



MAPPING DATA ACQUISITION AND PROCESSING SUMMARY REPORT

CRUISE EX-17-04: Telepresence Mapping in American Samoa and Independent Samoa (*Mapping*)

Authors: Elizabeth Lobecker¹

Other Contributors: Charles Wilkins², Amanda Bittinger³, Daniel Freitas³

October, 2020

¹Cherokee Federal, at NOAA Office of Ocean Exploration and Research

² NOAA Office of Marine and Aviation Operations

³ Cooperative Programs for the Advancement of Earth System Science, University Corporation for Atmospheric Research

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.



**Ocean Exploration
and Research**

Contents

1. Introduction	2
2. Report Purpose	4
3. Cruise Objectives	4
4. Summary of Mapping Results	5
Cruise Overview Map	6
5. Mapping Statistics	6
6. Mapping Sonar Setup	8
Kongsberg EM 302 Multibeam Sonar	8
Simrad EK60 Split-beam Sonars	8
Knudsen 3260 Sub-bottom Profiler	8
Teledyne ADCPs	9
7. Data Acquisition Summary	10
8. Multibeam Sonar Data Quality Assessment and Data Processing	12
9. Data Archival Procedures	15
10. Cruise Calendar	17
11. Daily Cruise Log Entries	18
12. References	26
13. Appendix	28
Intern Products	28



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 mapping expedition EX-17-04, and to present a summary of the overall mapping results and mapping related cruise activities. A detailed description of NOAA Ship *Okeanos Explorer's* mapping capabilities is or will be available in the 2017 NOAA Ship *Okeanos Explorer* Survey Readiness Report, available in the NOAA Central Library.

3. Cruise Objectives

Operations for this cruise included focused mapping operations and strategic mapping transits within the waters of American Samoa and Independent Samoa. The expedition commenced on April 4, 2017 in Apia, Independent Samoa and concluded on April 20, 2017 in Pago Pago, American Samoa. Due to time zone changes, when the ship made port in Pago Pago at the end of the cruise, the date April 20 was repeated (it was still 4/21 in Apia, the departure port), the calendar in Section 10 includes these details. To minimize impact on crew from time zone changes, Independent Samoa Daylight Savings Time (UTC +14) was used as local ship time throughout the cruise. Operations included the use of the ship's deep water mapping systems (Kongsberg EM302 multibeam sonar, EK60 split-beam fisheries sonars, Acoustic Doppler Current Profilers: (ADCPs), and Knudsen 3260 chirp sub-bottom profiler sonar), and the ship's high-bandwidth satellite connection for hourly data transfer, real-time ship to shore communications, real-time sonar control from shore, and real-time video streaming of sonar screens and ship's cameras.

This expedition was part of a three year Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE) focused on systematically collecting baseline information to support science and management needs within and around the National Marine Monuments and other protected places in the Pacific, and served as an opportunity for NOAA and the Nation to highlight the uniqueness and importance of these national symbols of ocean conservation. NOAA continues to work with the scientific and management community to characterize unknown and poorly-known areas through telepresence-based exploration. Baseline information collected during this cruise will support and catalyze further exploration, research and management activities.

Operations for this cruise included 24 hour mapping, and continuous telepresence-based shoreside participation in mapping operations. Multibeam, sub-bottom profiling and split-



**Ocean Exploration
and Research**

beam mapping operations were conducted 24 hours a day throughout the cruise. XBT and Underway CTD sound velocity casts in support of multibeam sonar mapping operations were conducted at an interval defined by prevailing oceanographic conditions, and did not exceed 6 hours. All mapping data was fully processed according to OER standard procedures and was archived with the National Centers for Environmental Information (NCEI) within 90 days of the end of the cruise.

This expedition was the sixth cruise to successfully utilize telepresence enabled mapping operations on *Okeanos Explorer*. The Expedition Manager for the cruise was based on shore at the Exploration Command Center (ECC) at University of New Hampshire Center for Coastal and Ocean Mapping/Joint Hydrographic Center (UNH CCOM/JHC) with regular and ongoing communications with the ship (OPS, CO) and the onboard mapping lead. The onboard mapping lead was the primary liaison between ship and OER operations and will attend all the shipboard daily meetings and provide daily situation reports (SITREPS) to the broader OER *Okeanos* operational team. Google Chat was used for round the clock communication between ship and shore.

The screens of the mapping acquisition systems (EM 302, EK 60, SBP etc.) were broadcast 24 hours per day through two live video streams, and were monitored by both onboard and onshore mapping scientists. A specially configured laptop enabled remote access to all the sonar acquisition and data processing machines from shore. The raw data from all sonars was transmitted to shore and detailed processing was completed on shore. Automated bathymetric gridding occurred on the ship in order for the onboard team to monitor and ensure adequate seabed coverage.

The complete objectives for this cruise are detailed in the EX-17-04 Project Instructions, which are archived in the NOAA Central Library at <https://repository.library.noaa.gov/view/noaa/14790> (last accessed 9/20/20).

4. Summary of Mapping Results

EX-17-04 mapped 30,960 square kilometers of seafloor in the vicinity of American and Independent Samoa during the 18 days at sea (Figure 1 and Table1). 28,329 square kilometers of this area is within the U.S. Exclusive Economic Zone (U.S. EEZ) in depths deeper than 200 m. Multibeam bathymetry data coverage from EX-17-04 is shown in Figure 1.

Cruise Overview Map

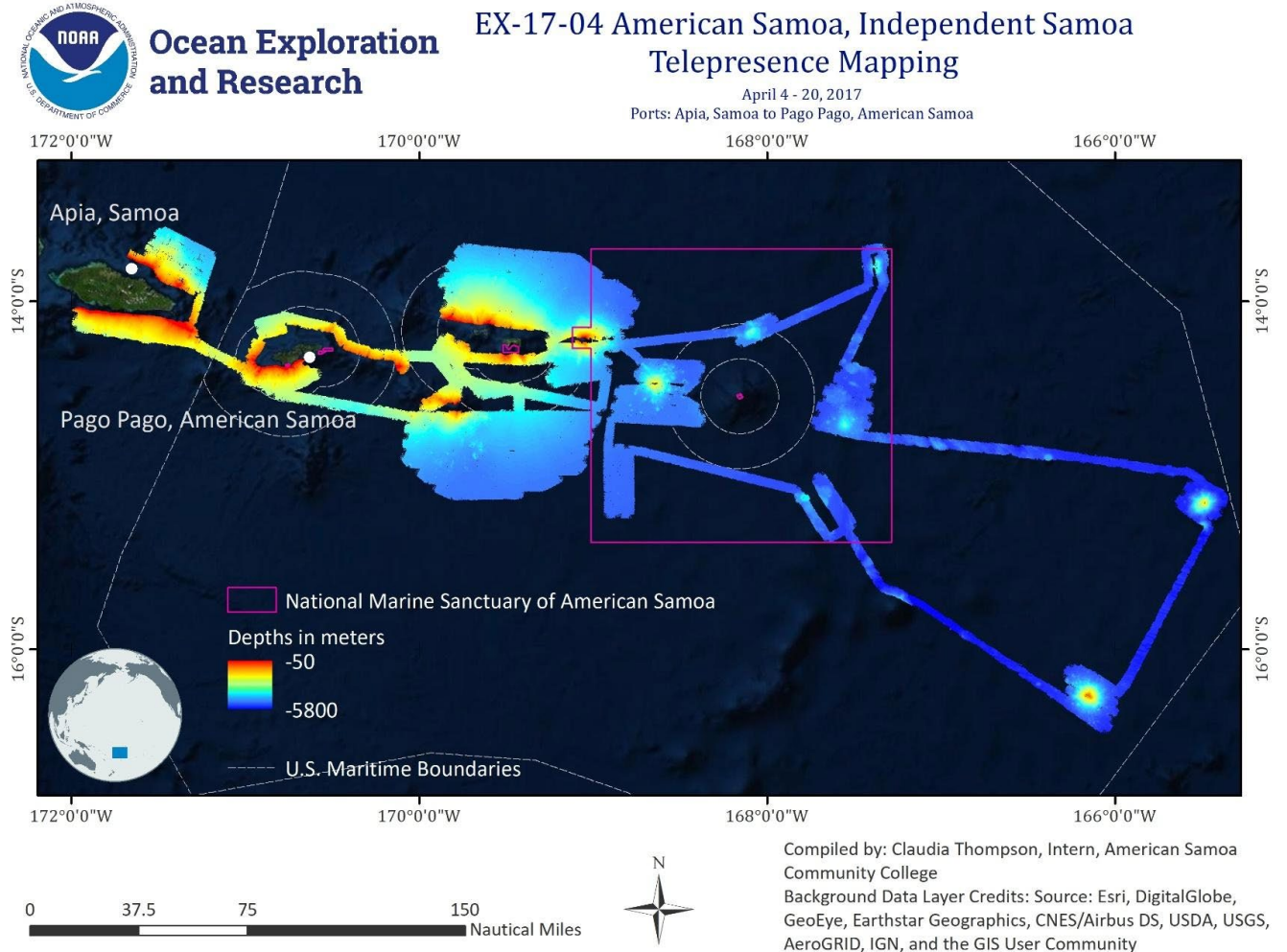


Figure 1. Overview of bathymetric mapping coverage completed during the American Samoa, Independent Samoa Telepresence Mapping expedition EX-17-04. Color bar indicates depths in meters.

5. Mapping Statistics

Table 1. Summary statistics of ocean mapping work completed during EX-17-04.

Dates of cruise data collection (GMT)	04/03/2017 - 04/20/2017
Ship's draft: Start of cruise (04/04/2017) End of cruise (04/21/2017)	Fore STBD: 14'04"; Aft STBD: 14' 06"; Aft Port: 14' 06" Fore STBD: 15' 02"; Aft STBD: 14' 00"; Aft Port: 14' 06"
Linear kilometers of survey with EM 302	6,400
Square kilometers mapped with EM 302	30,960
Square kilometers mapped with EM302 within U.S. EEZ deeper than 200 meters	28,329
Number / data volume of EM 302 raw bathymetric / bottom backscatter multibeam files (.all)	599 files/ 26.8 GB
Number / data volume of EM 302 water column multibeam files	599 files / 100 GB
Number / data volume of EK 60 water column split-beam files (.raw)	201 / 10.4 GB
Number / data volume of sub-bottom sonar files (.segy, .kea, .keb)	854 / 5.9 GB
Number of XBT casts	57
Number of CTD casts (including test casts)	0



6. Mapping Sonar Setup

Kongsberg EM 302 Multibeam Sonar

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 shallower than 3300 meters the system is operated in dual swath mode, and obtains up to 864 soundings per ping by generating two swaths per ping cycle. The multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter data. Backscatter represents the strength of the acoustic signal reflected from a target, such as the seafloor or bubbles in the water column. The system is calibrated with a multibeam sonar patch test annually and the results are reported in the annual readiness report. The 2017 NOAA Ship *Okeanos Explorer* Mapping Systems Readiness Report (forthcoming) will be available in the NOAA Central Library.

Simrad EK60 Split-beam Sonars

The ship operated four Simrad EK60 split-beam fisheries sonars: 18, 38, 70, 120, and 200 kHz. 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. These sonars were calibrated on the EX-16-09 cruise, and calibration values from that cruise were applied to the EK sonars for EX-17-04. The EX-16-09 NOAA Ship *Okeanos Explorer* EK60 Calibration Report (forthcoming) will be available in the NOAA Central Library. The 70 kHz is capable of operating in narrowband or wideband mode with a frequency modulated ping. The 38 kHz transducer was not operated due to interference with the EM 302 sonar.

Knudsen 3260 Sub-bottom Profiler

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 are 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 are typically not run concurrently with the other sonars during mapping operations due to interference issues. 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.

7. Data Acquisition Summary

Mapping operations included data collection via the EM 302 multibeam sonar, EK 60 split-beam (18, 70, 120, and 200 kHz) sonars, and the Knudsen 3260 sub-bottom profiler. Data were collected by each sonar concurrently during the transits. The 38 kHz EK was secured due to causing interference with the multibeam.

Survey lines were planned to either maximize edge matching of existing bathymetric data, or to fill data gaps in areas with existing bathymetric coverage. In regions with no existing data, lines were planned to optimize potential exploration discoveries. Focused mapping operations occurred in the U.S. Exclusive Economic Zone around American Samoa, and in the EEZ of Independent Samoa (Fig. 1). Detailed information for each survey is discussed in Section 4 of this report.

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 $\frac{1}{4}$ swath width overlap between lines. Cutoff angles in the multibeam acquisition software Seafloor Information 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.

Line spacing at the Samoan Clipper wreck site was tighter than normal to allow for reduction of swath and higher density across track soundings, and survey speed was reduced to 6 – 6.5 kts.

Multibeam data received real time surface sound velocity corrections via the Reson SVP-70 probe at the sonar head, as well as through profiles generated from Expendable Bathythermographs (XBTs) conducted at intervals no greater than 6 hours, as dictated by local oceanographic conditions. Reson sound velocity 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 split-beam water column sonar data were collected throughout the majority of the cruise, (Fig. 2). Data were monitored in real time for quality but were not post-processed.

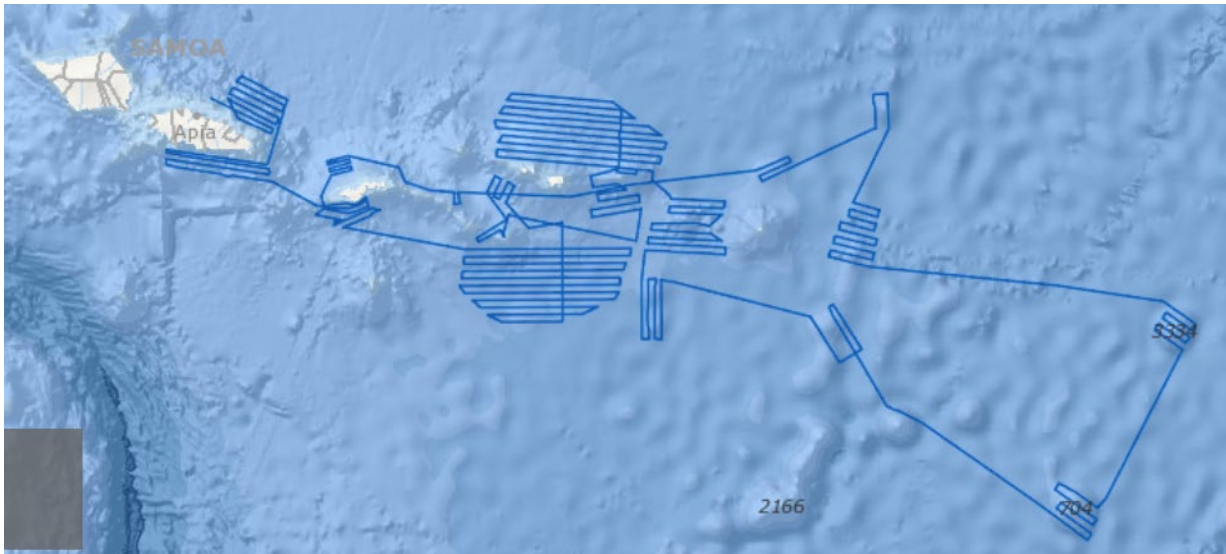


Figure 2. Simrad EK60 spit-beam sonar data tracklines (in blue) collected during EX-17-04.

Knudsen 3260 sub-bottom profiler data were also collected during the majority of the EX-17-04 (Fig. 3).

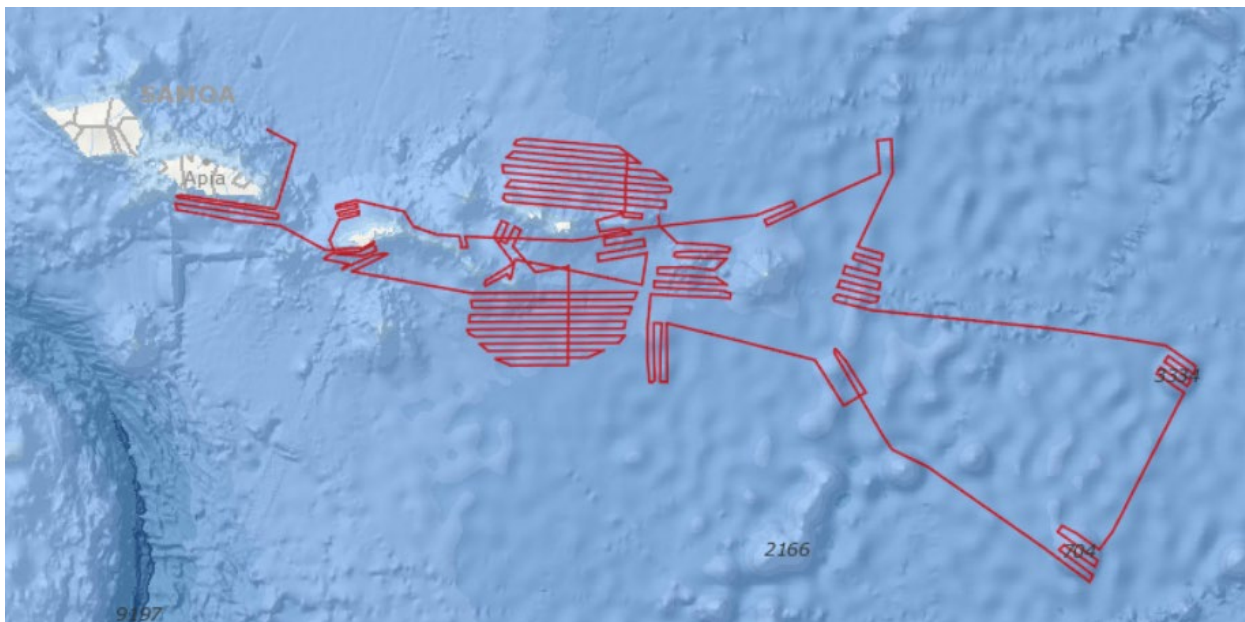


Figure 3. Sub-bottom profiler data tracklines (in red) collected during EX-17-04.



8. Multibeam Sonar Data Quality Assessment and Data Processing

Figure 4 shows the multibeam data processing workflow for this cruise. 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 in SIS, then imported into QPS Qimera for processing. In Qimera, the 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 exported utilizing QPS Fledermaus software 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. With the vast majority of surveying completed in deep water, depth measurements were not adjusted for tides, as they are an essentially insignificant percent of the overall water depth. Data cleaning projects were in UTM zone projections for the operations area. Final data products were exported and archived as field geographic WGS84 coordinate reference frame (i.e., unprojected).

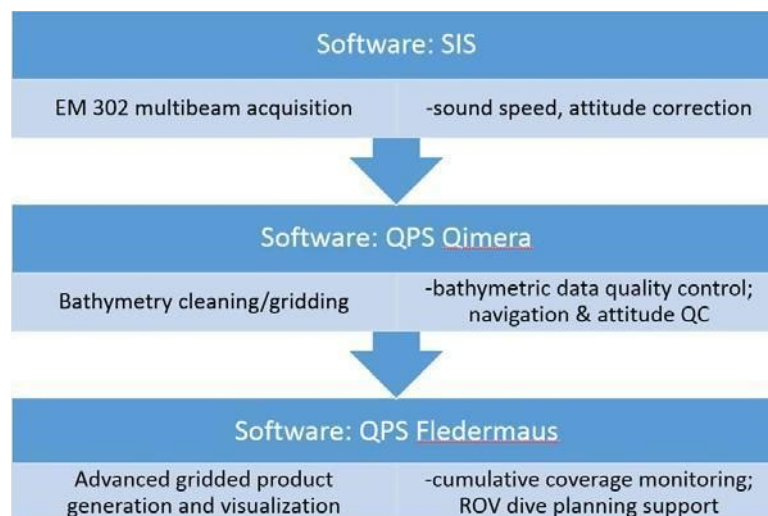


Figure 4. Shipboard multibeam data processing workflow.

Crosslines

Comparing depth values from orthogonal survey lines is a standard hydrographic quality control measure to evaluate the consistency of the multibeam sonar data collected during a cruise. A crossline was run on April 9, 2017 as shown in Figure 5. Crossline analysis was

completed using the Crosscheck Tool in QPS Qimera software to evaluate the data against standards set by the International Hydrographic Organization. The results are shown below.

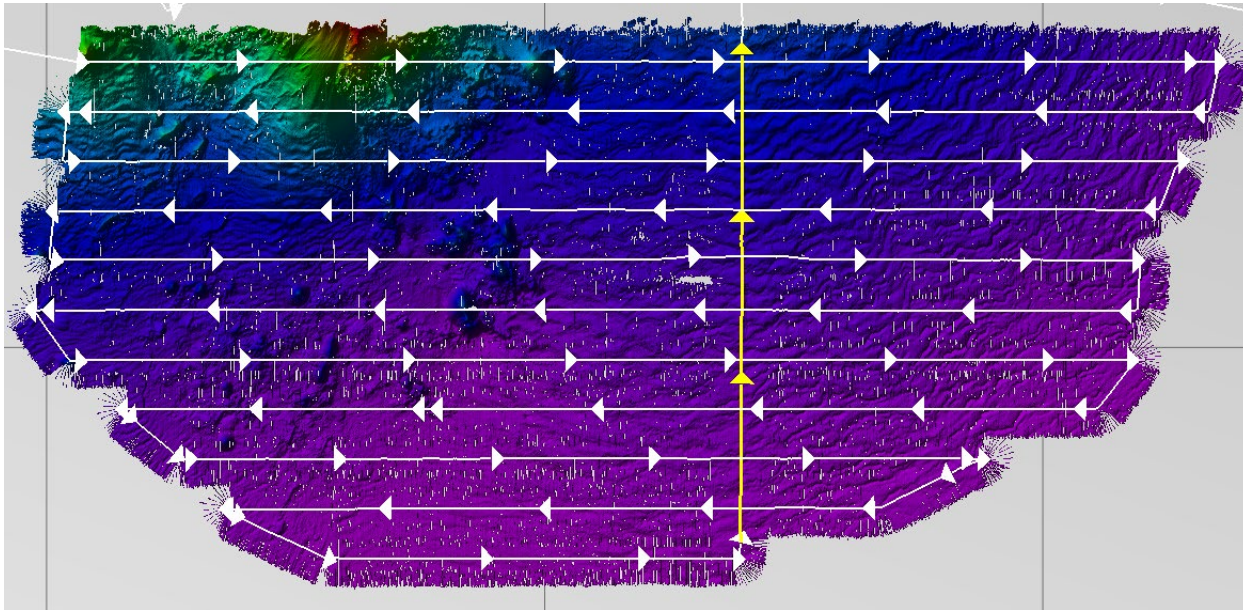


Figure 5. EX-17-04 crossline (shown in yellow) used for comparison against the bathymetric grid generated via orthogonal multibeam survey lines.

Crossline file:

- 0180_20170409_082848_EX1704_MB
- 0181_20170409_092850_EX1704_MB
- 0182_20170409_102845_EX1704_MB

Mainscheme line files:

- 0096_20170406_134744_EX1704_MB
- 0103_20170406_192038_EX1704_MB
- 0104_20170406_202036_EX1704_MB
- 0114_20170407_044918_EX1704_MB
- 0120_20170407_101018_EX1704_MB
- 0130_20170407_191530_EX1704_MB
- 0136_20170408_001911_EX1704_MB
- 0146_20170408_083513_EX1704_MB
- 0147_20170408_093514_EX1704_MB



0152_20170408_133626_EX1704_MB
0153_20170408_143629_EX1704_MB
0164_20170408_220605_EX1704_MB
0169_20170409_005953_EX1704_MB

<u>Statistic</u>	<u>Value (depths in meters)</u>
------------------	---------------------------------

Number Of Points 448896

Grid Cell Size 60.000

Difference Mean -0.012

Difference Median -0.149

Difference Std. Dev 2.913

Difference Range [-41.207, 33.729]

Mean + 2*Stddev 5.838

Median + 2*Stddev 5.974

Data Mean -4716.666

Reference Mean -4716.654

Data Z-Range [-5060.295, -4209.246]

Reference Z-Range [-5053.272, -4210.477]

Special Order Error Limit 35.3758

Special Order # Rejected 2

Special Order P-Statistic 4.45537e-6

Special Order Test ACCEPTED

These results confirm that the data collected meet International Hydrographic Organization (IHO) Special Order (and Order 1 and 2) specifications for data quality.



**Ocean Exploration
and Research**

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-17-04 project instructions, 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)
- 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 water column data review log if data were reviewed for presence of seeps in Fledermaus MidWater

All sonar data is permanently discoverable at <https://www.ngdc.noaa.gov/>

At the time of writing this report,

EM 302 and EK 60 / 80 water column data, supporting data, and informational logs were/will be available in the NCEI Water Column Sonar Archives:

https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html (last accessed 9/23/2020). Direct links to data include:

- EK data <http://doi.org/10.7289/V50Z71HJ>
- EM 302 data <http://doi.org/10.7289/V5W957C0>

Sub-bottom data, supporting data, and informational logs will be available in the NCEI Data Archives accessible at <https://www.ngdc.noaa.gov/>. For any challenges accessing SBP data, send an inquiry to ncei.info@noaa.gov requesting access to EX-17-04 Knudsen 3260 sub-bottom raw and processed data.

EM 302 bathymetry data, supporting informational logs, and ancillary files were/will be available in the NCEI Data Archives accessible at <https://maps.ngdc.noaa.gov/viewers/bathymetry/>(last accessed 09/23/2020).

All data collected at the site of the Samoan Clipper wreck were not deemed restricted-access from an underwater cultural heritage standpoint, and therefore are available in the publicly accessible NCEI archives.

10. Cruise Calendar

All times listed are local ship time, +14 hours from UTC

For each date, offshore activities are listed first, *onshore activities are listed second and italicized.*

April 2017

Sun	Mon	Tues	Wed	Thur	Fri	Sat
<p>2 Mission personnel arrive to ship in Apia, Independent Samoa</p> <p><i>EiTs arrive from American Samoa and New York and settle in at lodging accommodations in Durham NH.</i></p>	<p>3 Mission personnel orientation, review cruise plan.</p> <p><i>Training and orientation of EiTs commenced at the University of New Hampshire Center for Coastal and Ocean Mapping.</i></p>	<p>4 Ship departs, mapping operations commence immediately on north side of Ind. Samoa.</p> <p><i>Commence shoreside data processing.</i></p>	<p>5 Mapping on north side of Ind. Samoa complete, transit to south side of island to map.</p> <p><i>Continued EiT orientation and training on first survey area north of Ind. Samoa.</i></p>	<p>6 Ind. Samoa mapping complete, commence mapping south of American Samoa towards Tau. Test CTD cast completed.</p> <p><i>EiTs doing great with shore processing.</i></p>	<p>7 Mapping south of Tau continued.</p> <p><i>Shore processing continues to keep up with 24 hr data collection.</i></p>	<p>8 Mapping south of Tau continued.</p> <p><i>Shore processing continues to keep up with 24 hr data collection.</i></p>
<p>9 Mapping south of Tau continued.</p> <p><i>Independent weekend watches by EiTs successful.</i></p>	<p>10 Mapping south of Tau continued. Test CTD cast with Niskin bottles completed.</p> <p><i>Independent weekend watches by EiTs successful.</i></p>	<p>11 Mapping north of Tau continued.</p> <p><i>Shore processing continues to keep up with 24 hr data collection. UNH tours with 120 elementary school students.</i></p>	<p>12 Mapping north of Tau continued.</p> <p><i>Shore processing continues to keep up with 24 hr data collection.</i></p>	<p>13 Mapping north of Tau continued.</p> <p><i>Shore processing continues to keep up with 24 hr data collection. UNH tours with 120 elementary school students.</i></p>	<p>14 Mapping north of Tau complete. Transit towards Rose Atoll.</p> <p><i>EiTs start processing bottom and water column backscatter data.</i></p>	<p>15 Rose Atoll mapping.</p> <p><i>EiT start work on focus maps for each survey area.</i></p>
<p>16 Rose Atoll mapping completed. Transit to eastern seamount mapping areas.</p> <p><i>EiTs continue excellent processing and independent watchstanding.</i></p>	<p>17 Eastern seamount mapping.</p> <p><i>EiTs continue excellent processing and independent watchstanding.</i></p>	<p>18 Eastern seamount mapping completed, transit mapping back to Rose Atoll.</p> <p><i>EiTs continue excellent processing and independent watchstanding.</i></p>	<p>19 Potential feature mapping in Rose Atoll vicinity.</p> <p><i>EiTs continue excellent processing, advanced product generation, and independent watchstanding.</i></p>	<p>20 Mapping in vicinity of Rose Atoll complete, transit to Vailulu'u and Samoan Clipper mapping areas.</p> <p><i>EiTs continue excellent processing, advanced product generation, and independent watchstanding.</i></p>	<p>20 (repeated date due to time zone crossing)</p> <p>Focused mapping at Samoan Clipper site. Arrive fuel pier in Pago Pago, AS.</p> <p><i>All bathymetry processing complete.</i></p>	



11. Daily Cruise Log Entries

Generated from the daily expedition situation reports. All times listed are in local ship time (+14 hours from UTC)

For each date, offshore activities are listed first, *onshore activities are listed second and italicized.*

April 2

Mission personnel arrive to the ship in Apia, Samoa.

Explorers-in-Training Claudia Thompson (Community College of American Samoa) and Brandon O'Brien (University of New Hampshire) arrived to UNH.

April 3

Watch schedules established onboard and onshore.

EiT orientation including computer, network introduction, CCOM building tours and key local personnel introductions, OER program introduction, project instruction review, and Qimera multibeam bathymetry processing SOP review.

April 4

The ship got underway from Apia and mapping operations commenced immediately with EM 302, EK60, and sub-bottom profiler data collection. Onboard data processing includes minimal multibeam processing to produce daily grids to send to shore, and sub-bottom data processing.

Raw sonar data is regularly streaming to shore, thank you to onboard data team from EX1703 for helping to set this up in advance. EC conducted EiT orientation including computer, network introduction, CCOM building tours and key local personnel introductions, OER program introduction, project instruction review, and Qimera multibeam bathymetry processing SOP review.

April 5

Mapping operations continue with EM302, EK60 and sub-bottom profiler.

Auto XBT launcher is consistently inconsistent. Cycling power seems to reset when check tubes is not working. Still continuing to find solutions to the different problems with it.

Data quality is consistent with existing weather conditions.

Minimal processing for daily multibeam products. Sub-bottom review for previous cruises and processing for the current cruise, output files will be jpg of images and shapefiles of tracklines.

Sub-bottom profiler was missing GPS input for lines 00-19 (noted in the log). Crazy mouse took over the mouse cable due to sharing issues between GPS feed and mouse cable, and computer was rebooted to fix the problem.

EiT training continued including gridding and ping editing of first survey north of Independent Samoa. File/network permissions issues related to the EITs new network logins at CCOM required troubleshooting throughout the day. Overall the EITs are coming along well and are eager learners. Communications between ship and shore are occurring regularly throughout the day and night to maintain situational awareness and efficient cruise execution. Data transfer from ship to shore is steady.

April 6

Mapping operations continue with EM302, EK60 and sub-bottom profiler. Data quality has improved with existing weather conditions on the south side of Samoa and America Samoa. Mapping line plans Samoa1 and Samoa2 have been completed. En route to line plan AmSam1 in the morning. Halting mapping operations, at approximately 1400 a test CTD cast was deployed at the surface and Nissin bottles were triggered to test the manual triggering mechanism. The trigger test was successful. Focused mapping resumed after CTD operations were completed. The expected completion time for the AmSam1 line plan is 04/07/2017 at 0015. The next line plan will be Landslide2. Due to seas and wind states the transit speed has been about 9.0 to 9.5 knots.

Auto XBT launcher is consistently inconsistent. The XBT hand launcher is being used as a secondary launching device when AXBT is not connecting.

EITs continue to come up to speed on multibeam bathymetry data logging and processing. Onshore watches are staggered by two hours at this point, possibly by more as the students become more independent.

April 7

Mapping operations continue with EM302, EK60 and sub-bottom profiler. Data quality has improved significantly. The onboard team continues to create daily multibeam products to send to shore and to maintain onboard team awareness of data quality and coverage of survey areas. Minimal processing is necessary, particularly with improved weather. Landslide2 line plan was started. EM302 is showing more COM1 PPS drop out errors than usual.

Hypack UTM03S project created for second half of cruise.



**Ocean Exploration
and Research**

Auto XBT launcher was found to (again) have water accumulating in the external control box, and the impact is different than previously observed impact. Two casts were attempted and kept getting temperatures about 1-1.5 degrees higher than what they should have been according to the TSG and the rest of the cast was slightly off as well. It is possible it was putting the sound velocity about 3 m/s off in SIS at the top of the cast. A new water-tight deck box is being ordered. After draining the water and drying with contact cleaner the auto launcher was working as expected for a few hours, then failed again. XBT hand launcher operations are in use and reliable.

Regional CAPSTONE SBP data from previous is being processed to create jpgs of data and shapefiles of tracklines as time allows.

EiTs continue to stay on top of bathymetric data cleaning and gridding. FM Geocoder Tool for generating bottom backscatter mosaics was reviewed and the plan is for each discrete survey area to be mosaiced and draped over bathy. EiTs are eager to learn new aspects of data processing and to sail on the ship. Being immersed in the 'survey simulation' environment seems to agree with them.

April 8

Mapping operations continue with EM302, EK60 and sub-bottom profiler on landslide 2 area south of Tau. Completion of this area is expected to be tomorrow at 2130. The CTD test cast is tentatively planned for April 10 at 1430. The video feed will be switched to outside cameras for viewing at that time.

Auto XBT failed overnight. After the AXBT cast is processed it looks like the profile is in error of 3-5m/s when applied in the SIS acquisition software. There is a question if this is occurring because the processing program Sound Speed Manager uses a global salinity database. The XBT hand launcher and Velocity processing software do not create the 3-5m/s data discrepancy. The XBT hand launcher will be used until this discrepancy can be addressed. ST Wilkins provided a detailed description of troubleshooting and status of AXBT equipment and software thus far; mapping team plans to communicate with AOML about field support. The system is clearly not performing as expected.

Data quality has improved significantly. Minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1703 and EX1704.

Data continues to regularly stream to shore, EiTs are keeping up with gridding and cleaning bathy well. Today is their first round of weekend shifts. SOPs and documentation for onshore telepresence mapping are being updated.



April 9

Mapping operations continue with EM302, EK60 and sub-bottom profiler on landslide 2 area south of Ta'u. Completion of landslide 2 area is expected to be at 2130. Upon completion a crossline and holiday fill lines will be done in transit to the CTD test cast site. The CTD test cast is tentatively planned for April 10 at 1430. The video feed will be switched to outside cameras for viewing at that time.

Data quality has improved significantly and remains high, requiring minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1703 and EX1704.

EiTs experienced multiple crashes of Qimera due to a corrupt dynamic surface file. Communication with shipboard personnel was very helpful in troubleshooting the issue, and fostered team development for when these four watchstanders sail together in August. Shore based EiTs performed their first round of semi-independent watchstanding. International Hydrographic Organization standards were introduced in the context of the multibeam crossline that the ship ran. Procedure for generating focus maps in Arc for each survey was reviewed. EiTs are getting very comfortable with Qimera and FMGT, as well as situational awareness using live feeds of EM302, SBP, and EK sonars, and refreshing the Okeanos Atlas to determine ship survey progress, and G-Chatting with onboard watchstanders.

EiT Claudia Thompson is expected to give informational presentations to school groups when she returns to American Samoa. EC is helping her with slide material.

It is looking unlikely the small seamount chain within American Samoa outside of the Marine National Monument will be surveyed due to time constraints. The Samoa Clipper survey was bypassed initially due to weather as the ship took shelter south of the islands from weather coming from the north, but is still on the table to return to as the last survey of the cruise.

April 10

Mapping operations continued pre- and post-cast with EM302, EK60 and sub-bottom profiler. Landslide area south of Ta'u will be completed tonight. Data quality has improved significantly. Minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1703 and EX1704. Qimera project is having dynamic surface creation issues. A new project was created using QPD files from the original project. EM302 is again flagging areas of data that are being rejected by Qimera, especially small mounds. Spline filter does not seem to be doing as good of a job even though the data quality has improved. Manual editing is still required, largely to validate data that is being incorrectly automatically invalidated by either SIS or Qimera.



The XBT hand held launcher is being used due to poor performance of AXBT system. AOML will be contacted to pursue field support immediately.

A CTD test cast was done in a shallower area of Malumalu to test the manual firing of Niskin bottles at depth. Manual firing was unsuccessful for all depths specified. The altimeter (on the CTD) test was successful. CTD cast operations for tomorrow have been postponed.

The onshore EiTs had a successful first weekend of semi-autonomous watchstanding. They were able to troubleshoot basic Qimera software bugs like corrupt multibeam dynamic surfaces with consultation from onshore and offshore personnel. They continue to keep up with incoming bathy and bottom backscatter data in real time.

April 11

Mapping operations continued in the landslide area north of Ta'u. The TSG was secured for 30 minutes to patch a pipe that was leaking on a motor. Manual values were input into the EM302 at that time. Data quality remains good. Minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1703 and EX1704.

CTD troubleshooting.

EiTs continued to keep up with steady flow of multibeam data coming off the ship and are also focusing on processing backscatter data into mosaics. Line plans for mapping within Rose Atoll MNM bounds were revised to be more targeted to map only features and not surrounding benign seafloor in order to reserve more time to get to eastern seamounts at the American Samoa / Cook Islands boundary.

UNH CCOM conducted school tours, approximately 33 students came through in four groups throughout the day. As part of a larger STEM event, approximately 120 local elementary and middle school students toured the ECC today, OER mapping team members gave talks to very engaged students. Another 120 are expected on Thursday.

April 12

Mapping operations continued in the landslide area north of Ta'u. The line plan will be revised for tomorrow's operations to accommodate sewage tank repairs.



Line planning for Muliava Sanctuary unit completed. Two eastern seamounts at the edge of the American Samoan EEZ will be mapped. There is not enough time for the seamount within the Cook Island EEZ.

CET and ST continue to troubleshoot CTD.

Participating geologists Konters, Jackson, and Koppers have been contacted to provide web logs discussing initial results of mapping areas.

April 13

Mapping operations continued in the landslide area north of Ta'u. The line plan was revised to eliminate lines within 12nm of Rose Atoll for the next 18 hours due to MSD system troubleshooting. Data quality remains good, though swath widths are 5200m in 5000m of water. Engineers working on the sewage tank is producing random interference from hull reverberation throughout the day in all sonars. It is not continuous.

Sub-bottom profiler data is being processed for EX1704. Sub-bottom data processing for EX1703 was completed, and processing for EX1701 has commenced. Output products include shapefiles of tracklines and jpg images of sub-bottom data; both are part of data management plan and will be archived.

As part of a larger STEM event, approximately 120 local elementary and middle school students toured the ECC today, OER mapping team members gave talks to very engaged students. This was the second phase of the STEM event that started on Tuesday. OER mapping team members described realtime ocean exploration and the importance of seafloor mapping and ROV dives to the students.

EiT Claudia Thompson worked on her presentation for when she returns to American Samoa. Topics include: OER, CAPSTONE, EX1704, hydrography, free online training resources, and American Samoa maps.

Onboard EC doing a great job communicating needs for line plan changes.

April 14

Focused mapping north of Ta'u was completed. The next phase of focused mapping is the west side and southwest corner of the Rose Atoll Sanctuary boundary. The line plan was revised to eliminate all lines inside of 12nm of Rose Atoll due to sewage tank problems. Data quality remains good. Swath widths are 7500m in 4000m of water. Minimal processing for daily multibeam products. Daily products are being created.

EiTs continue training with bathy and backscatter processing.



**Ocean Exploration
and Research**

April 15

Focused mapping within of the Rose Atoll Sanctuary boundary outside 12nm of Rose Atoll. Lines west of Rose Atoll islands completed. En route to the feature in the southwest corner for focused mapping.

Data quality remains moderate to good. Swath width angles are slightly reduced when mapping in a north south direction due to sea states.

The new XBT launchers have been soldered and are currently in operation.

Onshore EITs maintain multibeam data processing and continue to work on focus maps for each survey area.

April 16

Focused mapping within of the Rose Atoll Sanctuary boundary outside 12nm of Rose Atoll. Lines southwest of Rose Atoll completed, no feature found. Lines completed southeast of Rose Atoll to extend feature mapped on EX1702 completed. The next phase is transit mapping to the eastern seamounts. Data quality remains moderate to good.

EITs continue to keep up with bathy, backscatter, and slope processing. Weekend shifts went smoothly. Focus maps for each survey area are being generated in ArcMap and will be ready for archiving and sharing at the end of the cruise.

April 17

Completed transit mapping to the eastern seamounts. Focused mapping at eastern seamount coverage to ~5000m. Planned lines are being shortened as required to optimize mapping. Data quality remains good, 9100m swath in 5100m of water.

EITs continued with ping editing bathymetry data and producing focus survey area maps.

April 18

Completed transit mapping and focused mapping over eastern seamounts. Transit mapping back to Rose Atoll eastern and northeastern feature development. Data quality remains good, 8700m swath in 5300m of water. Minimal processing for daily multibeam products. Daily products are being created.

New XBT hand launchers seem to have less failed casts, however communication issues remain within the CTD computer. CET Blessing and ST Wilkins are working together to plan a new computer configuration to resolve communication issues during summer dry dock.



EiTs continued to keep up with overall ping editing and focus maps of each survey area. EiT Claudia Thompson worked on her presentation, which will be used when she is the guest/main speaker at the Taiala O le Sami (Stewards of the Ocean) Youth Summit. Remote desktop access to the ship's network using the OMAO supplied laptop was attempted but ultimately failed today. We are able to VPN into the NOC onshore, but then cannot ping or RD to any IP addresses on the ship. CET reenabled the onshore login but this did not fix the problem. NOAA Electronics and Engineering Branch staff onshore is able to ping IPs on the ship, so current suggestion is that the user for the OMAO laptop is not on the correct user list to get ship access.

April 19

Focused mapping on eastern and northeastern features within Rose Atoll boundary. Line plan extended 70km coverage in eastern Rose Atoll to utilize extra survey time left over from faster than expected transit speeds from eastern seamounts.

Knudson has been freezing periodically this cruise. The remote access is lost to the EK60. When KVM-ing into the Knudson machine, the program is still frozen and does not respond. It seems to require a hard restart of the computer and reloading the configuration files from the EX1609 calibration cruise. Undetermined at this point if the display is just frozen or if the sonar is no longer pinging.

Data quality remains good, 8700m swath in 5300m of water. Minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1704. Processing for EX1701 is complete.

EiTs continue to conduct data processing onshore.

Eastern seamount mapping was completed, and preliminary maps for one of the two seamounts were generated.

Cruise wrap up meeting with ship to review accomplishments. Overall the cruise was a great success from a telepresence standpoint, with steady video and data flow to shore. Survey areas were impacted by weather and loss of 1 day for fueling. EiTs are well prepared to sail and experience life at sea as experienced junior watchstanders.

April 20

Focused mapping on eastern and northeastern features within Rose Atoll boundary was completed. Transit mapping began from the Vailulu'u area to a site 25nm offshore. A one to three hour window with minimal or no multibeam coverage was selected between the 25nm marks of American Samoa and Manua Islands for disposal of any food that does not comply



**Ocean Exploration
and Research**

with American Samoa customs and immigration regulations. Transit mapping toward the Samoan Clipper site will resume after disposing of food.

The EM302 is flagging seemingly good sounding as bad in particularly rough areas south of the island of Ta'u. POS COM1 dropout errors on the EM302 system were more prevalent yesterday and still seem to vary day-to-day with no definite resolution of the cause.

Minimal processing for daily multibeam products. Daily products are being created. Raw data EM302 files are being copied to the ForFTP folder and pushed to shore. Sub-bottom profiler data is being processed for EX1704.

Maps for the second eastern seamount were created (below). EITs are working on their profiles for the <http://oceanexplorer.noaa.gov/edu/explorer-in-training/welcome.html> page.

April 21

Completed transit mapping to the Samoan Clipper site. The Samoan Clipper site was mapped at reduced swath angles and slower survey speeds of 6.5 to 7.5 knots to increase resolution. Arrived to fuel pier in Pago Pago, AS, 0900 local.

All *.ALL and SEGY files have been processed for EX1704. The last daily product was created. A FMGT project of the Samoan Clipper site was created. Data is backed up to the cruise data folder and transferred to a portable drive, which will be shipped when reaching the mainland.

All bathy data is cleaned and gridded. EITs wrapped up final map projects.

12. References

OER, 2020. The 2017 NOAA Ship *Okeanos Explorer* Survey Readiness Report is forthcoming and will be available in the NOAA Central Library.

OER, 2017. The EX-17-04 Project Instructions can be obtained in the NOAA Central Library in the OER Institutional Repository at <https://repository.library.noaa.gov/view/noaa/14790> (last accessed 09/01/2020). The EX-17-04 Data Management Plan is an appendix of the project instructions.

OER, 2020. The EX-16-09 EK60 Calibration Report, which provides EK calibration values relevant to EX-17-04, is forthcoming and will be available in the NOAA Central Library.

Tozer, B. , D. T. Sandwell, W. H. F. Smith, C. Olson, J. R. Beale, and P. Wessel, 2019. Global bathymetry and topography at 15 arc seconds: SRTM15+, Accepted Earth and Space Science, August 3. <https://doi.org/10.1029/2019EA000658> (last accessed 10/1/2020).



**Ocean Exploration
and Research**

13. Appendix

Intern Products

An important component of telemapping cruises is the onshore training opportunities for Explorers-in-Training. The following maps were created during the cruise by two interns who were new to the sonar technology and data processing techniques used by OER. The following series of maps results from turning raw sounding data into cleaned bathymetric surfaces, bathymetric-derived slope surfaces, and bottom backscatter mosaics, and then using those surfaces to create summary maps of each focus survey area.

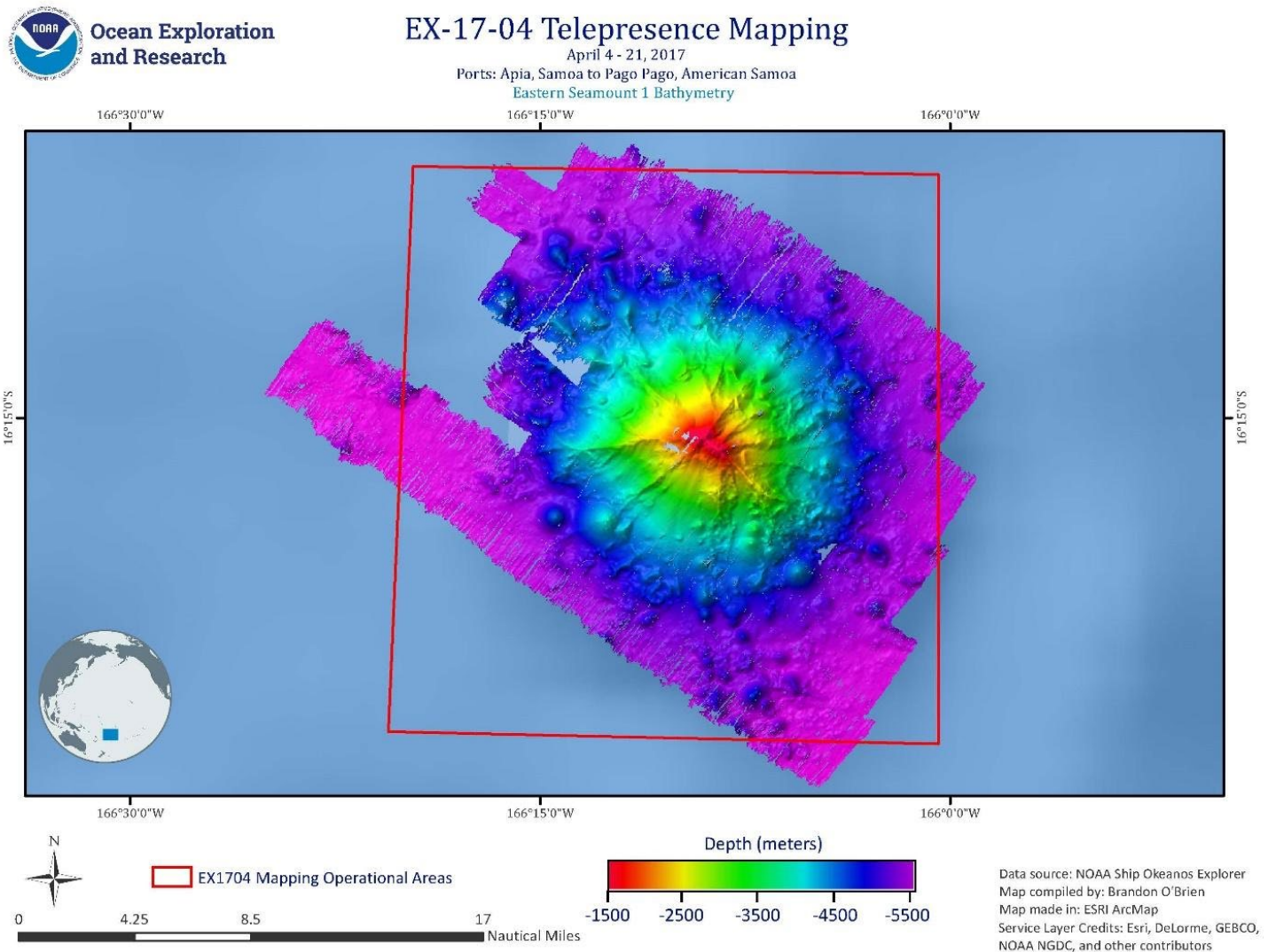


Figure 6. Focus map of 60 meter resolution gridded bathymetry collected at survey "Eastern Seamount 1".



EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Eastern Seamount 1 Slope

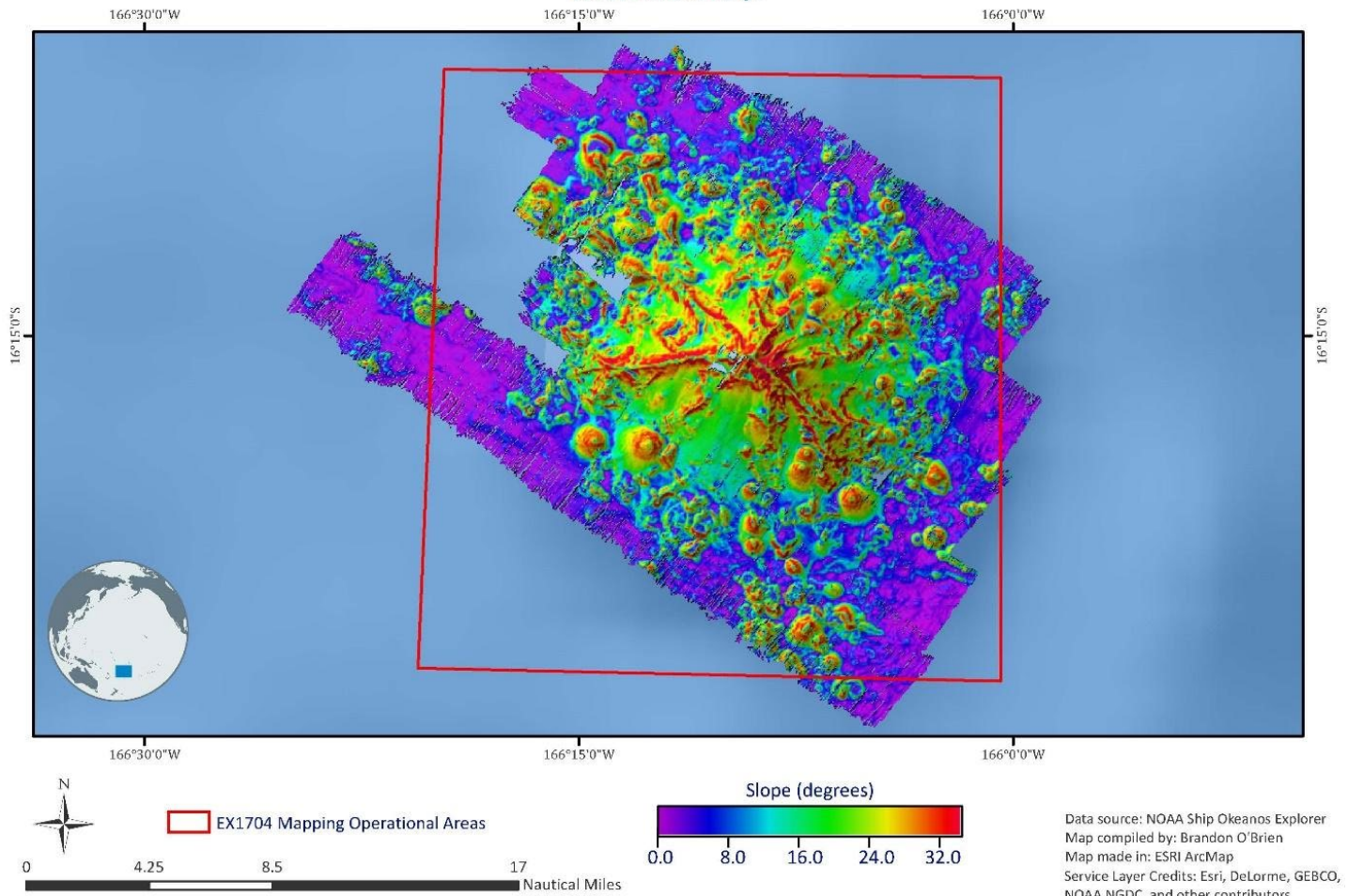


Figure 7. Focus map of 60 meter resolution gridded bathymetry colored by slope collected at survey "Eastern Seamount 1".





EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Eastern Seamount 1 Backscatter Mosaic

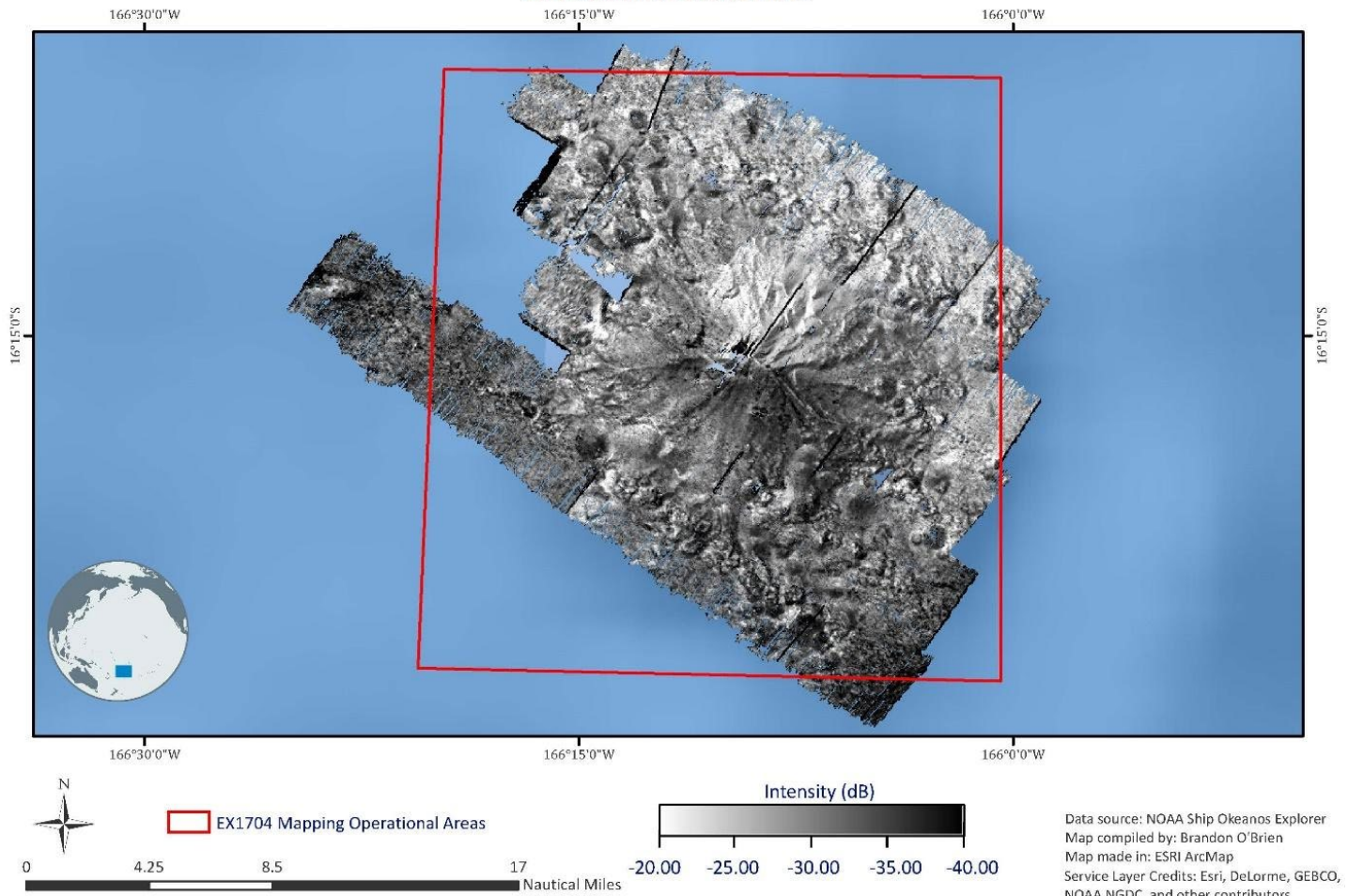


Figure 8. Focus map of 60 meter resolution gridded bottom backscatter collected at survey "Eastern Seamount 1".

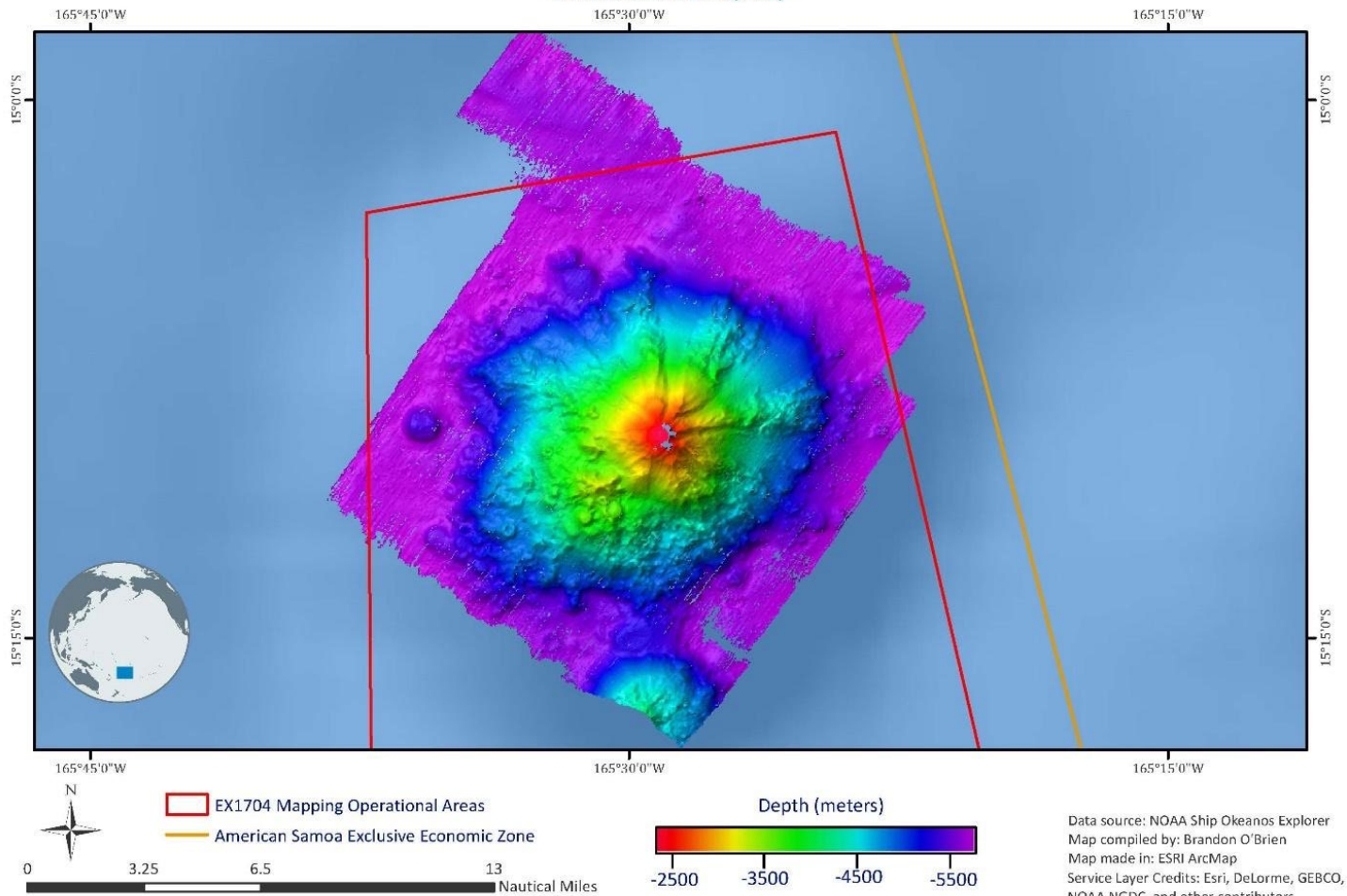




EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Eastern Seamount 2 Bathymetry



Data source: NOAA Ship Okeanos Explorer
Map compiled by: Brandon O'Brien
Map made in: ESRI ArcMap
Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Figure 9. Focus map of 60 meter resolution gridded bathymetry collected at survey "Eastern Seamount 2".





EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Eastern Seamount 2 Slope

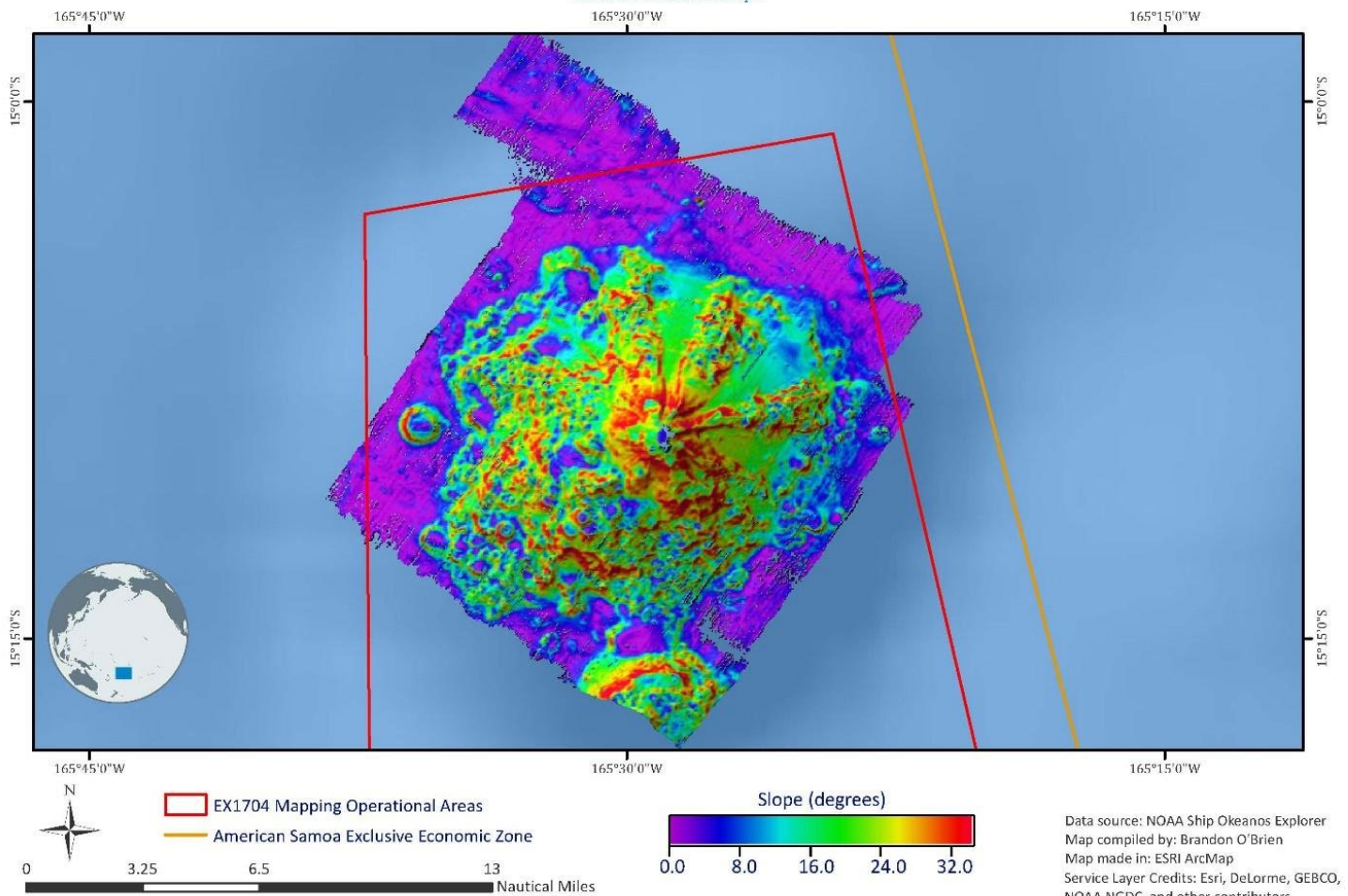


Figure 10. Focus map of 60 meter resolution gridded bathymetry colored by slope collected at survey "Eastern Seamount 2".





EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Eastern Seamount 2 Backscatter Mosaic

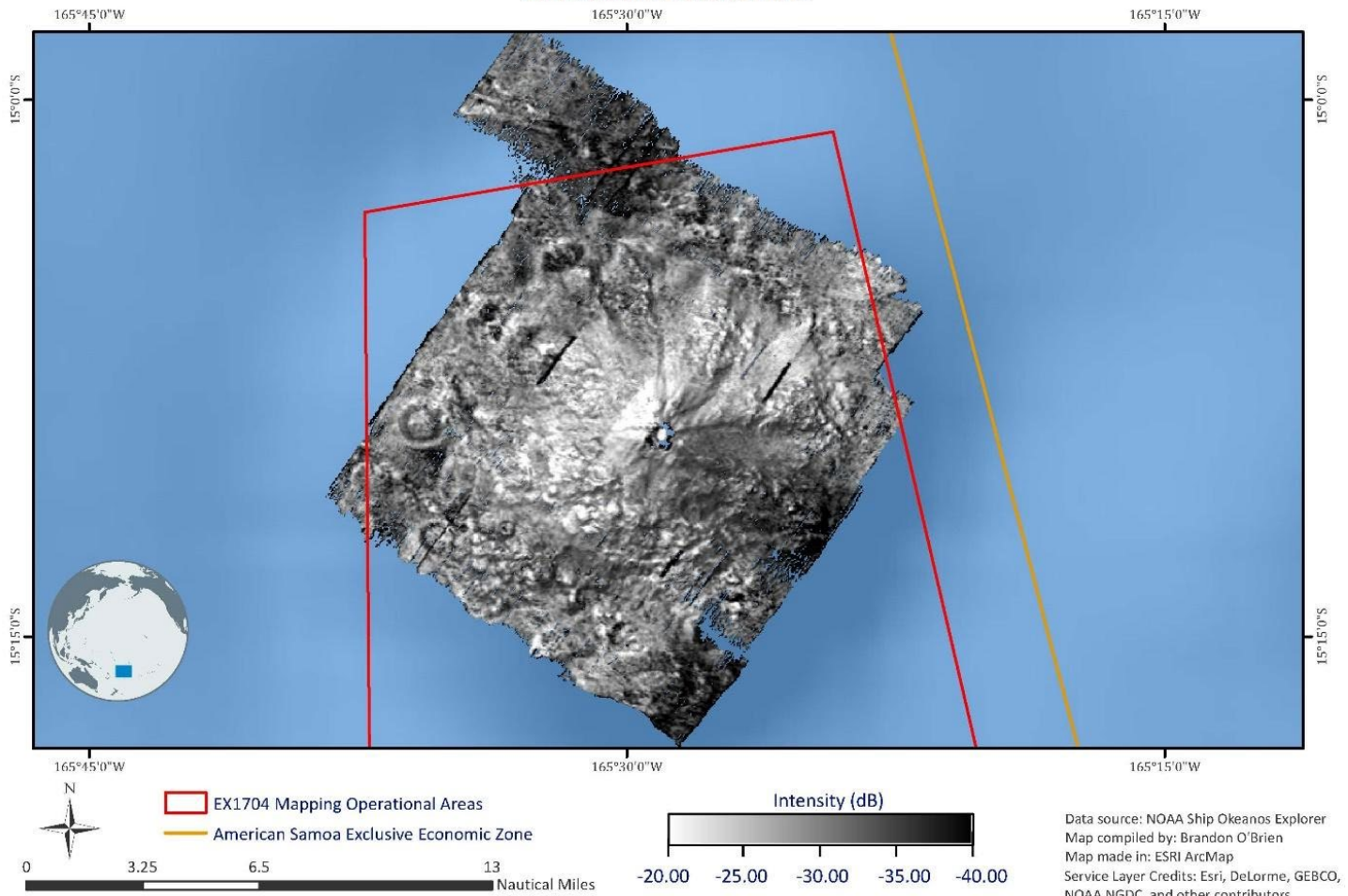


Figure 11 Focus map of 60 meter resolution gridded bottom backscatter collected at survey "Eastern Seamount 2".





EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Northern Samoa Bathymetry

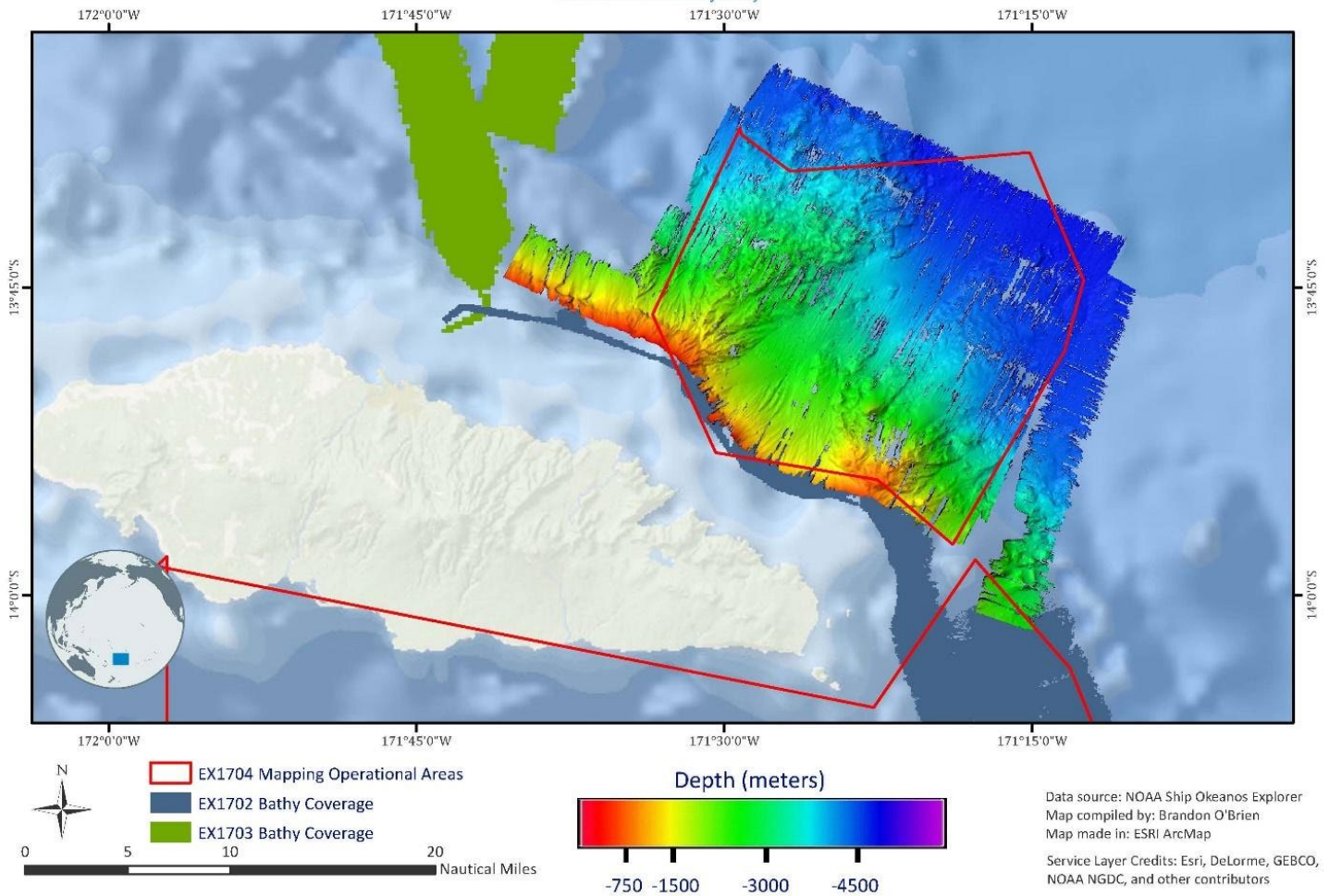


Figure 12. Focus map of 50 meter resolution gridded bathymetry collected on the north side of Upolu Island in Independent Samoa.





EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Northern Samoa Slope

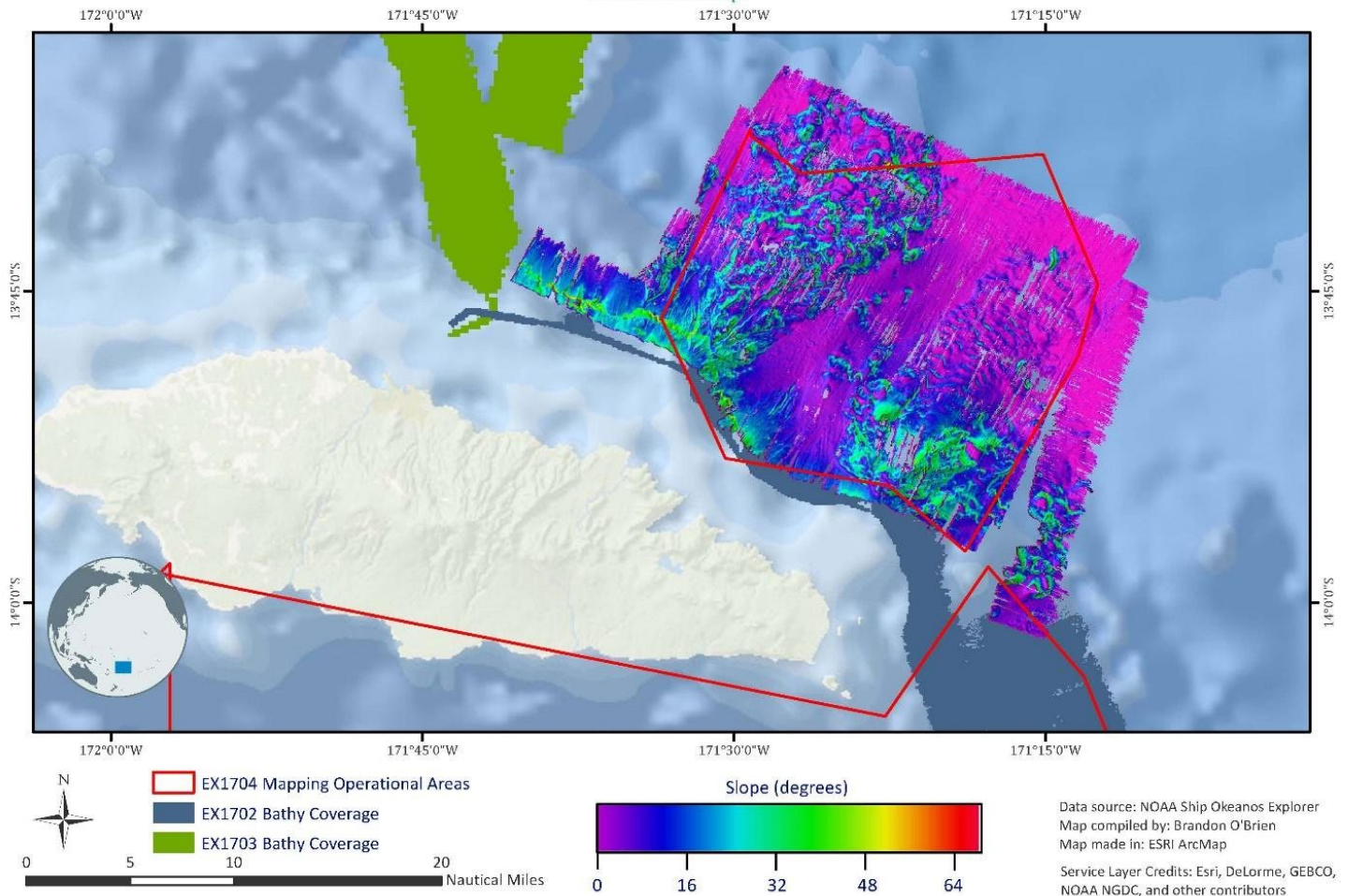


Figure 13. Focus map of 50 meter resolution gridded bathymetry colored by slope collected on the north side of Upolu Island in Independent Samoa.



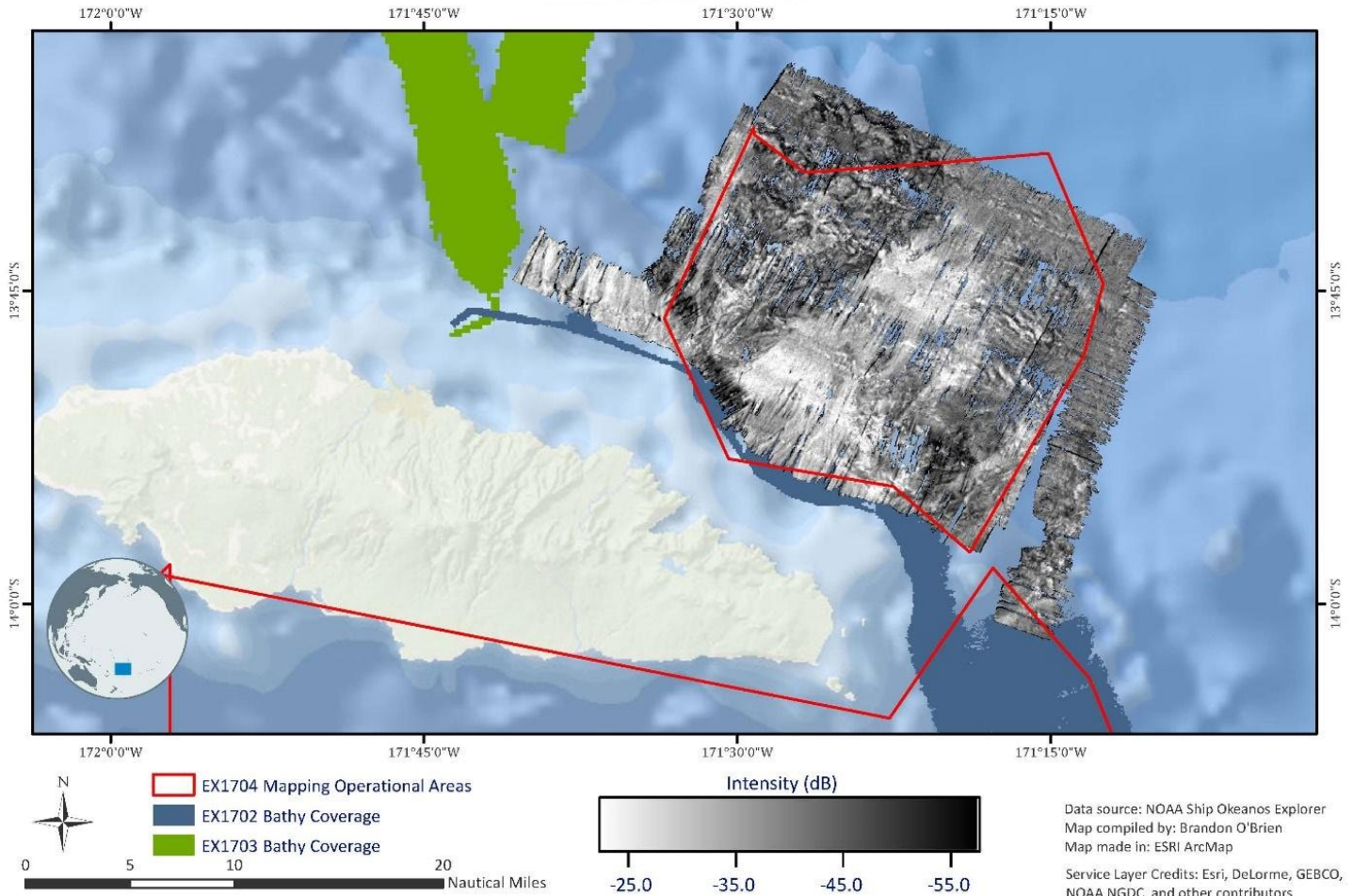


EX-17-04 Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Northern Samoa Backscatter Mosaic



Data source: NOAA Ship Okeanos Explorer
 Map compiled by: Brandon O'Brien
 Map made in: ESRI ArcMap
 Service Layer Credits: Esri, DeLorme, GEBCO,
 NOAA NGDC, and other contributors

Figure 14. Focus map of 50 meter resolution bottom backscatter data collected on the north side of Upolu Island in Independent Samoa.





Ocean Exploration
and Research

EX-17-04 Samoa Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Southern Samoa Bathymetry

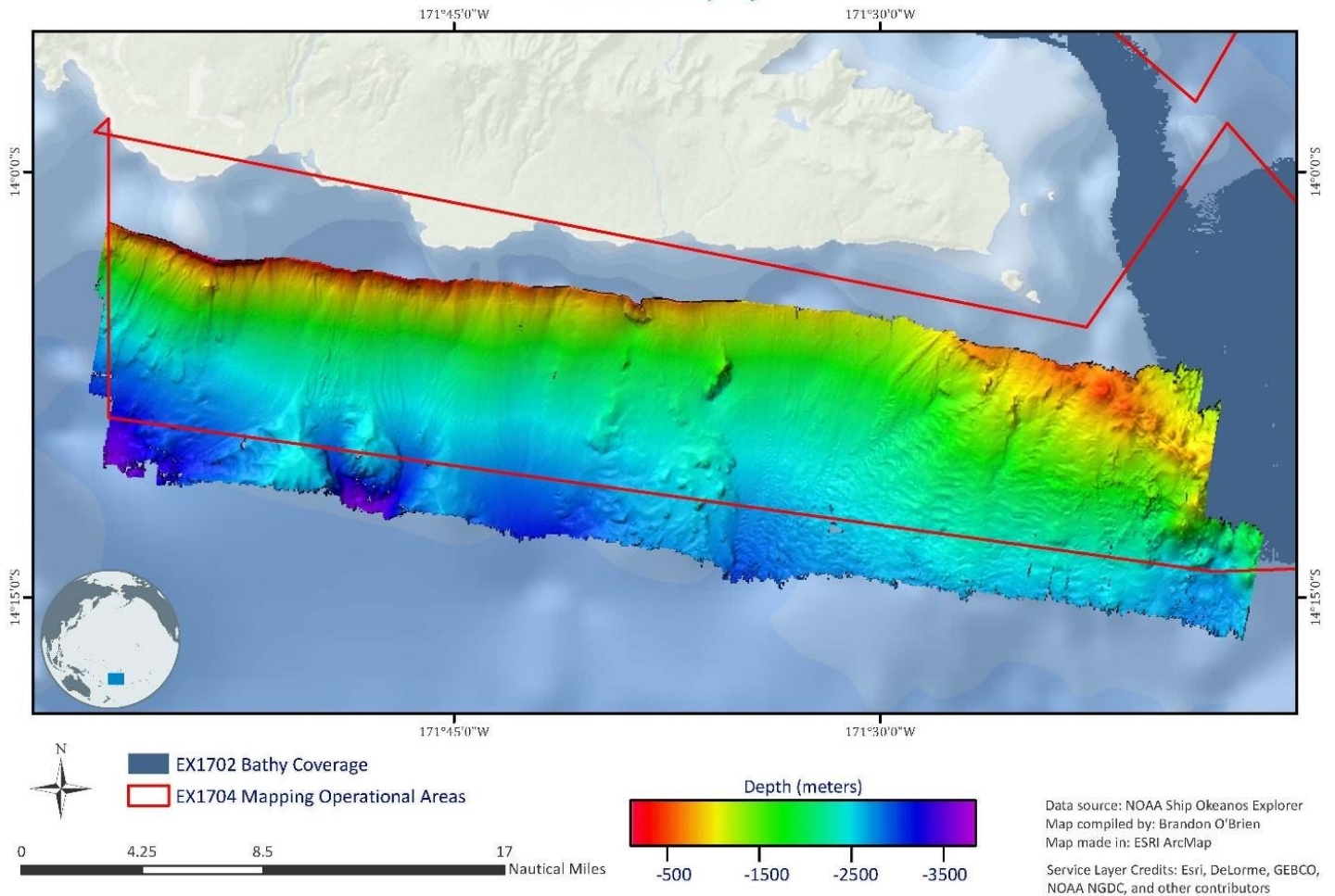


Figure 15. Focus map of 35 meter resolution gridded bathymetry collected on the south side of Upolu Island in Independent Samoa.



Ocean Exploration
and Research



EX-17-04 Samoa Telepresence Mapping

April 4 - 21, 2017
Ports: Apia, Samoa to Pago Pago, American Samoa
Southern Samoa Slope

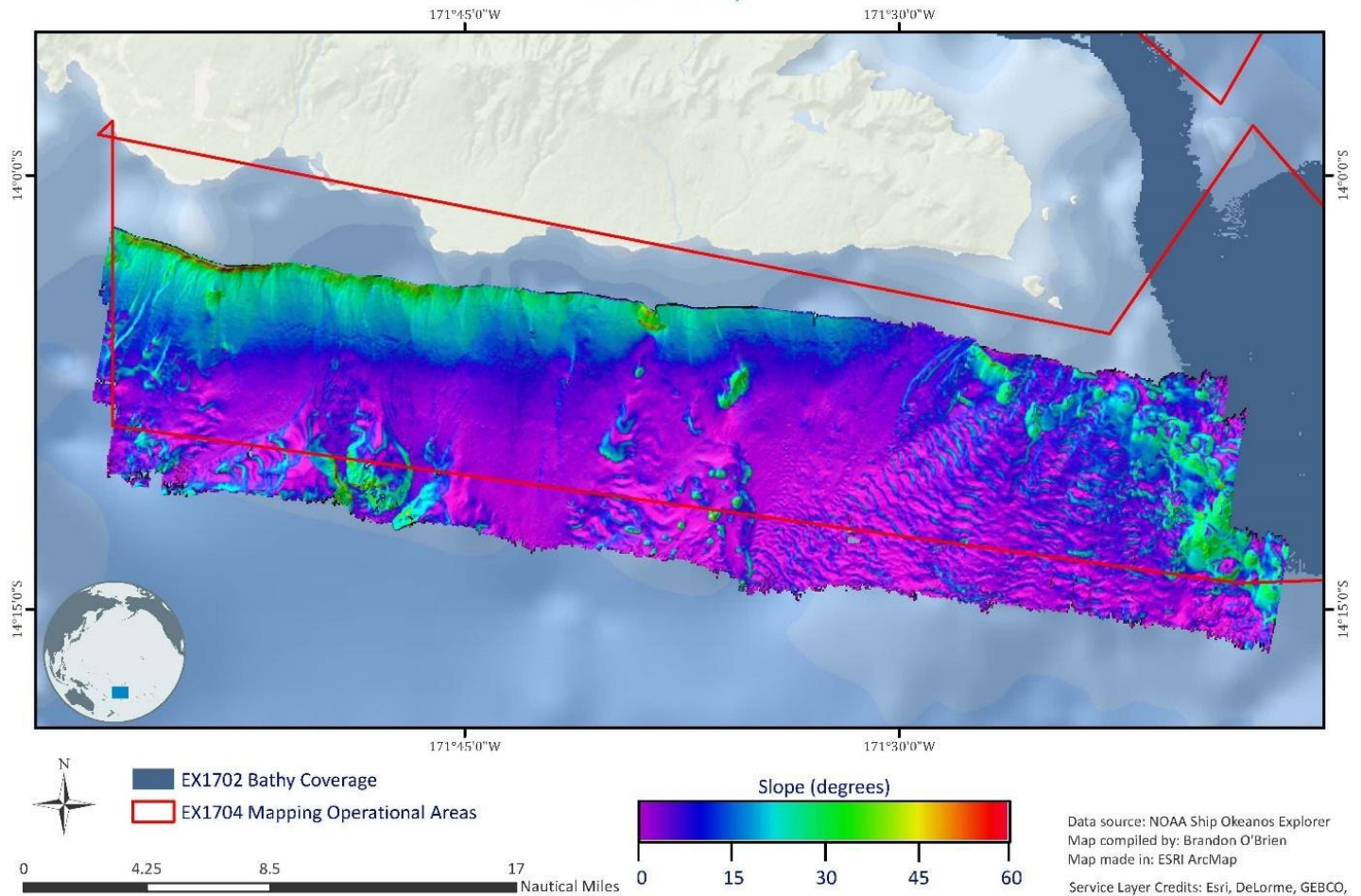


Figure 16. Focus map of 35 meter resolution gridded bathymetry colored by slope collected on the south side of Upolu Island in Independent Samoa.





EX-17-04 Samoa Telepresence Mapping

April 4 - 21, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Southern Samoa Backscatter Mosaic

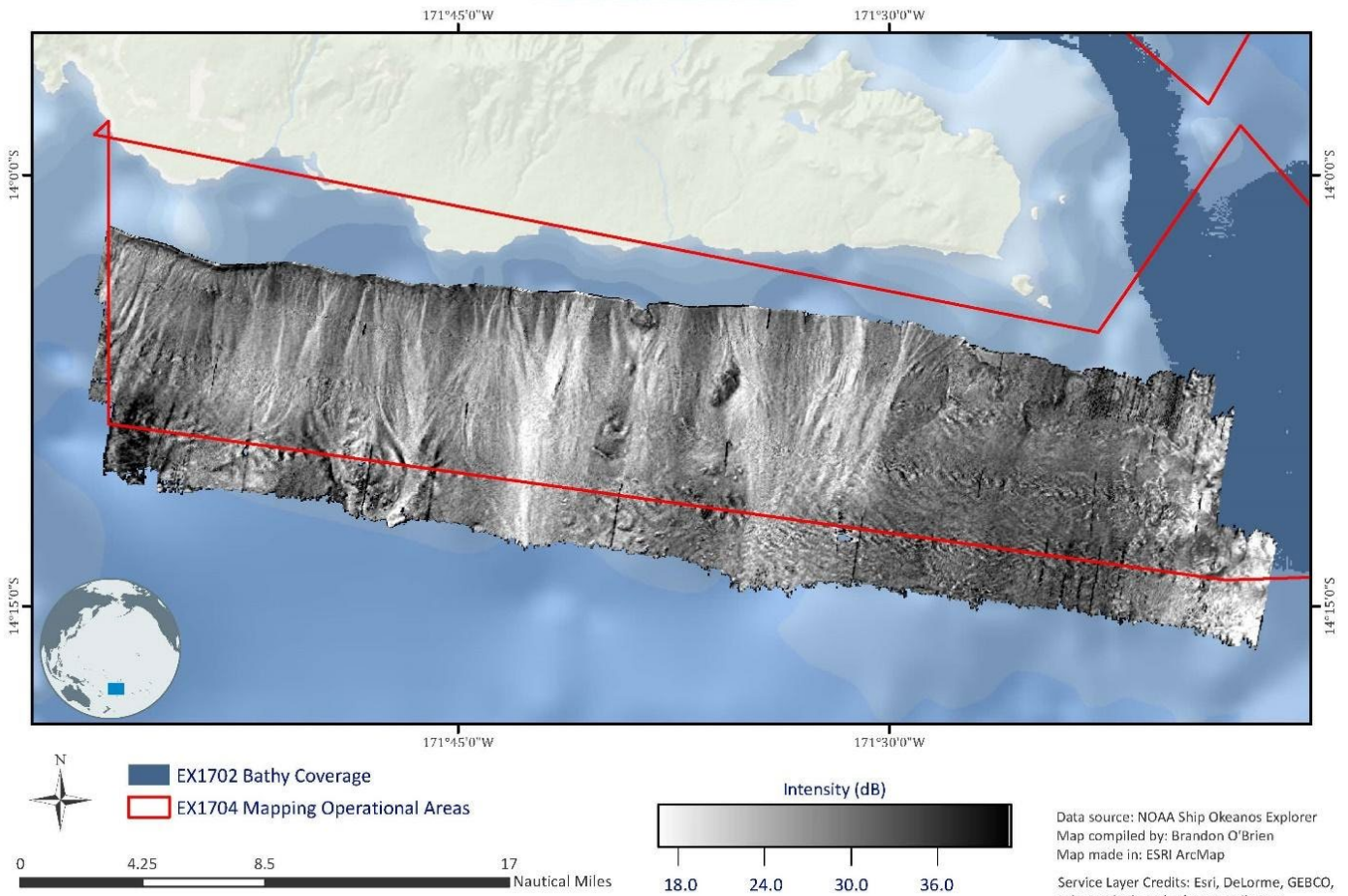


Figure 17. Focus map of 35 meter resolution bottom backscatter data collected on the south side of Upolu Island in Independent Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Tutuila South: Bathymetry

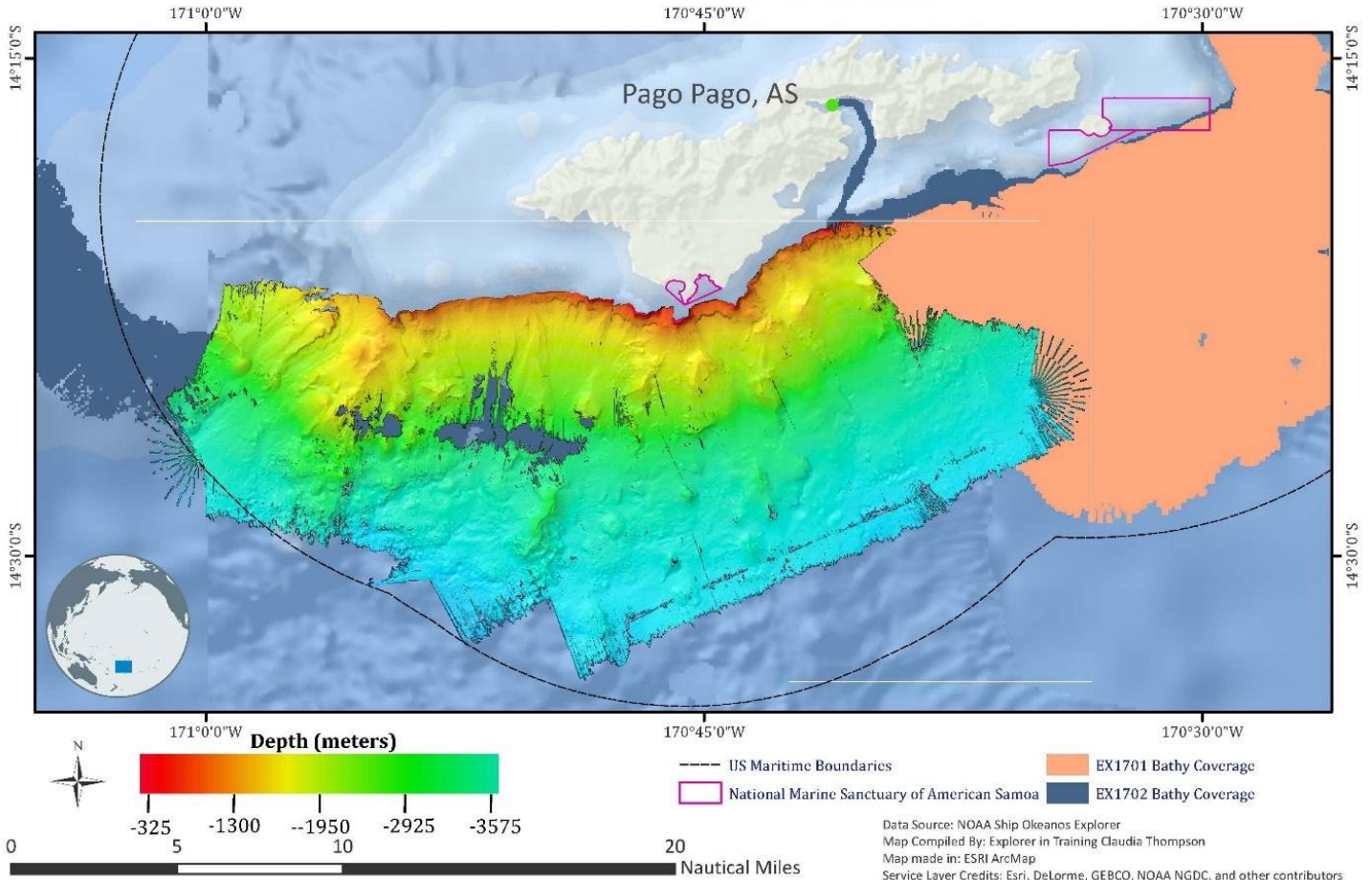


Figure 18. Focus map of 60 meter resolution gridded bathymetry collected on the south side of Tutuila Island in American Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Tutuila South: Slope Bathymetry

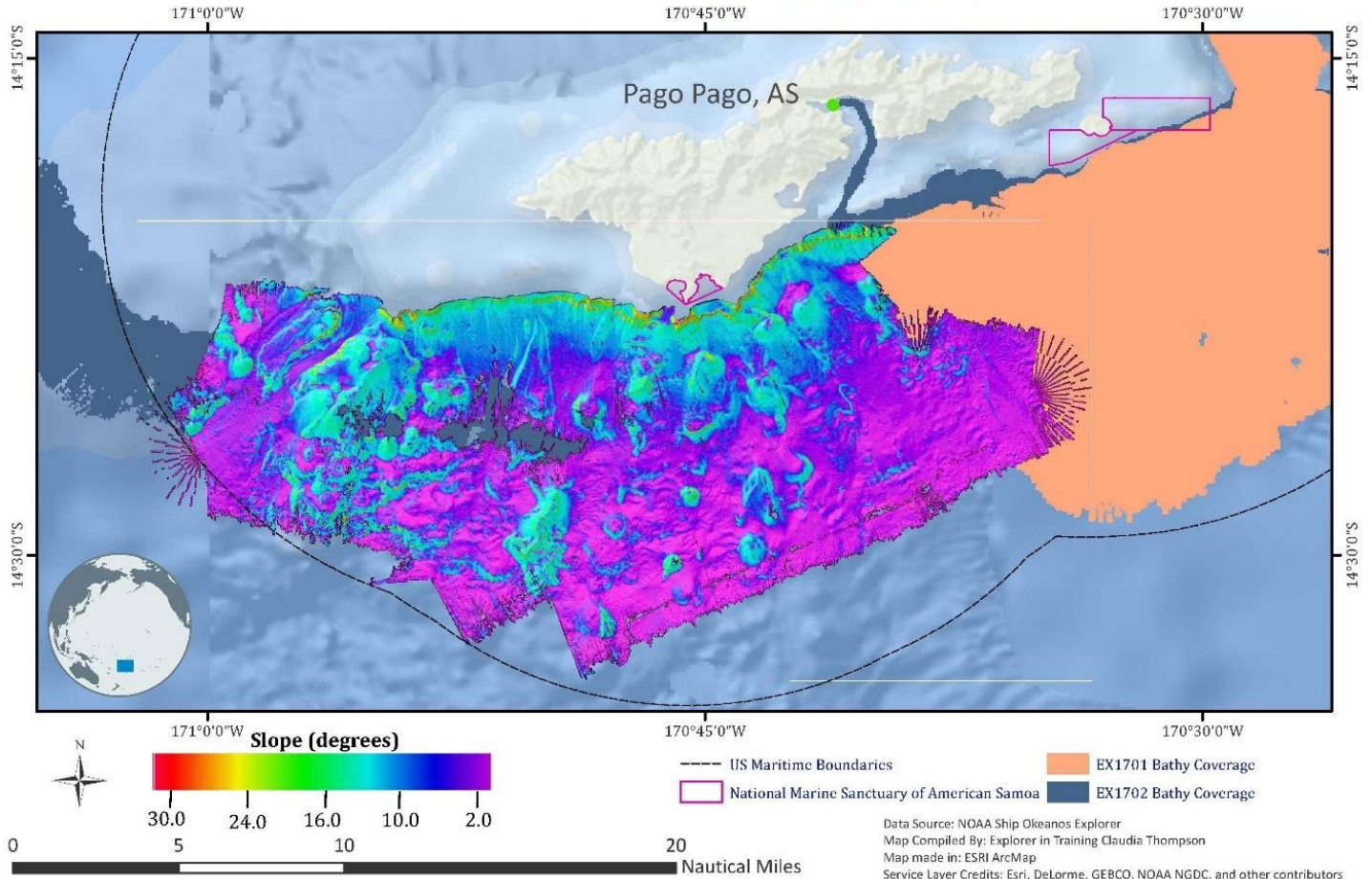


Figure 19. Focus map of 60 meter resolution gridded bathymetry colored by slope collected on the south side of Tutuila Island in American Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa

Tutuila South: Bottom Backscatter

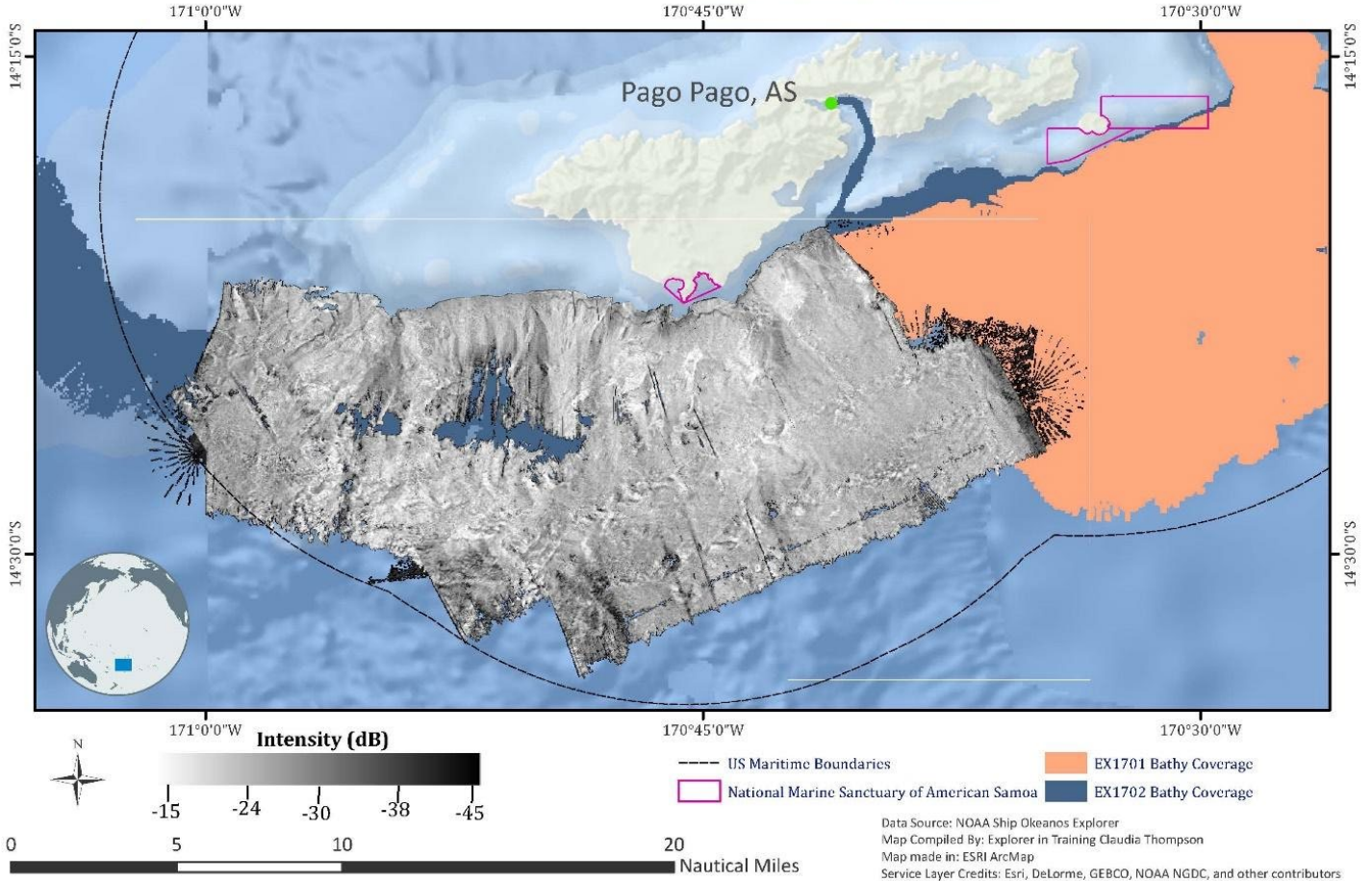


Figure 20. Focus map of 60 meter resolution bottom backscatter data collected on the south side of Tutuila Island in American Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Rose Atoll Marine National Monument: Bathymetry

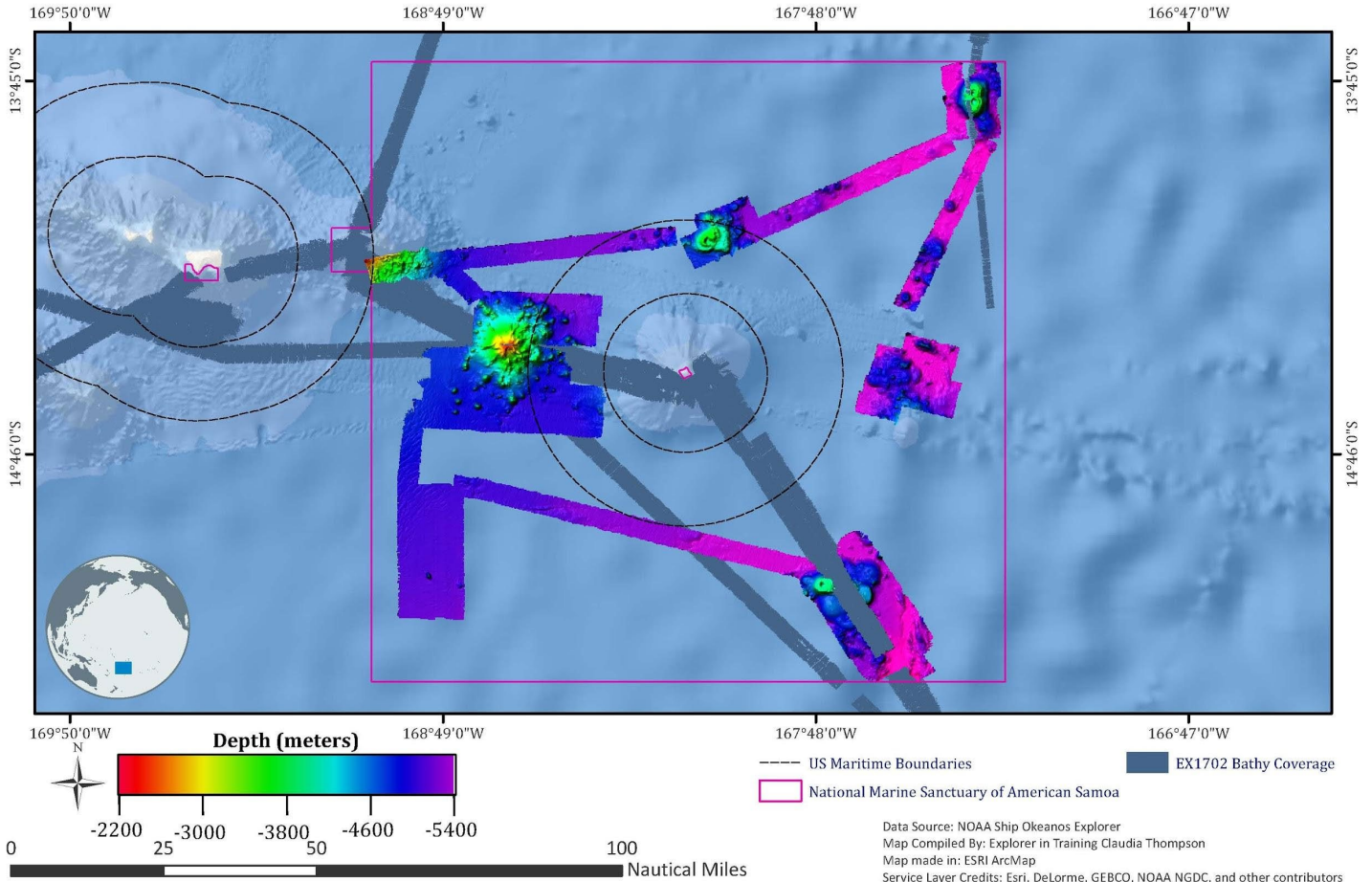


Figure 21. Focus map of 60 meter resolution gridded bathymetry collected within the National Marine Sanctuary of American Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Rose Atoll Marine National Monument: Slope Bathymetry

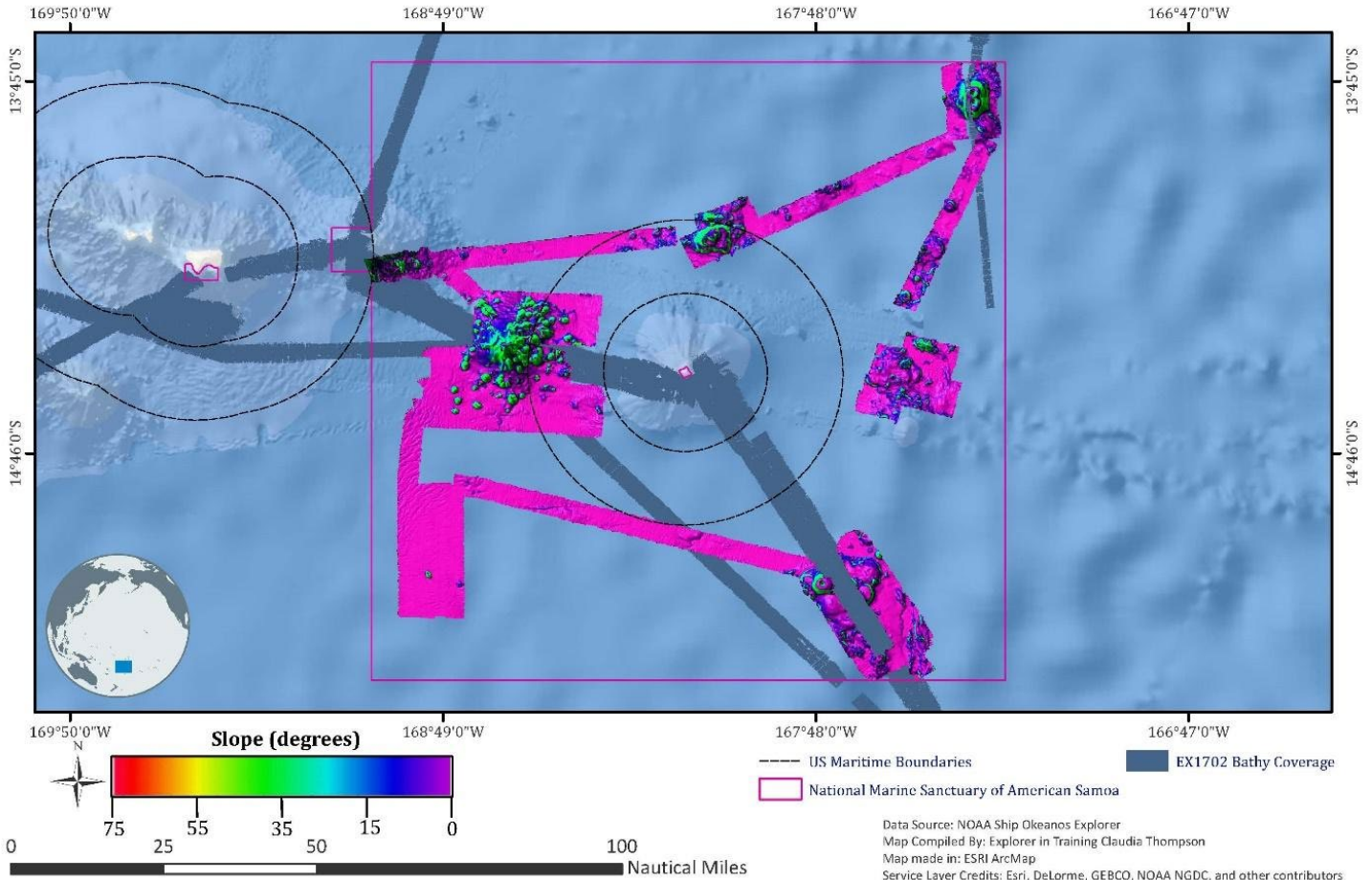


Figure 22. Focus map of 60 meter resolution gridded bathymetry colored by slope collected within the National Marine Sanctuary of American Samoa.





EX-17-04 Telepresence Mapping

April 4 - 20, 2017

Ports: Apia, Samoa to Pago Pago, American Samoa
Rose Atoll Marine National Monument: Bottom Backscatter

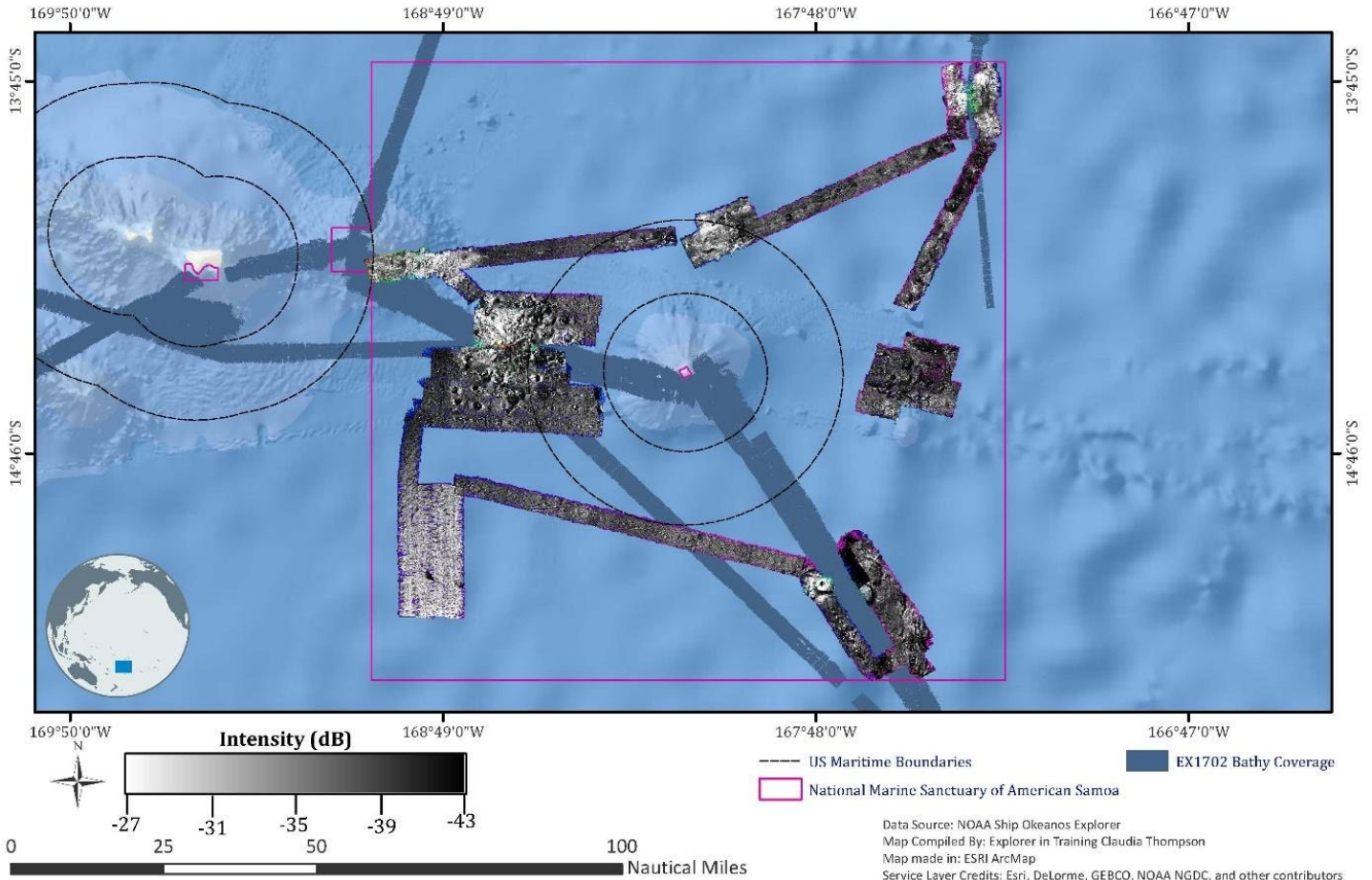


Figure 23. Focus map of 60 meter resolution bottom backscatter collected within the National Marine Sanctuary of American Samoa.



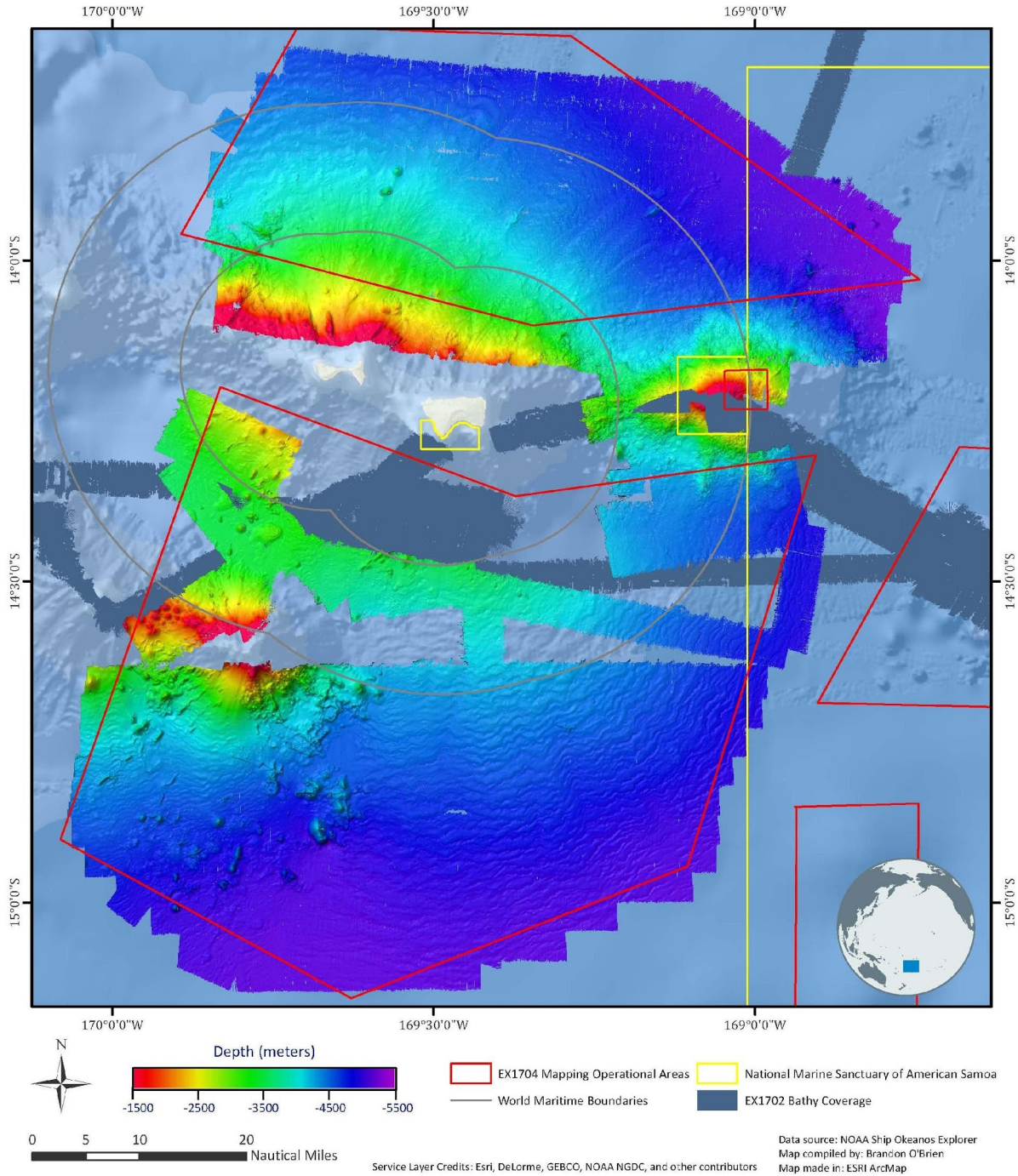


Figure 24. Focus map of 60 m resolution gridded bathymetry collected near Ta'u Island, American Samoa.



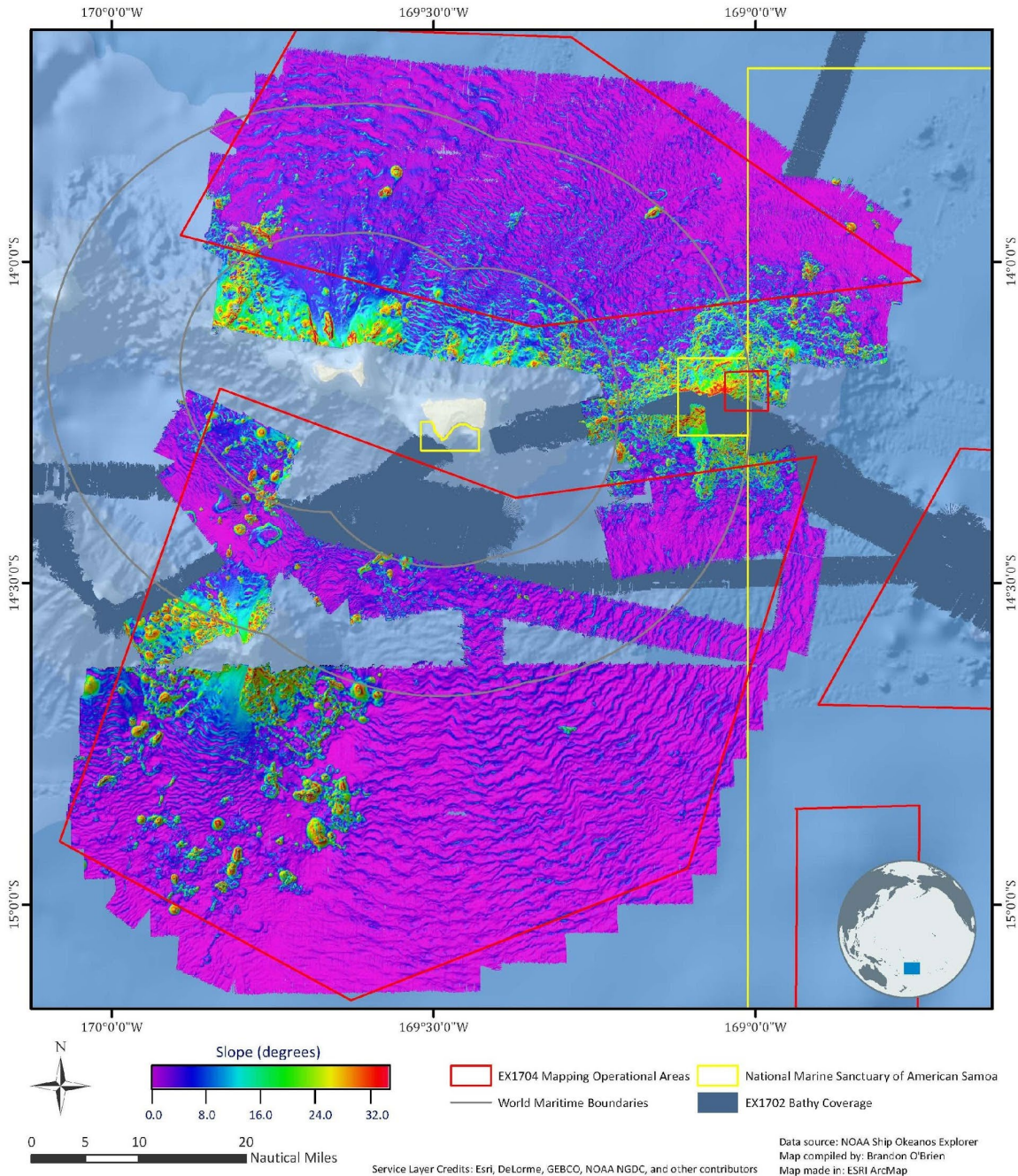


Figure 25. Focus map of 60 m resolution slope bathymetry collected near Ta'u Island, American Samoa. Image created in ArcMap.





Ocean Exploration and Research EX-17-04 Telepresence Mapping

April 4 - 21, 2017
 Ports: Apia, Samoa to Pago Pago, American Samoa
 Tau Backscatter Mosaic

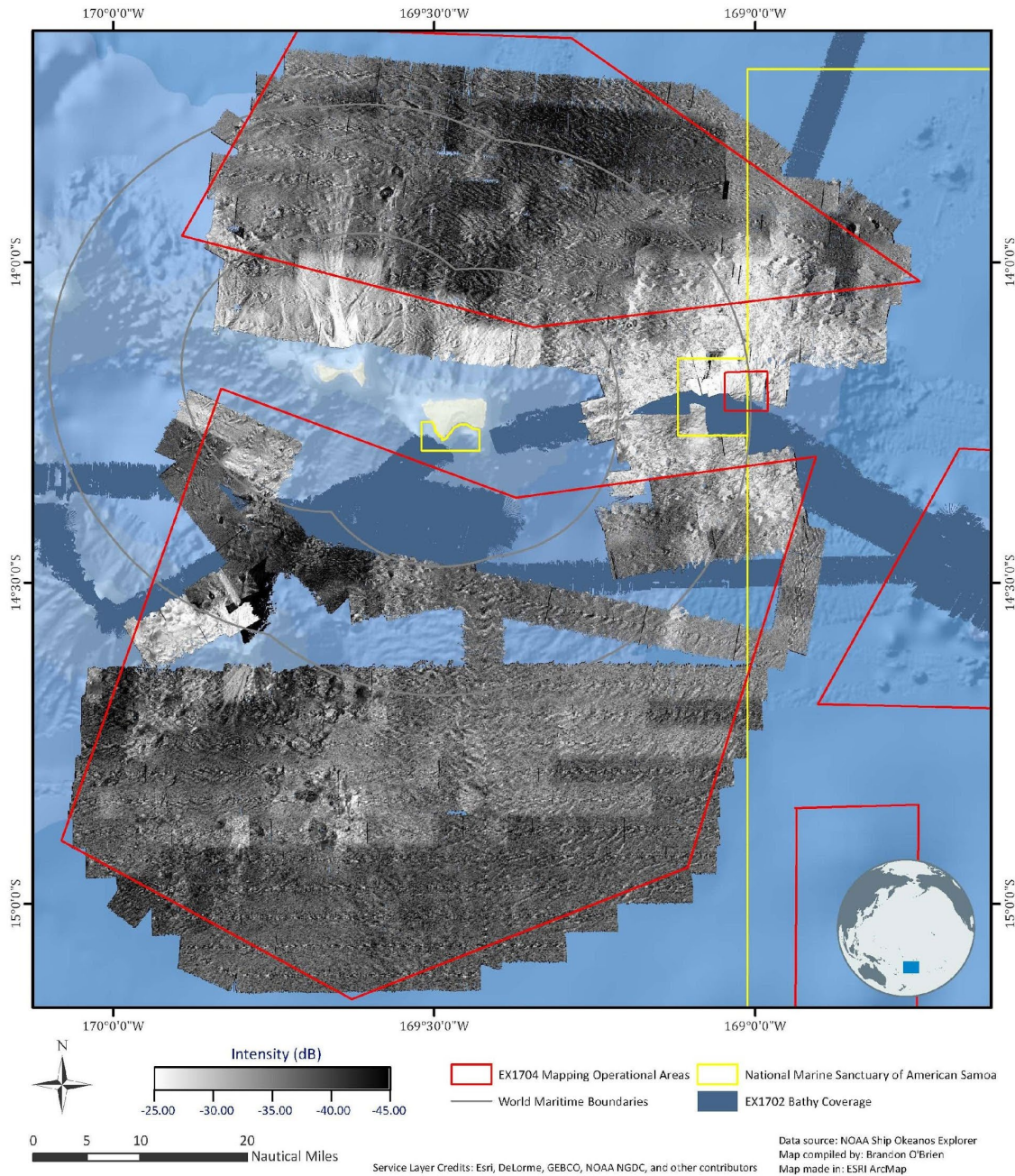


Figure 26. Focus map of 30 m resolution bottom backscatter collected near Ta'u Island, American Samoa. The data in this map was not corrected for changes in power and gain settings used during data collection.



Ocean Exploration and Research