

IODP Proposal Cover Sheet

 New Revised Addendum

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Title:	Continental Crust Formation at Intra-Oceanic Arc: Ultra-Deep Drilling to the Middle Crust of the Izu-Bonin-Mariana Arc		
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Keywords: (5 or less)	Intra-oceanic arc, upper crust, middle crust, continental crust, magmatism	Area:	Izu-Bonin

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Permission to post abstract on IODP Web site: Yes No

Abstract: (400 words or less)

This proposal is for the ultra-deep drilling site of a series of IODP proposals in the Izu-Bonin-Mariana (IBM) arc that aim at comprehensive understanding of arc evolution and continental crust formation. We propose to drill a deep hole that penetrates through a complete sequence of intra-oceanic arc upper crust and into the *in situ* middle crust that may be a nucleus of continental crust. The average continental crust possesses an intermediate composition (~60 wt.% SiO₂), which raises the question of how intra-oceanic arcs produce continental crust if the dominant product of mantle wedge melting and a major proportion of intra-oceanic arc lava are basaltic (50 wt.% SiO₂). There is no pre-existing continental crust in the IBM upper plate, yet recent seismic studies of this arc reveal a thick middle crust layer with 6.0-6.8 km/s *V_p* that is hypothesized to be intermediate in composition. The primary goals of sampling the *in situ* arc crust through drilling are: (1) to identify the structure and lithologies of the upper and middle crust, (2) to test seismic models of arc crustal structure, (3) to constrain the petrologic and chronological relationship of the middle crust to the overlying upper crust, (4) to establish the evolution of arc crust by relating this site with other regional drill sites and exposed arc sections, and (5) to test competing hypotheses of how the continental crust forms and evolves in an intra-oceanic arc setting. These objectives address questions of global significance, but we have specifically identified the IBM arc system as an ideal locale to conduct this experiment. The composition of the pre-subduction upper plate was normal oceanic crust, and the tectonic and temporal evolution of this arc system is well-constrained. Moreover, the IBM system is considered as the best-studied intra-oceanic arc on Earth by extensive sampling of the slab inputs and arc outputs through field studies and drilling, and by a series of recent, focused geophysical surveys. We propose returning to the region of ODP Site 792 to drill, *via*. Eo-Oligocene upper crust, to the middle crust at proposed site IBM-4. The mid-crustal layer in this area is shallow enough to be reached by drilling, and heat flow is low enough for drilling to proceed at mid-crustal temperatures. Samples recovered from IBM-4 will complement the drilling objectives at other proposed sites in Eocene (IBM-2) and Neogene (IBM-3) arc crust and pre-arc oceanic crust (IBM-1), which are proposed separately.



Scientific Objectives: (250 words or less)

Petrologic objectives focus on (1) identifying the lithology, bulk composition, and structure of the rocks that comprise the *in situ* upper and middle crust beneath the Eo-Oligocene IBM arc; (2) establishing the age and thermal/petrologic history of the IBM middle crust and its temporal and petrologic relationship to the upper crust overlying it; (3) relating the petrology, structure, and composition of this mature arc crustal section to equivalent sequences from older (Eocene; IBM-2) and younger (Neogene; IBM-3) arc crust from the same system, to upper- and mid-crustal rocks exposed in accreted arc terranes, and to rocks that represent middle and bulk continental crust; and (4) testing models of the formation of arc middle crust, i.e., simple fractionation of mantle-derived basalt or andesite magmas vs. partial melting of mafic arc crust. The main geophysical objective focuses on using the recovered rocks and borehole data from this deep crustal site to evaluate geophysical models of the seismic velocity structure of the IBM arc crust, i.e., a layered structure with relatively homogeneous velocities within each layer vs. a gradational crustal velocity structure.

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
IBM-4	32°24'N 140°23'E	1798	800	4700	5500	2000m penetration into the middle crust. 886 m of the necessary sampling at the IBM-4 Site has already been done by ODP Leg 126 Site 792