IODP Proposal Cover Sheet

967 - Full 2

Ontong Java Nui LIP

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Title	Testing the Ontong Java Nui hypothesis
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Proponent Information

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Abstract

Large Igneous Provinces (LIPs) such as the Ontong Java Plateau (OJP) in the western equatorial Pacific provide information on mantle processes and composition, and their formation may have had global environmental consequences. The OJP is the largest oceanic plateau and is probably the most voluminous igneous edifice on Earth. Despite its importance, the size, volume, and formation rate of the OJP are not yet well constrained. The maximum extent of OJP-related volcanism may be even greater than currently estimated, because volcanological studies indicate that long lava flows (or sills) from the OJP may have reached the adjacent Nauru, East Mariana, and possibly Pigafetta basins. Moreover, the similarity in age and geochemistry of lavas from the Ontong Java, Hikurangi, and Manihiki plateaus suggests that they may have formed together as a single LIP (Ontong Java Nui, OJN). If true, the massive volcanism may have covered >1% of Earth's surface and OJN's magma source would have involved a major part of Earth's upper mantle (16-48 % of mid-Cretaceous asthenosphere!), presumably lower mantle, and possibly some core material. The lack of detailed knowledge of the size, age, and composition of the OJP has given rise to various models such as a surfacing mantle plume head, bolide impact, and fusible mantle melting, but no model satisfies all observational data and no consensus has been reached on its origin. Likewise, geodynamic effects, evolution, and hydrothermal alteration of the OJP have not been clarified yet.

The OJP is divided into the High Plateau to the west and the Eastern Salient to the east. Basaltic basement of the OJP has been cored at seven Deep Sea Drilling Project (Site 289) and Ocean Drilling Program (Sites 803, 807, 1183, 1185, 1186, and 1187) sites – but these are exclusively located on the High Plateau. Assuming that the proposed OJN reconstruction is correct, the approximate center would be the Eastern Salient, the crust and lithosphere of which may have been thinned by rifting and breakup of the various plateaus. Therefore, the Eastern Salient is the best area to test the OJN hypothesis. In order to examine the true extent of the OJP (i.e., whether the flows in the Nauru, East Mariana, and Pigafetta basins, as well as the Manihiki, and Hikurangi plateaus are parts of the OJN), we propose drilling five sites on the Eastern Salient and adjacent basins to recover sediment and igneous basement samples with variable compositions.

Scientific Objectives

This project aims to investigate the true original areal extent of the Ontong Java Plateau (OJP).

The primary questions are:
(1) Did the OJP, Manihiki, and Hikurangi plateaus form as a single super plateau, Ontong Java Nui (OJN)?
(2) Where and how active were the main eruptive centers, and how might the adjacent basins have been covered by lava flows from OJP?

The secondary objectives are to:
(1) Provide critical data to test existing models and to develop new models of LIP formation,
(2) Examine the geodynamic effects and evolution of the OJP, and
(3) Quantify the timing, duration, and extent of hydrothermal alteration of OJP igneous basement.

The project will employ non-riser drilling to core sediments and basalts from five sites on the OJP and adjacent basins. Basalt samples will be analyzed for geochronology, geochemistry, paleoeruption depth, and paleolatitude to address primary objective 1 and secondary objective 1. Coring in adjacent basins will recover off-plateau lava flows to test their origin (primary objective 2). The basalt samples will also be analyzed to examine hydrothermal alteration (secondary objective 3). Sedimentary sections overlying OJP igneous basement will be recovered to reconstruct the subsidence history of the OJP following its formation (secondary objective 2). Temperature and thermal conductivity measurements will be conducted to test whether the mantle root beneath the OJP is thermal or chemical in nature (secondary objective 2).

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

None

Proposal History

Submission Type: Resubmission from previously submitted proposal

Review Response

Response to the SEP and Proposal Improvements

The SEP reviewed IODP 967-Full in June 2020. They recognized the “exciting potential in the first ever drilling to recover basement in the Eastern Salient of the Ontong Java Plateau (OJP)”. However, the panel pointed out that re-drilling of the Magellan Rise site would be logistically challenging and would make the proposal too scientifically diverse. The SEP strongly recommended focusing on the formation of the proposed Ontong Java Nui (OJN) by drilling basement sites exclusively on the OJP and in adjacent basins in a revised full proposal.

The SEP recommended preparing a separate proposal for re-drilling the Magellan Rise to investigate the record of environmental impacts. We followed these recommendations and the Magellan Rise site has been eliminated from 967-Full2. Accordingly, the secondary objective 3 (environmental consequences of OJP emplacement) was moved from 967-Full2 to another proposal (Manihiki Plateau and Magellan Rise, currently in preparation by Dickens, Kuroda, et al.; see McKay et al., 2018). Instead, the revised proposal’s secondary objective 3 now focuses on hydrothermal alteration of the OJP basement, based on the SEP’s request. Also, following advice of the SEP, the primary objectives are now presented as testable hypotheses, accompanied by a plan for how they can be tested by the proposed drill sites and subsequent analyses (see main text and Table 2).

The SEP commended the proponents for providing the new site survey data on the OJP but pointed out the lack of crossing seismic lines for the proposed sites. We fully agree with the SEP that, ideally, sites should be at seismic line intersections, but we will have no opportunity to obtain new MCS data from the OJP in the foreseeable future. As we noted in 967-Full, we are confident that the top of basement can be identified on the recently acquired MCS data because igneous basement surfaces of the plateau and adjacent basins are nearly flat, and no faults or other displacements can be identified near the proposed drilling sites. An exception is seen in the seismic reflection profile across Site OJP-06A, where SEP pointed out that the top of basement was not clear. We agree with this interpretation and relocated the position to the new primary Site OJP-12A. We have also added missing velocity data for Site OJP-07B. The SEP also pointed out that it is not always clear which site is alternate and which is primary. We have now clarified the designation for each site and updated the list of primary and alternate sites (see Tables 1 and 2).

The SEP suggested further discussion with the JRSO regarding installation of a re-entry cone vs. FFF for each drill site, approval for washing down overlying sediments, and inclusion of contingency time. Based on advice from the JRSO, the revised drilling strategy allows us to achieve the scientific objectives while coring the entire sediment succession and still gaining 24 hours of contingency time (see Table 1).

In addition to the above, all minor comments have been fully addressed.

Proposed Sites (Total proposed sites: 10; pri: 5; alt: 5; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
OJP-01A (Primary)	-5.2934 172.1152	4316	200	150	350	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Eastern Salient.
OJP-02B (Primary)	-7.4979 172.1160	5413	300	100	400	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Ellice Basin.
OJP-03B (Alternate)	-6.2220 167.5235	3494	140	150	290	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Eastern Salient.
OJP-04B (Primary)	-7.5131 166.7239	3650	350	100	450	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Stewart Basin.
OJP-07B (Alternate)	-7.3133 161.2194	1730	580	120	700	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Eastern Salient.
OJP-08A (Alternate)	-7.4697 172.1158	5414	300	100	400	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Ellice Basin.
OJP-09A (Alternate)	-7.1567 166.9454	3898	340	100	440	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Stewart Basin.
OJP-10A (Primary)	-0.0778 163.2456	4459	300	100	400	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Nauru Basin.
OJP-11A (Alternate)	0.0971 164.2338	4418	400	100	500	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Nauru Basin.
OJP-12A (Primary)	-7.0788 161.3984	1629	390	120	510	Core basaltic rocks for geochemistry, isotopic chemistry, and age. Determine geochemical and isotopic signature of Eastern Salient.