IODP Proposal Cover Sheet

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Havre Trough Backarc Formation

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Title	From arc splitting to oceanic spreading: testing models of back-arc basin formation		
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Keywords	Arc, back-arc, subduction, rifting, spreading	Area	Havre Trough

Proponent Information

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Abstract

Back-arc basins are found at convergent margins and constitute an integral part of the subduction factory. They are zones of significant crustal production and seafloor spreading, exhibiting volcanic and hydrothermal processes somewhat similar to those found at mid-ocean ridges. Despite their importance in the tectonic history of our planet, very little is known about the mechanisms of formation and early evolution of back-arc basins. Accepted models of rift-to-drift transition, from volcanic arc split to inter-plate separation leading to gradual development of oceanic spreading are complicated by global observations of significant changes in back-arc crustal properties, characterized by sudden spatial and temporal jumps of rift basins and concomitant spreading centers. Understanding what controls these episodic variations and instabilities of back-arc spreading centers, and the links with subduction processes and arc volcanoes has become of global importance for the international science community. Only scientific drilling provides the key to unravel these complexities by determining timing of cessation of arc and back-arc volcanism, understanding temporal changes in stress regimes, and resolve competing hypothesis to constrain the genesis and evolution of back-arc basins.

The Havre Trough is the ideal setting globally to achieve this outcome, because it is one of the few places on Earth where the early stages of back-arc basins formation are well displayed in the recent geological record and it displays the full spectrum of arc- and back-arc-related magmatic and hydrothermal processes. It is also uniquely linked to the continental rift of the Taupo Volcanic Zone, which is the site of the most active and voluminous rhyolitic volcanism in the planet. Furthermore the rare phenomenon of the subduction of a Large Igneous Province (LIP), the Hikurangi Plateau, is currently occurring under the Havre Trough. By drilling with current technologies at five primary sites we plan to pursue the following scientific objectives of global importance:
1) Determining location and mechanism of initial arc splitting;
2) Quantifying spatial and temporal feedbacks between decompression and flux melts;
3) Studying the processes of LIP subduction and continental collision;
4) Understanding the genesis of large-scale hydrothermal systems.

The purpose of this drilling proposal is directly related to challenges identified in the IODP Science Plan 2013-2023, including three under the Earth Connections theme and one under the Earth in Motion theme.

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Scientific Objectives

Our primary scientific task is to constrain the fundamental, underlying processes controlling the timing and mode of early evolution from volcanic arc breakup to back-arc spreading, by recovering cores and instrumenting drill holes across the Havre Trough. We plan to pursue this aim through the following objectives:
1) Determining location and mechanism of initial arc splitting;
2) Quantifying spatial and temporal feedbacks between decompression and flux melts;
3) Studying the processes of LIP subduction and continental collision;
4) Understanding the genesis of large-scale hydrothermal systems.

This proposal requires drilling and coring through sediments and sample rocks from the igneous basement at four primary sites across the Havre Trough, and to core sediments at one site west of the Colville Ridge. Igneous rocks and overlying sediments will be analyzed to investigate the geochronology, geochemistry, isotope chemistry and paleomagnetism to address all the scientific objectives. The sediment samples cored west of the Colville Ridge will be analyzed for tephra-, magneto- and bio-stratigraphy to determine timing of cessation of arc volcanism before rifting. In addition to coring, the analysis of downhole logs, particularly thermal and structural data, will be used to constrain areas of current active extension and magmatism in contrast with sites of arrested extension.

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

None

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Proposed Sites (Total proposed sites: 8; pri: 5; alt: 3; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
WCR-01A (Primary)	-33.8615 177.6906	3230	600	0	600	Core sediments for tephra-, magneto- and bio-stratigraphy to determine the cessation of arc magmatism accompanying breakup of the proto-Colville-Kermadec arc.
CR-01A (Primary)	-33.9970 178.2537	915	50	300	350	Site on the Colville Ridge to core igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age to study faults and structures associated with rifting, understand timing of breakup of the proto-Colville-Kermadec arc, and establish a stratigraphic correlation with a corresponding site on the Kermadec Ridge (KR-01A). Coring at CR-01A will provide mineralized and hydrothermally altered samples to understand whether large-scale hydrothermal systems developed in the early rifting phase of the proto-Colville-Kermadec arc. CR-02A is an alternate site.
CR-02A (Alternate)	-33.8746 178.1587	1493	50	300	350	Site on the Colville Ridge to core igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age to study faults and structures associated with rifting, understand timing of breakup of the proto-Colville-Kermadec arc, and establish a stratigraphic correlation with a corresponding site on the Kermadec Ridge (KR-01A).
WHT-01A (Primary)	-32.8593 179.1666	3383	400	150	550	Site on a sedimented basin to determine mimimum age of the split of the proto-Colville-Kermadec arc and investigate structure and age of the underlying igneous basement in the older western Havre Trough away from the active arc front. Core sediments for tephra-, magneto- and bio-stratigraphy and underlying igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age. WHT-02A is an alternate site.
WHT-02A (Alternate)	-33.5320 178.7329	3687	300	150	450	Site on a sedimented basin to determine mimimum age of the split of the proto-Colville-Kermadec arc and investigate structure and age of the underlying igneous basement in the older western Havre Trough away from the active arc front. Core sediments for tephra-, magneto- and bio-stratigraphy and underlying igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age.
EHT-01A (Primary)	-33.1864 179.8712	3360	150	150	300	Site on a sedimented basin to investigate structure and age of the underlying igneous basement in the younger eastern Havre Trough in proximity of the active arc front. Core sediments for tephra-, magneto- and bio-stratigraphy and underlying igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age. EHT-02A is an alternate site.
EHT-02A (Alternate)	-34.1906 179.3859	3607	150	150	300	Site on a sedimented basin to investigate structure and age of the underlying igneous basement in the younger eastern Havre Trough in proximity of the active arc front. Core sediments for tephra-, magneto- and bio-stratigraphy and underlying igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age.
KR-01A (Primary)	-34.9120 179.3024	541	50	300	350	Site on the Kermadec Ridge to core igneous rocks for geochemistry, isotopic chemistry, paleomagnetism and age to study faults and structures associated with rifting, understand timing of breakup of the proto-Colville-Kermadec arc, and establish a stratigraphic correlation with a corresponding site on the Colville Ridge (CR-01A/CR-02A).