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Mapping Data Acquisition and Processing Summary Report

EX-22-06: Voyage to the Ridge 3 (ROV and Mapping)

Azores Plateau, Mid-Atlantic Ridge, Puerto Rico

Horta, Faial, Azores to San Juan, Puerto Rico

August 6 - September 2, 2022

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Introduction

NOAA Ocean Exploration is dedicated to exploring the unknown ocean, unlocking its potential through scientific discovery, technological advancements, and data delivery. By working closely with partners across public, private, and academic sectors, we are filling gaps in our basic understanding of the marine environment. This allows us, collectively, to protect ocean health, sustainably manage our marine resources, accelerate our national economy, better understand our changing environment, and enhance appreciation of the importance of the ocean in our everyday lives.

With priority placed on exploration of deep waters and the waters of the U.S. Exclusive Economic Zone, NOAA Ocean Exploration applies the latest tools and technologies to explore previously unknown areas of the ocean, making discoveries of scientific, economic, and cultural value. By making collected data publicly available in increasingly innovative and accessible ways, we provide a unique and centralized national resource of critical ocean information. And, through live exploration video, online resources, training and educational opportunities, and public events, we share the excitement of ocean exploration with people around the world and inspire and engage the next generation of ocean scientists, engineers, and leaders.

Report Purpose

The purpose of this report is to briefly describe the acoustic seafloor, water column, and subseafloor mapping data collection and processing methods used by NOAA Ocean Exploration on NOAA Ship *Okeanos Explorer* during Voyage to the Ridge 3 (EX-22-06) and to present a summary of mapping results and mapping-related expedition activities. A separate report detailing the remotely operated vehicle activities of the expedition will be available through the NOAA Central Library.

Detailed descriptions of *Okeanos Explorer's* mapping equipment and capabilities is available in the "NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2022," which is archived in the NOAA Central Library.[1] Supplemental documents are added to the Readiness Report throughout the year if changes to, or recalibrations of, the equipment are made.

For further information about general equipment calibration procedures, data acquisition, processing, reporting, and archiving, see the "NOAA Ocean Exploration Deepwater Exploration

[1] https://doi.org/10.25923/g2ep-ae34

Mapping Procedures Manual V1," which is archived in the NOAA Central Library[2] and also available from the website.[3]

Expedition Overview

From August 6 - September 2, 2022 (Horta, Faial, Azores to San Juan, Puerto Rico) NOAA Ocean Exploration completed the Voyage to the Ridge 3 expedition (EX-22-06), a combined mapping and remotely operated vehicle (ROV) expedition to the Azores Plateau, Mid-Atlantic Ridge, and U.S. waters in the vicinity of Puerto Rico and the U.S. Virgin Islands. Operations during this 28-day expedition included the completion of 9 successful ROV exploration dives in the vicinity of the Azores, the Mid-Atlantic Ridge south of the Azores, and Puerto Rico.

The focus of this work was in the deep waters of the North Atlantic (deeper than 200 m for mapping operations and greater than 250 m for ROV operations). This expedition contributed to critical baseline information to support priority NOAA science, partner, and management needs.

Atlantic U.S. deep-sea exploration contributes to NOAA's Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE), a major multi-year, multi-national, collaborative ocean exploration campaign focused on raising our collective knowledge and understanding of the North Atlantic Ocean. Building on previous work in the North Atlantic, including the 2011-2014 Atlantic Canyons Undersea Mapping Expeditions (ACUMEN), NOAA's ASPIRE campaign provides data to inform research planning and management decisions in the region, by broadening both the geographic focus to include more of the U.S. Atlantic and Canada, and the scope of partnerships to include U.S. federal agencies, such as U.S. Geological Survey (USGS) and Bureau of Ocean Energy Management (BOEM), as well as international partners from Canada and Europe. ASPIRE also supports the National Strategy for Mapping, Exploring, and Characterizing the United States Economic Zone[4] and Seabed 2030.

The complete objectives for this expedition are detailed in "Project Instructions: EX-22-06 Voyage to the Ridge 3 (ROV and Mapping)," which is archived in the NOAA Central Library.[5]

[2] https://doi.org/10.25923/jw71-ga98

[3] https://oceanexplorer.noaa.gov/data/publications/mapping-procedures.html

[4] https://noaa.gov/sites/default/files/2022-07/NOMECStrategy.pdf (last accessed 10/17/2022)

[5] https://doi.org/10.25923/pcmg-6n94

Operational Personnel

EX-22-06 onboard operational personnel, inclusive of the ship's force and mission team, who participated in operational execution are detailed in **Table 1**.

Table 1. EX-22-06 Onboard personnel.

Name	Role	Affiliation
Kasey Cantwell	Expedition Coordinator	NOAA Ocean Exploration
Thomas Morrow	Expedition Coordinator (in training)	NOAA Ocean Exploration
Joana Xavier	Science Lead	University of Porto/UCAR
Deborah Glickson	Science Lead	National Academy of Science/UCAR
Sam Candio	Mapping Lead	NOAA Ocean Exploration
Treyson Gillespie	Mapping Watch Lead	UCAR
Megan Cromwell	Sample Data Manager	NOAA NCEI
Levi Unema	Global Foundation for Ocean Exploration Team Lead	Global Foundation for Ocean Exploration
Chris Wright	Engineering Team	Global Foundation for Ocean Exploration
Fernando Aragon	Engineering Team	Global Foundation for Ocean Exploration
Andy O'Brien	Engineering Team	Global Foundation for Ocean Exploration
Mark Durbin	Engineering Team	Global Foundation for Ocean Exploration
Sean Kennison	Engineering Team	Global Foundation for Ocean Exploration
Jon Mefford	Engineering Team	Global Foundation for

		Ocean Exploration
Todd Gregory	Engineering Team	Global Foundation for Ocean Exploration
Jim Meyers	Engineering Team	Global Foundation for Ocean Exploration
Art Howard	Engineering Team	Global Foundation for Ocean Exploration
Caitlin Bailey	Engineering Team	Global Foundation for Ocean Exploration
Anna Sagatov	Engineering Team	Global Foundation for Ocean Exploration
Roland Brian	Engineering Team	Global Foundation for Ocean Exploration
Brian Doros	Engineering Team	Global Foundation for Ocean Exploration

Summary of Mapping Operations

NOAA Ocean Exploration mapped 56,769 square kilometers (sq km) of seafloor during the 28 days at sea for EX-22-06. Of the 56,769 sq km mapped, 1,898 sq km were collected within the U.S. Exclusive Economic Zone and Territorial Sea in waters deeper than 200 meters (m). Multibeam bathymetry data coverage is shown in **Figure 1.**

Figure 1. Overview of bathymetric mapping coverage, ROV dives, and calibration locations during Voyage to the Ridge 3 (EX-22-06). Depths are in meters.

Mapping Statistics

Table 2 provides summary statistics of ocean mapping work during EX-22-06, August 6 - September 2, 2022 (UTC).

Table 2. Summary statistics of ocean mapping work during EX-22-06.

Statistic	Value
Ship's draft*: Start of expedition (08/06/2022) End of expedition (09/02/2022)	 Fore: 16' 0.5''; Aft STBD: 15' 10.0"; Aft Port: 15' 11.5" Fore: 15' 4.5"; Aft STBD: 16' 0"; Aft Port: 16' 0"
Linear kilometers of survey with EM 304	4883
Square kilometers mapped with EM 304	56,769
Square kilometers mapped with EM 304 within U.S. waters deeper than 200 m	1898
Number/data volume of EM 304 raw multibeam files (.kmall)	591 files/72.5 GB
Number/data volume of EM 304 water column multibeam files (.kmwcd)	588 files/183 GB
Number/data volume of EK60/EK80 water column split-beam files (.raw)	500/107 GB
Number/data volume of sub-bottom sonar files (.segy, .kea, .keb)	656/5.16 GB
Number of expendable bathythermograph (XBT) casts	141
Number of conductivity, temperature, depth profiler (CTD) casts (including test casts)	0

*Prior to EX-21-01, and as a result of the full marine survey completed during the 2020/2021 drydock, it was determined that the draft markers on the bow are referenced to the bottom of the original hull, and not the base of the sonar blister on the fairing which is 16.5" lower, requiring that a +16.5" offset be applied to the draft measurements. The measurements listed in Table 3 reflect the +16.5" offset.

Mapping Sonar Setup

Kongsberg EM 304 Multibeam Sonar

NOAA Ship *Okeanos Explorer* is equipped with a 26 kilohertz (kHz) Kongsberg EM 304 MKII multibeam sonar, capable of detecting the seafloor in up to 10,000 m of water and conducting productive mapping operations in up to 8,000 m of water. The nominal transmit (TX) alongtrack beamwidth is 0.5°, and the nominal receive (RX) acrosstrack beamwidth is 1.0°. The system generates a 150° beam fan, containing 512 beams with up to 800 soundings per ping cycle when in high-density mode. In waters shallower than approximately 3,300 m the system is able to operate in dual-swath mode, where one nominal ping cycle includes two swaths, resulting in up to 1,600 soundings. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter.

Simrad EK60/EK80 Split-Beam Sonars

The ship is equipped with a suite of Simrad EK60/EK80 split-beam fisheries sonars: 18 kHz (EK60), 38 kHz (EK80), 70 kHz (EK80), 120 kHz (EK60), and 200 kHz (EK60). These systems 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. In 2019, the 38 and 70 kHz transceivers were replaced with broadband units (WBTs). WBTs use frequency modulation to acquire higher resolution water column data allowing for the detection of finer features, improved depth capability without loss of range resolution, and support of broadband frequency response of targets.

Due to the emergency dry dock following EX-22-04, calibrations were performed during this expedition (EX-22-06) on the Azores Plateau. The calibration files are archived with the sonar data and an updated calibration report is available in the NOAA Central Library as a supplemental document to the 2022 Readiness Report.

Knudsen 3260 Sub-Bottom Profiler

The ship is equipped with a Knudsen 3260 sub-bottom profiler (SBP) 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 m below the seafloor. The sub-bottom profiler is operated to provide information about sub-seafloor stratigraphy and features.

Teledyne Acoustic Doppler Current Profilers

Two acoustic Doppler current profilers (ADCPs), a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz), are installed on the ship. Depending on environmental conditions, the 300 kHz system provides ocean current data to approximately 70 m deep, and the 38 kHz system provides data to approximately 1,200 m deep. The 38 kHz system is capable of collecting data in narrowband and broadband frequency ranges. The ADCPs gather data prior to remotely operated vehicle (ROV) and conductivity, temperature, depth profiler (CTD) deployments in order to assess currents in support of safe operations. The ADCPs are typically not run concurrently with the other sonars during mapping operations due to issues of interference.

Data Acquisition Summary

Standard mapping operations included the EM 304, EK60/EK80 (18, 38, 70, 120, and 200 kHz), and the Knudsen 3260 sub-bottom profiler, with these sonars operated concurrently using a Kongsberg Synchronization Unit (K-Sync). During ROV operations, the EM 304 multibeam and Knudsen sub-bottom profiler were secured to allow for the ADCPs and the entire suite of EK split-beam sonars to acquire data.

Multibeam survey lines were planned to maximize either edge-matching of existing bathymetric data or data gap filling in areas with existing bathymetric coverage. In regions with no existing data, lines are optimized for potential discoveries and to complete relatively large contiguous areas to support interpretation of features from bathymetry and backscatter.

Throughout the expedition, multibeam data quality was monitored in real time by acquisition watchstanders. Ship speed was adjusted to maintain data quality and sounding density as necessary, and line spacing was planned to ensure one-quarter to one-third swath-width overlap between lines, depending on the environmental conditions and impact on the quality of the outer swath regions. Angles were generally left open (70°/70°) during transits to maximize data collection and were adjusted on both the port and starboard sides to ensure the best data quality and coverage. If outer beams were returning obviously spurious soundings (e.g., due to attenuation or low grazing angle), beam angles were gradually reduced and monitored closely until a high-quality swath was obtained.

Real-time corrections to the data upon acquisition included the continuous application of surface sound speed obtained with a hull-mounted Reson SV-70 probe, and application of water column sound speed profiles obtained with Sippican Deep Blue Expendable Bathythermographs (XBTs) and/or Seabird CTD 9/11. No tidal corrections were applied to the raw or processed data. Sound speed profiles were conducted every four hours, or more

frequently as dictated by local oceanographic conditions (typically every two hours when operating in more dynamic areas). Reson sound speed values were constantly compared against secondarily derived sound speed values from the ship's onboard thermosalinograph flow-through system as a quality assurance measure. .

Simrad EK60/EK80 split-beam water column sonar data were collected throughout the majority of the expedition, including during ROV dives. Data were monitored in real time for quality but were not post-processed. Knudsen 3260 sub-bottom profiler data were also collected during the majority of the expedition.

Multibeam Sonar Bathymetric Data Processing and Quality Assessment

The bathymetry data were generated using a Kongsberg EM 304 MKII multibeam system and recorded using Kongsberg's Seafloor Information System (SIS) software as *.kmall files. Collocated to the bathymetric data, bottom backscatter data were collected and stored within the *.kmall files, both as beam-averaged backscatter values, and as full time-series values (snippets) within each beam. Water column backscatter data were recorded separately within *.kmwcd files.

The full-resolution multibeam .kmall files (Level-00 data) were imported into QPS Qimera, and then processed and cleaned of noise and artifacts. Outlier soundings were removed using multiple methods including automatic filtering and/or manual cleaning with the swath and subset editing tools. The default sound speed scheduling method used was "Nearest-in-Time; SVP Crossfade 60 sec" If another method was implemented, it will be noted in the associated log. All files were set to have the Seapath as the primary positioning and motion data source due to the failing POS MV GNSS antenna. Gridded digital terrain models were created using the weighted moving average algorithm and were exported in multiple formats using QPS Fledermaus software. Daily bathymetric surfaces were created and sent to shore. **Figure 2** shows the onboard multibeam data processing workflow.

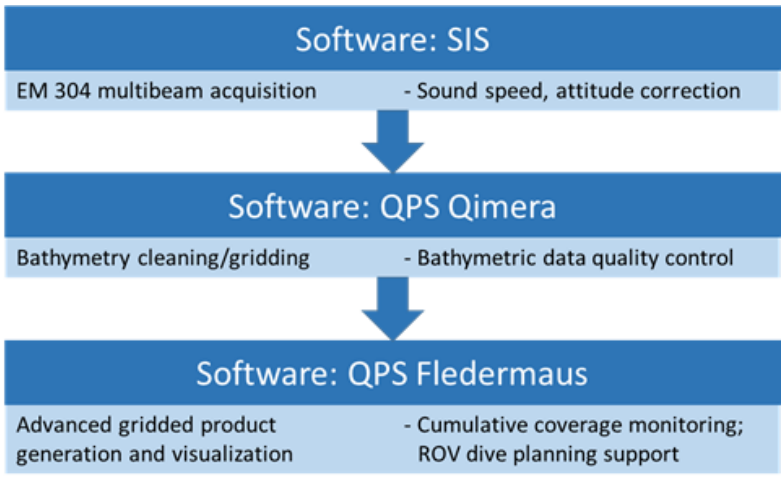

Figure 2. Shipboard multibeam data processing workflow.

On shore, the Mapping Team performed a final quality check of the data using QPS Qimera and Fledermaus software. This involved additional fine cleaning of soundings and minimization of residual artifacts from sound speed biases and field-cleaning errors. Depth values were compared from orthogonal lines (crosslines) to evaluate the consistency of the multibeam sonar data collected during the expedition.

A crossline analysis was completed using the Crosscheck Tool in QPS Qimera software to evaluate the data against the Order 1 S-44 standards set by the International Hydrographic Organization (IHO, 2008).

Each line of cleaned full-resolution data was exported to a *.gsf file (Level-01 data). The processed and cleaned files were used to create a static surface in QPS Qimera. This final surface was re-projected into the field geographic WGS84 reference frame in QPS Fledermaus software and saved as a .sd file for archiving. Using QPS Fledermaus, this *.sd bathymetric grid file was then exported into ASCII XYZ text file (*.xyz), color *.tif, floating point *.tif, and Google Earth *.kmz file formats. The *.gsf files were used to create daily backscatter mosaics using QPS FMGT. All products maintain horizontal referencing to WGS84 (G1762) and vertical referencing to the assumed mean waterline. There is a complete accounting of each individually archived multibeam data file and of each bathymetric surface product in the multibeam data acquisition and processing logs archived with the dataset.

Crossline Analysis

A crossline was run on August 23, 2022, as shown in **Figure 3**, and the results are presented in **Table 3**.

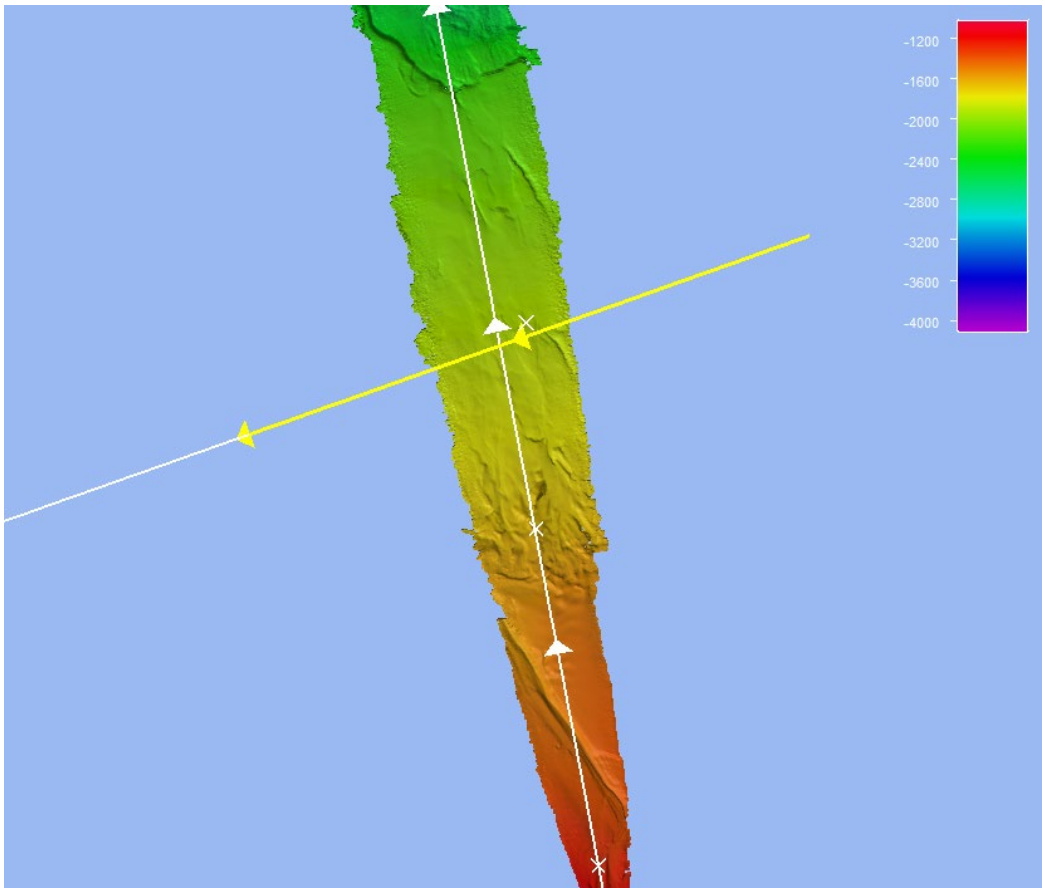

Figure 3. EX-22-06 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines (depths in meters).

Crossline files:

- 0041_20220823_003809_EX2206_MB.kmall
- 0042_20220823_013809_EX2206_MB.kmall

Mainscheme line files:

- 0205_20220831_040900_EX2206_MB.kmall
- 0206_20220831_050900_EX2206_MB.kmall

Table 3. Crosscheck results.

Statistic	Value
Number of points of comparison	251,232
Grid cell size (m)	50.000
Difference mean (m)	0.231447
Difference median (m)	-0.179932
Difference standard deviation (m)	5.850722
Difference range (m)	[-51.45, 54.01]
Mean + 2* standard deviation (m)	11.932891
Median + 2* standard deviation (m)	11.881375
Data mean (m)	-2400.479871
Reference mean (m)	-2400.711318
Data z-range (m)	[-2682.91, -2104.00]
Reference z-range (m)	[-2683.78, -2124.05]
Order 1 error limit (m)	31.213253
Order 1 # rejected	744
Order 1 p-statistic	0.002961
Order 1 survey	ACCEPTED

These results confirm that the data collected meet International Hydrographic Organization Order 1 specifications for data quality.

Acquisition and Processing Software

Table 4 provides a list of the acquisition and processing software versions that were used during EX-22-06.

Table 4. Versions of acquisition and processing software used during EX-22-06.

Software	Purpose	Version
SIS	EM 304	5.10.1
EK80	EK suite	21.15
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04
AMVERSEAS	Autolaunch XBT	9.3
WinMK21	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Fledermaus 7	Visualization/Data Analysis	7.8.11
Qimera	Bathymetry	2.4.9
FMGT	Backscatter	7.10.1
FMMidwater	Water Column	7.9.4
Sound Speed Manager	Sound Speed Profiles	2022.1.0
NRCan (SegJp2)	Sub-bottom	1.0

Data Archiving Procedures

All mapping data collected by NOAA Ocean Exploration on *Okeanos Explorer* are archived and publicly available within 90 days of the end of each expedition 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 expedition) is available as an appendix in the "Project Instructions: EX-22-06, Voyage to the Ridge 3 (ROV and Mapping)," which is archived in the NOAA Central Library. For each data type, raw data (Level 00), processed data (Level 01), derived products (Level 02), and ancillary files may be available, depending on the dataset and the level of staffing for the expedition. **Tables 5-9** describe the data archived for each dataset. For further information about proprietary software and freeware that can handle the varying data types, refer to the "NOAA OER Deepwater Exploration Mapping Procedures Manual."

Table 5. EM 304 bathymetry and seabed backscatter dataset.

Level	Description	File Type
Level 00	Raw multibeam files (in native sonar format) that include both raw bathymetry and backscatter (horizontal referencing = WGS84)	.kmall
Level 01	Processed multibeam files in generic sensor format that include bathymetry and backscatter (horizontal referencing = WGS84)	.gsf
Level 02	Gridded multibeam data and backscatter mosaics (horizontal referencing = WGS84)	.xyz, .tif, .tif (floating point GeoTIFF, .kmz, .sd, .scene
Ancillary files	Mapping watchstander log, weather log, sound speed profile log, multibeam acquisition and processing log, backscatter correction file, built-in self test logs, processing unit parameters, telnet session records	.xlsm, .xlsx, .txt

Table 6. EM 304 water column backscatter dataset.

Level	Description	File Type
Level 00	Raw multibeam files (in native sonar format) that include water column backscatter (horizontal referencing = WGS84)	.kmwcd
Level 01	n/a	n/a
Level 02	QPS Fledermaus objects such as beam fan, beam line, volume and/or track line; produced if time and staffing allows (horizontal referencing = WGS84)	.sd, .scene
Ancillary files	Mapping watchstander log, weather log, sound speed profile log, multibeam acquisition and processing log, water column data log, built-in self test logs, processing unit parameters, recorded telnet sessions	.xlsm, .xlsx, .txt

Table 7. EK60/EK80 split-beam echosounder dataset.

Level	Description	File Type
Level 00	Raw water column files provided in native sensor format (horizontal referencing = WGS84)	.raw, .idx
Level 01	n/a	n/a
Level 02	n/a	n/a
Ancillary files	Mapping watchstander log, weather log, EK data log, EK calibration report, calibration files and the raw files used for calibration	.xlsm, .xlsx, .txt, .pdf, .xml, .raw, .idx

Table 8. Knudsen 3260 sub-bottom profiler dataset.

Level	Description	File Type
Level 00	Raw sub-bottom files provided in native sonar format (horizontal referencing = WGS84)	.sgy, .kea, .keb
Level 01	Raw sub-bottom files converted to images and shapefiles of the tracklines; produced as time and staffing levels allow	.jpg, .shp
Level 02	n/a	n/a
Ancillary files	Mapping watchstander log, weather log, sub-bottom profiler data log	.xlsm, .xlsx

Table 9. Sound speed profiles dataset.

Level	Description	File Type
Level 00	Raw profile data for any XBT or CTD cast	.txt, .hex, .cnv
Level 01	Processed sound speed profiles created for multibeam data acquisition	.asvp
Level 02	n/a	n/a
Ancillary Files	Mapping watchstander log, sound speed profile log, profile locations as a shapefile and in Google Earth format, any associated calibration files	.xlsm, .xlsx, .shp, .kml, .cal, .xml, .pdf

All sonar data are permanently discoverable within the NCEI archives[6] and searchable through the Ocean Exploration Digital Atlas,[7] which provides access to all of the data collected during an expedition. The locations for specific data types (at the time of writing this report) are detailed in **Table 10**. For any challenges accessing data, send an inquiry to NCEI,[8] or contact the Ocean Exploration Mapping Team.[9]

[6] https://www.ngdc.noaa.gov/

[7] https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm

[8] ncei.info@noaa.gov

[9] oar.oer.exmappingteam@noaa.gov

Table 10. Locations of data collected during EX-22-06 (at the time of writing this report).

Data Type	Description	Location
EM 304 bathymetry and backscatter data	EM 304 bathymetric and backscatter data, supporting informational logs, and ancillary files are available through the NCEI Bathymetry Data Viewer	https://www.ncei.noaa.gov/maps/bathymetry/ Request raw sonar data (*.kmalls) from ncei.info@noaa.gov with oer.info.mgmt@noaa.gov cc'd. POSPac and BS correction files can be requested from oar.oer.exmappingteam@noaa.gov
Water column data (EM 304 and EK60/EK80)	EM 304 and EK60/EK80 water column data, supporting data, and informational logs are available through the NCEI Water Column Sonar Data Viewer	https://www.ncei.noaa.gov/maps/water-column-sonar/
Knudsen 3260 sub-bottom profiler data	Sub-bottom data, supporting data, and informational logs are available in the NCEI data archives	https://www.ncei.noaa.gov/maps/trackline-geophysics/
Sound speed profiles	Ancillary sound speed profiles are available along with all mapping data per expedition in the NCEI data archives, or within the oceanographic archive for the expedition.	https://www.ncei.noaa.gov/maps/bathymetry/ or through the oceanographic archives at: https://www.ncei.noaa.gov/
Reports	Reports are archived in the NOAA Central Library's Ocean Exploration Program (OEP) institutional repository	NOAA Central Library home: https://library.noaa.gov/ OEP institutional repository: https://repository.library.noaa.gov/cbrowse?pid=noaa%3A4&parentId=noaa%3A4

Expedition Schedule

Table 11. EX-22-06 schedule.

Date (UTC)	Activity
8/1	Ship tours in Horta, Faial, Azores.
8/3	Move aboard day for new personnel; Outreach: Meet the Explorers live interaction
8/4	Alongside mobilization. New personnel ship orientation
8/5	Alongside mobilization
8/6	Depart Horta, Faial, Portugal; transit mapping
8/7	Dive 01: João Valadão Ridge; overnight mapping
8/8	Dive 02: East of Formigas Rift; overnight mapping
8/9	Dive 03: Azores Plateau Mid-Water; overnight mapping
8/10	Dive canceled; mapping operations in the vicinity of the Azores
8/11	Dive canceled; small boat operations for luggage retrieval; mapping operations; EK calibrations
8/12	Dive canceled; mapping operations; EK calibrations
8/13 - 8/17	Dives canceled; transit mapping
8/18	Dive 04: Kane Fracture Zone Massif; transit mapping
8/20 - 8/22	Dives canceled; transit mapping
8/23	Arrival into San Juan, PR; Outreach: Georgia Tech Ocean Science and Engineering PhD program live interaction
8/24	Stores delivery and loading; depart San Juan, PR; overnight mapping operations
8/25	Dive 05: *Clipper Endeavor* UCH; Outreach: Expolab Centro Ciencia Viva (Sao Miguel) live interaction; overnight mapping operations
8/26	Dive 06: Mona Block; overnight mapping operations
8/27 -8/28	Dive canceled; mapping operations
8/29	Dive 07: Lang Bank; Outreach: Expolab Centro Ciencia Viva (Santa Maria) live interaction; overnight mapping operations

8/30	Dive 08: SW St. Croix; Outreach: Women's Aquatic Network Interview with an Explorer live interaction; overnight mapping operations
8/31	Dive 09: Main Ridge; overnight mapping operations
9/1	Dive canceled; mapping operations; Outreach: Knauss Fellows live interaction
9/2	Arrival in San Juan, PR; demobilization
9/3 - 9/5	Demobilization; sample packaging

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Appendix A: Daily Log Entries

The following entries were excerpted from each of the daily expedition situation reports provided by the onboard team to the onshore support team, and therefore are somewhat informal in language. These are included to provide situational awareness for future users of the data collected during this expedition.

August 6

Mapping operations commenced shortly after leaving Horta and transiting into appropriate water depths. All sonars started up properly, and data acquisition began without a hitch.

Throughout the night some dropouts occurred, similar to what was experienced during EX-22-05. GFOE and the mapping team continued to search for any hints as to what is causing this. Additionally, the mistracking along steep slopes seen during EX-22-05 also continued.

Otherwise data quality remained high, and the transit was adjusted to collect data over potential dive sites en route to Dive 01.

August 7

Transit continued towards Dive 01. Upon reaching the dive site, focused mapping operations were conducted to ensure that the ROV was deployed on high-resolution, high confidence data. New mapping products were provided to the ROV team.

Following the dive, transit mapping operations were conducted en route to Dive 02. This transit included some data collection within a priority area defined by scientists at The University of the Azores.

Similar mistracking issues were seen as yesterday, however data quality remained relatively high.

August 8

Transit mapping operations occurred from Dive 01 to Dive 02. Following the dive, transit mapping operations occurred en route to Dive 03. All systems operated as normal.

August 9

Transit mapping operations occurred from Dive 02 to Dive 03. Following the dive, transit mapping operations occurred en route to Dive 04. All systems operated as normal.

August 10

Mapping operations occurred over the Ilha Azul Ridge, in preparation for the dive that was canceled.

Focused mapping operations then occurred in the vicinity of the Pico Seamounts, as requested by partners at the University of the Azores. All systems behaved well.

Prepared for EK calibrations tomorrow near Faial Island to correspond with the luggage recovery small boat operations.

August 11

EK calibrations on the EK pod were successfully conducted following the luggage transfer in the vicinity of Faial island. Calibration of the 18 kHz will be completed tomorrow. NOAA Ocean Exploration team members were trained on the setup of the EK calibration gear and learned the EK calibration software. Following EK calibrations, focused mapping resumed in the vicinity of the Pico Seamounts.

August 12

The 18kHz EK was successfully calibrated. Following the calibrations, transit mapping occurred over Condor Seamount before the ship started making its way southward.

August 13

Transit mapping. All systems operated normally. Multibeam data quality deteriorated due to high transit speeds and desire to build as much buffer time for on station mapping and dive operations during the small window we may have.

August 14

Transit mapping en route to the next potential dive site. All systems normal.

We had a discussion about an odd feature in the EK sonar data that looked like dense returns above the seafloor. After further investigation in the water column data and consultation with science leads as well as the survey team, evidence suggests that we imaged a hydrothermal plume emanating from Condor Seamount on August 12th. We are putting together imagery to share with shore-side participants from the Azores, who have noted similar activity in the area previously and asked us to keep an eye out for it. The activity is relatively shallow and within their instrumentation range, so it may be a good target for further local study by our partners in the Azores.

August 15

Transit mapping operations. All systems normal.

August 16

Transit mapping operations. All systems normal.

August 17

Transit mapping en route to Dive 04. The inside corner high of the Kane transform fault was reached in the evening, and focused mapping operations over the feature commenced. This was a request by shoreside scientists, in addition to providing data for site selection for Dive 04. All conditions normal.

August 18

Focused mapping operations on the site of Dive 04 until 0530, when a dive site was chosen and the ship set up for a drift test. Following the dive, transit mapping occurred en route to Puerto Rico.

August 19

Transit mapping continued. Data quality is high, and all systems are operating normally.

August 20

A SIS dropout this morning led to a restart. Started recording before incrementing line, duplicated line 0113, reported to data team and removed from sync process. Water column data for 0113 is probably not available, but impact is minimal for transit data.

Dive track smoothing script is dropping entries with NaN after the smoothing function for X,Y,Z is applied. This leads to a case where water column dives are not properly smoothed, because the 'ALT' (altitude) column becomes NaN once the ROV loses ping on the seafloor. Previously this has not been a problem for benthic dives, since the descent and ascent (when ALT would read NaN) aren't areas of interest for the dive track anyways, but it erases all the water column tracking after smoothing. The fix is to strip the ALT column out before dropping NaNs - changed on local copy but not sure if it will reflect on the distributed copy. Need to add to GitHub anyways, will submit and update SOP.

Noticed a time discrepancy between XBT casts reported and recorded time, leading to a disconnect in SSM as well as Qimera. Raw XBT headers have the correct time, two SVPs in Qimera have the same timestamp, even though they were taken 3 hours apart. The suggested

problem is in Qimera. After investigation, we determined a duplicate-timed cast was in the record and resolved the issue. No impact to data quality.

August 21

Transit mapping continues. Later today we expect to cross into Antigua and Barbuda's EEZ and will secure all sonars until arrival to the BVI EEZ, where we have permission to collect mapping data.

August 22

Focused mapping targeted the UCH dive site for target confirmation. A star search pattern was run, but relatively close to the 3 nm state waters boundary, limiting coverage in some areas. Overnight mapping results will inform intended UCH dive on Aug 25.

August 23

Overnight mapping of the UCH site identified for Dive 05, including backscatter processing for potential target identification. Mapping efforts confirmed previous targets identified from previous backscatter data.

After arrival, all sonars were secured for nearby diving operations in the port.

August 24

Restarted mapping equipment for transit to survey a potential dive site before heading to the UCH site. Noted an intermittent loss of heading accuracy, but the issue appeared to resolve on its own and did not significantly affect data quality. Mapping data collection remained outside the 5 nm limit in UCH protocol and will be pulled out of restricted status after clearing the UCH dive.

August 25

Overnight mapping of a dive site for later in the cruise before securing early in the morning prior to approach to UCH dive site. Transit mapping resumed after the dive.

August 26

Overnight mapping of the potential dive site yielded quality results for that morning's dive. Heading drop issue has not reappeared, but is still being monitored.

August 27

Overnight mapping prior to diving refined the target. No issues to report.

August 28

Mapping continued after overnight operations to prepare for an alternate dive location after sargassum issues. Transit mapping continued after the dive canceled en route to Lang Bank. Area is well-covered and it is challenging to find mapping gaps to fill while also maintaining transit speed and timing to meet dive plans in the morning.

August 29

Transit mapping en route to new dive location. No updates to report.

August 30

Overnight mapping covered the dive site. Transit mapping after the dive to the next dive location.

August 31

Overnight mapping of the dive target at 6000 m refined depth targets. After the dive and determining we could not dive any more on this expedition, the survey team jumped into action again and found a gap in bathymetric coverage to fill that would be an excellent use of remaining ship time. Survey team created the lines, set the course, and prepared to process incoming new scientific observations of unexplored seafloor

September 1

Mapped a gap in bathymetric coverage along the US EEZ. After completing mapping objectives, survey settled into post-processing, QA/QC, and secured the sonars for final transit.

September 2

The ship arrived in San Juan, PR. Demobilization and data QA/QC continued.