2022 Co-Chief Review of FY 2021 Operations

Expeditions (FY21)

Expedition 390C and 395E: South Atlantic Transect (SAT)

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5 October–5 December 2020 / 6 April–5 June 2021

Expedition 395C: Reykjanes Mantle Convection and Climate: Crustal Objectives

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Expedition 396: Mid-Norwegian Margin Magmatism and Paleoclimate Implications

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6 August–5 October 2021

Executive Summary

The four *JOIDES Resolution* expeditions conducted during FY 2021 focused on scientific aspects related to the formation of oceanic basins and their implications on the paleoenvironment. Scientific drilling during the past five decades has been instrumental to the understanding of the world's ocean basins. But the borehole database is still very scarce, and the need for collection of new core data is key to assess the interactions between large-scale magmatic processes, hydrothermal fluid circulation, deep biosphere, and paleoclimate.

The FY21 operational conditions were very difficult due to the global COVID-19 pandemic, and major changes in the operational plans were implemented. Only Expedition 396 sailed with a scientific crew, albeit with fewer scientists than normal due to the pandemic situation. The two South Atlantic Transect (SAT) engineering expeditions prepared five of six drilling sites for deeper drilling and reentry in the future. The subsequent Reykjanes Ridge expedition was also partly preparing for future expeditions, coring five sites south of Iceland. Ten sites and more than 4 km of rocks and sediments were subsequently drilled during the very successful mid-Norwegian margin expedition, recovering an extensive suite of Paleogene sedimentary rocks, basalts, and wireline logging data.

We applaud JRSO for all their efforts to conduct operations during FY21 despite significant risks and operational challenges posed by the rapidly changing COVID-19 pandemic. We are extremely grateful to them and the JRFB for enabling the preparatory operations that will expedite operations during postponed Expeditions and enable us to maximize the science we can achieve.

1) Introduction

This review summarizes the Co-Chiefs' experiences from the International Ocean Discovery Program (IODP) expeditions of *JOIDES Resolution* conducted during FY2021. Maritime operations were very difficult during this year due to the COVID-19 pandemic. However, four successful expeditions were completed, providing important scientific samples and data.

The two planned South Atlantic Transect Expeditions 390 and 393 were postponed due to COVID-19 and rescheduled as a four-expedition project with the two main scientist-staffed voyages back-to-back in 2022. Two engineering Expeditions (390C, 395E) were completed in FY21. The overall objective of Expeditions 390C and 395E was to core with the advanced piston corer/extended core barrel (APC/XCB) system to basement for gas safety monitoring and to install a reentry system with casing a few meters into basement to prepare for basement drilling during the upcoming 390 and 393 expeditions. In total, 11 holes including 5 reentry holes were successfully completed.

IODP Expedition 395 (Reykjanes Mantle Convection and Climate) was scheduled for July-August 2020, and was postponed first to 2021, and then to 12 June–12 August 2023. Expedition 395C (Reykjanes Mantle Convection and Climate: Crustal objectives) was conducted from June 5–August 6, 2021. In total, 11 holes were completed. Its status was unusual in that none of the Science Party members was on board. Only the staff scientist Leah LeVay and a reduced technical team sailed on the JR to handle the cores, sampling, and measurements.

Expedition 396 (Mid-Norwegian Margin Magmatism and Paleoclimate Implications) was conducted from 6 August–6 October 2021, with 3-day transits from and to Reykjavik (Iceland). The expedition was very successful, with 10 sites occupied, 21 holes, and more than 2 km of core recovered. Due to a limited scientific and technical staff, the pace and workload were intense, but weather was pleasant and calm apart from one storm in the end of September. This is exceptional for the North Atlantic this time of the year. The expedition did not encounter any problems and all objectives were more than achieved.

2) Pre-Expedition

2.1 Clearances and Permitting

Expeditions 390C, 395C, and 395E were in international waters. The clearances and the permitting for Expedition 396 were applied for through JRSO. The proposal proponents supported the communication with the Norwegian authorities. We had to take onboard one observer from the Norwegian Petroleum Directorate (Andreas Bjørnestad). For deepwater scientific drilling, the 200 m open-hole industry drilling limit on the shelf was not applicable.

2.2 Staffing

The science party for Expedition 395C is the same as that for Expedition 395 and was staffed in the spring of 2020. A wealth of applications was received, screened, and ranked by the PMOs, except from Korea and ANZIC (Australia/New Zealand consortium), who had no applicants in 2020 because of the COVID-19 pandemic. The Co-Chiefs and EPM had no major difficulty staffing the different scientific groups following the ranking and the constraints from the PMOs. Except for one of the Outreach Officers, all members of the 2020 Expedition 395 science party were prepared to sail in 2021. In February 2021, however, the Co-Chiefs and EPM were notified that because of COVID restrictions, only half the science party would be allowed to sail. Then in the spring 2021 they were notified that only the EPM and technical staff would be able to sail. During Expeditions 390C and 395E, only the respective EPMs Emily Estes and Trevor Williams (from shore) as well as technical staff were able to sail.

Applications for Expedition 396 were dominated by European scientists, but sufficient applications were received to select a broad international crew combining experienced and early-stage scientists. Two crucial skills (biostratigraphy and physical properties) could not be sourced from the applicant pool, and we had to make a special call for these, which was successful. The staffing was heavily affected by COVID-19, and in the end only two-thirds of the science party were able to sail, putting a severe workload on the shipboard scientists.

Getting sufficient applications from some Program Member Offices (PMOs) remains a challenge - it is extremely helpful if there is sufficient breadth of application in terms of both career level/experience and scientific discipline from each PMO to allow the Co-Chiefs more flexibility in staffing the expeditions, and to enable them to establish the strongest science teams possible. We encourage all PMOs to continue to advertise expeditions widely/reach out and encourage applications!

It would be extremely helpful if the applications were standardized across PMOs. For the SAT expeditions (390/393) we had to read a vast number of applications - in part because we were staffing a double expedition but also because we have required multiple special calls to both fill expertise gaps in our initial staffing as well as to respond to withdrawals due to COVID restrictions and the 2-year delay in going to sea. Each PMO has a different application form and requirements, and it can be very difficult to compare ‘candidates’ when you can’t find the comparable information in their applications. Some PMOs require properly formulated research plans (helpful when attempting to build a team with complementary post-expedition interests), whereas others only require a one paragraph outline. Wading through 10-page CVs/publication lists is also not helpful. One option is to introduce a standard application form so everything is in the same place on all applications. This could for example include the key personal details, expertise, previous IODP experience, and research plan summary (one paragraph) followed by a short CV (2 pages incl. publications), research plan (2 pages), plus a letter of recommendation if PhD student. The PMO summaries (particularly US and ECORD) are very helpful.

2.3 Communication

All pre-cruise communications occurred electronically through regular Zoom meetings, email, and Slack channels. All these exchanges have been efficient, even despite the large difference in time zones between the Co-Chiefs and among the science party. Key to the success of the partially remotely conducted Expeditions 395C and 396 were the EPMs Leah LeVay and Carlos A. Alvarez Zarikian, who oversaw the analysis and transmission of all operations and scientific information from ship to shore during the expeditions, enabling efficient and timely decision-making. In conclusion, regular Zoom meetings worked well and should be continued, but cannot entirely replace in-person meetings.

2.4 Planning Related to Education and Outreach Activities

No Outreach Officers were able to sail during FY21, but shore-based outreach was done during all expeditions. Overall, the outreach and education activities were not optimal, and we suggest that an outreach and educational officer should sail on future expeditions.

3) Expedition

3.1 Communications

Communication during Expedition 396 was very good and benefitted tremendously from the dual-bandwidth internet connection (a first in IODP history). This allowed all cruise participants to use Zoom from their own computers. We would like to stress that it is a very good policy to have only one device connected to the internet per participant. This allows a sensible use of the available bandwidth when compared to the situation on some other research vessels where everything is open. We suggest keeping high-speed internet connection during future cruises and to facilitate social media groups for shipboard and post-cruise times (e.g., WhatsApp or Telegram).

Communication between the ship, JRSO, and Co-Chiefs was very good during Expedition 396, which was certainly helped by the excellent communication skills of the staff scientist. At one point we had to obtain permission to drill down to the target area at a new site to make use of a weather window. For this, we had to obtain permission from the safety panel. The timely response of the panel was extremely helpful.

3.2 Drilling Capability and Tools (including Logging)

During Expedition 390C, the extended core barrel (XCB) drilling system with polycrystalline diamond compact (PDC) cutting shoe, deployed in lowermost sediments/upper basement, resulted in very successful recovery of the sediment/basement interface at all five sites visited (out of a total of six primary sites).

An issue with the camera system failing at the water depths at which we were operating at Sites U1556 and U1557 (~5 km) caused lost operational time as a result of efforts to solve the

problem and as the problem ultimately required an onshore engineering solution, we had to leave some operations planned for 390C until 395E. It is unclear if this could have been avoided or should have been predicted. If equipment is mission-critical, it would be good to test it under the conditions it will be used at (if possible) prior to the expedition on which it is essential. We were fortunate that there was time between Expedition 390C and 395E to engineer a solution, and that the SAT is a multi-expedition project, so the operations superintendent was able to adapt our operations plans to conduct work in shallower water during the remainder of 390C and reschedule the deepwater operations during subsequent expeditions. Additionally, this highlights one of the immediate benefits of utilizing the JR for engineering legs when sailing scientists is not possible - if this had occurred during an expedition with scientists onboard, the loss of time would have been much more costly in terms of lost science and person hours wasted.

The installation of reentry systems with casing into basement is always challenging. We encountered unforeseen issues with installing reentry cones with casing that extends into basement using the Dril-Quip running tool. Again, the operations superintendent and drilling crew worked extremely hard to diagnose and resolve the problem (installing casing above basement rather than into basement during the remainder of Expedition 390C), and we were again fortunate that the multi-expedition nature of this project allowed us to use alternative hardware during operations on subsequent expeditions (the hydraulic release tool was used successfully on Expedition 395E). Presumably this system had not been used for casing into basement before; otherwise, it would have been a known problem.

For Expedition 395C, the drilling capability and the tools were adequate to collect sediment and basalt cores described much later by the science party. In several holes, using Half-Length Advanced Piston Corer allowed recovery of undisturbed sedimentary cores several tens of meters deeper than advanced piston corer (APC) refusal.

A recurrent problem during the beginning of vertical seismic (VSI) operations was a combination of the presence of marine mammals detected by observers and the arrival of fog in the area. Foggy conditions meant that it was not possible to rule out the presence of marine mammals, resulting in ~1 day of lost time over the entire expedition. An alternative, non-visual method for whale detection such as passive acoustic monitoring would have helped to reduce this uncertainty and prevent the resulting lost time.

Expedition 396 did not require special drilling capabilities. We made efficient use of the different options (APC, XCB, rotary core barrel [RCB]) and were well-advised by the drilling superintendent. The availability of high-resolution 3-D seismic data proved to be very useful for precise location of boreholes at Sites U1567-1570. APC coring yielded very high-quality cores, in some places as deep as 200 mbsf, whereas XCB cores were commonly quite disturbed. The RCB recovery in basement rocks was good, but the rate of penetration in basalt and hyaloclastite was sometimes very slow (1 m/h), and we suggest that development efforts should be made to improve drilling rates in such formation.

The logging operations ran smoothly, and we had the feeling that the drilling engineer took the right amount of risk. Information on the logging operations that can directly influence wireline responses could be summarized more clearly for each hole. The processing report from LDEO is a good start, but often does not clearly note for example the depths and influence of caliper closures on corrected log properties. Some information is in the operations report, but this is often not focused on individual logs, and the rationale behind logging decisions, where not obvious, would be very useful to see as a short summary from the engineer for each hole to aid interpretation. Guidelines on the use and pitfalls of photoelectric effect (PEF) logging data where barite mud is used could be improved/clarified. Also, the record of drilling additives in terms of volume/frequency of addition to drilling mud could be made more accessible to help troubleshoot anomalous logging values that may be influenced by pervasive barite mud invasion.

3.3 Laboratories and Equipment

Overall, the laboratories and the equipment in the labs during Expedition 396 were very good and did not leave a lot to wish for. The Section Half Multisensor Logger (SHMSL) for spectral reflectance and point-source magnetic susceptibility could be updated. The data acquisition times are often very long and spectral reflectance data seem only rarely used. To improve data acquisition, could it be possible to replace the spectral reflectance by hyperspectral camera allowing a recognition of standard minerals thanks to the spectral signature?

The training of core describers could also be improved especially the description of a wider variety of different observations and their upload in DESClogik. Most of the available training cores are too simple and don't capture the potential complexity encountered during the expedition. It would be useful to have training cores of igneous rocks with greater lithological variations and veins as well as different training cores of sedimentary rocks. This could help better prepare the core describers especially during the first weeks of the expedition. Data visualization on LIMS is not always straightforward. Although very useful to compare the different data acquired, the "default" scale and template can be improved.

During shipboard biostratigraphic analyses, particularly those focused on organic remains, in our case dinoflagellate cyst biostratigraphy and general palynology, we encountered very few options for improvement. However, there is one particular aspect that can be improved and might help secure more reliable sample yield and quality and thereby more reliable biostratigraphic assessment. The issue we encountered was that especially samples marked by high siliceous content (here diatomaceous, ash-rich sediments) did not respond to the acid (HF) processing methods as expected. This incomplete HF digestion of siliceous materials resulted in suboptimal sample quality.

Potential for improvement include processing with HF which was done in centrifuge tubes and includes a step where samples are on a vortex shaker for several hours. During this process, the material should be kept in suspension to maximize reaction between HF and sample material.

However, we found that, due to the V-shape of the bottom of the centrifuge tubes, the material in the tip of the tube was not in suspension, hampering reactions with much of the material. Although this might be solved by vortex-shaking the tubes horizontally, the HF reaction generates a fair bit of heat and gas and tubes simply cannot be entirely closed during reactions to prevent overpressure build up. A preferred alternative would be to use larger (~100-150 mL) centrifuge tubes/jars, most importantly with a flat or U-shaped bottom. This requires different centrifuge tubes/beakers and appropriate receptacles for the centrifuges, but otherwise very few changes to the process.

There were a few issues with certain geochemical instruments during the cruise, such as the ICP-AES, which gave very weird results toward the end (>100% silicates at Site U1574) and the Source Rock Analyzer, which was broken. Furthermore, the new X-ray diffraction (XRD) instrument had software that was more difficult to use than the older XRD machine.

All the current paleomagnetics equipment is highly functional and well maintained (the documentation is also current) and the settings of the two working stations are as ergonomic as can be in the ship space. A small digital library of current paleomagnetic and rock magnetic software would be useful.

The physical properties lab works well; however, the MAD protocols for porosity determination could include a clearer summary about the assumptions and 'type' of porosity that is delivered by each method. In practice 'porosity' is not clearly subdivided or sub-classified in the methods and as such the component of 'effective' porosity versus 'bound water' in clay-bearing lithologies is not clearly enough discussed in the methods. It was also discussed onboard that pycnometer measurements for saturated sample volume would have been very useful for comparing with dried volume for clay-bearing samples, but this did not seem to be advised. Clarification on this would be valuable for the effective/bound porosity division. Finally, cubes cut for P-wave measurements should be oriented, even if not planned for paleomagnetics analyses. This helps consistent triaxial measurement/comparisons over the entire sampled interval.

Sulfate measurements on Expedition 390C were artificially high because there was an issue with the Ion Chromatograph (IC). To fix this, S was used instead for assessing porewater profiles, and shore-based analysis indicated most S was sulfate, so the data are probably OK. It is not clear though if this could have been foreseen, but the suppressor on the IC was replaced and the numbers are good again, highlighting the need for regular maintenance.

3.4 Technical Support

There was overall an excellent effort during Expedition 390C by onboard technicians to collect as much data as possible in the absence of a science party, to ensure ephemeral properties were measured in sediments, and provide initial data prior to Expedition 390. The technical support during Expedition 396 was also perfect, and the technical team fulfilled all our wishes such as cutting core catcher samples or laying out previously acquired cores.

No microbiological samples were taken by the technicians – completely understandably – on Expeditions 390C/395E. Expedition 395C did subsequently manage this with no scientists. For the SAT we knew we would be returning, so we did not push to get microbiological sampling on Expeditions 390C or 395E. However, such sampling should be encouraged if this situation of no scientists onboard ever arises again, particularly if microbial work is a primary objective of an expedition.

Several Zoom meetings with JRSO during Expedition 395C were organized before and during the expedition to refine the operations plan, as well as the shipboard sampling and measurements, to the absence of the science party. The Operations Superintendent and the technical team on board were extremely cooperative and worked hard to cope for the absence of scientific personnel onboard.

3.5 Curation, IT, Software, Databases

The recovery of cores on one expedition that will be further described/analyzed/sampled on a second expedition raised issues around curation of cores that now 'belong' to two expeditions; JRSO is already developing new protocols to deal with this issue and the database is being adapted accordingly.

The ability to have ship to shore meetings was invaluable for both Expeditions 390C and 395E, when the science party was not on board, and also for multi-expedition projects such as SAT when not all Co-Chiefs/EPMs are on each expedition. Weekly meetings with all Co-Chiefs and EPMs helped improve the science conducted and allowed for efficient decision-making when problems or setbacks required changes in the science and/or operation plans.

Sample curation, IT, and software were running well during Expedition 396 except for two blackouts of several hours. We understand this was the result of a uninterruptible power supply (UPS) system that failed and was replaced. The blackouts did not result in a loss of data, but this should certainly be fixed for future expeditions. We further suggest that the sound system for the onboard conference facility should be improved.

3.6 Outreach and Education

Despite no Outreach Officers sailing, the technical staff on board the SAT expeditions made a sustained effort to engage the public via various social media streams, which was appreciated.

On Expedition 395C the Outreach Officer remained shore based, but along with some of the technicians onboard and some of the scientists onshore managed to communicate very successfully about the expedition. The O&E program was adapted to include primarily shore-based activities. No "ship-to-shore" broadcast was possible, as the team onboard was busy working on the cores full time. Seven "shore-to-shore" broadcasts were conducted with a variety of audiences from graduate students at universities to staff and general public at museums. Live broadcasts were organized on Facebook and YouTube, one with the Co-Chiefs presenting the scientific objectives of Expeditions 395/395C, and one with Filipino crew

members presenting their work on board the *JOIDES Resolution*. The social media program during Expedition 395C was extremely successful thanks to the Outreach Officer and the Imaging Specialist on the ship Sarah Kachovich.

Outreach and education during Expedition 396 was hampered by the pandemic, as the Outreach Officer could not join the shipboard party. This was partly compensated by the very good internet connection which allowed live streaming from the ship to shore and the enthusiasm of some of the shipboard scientists that held several outreach and education events. The Outreach Officer facilitated and moderated these events from shore.

3.7 Ship and Navigational Procedures (including Safety)

The ship and navigational procedures are extensively used and tested and did not leave much to wish for. We did not have any issues but do want to point out the Science Evaluation Panel (SEP) recommendation that we add extra alternative sites was useful when we encountered thicker than estimated sediments during Expedition 390C. The Environmental Protection and Safety Panel (EPSP)'s approval of deeper coring at our sites following Expeditions 390C/395E is also appreciated, as it provides additional operational flexibility during Expeditions 390/393.

Expedition 396 was based on an unusually comprehensive set of pre-existing bathymetry and seismic data. For future cruises, we suggest using the calibrated multibeam echosounder (MBES) water depth when spudding holes when this is available. This may occasionally save 20 minutes in situations in which the first APC is fired too high.

We note that the COVID-19 scheduling changes have several advantages that might benefit future expedition decisions. Clear advantages of back-to-back scheduling of joint project expeditions include: (1) being able to have in person handovers (in a non-COVID world!); (2) concluding operations more quickly so that any shore-based sample party can be earlier; and (3) being able to hire equipment such as the DMT core scanner more cost-efficiently. However, having a gap between expeditions provides time to engineer solutions and hardware needed to resolve operational problems, which would be advantageous for projects involving challenging engineering/operations.

4) Post Expedition

4.1 Sampling Meeting

There was no sampling meeting, but it was very helpful to have the cores returned to the Gulf Coast Repository at College Station because it allowed collection of X-ray fluorescence (XRF) data ahead of Expeditions 390/393. These data have been discussed by the science party and are directing sampling plans before scientists are even on the JR. The organization of a description and hard-rock sampling party for Expedition 395C has been delayed by the health hazards and travel restrictions due to the COVID-19 pandemic. The Expedition 395C sampling

part was organized in May 2022 at the Gulf Coast Repository, and the cores from will be ultimately archived in Bremen, Germany. The description party was organized in College Station because it was managed by JRSO personnel. Unfortunately, it was impossible to combine description and sampling with XRF core scanning. The Expedition 396 sampling meeting was done during 10 days in Bremen in April 2022 and went very well. The only suggestion is to try to have larger areas than presently available to lay out long basement cores for detailed logging and sampling.

4.2 Publications (before, during, and after the expedition)

There were no particular problems, although it is worth noting that editorial meetings for SAT were more efficient in person (Expedition Prospectus), rather than over email (Expedition 390C and 395E Preliminary Reports). This was due to the greater focus allowed by being away from the rest of our job demands and also being in the same room with co-authors and the same building with JRSO staff, especially publications and the operations team that could provide feedback regarding expedition planning (this would be the same post-expedition when details of what happened are needed).

The moratorium for Expedition 395C has been extended and merged with the one of Expedition 395 scheduled in 2023, so that a single editorial meeting will be held in 2023. Publication support from IODP for Expedition 396 was perfect all along. The Scientific Prospectus, Preliminary Report, and Expedition Reports were reviewed and edited in a timely and meticulous fashion. The staff scientist kept a keen eye on the reporting, ensuring that we never fell behind. The fact that all old reports are readily available on board (including old DSDP technical reports from the 70s) is very useful, as is the access to the very comprehensive digital library at TAMU. The editorial meeting for the cruise was done as a very efficient 1-week workshop at TAMU in February 2022, with some Zoom meetings with the non-US participants. Overall, the meeting was very efficient, and it would have been difficult to complete it in the same quality remotely.