IODP Proposal Cover Sheet

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Reykjanes Mantle Convection

Title	Mantle Convection, Paleoceanography and Climate Evolution in the North Atlantic Ocean
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Abstract

A present-day mantle upwelling beneath Iceland dynamically supports the bathymetry of the North Atlantic Ocean. Varying dynamic support has controlled uplift and subsidence at Earth's surface throughout Neogene times. Intersection of the Mid-Atlantic Ridge with the Iceland plume provides us with a window into time-dependent plume activity: the thickness and chemistry of newly formed oceanic crust is critically dependent on mantle temperature and composition. Plume-ridge interaction is manifest as V-shaped ridges and troughs located south of Iceland. We propose a drilling program that addresses three principal objectives: (1) to understand the compositional and thermal history of the Iceland mantle plume through time; (2) to understand how dynamic topography associated with the mantle plume has influenced ocean circulation and climate; (3) to reconstruct the evolving chemistry of hydrothermal fluids with increasing crustal age, varying sediment thickness and mantle temperature conditions. This drilling program will recover basaltic samples from oceanic crust that is blanketed by thick sediments and is thus inaccessible by dredging. Major, trace and isotope geochemistry of basalts will allow us to observe temporal variations in mantle composition and temperature. We will test the hypothesis that these variations occur on two timescales (5-10 Ma, and ~30 Ma) and are responsible for fundamental changes in crustal architecture. Millennial-scale paleoclimate records are contained within rapidly accumulated sediments of contourite drifts in this region. The accumulation rate of these sediments is a proxy for current strength, which is in turn moderated by dynamic support of oceanic gateways such as the Greenland-Scotland Ridge. These sediments also provide constraints for climatic events including Pliocene warmth, the onset of Northern Hemisphere Glaciation and abrupt Late Pleistocene climate change. Our combined approach will provide an opportunity to explore the relationships between deep Earth processes, ocean circulation and climate. Our objectives can only be addressed by recovering both sedimentary and basaltic cores. We plan to penetrate 200 m into igneous basement at five primary sites east of Reykjanes Ridge. Four primary sites intersect V-shaped ridges and troughs, one of which is also at the crest of Bjorn Drift. A fifth site is located over 32.4 Ma oceanic crust devoid of V-shaped features, chosen to intersect Oligo-Miocene sediments of Gardar Drift. We have also identified two lower priority primary and six alternate sites. Sediments and basalts recovered during this program will provide a major advance in our understanding of the coupled nature of Earth's deep and surficial domains.

Scientific Objectives

We propose to recover sedimentary and basaltic rocks from oceanic crust to the east of the Reykjanes Ridge. There are three principal objectives:

Objective 1: Mantle Plume Behavior and Crustal Architecture
We will explore the compositional and thermal history of the Iceland mantle plume on two temporal scales. First, we seek to test the hypothesis that the Iceland mantle plume has undergone transient thermal behavior on 5 to 10 Ma timescales. Second, we aim to test the general controls on crustal architecture over longer, 30 to 40 Ma timescales.

Objective 2: Ocean Circulation and Sedimentation
We plan to test the hypothesis that oceanic circulation in the North Atlantic Ocean has been moderated by transient activity of the Iceland mantle plume as far back as Oligocene times. This program will also extend the high-resolution climate record into late Pliocene times. Thus, we aim to evaluate both the millennial- and million-year scale variability in Neogene climate during important intervals when temperatures were warmer than today.

Objective 3: Time-Dependent Hydrothermal Alteration of Oceanic Crust
We will investigate the nature, extent, timing and duration of hydrothermal alteration within the upper Reykjanes Ridge flank. Drilling will enable us to quantify the timing and extent of hydrothermal fluid-rock exchange, to assess the hydrothermal contributions from a rapidly sedimented slow-spreading ridge flank to global geochemical budgets.

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

None

Proposed Sites

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
REYK-13A	60.2281, -28.5004	1520	210	200	410	V-shaped trough 1
REYK-3A	60.0989, -26.4404	2110	205	200	405	V-shaped ridge 3
REYK-4A	60.0992, -26.4436	2110	185	200	385	V-shaped ridge 3 (3A alternate)
REYK-7A	60.1507, -27.1698	1735	330	200	530	V-shaped ridge 2b and Bjorn Drift
REYK-8A	60.1491, -27.1370	1695	320	200	520	V-shaped ridge 2b and Bjorn Drift (7A alternate)
REYK-9A	60.1702, -27.5310	1700	310	200	510	V-shaped trough 2a
REYK-10A	60.1667, -27.4726	1690	155	200	355	V-shaped trough 2a (9A alternate)
REYK-11A	60.2000, -28.0000	1415	340	200	540	V-shaped ridge 2a
REYK-12A	60.1941, -27.9072	1487	445	200	645	V-shaped ridge 2a (11A alternate)
REYK-5A	60.1264, -26.7516	1894	675	200	875	V-shaped trough 2b and Bjorn Drift
REYK-6A	60.1251, -26.7016	1880	705	200	905	V-shaped trough 2b and Bjorn Drift (5A alternate)
REYK-1A	59.8496, -23.2473	2210	955	200	1155	Fractured basement and Gardar Drift
REYK-2A	59.8506, -23.2664	2205	970	200	1170	Fractured basement and Gardar Drift (1A alternate)

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