Ocean Exploration and Research

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MAPPING DATA ACQUISITION AND PROCESSING SUMMARY REPORT

CRUISE EX-19-03 Leg 2: Windows to the Deep 2019 *(ROV and Mapping)*

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1. Introduction

The NOAA Office of Ocean Exploration and Research is the only federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

Using the latest tools and technology, OER **explores** previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively **experience** ocean exploration, expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, OER makes the collected data needed to **understand** our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

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2. Report Purpose

The purpose of this report is to briefly describe the acoustic seafloor and water-column mapping data collection and processing methods used during the remotely operated vehicle (ROV) and mapping expedition EX-19-03 Leg 2, and to present a summary of the overall mapping results and mapping related cruise activities. A detailed description of the *Okeanos Explorer's* mapping capabilities is available in the 2019 NOAA Ship *Okeanos Explorer* Survey Readiness Report, available in the NOAA Central Library. A separate cruise report detailing the ROV activities of the cruise is planned to be available in the NOAA Central Library.

3. Cruise Objectives

The Windows to the Deep 2019 (EX1903 Legs 1 and 2) was the sixth in a series of expeditions that will contribute to NOAA's Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) campaign, a major multi-year, multi-national collaborative field program focused on raising collective knowledge and understanding of the North Atlantic. This campaign provides timely, actionable information to support decision making based on reliable and authoritative science. It also serves as an opportunity for the nation to highlight the uniqueness and importance of these deepwater environments. ASPIRE builds on the momentum of past U.S. campaigns and international initiatives to support ecosystem-based management of marine resources.

EX-19-03 Leg 2 was a remotely operated vehicle (ROV) and mapping expedition set to acquire data on deep water habitats in the Southeast and Mid-Atlantic U.S. Continental Margin to support priority science and management needs. These deepwater areas offshore Florida, Georgia, South Carolina, and North Carolina are some of the least explored areas along the U.S. East Coast.

The ship departed from Cape Canaveral, Florida on June 20th and ended in Norfolk, Virginia on July 12th. The primary mapping objective was to collect high-resolution bathymetry in areas with no (or low quality) mapping data. This was achieved by edge-matching previously existing data, building coverage of bathymetry data near dive sites, and performing systematic surveys. Ancillary mapping objectives included identifying methane seeps and potential underwater cultural heritage sites.

Mapping operations generally occurred overnight, maximizing the time in between ROV dives. Overnight acoustic data collection included EM 302 multibeam sonar seafloor bathymetry and backscatter, water column data collected with the EM 302 and the suite of EK 60/80 split-beam sonars, and sub-bottom data with the Knudsen 3260 sub-bottom profiler. During ROV dives, acoustic data was collected with the EK 60/80s and the ADCPs. The objectives for this cruise are further detailed in the EX-19-03 Leg 2 Project Instructions, which are archived in the NOAA Central Library.

4. Summary of Mapping Results

EX-19-03 Leg 2 mapped 14,314 square kilometers of seafloor offshore the southeast of the United States during the 23 days-at-sea (Figure 1 and Table 1).

Cruise Overview Map

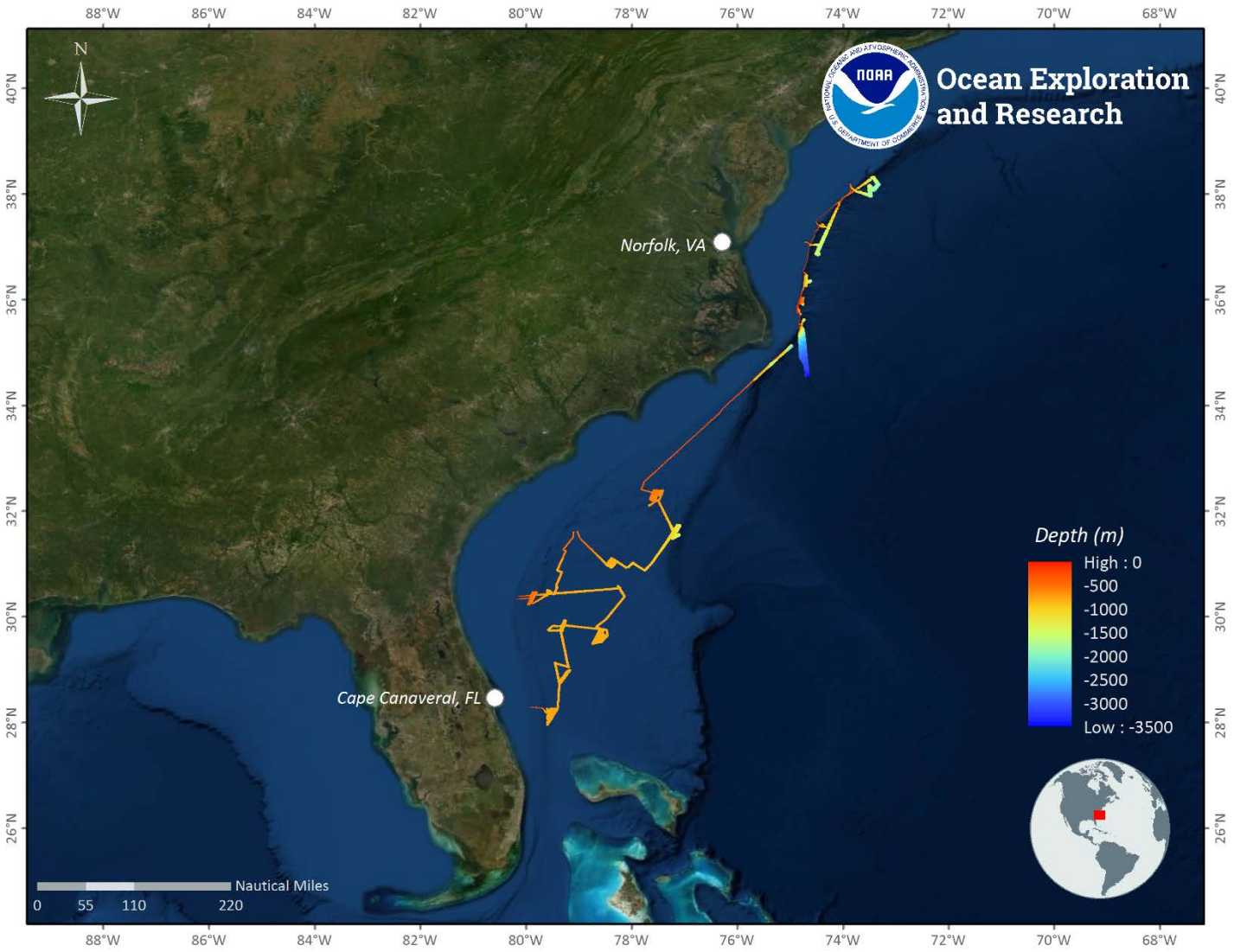


Figure 1. Overview map showing bathymetry mapping coverage completed during Windows to the Deep 2019 expedition (EX-19-03 Leg 2). Map created by NOAA Office of Ocean Exploration and Research (NOAA-OER), generated in ArcMap.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

5. Mapping Statistics

Table 1. Summary statistics of ocean mapping work completed during EX-19-03-Leg 2.

Dates of cruise	June 20 – July 12, 2019
Ship's draft Start of cruise (06/20/2019) End of cruise (07/12/2019)	Fore: 15' 2'', Aft STBD: 14' 4" Fore: 15' 1.5"; Aft STBD: 13' 11.5"
Linear kilometers of survey with EM 302	4,016
Square kilometers mapped with EM 302	14,314
Number / Data Volume of EM 302 raw bathymetric / bottom backscatter multibeam files (.all)	432 files/ 37.5 GB
Number / Data Volume of EM 302 water column multibeam files	432 files / 90.8 GB
Number / Data Volume of EK 60 water column split beam files (.raw)	2,455 / 562 GB
Number / Data Volume of sub-bottom sonar files (.segy, .kea, .keb)	778 / 3.39 GB
Number of XBT casts	141
Number of CTD casts (including test casts)	0

6. Mapping Sonar Setup

Kongsberg EM302 Multibeam Sonar

The NOAA Ship *Okeanos Explorer* is equipped with a 30 kilohertz (kHz) Kongsberg EM 302 multibeam sonar capable of detecting the seafloor in up to 10,000 meters of water and conducting productive mapping operations in 8,000 meters of water. The system generates a 150° beam fan containing up to 432 soundings per ping in waters deeper than 3300 meters. In waters less than 3300 meters, the system is operated in multi-ping, or dual swath mode, and obtains up to 864 soundings per ping, by detecting two swaths per ping cycle. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from a target, such as the seafloor or bubbles in the water column.

Simrad EK 60 Split-beam Sonars

The ship is equipped with five Kongsberg EK split-beam fisheries sonars, 18, 38, 70, 120, and 200 kHz. The 18 kHz transducer and transmits a 7° beam fan. The 38 and 70 kHz were upgraded to wide-band transceivers in 2019. These sonars are quantitative scientific echosounders calibrated to identify the target strength of water column acoustic reflectors - typically biological scattering layers, fish, or gas bubbles – providing additional information about water column characteristics and anomalies. It was determined during the 2019 EK calibrations that the 38 kHz transducer was compromised and therefore data was not collected with the 38 kHz transducer during this expedition.

Knudsen 3260 Sub-bottom Profiler

Additionally, the ship is equipped with a Knudsen 3260 sub-bottom profiler that produces a frequency-modulated chirp signal with a central frequency of 3.5 kHz. This sonar is used to provide echogram images of shallow geological layers underneath the seafloor to a maximum depth of approximately 80 meters below the seafloor. The sub-bottom profiler is normally operated to provide information about sub-seafloor stratigraphy and features. The data generated by this sonar is fundamental to helping geologists interpret the shallow geology of the seafloor.

Teledyne ADCPs

The ship utilizes a 38 kHz Teledyne RDI Ocean Surveyor Acoustic Doppler Current Profiler (ADCP), with a ~1000 meter range; and a 300 kHz Teledyne RDI Workhorse Mariner ADCP, with a ~70 meter range. The ADCPs gather data prior to ROV deployments in order to assess currents at the dive site in support of safe operations. They are kept running throughout the ROV dives. The ADCPs are typically not run concurrently with the other sonars while transiting due to interference issues.

7. Data Acquisition Summary

Mapping operations included EM 302 multibeam sonar, EK 60/80 split-beam (18, 70, 122, and 200 kHz) sonars, and Knudsen 3260 sub-bottom profile data collection.

Survey lines were planned to maximize either bathymetry edge matching of existing data or data gap filling in areas where existing bathymetry coverage existed. In regions with no existing data, lines were planned to optimize potential exploration discoveries.

Throughout the cruise multibeam data quality was monitored in real time by acquisition watchstanders. Ship speed was adjusted to maintain data quality as necessary and line spacing was planned to ensure at least ¼ swath width overlap between lines. Cutoff angles in the multibeam acquisition software Seafloor Acquisition System (SIS) were generally left wide open for maximum exploration data collection and routinely adjusted on both the port and starboard side to ensure the best data quality and coverage. Data were corrected for sound velocity in real time using the Reson SVP-70 data at the sonar head, and profiles from Expendable Bathythermographs (XBTs) that were conducted at intervals no greater than 6 hours, or as dictated by local oceanographic conditions.

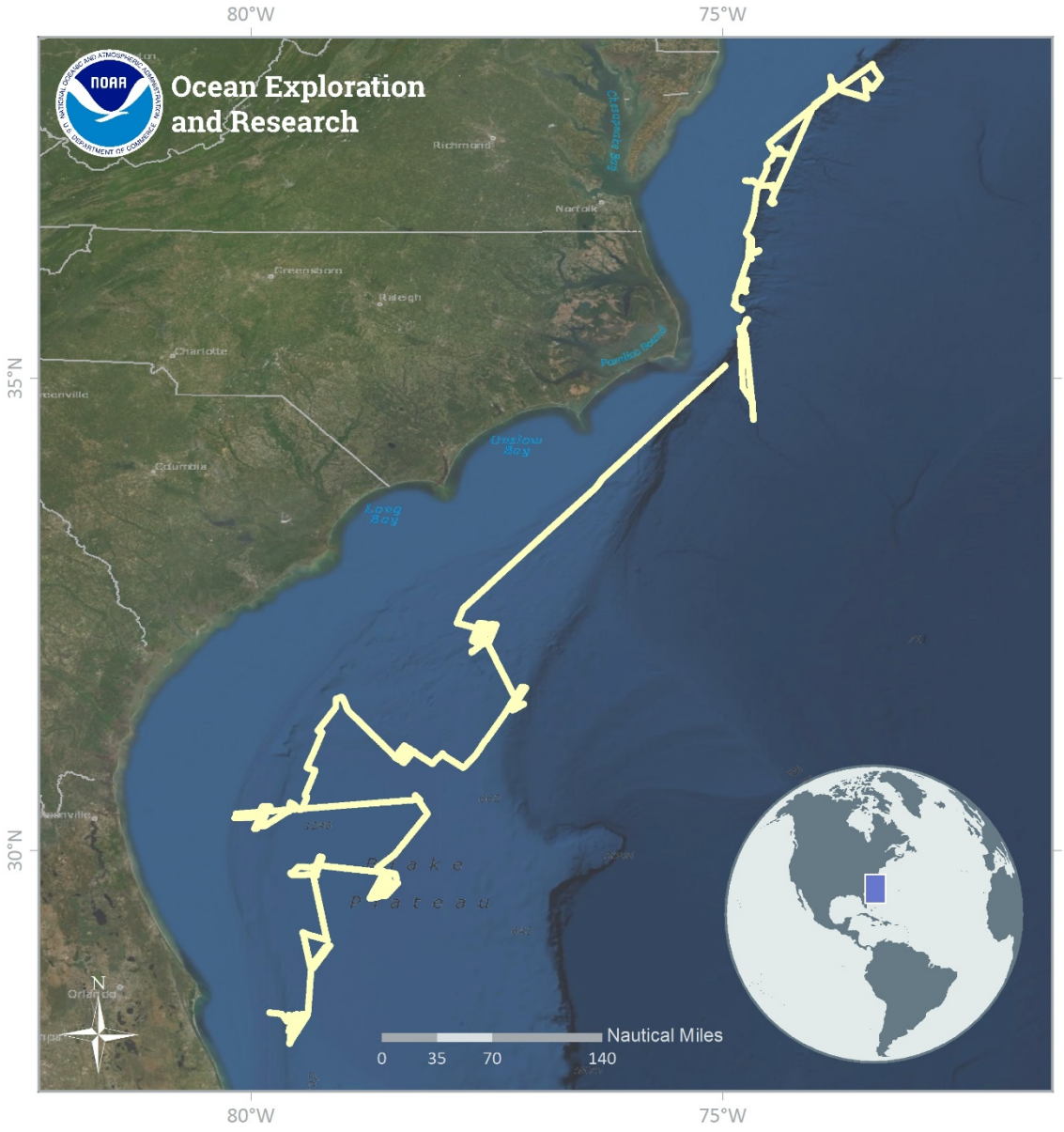
Simrad EK 60/80 split-beam water column sonar data were collected during most of the cruise, even during ROV dives when the multibeam was off (Figure 2). Primarily the EK 80 70 kHz was run in broadband mode, except during ROV dives when it was run in narrowband mode.

Knudsen 3260 sub-bottom profiler data were also collected during the majority of the cruise. Figure 3 shows where sub-bottom data was collected during EX-19-03 Leg 2.

Overview map showing tracklines of EK60/EK80 sonar data completed during the 2019 Mid and Southeast US ROV and Mapping cruise. Map created by NOAA Office of Ocean Exploration and Research (NOAA-OER).

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 2. Simrad EK 60/80 split-beam sonar data tracklines (in white) collected during EX-19-03 Leg 2.



Overview map showing tracklines of Knudsen sub-bottom profiler sonar data completed during the 2019 Mid and Southeast US ROV and Mapping cruise. Map created by NOAA Office of Ocean Exploration and Research (NOAA-OER).

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 3. Sub-bottom profiler data tracklines (in yellow) collected during EX-19-03 Leg 2.

8. Multibeam Sonar Data Quality Assessment and Data Processing

EM 302 Built-in Self Tests (BISTs) were run throughout the cruise to monitor multibeam sonar system status and are available as ancillary files in the sonar data archives. Raw multibeam bathymetry data files were acquired by SIS, then imported into QPS Qimera for processing the multibeam sonar data. In Qimera, attitude and navigation data stored in each file were checked, and erroneous soundings were removed using 2-D and 3-D editors. Gridded digital terrain models were created and posted to the ship's ftp site for daily transfer to shore. Final bathymetry QC was completed post-cruise onshore at the Center for Coastal and Ocean Mapping at the University of New Hampshire.

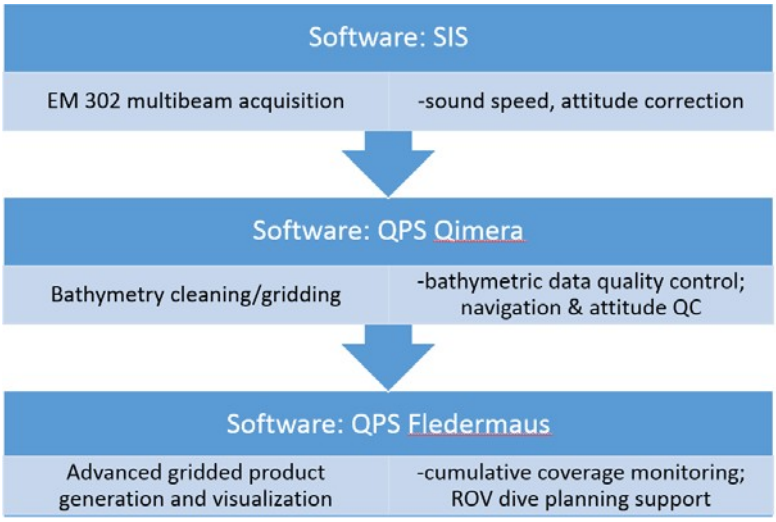


Figure 4. Shipboard multibeam data flow.

Crosslines

Comparing depth values from orthogonal survey lines is a standard hydrographic quality control measure to evaluate the consistency of the multibeam sonar data being collected during a cruise. Crossline analysis was conducted on data collected during EX-19-03 Leg 2 using the Cross Check Tool in QPS Qimera software (Figure 4). Mainscheme lines included in this analysis included lines 4, 6, 10, 14, 17, and 23 from 6/21/19. Crosslines are 18-19 also from 6/21/19. This check was conducted in an area with variable sound velocity (within the main axis of the Gulf Stream), and therefore represents challenging survey conditions encountered during the cruise. The results from the crossline comparison are in the table below (See Table 2). These results show that, even with the effect of the highly dynamic oceanographic conditions experienced during EX-19-03 Leg 2, the data collected still meets International Hydrographic Organization (IHO) Order 2 data quality requirements.

Table 2. Statistics provided from QPS Qimera software Cross Check Tool

Number of Points	638726	**Ref. Z – Range**	-847.43 : -766.16
Data Mean	-815.34	**Diff Z – Range**	-20.52 : 15.36
Reference Mean	-816.075	**Mean + 2*stddev**	6.743
Mean	0.733	**Median + 2*stddev**	6.813
Median	0.803	**Ord 2 Error Limit**	18.79
Std. Deviation	3.004	**Ord 2 P-Statistic**	.000002
Data Z – Range	-850.69 : -765.16	**Ord 2 - # Rejected**	1
		ORDER 2	ACCEPTED

EM 302 Patch Test

A multibeam patch test was conducted over the Pascagoula Dome in the northern Gulf of Mexico on May 13, 2019 (during EX-19-02), using the same location as the EX-18-02 patch test. In addition to the patch test, a speed noise test was performed on the EM 302. The full procedures and results are described in the 2019 *Okeanos Explorer* Survey Readiness Report.

EK 60/80 Calibration

EK 60 and EK 80 calibrations were conducted in the Gulf of Mexico in March 2019, west of Key West, Florida. During the calibration, the 38 kHz transducer showed impedance issues and was not able to be calibrated. The 18 kHz, 70 kHz, 120 kHz, and 200 kHz sonars were successfully calibrated in continuous wave mode (CW). The 70 kHz sonar has a wide band transceiver (WBT) and was calibrated for both CW and frequency-modulated (FM) pulses. Complete details about the EK 60/80 calibrations are described in the EX-19-02 EK Calibration Report archived at the NOAA Central Library.

9. Data Archival Procedures

All mapping data collected by the NOAA Ship *Okeanos Explorer* are archived and publicly available within 90 days of the end of each cruise via the National Centers for Environmental Information (NCEI) online archives. The complete data management plan (which describes the raw and processed data formats produced for this cruise) is available as an appendix in the EX-19-03 Leg 2 project instructions which is available in the NOAA Central Library.

Ancillary and supporting files are archived with the sonar datasets. These include:

EM 302 Multibeam bathymetry and bottom backscatter dataset:

- Mapping watch stander log
- Weather log
- Sound velocity profile log
- Multibeam acquisition and processing log
- Built-In-System-Tests (BISTs)
- Processor Unit Parameters
- Text files of telnet sessions on the EM 302 transceiver unit (TRU)

Simrad EK split-beam water column dataset:

- Mapping watch stander log
- Weather log
- EK data log

Knudsen 3260 Sub-bottom Profiler dataset:

- Mapping watch stander log
- Weather log
- Sub-bottom data log

EM 302 Multibeam water column dataset:

- Mapping watch stander log
- Weather log

- Sound velocity profile log
- Multibeam acquisition and processing log
- Built-In-System-Tests (BISTs)
- Processor Unit Parameters
- Text files of telnet sessions on the EM 302 transceiver unit (TRU)
- Multibeam WCD review log if data were reviewed for presence of seeps in Fledermaus MidWater

EM 302 water column data are available in the NCEI Water Column Sonar Archives: https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html (last accessed 8/11/2019).

Sub-bottom data, supporting data, and informational logs are available in the NCEI Data Archives accessible at https://www.ngdc.noaa.gov/ (last accessed 8/11/2019).

EM 302 bathymetry data, supporting informational logs, and ancillary files are available in the NCEI Data Archives accessible at https://www.ngdc.noaa.gov/ (last accessed 8/11/2019).

10. Cruise Calendar

All times listed are local ship time, which was -4 hours from UTC

June and July 2019

Sun	Mon	Tues	Wed	Thur	Fri	Sat
	17 Mission personnel began to arrive in Cape Canaveral FL.	18 Mobilization began and more mission personnel arrived.	19 Mobilization finishes.	20 Departed Cape Canaveral after fueling. Began transiting to first dive location.	21 Dive 01. Overnight mapping added coverage to EX-19-03-L1 data.	22 Dive 02. Overnight mapping added coverage to EX-19-03-1 data.
23 Dive 03. Overnight mapping added coverage to the "Stetson Mesa" / "Million Mounds" area.	24 Dive 04. Overnight mapping added coverage to the west of the "Blake Plateau Knolls".	25 Dive 05 transited to Jacksonville, FL. Transit mapping covered planned site for Dive 6.	26 Personnel transfer at Jacksonville, FL. Transited to Dive 06.	27 Dive 06. Overnight mapping added coverage to the "Stetson Mesa" / "Million Mounds" area, and a survey for seeps was performed at Dive site 06.	28 Dive 07. Edge matched and surveyed the potential shipwreck (found to not be a wreck) during overnight mapping.	29 Dive 08. Performed a systematic survey in an area of interest for USGS and BOEM.
30 Dive 09. Expanded mapping coverage to the northeast of the dive location.	1 Dive 10. Expanded coverage to the north of "Richardson Reef".	2 Overnight mapping in the 'North Richardson Hills' area. Transit mapped during the day.	3 Dive 11. Transit mapping between dives.	4 Dive 12. UCH mapping, looking for shipwreck targets.	5 Dive 13. Mapped over seep site for tomorrow's dive and identified many seeps. UCH mapping continues.	6 Dive 14. UCH Mapping continues.
7 Dive 15. Finished UCH mapping.	8 Dive 16. Transit and coverage mapping near Washington Canyon.	9 Dive 17. Overnight mapping focused on collecting sub-bottom lines across the canyons.	10 Dive 18. Overnight mapping continued to focus on collecting sub-bottom lines across the canyons.	11 Dive 19. Overnight mapping focused on the seep area for the upcoming dive.	12 Arrive in Norfolk, VA. Began demobilization.	13 Finished demobilization.

11. Daily Cruise Log Entries

Generated from the daily expedition situation reports. All times listed are in local ship time (-4 hours from UTC)

June 20

All systems started up normally and are working as expected. The EM 302 transceiver (TRU) was restarted while in-port, which does not seem to have affected the EM 302. We began recording data while transiting to our first dive site, and will add coverage to the south of EX-19-03 Leg 1 'alpha' polygon. To account for the Gulf Stream, we are currently conducting XBT's every three hours and will assess overnight if we need to increase the frequency.

The EK 80's 38 kHz transducer was uninstalled from the EK 80 software following the guidance provided by the water column data user community to not collect and archive the un-calibrated data. Also, while alongside, the data storage (E drive) on the EK computer was increased from 500 GB to 1 TB to account for the large data amounts produced by the EK 80 70 kHz in broadband mode.

June 21

Overnight we added coverage to the south of EX-19-03 Leg1 "alpha" polygon and transited to Dive 01. We increased our XBT frequency to every two hours, and in some cases every one hour, to account for highly dynamic oceanographic conditions.

Following Dive 01 we applied the SVP from the upcast from the Seirios camera platform's conductivity temperature depth (CTD) sensor, as the Deep Discoverer (D2) CTD had some spikes. We let the Global Foundation for Ocean Exploration (GFOE) team know and they will check the connections on this CTD tomorrow.

In preparation for tomorrow's midwater dive, after receiving guidance from Kongsberg, we changed the output recording options to only record Power and Angle (reduced file size) when the EK 80 70 kHz is running in CW mode. This should save unnecessary file storage when the 70 kHz is not operating in broadband mode, and should not affect broadband operations (a quick check seemed to confirm this).

We are currently running the Qimera project on the local computer as running off the network was slower and seemed to freeze Qimera more frequently.

June 22

Overnight we transited to Dive 02 and added coverage to the southeast of EX-19-03 Leg 1 polygon 'bravo.' The sea state has been excellent and the data quality looks good. We are taking XBTs every two hours to keep up with the dynamic oceanographic conditions and utilizing Qimera's 'TU Delft Sound Speed Inversion' tool when coverage allows. The Deep Discoverer CTD profile looked good after the GFOE team addressed the connections, and the downcast SVP was applied. We used the downcast due to performing midwater transects during the upcast.

June 23
Overnight we edge-matched EX-19-03 Leg 1 "bravo" polygon while transiting to Dive 03, adding coverage to the east of the "Stetson Mesa"/ "Million Mounds" area. The data looks great, and the storm only affected areas where we already had data.

We have been temporarily losing the display of the multibeam acquisition software Seafloor Information System's (SIS) gridding engine, especially if tightly zoomed in. It quickly returns and no grid data seems to be lost. We will continue to monitor.

The Mapping Department has been optimizing processing the multibeam data with the available sound velocity profiles during post processing in Qimera.

June 24
Overnight we expanded coverage to the west of the "Blake Plateau Knolls' dive site. Data looks great and we are continuing to take XBT casts every 2 hours.

June 25
Overnight we did a direct transit to Jacksonville, FL. Fortuitously, the upcoming planned Dive 06 site was 500 meters starboard of the direct route to shore. We took advantage of this opportunity to attempt to confirm and refine the seep target location (the driving factor for this dive). We passed over the site going 2-3 kts, and designed the survey to acoustically image the previously identified seep site at approximately 30 degrees from nadir. Unfortunately, we could not identify any indication of the seep during neither acquisition nor processing. We plan to survey the entire ridge in 'seep hunting mode', at slow speeds, and with the potential seep offset from nadir (~ 10 – 30 degrees), tomorrow evening in hopes of finding a seep to dive on.

While transiting we crossed the Gulf Stream and at times had to increase our XBT casts to every 20 minutes to keep up with the highly dynamic conditions (both spatially and temporally). This high frequency of casts continued for about an hour while we transited through the inner wall of the current.

We have had to hard restart the multibeam processing computer MBPROC2 a few times when the machine freezes, seemingly when using Google Earth.

June 26
Today we primarily transited from the personnel transfer location (Jacksonville) to our originally planned Dive 07 site. Most of the day was spent in depths shallower than 60 meters, and data was not collected in these depths.

We spent the day catching up on processing and other ancillary tasks.

June 27
On the transit to today's Dive 06 (original) site, we nearly filled in a polygon on the western side of the Stetson Mesa/Million Mounds area with systematic survey lines. We then proceeded to the dive location and performed a dedicated search for seeps in hopes to find a target for Dive 06. We ran two lines over the

ridge where the original seep target was found, one off by a few hundred meters (to ensonify the seep with a narrow angle beam, 20 degrees or so) and one with us traversing directly on top of the potential seep target. The mapping team collectively agreed that the survey showed no evidence of seeps. We still dove at this location.

June 28
We edged-matched while transiting overnight and allocated time to survey the potential shipwreck. We commenced underwater cultural heritage (UCH) protocols prior to being within 5 nautical miles of the potential wreck. We then performed two survey lines at speeds of 3 knots and slightly offset from the feature to maximize resolution. Inspection of the backscatter showed a slightly harder substrate about the size of the 'Bloody Marsh' shipwreck, however, it did not have as strong backscatter return as expected.

Once the UCH protocols were lifted, we unpartitioned the data that had been designated as 'Restricted' overnight.

We have been utilizing "Cleaning Projects" in Qimera, so WL Keven Jerram and SST Danielle Power can process the data concurrently. It has been going smoothly and increased efficiency.

Computers MBPROC1 and MBPROC2 occasionally need hard restarts, the reason for this has yet to be identified.

June 29
We performed a systematic survey in a previously identified area of interest by the U.S. Geological Survey (USGS) and Bureau of Offshore Energy Management (BOEM) as the location was both near our dive site and allowed us to expand coverage in the central plateau region.

Overall, the data is looking good and the mapping team has been focusing on optimizing sound velocity while processing.

The keyboard portion of the KVM for MBPROC1 has frozen up a couple of times, requiring a hard restart. We have flagged this for GFOE's awareness.

June 30
As we transited to Dive 09, we expanded coverage to the northeast of the dive location. Data looks good, apart from a small section (5 minutes or so) of data that experienced some random (non-ship) interference, the source of which could not be distinguished. We were monitoring telnet sessions and found no indication of TRU issues. We will continue to monitor for if it returns.

July 01
Overnight we mapped an area north of the Richardson Reef, previously mapped during EX-18-06, in hopes to find a feature to dive on the following day, eliminating the need for a "map and dive." The terrain was really interesting with more of the small mounds that we have found to be prolific in this region. To date, this area has had the most difficult sound velocity conditions and we are trying to mitigate with high frequency XBT casts (every 1 - 2 hours depending on the data) as well as in post-processing.

After one turn, we were seeing continual drop outs of a few beams in the port side's outer swath. We turned off and turned back on Yaw Stabilization and the issue fixed.

While post processing, WL Kevin Jerram suspected that we had a persisting roll offset further complicating cleaning. We collected short, shallow, 'roll calibration' lines while arriving and departing the dive site, and analysis produced a -.01 degree offset (from -.11 to -.12). We have applied these to the data in the Qimera project but not SIS. We wonder if there is any relationship of this behavior to our uncertainty about the vessel survey conducted last year. Perhaps small errors in array angles are manifesting as roll biases (the most obvious of the three offsets from the bathy data) in this new sound speed environment. We will monitor as we transit into new water masses and attempt to collect further small roll lines in deeper and flatter terrain, to help inform whether this -.01 offset should be added to SIS prior to the next expedition. It was found later in the expedition through a deeper roll calibration that no offset was needed, and that the previously observed offset was most likely due to extreme sound velocity issues.

MBPROC1 and MBPROC2 are occasionally freezing (once a day or so), requiring hard restarts. After discussing with the GFOE data team, we suspect this to be application errors rather than caused by projects running on the network. Mapping Lead Shannon Hoy is curious if we are starting to see incompatibilities between QPS applications and Windows 7.

Post Dive, CET Peperato, SST Power, and Josh Carlson of GFOE connected the Reson SVP probe to the EK 80 COM port 6, to provide constant surface sound speed at the transducer face to improve beam forming of the EKs. We also set the water column sound speed to a static 1500 m/s. These changes should produce a more robust dataset.

July 02

We performed a systematic survey in the North Richardson Hill's polygon, and continued to transit map throughout the day as we made our way to our northern dive sites. We utilized high frequency XBT casts (~2 hours) to keep up with the dynamic sound velocity environment as we transited through the Gulf Stream.

We changed from UTM 17 N and will be in UTM 18 N for the remainder for the expedition.

July 03

We left the ADCP on while searching for appropriate ROV sites for this morning, and overnight did a straight transit to the next dive site "Deep Pamlico."

We did a BIST today and all tests passed.
The x, y, and z offsets from the 2018 API marine offsets survey were applied to each transducer in the EK 80 software, as well as the 2.2 m waterline, which should produce a more geospatially robust dataset.

July 04

We did some surveying for UCH targets while transiting to our next site. While departing Deep Pamlico, we followed our inbound track to perform a deep roll calibration (3300 m) to get further information regarding

the previously reported .01 degree roll offset seemingly apparent in the southern data. The results of this calibration actually negated the results previously seen (a + .01 degree rather than a -.01 degree offset), supporting that our original values (EX-19-02 patch test) for the roll offset are the most appropriate. The thought is that in the highly dynamic sound velocity environment in the last sites within the Blake Plateau, the -.01 roll offset helped to mitigate the sound velocity errors. Therefore, applying the -.01 degree offset to these data was a processing step, and no further action with adjusting transducer offsets should occur at this time.

While switching from ROV to mapping operations, the EX-CTD 1 computer experienced KVM issues where the mouse would move extremely slowly and the keyboard would not work. The GFOE team worked hard to get the computer back up and running, but it took some time. This occurred during critical operations (roll calibration), where an XBT was needed, however we were unable to perform one. This highlighted that the CTD1 machine is a point of failure for operations as it is the only computer that can control the XBT AutoLauncher equipment. Therefore, we should ensure that CTD2 can work as a back up by deploying hand launched XBTs. We were unable to get CTD2 operational for this activity. It could be that it is already operational to do so, but the mapping team did not have enough experience to successfully deploy a hand launch.

GFOE found a work around for the KVM in hopes to limit further similar situations: use the video option only when setting up the left screen (push space). See further details in the KVM section.

July 05
We ran one line over the Bodie Island Seep Site provided by Adam Skarke and Carolyn Ruppel, going 4 kts. There were many abundant seeps in the area and processing showed that they were located very near the waypoints provided.

While processing the water column data in Qimera, it was apparent that the raw data needed to be copied locally, as well as running the project locally.

We also are searching for potential UCH targets in areas most likely for the EX to detect one.

July 06
Overnight we continued mapping in areas with the most likelihood that the EM 302 could detect a shipwreck (as flat as possible and between the depths of 100 and 1400 meters). This required mapping in areas previously mapped by the Okeanos but traveling as slow as possible (4 kts), and mapping in less than 150 meters water depth. We searched through both the bathymetry and backscatter but no targets of high confidence were found.

Prior to the Bodie Island seep dive we performed a systematic survey over the planned dive track and found numerous strong plumes. We quickly processed the water column data to use the locations of the seep sites to inform the ideal dive track for the ROV. At times, the ROV was off from the seep locations and we had to plot the current position in Fledermaus to find reference to the seeps. Operationalizing the real time plotting of D2's position in Fledermaus would greatly improve dives of this nature. Mapping Lead Shannon Hoy believes we are able to do this once GFOE creates a custom NMEA message.

July 07
We completed mapping of the diveable areas within the requested UCH box that have the highest likelihood that we can detect a large shipwreck (flat terrain and within 250 -1000 meters). No evidence of a shipwreck was found by our onboard mapping team.

We are continuing to see highly dynamic sound velocity environments, even though we are out of the main axis of the Gulf Stream and are still mitigating these issues with XBTs every 2 hours or so.

Fledermaus is crashing frequently - many times when you export a profile image or move a control point of a profile. There is a new version of Fledermaus available (7.8.8) and updating may improve these issues.

July 08
Overnight we collected transit data to Washington Canyon and performed a small survey over the dive site prior to launching. Most of the areas in this region have already been mapped, so we are prioritizing adding data to the shallow extent of the coverage, remapping in areas where existing data was collected by older multibeam systems capable of lower resolution and with poor navigation information and exploring the sub-bottom and water column. We have seen sporadic seeps as we transit over these Mid-Atlantic canyons.

July 09
Overnight we collected sub-bottom lines across the canyons. Data is looking great!

Onboard GFOE Data Manager was able to create and send NMEA messages that are readable by Fledermaus's Vessel Manager for D2, Seirios, and the Okeanos Explorer. The real-time position of these vehicles can now be monitored in Fledermaus on MBPROC2. This has many potential impacts for improving navigational, operational, and scientific awareness, as well as an outreach/engagement tool.

July 10
Overnight we continued to collect sub-bottom lines throughout the Mid-Atlantic canyons, as well as passing slowly over a potential shipwreck location in approximately 200 meters of water. No evidence of a wreck was found.

During Dive 18 we tested out the operational function of monitoring the real-time position of D2 and Seirios during the dive. The Science Leads mentioned that the added spatial awareness was extremely useful for navigating to the steepest and therefore most desirable location, which ended up being the massive coral field! Some troubleshooting and integration steps remain to ensure seamless use, as working with the fourth dimension (time) is new for us and can be misleading if not appropriately displayed or limitations of the spatial products discussed.

Throughout this cruise we have been experiencing a higher rate of pin failures with the XBT Autolauncher. A pin check was done at the beginning of the cruise and pin retraction issues were discovered in tube 2, tube 4, tube 6, and tube 8. Doing pin checks and checking tubes seemed to resolve issues at the time or for the short interim. As most tube issues seem to come from the lower tubes SST Power recommends doing

freshwater rinses after every cruise and a deep cleaning of the Autolauncher if problems persist between cruises as necessary.

Issues with the ADCP were noticed around 1200 ship local time by ROV Navigators. It appeared the WH300 was failing to connect to the software. We cycled power on the WH300, saw no change. We restarted the UHDAS program and saw no change. Then we brought up the multibeam and noticed interference, we shut down the ADCPs which proved to be the culprit of the interference. This lead us to leaving the sonars shut off and restarting the UHDAS server and then bringing everything back online approximately 20 minutes later, which resolved the issue. From our troubleshooting it appeared the issue was either a software or deck box glitch that caused the WH300 to separate from the software controls and for both sonars to continue pinging though within the software it appeared they had been secured. It has been noted the UHDAS team has been trying to plan a site visit for a while to upgrade the software and that will be prioritized in the near future for optimal system functionality.

Proper procedure to bring the system down and back up:
- Stop Recording
- End Cruise
- Exit UHDAS Software
- Top right corner, click adcp logging, shutdown
- Cycle power on sonars in sonar closet at circuit breaker level
- Start the UHDAS server in the server room
- Bring up the UHDAS software
- Start Cruise
- Start Recording

July 11
Prior to Dive 19 we surveyed the dive site with the objective to image seeps. We ran tightly spaced lines at 4 knots. To process the seeps we utilized the "Feature Detection" algorithm. Knowing the location of the currently active plumes allowed us to amend the track created from historical data to optimize bottom time. We utilized the live monitoring of the vehicles in Fledermaus to have the spatial awareness with the seeps that were identified from the overnight survey.

After the dive we conducted a speed noise test on the EM 302 to see if the higher noise at 10 kts that was apparent during EX-19-02 was still present. The results of the speed noise test show similar results to EX-19-02 with relatively higher noise at the top RPMs.

We also ran one sub-bottom line through Norfolk Canyon during our transit to port.

Mission systems are secured for cruise completion and wrap up is complete.

12. References

The 2019 NOAA Ship *Okeanos Explorer* Survey Readiness Report can be obtained in the NOAA Central Library or by contacting the NOAA OER mapping team at oar.oer.exmappingteam@noaa.gov.

The EX-19-03 Leg 2 Project Instructions can be obtained from the NOAA Central Library. The EX-19-03 Leg 2 Data Management Plan is an appendix of the project instructions.

EX-19-02 EK 60 / 80 Calibration Report can be obtained in the NOAA Central Library or by contacting the NOAA OER mapping team at oar.oer.exmappingteam@noaa.gov