IODP Expedition 391: Walvis Ridge Hotspot

Week 5 Report (2–8 January 2022)

The fifth week of the International Ocean Discovery Program (IODP) Expedition 391, Walvis Ridge Hotspot, included RCB coring from the seafloor to a final depth of 332.3 m below seafloor (mbsf) in Hole U1575A (proposed Site FR-01B), the transit to Site U1576 (proposed Site VB-14A), and RCB coring from the seafloor to 75.4 mbsf in Hole U1576A. All times in this report are in ship local time (UTC + 2 h).

Operations

This week began while the drill string was being lowered to the seafloor to spud Hole U1575A at the northeastern Valdivia Bank of Walvis Ridge. The drill pipe was drifted and strapped while lowering the drill string. After connecting 50 stands of drill pipe (each stand measures ~28.5 m), the pipe trip was halted to attach the circulating head to the top of the drill string. The pipe was then filled with surface seawater. At 0745 on 2 January 2022, the top drive was picked up and circulation through the drill pipe was established when the drill bit reached a water depth of 3193.9 m below sea level (mbsl). We then pumped a "pig" (pipe cleaning device) through the drill string to remove some of the rust. The drill bit was lowered further and positioned at the seafloor depth of 3231.3 mbsl as obtained from the precision depth recorder (PDR). A dressed, nonmagnetic RCB was dropped and pumped down to land in the outer core barrel (OCB). At 1015 h on 2 January, we spudded Hole U1575A and began RCB coring. Cores U1575A-1R to 41R penetrated from the seafloor to a final depth of 332.3 mbsf and recovered 185.2 m (56%) of sediments and igneous rocks. The sediment/igneous basement contact was intersected on 3 January while cutting Core 22R at a depth of 209.9 mbsf when the drilling rate slowed down from ~5 m/h to ~1.25 m/h. We switched to half-length (~4.8 m) advances on Cores 23R to 34R because of the slow penetration rate and to improve core recovery. In an attempt to increase the final depth in Hole U1575A, full coring resumed with Core 35R on 5 January. This continued through Core 36R on 6 January. On Core 37R, the penetration rate again dropped to 0.6 m/h. After almost 6.5 h of cutting Core 37R and with only a 4 m advance, the core barrel was pulled for inspection. The core recovery was exceptional, but the core catchers were damaged and barely managed to prevent the core from dropping out of the core barrel. While cutting the remaining 5.7 m to complete a full advance on Core 38R, the penetration rate had increased to the point where full coring was possible again. Thus, we switched back to full advances on Cores 39R to 41R that were recovered on 7 January. In total, 220 barrels of high-viscosity mud were pumped in 20-barrel sweeps for hole cleaning over the course of coring Hole U1575A. Coring was terminated in Hole U1575A following Core 41R on 7 January. The RCB core barrels were secured, and we started pulling the drill string out of the hole at 0700 h. The top drive was set back at 0745 h, the bit cleared the seafloor at 0842 h, and the top of the BHA reached the rig floor at 1300 h. Then, the four stands of drill collars were racked back in the derrick and the

OCB components were disassembled, inspected, and laid out. The bit arrived at the rig floor at 1430 h on 7 January. The rig floor was secured for transit at 1445 h, ending Hole U1575A and Site U1575. The time spent on Hole U1575A was 137.0 h or 5.7 d.

The thrusters were pulled and secured at 1506 h on 7 January. The vessel was then switched from DP to cruise mode and secured for transit. The sea passage to Site U1576, located at the western Valdivia Bank, began at 1512 h. The 183 nmi transit was completed in 16.6 h at an average speed of 11.0 kt. The vessel arrived on site at 0748 h on 8 January. The thrusters were lowered and secured at 0809 h. The operating mode was switched from cruise to DP mode at 0810 h. The drill floor was cleared for operations at 0812 h.

The OCB as part of the RCB BHA was made up during the transit to Site U1576. With no logging in the operations plan, the mechanical bit release was removed from the OCB and a normal bit sub was inserted. An additional drill collar was included in the BHA assembly and the 181.3 m long BHA was made up. We started lowering the drill string to the seafloor at 0915 h on 8 January 2022, continuing for 50 stands of drill pipe. We then paused to install the circulating head. The drill pipe was filled with surface seawater. The drill string was lowered further to a water depth of 3000.9 mbsl. PDR measurements of the seafloor recorded a depth of 3032.3 mbsl. Upon implementing a routine slip and cut of 115 ft of the drilling line, we picked up the top drive at 1500 h and lowered the drill bit to just above the seafloor. At 1640 h on 8 January, we spudded Hole U1576A and began coring. RCB Cores U1576A-1R to 8R advanced from the seafloor to 75.4 mbsf and recovered 60.7 m (81%) of sediment.

Daily COVID-19 antigen testing continued for all personnel through 6 January and another routine testing round was implemented on 8 January. All results were negative. Enhanced shipboard COVID-19 mitigation protocols continued to be followed.

Science Results

Scientists described and analyzed cores recovered from Holes U1575A and U1576A. The laboratory groups started drafting their Site U1575 reports.

Core Description

The core description team began describing cores from Site U1575 consisting of a combined ~332 m thick sequence of sediment and underlying igneous basement. The transition to igneous basement occurred at ~210 mbsf. Cores were described using a combination of macroscopic and microscopic (smear slides and thin sections) observations. The core description team took samples for X-ray diffraction (XRD) analysis.

The sediments recovered at Site U1575 are mostly biogenic, consisting of unlithified to partially coherent nannofossil-foraminifera ooze with minor radiolarians (Lithostratigraphic Unit I). Lithification to chalk occurs in the lowermost levels (Units II and III). Except for the lowermost

Cores U1575A-21R and 22R, siliciclastic material is scarce and limited to isolated layers containing volcanic fragments (mm) and ash material (including microscopic glass shards). The boundary between sediment and igneous basement is significantly affected by drilling disturbance and poorly recovered. There is a significant stratigraphical gap at the base of the sedimentary succession, which is subdivided into three lithostratigraphic units. Sedimentation of Unit I is suggested to be the result of pelagic biogenic production and deposition in the deep ocean, while Units II and III were likely deposited under shallower water conditions and affected by bottom currents.

Igneous basement extends from Section 22R-5 through Core 41R at the bottom of the hole. The volcanic sequence has been divided into 10 units based on volcanological observations, eruptive style, and petrography. All volcanic units consist of aphanitic to intersertal to holocrystalline basalt with glomerocrysts and phenocysts of plagioclase (3–15 vol%) and clinopyroxene (1–5 vol%). Olivine phenocrysts are sparse and only intermittently present (0–3 vol%). Few vesicles (0–1 vol%) are observed in the lavas, which are fresh or slightly to moderately altered. Massive lava flows intercalate with sequences of sheet, lobate, and pillow lava flows that show glassy margins. Three interbeds of nannofossil-foraminifera chalk are present in the lower part of the volcanic sequence.

Cores 1R to 3R from Hole U1576A were described and consist of nannofossil-foraminifera ooze.

Biostratigraphy

The micropaleontologists analyzed all Hole U1575A core catcher samples for foraminifera and calcareous nannofossils plus one toothpick sediment sample above basement. The maximum age at the bottom of the sedimentary succession is ~77 Ma (Campanian stage, late Cretaceous). The team also worked on their Site U1575 report upon the completion of Hole U1575A analyses and prepared a presentation to share the results with the rest of the science party.

The micropaleontology team began processing and analyzing samples for Hole U1576A, indicating an early Pleistocene age (<1.6 Ma) at the base of Core U1576A-3R.

Paleomagnetism

The paleomagnetism team completed shipboard measurements of the cores from Hole U1575A. This work included partial alternating field (AF) demagnetization of archive section halves, as well as stepwise AF and thermal demagnetization of discrete samples. Cores U1575A-1R to 20R were primarily composed of calcareous nannofossil ooze that was disturbed and had magnetization intensities too weak to confidently interpret with respect to magnetostratigraphy. Basal sediments immediately overlying the basaltic rocks had stronger magnetizations but had experienced structural deformation and tilting that precluded development of a robust magnetostratigraphy for all but the lowermost sediments in Sections 22R-4 and 22R-5. AF demagnetization of discrete basalt samples collected from Cores 22R to 41R produced consistent normal polarity directions, except for a single reversed sample in Core 40R, after removal of a

drilling-induced magnetic overprint by AF levels of ~20 mT. Thermal demagnetization of discrete specimens was often noisy and/or contained self-reversals that were more complex to interpret than the AF demagnetization results. Additional experiments including measurements of bulk magnetic susceptibility, AMS, partial anhysteretic remanence (pARM) acquisition, and isothermal remanent magnetization (IRM) acquisition were conducted on a subset of discrete specimens to ascertain contextual information about rock magnetic properties. The team also started working on summarizing the laboratory results in a Site U1575 report.

Geochemistry

The interstitial water (IW)/organic geochemistry team worked on samples from Hole U1575A. We collected 22 headspace gas samples and monitored C1-C6 hydrocarbon gases in these samples. Methane concentrations of these samples are all below 2 µL/L, at the atmospheric background level, and no other hydrocarbon gases higher than C1 were detected.

We collected 32 IW samples from 5–10 cm whole-round (WR) sediment samples. All the WR samples yielded enough pore water for both shipboard and postexpedition analyses. We completed all shipboard analyses on these IW samples, including pH/alkalinity, and concentrations of phosphate, ammonium, chloride, sulphate, and bromine. We also measured routine major and trace element concentrations (Na, Ca, Mg, Sr, K, Li, Si, Mn, Fe, B, and Ba) of these samples on the inductively coupled plasma–atomic emission spectrometry (ICP-AES) instrument. We identify an alkalinity maximum at a depth of ~20 mbsf. Slightly below this depth, i.e., at ~30 mbsf, we observed a maximum for elements Ca and Sr, and a minimum for Mg. At the bottom of the sediment section, Ca and Mg concentration patterns show signs of ion exchange with the igneous basement. Additionally, we measured inorganic and organic carbon concentrations in 39 sediment samples. Carbonate concentration remains high (>90%) from Cores U1575A-1R to 19R and declines toward the transition to the basement in the lowermost two samples (~75%). The team also prepared for sampling and measurements at Site U1576. Particularly, the team prepared new standards for ammonium measurements that will lead to a two-fold increase in calibration sensitivity.

The igneous geochemistry team members selected 34 samples for shipboard ICP-AES measurements from the Site U1575 cores. Basement rock samples collected from Hole U1575A were ignited in a furnace at 950°C for 4 h and weighed to calculate the loss on ignition (LOI). Then, samples were weighed and prepared for the generation of silica beads and carbon, hydrogen, nitrogen, and sulfur (CHNS) analysis.

Physical Properties

The physical properties team measured a total of 41 cores from Hole U1575A using the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGRL) as well as a suite of instruments designed to measure whole-rounds, section halves, and discrete samples for gamma ray attenuation (GRA) bulk density, *P*-wave velocity, magnetic susceptibility (MS), thermal conductivity, shear strength (in unconsolidated sediments), and porosity. Following

standard protocols, the team performed measurements on one working half section per core unless a notable change of lithology was observed. In such a case, each representative unit was subject to section half and discrete sample measurements. In the calcareous ooze interval (Lithostratigraphic Unit I), shear strength was measured using the automated vane shear (AVS) system and thermal conductivity was measured with a probe. Coherent pieces of igneous and sedimentary rock 10–20 cm in length were selected for thermal conductivity measurements and were soaked in seawater, under vacuum, for 4 h; AVS measurements were not obtained from lithified core material. The acquired physical properties data are in good agreement with observations and measurements from other laboratory teams and clearly reflect the three lithostratigraphic contacts observed in Hole U1575A at depths of ~194 mbsf (calcareous ooze and chalk) and ~210 mbsf (chalk and igneous basement). Evidence of a broader geochemical transition in the Hole U1575A basalts between ~277 and 279 mbsf is indicated by MS data.

Outreach

This week, Expedition 391 hosted three live broadcast events, reaching an audience of 53 people in one country (USA). Fourteen posts were made on Twitter, leading to 100,638 impressions, 3,932 engagements, 1,108 likes, 197 retweets, and 22 replies. Twitter engagement increased by 355% compared to the previous seven days. The Twitter account gained 112 new followers. Eight posts were made on Facebook, reaching 50,088 people, and leading to 2,809 engagements, 799 reactions, 66 shares, and 28 comments. Facebook engagement increased by 196% compared to the previous seven days. Six posts were made to Instagram, which reached a total of 5,290 people, elicited 640 reactions, 42 shares, and 16 comments. Instagram reach increased by 140% compared to the previous seven days. Two new blog posts were published on the *JOIDES Resolution* web page: one authored by a scientist and one by the Expedition 391 Outreach Officer. The shipboard Outreach Officer provided a virtual training to the Outreach Officer of the upcoming Expedition 392.

Technical Support and HSE Activities

This week, JRSO technical staff focused on processing cores from Holes U1575A and U1576A.

Laboratory Activities

- Received, processed, and sampled cores from Holes U1575A and U1576A.
- Coordinated routine COVID-19 testing for the IODP JRSO staff and science party.
- The Barnstead™ GenPure™ Pro water purification and dispenser system is not working properly. The dispenser does not respond correctly to the commands and behaves erratically. The technicians were able to make it work well enough to have a sufficient

volume of water and the quality of the water is not affected. Shore personnel have been assisting with troubleshooting.
- We attempted to deploy the towed magnetometer on the transit to Site U1576, but when the system was powered up, the communications transceiver showed an overload condition and would power down. The manufacturer recommended replacing the transceiver with our second transceiver. The transceiver was replaced, and the system appears to be functioning normally and will be tested on the next transit.
- ShatterBox® ring and puck mill needed numerous repairs of various components to keep it together and working properly.

IT Support Activities

- Update of Microsoft computer systems management software ZENworks 2020 applied to ZENworks server and all shipboard Microsoft workstations.
- ZEISS microscope Zen software was set up on the Axioplan epifluorescence microscope in the Microbiology Laboratory.
- We investigated vulnerability and security update requirements for VMware vCenter server management software. A package of security patches will be applied once fully released by VMware.
- Worked with Texas A&M University Microsoft Exchange group on shore and prepared the shipboard Exchange servers for security patch updates that will be applied next week.

Application Support Activities

- The DESCLogik application and Catwalk Module of the SampleMaster application stopped running. The applications were uninstalled and reinstalled, fixing the bug.
- The Windows application MegaUploadaTron (MUT) upload for XRD instrument data was configured incorrectly. The configuration was fixed along with all of the data that were already uploaded.
- Some 360° images of whole-round rock pieces were uploaded incorrectly and were canceled.
- An error in the Drilling Report was fixed to reflect the accurate number of hours.
- We deployed dropdown selection features for type of analysis and display of date format in the "Measurements on Standards" section of the LIMS application.
- Inserted components for pXRF analysis into LIMS so that the QCViewer and LIMS-to-Excel (L2e) software packages can download the acquired data.

HSE Activities

- The safety shower and eye wash stations were tested.