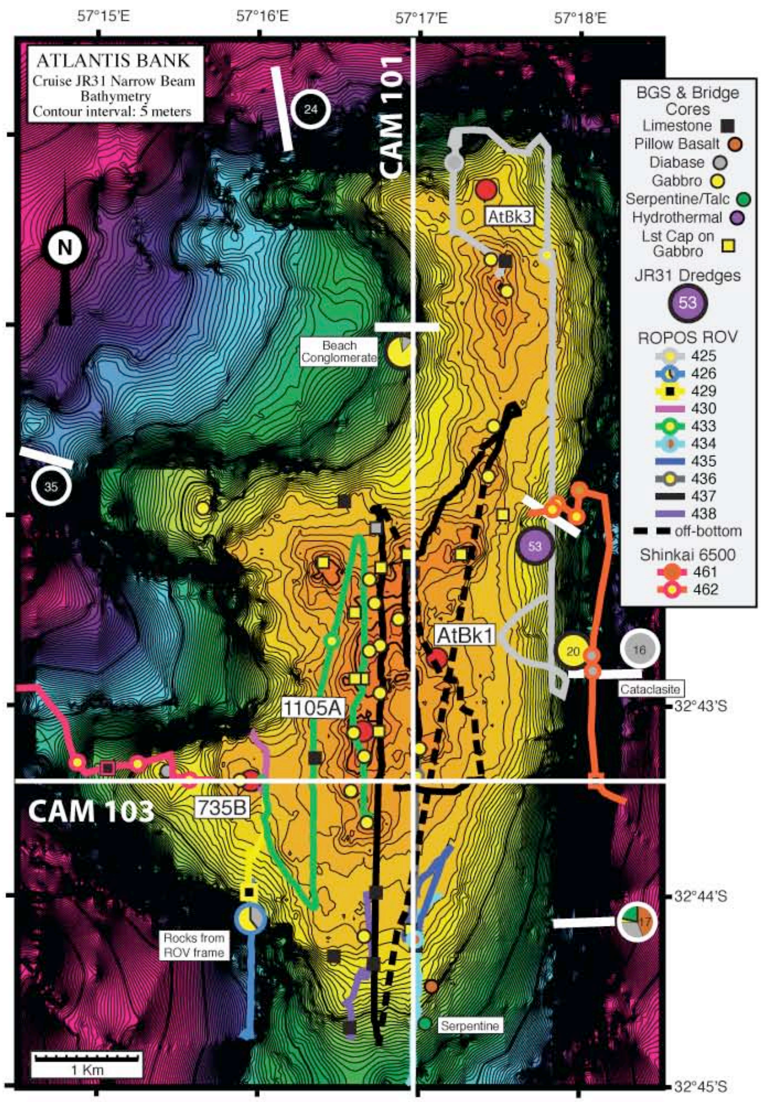
This drilling will:
Provide an important step towards a full penetration in the Pacific by providing critical needed experience in deep drilling in lower crustal and mantle rock.
Create a laboratory for hole-to-hole and ship-to-hole experiments for in-situ determination of the seismic character of lower crust and mantle rock at a seismically appropriate scale.

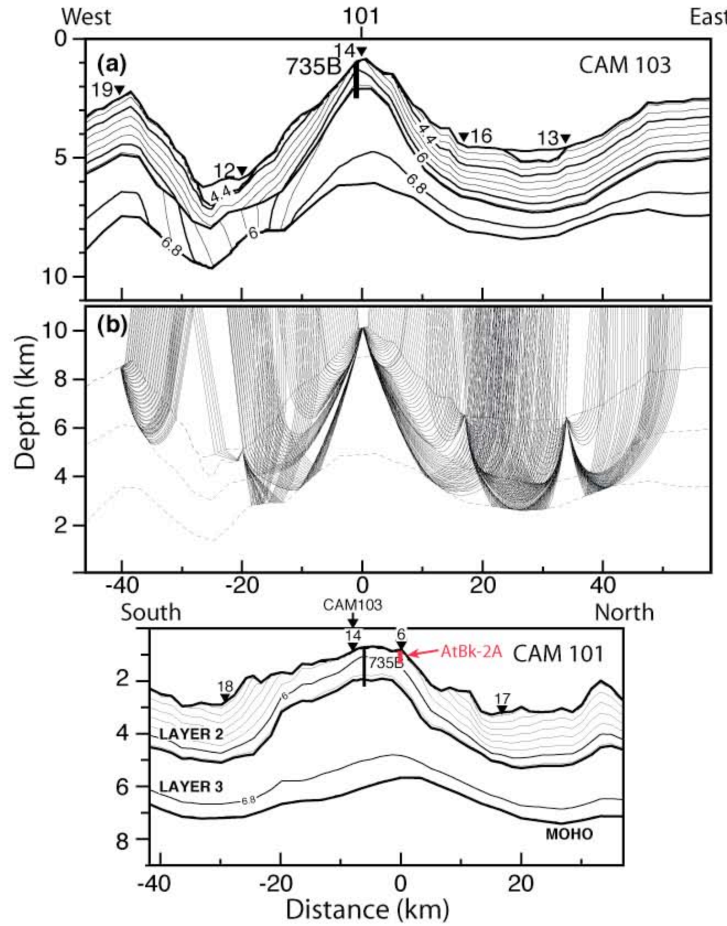
Non-standard measurements technology needed to achieve the proposed scientific objectives

biogeochemical tools

Site Summary Form 6

Proposal 535Full
Site AtBk-3A





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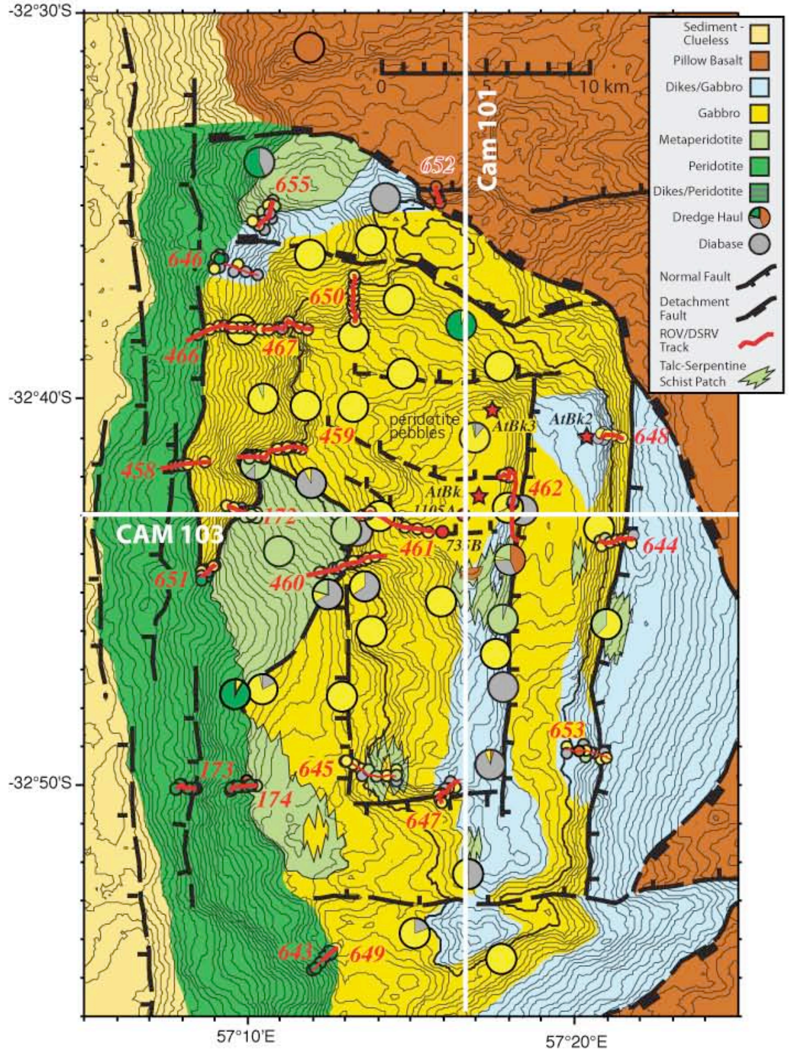
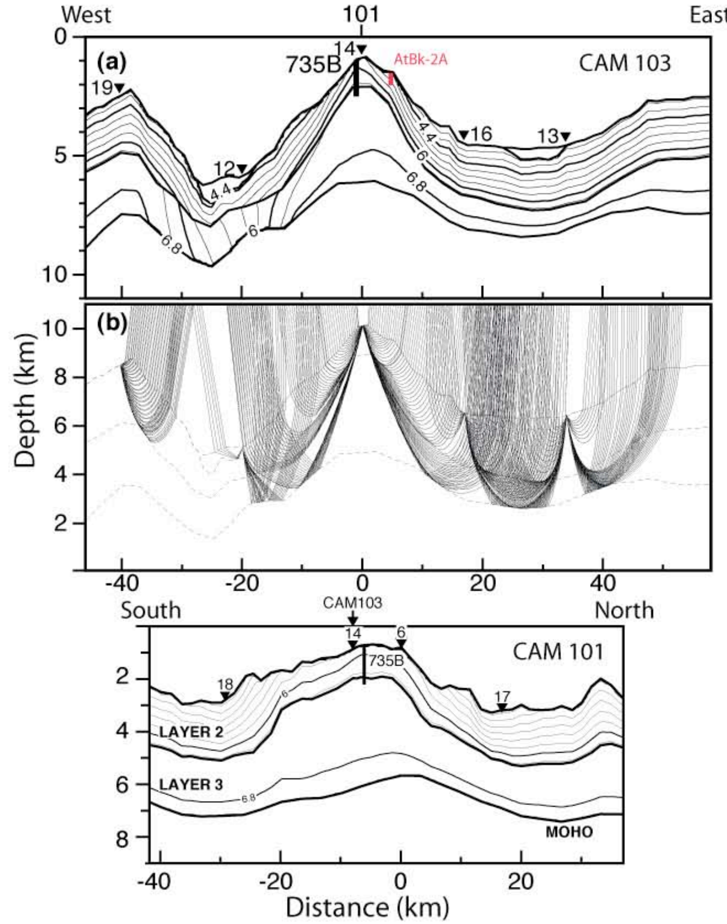
Site Summary Form 6

Proposal 535Full
Site AtBk-2A





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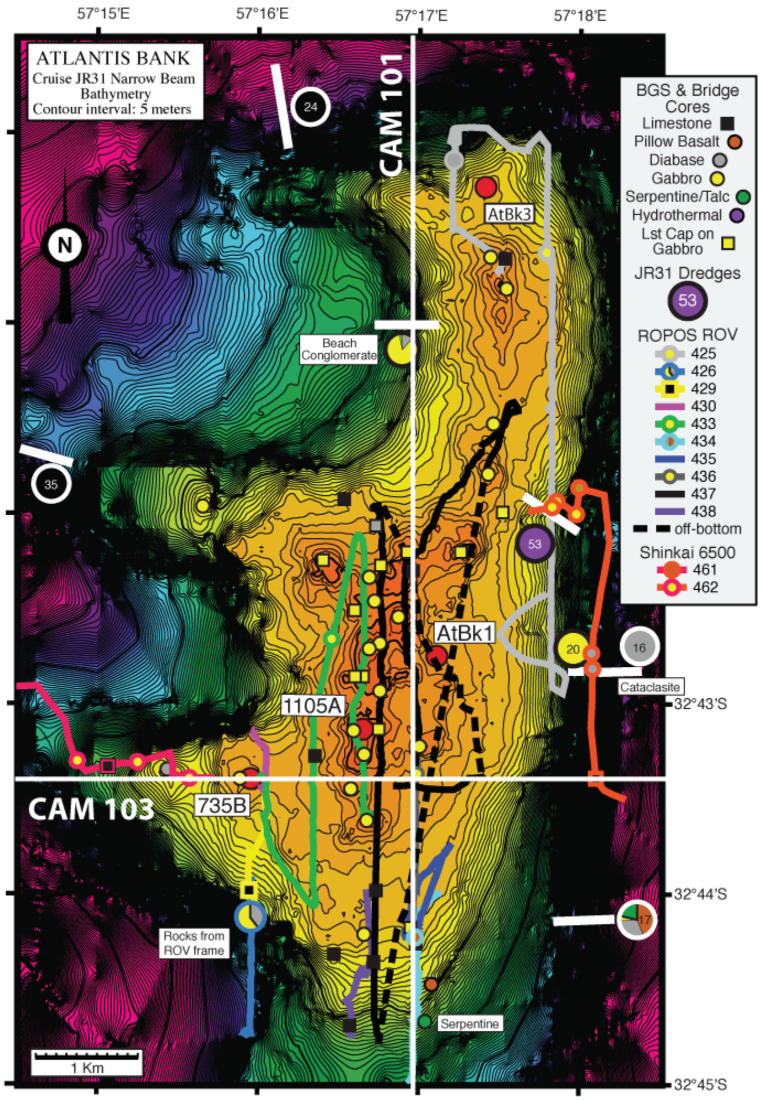
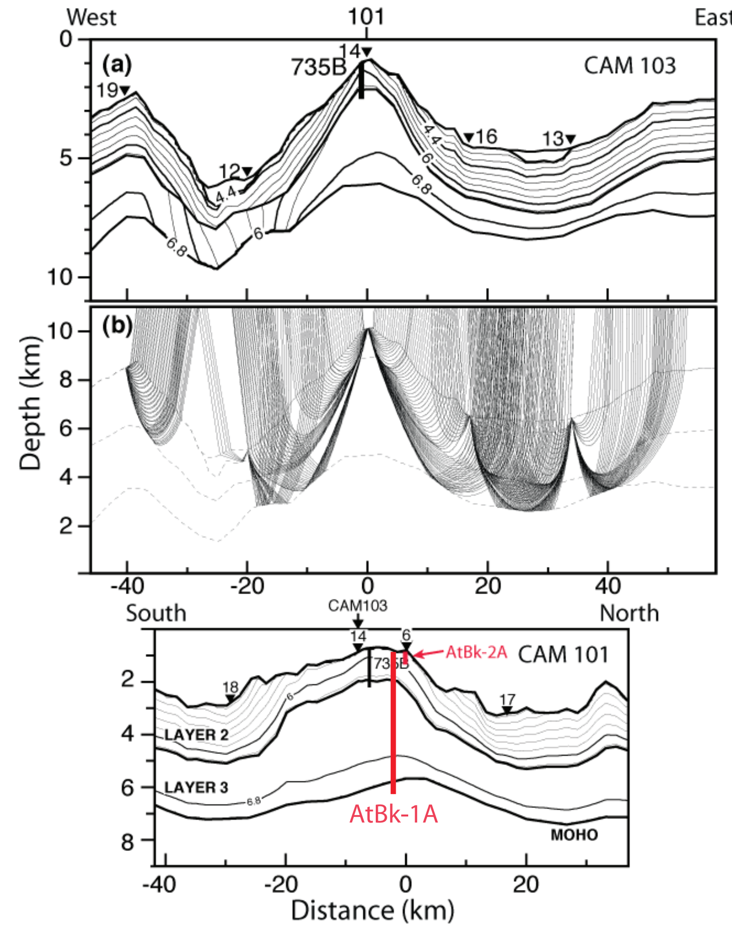
Proposal 535Full6
Site AtBk-1A

Site Summary Form 6





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Proposed Sites (Total proposed sites: 3; pri: 1; alt: 2; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
AtBk-3 (Alternate)	-32.6716 57.29166	700	0	1000	1000	AtBk-3 lies on the northernmost lip of the Atlantis Bank Platform and has the objective of examining the shallow igneous and high-temperature detachment deformation history at a significantly later point in its history (~500,000 yrs) than at either AtBk-1 or 1105A or 735B. We would occupy this location in the event that we were unsuccessful in spudding in at AtBk-2.
AtBk-2 (Alternate)	-32.68333 57.339166	1700	3	1000	1003	Drill the dike-gabbro transition in ultraslow spread crust to examine the history of alteration, deformation and intrusion
AtBk-1a (Primary)	-32.7125 57.28516	700	0	6000	6000	I. Test the hypothesis that the Moho beneath Atlantis Bank is a serpentinization front. II. Recover the igneous lower crust and the crust-mantle