General Information
F2022-097 – IODP Expedition 395: Reykjanes Mantle Convection and Climate

Sponsoring institution(s): International Ocean Discovery Program, Texas A&M University
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Description of Project (Nature and objectives of the project):
The scientific research drillship JOIDES Resolution is operated by Texas A&M University on behalf of the US National Science Foundation for the International Ocean Discovery Program (IODP). IODP is an international research collaboration among 21 nations that is dedicated to exploring Earth's history and dynamics using ocean-going research platforms to recover data recorded in sub-seafloor sediments and rocks, as well as to monitor sub-seafloor environments. The goal of IODP Expedition 395: Reykjanes Mantle Convection and Climate is to advance our understanding of mantle dynamics and the linked nature of Earth's interior, oceans, and climate.

From insights into past climates to the confirmation of the theory of plate tectonics, scientific ocean drilling has transformed our understanding of Earth's internal processes. However, the convicting behavior of Earth's mantle and its effects on surface processes such as ocean circulation and climate remain poorly understood. Convection within the mantle can be observed through various geologic processes, such as mid-ocean ridges and mantle plumes. Intersections between mid-ocean ridges and mantle plumes are uncommon but one such intersection is in the North Atlantic Ocean, where the Iceland mantle plume is bisected by the Mid-Atlantic Ridge. This intersection provides a natural laboratory where the composition and dynamics of Earth's upper mantle can be observed.

IODP Expedition 395 has three science objectives. The first will be to test competing hypotheses for the formation of V-shaped ridges along the Mid-Atlantic Ridge south of Iceland. It is believed that these structures observed on bathymetric maps are produced by the interaction between the mid-ocean ridge and the Iceland mantle plume. The second objective is to understand changes in deep water ocean circulation in the past and explore connections with plume activity. Cold water from the Norwegian and Greenland seas enters the North Atlantic through gateways on either side of Iceland. Increased mantle activity can cause the Earth's crust to warm and become more buoyant. It is believed that during these times the increased mantle activity has caused the seafloor to rise in these areas and block off cold water from entering the North Atlantic. The final objective is to reconstruct the chemistry of hydrothermal fluids in the oceanic crust as it ages. This expedition will recover samples of basalt from the oceanic crust that is blanketed by thick sediments. The chemistry of the basalts will allow us to observe spatial and temporal variations in mantle melting processes. This will test the hypothesis that the Iceland plume increases in activity on two timescales (5–10 and ~30 million years), leading to

fundamental changes in the structure of the crust. This idea will be tested against alternative hypotheses involving propagating faults and buoyant mantle upwelling. Millennial-scale records of ancient climate are contained in rapidly accumulated sediments in this region. The accumulation rate of these sediments is an indirect measure for deep water current strength, which is moderated by the oceanic gateways near Iceland. These sediments also provide constraints for past climate events including Pliocene warmth, the onset of Northern Hemisphere glaciation, and abrupt Late Pleistocene climate change. Our combined approach will explore relationships between deep Earth processes, ocean circulation, and climate.

In addition to the primary objectives, Expedition 395 requests to collect sediment samples for microbiological research at the occupied sites. These samples will be used to investigate the microbial community composition that is living in the subsurface sediments. The community abundance (what is present and in what quantities) will be studied in relation to sediment water chemistry measured on board the ship.

The current operations plan for IODP Expedition 395 includes drilling, coring, and downhole measurements at three (3) primary sites with seven (7) alternate sites identified as contingency options should operations not proceed as planned (see attached site map and site coordinate table). One (1) Primary Site (REYK-14B) is located within the Greenland EEZ. Additionally, one (1) Primary Site (REYK-6A) and five (5) Alternate Sites (REYK-5A, REYK-7A, REYK-8A, REYK-9A, and REYK-10A) are located within the Iceland Extended Continental Shelf (ECS). Based on Iceland's Revised Partial ECS submission (2022), the one (1) remaining Primary Site (REYK-2A) and two (2) Alternate Sites (REYK-1A and REYK-4B) are located in international waters.

Currently, the expedition is scheduled to start in Ponta Delgada, São Miguel Island, Portugal on 12 June 2023 and end in St. John's, Canada on 17 August 2023 (these ports could change depending on the COVID-19 Pandemic). The current expedition plan is to visit the sites in the following order: REYK-2A, REYK-6A, and REYK-14B. However, sea state, weather, and operational conditions could change the order of the sites. Additionally, there are seven alternate sites (REYK-1A, REYK-4B, REYK-5A, REYK-7A, REYK-8A, REYK-9A, and REYK-10A) that provide contingency options in case the objectives cannot be met at the primary sites because of operational or scientific reasons (see attached site table). Our current operations plan is to drill at least 2-4 holes at the primary sites to ensure complete recovery of the sedimentary record. Additional holes may be required depending on sea state, operational conditions, or shipboard decisions. All the holes will be cored to the estimated depth listed on the attached site table. Note that the target depths are estimates, the actual depth may be more or less depending on when the objectives are achieved. The exact penetration depth will be provided in the Preliminary and Final Reports.

To achieve our objectives, we plan to use a variety of coring/drilling tools to reach the target depth. These include the Advanced Piston Corer (APC), the Half-Length Advanced Piston Corer (HLAPC), the Rotary Core Barrel (RCB), and the Extended Core Barrel (XCB) (see links to the coring tools in the methods section). Under normal drilling conditions, seawater will be the primary drilling fluid. However, there will be occasions when drilling mud, which has a higher specific gravity than seawater, will be needed to displace cuttings more effectively from the

borehole, maintain well bore stability, or assist in formation evaluation via logging equipment. When needed, we will use sepiolite, attapulgite, or barite, naturally occurring clay minerals, mixed with seawater as drilling mud. Additionally, to prevent unstable hole conditions, a free-fall funnel may be installed in the upper 1-3 meters of the deep hole at Site REYK-14B.

We intend to deploy the following suites of downhole logging tools at all proposed drill sites: the triple combination ("triple combo") tool string, the Formation MicroScanner (FMS)-sonic tool string, the Versatile Seismic Imager (VSI) and the Ultrasonic Borehole Imager (UBI) to collect seismic data for integration of borehole and surface seismic data. See links to the downhole logging tools in the methods section. The logging tools will be run in the final hole at each site if borehole conditions permit. The wireline logging plan aims to provide continuous stratigraphic coverage of in-situ formation properties at all proposed sites.

If microbiological work at the sites is approved, the community abundance (what is present and in what quantities) will be studied in relation to sediment water chemistry measured on board the ship. DNA will be extracted from the cells and the 16S rRNA gene will be sequenced. These measurements are necessary to identify the species of microbes that are living within the seafloor sediments. Microbiology work will be conducted at the Bigelow Laboratory for Ocean Sciences in East Boothbay, Maine, USA. For more information about the lab, you can refer to their website: https://www.bigelow.org/science/lab/deep-biosphere/.

Further details on science and operations are available in the Expedition 395 Scientific Prospectus and the Addendum, which can be found at:
http://publications.iodp.org/scientific_prospectus/395/

Relevant previous or future research projects:
IODP and its legacy programs have been conducting scientific ocean drilling research for over 50 years and have completed several expeditions in Greenland, Denmark, Iceland, and surrounding international waters: Deep Sea Drilling Program (DSDP) Leg 38 (White et al., 1976), DSDP Leg 49 (Luyendyk et al., 1978); Ocean Drilling Program (ODP) Leg 105 (Srivastava et al., 1989), ODP Leg 151 (Thiede et al., 1996), ODP Leg 152 (Saunders et al., 1998), ODP Leg 162 (Raymo et al., 1999), ODP Leg 163 (Larsen et al., 1999); Integrated Ocean Drilling Program (IODP [2004-2013]) Expedition 303 (Channell et al., 2006), IODP Expedition 347 (Andrén et al., 2015); International Ocean Discovery Program (IODP [2013-] Expedition 384 and IODP Expedition 395C.

Geographical Areas:
Please see the attached Site Map and Site Coordinates Table.

Methods and means to be Used:
Name: JOIDES RESOLUTION
Type/Class: Ship: R/V
Nationality (Flag state): Cyprus
Identification Number (IMO/Lloyds No.): IMO 7423081
Owner: Overseas Drilling Ltd
Operator: Texas A&M University on behalf of the U.S. National Science Foundation

Overall length: 143.00 m
Maximum draught: 7.60 m
Displacement/Gross tonnage: 10,282.0
Propulsion: Main Screws: 2 shafts, 4500 hp each 12 each 750 hp thrusters (10 retract, 2 fixed);
Engines/Generators: 7 EMD 16-cylinder diesel
Cruising: 19.50 km/h
Maximum speed: 19.50 km/h
Call sign: 5BMM3
INMARSAT number and method and capability of communication (including emergency frequencies): INMARSAT-FBB500
+ 870 773 409 095 (Bridge/Radio Room);
+ 870 783 401 565 (FAX);
Inmarsat VSAT line 1: + 31 10 808 1154 (Holland);
Inmarsat VSAT line 2: + 1 281 886 5024 (USA)
Name of master: Jacob Robinson
Number of crew: 65
Number of scientists on board: 65

Particulars of methods and scientific instruments

Types of samples and measurements:	Methods to be used:	Instruments to be used:
Sediment Cores	Wireline Coring	Standard IODP coring tools: Advanced Piston Corer (APC), Half-Length Advanced Piston Corer (HLAPC), Extended Core Barrel (XCB), and the Rotary Core Barrel (RCB). Detailed information on coring tools is provided at http://iodp.tamu.edu/tools/.
Laboratory Core Data	Detailed information on standard IODP lab methods, which are well documented in the IODP publication series, can be found at http://iodp.tamu.edu/publications/proceedings.html	Detailed information on IODP shipboard instruments is available at https://wiki.iodp.tamu.edu.
Downhole Logging Data	Wireline Logging	Standard downhole logging tools: Triple combo, FMS-Sonic tool strings, Versatile Seismic Imager, and the Ultrasonic Borehole Imager tool. Detailed information is available at http://iodp.tamu.edu/tools/logging/index.html

Bathymetric Data (3.5 kHz and 12 kHz)	Bathymetric data will be collected between sites and during transit in Greenland waters.	The Bathymetric data will be collected by the standard IODP Underway Geophysics Tool: Knudsen Sounder Suite for CHIRP 3260 Subbottom Profile. Detailed information can be found at https://wiki.iodp.tamu.edu/display/LMUG/Underway+Geophysics
Sediment samples for microbiological research	DNA will be extracted from the cells and the 16S rRNA gene will be sequenced	Microbiology work will be conducted at the Bigelow Laboratory for Ocean Sciences in East Boothbay, Maine, USA. For more information about the lab, you can refer to their website: https://www.bigelow.org/science/lab/deepbiosphere/.

Indicate nature and quantity of substances to be released into the marine environment:
The research does not plan any release of harmful substances into the marine environment. There are two tools within the wireline logging program described below that contain radioactive sources encased within the tools and both can be used as possible combinations for the triple combo string (Hostile Environment Litho-Density Sonde and the Accelerator Porosity Sonde). These tool strings are lowered in the open borehole on a wireline to make in situ measurements and are then returned to the ship. If there are concerns about borehole stability, then the tool string is run without the sources with a loss of the density and porosity measurements.

Indicate whether drilling will be carried out. If yes, please specify:
Scientific coring, drilling, and logging will be carried out. See project description and methods for more information.

Indicate whether explosives will be used. If yes, please specify type and trade name, chemical content, depth of trade class and stowage, size, depth of detonation, frequency of detonation, and position in latitude and longitude:
Explosives are not used during regular operations. In rare cases, a small explosive charge may need to be used to sever the drill pipe in the unusual circumstance that the pipe is stuck in the borehole and cannot be worked loose. The charge is lowered through the drill string to the point where the drill string is stuck in the borehole, which is always well below the seafloor. The charge is just large enough to free the pipe and does not disturb biota. The use of explosives in stuck pipe episodes is a rare occurrence (we have operated in hundreds of locations, and this has only happened 5 times in the last 10 years). Low explosives are also used as part of the Kinley cutters to cut the wireline when stuck (we have operated in hundreds of locations, and we have only had this happen 1 time in the last 10 years). All explosives are classified/labeled as 1.4S and are stored in the same configuration as when shipped. Explosives are stored in secured bunkers on the aft of the ship with the detonators stored away from the secondary high explosives (opposite side of the ship). Explosives onboard: *HMX (Octogene) Cyclotetramethylen Tetranitramine (C4H8N8O8): articles, fuses, and detonator cords *Lead Azide (PbN6): detonators *Nitrocellulose (C6H7(NO2)3O5) 2, 4-Dinitrotoluene C6H3

(CH3)(NO2): sandline cutter.

Indicate whether protected species be studied. If yes, please specify:
No

Installations and Equipment
Details of installations and equipment (including dates of laying, servicing, method and anticipated timeframe for recovery, locations and depth, and measurements):
In case there are unstable hole conditions, or we need to change the drill bit and renter a borehole, a free-fall funnel may be deployed in the upper 1-3 meters of the hole. The dimensions of a free-fall funnel are 1 m above the seafloor and 2.3 m in diameter.

Estimated overall project start and end dates:
Project Start Date: 6/12/2023
Project End Date: 8/17/2023

Coastal State-specific details:
Coastal Area Portugal
Estimated Entry Date: 6/12/2023
Estimated Departure Date: 6/17/2023
Estimated Research Start Date:
Estimated Research End Date:
Explanation of multiple entries: N/A
Research will be performed: Port Call Only
Extent to which Portugal will be enabled to participate or to be represented in the research project: N/A
Name, affiliation and contact information for all participants from Portugal: N/A

Coastal Area Iceland
Estimated Entry Date: 6/20/2023
Estimated Departure Date: 7/25/2023
Estimated Research Start Date: 6/20/2023
Estimated Research End Date: 7/25/2023
Explanation of multiple entries: N/A
Research will be performed: Beyond 200 nm
Extent to which Iceland will be enabled to participate or to be represented in the research project: We can extend one berth for an official observer.
Name, affiliation and contact information for all participants from Iceland: N/A

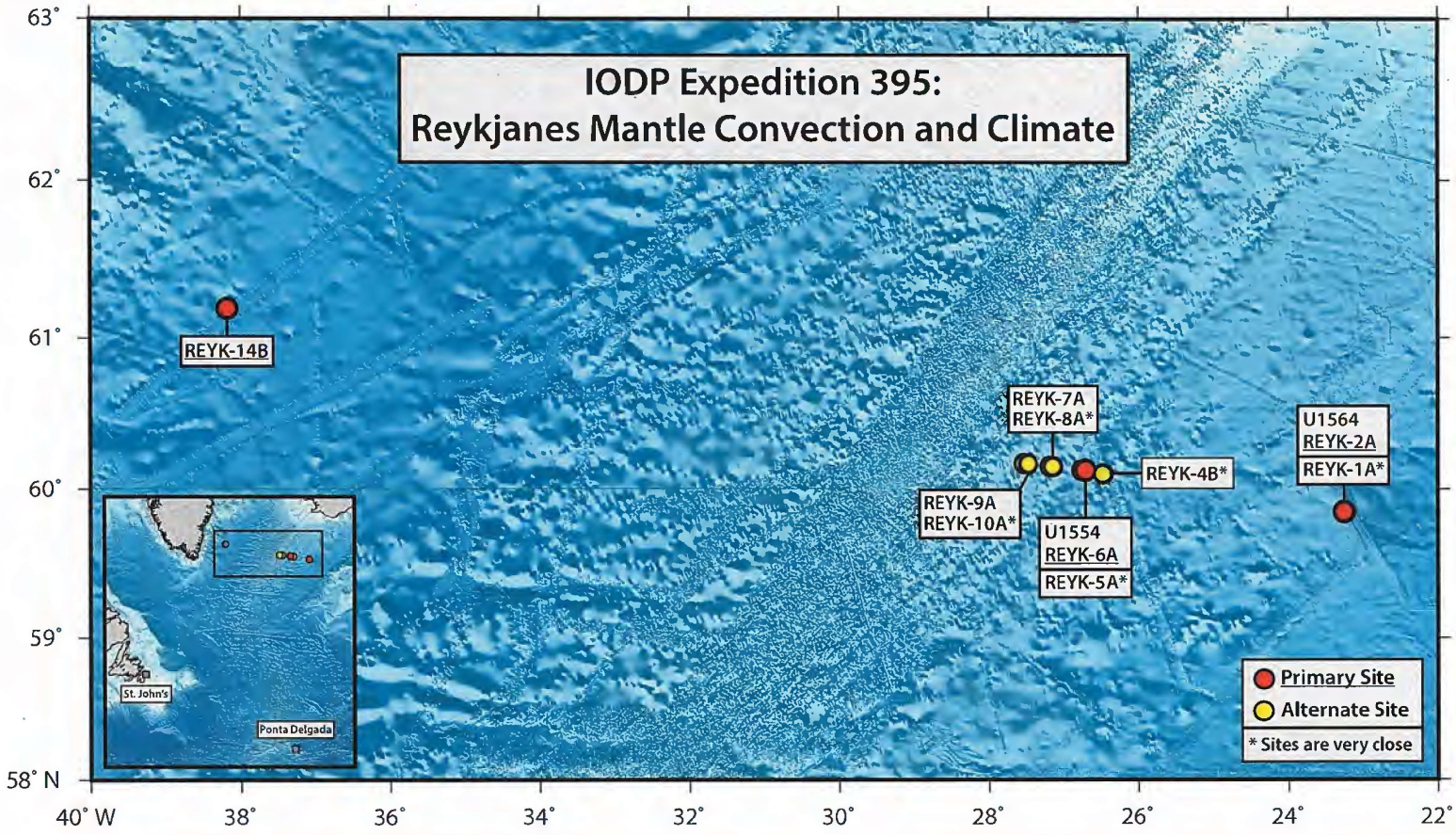
Coastal Area Greenland
Estimated Entry Date: 7/15/2023
Estimated Departure Date: 8/8/2023
Estimated Research Start Date: 7/15/2023
Estimated Research End Date: 8/8/2023
Explanation of multiple entries: N/A
Research will be performed: Between 12-200 nm

Extent to which Denmark will be enabled to participate or to be represented in the research project: We can extend one berth for an official observer.
Name, affiliation and contact information for all participants from Denmark: N/A

Coastal Area Canada
Estimated Entry Date: 8/12/2023
Estimated Departure Date: 8/17/2023
Estimated Research Start Date:
Estimated Research End Date:
Explanation of multiple entries: N/A
Research will be performed: Port Call Only
Extent to which Canada will be enabled to participate or to be represented in the research project: N/A
Name, affiliation and contact information for all participants from Canada: N/A

Access to Data, Samples and Research Results
Anticipated dates of submission to the coastal State of the final report:
No more than 2 years from the end date of the research. Data will be provided through official channels at no cost to the coastal State(s). Samples will be provided upon request.

Proposed means of making results internationally available:
The IODP Preliminary Report will be published about two months after the completion of the expedition: http://publications.iodp.org/
The Proceedings of the International Ocean Discovery Program (i.e., the final report) will be published around 1.5-year post cruise: http://publications.iodp.org/
Digital data will be released about 1.5-year post cruise: http://web.iodp.tamu.edu/OVERVIEW/
Cores and samples will become available internationally after a 1.5-year moratorium. Cores will be stored at the IODP Bremen Core Repository in Bremen, Germany for permanent storage.


IODP Expedition 395:
Reykjanes Mantle Convection and Climate
63°
62°
61°
60°
59°
58° N
40° W
38°
36°
34°
32°
30°
28°
26°
24°
22°
REYK-14B
REYK-7A
REYK-8A*
REYK-4B*
REYK-9A
REYK-10A*
U1554
REYK-6A
REYK-5A*
U1564
REYK-2A
REYK-1A*
St. John's
Ponta Delgada
Primary Site
Alternate Site
* Sites are very close

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Site Name	Site Type	Latitude	Longitude	Water Depth (m)	Estimated Total Penetration (mbsf)
REYK-2A	Primary	59.85060	-23.26640	2206	1170
REYK-6A	Primary	60.12510	-26.70160	1871	905
REYK-14B	Primary	61.19523	-38.18031	2829	1376
REYK-1A	Alternate	59.84960	-23.24730	2209	1155
REYK-4B	Alternate	60.10094	-26.46111	2109	615
REYK-5A	Alternate	60.12640	-26.75160	1894	875
REYK-7A	Alternate	60.15070	-27.16980	1735	530
REYK-8A	Alternate	60.14910	-27.13700	1695	520
REYK-9A	Alternate	60.17020	-27.52994	1701	510
REYK-10A	Alternate	60.16670	-27.47260	1689	355

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