SCIENTIFIC OCEAN DRILLING

Science Mission Requirements for a Riserless Drilling Vessel

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Talk Outline

- NSF's request for assistance
- Process
- Synthesis of desired vessel capabilities
- Other important issues raised during discussions

Request for Assistance

Science Mission Requirements

NSF's Request for Assistance (Fall 2021)

- To prioritize science objectives and initiatives of the US scientific ocean drilling community
- To prioritize regions of operations
- To define necessary vessel design characteristics to meet these priorities

NSF's Request for Assistance

Hard Requirements

- Rapid mobilization and demobilization between scientific drilling sites
- Inflation-adjusted operational cost structure similar to the current *JOIDES Resolution*

Vessel Does Not Need

- An **ice-breaking** hull
- To conduct operations in shallow water of less than 70 m water depth
- To conduct **routine** Logging-While-Drilling

Process

US Community Input

Steering Committee

Online Survey

Virtual Workshops

- Coring Capabilities
- Mission Critical and Time Sensitive Measurements
- Downhole, Observatory, and Near-Seafloor Capabilities
- Vessel Operations
- Communications/Telepresence

SMR Workshop

Co-Chairs:

Brandon Dugan, Colorado School of Mines

Rebecca Robinson, U Rhode Island

SMR Committee Members:

Stephanie Carr (Hartwick College)

Tim Collett (USGS)

Justin Dodd (Northern Illinois U)

Patty Fryer (U Hawaii)

Patrick Fulton (Cornell U)

Sean Gulick (U Texas, Austin)

Hiroko Kitajima (Texas A&M U)

Anthony Koppers (Oregon State U)

Jay Miller (JRSO - retired)

Yair Rosenthal (Rutgers U)

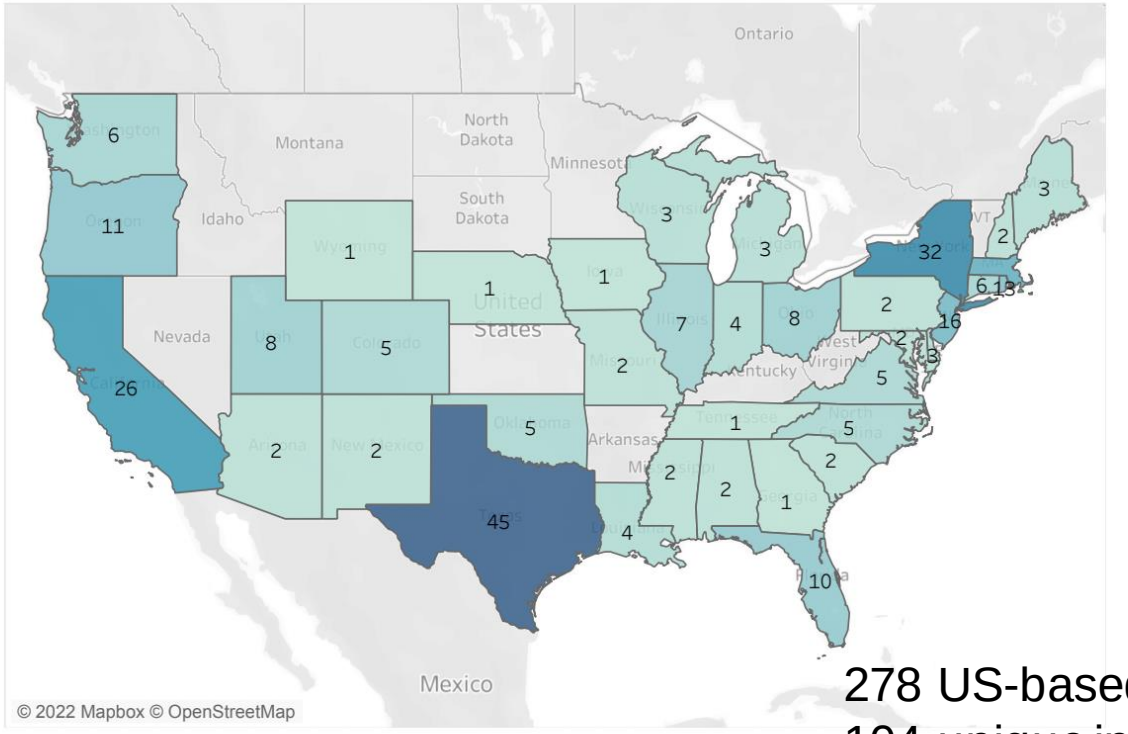
Masako Tominaga (WHOI)

Marta Torres (Oregon State U)

Julia Wellner (U Houston)

Larry Krissek (*ex officio*, Ohio State U)

Survey: Demographics



278 US-based participants
104 unique institutions
39 states and Washington DC
15 participants from 14 non-US institutions

The survey was created with expert advice from Dr. Megan Sanders, Colorado School of Mines

Areas of expertise

- Biology
- Downhole measurements
- Geophysics
- Hydrogeology
- Hydrology
- Igneous petrology
- Inorganic geochemistry
- Lithostratigraphy
- Log-seismic interpretation
- Logging
- Metamorphic petrology
- Microbiology
- Oceanography
- Organic geochemistry
- Paleomagnetism
- Paleontology/biostratigraphy
- Palynology
- Petroleum geology
- Petrology
- Physical properties
- Sedimentology
- Seismology
- Stratigraphic correlation
- Structural geology

Science interests of respondents

Which Flagship Initiative are you most excited to discuss?

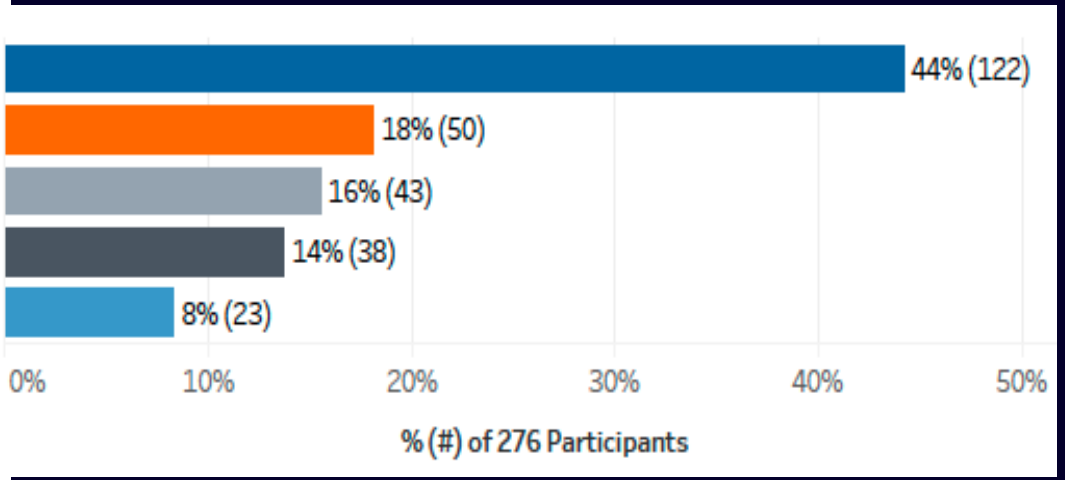
Groundtruthing Future Climate Change

Probing the Deep Earth

Exploring Life & its Origins

Assessing Earthquake & Tsunami Hazards

Diagnosing Ocean Health



Where do we need to Operate?

Geographic

- Pacific Ocean
- Arctic Ocean
- Antarctic Waters
- Atlantic Ocean
- Southern Ocean
- Indian Ocean

Geologic and Oceanographic

- high latitudes
- continental shelves (>70 m)
- continental slopes
- glaciated margins
- ocean ridges
- subduction zones/trenches

Takeaway:
Truly global ship
High latitudes are priority

SMR Workshops

Virtual Workshops

- Explored technological capabilities for a new vessel
- Highlighted science gains we can accomplish with a new riserless drilling vessel

In person workshop

- Prioritized science, including required technology and primary regions of operation
- Outlined specific criteria that define when a given expedition will have achieved its science goals
- Discussed what we lose without a new riserless vessel

Desired Capabilities

A new vessel must be capable of:

- Working in unexplored locations (e.g., high latitudes, deeper water depths, and deeper beneath the seafloor).
- Recovering cores that are representative of the target geology and its microbiome, with an emphasis on characteristically difficult settings (e.g., sand or unconsolidated sediments, glacial and glaciomarine sediment, fractured formations).
- Logging the upper 50-100 meters below seafloor.
- Installing observatories and implementing a range of tools for *in situ* measurements.

Prioritization

Foundational Requirements: base level capabilities

Primary Requirements: provide substantial scientific value to the Foundational SMRs in terms of robust data generation and capability to appropriately work with the generated data.

Foundational Requirements

A1 Modern safety and environmental standards
- including minimizing ship & program's environmental footprint

A2 Locations and water depths
- globally from mid-continental shelf to abyss
- ice strengthened hull (likely Polar Class 6 - icy waters)

A3 Heave compensation, dynamic positioning, and drillpipe stability
- stability in ~13' heave, strong currents, deep water

A4 Modern mud and cement/casing systems


R. Scherer

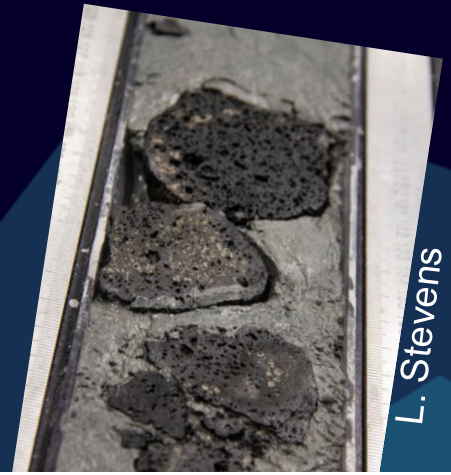

S. Hermann

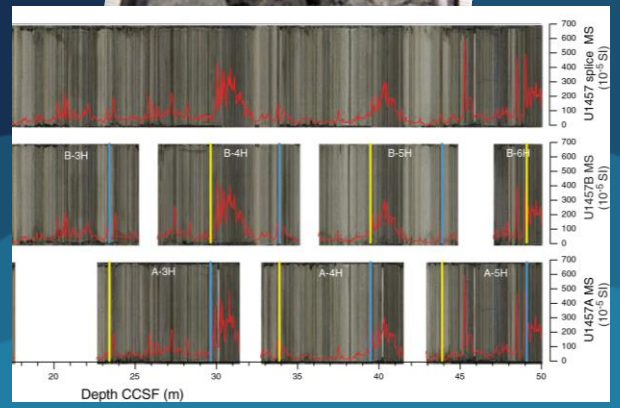
Foundational Requirements
(continued)

A5 High-quality core and continuous cores from key environments
- high latitudes
- mixed matrix, sands, sediment-crust contact
- deep sediments & crust

A6 Onboard measurements
- for safety & decision making
- time sensitive measurements of ephemeral properties

A7 Personnel
- technical
- scientific


L. Stevens

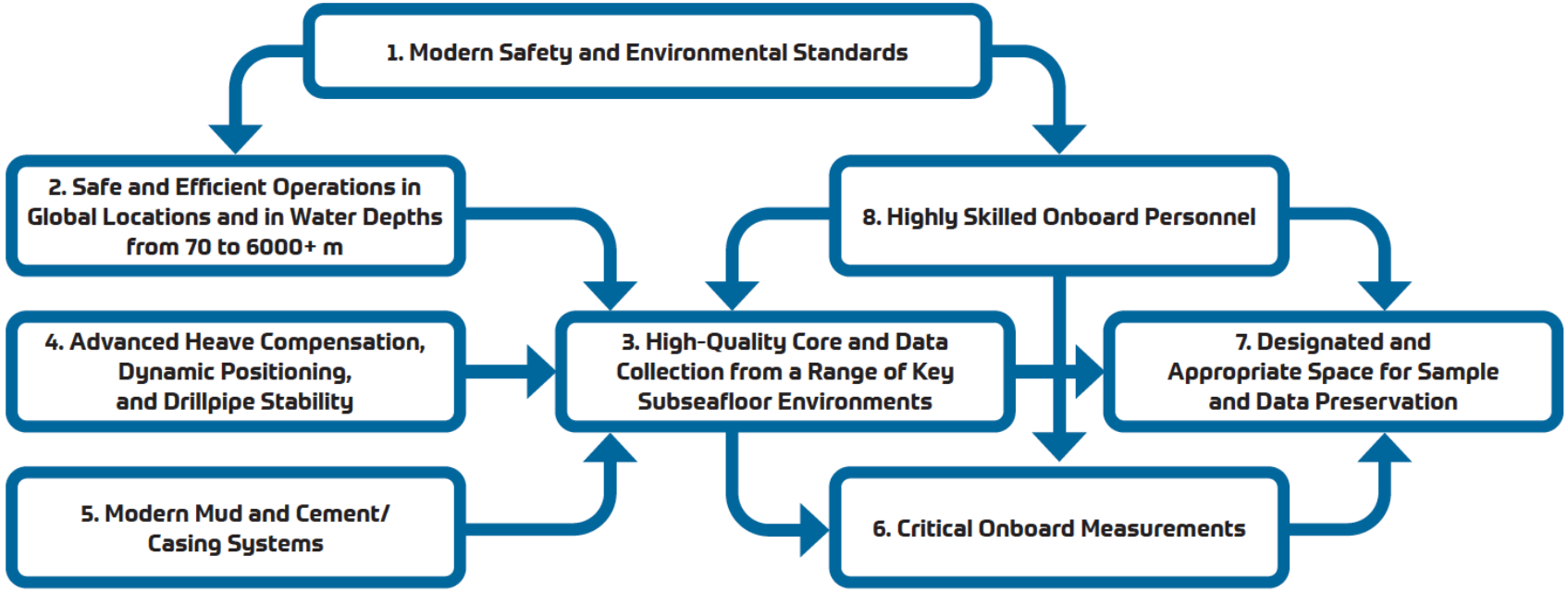



T. Liao, IODP JRSO

L. Stevens

Andreas Teske

Foundational Requirements



Primary Requirements

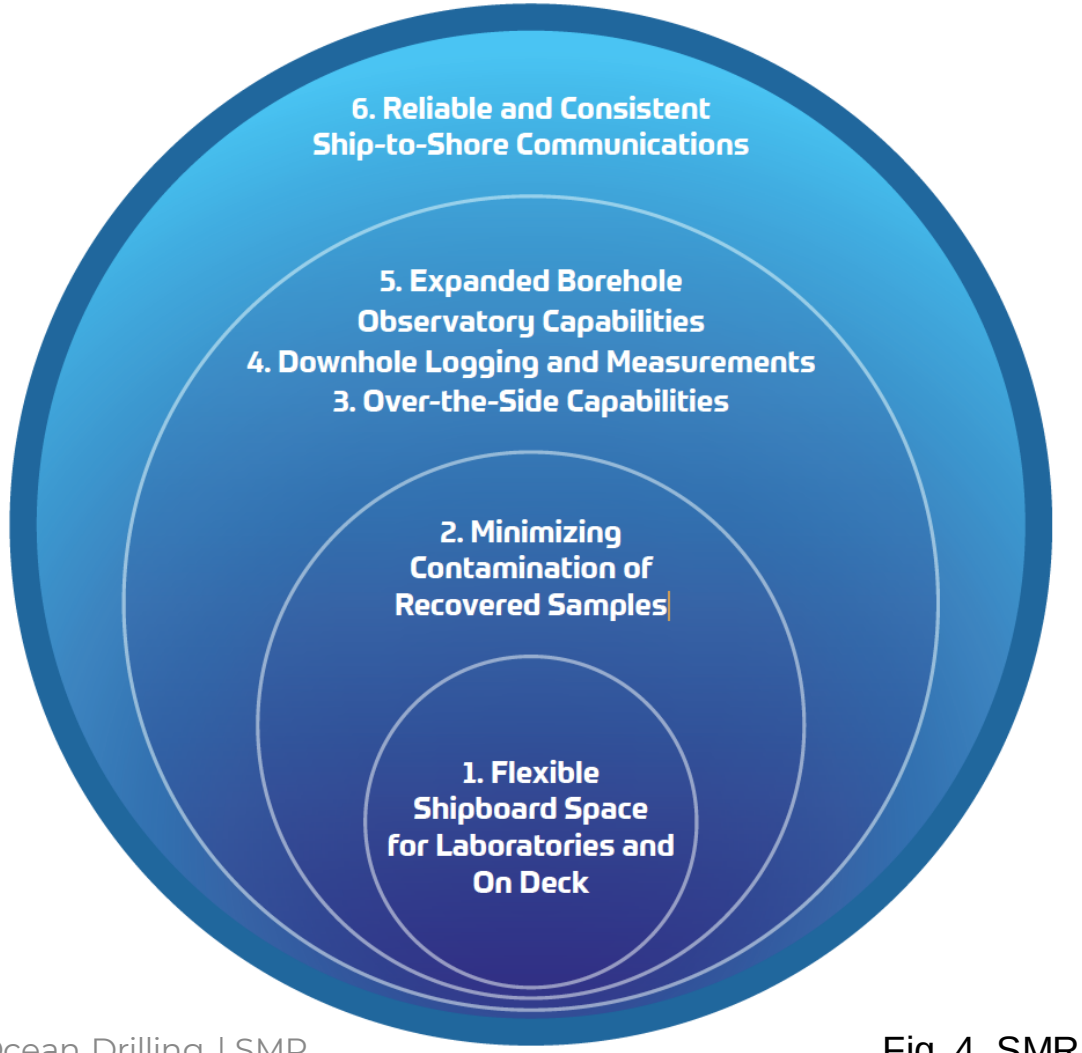
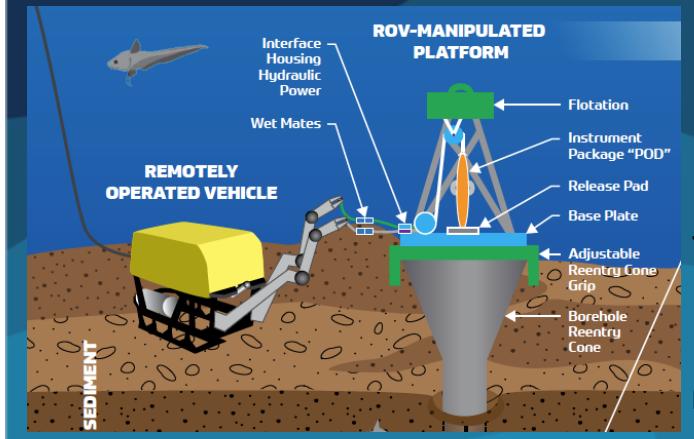


Fig. 4, SMR Final Report



All images from 2050 Science Framework

This is not a JR replacement

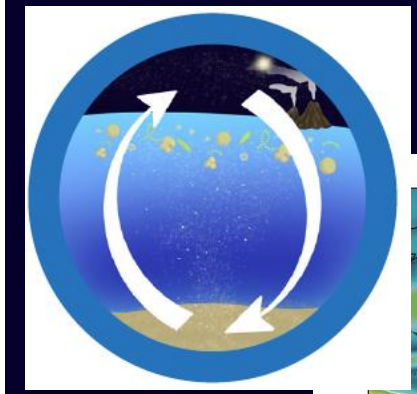
We need a tool that can:

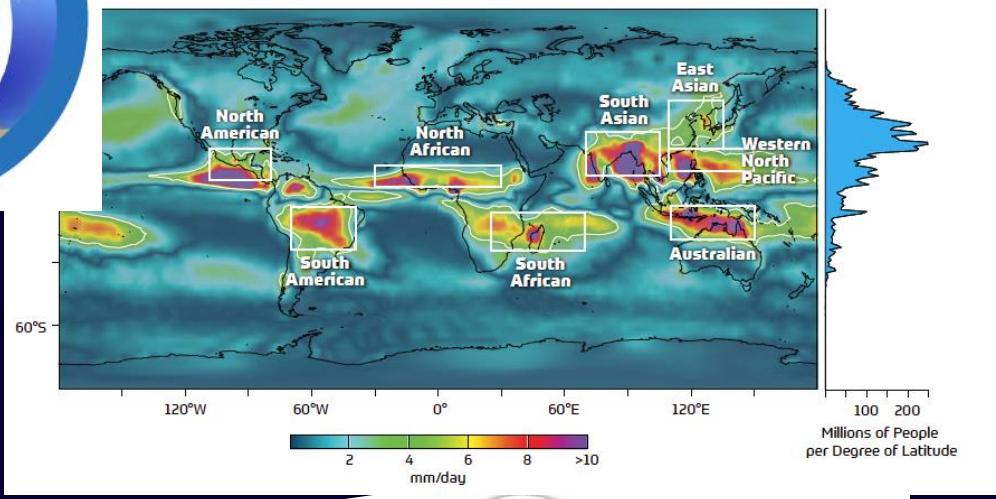
- Core
- Work in high latitudes, deep water
- Install observatories
- Host equipment to make time sensitive, mission-critical measurements (e.g. safety, drilling decisions)
- Host equipment to make ephemeral measurements

Rethink where and when we make standard measurements, how we participate in science parties, and what is possible with flexible space for customizable science needs.

Science Priorities

- **Climate change**: High density, globally distributed, continuous, high quality sediment cores containing a range of lithologies and ability to work in icy waters (crew and ice strengthened hull) to address ice sheet stability, SLR, ocean circulation, C cycle, hydroclimate, etc…
- **Life on Earth**: Contamination-free core and pore fluid sampling in a range of temperature, pressure, and carbon & nutrient availability regimes in both sediments and crust to explore the limits of life, influence on chemistry and biology of ocean and atmosphere.





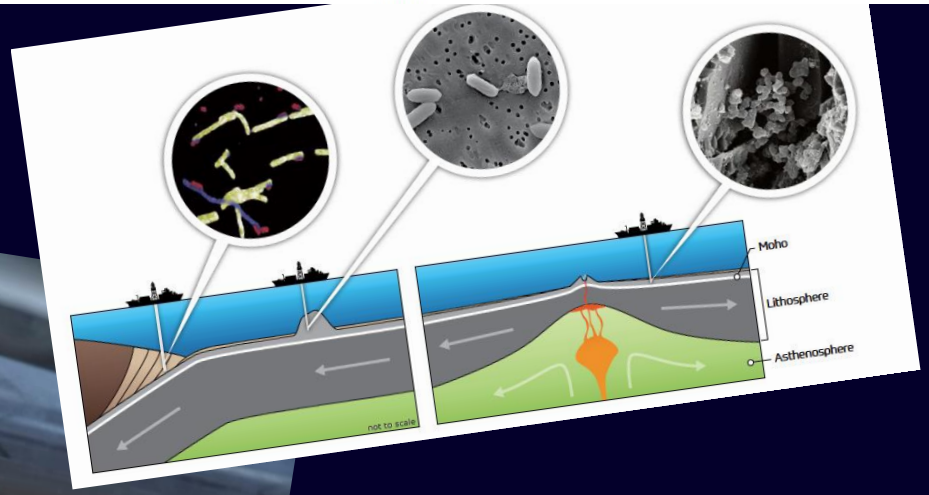
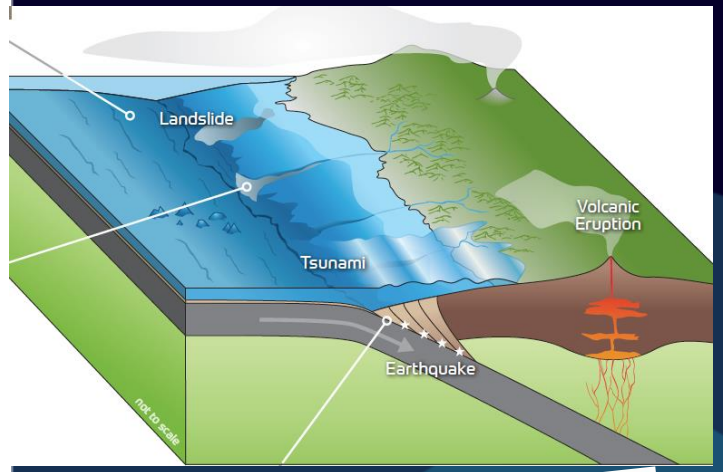
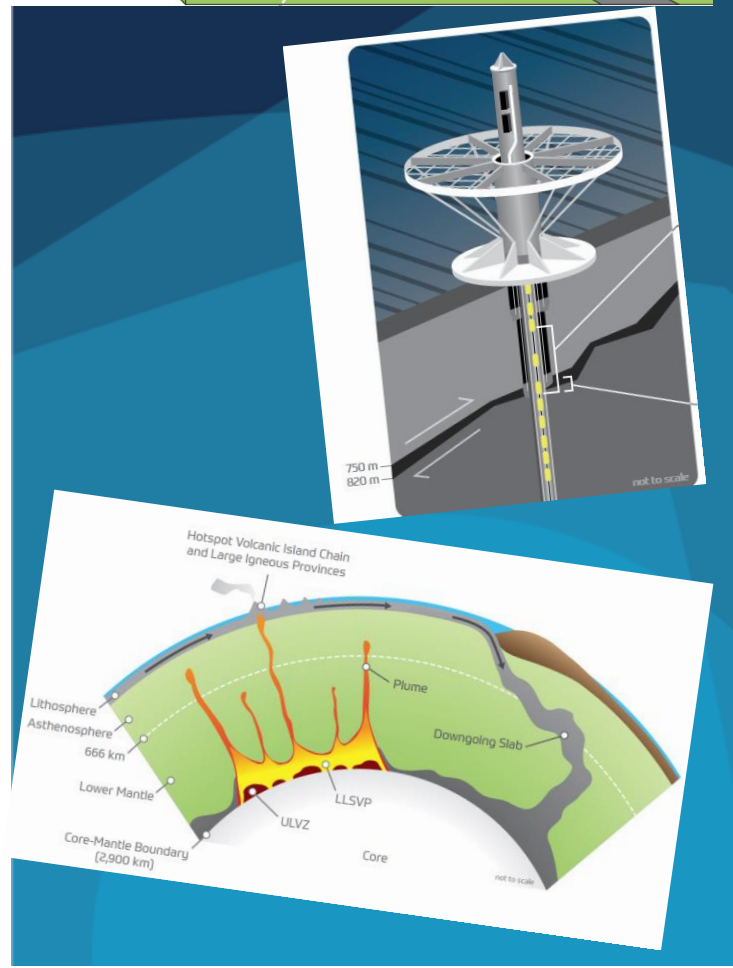


Image credits: B. Marcks, SMR; 2050 Science Framework;J. Sylvan; JAMSTEC

Science Priorities (continued)

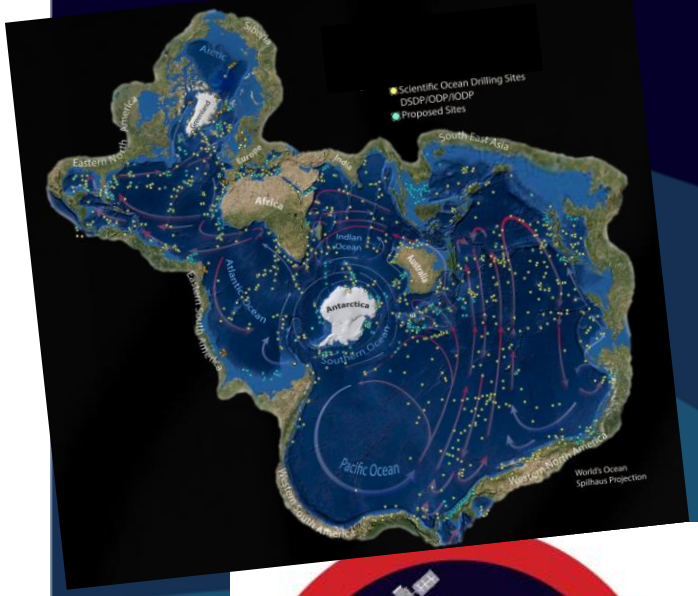
- **Natural Hazards:** High quality sedimentary records, crustal coring and fluid sampling, and borehole observatories are required to examine a range of hazards, including earthquakes and tsunami generating events.
- **Cycling of Tectonic Plates, Energy, and Matter:** Globally representative sections of oceanic crust and sediments, *in situ* monitoring of physical, biogeochemical, & hydrogeologic conditions, and pore fluid sampling are required to explore global cycling of ocean crust, heat, water, carbon and metals and to explore carbon sequestration potential of deep subseafloor.





Additional considerations

- Consistency and Data Standards: We should not underestimate the power of the global sampling and routine measurements conducted over DSDP-ODP-IODP I and II.
- Expanding access: Maximizing scientific expertise and impact requires real time exchange of information and data and growing the user base of scientific ocean drilling samples and data. Alternative staffing options, shore-based participation.
- Growth potential: Given the long timeline, need to decrease environmental impact, and fiscal constraints any design must allow for growth in the diversity of science conducted shipboard, the potential for customized, shipboard sampling capabilities, and elasticity in staff and science party sizes.



S. Kachovich; B.Marcks, SMR; NIOZ

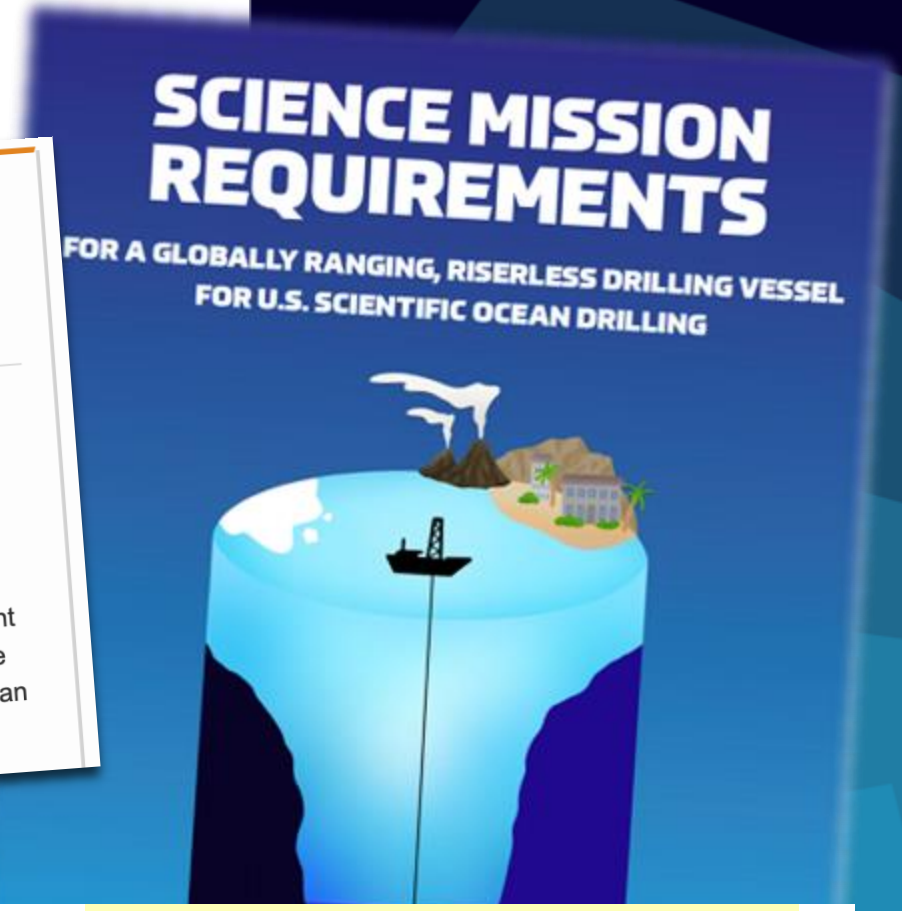
Status of SMR

NSF's response to the Science Mission Requirements report for a potential new U.S. scientific ocean drilling vessel

March 6, 2023

Dear members of the Scientific Ocean Drilling community and editors and authors of the" Science Mission Requirements for a Globally Ranging, Riserless Drilling Vessel for U.S. Scientific Ocean Drilling" report:

I would like to extend my sincere gratitude for the SMR report, submitted to NSF in September 2022. This report was a significant effort to identify the possible capabilities of a future scientific ocean drill ship. I also share a summary for how the report could be used to help direct efforts of the NSF Division of Ocean Sciences (OCE) regarding possible procurement of a new scientific ocean drillship to serve the U.S. science community and NSF's international science partners.



of operations and vessel design characteristics." In considering the recommended SMRs, NSF/OCE understands that prioritization needs to occur in a much broader context, whereby the research priorities for the coming decades of the entire U.S. ocean sciences community and, indeed, the priorities of the U.S. as a nation need to be determined before development of a potential vessel may begin. In the coming years, NSF/OCE intends to engage the U.S. ocean science community in a broad and intensive manner to determine areas of highest priority for ocean drilling, including through the implementation of a second Ocean Sciences Decadal Survey. This activity will help inform future directions for the Division of Ocean Sciences.

Recovery after catastrophe

Immediate future

- Determine areas of highest science priority for ocean drilling

5-7 year timescale

- Conceptual design for a new vessel, supported by community
- Shorebased laboratory facility that allows for continuity of data and instrument advancement/development
- Site surveys
- Proposal development
- Enabling infrastructure

Thank you!

Questions?