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iSAS/IODP Proposal Cover Sheet

☐ **New** ☑ **Revised** ☐ **Addendum**

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Title:	**The Hydrogeologic Architecture of Basaltic Oceanic Crust: Compartmentalization, Anisotropy, Microbiology, and Crustal-scale Properties on the Eastern Flank of Juan de Fuca Ridge**
Proponent(s):	Fisher, A. T., Alt, J., Bach, W., Baross, J., Cowen, J., D'Hondt, S., Davis, E. E., Hutnak, M., Kadko, D., McCarthy, M., McClain, J. S., Mottl, M. J., Sinha, M., Spinelli, G., Spiess, V., Teagle, D., Villinger, H., Wheat, C. G., Zühlsdorff, L.
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Area:	Northeast Pacific Ocean

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Permission to post abstract on iSAS Web site: ☐ Yes ☐

Abstract: *(400 words or less)*

We propose a multidisciplinary research program to evaluate the formation-scale hydrogeologic properties (transmission, storage) within oceanic crust; determine how fluid pathways are distributed within an active hydrothermal system; establish linkages between fluid circulation, alteration, and geomicrobial processes, and determine relations between seismic and hydrologic anisotropy. We will accomplish these goals through replacement of two existing subseafloor observatories penetrating the upper crust, and through drilling two new holes (600 m and 200 m into the crust) that will be cored, sampled, instrumented, and sealed. We will conduct the first multi-dimensional, cross-hole experiments attempted in the oceanic crust, including hydrologic, microbiological, seismic, and tracer components. After completion of drill-ship operations, we will initiate multi-year tests using this network of subseafloor observatories, allowing us to examine a much larger volume of the crustal aquifer system than has been tested previously. By monitoring, sampling, and testing within multiple depth intervals, we can evaluate the extent to which oceanic crust is connected vertically and horizontally; the influence of these connections on fluid, solute, heat, and microbiological processes; and the importance of scaling on hydrologic properties. We propose to complete this work where (1) thick sediment cover isolates permeable basement, allowing small pressure transients to travel long lateral distances, (2) outstanding coverage of seismic, heat flow, coring, geochemical, and observatory data allow detailed hypotheses to be posed and tested, (3) existing ODP drill holes and long-term observatories provide critical monitoring points for pre- and post-drilling experiments, (4) the formation is naturally overpressured so as to drive multi-year, cross-hole experiments (5) and a planned, cabled seafloor observatory network will facilitate long-term experiments, data access, and instrument control. Alternate sites are proposed within a shallow hydrothermal upflow zone, and in deeper basement areas where the crust is more mature. This work will elucidate the nature of permeable pathways in the crust, the depth extent of circulation, the importance of permeability anisotropy, and the significance of hydrogeologic barriers in the crust. We will learn where viable microbiological communities live, and how these communities cycle carbon, alter rocks, and are influenced by flow paths. We will quantify lateral scales over which solute transport occurs, the extent of flow channeling and mixing in the crust, and how these processes relate to rock structure and fabric. We will determine how to relate seismic velocities and velocity anisotropy to hydrogeologic properties.

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Scientific Objectives: (*250 words or less*)

Second Ridge (first priority): Drill at Site SR-1, 1000 m SSW of ODP Site 1026, where sediment thickness is 260-275 m. Core into basement upper basement and set casing, then penetrate 600 m into basement. Log, packer, VSP, and CORK Hole SR-1A to isolate multiple levels in basement. Drill at Site SR-2, 200 m SSW of Site 1026, and 800 m NNE of Site SR-1. Operational plan is identical to that at SR-1, except that (1) basement penetration will be 200 m, and (2) we will conduct a long-term hydrogeologic and tracer experiment by pumping into Hole SR-2A for 24 hours. Monitor pressures and chemistry at nearby holes. CORK Hole SR-2A and allow to equilibrate. Open seafloor valves post-drilling to initiate multi-year hydrologic and microbiological test, using natural overpressure to generate pressure perturbation.
First Ridge (second priority): Drill one to three holes into hydrothermal up flow zone, where the extent and significance of basement alteration, and the likely nature of along-strike hydrothermal recharge, can be evaluated. Sediment thickness is 40-70 m and basement penetration will be 0-40 m.
Deep Ridge (second priority): Drill into deeply-buried basement ridges, 125-145 km from the spreading center, where basement temperatures may approach and exceed 100°C, to evaluate the influences of hydrothermal circulation on crustal evolution and microbiology. Sediment thickness is 500-900 m and basement penetration will be 20-50 m.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SR-1 SR-2	47°45.19'N, 127°45.74'W 47°45.64'N, 127°45.59'W	2600 2600	275 275	600 200	875 475	hydrogeologic properties, distributions, alteration, construction, layering, microbiology, chemistry
FR-1	47°53.9'N, 128°34.50'W	2600	40-70	0-40	50-110	nature of and alteration in hydrothermal upflow zone, microbiology, chemistry
DR-1	47°46.69'N 127°21.52'W	2600	500	20-50	520-550	sediment, basement, chemistry, microbiological sampling, evaluate crustal evolution
DR-2	47°46.07'N 127°10.12'W	2600	900	20-50	920-950	sediment, basement, chemistry, microbiological sampling, evaluate crustal evolution