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Mapping Data Acquisition and Processing Summary Report

EX-22-04: Voyage to the Ridge 1 (Mapping)

Charlie-Gibbs Fracture Zone

Newport, Rhode Island, to St. Johns, Newfoundland

May 14, 2022- Jun 7, 2022

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Table of Contents

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.

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 EX-22-04, and to present a summary of mapping results and mapping-related expedition activities.

A detailed description 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]

For further information about general equipment calibration procedures, data acquisition, processing, reporting, and archiving, see the "NOAA Ocean Exploration Deepwater Exploration Mapping Procedures Manual V1", which is archived in the NOAA Central Library[2] and also available from the website.[3]

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

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

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

Expedition Objectives

EX-22-04 involved a transit northeastward followed by focused ocean mapping operations on the Mid Atlantic Ridge (MAR) and the Charlie-Gibbs Fracture Zone (CGFZ), mostly in deep water (>200 m). The expedition included 24-hour-a-day exploratory mapping operations to fill mapping gaps and provide data for remotely operated vehicle (ROV) dive planning for future remotely operated vehicle (ROV) expeditions. The data collected throughout this expedition aim to improve knowledge of unexplored areas along the CGFZ and MAR.

Atlantic U.S. deep-sea exploration contributes to NOAA's Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) campaign, 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 will provide 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 will also support 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-22-04, Voyage to the Ridge 1 (Mapping)", which is archived in the NOAA Central Library.[5]

[4] https://oeab.noaa.gov/wp-content/uploads/2021/01/2021-national-strategy-implementation.pdf

[5] https://doi.org/10.25923/g2xt-e727

Operational Personnel

EX-22-04 included onboard operational personnel, inclusive of ship's force and mission team, who participated in operational execution (see **Table 1**).

Table 1. EX-22-04 Onboard personnel.

Name	Role	Affiliation
Sam Candio	Expedition Coordinator	NOAA Ocean Exploration
Daniel Freitas	Mapping Watch Lead	UCAR[1]
Anna Coulson	Mapping Watch Lead	UCAR[1]
Mia DeNardi	Explorer-in-Training	UCAR[1]
Gabriel Hernandez	Explorer-in-Training	UCAR[1]
Margaret Hanley	Explorer-in-Training	UCAR[1]
Catalina Rubiano	Explorer-in-Training	UCAR[1]
Charlie Wilkins	Senior Survey Tech	OMAO[2]
LTJG Hunter Brendel	Operations Officer	OMAO[2]
Chris Wright	Data Manager	GFOE[3]
Jim Meyers	Data Manager	GFOE[3]
Bob Knott	Video Engineer	GFOE[3]

[1]University Corporation for Atmospheric Research
[2]NOAA Office of Marine and Aviation Operations
[3]The Global Foundation for Ocean Exploration

Summary of Mapping Operations

NOAA Ocean Exploration mapped 46,250 square kilometers (sq km) of seafloor during the 24 days at sea for EX-22-04. Multibeam bathymetry data coverage is shown in **Figure 1.**

- Satellite map of the Western Atlantic Ocean showing the bathymetric mapping coverage depicted in a red to blue gradient, with deep sea camera casts stations depicted with red circles and sun photometer measurements depicted with white circles.

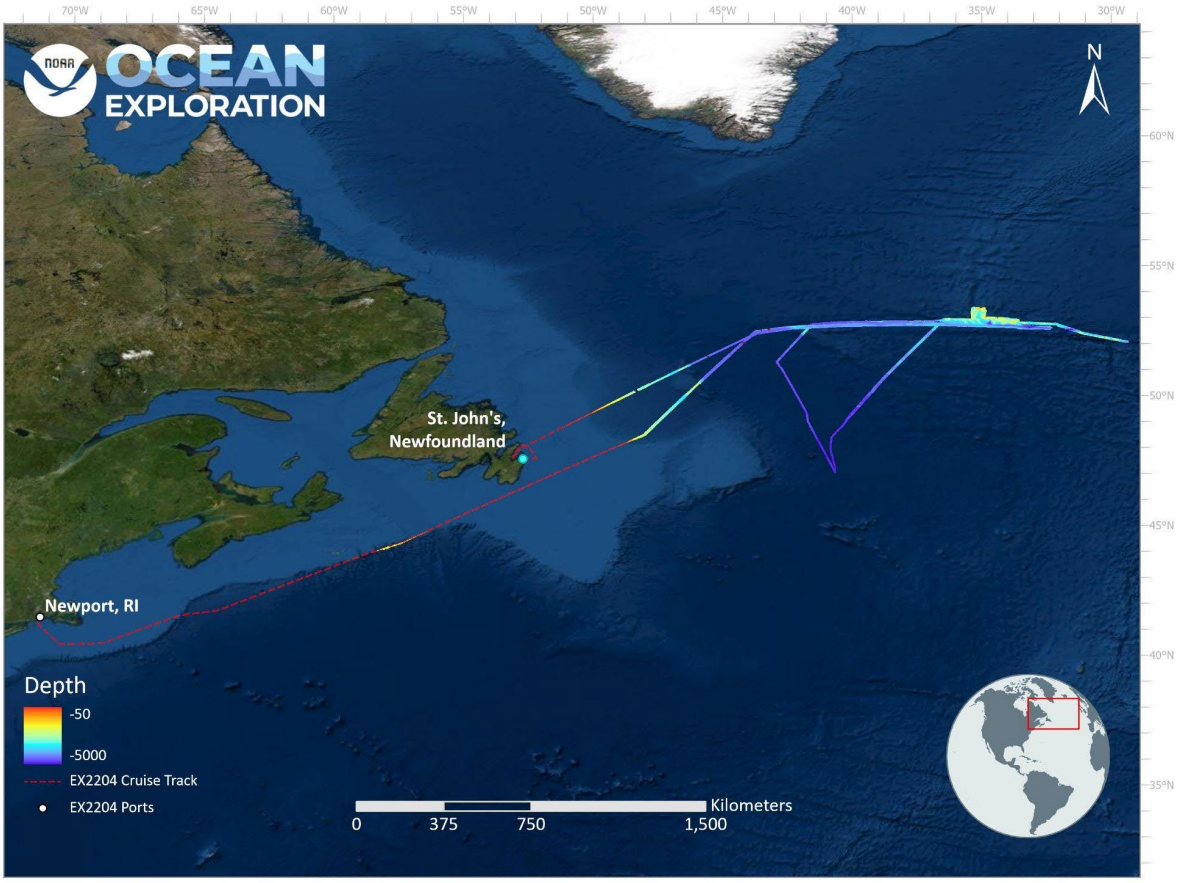

Figure 1. Overview of bathymetric mapping coverage completed during EX-22-04 (depths in meters).

Mapping Statistics

Table 2 provides summary statistics of ocean mapping work during EX-22-04 [May 14 - June 7, 2022] (UTC).

Table 2. Summary statistics of ocean mapping work during EX-22-04.

Statistic	Value
Ship's draft: Start of expedition (05/14/2022) End of expedition (06/07/2022)	 Fore: 16' 1.5''; Aft STBD: 16' 0"; Aft Port: 16' 0" Fore: 15' 7"; Aft STBD: 15' 5.5"; Aft Port: 15' 5.5'
Linear kilometers of survey with EM 304	7366
Square kilometers mapped with EM 304	46,250
Square kilometers mapped with EM 304 within U.S. waters deeper than 200 m	0
Number/data volume of EM 304 raw multibeam files (.kmall)	773/105 GB
Number/data volume of EM 304 water column multibeam files (.kmwcd)	771/211 GB
Number/data volume of EK60/EK80 water column split-beam files (.raw)	725/3.45 GB
Number/data volume of sub-bottom sonar files (.segy, .kea, .keb)	420/3.45 GB
Number of expendable bathythermograph (XBT) casts	133
Number of conductivity, temperature, depth profiler (CTD) casts (including test casts)	0

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 mof 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 140° beam fan (70° port/70° starboard maximum angles), 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.

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

Following port departure, data are typically collected with the ADCPs until the sea buoy is reached, at which point the ADCPs are secured. Then, data acquisition begins with the EM 304, EK60/EK80 (18, 38, 70, 120, and 200 kHz), and the Knudsen 3260 sub-bottom profiler, with these sonars running concurrently using a Kongsberg Synchronization Unit (K-Sync).

Multibeam survey lines are 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.

Focused mapping operations were conducted in the vicinity of the Charlie-Gibbs Fracture zone as weather conditions allowed. A large storm impacted the survey area between May 26 and May 29, resulting in a southward diversion to avoid the system. As weather conditions improved, operations resumed on the CGFZ on May 30 until beginning the transit to St. Johns, Newfoundland on June 2.

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: continuous application of surface sound speed obtained with a hull-mounted Teledyne RESON SV-70 probe; application of water column sound speed profiles obtained with Sippican Deep Blue Expendable Bathythermographs (XBTs) and/or Seabird CTD 9/11; application of roll, pitch, and heave motion corrections obtained by either the POS MV 320 V5 or Seapath 320-R3 inertial position and orientation system (refer to the watch log to determine which system was the primary source used). 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 near currents). 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. Data were monitored in real time for quality but were not post-processed. A calibration of the EK60/EK80 sonars was conducted in Conception Bay on June 6. See the 2022 EK60/80 Calibration report, a supporting document included with the NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report 2022 for more information.

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." If another method was implemented, it will be noted in the associated log. 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.

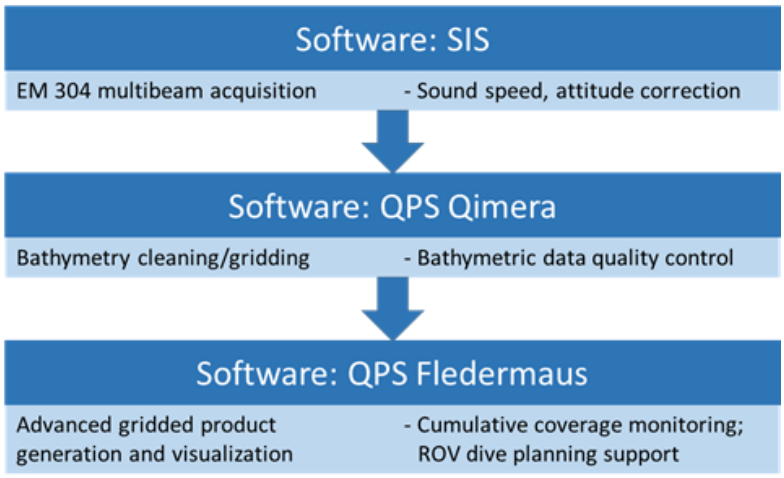

Figure 2. Shipboard multibeam data processing workflow.

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 June 1, 2022, as shown in **Figure 3**, and the results are presented in **Table 3**.

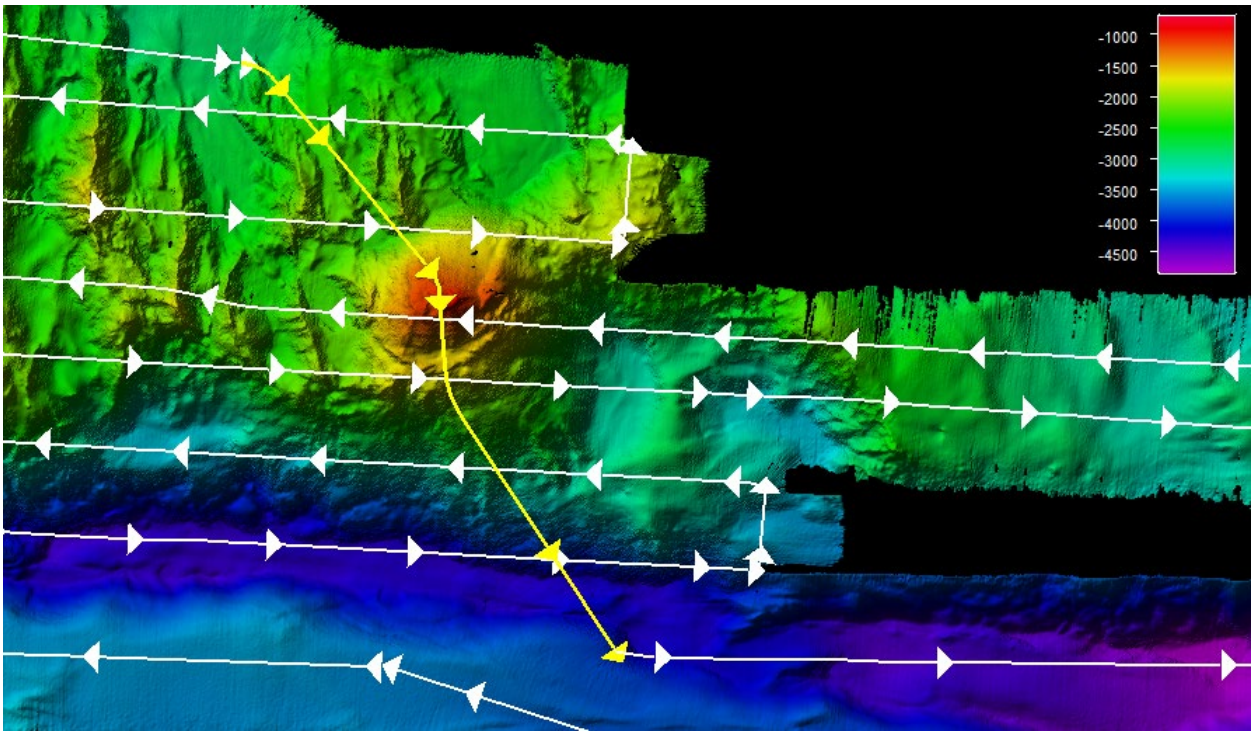

Figure 3. EX-22-04 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines.

Crossline files:

0647_2022061_102016_EX2204_MB

0648_2022061_103343_EX2204_MB

0649_2022061_111117_EX2204_MB

0650_2022061_111834_EX2204_MB

0651_2022061_121834_EX2204_MB

Mainscheme line files:

0165_20220522_205055_EX2204_MB

0166_20220522_212055_EX2204_MB

0172_20220522_225833_EX2204_MB

0173_20220522_232833_EX2204_MB

0221_20220523_214421_EX2204_MB

0222_20220523_221421_EX2204_MB

0221_20220523_214421_EX2204_MB

0311_20220525_165205_EX2204_MB

0312_20220525_172205_EX2204_MB

0313_20220525_175205_EX2204_MB

0583_20220531_033128_EX2204_MB

0584_20220531_040128_EX2204_MB

0589_20220531_055004_EX2204_MB

0590_20220531_062004_EX2204_MB

Table 3. Crosscheck results.

Statistic	Value
Number of points of comparison	941,740
Grid cell size (m)	100.00
Difference mean (m)	1.62481
Difference median (m)	0.856150
Difference standard deviation (m)	10.932051
Difference range (m)	[-120.75, 148.27]
Mean + 2* standard deviation (m)	23.488928
Median + 2* standard deviation (m)	22.720268
Data mean (m)	-2275.104172
Reference mean (m)	-2276.728982
Data z-range (m)	[-4308.06, -867.90]
Reference z-range (m)	[-4296.40, -876.08]
Order 1 error limit (m)	29.6017
Order 1 # rejected	33689
Order 1 p-statistic	0.035773
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-22-04.

Table 4. Versions of acquisition and processing software used during EX-22-04.

Software	Purpose	Version
SIS	EM 304	5.9.3
EK80	EK suite	2.0.0
EchoControl	Knudsen	4.09
UHDAS	ADCPs	14.04
AMVERSEAS	Autolaunch XBT	9.3
WinMK22	XBT	3.0.2
K-Sync	Synchronization	1.9.0
Qimera	Bathymetry	2.4.8
FMGT	Backscatter	7.9.6
FMMidwater	Water Column	7.9.3
Sound Speed Manager	Sound Velocity Profiles	2022.1.0
NRCan (SegJp2)	Sub-bottom	1.0
Fledermaus 7	Visualization/Data Analysis	7.8.12

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-22-04, Voyage to the Ridge 1 (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,	.xlsm, .xlsx, .txt

	processing unit parameters, recorded telnet sessions	

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	.xlsm, .xlsx, .shp, .kml, .cal, .xml, .pdf

	and in Google Earth format, any associated calibration files	

All sonar data is permanently discoverable within the NCEI archives[4] and searchable through the Ocean Exploration Digital Atlas,[6] 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,[7] or contact the Ocean Exploration Mapping Team.[8]

Table 10. Locations of data collected during EX-22-04 (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/

[6] https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm
[7] ncei.info@noaa.gov
[8] oar.oer.exmappingteam@noaa.gov

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-22-04 schedule.

Date (UTC)	Activity
5/9	Mission personnel began to arrive in Newport, RI.
5/10	Mobilization began and more mission personnel arrived.
5/11-5/13	Sailing was delayed due to medical related delays.. Training/mobilization continued.
5/14	Departed Newport. Swung the compass with a compass adjuster aboard. Began transiting towards the priority mapping areas.
5/15 - 5/20	Transit mapping towards the priority mapping areas.
5/21 - 5/26	Focused mapping operations on the CGFZ and MAR.
5/27 - 5/29	Transit mapping to avoid inclement weather in the priority areas.
5/30 - 6/2	Focused mapping operations on the CGFZ.
6/3 - 6/5	Transit towards EK calibration site.
6/6	EK Calibrations.

6/7	Arrive in St. Johns, Newfoundland.
6/8	Mission personnel depart.

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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. All times are in local ship time (-4 hours from UTC).

May 14, 2022

Dockside BISTs showed warnings of elevated noise on the RX channels. This was initially thought to be due to the shallow water and potential noisy environment around the Navy pier. Following the compass calibrations, the ship began its ~7 day transit north to the primary working grounds on the Charlie-Gibbs Fracture Zone. Continual BISTs showed various errors of the CBMF-RX link and RX noise levels. It was brought to the attention of the EC and SST that the CETs adjusted some of the cables in the sonar closet to be in compliance with ABS safety standards. All cables will continue to be evaluated to ensure that the connections are valid.

The EiTs have been assigned watches, and familiarization with the systems/ start-up procedures has begun. The EC has been compiling a brief training data set to get the interns familiar with the processing softwares and techniques.

During the transit northward the ship remained in water < 70 meters. With the issues with the EM 304 ongoing, data collection consisted solely of the suite of EKs.

May 15, 2022

Troubleshooting of the EM 304 continued. Kongsberg was notified of the ongoing issues, however due to it being the weekend response was slow. The team onboard was hesitant to further adjust the system without guidance from Kongsberg. Water depths still remain shallow (~70m), and data collection continued with the suite of EKs.

A brief failure of the Seapath positioning system occurred in the morning, and resolved itself after ~15 minutes. Monitoring of the consistency of this system and the Applanix system will continue throughout the cruise.

The EiTs continue to settle into ship life, and have begun their training datasets.

May 16, 2022

Continued troubleshooting of the EM 304 with periodic assistance from Kongsberg. Data collection continued with the EKs, and commenced with the Knudsen as the ship transited into deeper water.

The EiTs continued to dig into the training dataset, and are gaining confidence in navigating the software/data cleaning.

May 17, 2022

Let there be multibeam! The issue with the EM 304 was identified to be a loose connection within the processing unit, and once resolved all sonars began happily pinging away. The timing was fortuitous, as we were just entering an area flagged by shoreside scientists as a part of an iAtlantic case study. A line of multibeam was run through this priority area as we continued our transit northeastward.

The ship has been enshrouded in a fog bank since departing Newport. Seas are 3-4ft, and data quality is high.

May 18, 2022

Transit continued over relatively shallow water on the Grand Banks of Newfoundland. The Knudsen was secured in these depths, and data collection with this sonar will continue once we reach deeper water. EM 304 and EK60/80 data collection continued. Weather is fair, with seas 4-6 ft and relatively calm winds.

Small periodic dropouts of the EM 304 and EKs have been occurring, potentially due to the K-Sync in these shoaler areas. This will be monitored as we transit into deeper waters to ensure that this issue doesn't persist.

May 19, 2022

Transit continued over relatively shallow water on the Grand Banks of Newfoundland, moving off the shelf in the evening. Once in deeper water, the Knudsen was energized and data were collected by all sonars. Weather is fair, with seas 4-6 ft and relatively calm winds.

May 20, 2022

Transit towards the CGFZ continued. Sea state increased steadily, however data quality remained high.

An issue with the data gridding within SIS was realized where the grid seemed to stop at a hard longitudinal border. This issue was somewhat resolved through restarts of the software, however Kongsberg has been notified to see if we can find the root of the issue.

May 21, 2022

The priority survey areas were reached shortly after midnight. There were a series of issues with SIS that were resolved through multiple restarts of the system. Sea state is manageable, and data quality remains high.

May 22, 2022

Continued operations in the main priority area. Data quality remains high. Sea state has increased slightly, and contingency line plans have been created to try to alleviate the impacts of the impending weather.

May 23, 2022

Data acquisition continued in the primary priority area. Weather is anticipated to increase throughout the week; seas are currently 4-6 ft and data quality is relatively high.

The EiTs are doing a great job staying on top of cleaning and getting comfortable with generating daily products.

May 24, 2022

Weather has become less than favorable. Seas are 8-10 ft with 30 kn+ winds. Longer lines were run into the lower priority areas to limit the amount of turns and attempt to get the best ride for the data and personnel. Data quality is usable so far.

May 25, 2022

Weather has continued to move further away from favorable. Seas are 8-10+ ft with 30+ kn winds. The line running with the wind/swell came to an end around 1400, and the ship turned into the mess. The ride isn't the worst, and the data are still more or less hanging in there for now. It is looking likely that the ship will have to divert to avoid weather in the coming days.

May 26, 2022

Mapping operations continued westward to avoid incoming weather. Seas are 6-8ft long period swell, and the wind has died down considerably for now. Data quality is high, but the ship's motion is beginning to wear on the personnel aboard. Once reaching the end of the western

extent of the CGFZ (or as far as we can get before the weather dictates our next move), the ship will transit southward towards the Flemish Cap to attempt to collect data in more favorable conditions within an area deemed a priority by ASPIRE while waiting for the weather to dissipate over the CGFZ.

May 27, 2022

Mapping operations continued in a southward direction to avoid building seas. Data quality has diminished, with winds 30+ and seas 8-12 ft and building. Operations are planned to continue in the direction of the Flemish Cap, however prevailing conditions may limit the ability to transit in certain directions. Contingency plans are being created to make the most of the rest of the time here, with hope that a pattern of favorable conditions on the Charlie-Gibbs will allow for return to the main priority area.

May 28, 2022

Southbound avoidance-mapping continued until ~1300, when the ship maneuvered around to begin the transit back to the Charlie-Gibbs Fracture Zone. Winds have dropped considerably, however the seas are still 6-10 ft. Speed has been reduced to ameliorate (slightly) the conditions aboard as the ship crawls back towards the priority area. Weather models show vastly improving conditions over the next 48 hours, so there is (perhaps misguided) hope that favorable conditions will await the return to the CGFZ. Current anticipated arrival back to the priority area is Monday afternoon.

May 29, 2022

Transit continued towards the CGFZ. Conditions have become much more favorable, with seas 4-6ft and winds ~10kts. Data quality improved throughout the day with the conditions. This pattern of favorable weather should continue for the next few days, allowing for focused operations within the main priority area prior to beginning the transit back to St. John's, NL.

May 30, 2022

Focused mapping operations resumed on the CGFZ within the highest priority area. Seas are 4-5ft with winds ~10kts. Data quality is high. All systems are operating normally.

May 31, 2022

Mapping operations continued in the main priority area of the CGFZ. Seas are 3-4 ft

with light winds, and data quality is high with a swath exceeding 10 km. All systems are

operating normally.

Jun 1, 2022

Continued operations within the main priority area. A crossline was run following the completion of the northern extension of the ASPIRE polygon, and data were collected along the fracture zone to the east. Weather conditions have begun to deteriorate slightly, however data quality is still high.

Looking ahead, data acquisition is planned to edge match the previous line along the western extent of the fracture zone as we begin our transit back towards St. John's, NL.

Jun 2, 2022

Data acquisition continued along the fracture zone towards the furthest extent to the west. Seas/winds built steadily, with some impact on the data quality.

Jun 3, 2022

Transit mapping towards the potential EK calibration site in Conception Bay, NL. Seas are 6-8 ft, with 20-30 kn winds.

Network connectivity/functionality of the EK equipment was tested in the wet lab, and all routers/base stations were functioning normally.

Jun 4, 2022

Transit mapping continued. Seas are tolerable but not the most ideal.

The EiTs have been pouring through the water column data hungrily hunting for evidence of seeps/vents.

Some of the external equipment necessary for the EK calibrations were staged on deck - the bulk of the setup will occur once the ship enters more amenable seas to help prevent any potential damage to the systems. The setup procedure is a little bit chillier than the last calibration area off of Key West.

Jun 5, 2022

Transit towards the EK calibration site continued. The ship arrived on site at ~2000, however conditions were unfavorable due to elevated sea state and winds and the calibration sphere was unable to be detected. The ship moved further into the bay overnight to attempt to find a more sheltered location.

Jun 6, 2022

EK calibrations were conducted within Conception Bay. Multiple failures were experienced with the auto calibration gear, which were all resolved. All frequencies within the pod were calibrated, however the 18kHz remains uncalibrated.

Jun 7, 2022

The ship arrived in St. John's at 0900. Demobilization began, and all data were transferred to an external hard drive.