IODP 955-Full 2: Integrating subseafloor microbial, hydrological, geochemical, and geophysical processes in zero-age, hydrothermally active oceanic crust at Axial Seamount, Juan de Fuca Ridge

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Goal

Understand the relationships between microbial, hydrological, geochemical, and geophysical processes in zero-age, hydrothermally active oceanic crust at the summit of Axial Seamount

Objectives of Drilling Axial Seamount

1: Determine the distribution and composition of **crustal subseafloor microbial communities**, their association with mineral assemblages, rates of activity, and role in **biogeochemical cycling** of carbon, iron, nitrogen, hydrogen, and sulfur;

2: Determine the **4-D architecture of an active hydrothermal system** and understand how the connectivity of the hydrological, chemical and physical properties of the upper oceanic crust is linked to **magmatic and tectonic deformation** through a volcanic cycle;

3: Determine the temporal characteristics and nature (structure, composition, hydrostratigraphy) of the **upper oceanic crust** in an active mid-ocean ridge volcanic setting, including **host rock petrology, geochemistry, alteration, and physical properties.**

Site	Depth into Basement, m	Purpose
AXIAL-01B	325	Establish a network of stable holes to enable cross-hole experiments and direct measurements of critical crustal properties
AXIAL-02B	325	
AXIAL-03B	325	
AXIAL-04B	50	Installation of a broadband seismometer

Leveraging the RCA

Instrumentation of the RCA will enable monitoring of nearby vent systems at the International District during drilling and rebound of environmental conditions in the boreholes. Post-drilling, cased boreholes will be leveraged for installation of "CORK-Lite" observatories linked to the RCA for cross-hole and borehole experiments to extend all objectives

Proposed Drill Sites

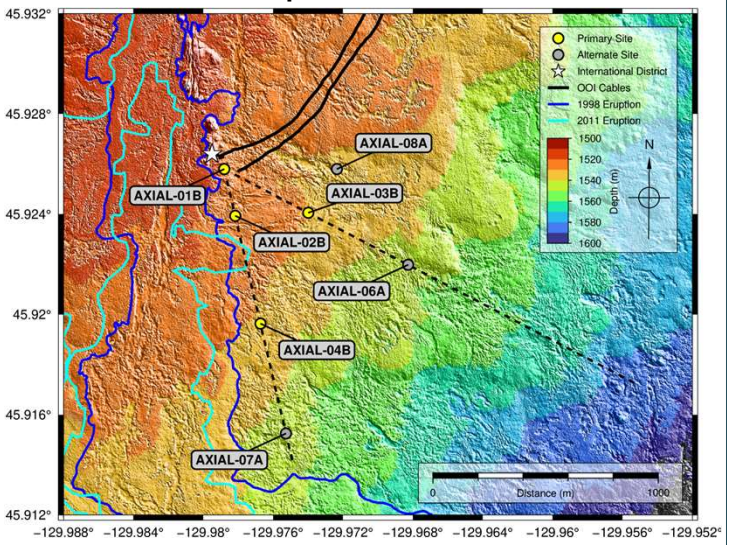

Figure 1: Bathymetric map (MBARI AUV Data) with planned drill sites as well as three alternate sites. Site AXIAL-01B is situated approximately 50 m southwest of International District, and between cable junction boxes MJ03C and MJ03D. Dotted lines represent the two transects all but 1 of the proposed drill sites fall along.

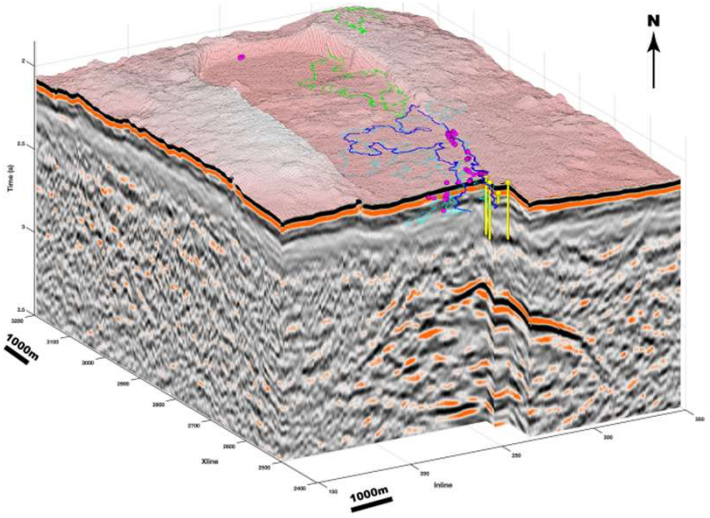

Figure 2: IODP drill sites (vertical yellow lines) placed in the context of 3-D seismic data from A. Arnulf. Vents are shown as pink dots and previous lava flows as blue and green outlines.

Drilling Strategy

- Mixture of drilling, casing, cementing, coring, and downhole measurements and sampling
- Synthetic volatile tracer will be injected during RCB coring to enable contamination testing
- Expect 10-30% core recovery in fractured basalt
- Deploy "Triple Combo" logging tool, Formation MicroScanner-sonic, Elevated Borehole Temperature Sensor; test permeability; collect any fluids if holes produce

Observatory Infrastructure

- Perturbation of drilling coupled to monitoring at nearby vents during and after drilling will enable quantitative assessment of permeability, fluid flow dispersion patterns, subseafloor mixing, and responses of microbial communities
- Pre-drilling, install uncabled temperature probes and osmotic fluid samplers at nearby vents, as well as potentially cabled remote access fluid and DNA samplers
- Post-drilling, install CORK-Lite borehole observatories, broadband seismometer, and additional down-hole instrumentation and connection to the RCA

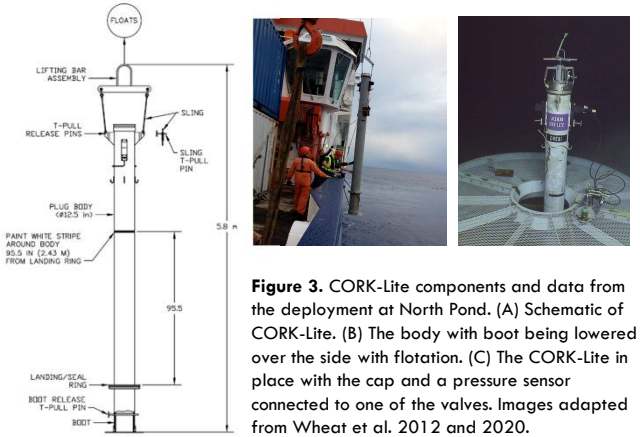

Figure 3. CORK-Lite components and data from the deployment at North Pond. (A) Schematic of CORK-Lite. (B) The body with boot being lowered over the side with flotation. (C) The CORK-Lite in place with the cap and a pressure sensor connected to one of the valves. Images adapted from Wheat et al. 2012 and 2020.

While core and fluid samples collected during the drilling expedition will be essential for addressing all objectives at Axial, the borehole observatory infrastructure linked to the RCA adds considerable value to the drilling operations. This cutting-edge infrastructure will provide a legacy to serve mid-ocean ridge and broader volcanological science for decades to come!