IODP Proposal Cover Sheet

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Godzilla Megamullion Lithospheric Architecture

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Title	The nature of the back-arc basin lower crust and upper mantle at the Godzilla Megamullion
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Area	Parece Vela Basin, Philippine Sea

Proponent Information

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Abstract

Our knowledge of modern oceanic crust comes largely from the three locations of the “ODP/IODP reference sites of oceanic crust”: Atlantis Bank (Holes 735B and U1473A), Atlantis Massif (Hole U1309D), and Hess Deep (Sites 894, 895 and U1415). However, a significant fraction of the ocean floor is created in back-arc basins, where water plays a major role in generating back-arc basin basalts, strikingly contrasting with magmatic process at mid-ocean ridges. In addition, much of our understanding of all oceanic crust comes from ophiolites, which are largely attributed to supra-subduction zone environments. A better understanding of the architecture of back-arc basin crust should be a necessary contribution that will bridge the results of ophiolite analog studies and the overall geology of oceanic crust. However, there has been no single long section of lower oceanic crust and uppermost mantle of back-arc basin to understand the differences that likely characterize the architecture and composition of the oceanic lithosphere at this key tectonic setting.

The Godzilla Megamullion is the largest known oceanic core complex, located in the extinct Parece Vela Basin in the Philippine Sea. It is uniquely defined by its vast area of exposed lower crust and upper mantle material after ~4 m.y.-long detachment faulting. The Godzilla Megamullion records secular evolution of mantle melting beneath a dying back-arc spreading ridge along the length of the detachment. Furthermore, strong heterogeneity in P-wave velocity structure is observed along the length of the megamullion, with normal oceanic crust-like structure in the distal (= breakaway) to medial parts, and high-velocity bodies in the proximal (= termination) part.

Here we propose a two-leg riserless drilling program of the Godzilla Megamullion. By placing three 400- to 800 m-deep drill holes along its length, we will obtain key data to better understand and constrain the composition of back-arc basin oceanic crust and uppermost mantle, as well as the architecture of oceanic core complexes. The extinct back-arc basin environment at the Godzilla Megamullion further provides a unique opportunity to explore life in an oceanic crust after extinction of its hydrothermal activity. Our proposed drilling program will allow us to test if and how life has been able to adapt to the drastic changes of its living environment. By recovering a substantial section of the lower crust and upper mantle of the Godzilla Megamullion, we will be able to address Challenges 6, 7, 8, 9 and 14 of the IODP Science Plan 2013-2023.

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Scientific Objectives

We set three objectives to test proposed Hypotheses 1 to 4:

- Objective 1 is aimed at testing Hypotheses 1 and 2, to understand the architecture and composition of back-arc basin lithosphere, and thereby establishing the Godzilla Megamullion as the fourth IODP reference site for oceanic lower crust and uppermost mantle, following the sites in the Atlantis Bank, the Atlantis Massif, and the Hess Deep.
- Objective 2 is aimed at testing Hypothesis 3, to understand the architecture of an oceanic core complex.
- Objective 3 is aimed at testing Hypothesis 4, to seek for deep biosphere in an extinct back-arc basin environment.

The proposed testable hypotheses are:

- Hypothesis 1: Tectono-magmatic processes in back-arc basins are influenced by water and thus different from those at mid-ocean ridges.
- Hypothesis 2: The crustal architecture and composition of back-arc basins are similar to those of major ophiolites.
- Hypothesis 3: The overall structure of the anomalously huge Godzilla Megamullion is similar to that of Mid-Atlantic Ridge oceanic core complexes, where a thick gabbroic core constitutes a part of the complex near the termination.
- Hypothesis 4: The Godzilla detachment fault facilitated the flow of fluids to depth during its activity, resulting in the development of hydrothermal vents and the associated microbial communities. These microbial communities have now adapted to the drastic change of living environment that followed the extinction of the hydrothermal fluid flow.

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

None

Proposed Sites (Total proposed sites: 6; pri: 3; alt: 3; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
GM-01A (Primary)	15.6004 139.0342	4554	20	380	400	To characterize the normal oceanic crust-like structure imaged by P-wave velocity model in the distal part of the Godzilla Megamullion.
GM-05A (Primary)	15.9084 139.2021	4406	20	380	400	To characterize the normal oceanic crust-like structure imaged by P-wave velocity model in the medial part of the Godzilla Megamullion.
GM-02A (Primary)	16.3002 139.4175	3817	0	800	800	To characterize the shallow high-velocity body imaged by P-wave velocity model in the proximal part of the Godzilla Megamullion.
GM-06A (Alternate)	16.1258 139.3123	4256	20	800	820	To characterize the shallow high-velocity body imaged by P-wave velocity model in the proximal part of the Godzilla Megamullion.
GM-03A (Alternate)	15.6519 139.3009	4756	20	380	400	To characterize the normal oceanic crust-like structure imaged by P-wave velocity model in the distal part of the Godzilla Megamullion.
GM-04A (Alternate)	15.8208 138.9235	4537	20	800	820	To characterize the shallow high-velocity body imaged by P-wave velocity model in the distal part of the Godzilla Megamullion.