Fluid and volatile sampling at and below the seafloor

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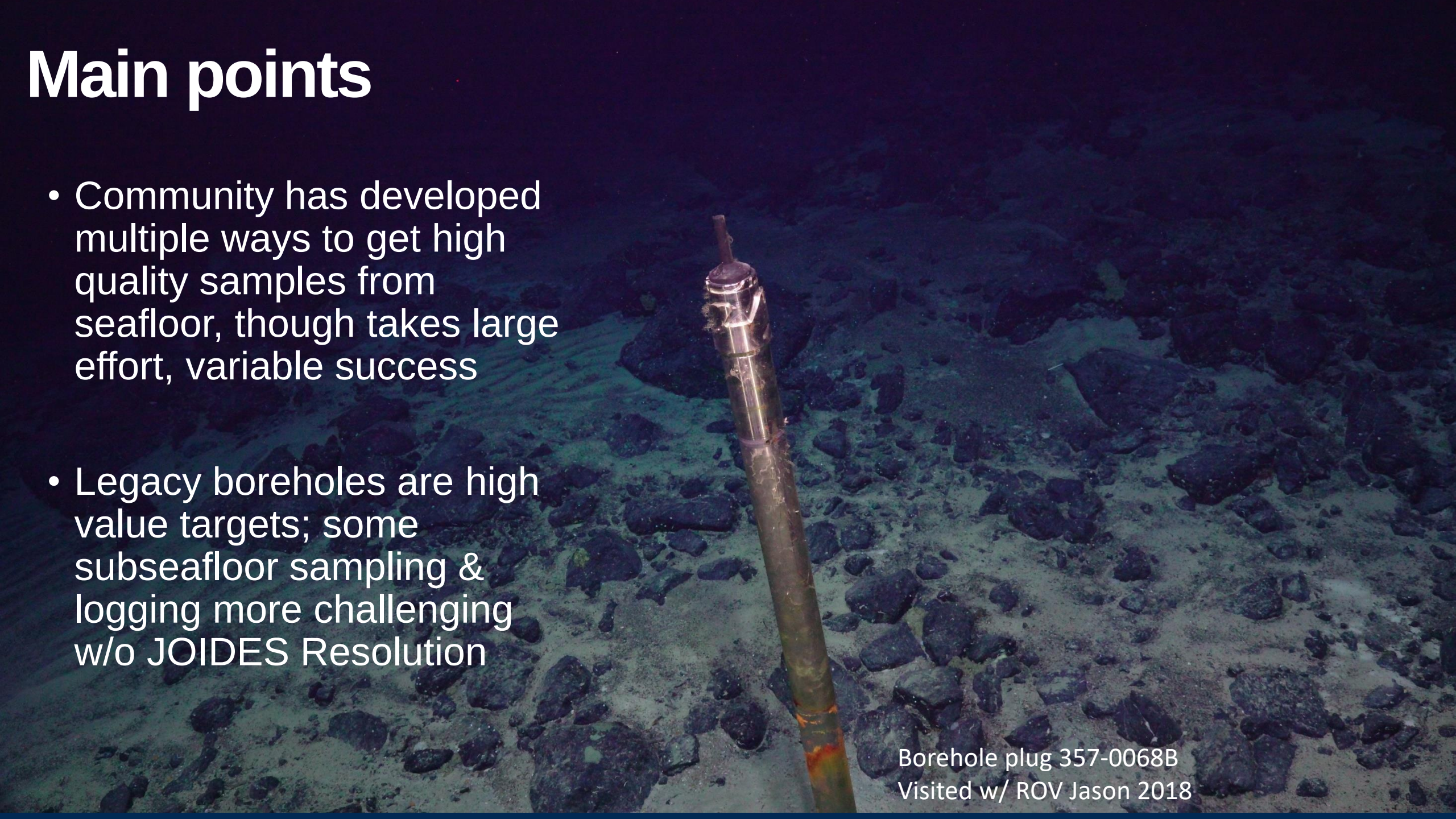
WOODS HOLE OCEANOGRAPHIC INSTITUTION

Main points

- Community has developed multiple ways to get high quality samples from seafloor, though takes large effort, variable success

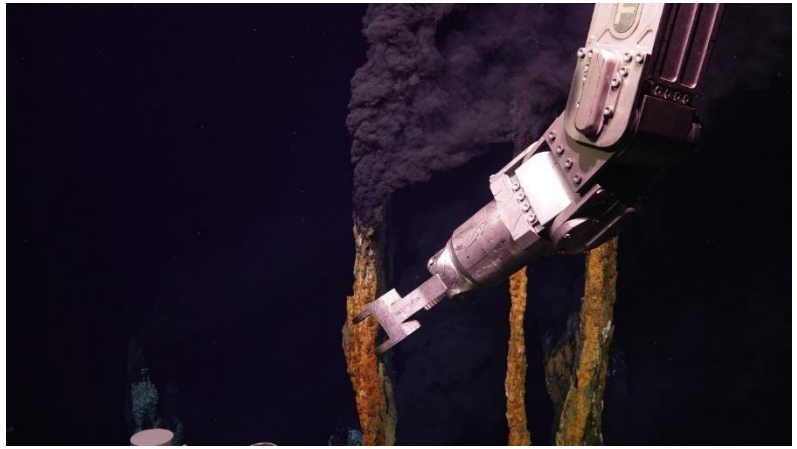
- Legacy boreholes are high value targets; some subseafloor sampling & logging more challenging w/o JOIDES Resolution



Borehole plug 357-0068B
Visited w/ ROV Jason 2018

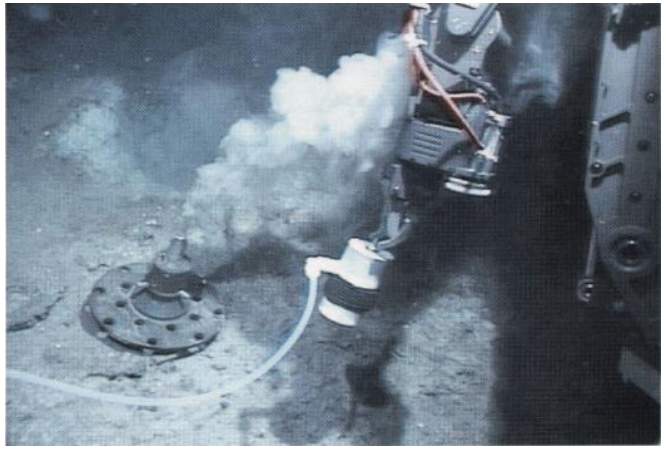
Goals of fluid & volatile sampling

- Transfer of heat and elements between crust and ocean
- Geophysical, chemical, biological character of the subseafloor
- Characterizing conditions for subseafloor life



J. Seewald, WHOI/ NSF /ROV Jason/2020 © WHOI

S. Lang, UofSC/ NSF /ROV Jason/2018 © WHOI



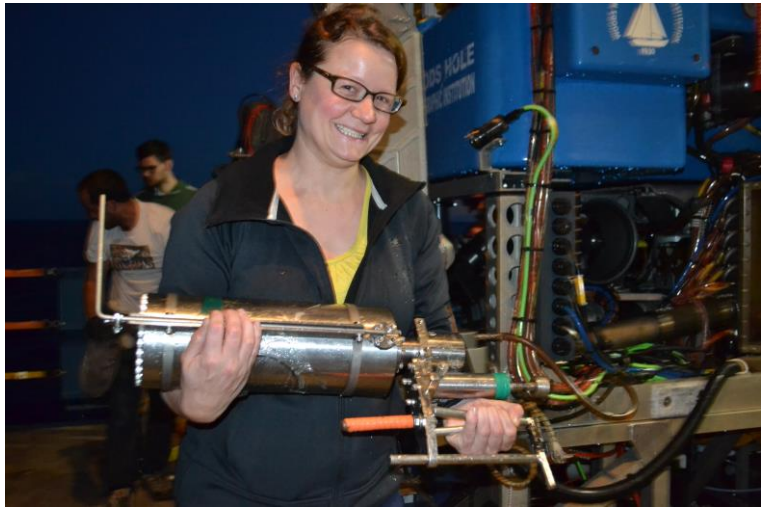
P. Johnson © UW

Challenges of Sampling at the Seafloor

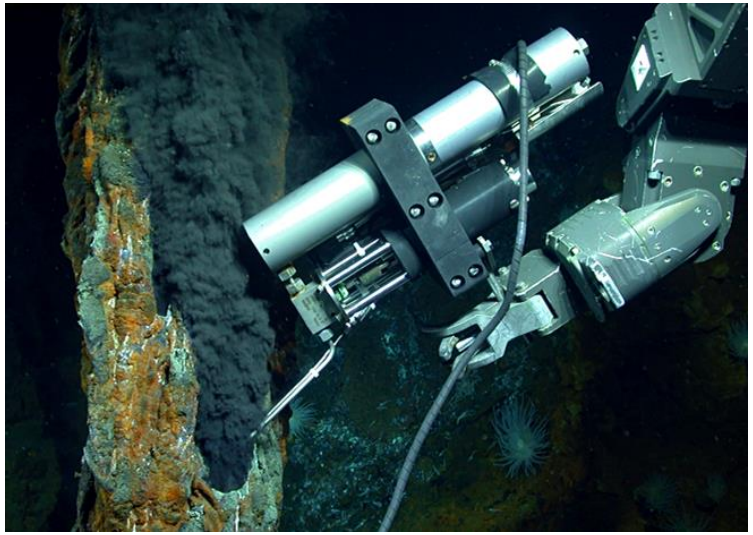
- Intake: cm-scale differences for point sources; seep samplers capture large areas
- Volatile sampling requires maintaining pressure
- Contamination: specialty materials & cleaning needed, and sometimes conflict (organics, trace metals, mbio, etc)
- Large volumes sometimes needed

Sampler	fluid volume	collection method	Gas tight	in situ filtering & preservation
Major Samplers**	750 mL	syringe	no	no
Gas Tights	150 mL	syringe	yes	no
Isobaric Gas Tight (IGT)	150 mL	syringe	yes	no
Hydrothermal Particle and Fluid Sampler (HPFS)	variable	displacement	foil bags / piston	yes
Mobile Pumping System (MPS)	variable	displacement	foil bags / fluid trap	yes
SUPR	variable	positive pumping	no	yes
Hydrothermal Organic Geochemistry (HOG)	variable	displacement	no	yes
Universal Fluid Obtainer (UFO)**	variable	positive pumping	no	yes

**can be requested with deep submergence vehicles



Gas Tight Sampler (Lilley)



Isobaric Gas-Tight Sampler (Seewald)

Sampler	fluid volume	collection method	Gas tight	in situ filtering & preservation
Major Samplers**	750 mL	syringe	no	no
Gas Tights	150 mL	syringe	yes	no
Isobaric Gas Tight (IGT)	150 mL	syringe	yes	no
Hydrothermal Particle and Fluid Sampler (HPFS)	variable	displacement	foil bags / piston	yes
Mobile Pumping System (MPS)	variable	displacement	foil bags / fluid trap	yes
SUPR	variable	positive pumping	no	yes
Hydrothermal Organic Geochemistry (HOG)	variable	displacement	no	yes
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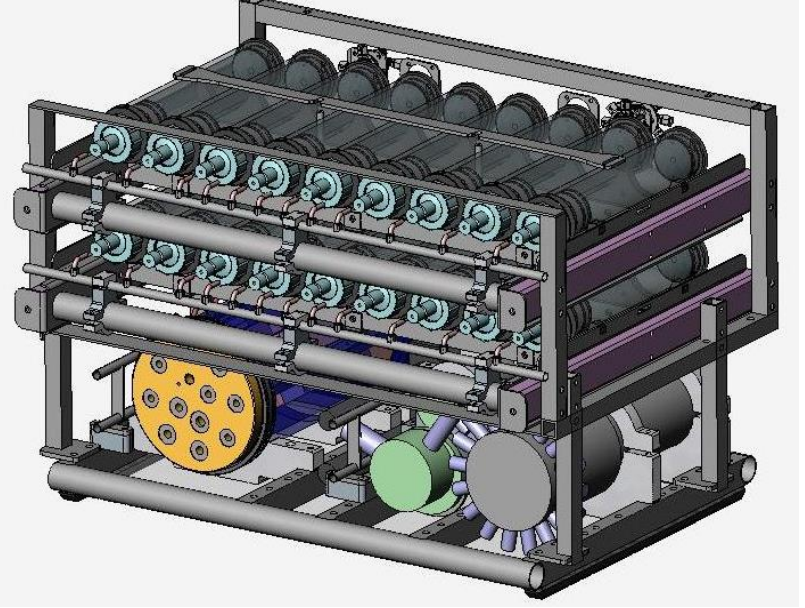
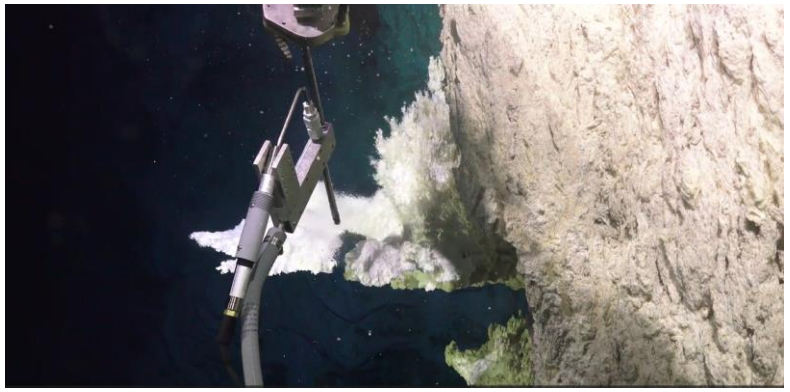


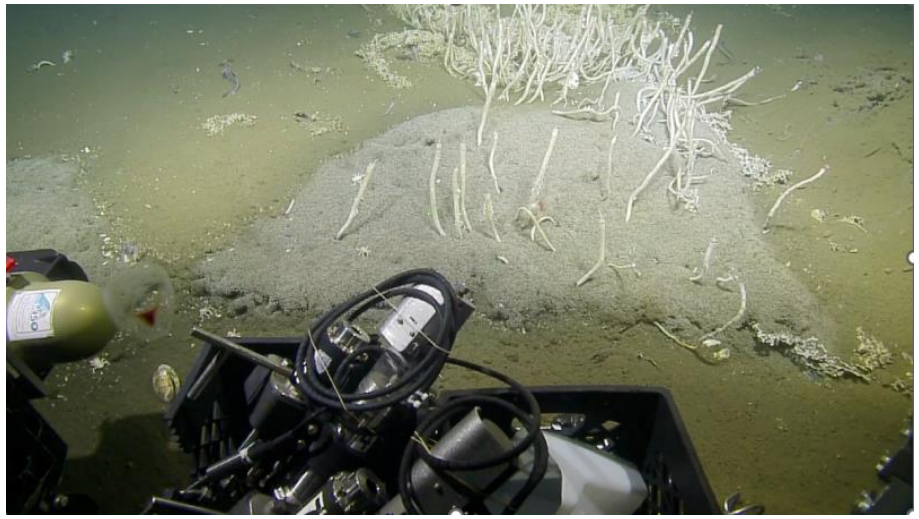
Hydrothermal Particle and Fluid Sampler (Butterfield)



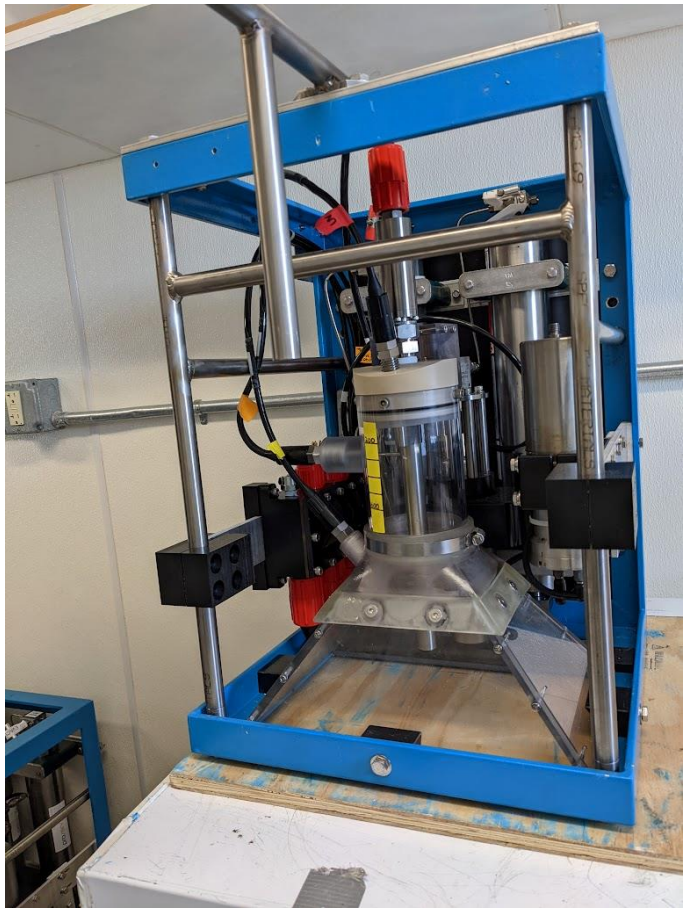
Hydrothermal Organic Geochemistry Sampler (Lang)

Seep samplers

- Large collection areas
- Hydrate formation while sampling



© Schmidt Ocean Institute



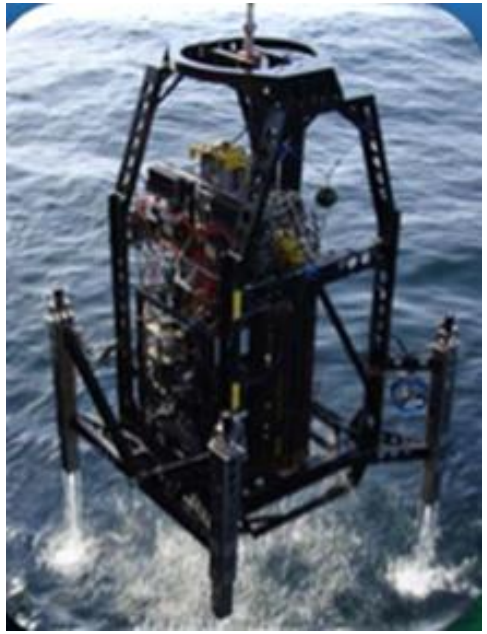
Heated Seep Sampler © Seewald

Sampling below the seafloor

Dedicated drill ship

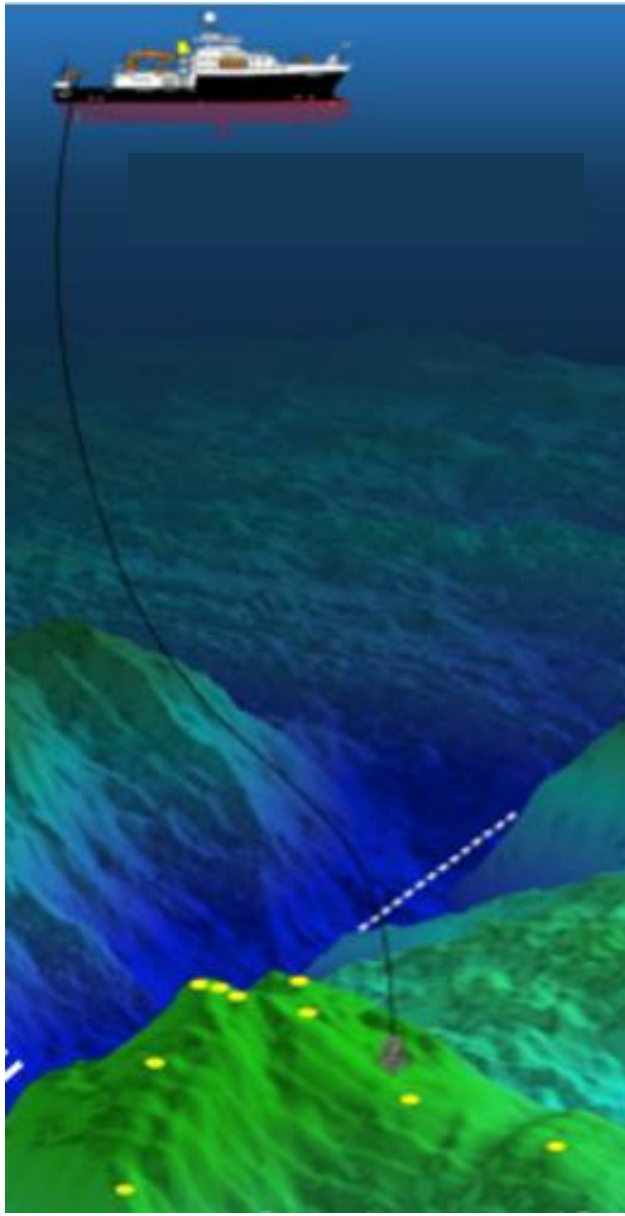
Joides Resolution

Seabed rock drilling

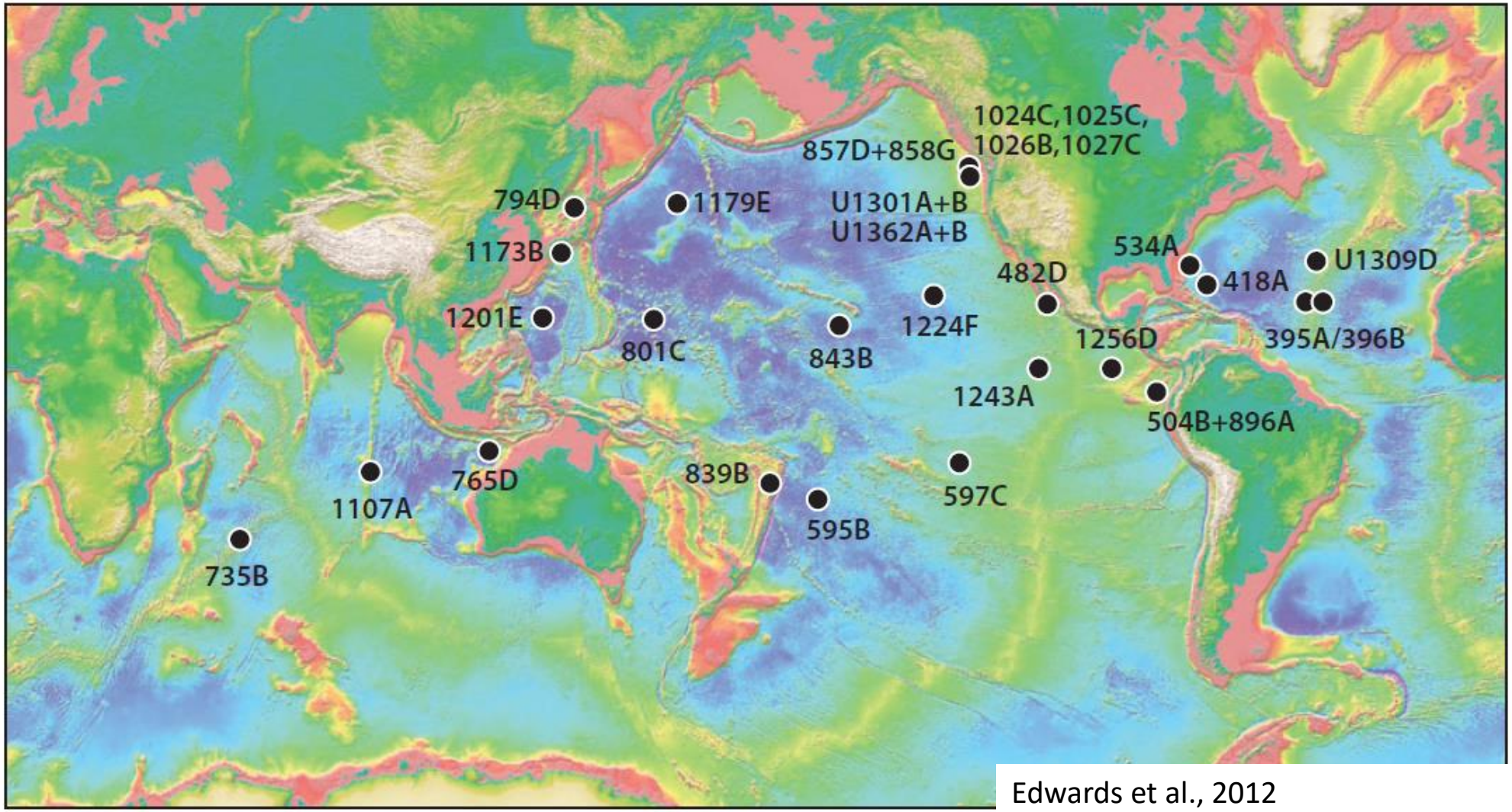


RockDrill II

MeBo



Legacy boreholes



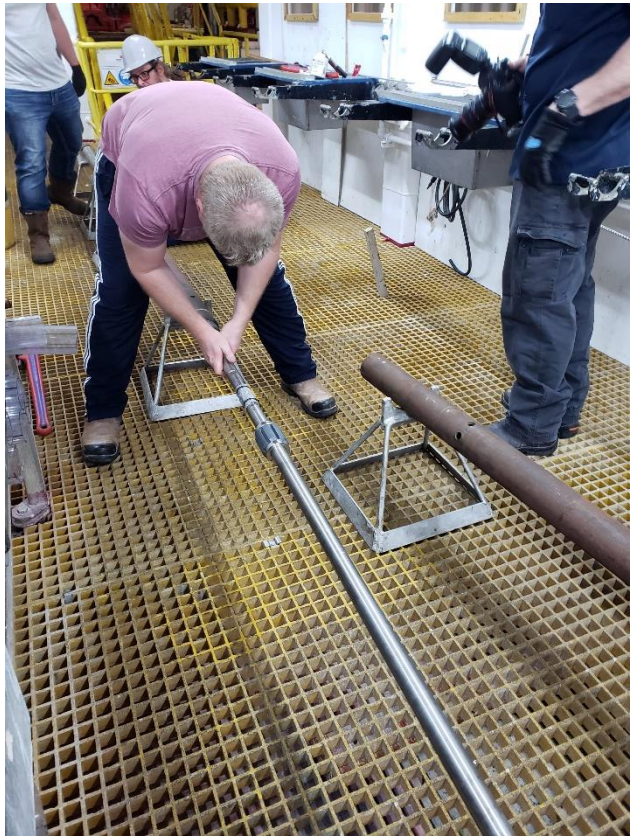
Edwards et al., 2012

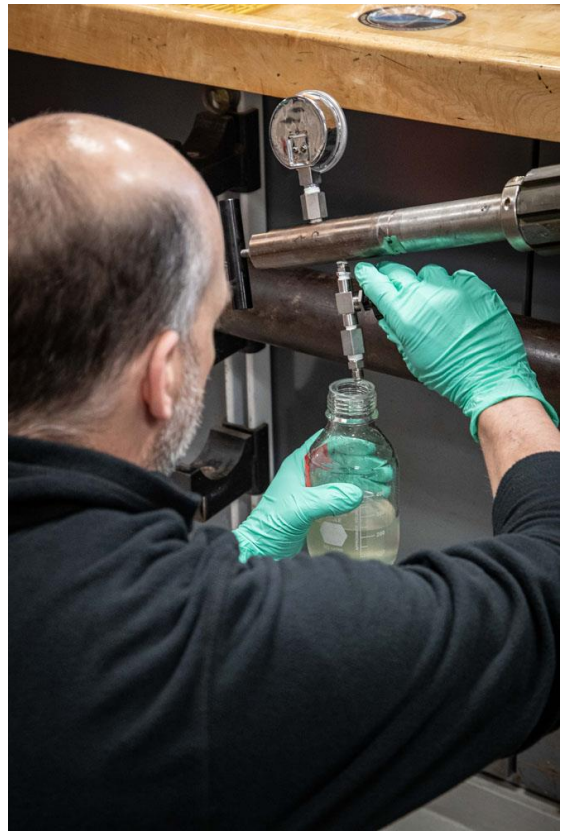
Value of fluid samples from boreholes

- Surface processes overwhelmed by oxygenated conditions, photosynthesis

- Borehole sampling: direct access to the anoxic subseafloor

Borehole fluid samplers: MTFS, Kuster





- Samplers deployed by JR in borehole after drilling
- MTFS: multi-temperature fluid sampler (Wheat et al., 2021)
- Collect 0.5 – 1L water

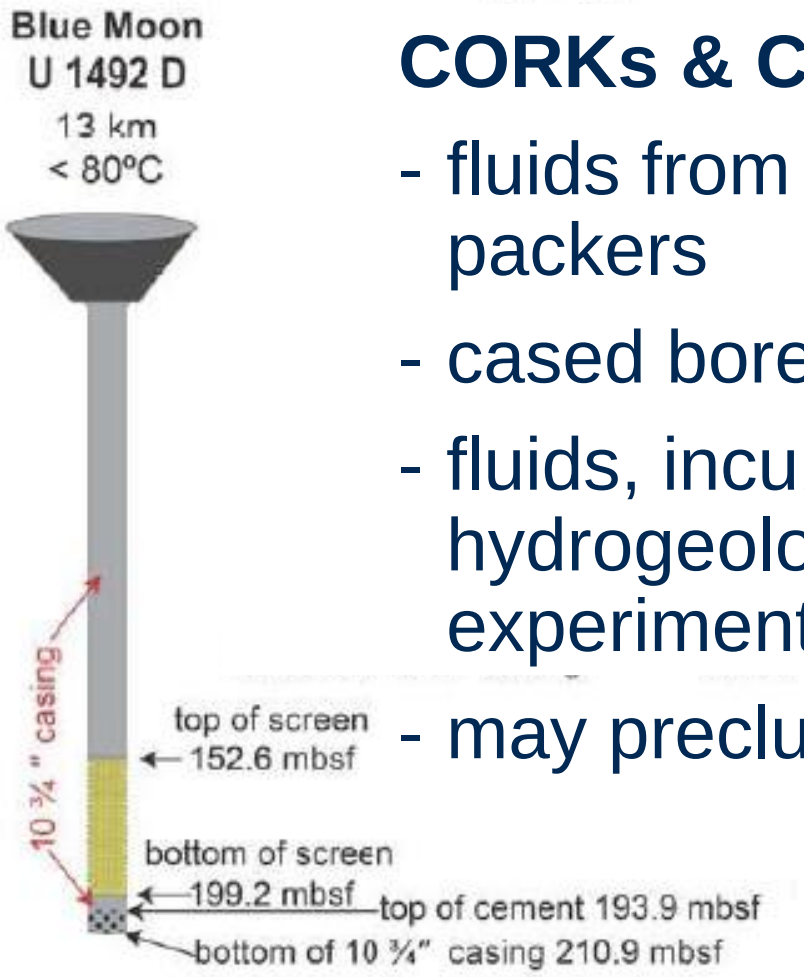
Logging boreholes: continuous record

- Measurements: temperature, density, porosity, magnetic susceptibility, sonic velocity…
- Informs: lithology, degree of alteration, orientation of recovered cores, fault locations

Temperature

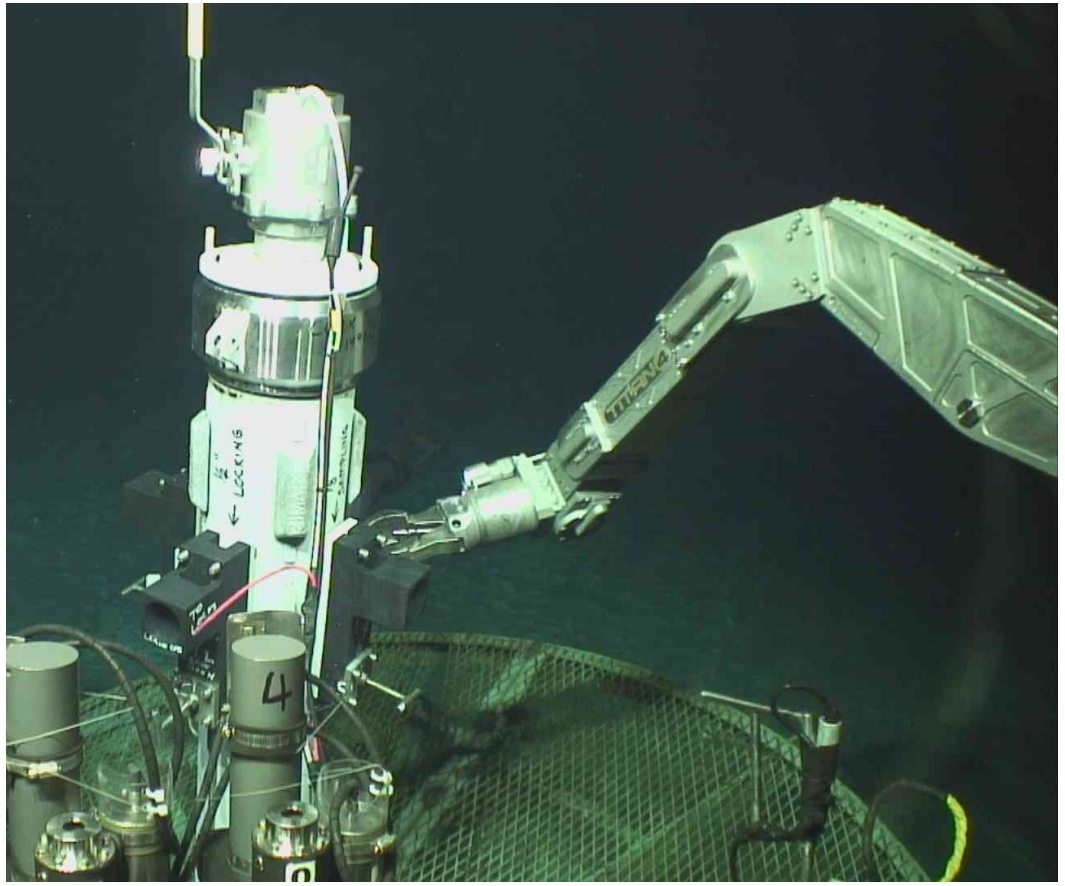
- Fluid flow pathways
- Heatflow
- Large scale circulation

What options exist for fluid & logging in legacy boreholes?



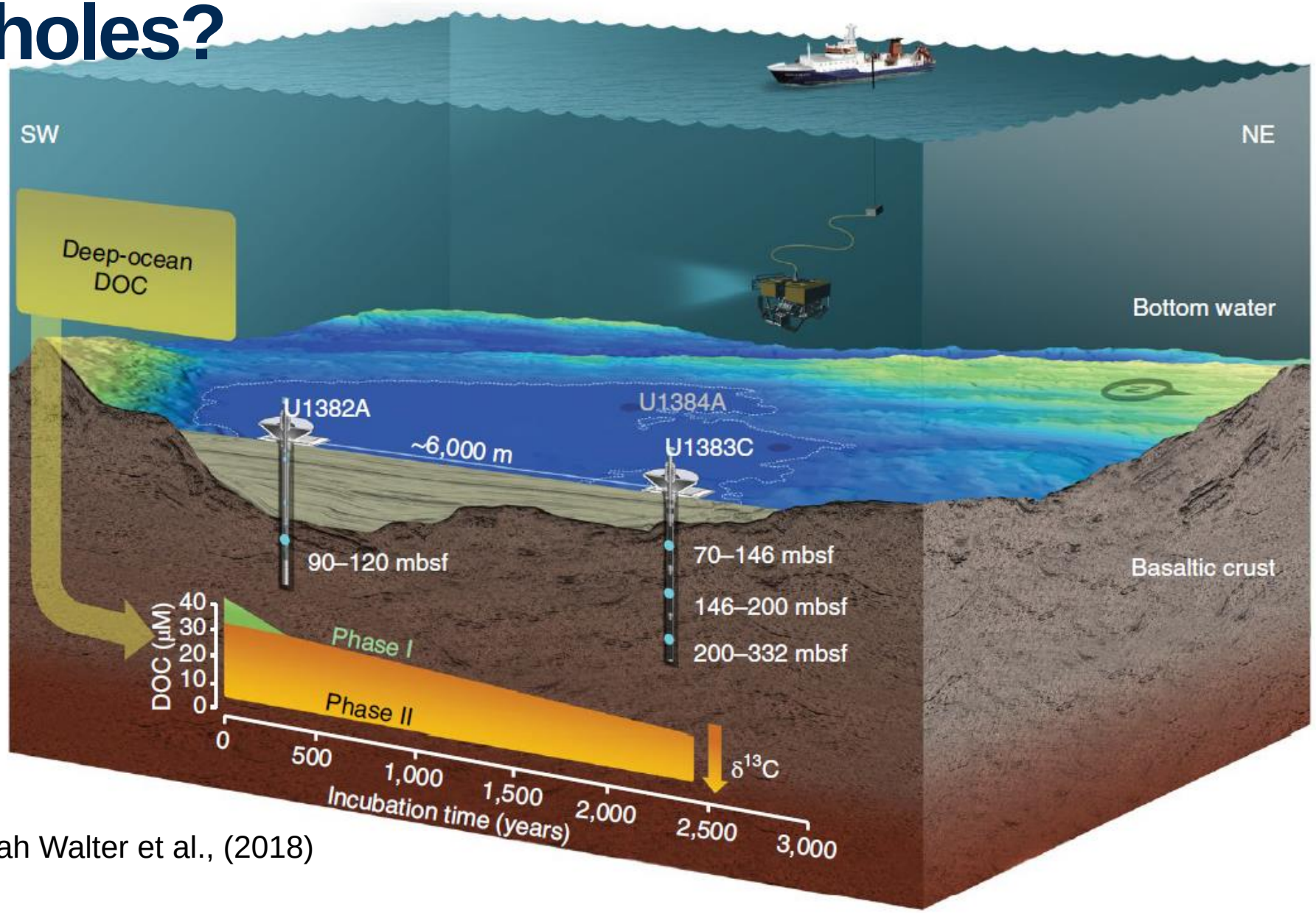
CORKs & CORKlites

- fluids from different depths w/ packers
- cased boreholes
- fluids, incubations, pressure, hydrogeologic (tracer) experiments, other
- may preclude future logging



C.G. Wheat, U. Alaska/ NSF /ROV Jason/2022 © WHOI

What options exist for sampling & logging in legacy boreholes?



Shah Walter et al., (2018)

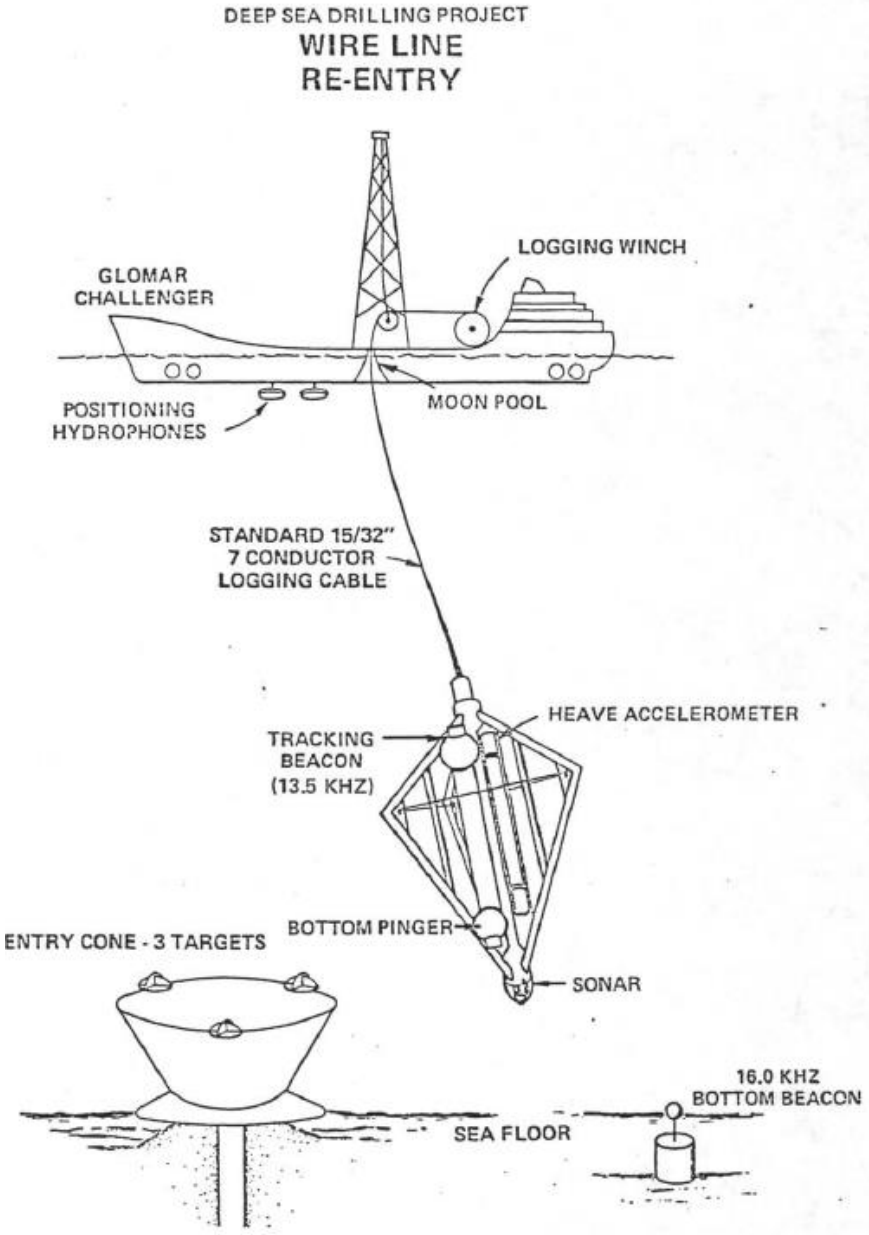
What options exist for logging in legacy boreholes?

INTERNATIONAL PHASE OF OCEAN DRILLING (IPOD)
DEEP SEA DRILLING PROJECT
DEVELOPMENT ENGINEERING
TECHNICAL NOTE NO. 4

June 1984

W. A. Nierenberg, Director
Scripps Institution of Oceanography

M. N. A. Peterson
Principal Investigator and
Project Manager
Deep Sea Drilling Project
Scripps Institution of Oceanography



Thank you

S. Lang, U. of So. Carolina/ NSF /ROV Jason/2018 © WHOI

Sampler	fluid volume	#samples per dive	collection method	Gas tight	in situ filtering & preservation	contact
Major Samplers	750 mL	1 per	syringe	no	no	Alvin / Jason groups
Gas Tights	150 mL	1 per	syringe	yes	no	Marvin Lilley
Isobaric Gas Tight (IGT)	150 mL	1 per	syringe	yes	no	Jeffrey Seewald
Hydrothermal Particle and Fluid Sampler (HPFS)	variable	24	displacement	foil bags / piston	yes	David Butterfield
Mobile Pumping System (MPS)	variable	46	displacement	foil bags / fluid trap	yes	Mike Rappe
SUPR	variable	14	positive pumping	no	yes	Chip Brier
Hydrothermal Organic Geochemistry (HOG)	variable	24	displacement	no	yes	Susan Lang
Universal Fluid Obtainer (UFO)	variable	7	positive pumping	no	yes	Alvin / Jason groups