SEISMIC EARLY CAREER CHIEF SCIENTIST TRAINING CRUISE 2017

Cascadia Margin (RR1718)

R/V Roger Revelle

September 25 – October 2, 2017

Seismic Early Career Chief Scientist Training Cruise Participants & Masako Tominaga, Anne Trehu, Mitch Lyle, Gregory Mountain, Rebecca Fowler, Kathy Davenport, and Ben Phrampus.

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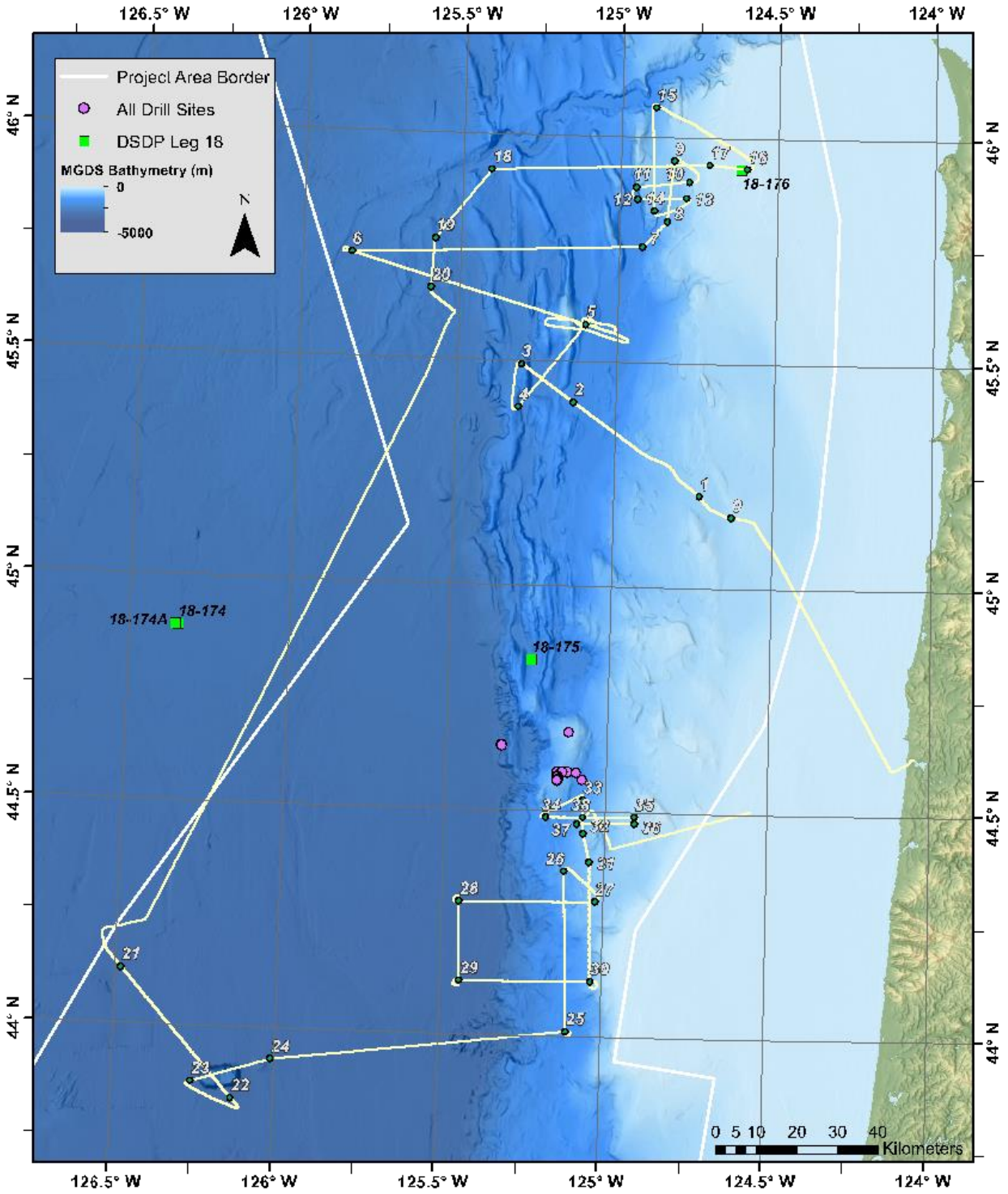
Project Synopsis

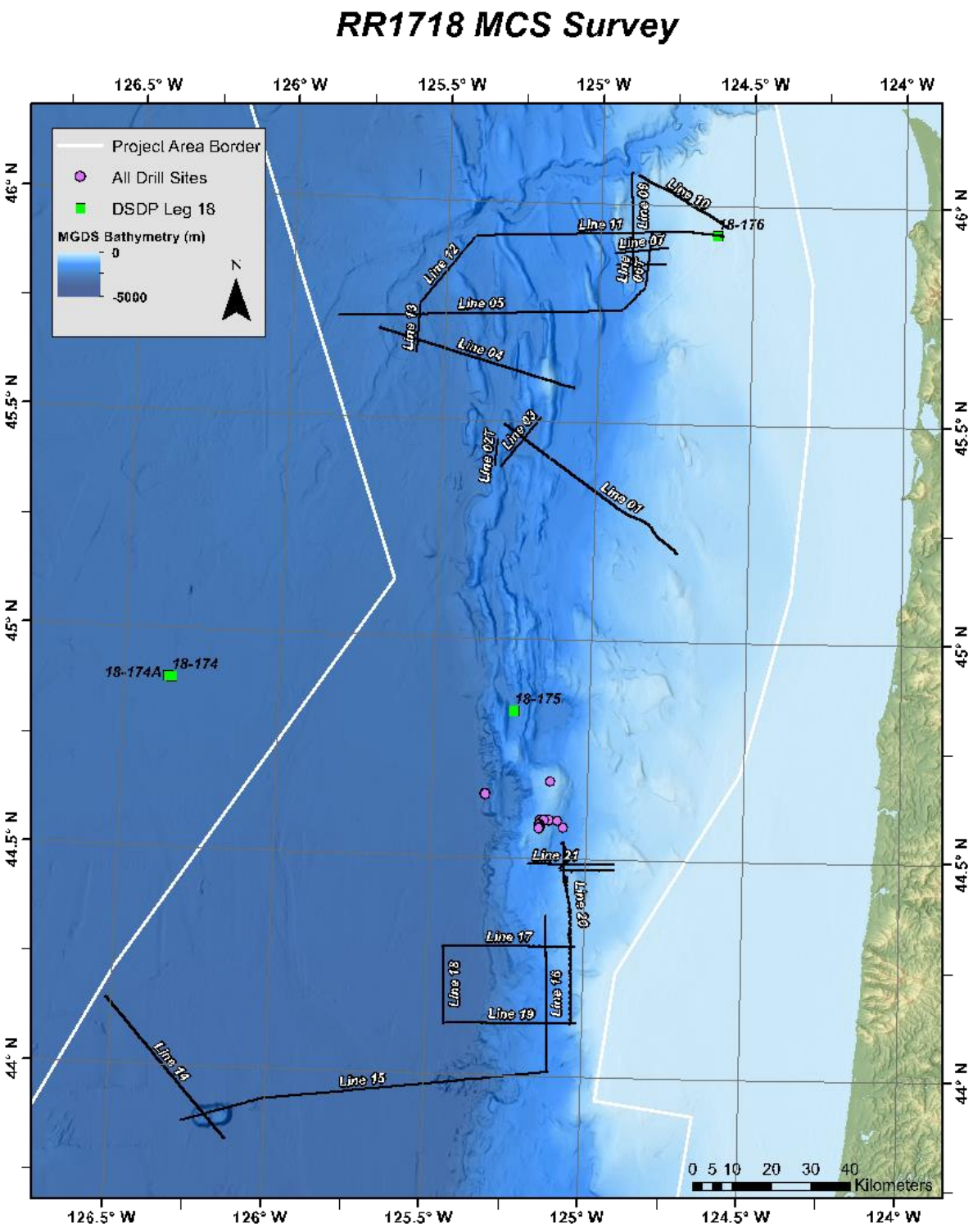
Results of the University-National Oceanographic Laboratory System (UNOLS) Marine Seismic Questionnaire (MSQ) in 2016 point to the value of an early career scientist Multi-Channel Seismic (MCS) chief scientist training cruise. Given the fact that approximately half of the MSQ respondents expressed interest in using seismic data for their research, while admitting a lack of knowledge and hands-on experience in acquiring and processing such data, we conducted a 15-day MCS training program that includes 7 days of at-sea seismic data acquisition to increase the number of early career scientists (ECS) experienced in marine seismology and to demonstrate the value of the Scripps Institution of Oceanography portable MCS system, a UNOLS facility.

Our proposed survey regions are on the active continental margin of the west coast of the United States, where a variety of sedimentary and tectonic settings are available, thus providing targets of interest to a wide range of participants. At the extended continental margin off the coast of Oregon, the seismic reflection profiles that would be acquired, processed, and archived from this cruise can be used to image the Juan de Fuca subducting plate and the Astoria Fan, as well as accretionary ridges hosting gas hydrate and pockets of hemipelagic sediment containing paleoclimate and paleoceanographic information. Our targets have implications for addressing important societally relevant questions, such as earthquake hazards and paleoclimate records in basins. We made all the data open to the public for a broader community to augment on-going and near-future science (see the below links).

The training program consisted of three parts: the pre-cruise webinars and application process, the cruise, and the post-cruise interpretation workshop. Webinars prior to the cruise to expose the participants to the fundamentals of active source marine seismology, to provide the scientific background needed to plan the upcoming survey effectively, and to introduce the participants to *open source* processing and interpretation tools. The webinars also covered Proposal Writing and Data Management training. We solicited applications, including a maximum 2-page scientific proposal, after the webinar series. After selection, participants further discussed their cruise plans with PI team over the course of July-August 2017; then, during a 2-day workshop immediately before the cruise, the participants finalized and presented the cruise plan. During the short, 7 day cruise, each participant took turn servicing the project as a chief scientist while learning how to operate an at-sea science expedition collaboratively with other PIs. Each participant contributed to the entire team walking off the ship with post-stack time migrated data, as well as writing a cruise report collaboratively. After the conclusion of the cruise, the science party members participated in a 2-day data interpretation workshop with computer-based visualization software, where research intents were hashed out and agreed upon.

RR1718 Cruise Track




RR1718 MCS Survey
126.5° W
126° W
125.5° W
125° W
124.5° W
124° W
46° N
45.5° N
45° N
44.5° N
44° N
Project Area Border
All Drill Sites
DSDP Leg 18
MGDS Bathymetry (m)
0
-5000
N
Line 10
Line 09
Line 11
Line 07
Line 08
Line 12
Line 13
Line 05
Line 04
Line 02T
Line 03
Line 01
18-176
18-174A
18-174
18-175
Line 21
Line 20
Line 17
Line 18
Line 16
Line 19
Line 14
Line 15
0 5 10 20 30 40
Kilometers

Data Archive and Access:

All the seismic data are unrestrictedly available at:
http://www-udc.ig.utexas.edu/sdc/cruise.php?cruiseIn=rr1718
The seismic data DOI is: 10.1594/IEDA/500194
http://www-udc.ig.utexas.edu/sdc/DOI/datasetDOI.php?datasetuID=500194
The underway data are unrestrictedly available at:
http://www.marine-geo.org/tools/search/entry.php?id=RR1718
Cruise DOI is: 10.7284/907830

Acknowledgement

PIs and the Science Party of the RR1718 cruise thank National Science Foundation (NSF), Scripps Institute of Oceanography Shipboard Science Support Group, the Shipboard Geophysics Team lead by Lee Ellet, and the University National Oceanographic Laboratory System office at Univ. of Rhode Island, for their incredible support from the planning stage of the proposed seismic ECS program, to executing the program, and to following up on the program results. PIs and the Science Party of the RR1718 would like to thank the Captain and crew of *R/V Revelle* during the RR1718 cruise for their unfathomable understanding of the program goals and incredible patience to accommodate the **19** Early Career **Chief Scientists** (and the **3** sailing PIs) in achieving the goals. This program was funded by NSF-OCE17-14168 (Tominaga) and NSF-OCE17-14413 (Trehu and Lyle).

1. Personnel

The personnel for RR1718 can be broken down into four groups: the science party, 25 individuals onboard and 26 post-cruise; marine science technicians, 5 individuals; protected species observers, 3 individuals; and ship's crew, 21 individuals. On this cruise there were a total of 54 participants.

1.1. Science Party

The Science Party included four principle investigators, three of which who were onboard, two post doctorate mentors, 19 early career scientists, and one outreach specialist.

1.1.1. Principal Investigators

Mitch Lyle, Oregon State University (Co-chief Scientist)
Greg Mountain, Rutgers University
Masako Tominaga, Texas A&M University (Chief Scientist)
Anne Trehu, Oregon State University (Co-chief Scientist)

1.1.2. Post Doctorate Mentors

Kathy Davenport, Oregon State University
Benjamin Phrampus, Oregon State University

1.1.3. Early Career Scientists

Collin Brandl — M.S. student, University of New Mexico
John DeSanto — Ph.D. student, Scripps Institution of Oceanography
Irina Filina — Assistant Professor, University of Nebraska at Lincoln
Casey Hearn — Ph.D. student, University of Rhode Island
Brandi Lenz — Ph.D. student, Ohio State University
Ashley Long — Ph.D. student, Coastal Carolina University
Estefania Ortiz — M.S. student, Texas A&M University
Brendan Philip — Ph.D. student, University of Washington
Brendan Reilly — Ph.D. student, Oregon State University
Valerie Sahakian — postdoc, USGS
Jessie Saunders — Ph.D. student, Scripps Institution of Oceanography
William (John) Schmeltz — Ph.D. student, Rutgers University
Emily Schottenfels — Ph.D. student, Boston University
Srisharan Shreedharan — Ph.D. student, Penn State University
Kittipong Somchat — Ph.D. student, Texas A&M University
Parker Sprinkle — M.S. student, North Carolina State University
Maureen Walczak — postdoc, Oregon State University
Alexis Wright — Ph.D. student, USGS/Colorado School of Mines
Subbarao Yelisetti — Assistant Professor, Texas A&M University—Kingsville

1.1.4. Outreach Specialist

Rebecca Fowler, Science Writer

1.2. Marine Science Technicians

Lee Ellett — Geophysical engineer, Scripps Institution of Oceanography
John Collins — Geophysical engineer, Scripps Institution of Oceanography
Kolby Pedrie — Geophysical engineer, Scripps Institution of Oceanography
Keith Shadle — Senior resident technician, Scripps Institution of Oceanography
Jon Meyer — Computer technician, Scripps Institution of Oceanography

1.3. Protected Species Observers (PSO)

Meike Holst — Environmental research associates, LGL Limited (Lead PSO)
Patrick Abgrall — Environmental research associates, LGL Limited
Lauren Bisson — Environmental research associates, LGL Limited

1.4. Ship's Crew

Chris Curl— Captain
Dave Herman — Chief engineer
Eric Wakeman — Chef mate
Brian Kane— First Assistance engineer
Eric Wakeman— First mate
Heather Galiher— Second mate
John Clifford — Second Assistance engineer
Patrick — Third Assistance engineer
Jay Erickson — Senior cook
Mike Brown— Marine cook
Ed Keenan — Bosun
Joe Martino — AB
Brian Neillis — AB
Tobi Fisher — AB
Harry Smith — Electrician
Ton Brown — Oiler
Gio Vargas — Oiler
Bob Juhasz — Oiler
Jake Pate — Oiler
Matt Wilson — OS
Malcom Donohoe — Wiper

2. *R/V Revelle* Systems

The Revelle Sytems can be broken down into two categories: ship navigation and shipboard scientific systems.

2.1. Ship Navigation Systems

The scientific metadata on the R/V Revelle use navigation data from two systems with integrated double-difference GPS and motion reference unit (MRU) or interial motion unit (IMU) data. The main navigation system for the multibeam and subbottom profiler data is the Kongsberg Seapath 330+. This system has an internal dual-frequency GNSS receiver for dual-frequency GPS antennae mounted on the ship's aftermast, and processes these for double-differenced positions. Integrated with this time series are data from the Seatex MRU 5+ MK-II, mounted beneath the main lab by the Engine room entrance. The Seapath 330+ incorporates these data with a processing unit and human machine interface (HMI) unit in the computer lab to provide precise positioning for multibeam motion corrections. Roll and pitch accuracy are 0.008 degrees RMS, heading accuracy is 0.04 degrees RMS, and position accuracy is 0.5 m RMS with the DGNSS and GLONASS satellites.

In addition to the Seapath 330+ there is an Ixblue Phins III system which incorporates data from GPS antennae with a trimble SPS351 receiver and a Phins IMU mounted next to the Seatex MRU. This provides redundancy to the positioning information of the Seapath 330+.

2.2. Shipboard Scientific Systems

The following sections describe the four scientific systems: sub-bottom profiler, multibeam, ADCP, and MCS System.

2.2.1. Sub-bottom Profiler

Sub-bottom profiling data are collected with an array of 12 TR-109 transducers operating at 3.5 kHz, and two 12 kHz transducers operated separately. The Knudsen 3260 deck unit is the primary system for the multibeam and sub-bottom profiling data, with the 320B/R backup.

2.2.2. Multibeam

The multibeam data onboard the R/V Revelle are collected with the Kongsberg EM122 system. Transducers and receivers are mounted on the hull. The transducers are modular linear arrays in a Mills cross configuration, available in 0.5, 1, 2, or 4 degree resolution. The receive array is perpendicular to the transmitter array and is available as 1, 2, or 4 degrees. The EM122 operates at a 12 kHz frequency, with dual swath and 432 soundings per swath. The depth range of this system is 20 to 11000 m, with swath width up to 6 times water depth per 30 km.

2.2.3. ADCP

Onboard Acoustic Doppler Current Profiling (ADCP) data are collected with a Teledyne RDI Ocean Surveyor ADCP with three frequency modes: 38 kHz, 75 kHz, and 150 kHz; providing 24, 16, and 8 meter cell sizes respectively. The University of Hawaii's UHDAS software is used to run the profilers.

2.2.4. MCS System

Cruise RR1718 used the Scripps Multichannel Seismic System to collect MCS data. This consists of a 48 channel GeoEel streamer with 12.5m hydrophone spacing; 800 m long with a 600 m long active section. Digitizers were present for each streamer section, so digital data was transferred to the topside. Four birds were used along the active section to maintain a nominal towing depth of 3 – 5 meters, depending on the swell.

An array of two GI gun was used in 45/105 mode, with 25 m shot spacing; compressed air was provided by the R/V Revelle's compressors, operated by Revelle engineers. One compressor was malfunctioning for portions of the survey. Two shot instant hydrophones were mounted on the gun assemblies to record and archive source properties in separate SEGY files. Navigation was controlled by the Seapath 330+. Data were recorded in SEGD format, and merged with the navigation data to create SEGY files for each line.

3. Operations

Science party operations included daily roles among three shifts. During operations, the scientists communicated with the bridge to clarify which tracklines were being targeted, and how to turn between those lines and to assist with making major operational decisions (e.g. equipment deployment and retrieval or continuation of data collection with malfunctioning equipment).

3.1. Daily Operations

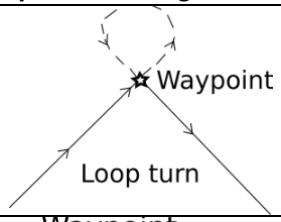
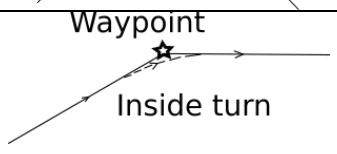
The 19 ECS participants of RR1718 were organized in 3 shifts: 0400-1200, 1200-2000, and 2000-0400. At the start of each shift, participants were assigned roles with the goal of each participant having the opportunity to experience the different roles. These roles included Chief Scientist, Co-Chief Scientist, Event Logger, Multibeam Processing, Seismic Processing, and/or Mapping. The principle investigators and post-doc mentors coordinated to make sure someone with expertise was available for all shifts. If there was an event, such as equipment deployment/recovery or an unforeseen need to alter track plans, members of the watch group during that shift contributed to those activities, along with any real-time data processing. Operation plans and maps were created as needed, with the goal of providing the science party, technicians, and ship crew with a science plan for at least the next 12 hours.

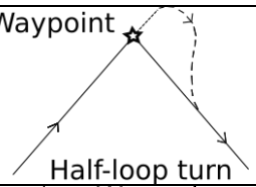
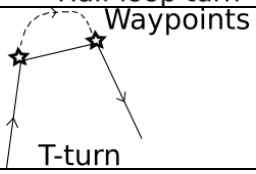
Science meetings were held daily at 1900 to communicate information and report the events of each shift. These meetings also provided time for science talks by members of the science party, and time to display and discuss newly collected data.

3.2. Turn Nomenclature

To ensure turns were accurately communicated to the bridge, RR1718 participants defined turns and provided the bridge and science party with a nomenclature document. These turns included Loops Turns, Inside Turns, Half-loop Turns, and T-Turns. These definitions are provided as Table 3.1.

Table 1. Turn definitions.

Turn	***Definition***	***Conceptual Drawing***
Loop Turn	Passes through the waypoint, turns in a direction opposing the direction of the next line (~270°) and passes through the waypoint again, creating crossing profiles of the waypoint.	
Inside Turn	Begin turning before reaching the waypoint and turn in the direction of the next line. Typical of soft turns. End of streamer, in this turn, will not pass through the waypoint.	

Half-Loop Turn	Pass through the waypoint, turn in the direction of the next line until you merge with the next line.	
T-Turn	Pass through waypoint at the end of a line (L1), make a wide turn (L1-T) that aligns with the next waypoint in the direction of the next seismic line (L2).	

3.3. Data Collection

RR1718 collected MCS data using the portable Scripps MCS system, chirp sub-bottom profiles using a Knudsen 320 BR 3.5/12 kHz, swath bathymetry using a Kongsberg EM122, the magnetic field using a Marine Magnetics SeaSPY (with BOB software), and gravity using a Bell BGM-3 ship gravimeter. Chirp sub-bottom and swath bathymetry data were only collected within the permitted area, while the MCS streamers were in the water. The magnetometer was deployed for data collection during longer segments, but needed to be recovered or brought close to the ship before any turns to ensure that the magnetometer would not tangle with the MCS streamer. Plans for which data would be collected between waypoints were generally determined at least 12 hours in advance by the ECS participants, in coordination with the PIs, technicians, and ship crew. MCS and swath bathymetry data were processed on ship, following collection, by the post-doc mentors and ECS participants.

3.4. Waypoints, Cruise Track, and Survey Lines

An initial list of waypoints was initially generated by the 19 participants, after being organized into four groups (A, B, C, and D). These went through a series of revisions after initial presentations during pre-cruise discussions and identification of overlapping geographic interests. These plans were merged into a final survey plan before departing Newport. The waypoints were modified throughout the cruise due to unforeseen equipment malfunctions, time constraints, and discussions with the science party, technicians, and ship crew. The final waypoints are listed in Table 5.2. MCS data were acquired between all waypoints, except during most T-turns segments, between waypoint 0 and waypoint 1 when the acoustic source was being tested, and a transit between waypoint 20 and waypoint 21.

Technical issues with the ship's compressors led to an early termination of MCS line 3. While the engineers solved the issue, an extended chirp sub-bottom and swath multibeam survey was conducted around waypoint 5, near Kulm Ridge.

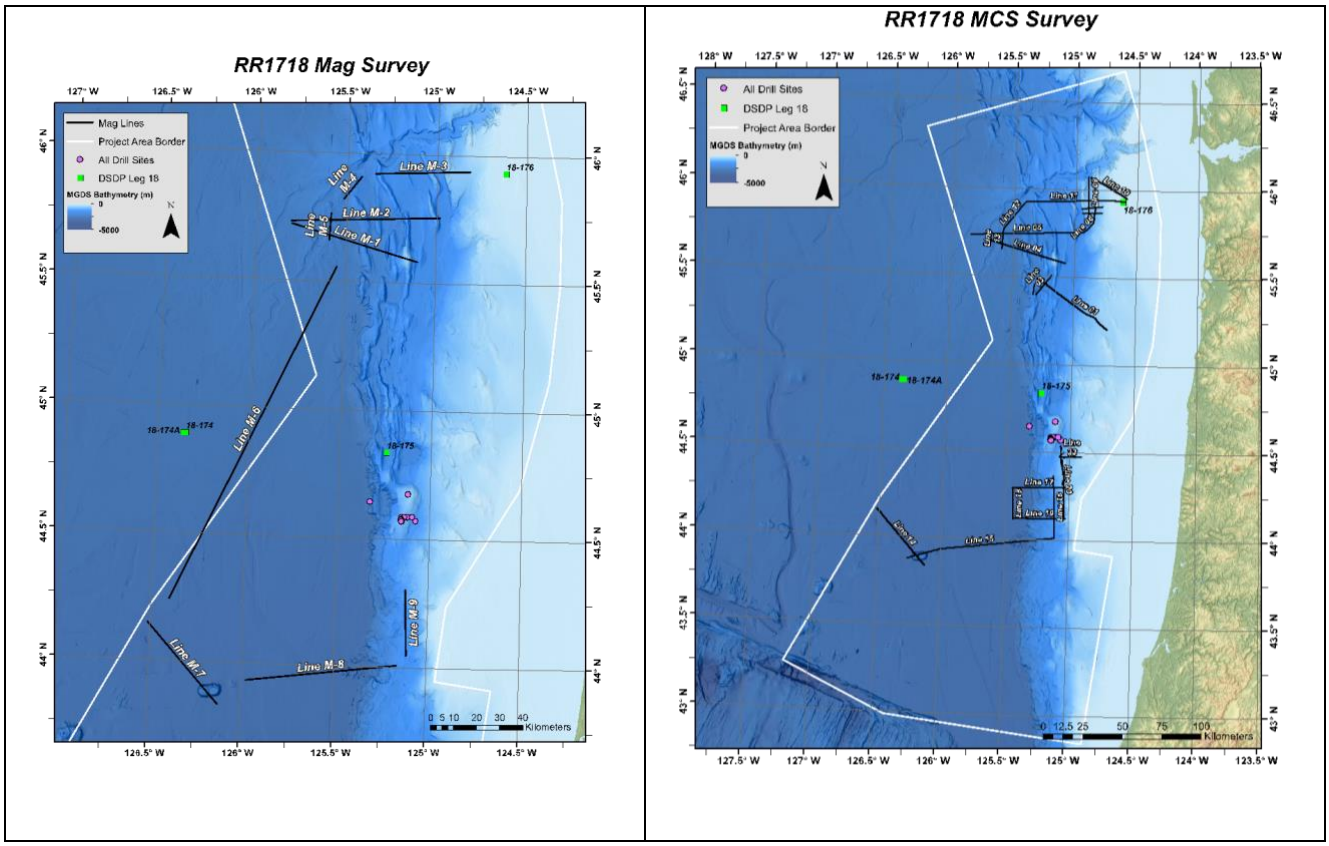


Figure 1. Magnetometer and MCS trackline locations..

Table 2. List of waypoints.

Waypoint	Longitude	Latitude	Comment
0	-124.6250	45.1577	Acoustic Source Activated and Tested
1	-124.7270	45.2040	Start Line 1
2	-125.1295	45.4080	Start Line 2
3	-125.2970	45.4910	Start Line 2-T (T-Turn)
4	-125.3040	45.3950	Start Line 3
5	-125.0980	45.5810	Start Line 4 and M-1
6	-125.8430	45.7290	Start Line 5 and M-2
7	-124.9225	45.7571	Start Line 6
8	-124.8470	45.8130	Start Line 6T*
9	-124.8292	45.9478	T-Turn
10	-124.7795	45.9025	Start Line 7
11	-124.9460	45.8887	T-Turn
12	-124.9420	45.8630	Start Line 8
13	-124.7864	45.8659	T-Turn
14	-124.8894	45.8369	Start Line 9
15	-124.8900	46.0663	Start Line 10

16	-124.5962	45.9320	Start Line 11 and M-3
17	-124.7160	45.9410	Continue Line 11
18	-125.4065	45.9207	Start Line 12 and M-4
19	-125.5810	45.7651	Start Line 13 and M-5
20	-125.5896	45.6555	Transit to South and Start Line M-6
21	-126.4775	44.1223	Start Line 14 and M-7
22	-126.1268	43.8406	T-Turn
23	-126.2501	43.8749	Start Line 15
24	-126.0069	43.9299	Continue Line 15 and Start Line M-8
25	-125.1054	44.0102	Start Line 16
26	-125.1216	44.3658	T-Turn
27	-125.0249	44.2992	Start Line 17
28	-125.4425	44.2937	Start Line 18
29	-125.4351	44.1179	Start Line 19
30	-125.0344	44.1223	Start Line 20
31	-125.0436	44.3866	Continue Line 20
32	-125.0651	44.4496	Continue Line 20
33	-125.0679	44.5254	T-Turn
34	-125.1833	44.4846	Start Line 21
35	-124.9085	44.4889	T-Turn
36	-124.9077	44.4749	Start Line 22
37[+]	-125.0859	44.4716	Start Line 23
38	-125.0679	44.4867	End of Science

3.5 Watch Standing Roles and Responsibilities

The following sections contain information about tasks assigned for each of the five roles a scientist on watch may have in addition to special operations.

3.5.1 Chief Scientist / Co-Chief Scientist

The Chief Scientist (CS) and Co-Chief Scientist (CCS) of the watch are principally responsible for overseeing and coordinating the planning and execution of shipboard research activities. The CS works closely with all members of their team and communicates frequently with research technicians, geophysical technicians, and the bridge to ensure that everyone is aware of what activities will be happening and when, what equipment or personnel will be needed, and what contingencies exist if the plan needs to be changed. On a typical cruise, there would be one CS and perhaps one to two CCSs, but we had the added complexity and challenge of rotating through the position with each shift change. The importance of good communication was even greater with our group as each shift needed to hand off the events that occurred, the existing plan, and a summary of what additional communication was necessary with the various departments on board.

Often the most challenging task for the CS and CCS is adapting to the ever-changing conditions regarding scientific equipment and ship functions. On a ship that operates 24-hours a day for

most days of the year, equipment problems are commonplace and maintenance is a regular activity. When problems arise that affect the ability to collect data or perform research, the CS and CCS must be able to change the plan on the fly. Strategic decision-making and communication skills were necessary for success in such a dynamic environment, and consultation with our 3 PI's was key. Many of our temporary CSs and CCSs had never been to sea before, and being thrust into a high-pressure leadership position was daunting. The additional team members offered support for the CSs and CCSs, with more experienced scientists adding their recommendations. Many new and skilled leaders emerged from a group of students that rarely have a need to take charge and make big decisions, especially with so much on the line.

3.5.2 Event Logger

The event logger uses the on-board ELOG system to keep a running log of all activities related to scientific research. New log entries are made for the start and end of seismic lines, when data acquisition equipment is stopped or started, when a problem arises and again when the issue is resolved, and so on. Additional log entries are made for unique observations, such as bubble plumes in the Multibeam water column data or great sediment penetration in a location with the 3.5 kHz. Any time a log entry occurred, the UTC time and ship's position are automatically integrated from the ship's systems and recorded for individual log entries.

This type of record keeping is essential while underway and after the conclusion of the cruise. During active or busy times on board, the event logger is recording information from multiple sources every few minutes. Scientists on the following watch often consult the event log for additional details on the happenings of the previous watch and use the time and position information from the log to adjust the science plan. After the cruise, the event log will be one of the most important and useful records for integrating the data with a history of activities and decisions made on board.

3.5.3 MCS Processor

The MCS processor on our expedition worked closely with the geophysical technicians and our extremely knowledgeable post-docs to ensure that seismic data quality was being checked regularly and that files were available for download and processing in a timely fashion. Once MCS data had been downloaded from the ship's servers, the processor used Seismic Unix software and a detailed workflow to perform an initial processing of seismic lines. Nearly all of our early career scientists were previously unfamiliar with processing is Seismic Unix, so there were many hours spent learning (and teaching) how the process worked. The command-line interface for Seismic Unix also required the processor to be familiar with Unix commands, requiring a great deal of patience and practice especially for PC users.

Processed seismic lines were reviewed by the entire science party during evening science meetings and allowed for early interpretation of our sections. After the cruise, the raw and

processed MCS data handled by the MCS processors would be one of the most valued data products from our expedition.

3.5.4 Multibeam Sonar Processor

The Multibeam Sonar Processor accessed raw data output from the onboard EM122 Multibeam Sonar System from the ship's servers after each line was finished writing. Depending on the quality of the data, in large part a function of the sea state and the ship's heading, the processor would spend time carefully removing erroneous pings using MB system sonar processing software. The raw Multibeam data contained many artifacts (artificial errors introduced by environmental noise or issues with system functionality) that had to be manually removed in order to produce a final data product that had reliable depth information. After quality control, the cleaned Multibeam data were output to the science party shared folder.

3.5.5 Mapper

The mapper worked closely with the CS and CCS to update and revise the planned survey activities, keeping careful track of exact positions for upcoming seismic lines, turns, and transits, and frequently produced paper maps for distribution. In this role, the ECS participant kept a close running list of upcoming waypoints, activities to be performed at each site, and educated estimates of time. Keeping an updated survey plan was critical for keeping survey activities and plans on schedule, ensuring that there was sufficient time for all science objectives. Whenever the bridge needed an update, or the plan had to be adjusted for equipment issues or changes in strategy, the mapper coordinated with the CS to provide accurate waypoint information to the bridge and geophysical technicians. The mapper also needed to know which seismic lines were critically important and which existed largely to connect other areas of interest so that necessary changes did not impact major science objectives. The mapper communicated regularly with the CS and CSS, the PIs, and many other scientists off-watch to effectively coordinate dynamic survey planning.

The mapper used ArcGIS software to plan survey lines and track the ship's position in real time thanks to a live GPS feed from the ship's navigation system. Many early career scientists were unfamiliar with the proprietary software, and numerous newly minted mappers and planners were created during the expedition.

3.5.6 Deck Ops

At specific times during the cruise, multiple watch-standers would be asked to step away from their usual duties to assist with deck operations. The deployment and recovery of the seismic streamer required three able-bodied helpers to perform a complicated task. Deck Ops scientists worked closely with the research tech and under the supervision of the lead geophysical technician. Deploying or recovering the seismic streamer took up to two hours of work on the ship's fantail and many great photo ops were taken with greenhorn ocean scientists outfitted in work vests and hard hats.

4. Multichannel Seismic Data Acquisition and Processing

In this section, the SIO portable multichannel seismic system will be described in terms of its geometry and sound source. Additionally, the quality assessment and control steps, processing protocol, and final interpretation will be outlined. Finally, a discussion on the mitigating steps associated with protected species observations will conclude this section.

4.1. SIO Portable System: Geometry and Other Parameters

We used the Scripps Institution of Oceanography (SIO) portable high-resolution multi-channel (MCS) system to collect reflection data during cruise RR1718. This system consists of an 800 m long (600 m active) 48-channel Geometrics GeoEel streamer (12.5 m spacing per channel), and a 2 GI-gun cluster. We shot on a distance of 25 m using ship speed and navigation. The sampling rate is 0.5 ms and recording length is 8.0 s. Max fold is 12. Layback is 402.125 m. We traveled at about 4.5 knots when collecting seismic data. We have over 770 km of seismic profiles. The Scripps team onboard created SEG-Y files and the science party processed the MCS through Seismic Unix and migrated the seismic profiles through SIOSEIS.

SIO Portable Marine Seismic System

Geometry

Cruise: **RR1718**
Vessel: **R/V Roger Revelle**
Date: **Sept 2017**
Chief Sci: **UNOLS ECS Training**

Techs:
Lee Ellett
Kolby Pedrie
John Collins

Item or Channel	Distance (m) from Stern	Distance (m) from Source	Distance (m) From GPS	Distance (m) port/stbd	Depth/Height from water
1	106.25	80.25	142.25	6.7 port	3-4
48	693.75	667.75	729.75	6.7 port	3-4
Source	26	0	62	6.7 stbd	2
GPS	36	62	0	0	0

Section	Length (m)	Number of Channels
Towing Cables	100	
Active Sections	600	48
Tail Stretch and Rope	75	
Group Int	12.5	

Bird Locations (Streamer, GPS Ref Plate)

Bird 1	Start of Tow Stretch, (111x, 6.7y)
Bird 2	Start of Ch17 (Active 3), (336x, 6.7y)
Bird 3	Start of Ch 33 (Active 5), (536x,6.7y)
Bird 4	Start of Tail Stretch, (736x, 6.7y)

Source:	GI gun	45/105 True GI	**Qty:**	2
Acq. Sys.	GeoEel	**PreAmp Gain:**	18 db	
Sample Int:	.5ms	**# of Channels:**	48	
File Format:	SEGD	D 8058 Rev 1		
Rec. Length:	8 sec	**Shot Interval:**	25m	

FOLD =

$$\frac{\text{No. Traces} * \text{Grp. Int}}{2*(\text{Shot Interval})}$$

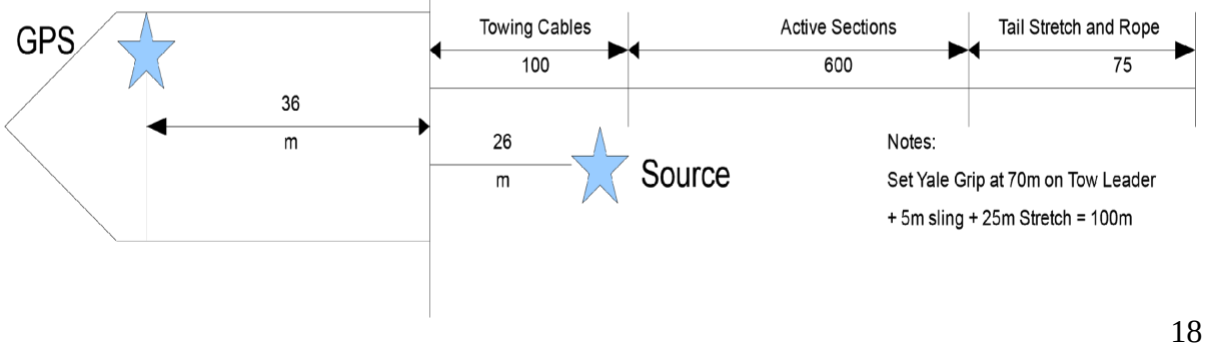


Figure2 (previous page). SEQ Figure 3. ARABIC 2. Photograph of the two GI-sound sources before deployment.*

4.2. QA/QC

The SEG-D files contain seismic traces for a single acoustic pulse at each of the 48 active channels, in addition to one for the two hydrophones located on each acoustic source. Similar to the SEG-Y format, this type of data stores multichannel seismic traces organizing the information through standardized headers. The SEG-Y format stores traces from multiple shot points, while the SEG-D format only stores traces from a single shot.

This data can be used to perform a QA/QC check on particular components of the seismic system as the survey is underway. This is particularly useful if the SEG-Y data is not yet available to review. The objective of the QA/QC using the SEG-D data is to ensure that all of the hydrophones are properly recording data and that the source pulse from the two guns is consistent. Both of these items can be watched during the cruise in real time at the workstations in the computer lab; however, these displays only show the data for individual shot gathers until the next shot is taken. If a potential problem is identified on the workstations during the cruise, the SEG-D files can be used to identify if the issue is ephemeral or persistent through a significant portion of the data.

The SEG-D data can be found within the within the network directory:

\\nas-1\mcs\data\segd\site-RR1718

Within this folder, there is a sub-folder for each line collected during the cruise. The individual SEG-D files within each of these subfolders are named after the shot point they contain the data for. The files can be opened within either SegDSee or SioSeis software.

Figure 1A shows a typical shot gather, with a trace from each hydrophone in channels 1-48. The direct arrival should be readily identifiable and each trace should have a relatively similar amount of visually identifiable noise. Figure 2 shows a shot gather with some extraneous noise in traces 17 and 33, two channels located close to the birds on the streamer.

Timing issues between the guns can occur and can alter the coherence of the seismic images. It is therefore important to confirm that the guns are firing synchronously. The most common sign of a timing issue would be a double or ringing associated with prominent reflectors, such as the seafloor. Figure 1B shows channels 49-52 contained in a SegDChannel 49 contains the timing pulse recorded using hydrophones on the two airguns. The pulse should arrive at approximately 50 ms. It is simply the sum of the timing pulse from the two guns. While it does not carry the signature of the acoustic source, it would show any larger variations in timing between the two guns. Variations in the source timing will typically be very small, and unidentifiable visually. The data from the ship's Hotshot computer tracks the relative timing between the two guns and a .csv file is uploaded to the data folder on the ship's network server.

In the event of a source array hydrophone malfunction, a first way to identify an issue with the relative timing between the two guns is to observe the direct arrival from individual shots before and after the hydrophone failure occurred. A follow-up would be to compare the frequency content of the direct arrival for shots fired before a hydrophone issue and one after the hydrophone issue. A double pulse will alter the ghost notch and the frequency content of the source pulse.

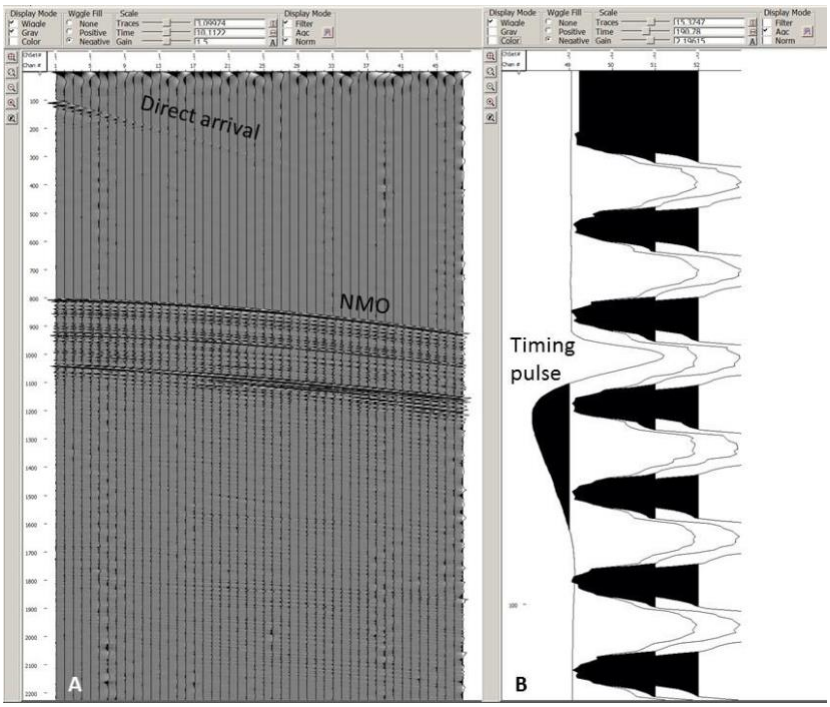


Figure 4. The contents of a SEG-D shot gather file visualized in SegDSee software. A) The first 48 traces in the file contain the shot gather. B) The sum of the traces recorded from the two hydrophones located on the airguns are located in channel 49.

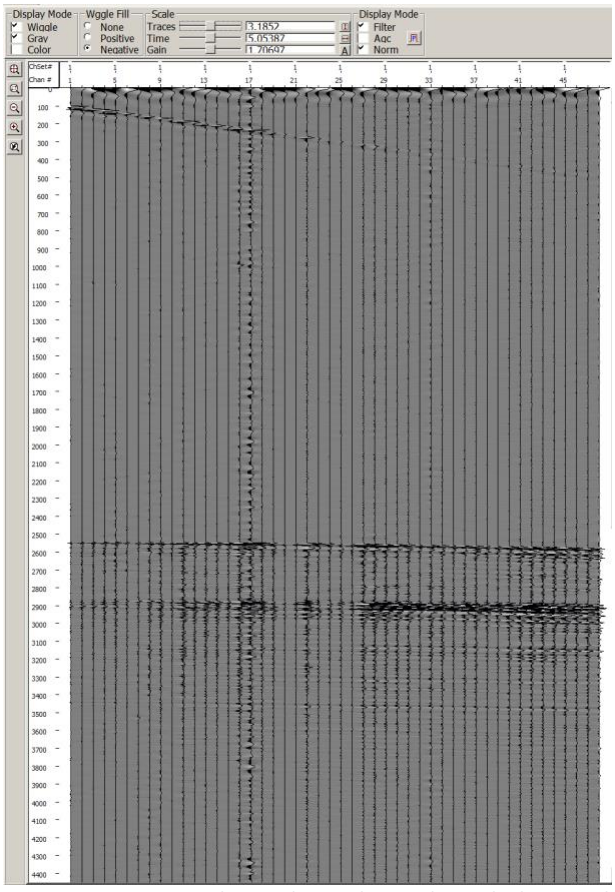


Figure 5. A shot gather with two channels that are slightly noisier than the others, 17 and 33. These channels are located near the birds.

4.3. Processing Protocol

The SEG-D data obtained from the shipboard SIO portable MCS system were merged with navigation information in the headers and converted to SEG-Y format using SIOSeis (seismic processing software from Scripps Institute of Oceanography). The non-zero headers were written out to a text file. Channel 49 detects the pressure wave from the acoustic sources and channels 50 through 52 are open channels. In the next processing step, these auxiliary channels (49-52) were removed and subsequent analyses were performed on the 48 channel file. As a first clean up process, an Ormsby bandpass filter was applied to remove low and high frequency noise. For most of the data processed in this cruise, the corner frequencies for the filter were 15-25-350-500 Hz. This filter was sufficient to remove the interference from ocean waves etc. Data were then converted from SEG-Y format to su format for further processing us SeismicUnix (seismic processing software from Center for Wave Phenomena, Colorado School of Mines).

The shot gathers were checked to determine if there were any bad channels. We found that channels 1, 17 and 33 were consistently noisy across all seismic lines, possibly due to their proximity to the birds on the streamer. These channels were muted for subsequent analyses. Trace offsets and CDP numbers were written to the trace headers based on the experiment geometry. The data were then filtered with a zero-phase bandpass filter with corners at 15-25 and 250-500 Hz, sorted into CDP gathers, and corrected for spherical divergence. The receiver spacing of 12.5 m and shot spacing of 25 m yielded a maximum fold of 12 for the survey data. After initial tests to check the sensitivity of the data to stacking velocity, we decided that for the water depths characteristic of the main part of the survey, a normal moveout (NMO) correction assuming a constant velocity of 1500 m/s was adequate before stacking the CDP gathers. Follow-up research on these data should be done to test the impact of stacking velocity models constrained by regional velocities obtained from OBS or long-streamer data. A frequency-wavenumber migration (stolt migration in Seismic Unix) was performed on the stacked data, again assuming a constant velocity of 1500 m/s. This migrated data was used for further analyses and interpretation. Finally, a layback correction was applied to the location headers.

Several examples of data are shown in Figures X and Y. Track lines were chosen to fill holes in existing coverage and several surprising and previously unknown structures were discovered that captured the imagination of all participants, whose interests included subduction zone tectonics, intraplate volcanism, sedimentology, slope stability and paleoceanography.

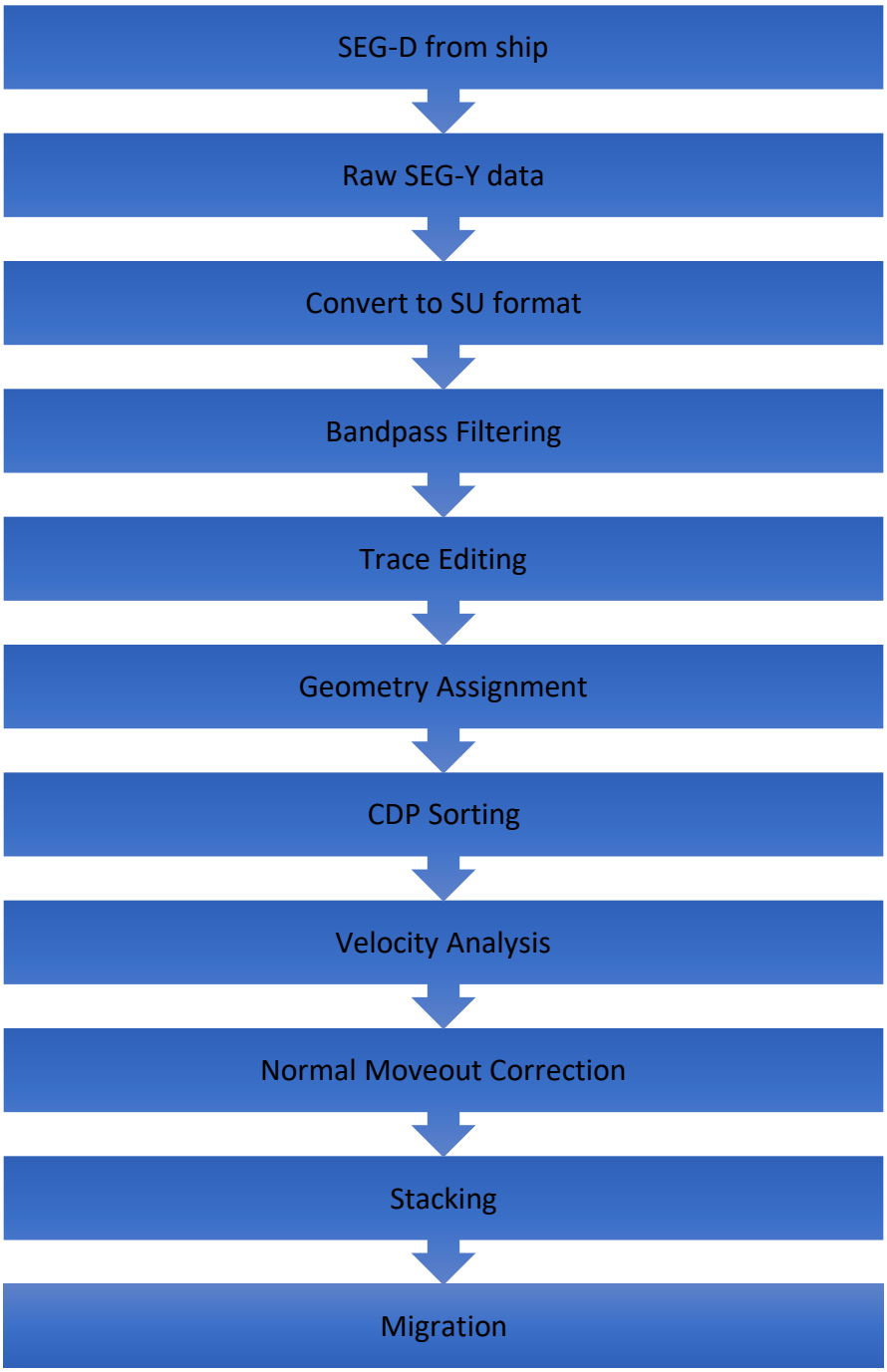


Figure 6. Onboard seismic processing workflow

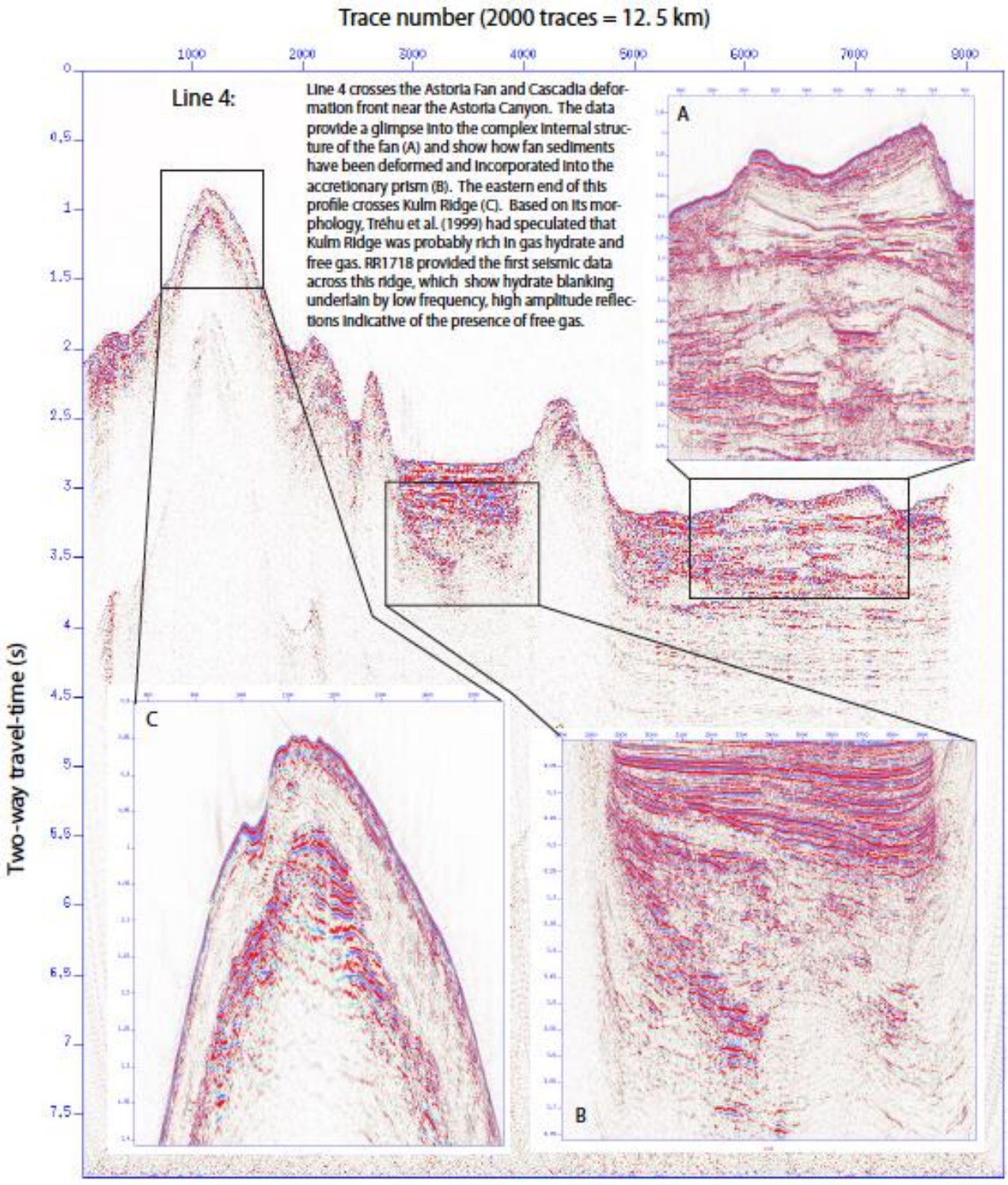


Figure 7a. An example of MCS processed data from lines in Astoria Fan

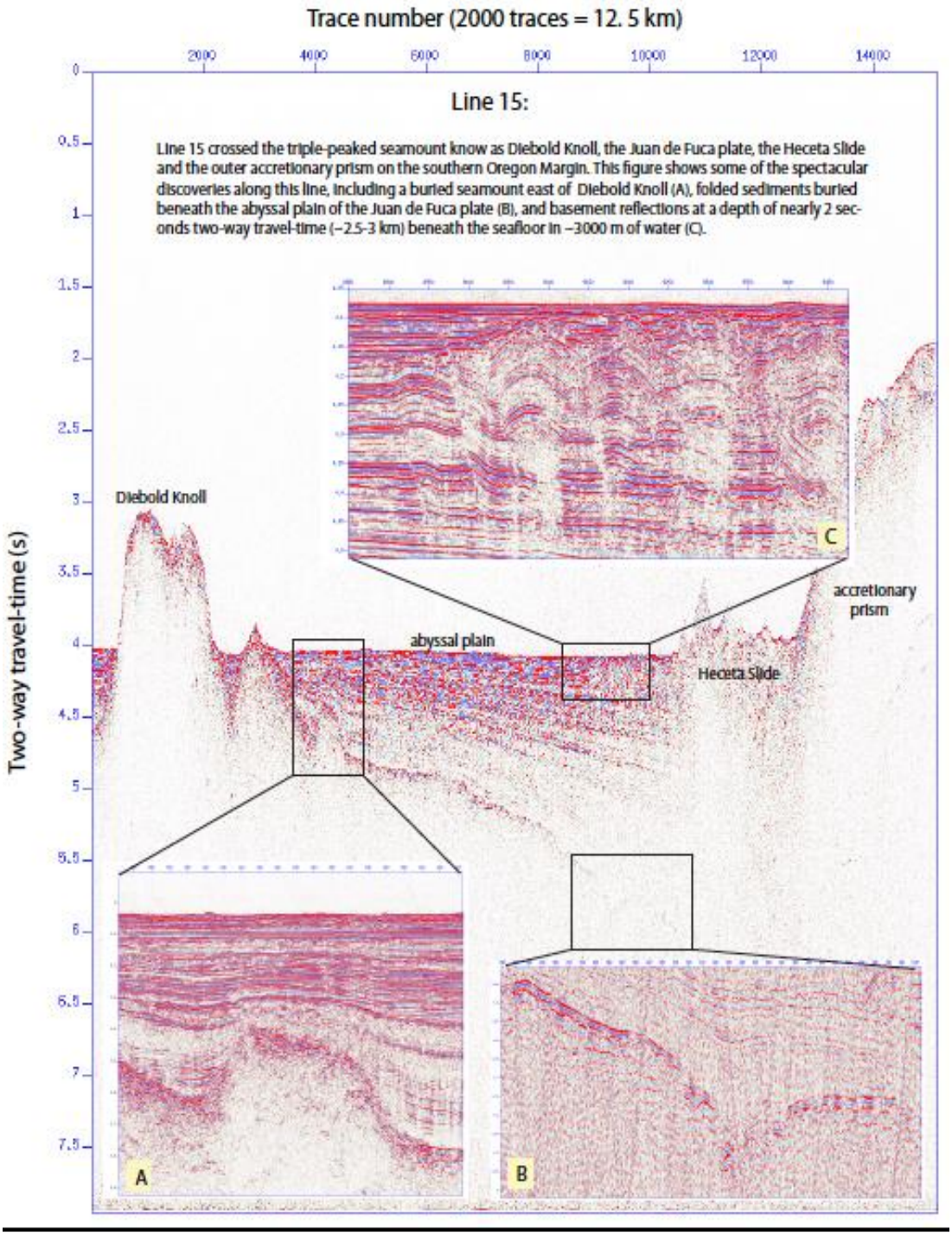


Figure 7b. An example of MCS processed data from lines near Diebold Knoll.

5. Multibeam Data Acquisition and Processing

A multibeam sonar is an instrument used to map the bathymetry of the seafloor. It does this by transmitting an acoustic signal and measuring the time required for the echoes reflecting from the seafloor to return to the instrument. Multibeam sonars are able to cover a broad area of seafloor by orienting the transmitting and receiving arrays at right angle to one another. The transmitter array is oriented along the hull of the ship and ensonifies an area that is precise along-track but broad across-track. Likewise, the receiver array is oriented across the hull of the ship such that it is very sensitive to variations in across-track energy but not to along-track energy. The result is that every time the instrument emits and measures a pulse (called a "ping") a line of seafloor perpendicular to the current ship track is mapped by the system.

The *R/V Roger Revelle* utilizes a Kongsberg EM122 multibeam sonar to collect bathymetry. The EM122 is a deep-water system that transmits a 12 kHz pulse frequency, suitable for surveying ocean depths greater than ~1000 meters at a manufacturer quoted bathymetric resolution of 100-150 meters. The resolution actually depends on the pulse frequency, which is fixed, and the seafloor depth, with shallower depths yielding denser, more precise pings. The EM122 plots the energy collected in each ping according to incidence angle and range in a water column profile and automatically generates a pick of the seafloor based upon where the most intense energy is reflected.

Raw multibeam data were processed on the ship after collected using MB-System. The MB-System processing is performed manually, with the user flagging bad pings that are removed from the data set during post-processing.

Multibeam bathymetry was collected concurrently with all multi-channel seismic data when possible.

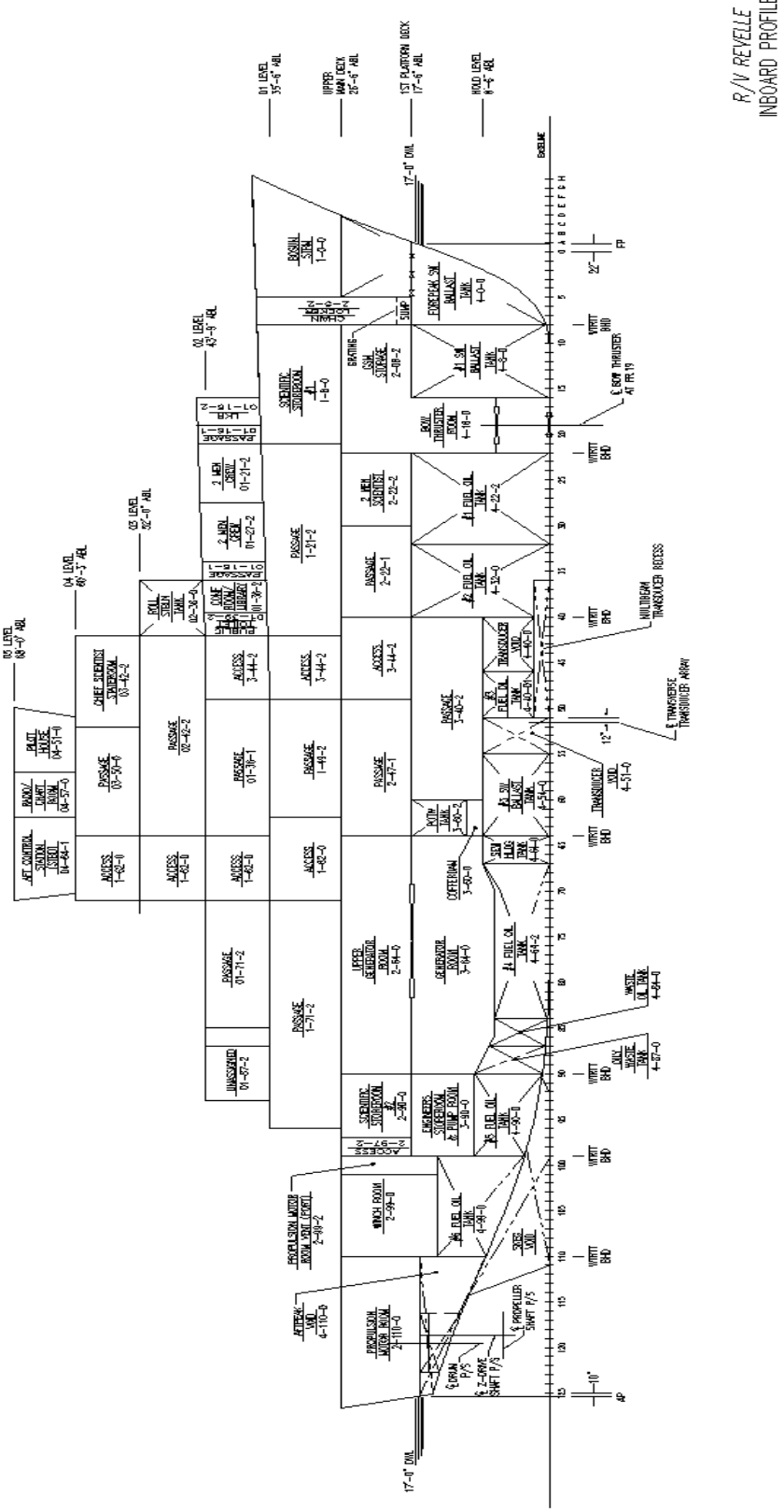


Figure 8. Location of the mutibeam onboard the RR Revelle.

5.1. Expendable Bathytermograph (XBT)

At least one Turo 1000m XBT was dropped every 24 hours to measure temperature versus depth of the ocean in a near vertical profile. The measured temperature curve is lightly processed, if needed, to remove obvious abnormalities, combined with a standard salinity curve for the region, and extended to 3000 m depth. The calculated result is a sound speed curve that is used to calibrate the Multibeam bathymetry system. The temperature curves can also be used to correlate with seismic reflectors found in the water column. All XBT drop locations are shown in Table 3; additional XBT's were dropped for seismic oceanography purposes at locations marked with a (*) and unsuccessful drops are marked with a ($).

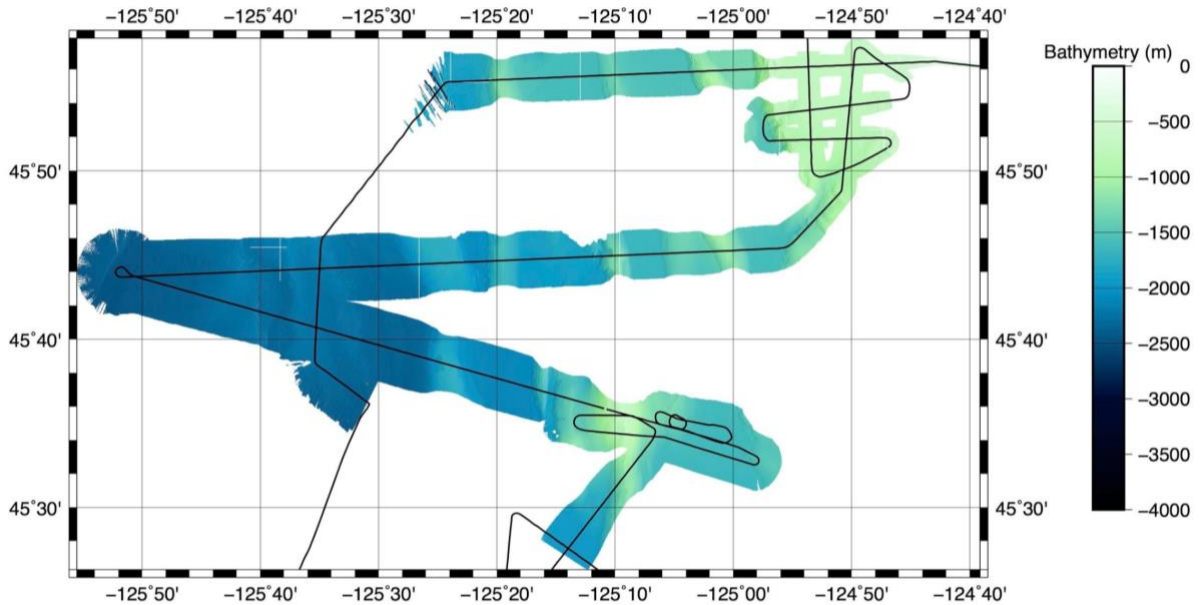
Table 3. Location information for XBT sites.

XBT Drop #	Latitude	Longitude	Time (UTC)
001	45 19.693N	124 58.204W	9/27/2017 4:53:59 AM
002	45 39.960N	125 31.517W	9/28/2017 3:28:47 AM
003	45 55.550N	125 14.051W	9/29/2017 2:21:37 PM
004	43 55.413N	126 02.116W	9/30/2017 7:37:33 PM
005 $*	43 57.568N	125 40.664W	9/30/2017 11:09:09 PM
006*	43 57.670N	125 39.300W	9/30/2017 11:16:27 PM
007*	44 00.590N	125 06.475W	10/1/2017 4:45:56 AM
008	44 23.357N	125 02.682W	10/2/2017 3:14:49 AM

5.2. Data

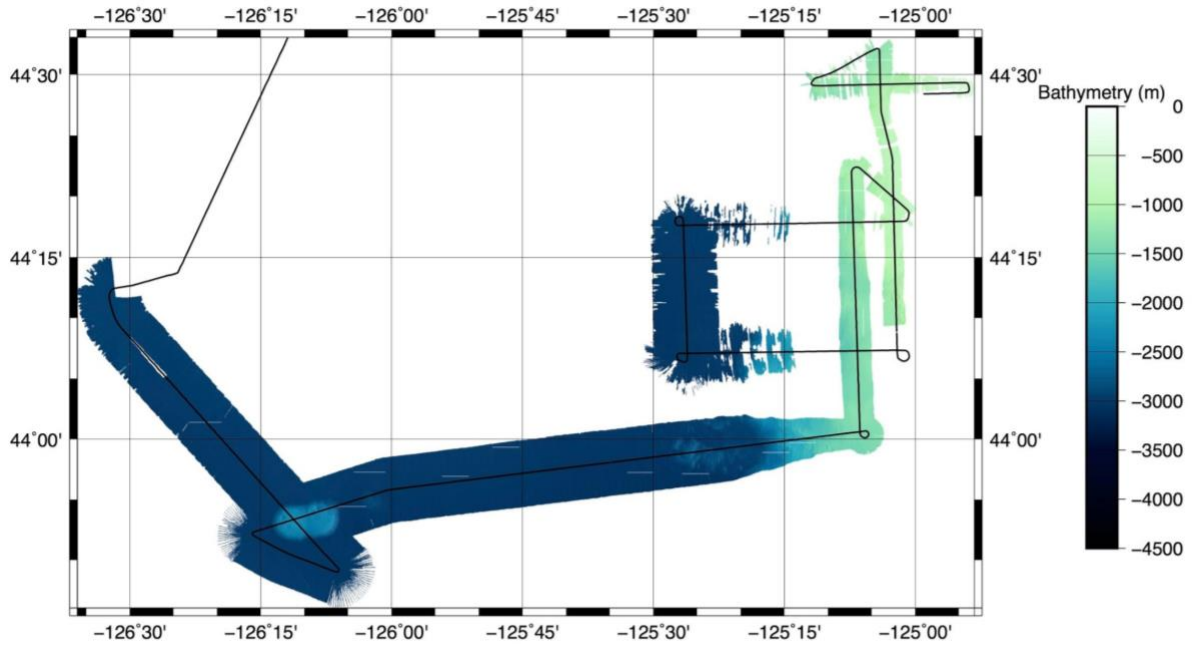
The bathymetric data collected can be divided into two sections based on geographic area: north and south. Below are maps compiled from those two areas. Additionally, the multibeam data was collected with the midwater data recorded. These data were collected to look for bubble plumes.

5.2.1. North Area



F

5.2.2. South Area



Figures 9 (previous page) and 10: Bathymetric map from the multibeam collected in the north (Fig. 9) and south(Fig.10) area.

5.2.3. Bubble Plumes

Several bubble plumes were detected in the EM122 water column viewer while passing over the northern end of Kulm ridge. The plumes were sourced from ~1460 m depth and extended several hundred meters into the overlying water column. The true position of the seeps is several hundred meters south of the reported ship position (45.74955°N, 125.1608°W). The sonar files that captured the plumes are: *0078_20170928_141439_revelle.wcd* and *0078_20170928_141439_revelle.all*, and MCS line 006 covered this site. These files were processed using FMMidwater and the extracted plume source location data are as follows:

Plume 1: 45.745795°N, 125.161848°W, 1248 m, plume top: 674 m depth
Plume 2: 45.74581°N, 125.156742°W, 1326 m, plume top: 848 m depth

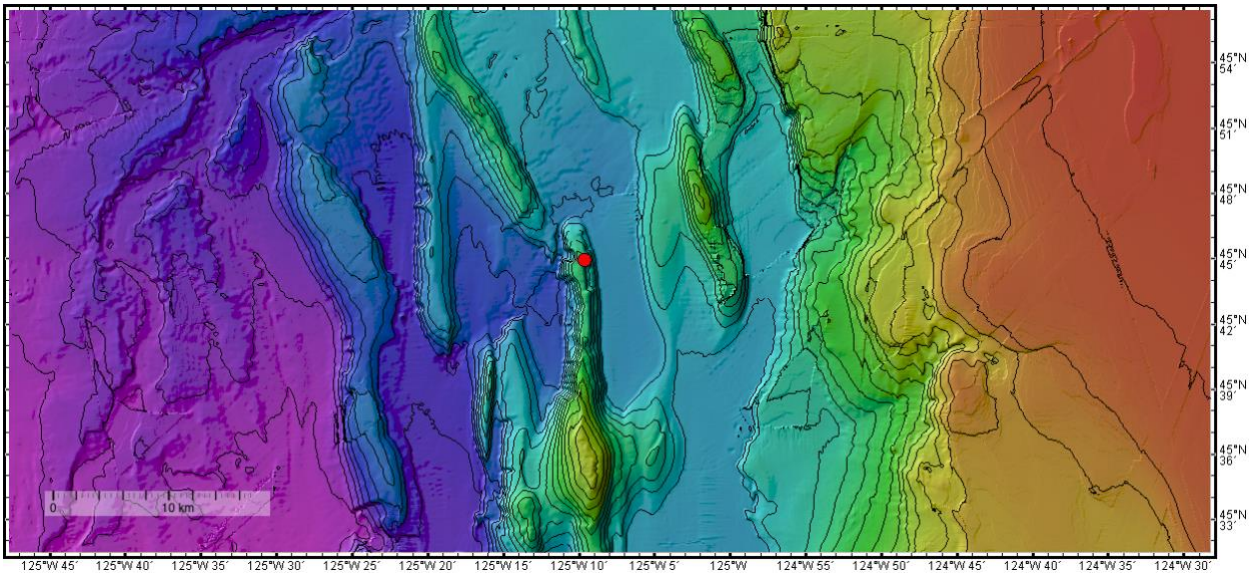


Figure 11. Bubble plume marked by red dot. This marker represents the position of the ship at the time of plume observation; the true position of the seep is several hundred meters south of this point.

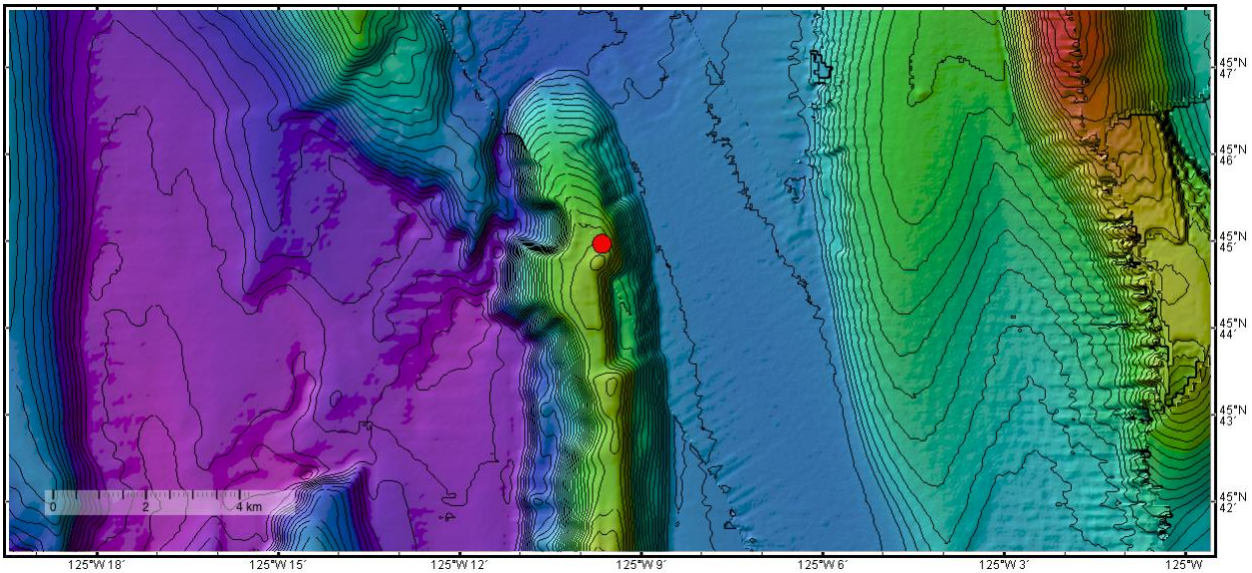


Figure 12. Close up of the north end of Kulm ridge and observed seep (red dot). The plumes are likely sourced from the topographic high just south of the marker.

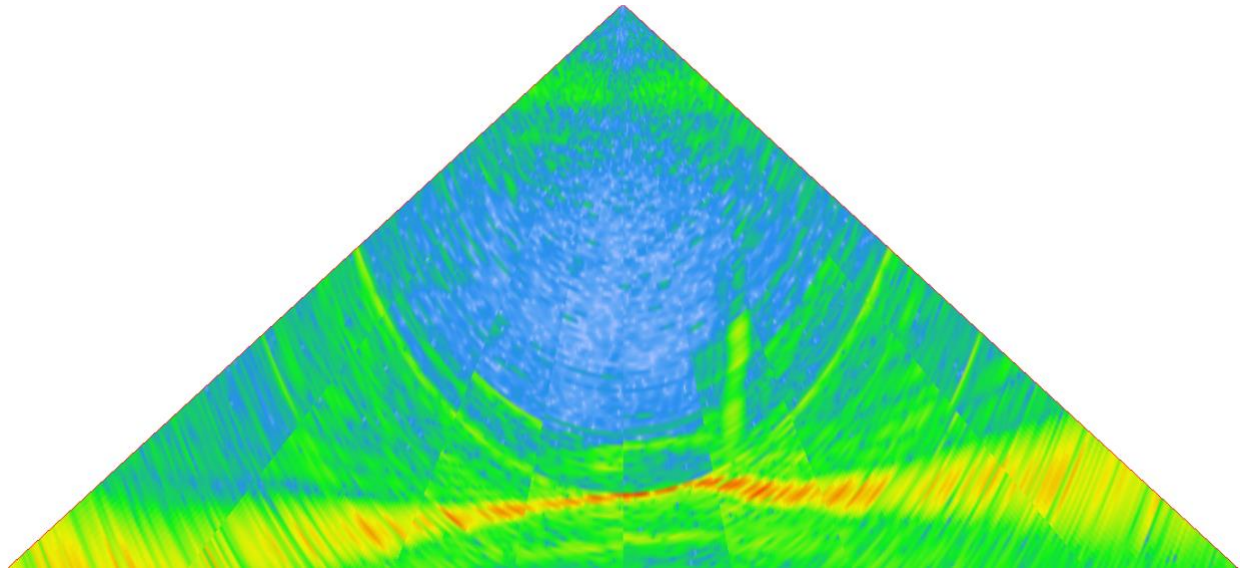


Figure 13. Raw water column data displayed using FMMidwater. The vertical structure to the right of nadir is plume 1.

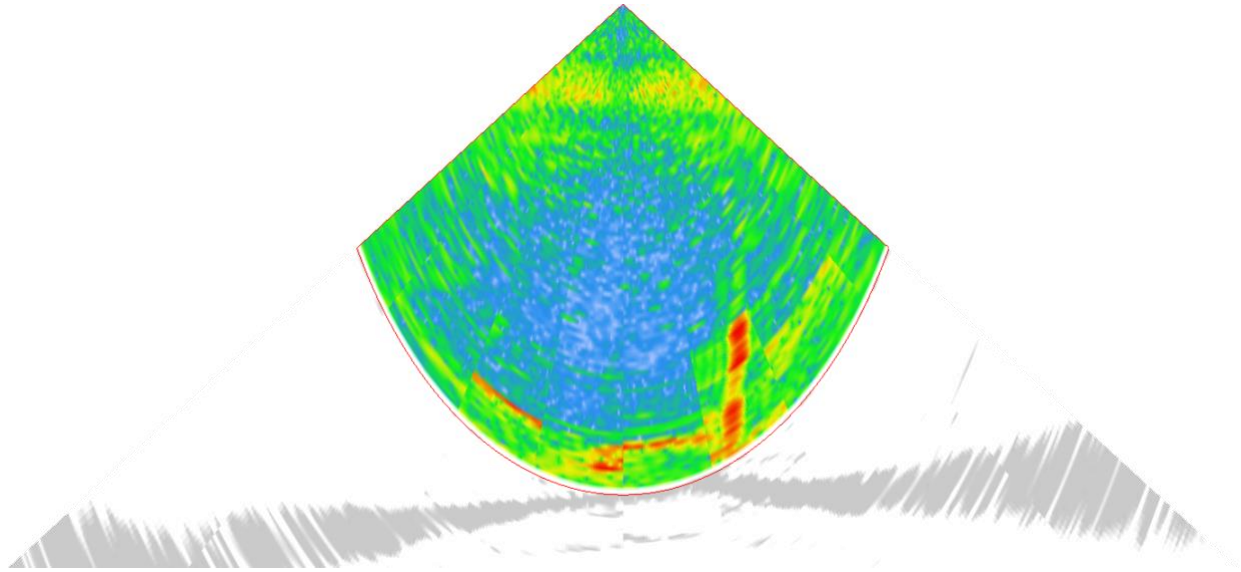


Figure 14. Range and amplitude filters applied to isolate and boost signal created by rising bubbles above the North Kulm ridge seep site.

5.3. Event Log Summary

Bubble plumes were sited on Sept. 28th at 13:35, Sept. 29th at 02:31, and Oct. 2nd at 02:13.

Errors with the multibeam typically occurred when in areas of < 150 m, which falls outside of the designed range for the equipment. Some errors occurred due to sea state and ship heading, which we believe to be due to bubbles that went under the ship and interfered with the multibeam path.

Date	Action	Latitude	Longitude	Comment
Tue 26 Sep 2017 22:33:51	start	45.112293	124.522201	
Tue 26 Sep 2017 22:41:30	other	45.116418	-124.525802	Start Mosaic
Wed 27 Sep 2017 00:22:30	stop	45.157165	-124.619615	Stopped to readjust parameters
Wed 27 Sep 2017 00:29:05	other	45.15893	124.63063	MB power cycle
Wed 27 Sep 2017 00:36:18	start	45.158933	-124.61275	logging started
Wed 27 Sep 2017 03:14:54	start	45.273562	-124.832833	
Wed 27 Sep 2017 03:38:24	other	45.284648	124.871073	multibeam signal and echo sounder poor for previous 30 min
Wed 27 Sep 2017 04:16:18	other	45.307503	-124.928282	multibeam configured to properly record depth below ship
Wed 27 Sep 2017 04:16:57	other	45.307579	-124.928454	multibeam configured to properly record depth below ship
Wed 27 Sep 2017 04:23:04	other	45.311968	124.937352	lost signal
Wed 27 Sep 2017 04:29:50	stop	45.316517	-124.946205	Instrument turned off
Wed 27 Sep 2017 04:32:32	other	45.318524	-124.950557	total power down of instrument
Wed 27 Sep 2017 04:40:53	other	45.324233	124.961805	multibeam restarted for troubleshooting not yet logging
Wed 27 Sep 2017 06:44:09	start	45.408326	-125.133045	started logging
Wed 27 Sep 2017 09:14:54	start	45.466848	-125.315572	Multibeam back online after ship turned (seismic line 21)
Wed 27 Sep 2017 11:27:08	other	45.436342	125.257892	Water Column logging turned on
Wed 27 Sep 2017 15:19:22	other	45.545353	-125.137555	Crossing Kulm ridge but did not observe any bubbles
Thu 28 Sep 2017 19:05:41	other	45.745615	-125.182486	Bubble plume observed in EM122
Thu 28 Sep 2017 23:13:01	stop	45.864808	-124.847539	Stopped pinging on multibeam
Thu 28 Sep 2017 23:13:55	start	45.864357	-124.843031	Started pinging again. Data quality appears improved
Thu 28 Sep 2017 23:25:49	stop	45.865304	-124.821831	Data looked strange again. Stopped pinging
Thu 28 Sep 2017 23:26:40	start	45.865373	-124.820042	Started pinging again. Data quality improved
Thu 28 Sep 2017 23:32:15	stop	45.865396	-124.809179	stopped pinging
Thu 28 Sep 2017 23:38:22	start	45.865399	-124.808342	started pinging again
Fri 29 Sep 2017 00:25:15	stop	45.840538	-124.823253	stopped pinging
Fri 29 Sep 2017 00:26:27	start	45.840305	-124.824016	Restarted pinging
Fri 29 Sep 2017 00:43:23	stop	45.832809	124.850656	stop multibeam
Fri 29 Sep 2017 00:45:00	start	45.83139	-124.853394	Multibeam start logging again
Fri 29 Sep 2017 02:19:29	other	45.919373	-124.863271	Received a warning from UDP6. Data quality unchanged
Fri 29 Sep 2017 02:27:25	other	45.926307	124.893549	John re-seeded the network cable. Small data gap. Will continue monitoring
Fri 29 Sep 2017 02:31:03	other	45.938949	-124.863925	Possible gas seep
Fri 29 Sep 2017 07:35:18	other	45.960407	124.601046	at UTC 07:04 multibeam depth was incorrect. Anomalous data collected (error corrected)
Fri 29 Sep 2017 07:38:56	other	45.957693	-124.595547	Multibeam data stopped due to too shallow water depths
Fri 29 Sep 2017 08:16:17	start	45.932552	124.6039	started multibeam data collection seismic line 11
Fri 29 Sep 2017 08:36:09	other	45.935117	-124.63645	multibeam data were off due shallow waters - back once deeper than ~170 m
Fri 29 Sep 2017 14:38:59	other	45.924278	125.297592	New Sound Velocity Profile loaded into SIS
Fri 29 Sep 2017 16:02:37	other	45.906608	-125.422423	Multibeam data quality decreased during turn and did not improve on new line - likely due to heading
Fri 29 Sep 2017 16:24:20	other	45.887358	-125.443268	SIS restarted to try and improve data quality - data quality did not improve
Fri 29 Sep 2017 16:48:07	stop	45.865491	125.468244	Multibeam has stopped logging due to poor data quality - likely due to heading
Fri 29 Sep 2017 18:41:47	other	45.747615	-125.582154	MB still not good after turn - still not logging - will monitor for improvement
Fri 29 Sep 2017 18:58:22	other	45.726883	125.584021	Multibeam logging turned back on - multibeam line 137
Fri 29 Sep 2017 19:23:25	other	45.696313	-125.586404	Increasing beam width from 30 to 60 degrees
Fri 29 Sep 2017 21:43:40	stop	45.503865	-125.61505	Turned off multibeam
Sat 30 Sep 2017 08:17:33	start	44.206802	-126.530975	Multibeam and Echosounder turned on
Sat 30 Sep 2017 19:50:12	other	43.950327	-126.002431	Applied XBT data to MB
Sat 30 Sep 2017 23:27:19	other	43.962923	-125.605157	Applied XBT sound profile to MB
Sun 01 Oct 2017 10:24:53	other	44.354632	-125.078051	Multibeam started picking up unrealistic values ~3000m depth
Sun 01 Oct 2017 10:44:53	other	44.336859	-125.052725	Multibeam occasionally picking inaccurate values - may be due to ship heading
Sun 01 Oct 2017 15:33:38	other	44.293374	-125.74495	Multibeam file 0208 for turn

Figure 15. A snapshot of Multibeam related event logs.

6. Sub-bottom Profiler (Knudsen Chirp)

During most of the Seismic ECS Cruise (RR1718), we operated the 3.5 kHz echosounder, except during transit from the north to south site. The ping duration was maintained constant at 70 ms, and the duration of the transmit pulse was between 2 to 4 ms.

These data were recorded in native Knudsen "keb" and “SEG-Y” format and can be played back using the free software package PostSurvey (Figure 1). The following paragraphs contain notes on procedures to follow at the beginning of a watch and parameters to keep an eye on while collecting data.

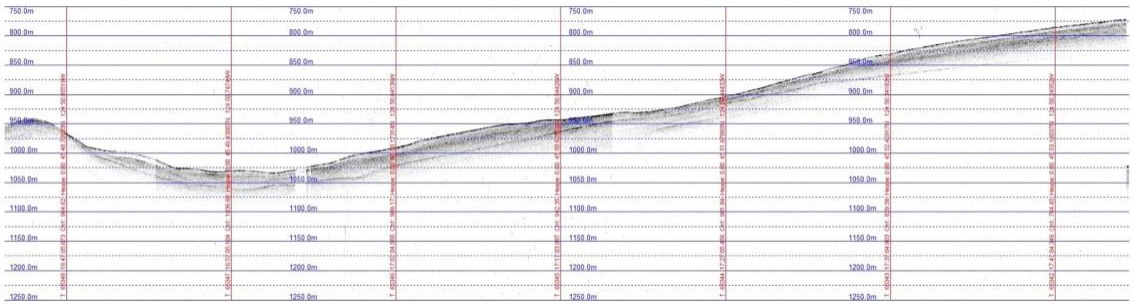


Figure 16. Knudsen echosounder data collected from Seismic ECS Training cruise during julian day 212 using PostSurvey software package.

6.1. Knudsen Acquisition Notes

The Knudsen 3.5kHz subbottom profiler depth resolution of 10’s of m below the sea floor, and can be used to determine fault offsets, locate places to core, or identify hard grounds formed by seeps.

For data acquisition, the primary objective is to achieve as much penetration as possible, while retaining low vertical resolution. Mechanically, this means while on watch, we must keep the trace within the depth (time) gate that is being recorded. Depth is based on 1500 m/sec. The data recorded is only for the depth interval shown on the screen.

6.2. Procedure

The following section addresses the procedures to follow while supervising the Chirp systems at the beginning and during a watch stand.

6.2.1. Start of Watch

1) Check to see that the screen is on Ch1: 3.5 kHz
2) Check to see that under “Recording”, start line is on (grayed out). Go to cruise data file—see if there is a current Keb, Kea, and SEG-Y file being created.
3) Gain mode should be in manual; Phase mode (depth range) should be in manual

4) Make a note of the settings for Tx Pulse; Tx Power, Gain value. In shallow water, the pulse length is typically less than 1 ms. In deep water, it is best to keep the pulse length as short as possible. On this cruise, we primarily used a pulse length of 2 ms. Tx power should be 3 or less. In shallow water, it should be 1; in deeper water we have been using 2. We have kept the gain below 10 dB in deeper water.
5) Transmit (Tx) pulse length, Tx power, control the pulse sent out by the transducer. Gain value changes the amplification at the receiver. Typically leave these alone unless there is a problem following the bottom or if there are major changes in water depth. Check with watch leader before fiddling. All these controls will affect the amplitude of the recorded signal. If they are set too high, the data will be severely clipped. Vice versa if they are set too low, there will be little signal recorded.
6) Check process shift level. Typically we have been using process shift 3 or 4. Process shift is a setting that you can use to set the screen gain—it does not affect the recording. The basic rule for process value level: if its black, dial it back. You want to get penetration. If the ship is going over a hard bottom, it will be black. You can try dropping the process shift to a lower number, but pay attention when you cross onto a softer bottom.
7) Range—should be set to 500 m, unless you are told otherwise.

6.2.2. On Watch

Keep an eye on the screen to make certain the 3.5 kHz data stay on the screen. Only the depth window shown on the screen is recorded. Potentially 20-50 m of data are recorded below the sea floor, so the screen should be shifted to keep not only the sea floor trace but also the subbottom returns.

Sometimes the data will wipe out (i.e. no penetration and blank data below). This is potential evidence of a seep, where there is a hard surface and gas-rich fluid below. If you see one of these, note it in the log (Figure 2).

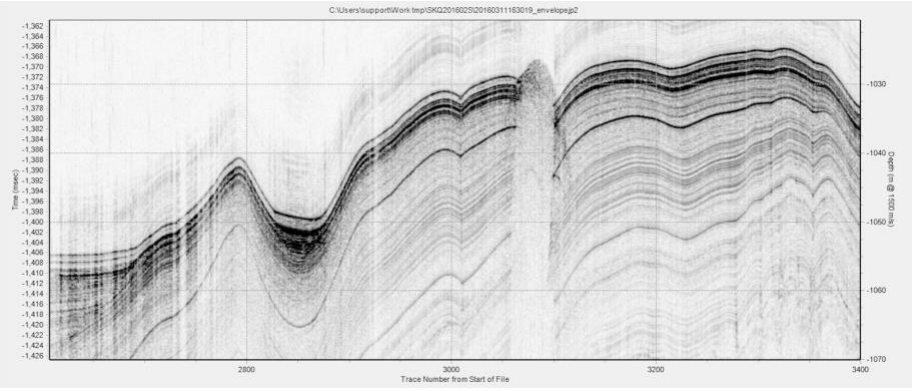


Figure 17. Example of a cold seep in San Diego Trough. It is the spot with a hyperbolic echo and wipeout beneath.

To shift depth range being recorded, adjust the phase (Knudsen nomenclature). We normally leave the shift phase in manual mode, because the auto mode intended to track the bottom

does not work well. The overlap should be 50% (depth is shifted by only half the screen). Phase is below this with 2 numbers e.g. 1400-1600 (current depth range in m), and a left or right arrow. For the depth to be shifted shallower, press the left arrow. To go deeper, press the right arrow.

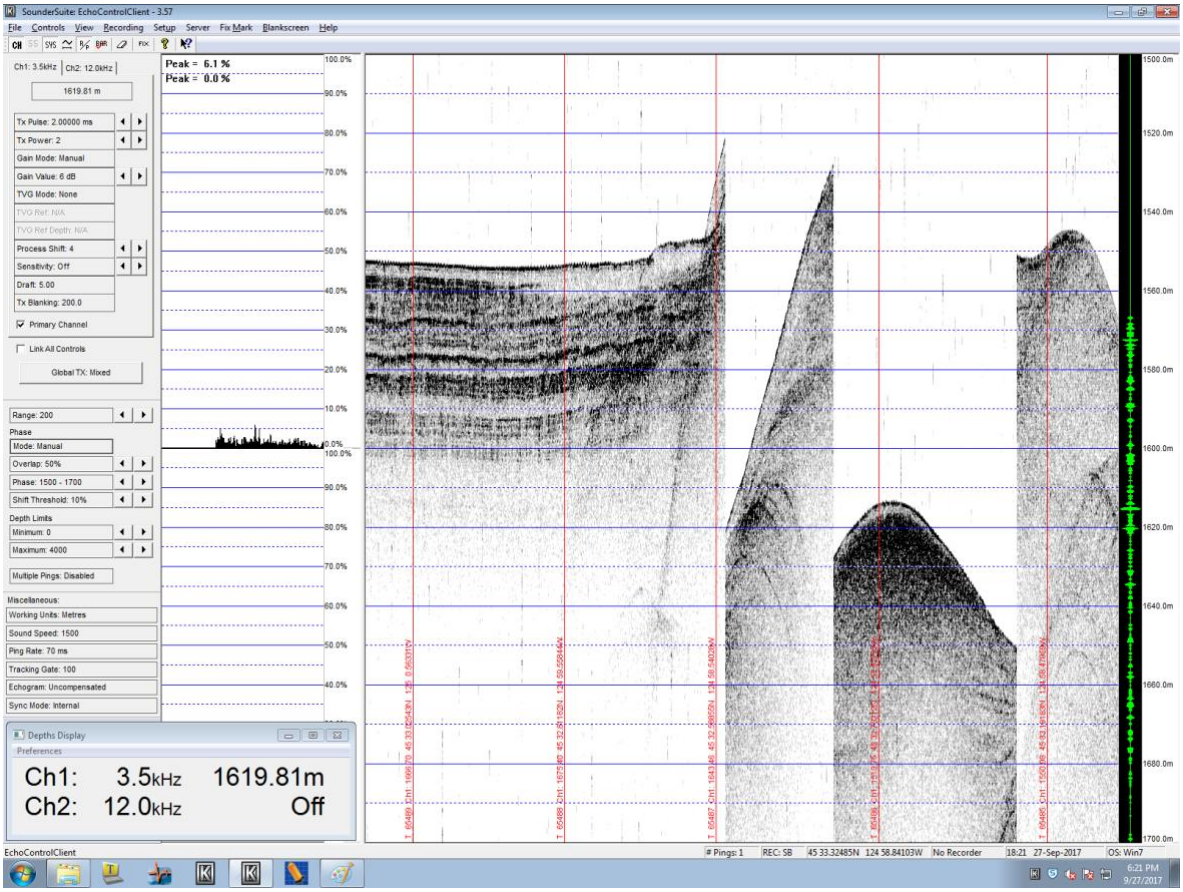


Figure 18. Screen grab of the Knudsen screen display. Data from Basin to east of Kulm Ridge.

Figure 3 is a screen grab from the Knudsen display. On the top menu line is the recording menu. The gain, Tx, Process shift, and Phase controls are on the left. The lower left corner shows that Ch1 3.5 kHz is on, measuring 1619.8 m water depth. Immediately right of the control panel is a display of relative power of returns through time (start time to the left). Next is the screen display of the chirp data going over a small hill. Each time the depth is shifted shallower, the current depth is shifted down relative to the previous trace, producing a discontinuity in the record but keeping the trace within the 200 m window.

7. Potential Fields

This section will be divided into Gravity and Magnetic potential fields. An additional section on the onboard GPS systems and data extract is all included.

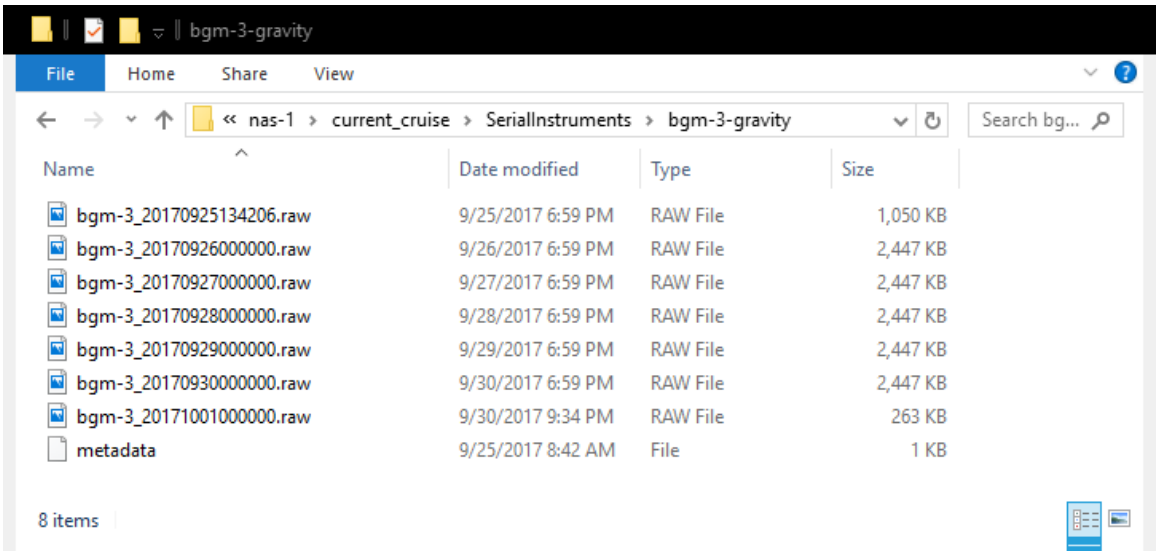
7.1. Gravity

Instrument description and location within the ship

The Gravimeter onboard of RV Roger Revelle is marine BGM-3 system manufactured by Bell Aerospace, Serial number BG-1211-01.

Figure 19. Shipboard BGM-3 gravimeter

This gravimeter that was used during RR1718 cruise was installed in the electronics computer lab (rm 01-45-2) on the Main deck in July 2017. Please note that the center of the ship (the origin point for all GPS recorders) is one deck below the gravimeter. The data recorded by the gravimeter are located at the shared-drive: \\nas-1\current_cruise\SerialInstruments\bgm-3-gravity



The metadata file for the gravimeter is shown below:

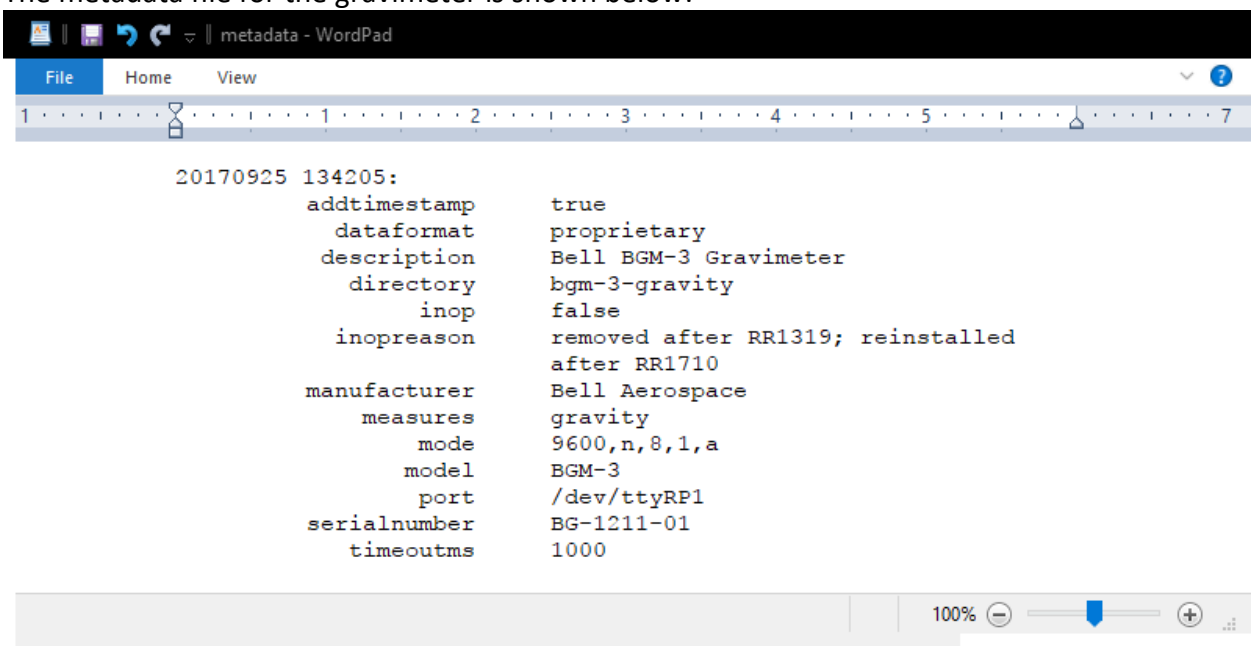


Figure 20. A screenshot of gravity data folder

One ASCII file per day is recorded with the year_month_day_start_time information registered in the filename. The file extension is .raw. The example of the file is shown below:

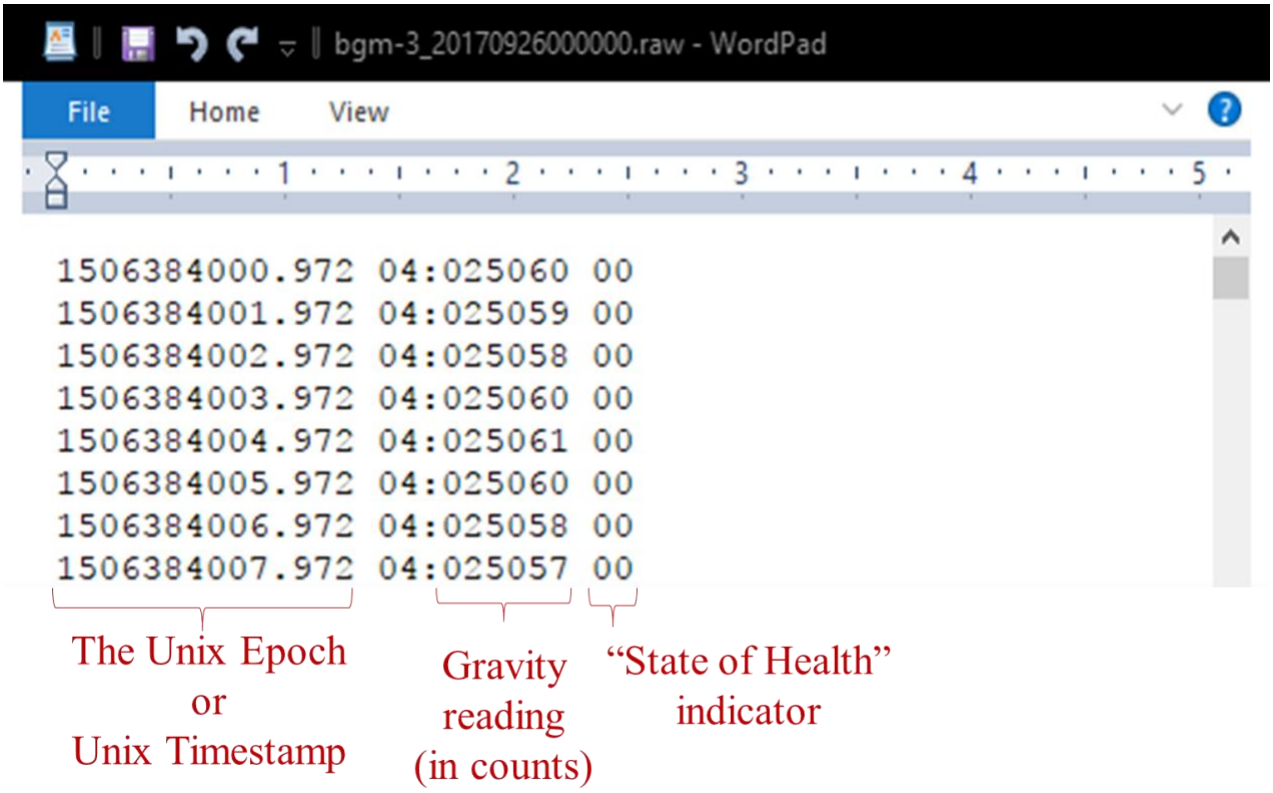


Figure 21. A screenshot of the gravity data

The first column is the Epoch timestamp (the number of seconds between a particular date and time that starts at the Unix Epoch on January 1st, 1970 at UTC). The gravity reading is the value that follows "04:" column. The last column is a "state of Health" indicator. The "00" values in that column indicate that the reading was successful.

Gravity ties

The gravity ties were conducted before the cruise in Newport, Oregon. Gravity base station is located within Hatfield Marine Center (Genetics Lab, rm 149/151).

Figure 22. Gravity tie station. Gravity Value: **g = 980 595.99 mgals**

The repeated gravity tie will be taken on October 03, 2017 (per Jon Meyer of Scripps). Jon Meyer will provide the reports with both gravity ties measurements on October 03, 2017 (jmeyer@ucsd.edu).

7.2. Magnetics

Instrument description

The magnetic measurements were taken with the SeaSpy Magnetometer system designed by Marine Magnetics, serial number is SS-257331-01

Figure 23. Towing magnetometer (SeaSPY)

Once deployed, the magnetometer was towed behind the ship at the distance of 300 m. However, magnetic data were not collected for all of the seismic survey profiles (see the table below).

Table 4. A summary of magnetometer survey lines

Seismic line	Magnetic line		Day and time from eLog		waypoints	Coordinates from eLog		Comment
			Epoch	UTC		Lat	Lon	
Line 4	M-1	start	20170927.01	9/27/17 1:17	5	45.18057	-124.69801	coordinates srom e-Log, need to be verified
		end	20170928.06	9/28/17 6:04	6	45.72045	-125.80149	
Line 5	M-2	start	20170928.07	9/28/17 7:28	6	45.7298	-125.80787	
		end	20170928.15	9/28/17 15:18	7	45.7552	-124.97766	
Line 11	M-3	start	20170929.1	9/29/17 10:20	17	45.93809	-124.81707	
		end	20170929.15	9/29/17 15:15	18	45.92252	-125.34381	
Line 12	M-4	start	20170929.16	9/29/17 15:57	18	45.91165	-125.4166	start of seismic line entered, no record in eLog
		end	20170929.17	9/29/17 17:33	19	45.82062	-125.51886	
Line 13	M-5	start	20170929.22	9/29/17 22:07	19	45.55697	-125.54585	coordinates srom e-Log, need to be verified
		end	20170930.06	9/30/17 6:25	20	44.24039	-126.40055	
	M-6	start	20170930.1	9/30/17 10:27	20	44.08417	-126.43028	No seismic recorded, long transect to the southern part
		end	20170930.15	9/30/17 14:52	21	43.83672	-126.12126	
Line 14	M-7	start	20170930.09	9/30/17 9:14	21	44.14827	-126.51068	coordinates from from seismic line, no record in eLog
		end	20170930.15	9/30/17 14:55	22	43.83456	-126.1183	
Line 15 (second part)	M-8	start	20170930.2	9/30/17 20:08	24	43.93332	-125.96893	
		end	20171001.04	10/1/17 4:04	25	44.00553	-125.15745	
Line 16	M-9	start	20171001.05	10/1/17 5:29	25	44.04339	-125.10695	
		end	20171001.09	10/1/17 9:00	26	44.30171	-125.11876	

For the magnetic lines M-1 through M-9, the magnetometer was deployed after the seismic acquisition started, once the ship was on the course, in order to avoid magnetic cable tangled around the seismic streamer cables during turns. The depth of the magnetometer was recorded in the magnetic data file. During the RR1718 survey the magnetometer depth varied from 15 to 30 m for various lines.

Data location and format

The data recorded by the magnetometer are located at the shared-drive: [\\nas-1\current_cruise\SerialInstruments\seaspy-magnetometer](\\nas-1\current_cruise\SerialInstruments\seaspy-magnetometer)

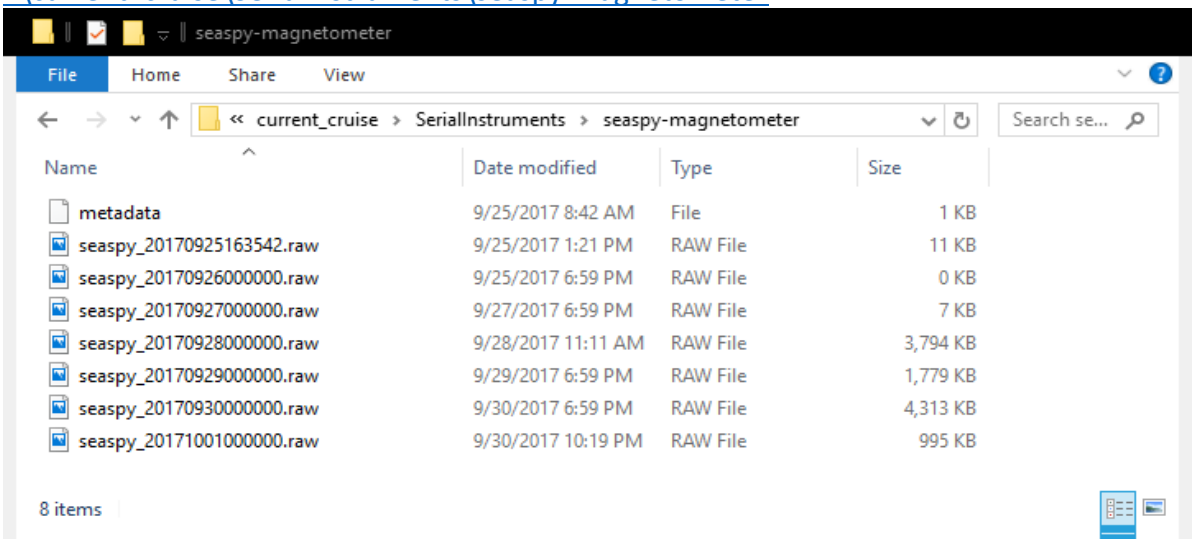
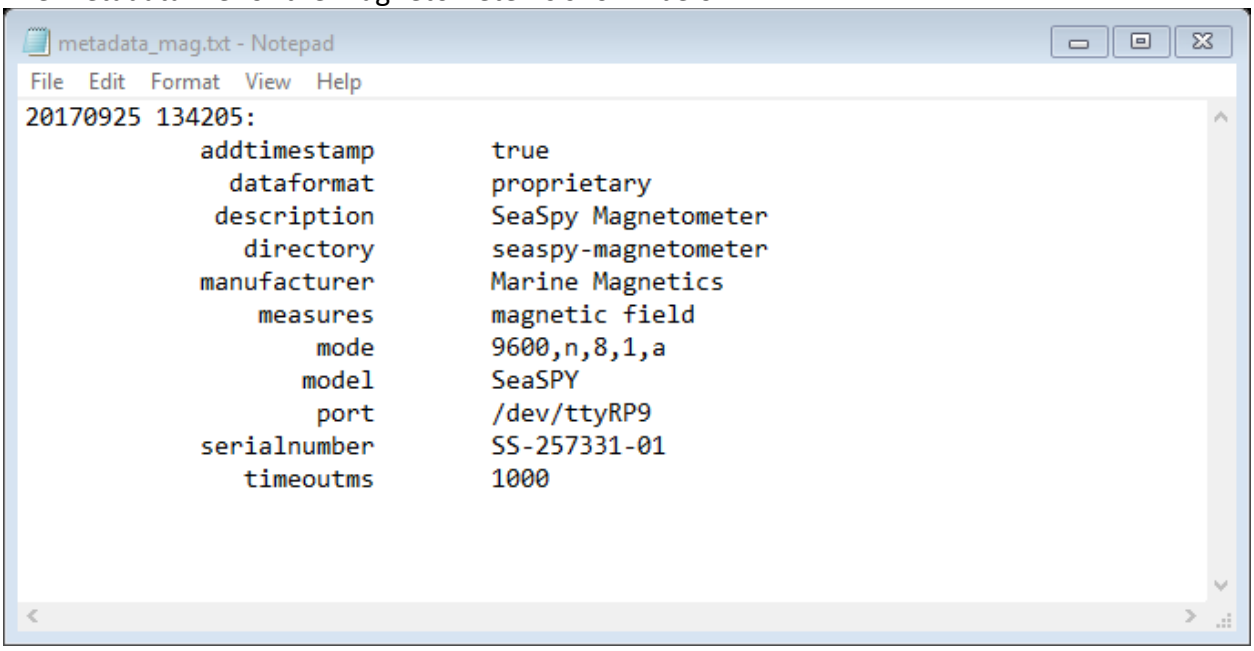


Figure 24. A snapshot of magnetometer data folder (above) and metadata (below)

The metadata file for the magnetometer is shown below:



The ASCII file with magnetic measurements was recorded daily. Each file consists of two major parts: the header and the data columns. The former simply includes all the text log as the magnetometer is being deployed, while the data part has a pre-defined structure outlined below.

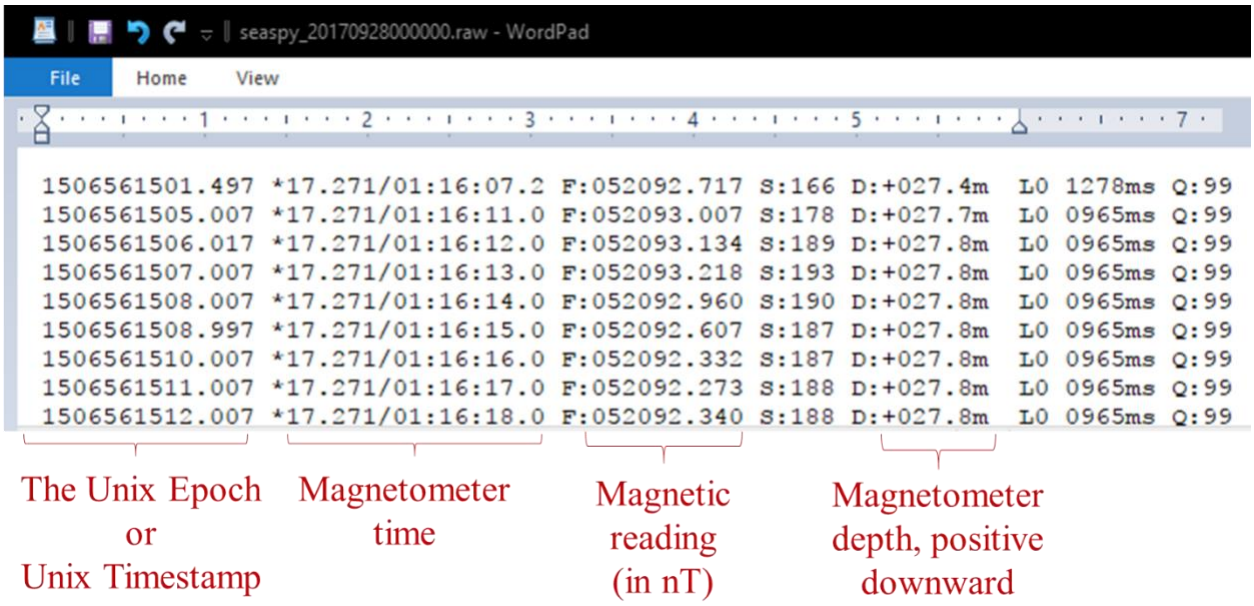


Figure 25. A snapshot of magnetometer data.

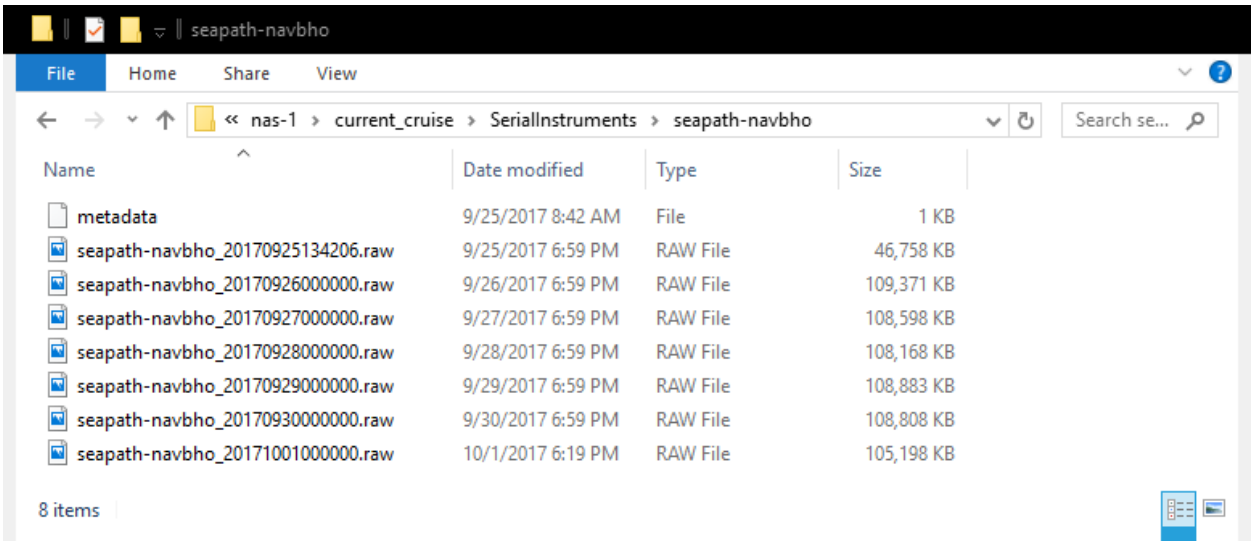
The following parameters are recorded in the magnetic file "seaspy_*.raw". The first column is the Unic Epoch timestamp, similar to the one recorded in gravimeter data file. The second column is the time recorded by the magnetometer; this is supplied by one of GPS's and may not correspond to the timestamp in the first column. We were advised by Scripps personnel (Jon Meyer) to ignore this magnetometer time and use the timestamp from the first column instead. The magnetic reading in nT follows the "F:" in column 3. The parameter after S: is unknown. The column D indicates the magnetometer depth in meters below sea level (positive downward). Finally, the rest of the columns are unknown.

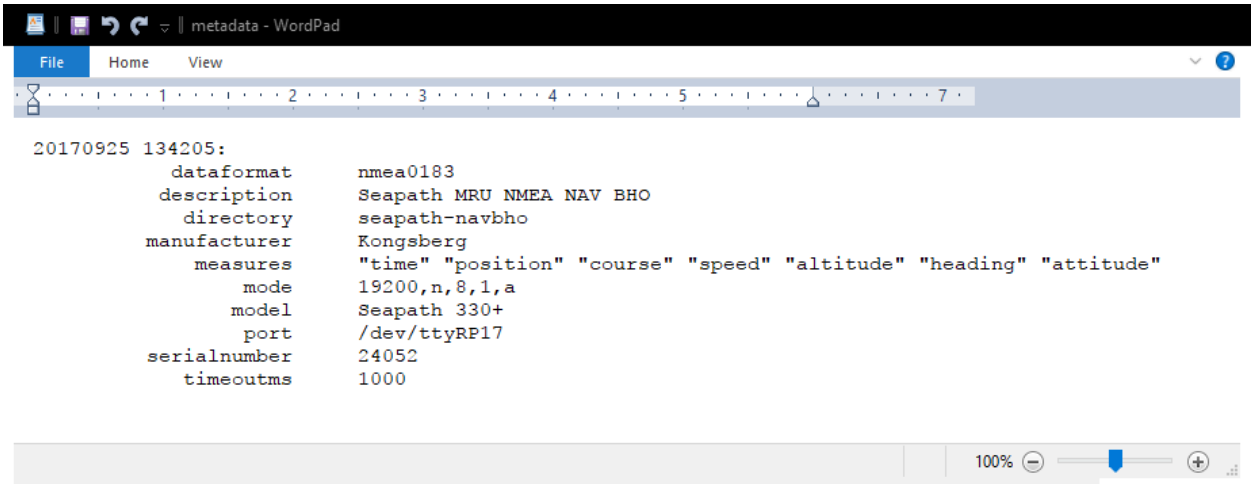
7.3. GPS

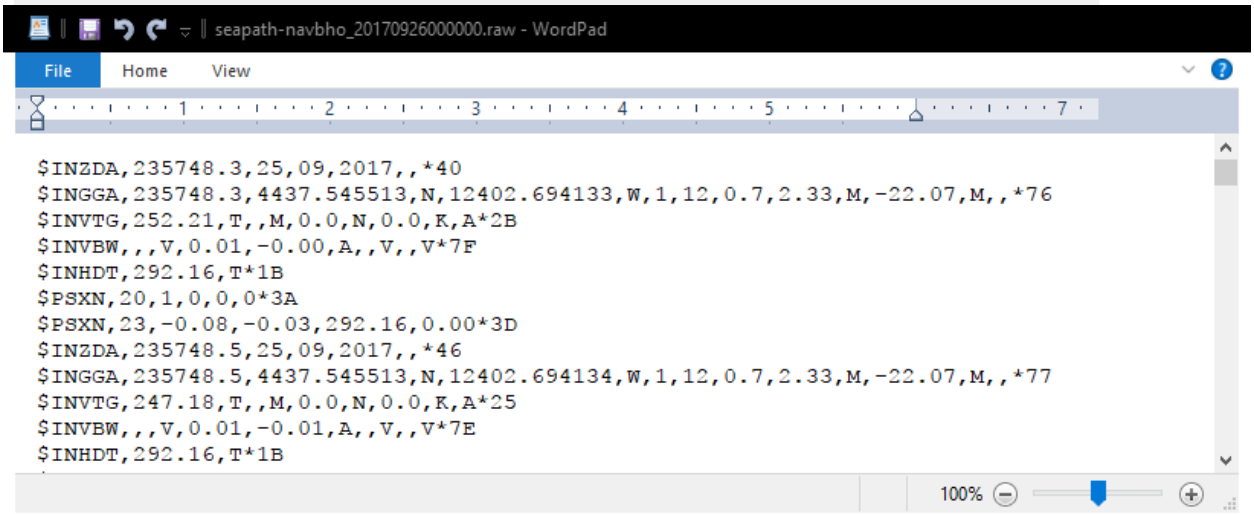
The ship location is recorded with multiple GPS instruments. The preferred one (per Jon Meyer of Scripps) is SeaPath (manufactured by Kongsberg), the second preferred one is Phins-Gyro (manufactured by IXSEA). Both SeaPath and Phins-Gyro report the location of the center of the ship (one deck down from the science lab). The ASCII files are recorded daily to the following folders:

The SeaPath navigation data

SeaPath: \\nas-1\current_cruise\SerialInstruments\seapath-navbho

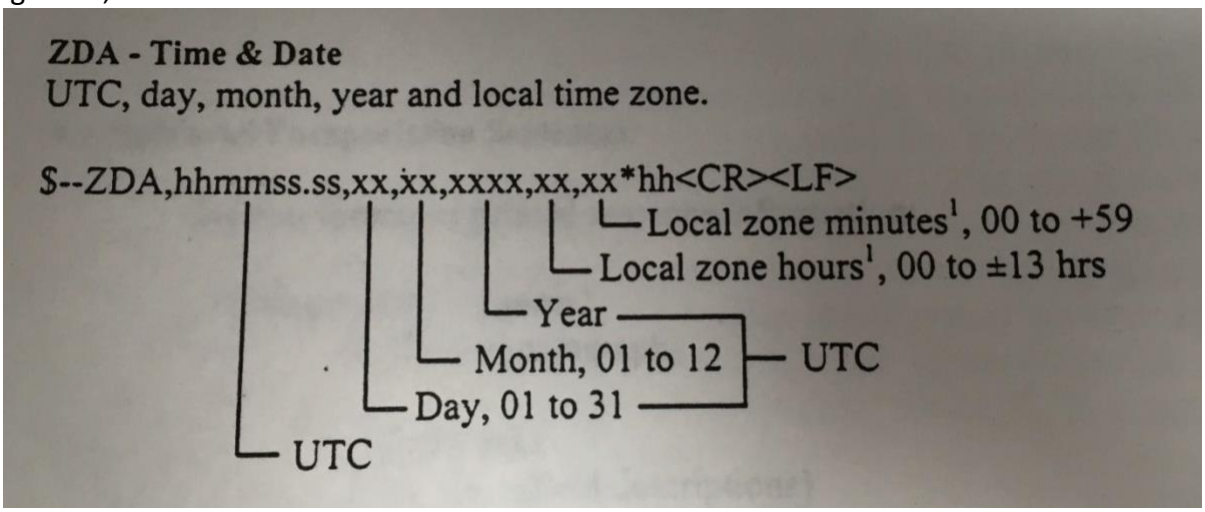




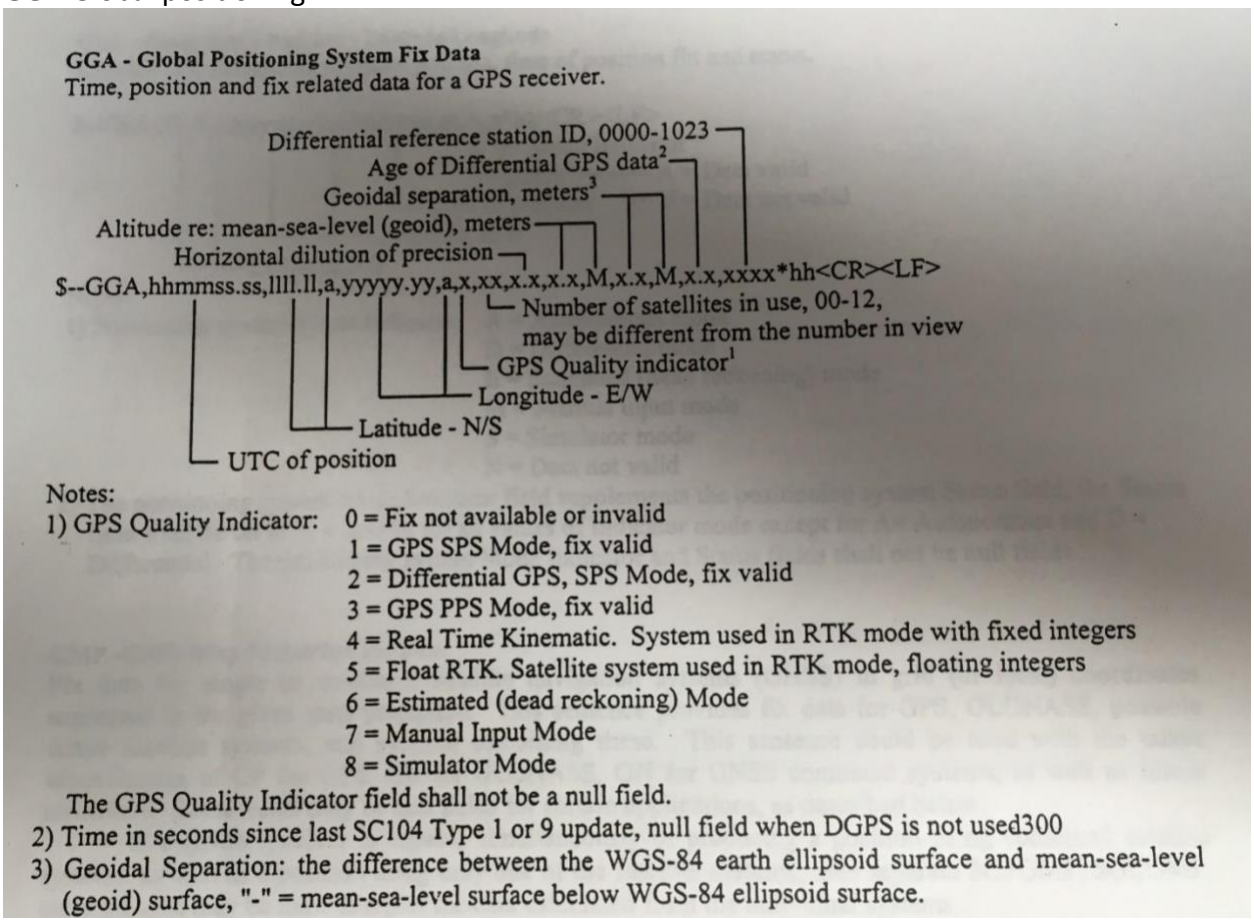


The file format for all GPS records is described in the ***NMEA 0183*** specification document (National Marine Electronic Association, version 3.00, 2000). The paper copy of this document was available in the technical lab. Below are some pages that refer to the file structure.

$INZDA is the record corresponding to time. The $ sign and the first two letter should be ignored, so the true time record is **ZDA**



GGA Global positioning



VTG

VTG - Course Over Ground and Ground Speed

The actual course and speed relative to the ground.

$--VTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>

- Mode Indicator[1]
- Speed over ground, km/hr
- Speed over ground, knots
- Course over ground, degrees Magnetic
- Course over ground, degrees True

Notes:

1) Positioning system Mode Indicator:
- A = Autonomous mode
- D = Differential mode
- E = Estimated (dead reckoning) mode
- M = Manual input mode
- S = Simulator mode
- N = Data not valid

The positioning system Mode Indicator shall not be a null field.

VBW

***VBW - Dual Ground/Water Speed**

Water referenced and ground referenced speed data.

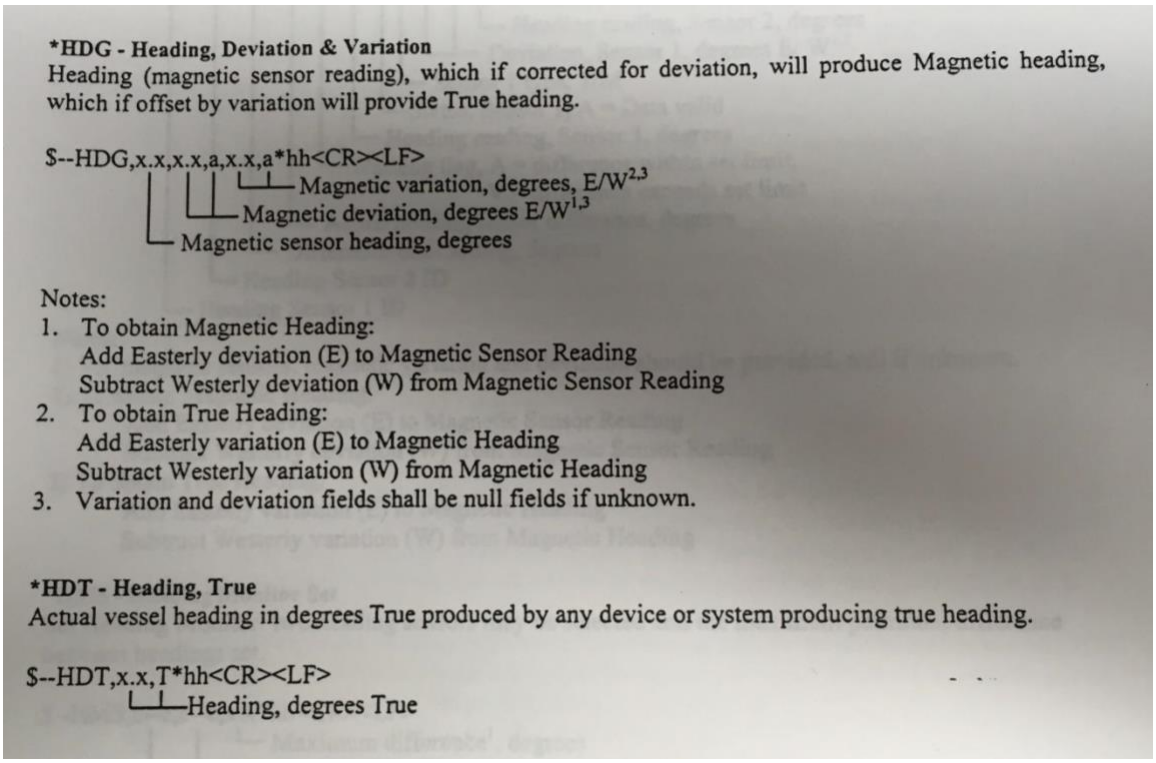
$--VBW,x.x,x.x,A,x.x,x.x,A,x.x,A,x.x,A*hh<CR><LF>

- Status, stern ground speed — A = Data valid, V = Invalid
- Stern transverse ground speed[1], knots
- Status, stern water speed, A = Data valid
- Stern transverse water speed[1], knots
- Status, Ground speed, A = Data valid
- Transverse ground speed[1], knots
- Longitudinal ground speed [1], knots
- Status: Water speed, A = Data valid
- Transverse water speed[1], knots
- Longitudinal water speed[1], knots

Notes:

1) Transverse speed: "-" = port, Longitudinal speed: "-" = astern

$HDT is heading/track control data



***HDG - Heading, Deviation & Variation**

Heading (magnetic sensor reading), which if corrected for deviation, will produce Magnetic heading, which if offset by variation will provide True heading.

$--HDG,x.x,x.x,a,x.x,a*hh<CR><LF>

- Magnetic variation, degrees, E/W[2,3]
- Magnetic deviation, degrees E/W[1,3]
- Magnetic sensor heading, degrees

Notes:

1. To obtain Magnetic Heading:
   Add Easterly deviation (E) to Magnetic Sensor Reading
   Subtract Westerly deviation (W) from Magnetic Sensor Reading
2. To obtain True Heading:
   Add Easterly variation (E) to Magnetic Heading
   Subtract Westerly variation (W) from Magnetic Heading
3. Variation and deviation fields shall be null fields if unknown.

***HDT - Heading, True**

Actual vessel heading in degrees True produced by any device or system producing true heading.

$--HDT,x.x,T*hh<CR><LF>

- Heading, degrees True

The following script was written by John DeSanto to extract the time, latitude and longitude from the SeaPath navigation files:

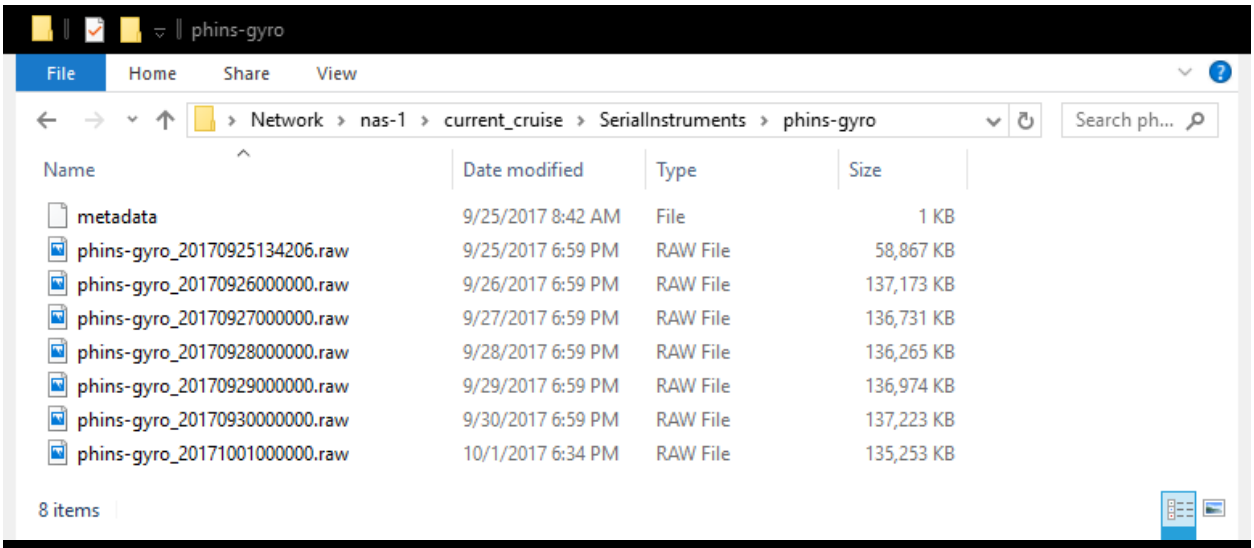
```
#This script is meant to read a raw data file from the R/V Roger
#Revelle Seapath330+ navigation (titled seapath-navbho_YYYYMMDD000000.raw)
#and extract the time, latitude, and longitude using the awk script
#parse_ingga.awk.
#
#For the script to work, make sure that your raw navigation file and
#parse_ingga.awk are in the same directory as this executable script.
#
#Execute the script by running the command:
#      get_latlon.sh YYYYMMDD
#
#This will generate a file sp_shipnav_YYYYMMDD.dat. in the same directory.

grep INGGA seapath-navbho_$1000000.raw > tmp

awk -f parse_ingga.awk tmp > sp_shipnav_$1.dat

rm tmp
```

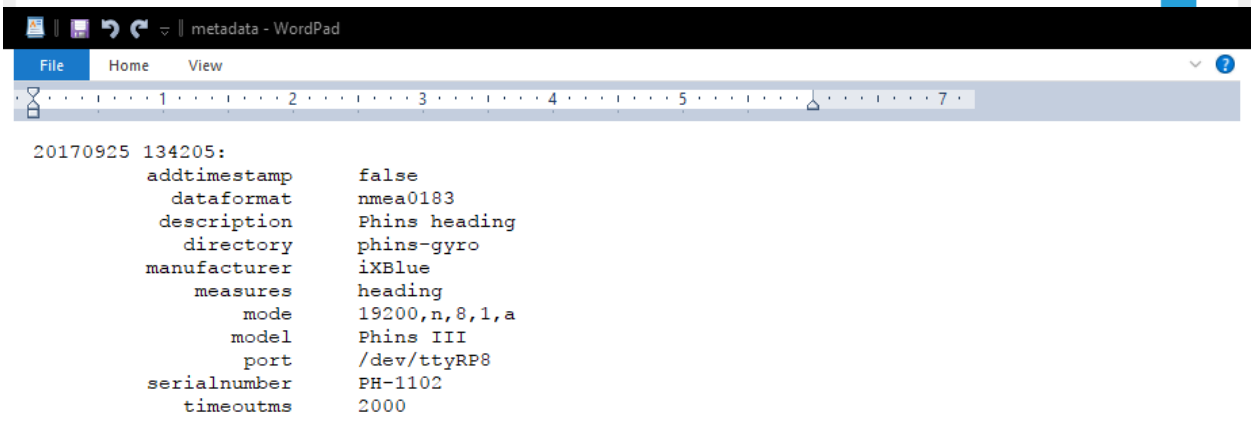
The parse_ingga.awk script is below:

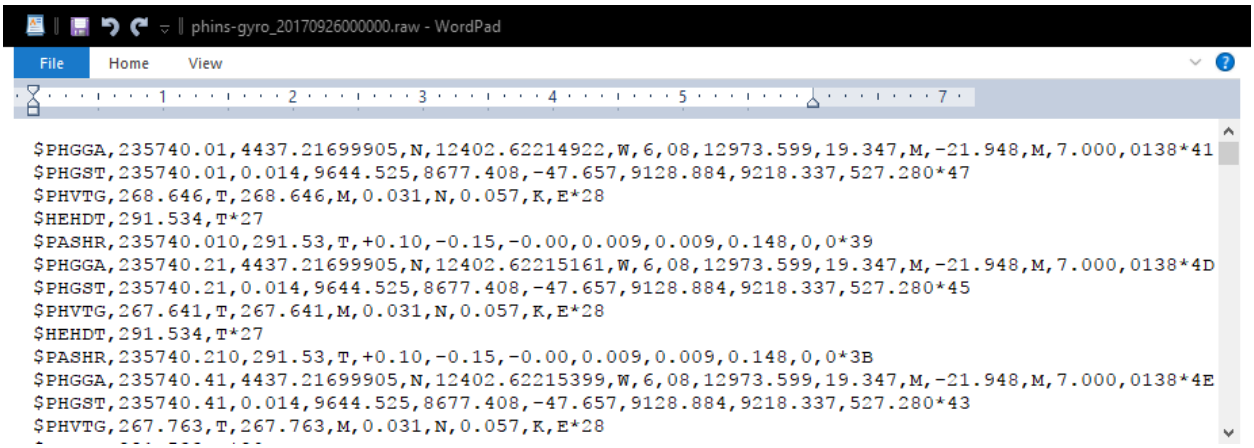
```
#!/bin/awk -f

BEGIN {
        FS = ","
}
{
        hh = substr($2,1,2);
      mm = substr($2,3,2);
      ss = substr($2,5);
        latd = substr($3,1,2);
        latm = substr($3,3);
        a = 1;
        if ($4 == "S"){
                a = -1;
        }
        lond = substr($5,1,3);
        lonm = substr($5,4);
        b = 1;
        if ($6 == "W"){
                b = -1;
        }
        lat = a * ( latd + latm/60 );
        lon = b * ( lond + lonm/60 );
        printf("%s %s %s %.9f %.9f\n",hh,mm,ss,lat,lon);
}
END {
}
```

Phins-Gyro navigational data

Phins-Gyro data are located in: \\nas-1\current_cruise\SerialInstruments\phins-gyro







GGA, **VTG**, **HDT** parameters are the same as in the SeaPath datafile.

8. Daily Reports

The daily reports cover onboard operations from September 26 until October 2, 2017 (Julian days 269 through 275) and are composed of daily summaries and more detailed watch stand reports for handoff purposes.

8.1. Tuesday, September 26, 2017 (JD 269)

Daily Summary
The R/V Revelle departed from the marine science dock in Newport, Oregon at 17:48 UTC. At 19:30 UTC, the all hands participated in an abandon ship drill, at which point the R/V Revelle slowed to ~2.5 kt. At the conclusion of the abandon ship drill at 20:07 UTC, the ship continued moving toward the way point for seismic streamer and source deployment. During this time, preparation for deployment of the MCS equipment was also underway. The ship slowed to 3 knots at 21:48 UTC in order to deploy the streamer in the water. Once the streamer was in the water, the multibeam was turned on at 22:33 UTC, followed by the echosounder at 22:34 UTC. Operations are now focused on getting the MCS system fully operational.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Brandi Lenz
Watch began at 1600 UTC. Terminology regarding turns and MSC line numbers were defined. Watch duties were assigned and a rotation was agreed upon. Communicated with the bridge regarding turn nomenclature and plans.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Emily
Co-Chief: Collin Brandl
Watch duties were assigned and a rotation was agreed upon. Around 21:45 UTC, team went out on the deck for MCS deployment.

8.2. Wednesday, September 27, 2017 (JD 270)

Daily Summary
R/V Revelle continued working to get the Scripps Portable MCS system fully operational. The MCS system was fully deployed at 00:05 UTC, at which point the ship sped up to 5 knots to return to the planned course before testing. The multibeam was stopped at 00:29 UTC for troubleshooting, as the center portion of the mosaic was missing. After conducting a power cycle on the MB computer at 00:29 UTC, the multibeam returned to logging at 00:36 UTC. The first MCS check shot was at 00:25 UTC and the second seismic source was turned on with a check shot at 00:30 UTC. At 00:42 UTC, the chirp echo sounder was switched to external mode. At 1:45 UTC the first shot of Line 1 commenced at water depth of 566m. Shot-points 377-379 seismic source 1 delta error. Poor multibeam data was acquired from 3:38 through 4:23 UTC and then power cycled. XBT deployed at 5:05 UTC. Multibeam was back online and logging at 6:44 UTC. Seismic Line 1 ends at 6:50 UTC. Seismic Line 2 begins at 6:56 UTC and ends at 8:44

UTC. Seismic Line 2T began at 9:44 and ended at 10:24 UTC. Seismic Line 3 begins at 10:44 and ends at 12:46 UTC (shot 3965) due to compressor leak/acoustic source malfunction. We crossed Kulm Ridge at 13:21 UTC and did not observe bubbles. Acoustic source testing resumed at 20:07 UTC.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Emily
Co-Chief: Collin
Finished deploying the MCS streamers and GI Sound Sources at 00:05 UTC. MCS line naming scheme was adjusted to not include a line number 0. MCS data began recording at 01:45 UTC.

Watch Stand 3 (20:00 – 04:00 local)
Chief: Brendan R.
Co-Chief: Irina
Soon after the start of the watch the sonar systems, both multibeam and echosounder, encountered a significant noise source that reduced the quality of both measurements. The echosounder was switched to dual-ping mode at 3:42 UTC, which allowed it to continue collecting satisfactory data, but the multibeam remained unstable. At 4:23 UTC both instruments were turned off for troubleshooting purposes. The instruments were turned back on at 4:39 UTC. The multibeam data quality was not improved, so it was set to not log data. The echosounder continued logging data. At 08:47 UTC, we began the first turn named Seismic Line 2T, we decided to name each turn after the last seismic line acquired and added a T to the name to indicate it is a turn. First attempt to collect data for Seismic Line 2T failed, at 09:44:34 UTC we began Seismic Line 2T collection successfully. At 09:14 UTC, multibeam data quality improved after the ship started to turn during the collection of Seismic line 2T.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Valerie
Co-Chief: Subbarao
There was a compressor leak and the air guns were turned off at 12:26 UTC on shot 3965, seismic line 3. Base stn. gasket blown. Multibeam and echosounder remained online and collecting good data. Decided to circle around until MCS is back online to begin Seismic line 4. We also updated the master waypoint spreadsheet since seismic line 3 had to be shortened by 10 km.

Watch Stand 2 (12:00-20:00 local)
Chief: Collin
Co-Chief: Ashely
The compressor was repaired and is operational however the acoustic sources are malfunctioning. Multiple ship turns are performed while trouble shooting the compressor/source issue. Source testing is ongoing through 20:30 UTC.

8.3. Thursday, September 28, 2017 (JD 271)

Daily Summary
R/V Revelle continued operations for MCS Line 4. We finished troubleshooting the magnetometer and deployed it at 00:27 UTC. The magnetometer began logging at 01:17 UTC. There was an issue with the one functional compressor at 4:50 UTC. The second compressor was up and running by 5:10 UTC. A strong bubble plume was detected on the multibeam above Kulm Ridge at 13:35 UTC. One of the sound sources had an operating issue, so we decided to obtain Lines 7 and 8 with only one sound source. For a quality check, we promptly processed Line 7 data and ensured that we have acquired quality data with 2 second penetration even with these issues.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Collin
Co-Chief: Ashley
Continued the collection of MCS Line 4. The magnetometer was operational on the deck, however we would lose signal once the instrument was deployed. The magnetometer was fixed and deployed at 00:27 UTC and went online for logging at 01:17 UTC.

Watch Stand 3 (20:00 – 04:00 local)
Chief: John Schmelz
Co-Chief: John De Santo
XBT deployed at 3:30 UTC. Sound velocity profile applied to EM122. We planned to shut down the seismic units during the loop turn at waypoint 6, and the PSOs confirmed that they were comfortable observing during current night-timing conditions. However at 4:50 UTC there was trouble with the one functional compressor and the source was shut down. The last data collected on line 4 was with shot 5924, although the last FFID was 6045. By ~ 5:10 UTC the engineers reported that the second compressor was up and running but the other compressor would need time to cool down before repairs could be made. At 5:25 UTC the PSOs begin the 30 min observation period and cleared startup of the source at 5:55 UTC. The first and second sources were promptly ramped back up. Possible northern lights sighting at 6:05 UTC. The magnetometer was turned off at the end of magnetometer line 1, then pulled close to the ship so in preparation for the turn at WP6. After the turn, line 5 started with shot number 6046 at 7:08 UTC.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Casey
Co-Chief: Sharan
Modified waypoints for northern survey section in consultation with Watch 3 to ensure successful survey in the southern sections. An interim decision has been to remove the NS line and portions of the Orwell reoccupation line, while retaining tie line to DSDP 176. Changes are ongoing to shorten the survey by ~24 hours due to previously lost time. We detected a strong bubble plume on the Multibeam at 13:35 UTC. WP7 was moved closer to the ship as part of the time saving measures and the magnetometer was pulled in closer in anticipation of a turn. Hydrophone from gun 2 stopped detecting the gun for a few minutes at 15:15 UTC. Everything

up and running by 15:20, and the last 5-10 minutes of data of line 5 from the magnetometer is noisy due to not turning it off on time. The magnetometer has been recovered until WP16, where it will be deployed again. Air gun 2 hydrophone offline again at 16:20 UTC but guns firing as normal. Turn nomenclature created some confusion today. Line 6 is erroneously named as line 6T and T-turn 6T is renamed as 6T2. For future reference, if there is a waypoint, irrespective of how soft the turn at the waypoint is, a new line must be created. In addition to the T-turns named as line N-T, we will also name the loop and half-loop turns as N-L and N-HL respectively.

At 18:25 UTC, we decided to haul in the acoustic sources to fix the hydrophone on source 2. This was scheduled to happen after passing through WP9, during a large transit T-turn to WP10. ETA to fix hydrophones and restart firing is about 1.5 hours. During repair phase, after WP9, air gun 2 was turned off. Both air guns were on deck as of 1907 UTC.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Ashley
Co-Chief: Parker
The hydrophone was replaced on air gun 2 and both air guns were put back into the water as of 19:25 UTC. Still saw an issue with air gun 2, so it could be an problem with the connection and not an issue with the hydrophone. We were presented with two options: proceed with only one air gun or have both and risk a timing offset. We decided to go with the first option. Line 7 started at 20:14 UTC with shot 9769. We decided to fire Lines 7 and 8 with air gun 1 and will check the quality of the data and penetration depth. If we are confident that the single air gun can penetrate enough for WP16-WP18 we will continue with one air gun. Finished Line 7 at 21:50 UTC. Lee tried switching out an air gun cable during turn 7T, but it did not fix the problem. We started Line 8 at 22:20 UTC at shot 10506, still using air gun 1 only. At 22:56 UTC we discovered that the birds had not been lowered into the water because the DOS box had not been reset. We reset it and lowered the birds, and saw an improvement in the data quality starting at shot 10560. The multibeam data was behaving strangely starting at the end of Line 7 through most of Line 8. We stopped and restarted the multibeam several times during Line 8, and the multibeam became more stable starting at 23:33 UTC. We finished Line 8 at 23:48 UTC, and turned off the air guns for troubleshooting at 23:56 UTC. Kittipong and Ben processed Line 7. It shows that with one air gun we are getting about 2 s of penetration, so the current plan is to wait to take out the air guns after WP18. Lee said that he will have to open up the air guns to better diagnose the problem, and he feels most comfortable doing that during the longer transit time than between WP15-16.

8.4. Friday, September 29, 2017 (JD 272)

Daily Summary
R/V Revelle completed MCS lines 9-13 with one sound source and one compressor; the multibeam and echosounder were synced to improve data quality. At 02:31 UTC, a possible gas seep was detected in the multibeam data. The sound source was turned off at 4:15 UTC for about 10 minutes for compressor maintenance. The multibeam was turned off at 4:45 UTC for 2

hours during a turn in shallow water which was causing poor data quality. Once in deeper water it was turned on again for the remaining lines. The magnetometer was deployed at 10:16 UTC and recovered at 5:33 UTC in preparation for the MCS recovery. MCS recovery lasted 03:03 from 04:42. By 05:07, the MCS, multibeam, and echosounder were fully stopped acquiring data. R/V Revelle is now underway to WP 21 with the magnetometer collecting data.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Ashley
Co-Chief: Parker
The day began during turn 8T. The sound sources were turned off as of 23:56 UTC (JD 271) so Lee could troubleshoot them on deck before Line 9 at WP14. We began Line 9 at 01:11 UTC with only one sound source. The mutibeam and chirp echosounder were synced to improve the quality of the multibeam data. If the multibeam goes down again, we need to change the sync setting on the echosounder to preserve the chirp data quality. John Collins reseeded the network cable for the multibeam data to make it less noisy. At 02:31 UTC we saw a possible gas seep in the multibeam data. This seep was coming from the north end of Kulm ridge. The multibeam water column data was processed in FMMidwater to get exact locations.

Watch Stand 3 (20:00 – 04:00 local)
Chief: Alexis
Co-Chief: Estefania Ortiz
Our shift began during Line 9. Due to miscommunication with the bridge, the end of Line 9 was slightly off course. Started Line 10 at 04:32 UTC with only one sound source. At 07:34 UTC we stopped the multibeam because we approached shallow waters and were collecting anomalous data. At 08:16 UTC we entered deeper waters and turned on the multibeam to collect data. At 10:16 UTC we deployed the magnetometer.

Watch Stand 1 (0400-1200 local)
Chief: Brendan P.
Co-Chief: Maureen
At the start of the watch, we were still operating on one air gun and one compressor. Launched XBT at 14:30 UTC. At 14:30 UTC, PSO reported moving onto the bridge due to rain. The sound velocity profile was applied to the multibeam acquisition software at 14:45 UTC. Magnetometer recording was stopped and the instrument was pulled in at 15:15 UTC in preparation for the turn at WP 18. We reached WP 18 at 15:50 and turned to the southwest for line 12. Multibeam data quality decreased during the turn and didn't improve, likely due to beam seas. For this reason, multibeam logging was turned off at 16:45. At 16:13, the PSO reported that they were back at their station on the O3 deck. At 16:15, we stopped shooting the air guns so that the ship's engineers could add oil to the compressor, which was an urgent need. The compressors came back online at 16:26 and we resumed firing line 12 after being cleared by the PSO. There's a small gap in the line 12 data for this period of time. The magnetometer was fully recovered at 17:33 in preparation for the air gun and streamer recovery (planned for next shift) and we reached WP 19; this marked the end of line 12 and the beginning of line 13. The chirp data improved slightly after the turn and the multibeam did not recover by the end of shift.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Jessie
Co-Chief: Kittipong
Line 13 ended at 20:00 UTC– we did a turn away from the prevailing current to release some of the tension on the streamer. The MCS recovery process took two hours and went smoothly. Full MCS recovery, multibeam and echosounder were turned off at 21:45 UTC. The magnetometer was deployed at 22:05, line M6 started shortly after, and we began cruising southwards full steam to WP 21. We will discuss with the PSOs if they feel comfortable observing at night. If so, we will consider the expected conditions and decide to deploy the streamer at that time. Lee is prioritizing fixing the air gun cable connection before converting the SegD to SegY files for lines 1, 2, 3, and 4.

8.5. Saturday, September 30, 2017 (JD 273)

Daily Summary
R/V Revelle completed its transit to the southern portion of the survey region at 06:45 UTC and we deployed the seismic systems. The PSOs spotted dolphins, so we waited for the dolphins to swim a safe distance away before starting the seismic systems. We began Line 14 at 09:14 UTC. We deployed and began magnetometer line M7 at 10:27 UTC. We completed magnetometer Line M7 at 14:52 UTC and Line 14 at 14:55 UTC. We noticed some issues with the hydrophone on the sound source towards the end of Line 14. This was fixed before starting Line 15 at 17:14 UTC. We began magnetometer line M8 at 20:08 UTC after a slight turn at waypoint 24.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Jessie
Co-Chief: Kittipong
This portion of the watch was spent in transit to WP21. We expect to reach WP21 around 07:00 UTC. Lee talked with the PSOs, and they feel comfortable observing at night for the streamer deployment. Lee is prioritizing fixing the air gun cable connection before converting the SegD to SegY files for lines 1, 2, and 3.

Watch Stand 3 (20:00 – 04:00 local)
Chief: John
Co-Chief: Alexis
At the start of the watch we were transiting to Line 14. Around 06:45 local time we deployed the equipment and the PSOs began to watch after we completed the task. They saw dolphins at around 08:30 local time, and more a few minutes later. This delayed the start of seismic collection. After the compressors were fired up, it was confirmed that the hydrophone on the second gun was working correctly. At 08:17 UTC we turned on the multibeam and echosounder. Some of the team observed bioluminescence off the port side of the boat, but others gave up before their eyes properly adjusted to the darkness and missed out. At 10:27 UTC the magnetometer was deployed starting mag line 7.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Subbarao
Co-Chief: Brandi
At the start of the watch we were on seismic line 14 on our way to waypoint 22. Air gun 2 started having issues again at 13:51 UTC on shot 18212 of seismic line 14. We ended magnetometer line 7 at 14:52 UTC and recovered the magnetometer. We shut down the air guns at 14:55 UTC and ended line 14 at shot 18575 for troubleshooting. We extended line 14 to allow more time for troubleshooting, took a wider turn to waypoint 23, and slowed down to 3 knots. Started ramping up one air gun at 15:58 UTC for testing, however issue still remained. Troubleshooting continued. Both air guns came back online at 16:17 UTC and appear to be working correctly. Ship speed increased back to 4.5 knots and proceeded to waypoint 23. We reached waypoint 23 at 17:14 UTC and began seismic line 15.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Kittipong
Co-Chief: Parker
Our watch started on Line 15. We released an XBT at 19:36 UTC and updated the sound velocity profile in the multibeam at 19:47 UTC. We reached WP24 at 19:47 UTC and took a slight turn towards WP25, continuing seismic line 15. After the streamer straightened out, the magnetometer was deployed and line M8 started at 20:08 UTC. We released another XBT at 23:20 UTC and added the sound velocity profile to the multibeam at 23:26 UTC.

8.6. Sunday, October 1, 2017 (JD 274)

Daily Summary
We continued our expedition, collecting data for seismic Line 15, over the Diebold Knoll. During the day, we had the opportunity to deploy an XBT, used to measure the ocean temperature and calculate a sound velocity curve to calibrate bathymetry. Halfway through our day, we were delighted to learn we were 7 hours ahead of schedule, giving us extra seismic data acquisition time. We adjusted our plan accordingly and extended Lines 21 and 22, going over Brendan's Seep, to acquire data that would give us greater geological context for the region.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Kittipong
Co-Chief: Emily
Nothing of note occurred during this portion of the watch. We continued along line 15 from WP24 to WP25.

Watch Stand 3 (20:00 – 04:00 local)
Chief: Estania
Co-Chief: John
At 4:04 UTC on the way to waypoint 25 we turned the magnetometer off but kept it behind the ship to do the turn. At 04:41 UTC we ended seismic line 15 (last ffid: 22341). At 04:45 we released XBT 7. At 05:03 we started seismic line 16 (ffid: 22346). At 05:29 we redeployed the

magnetometer and started recording line M9 until 09:00 UTC. At 09:27 the magnetometer was on deck. At 09:54 we ended seismic line 16. At 10:24 the multibeam started picking up unrealistic values (~3000 m depth) that may be due to ship heading.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Brandi
Co-Chief: Srisharan
Starting line 17. We just found out that we might be ahead of schedule by 7 hours, after accounting for gear recovery time and transit. Currently, we extended lines 17 and 19 seaward by 2 nautical miles each to probe incoming sediments. We are planning on extending the line going over Brendan's Seep in an EW direction before heading to Newport. We encountered a fishing boat near WP29 and had to extend line 18 further south to let the boat pass before making the loop turn to head to WP 30. This quickly became a non-issue since the fishing boat went in a different direction and our longer loop cost us an extra ~10-15 minutes.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Parker
This shift started after the loop turn at WP 29 (had to be a little wide to avoid a fishing boat), then proceeded on seismic line 19 to WP 30. Performed loop turn at WP 30 and started seismic line 20 towards WP 31.

8.7. Monday, October 2, 2017 (JD 275)

Daily Summary

This day began with the continuation of line 20, which was the longer line that connected the two trench-perpendicular lines in the southern survey and ended north of the Pythia seep. There was a brief period after line 20 where the guns were shut down for compressor maintenance, but we were firing again prior to line 21. Lines 21 and 22 proceeded without incident until a fishing vessel was spotted in the ship's path along the western end of line 22. The rest of line 22 was aborted and a final crossing was made over the seep, headed northwest. All gear was recovered after line 23 and the ship began the transit back to Newport. The cruise came to an end when the Revelle docked at the OSU dock around 1900 UTC.

Watch Stand 2 (12:00 – 20:00 local)
Chief: Parker
We continued along line 20, reaching WP32 around 04:15 UTC. Line 20 continued on to cross over the seep and line 20 ended around 05:00 UTC. We then turned to the southwest towards the start of line 21, but the guns were powered down during transit due to the air compressors vibrating excessively (this was determined based on a call from the engine room). The compressors were turned back on and the PSO cleared air gun firing before reaching the start of line 21. We passed over the seep again on line 21 at 0750 UTC. This shift ended with the start of line 22, which passes to the south of the seep.

Watch Stand 1 (04:00 – 12:00 local)
Chief: Casey

We began our shift on the second half of line 22 nearing the end of our planned survey activities for the cruise. After a call from the bridge about a stationary fishing boat at the end of line 22, a quick revision to the plan was made. The ship turned off line 22 early (after completing the cross with N-S line 20) and headed NE to make one final pass over the seep site. The ship passed the intersection between lines 20 and 21, heading NE until the streamer had cleared the seep and the science party was convinced that a full fold had been achieved over the target. While the multibeam data from line 23 still suffered from a poor ship heading, a noticeable return in the water column above the seep could be seen in the seismic brute stack image, suggesting the presence of a bubble plume. After completing the improvised line 23, the ship turned south (for following seas) and slowed to 2 knots for the recovery of the seismic streamer. Air guns were turned off at 12:02 UTC and the seismic streamer was recovered by 14:13 UTC. A small fluid leak from the seismic streamer was identified during recovery, possibly due to an exploratory bite from a shark, and a patch was made with electrical tape and a fast-drying liquid sealant. After recovery of the seismic streamer, the Multibeam and 3.5 kHz echosounder were shut off by 14:25 in accordance with our permitting. We began our transit back to Newport harbor at approximately 14:20 UTC. We reached the Newport harbor entrance around 18:30 and encountered the R/V Siquliaq as she headed out to service the OSU Ocean Observatory Initiative surface moorings. The R/V Revelle reached the OSU dock around 19:00 UTC, bringing a successful cruise to a close. Cruise participants were off the boat by 20:00 UTC for the start of the post-cruise workshop on the Hatfield campus.

Appendix-1 EAGER Proposal (01.24.2017, v.9)

Collaborative EAGER project:

Early Career Seismic Chief Scientist Training Cruise

Motivation

Results of the recent UNOLS Marine Seismic Questionnaire (MSQ) demonstrate the value of an early career scientist (ECS) Multi-Channel Seismic (MCS) chief scientist training cruise. We particularly encourage participation of *non-seismic specialists* because we note that approximately half of the MSQ respondents expressed interest in using seismic data for their research, while admitting a lack of knowledge and hands-on experience in acquiring and processing such data. This regrettable situation has evolved as mentorship and shipboard training opportunities available to U.S. graduate students and early career scientists have been in decline. We are targeting "non-specialists" because we are aware of other training efforts in development that are designed for more experienced ECS participants. This would be a complementary effort.

We propose an MCS training cruise on *R/V Roger Revelle* that would (1) increase the number of early career scientists experienced in marine seismology to maintain the U.S. marine seismology community, (2) increase the visibility of the Scripps Institution of Oceanography (SIO) portable MCS system and promote its value as an available UNOLS resource. The novel, transformative part of this 15-day activity that is appropriate for Early-concept Grants for Exploratory Research (EAGER) funding would be that ECS non-specialists would gain first-hand experience in planning survey tracks, generating and processing high-quality data, and utilizing the results for future proposals and/or research. It would also provide a relatively low cost opportunity to expose participants to a broad range of seismic capabilities, thus deepening their appreciation for the range of seismic facilities available to the community. The PIs, Tominaga, Trehu, Lyle, Mountain, and Bangs have used this or other portable MCS systems, as well as other NSF facilities, and are now willing to lead this training effort.

Cruise Synopsis

We request shiptime ideally aboard *R/V Revelle* with two working compressors (with a compressor engineer participating in the cruise), with the transit from/to possible ports of Seattle, Astoria, San Francisco, and San Diego in Summer-Fall 2017. The U.S. Pacific Northwest region would provide (i) an important science target (see the later *Science* section) to focus the trainees' attention on contributing to a meaningful advance of scientific knowledge that will result in publications, and (ii) a facility to accommodate post-cruise seismic processing and interpretation workshop (e.g. Scripps Institute of Oceanography, San Diego, CA; Hatfield Marine Science Center, Newport, OR, etc.).

Once cruise dates are confirmed, we would schedule a three-part training activity and solicit applications. The first part involves hosting three **webinars** to expose prospective applicants to the fundamentals of active source marine seismology and provide the scientific background needed to plan the upcoming survey effectively. Through the webinars, we plan to give the prospective applicants a general survey region, within which we will provide background on the science problems but allow the participants to define science goals and make detailed cruise plans to meet those goals. Webinars will also introduce the participants to *open source* processing and interpretation tools. We will also instruct the participants in Proposal Writing and Data Management. We would like the former to also include a 45-min web seminar with an NSF MG&G program director to accomplish three things: 1. Provide a primer on how the NSF works, 2. Summarize the do's and don'ts of proposal writing, and 3. Simply put a face on the NSF to familiarize participants with the organization. The introduction to protected species permitting would also include an overview by Holly Smith (NSF). The Data Management instruction would include an overview by R2R and Marine Seismic Data System personnel and how to search for and access available data, manage post-cruise data archiving and dissemination, and communicate with data archive facilities, systems, and personnel. After the webinars, we will solicit applications that will include **a maximum 2-**

page science proposal along with other materials on their background. Participants will be selected based largely on the quality of the science plan described in their proposal. Once selected, participants will communicate and discuss their cruise plans with PI team prior to the in-person pre-cruise workshop via several telepresence meetings; then during a 2-day workshop immediately before the cruise, the participants will finalize the cruise plan under the PI teams' guidance.

The second part of the proposed training plan is a short cruise that includes 4 days of seismic acquisition. The total length of the cruise will depend on when it is scheduled, with a longer total cruise length needed if the project were conducted during a transit between ports. On *R/V Revelle*, we anticipate a total of ~32 (Max = 37) members of the science party, including 4 mentors, 16 early-career scientists, 2 postdoctoral instructors, an outreach specialist, Shipboard Science Supporting Group (2), seismic and shipboard geophysics-related support (2), compressor mechanics (1), and maximum 4 (likely 3) protected species observers. When appropriate, we will use a light hand in guiding the participants' survey planning and equipment use for their future proposal as chief scientist roles; our goal is for them to learn by doing, not by watching. We will teach them to use processing software provided, and each participant will contribute to the entire team walking off the ship with processed data (to the point that is practical in the time available) including post-stack time migration.

We will complete the training by holding a two-day data interpretation workshop at, e.g. SIO, with computer-based visualization software. The novel, transformative part of this three-part activity is that ECS non-specialists have the opportunity to gain first-hand experience in designing survey tracks to address science goals, generating and processing high-quality data, and utilizing the results for future proposals and/or research. This workshop is also an opportunity to engage non-scientists in the unique and essential contributions of the role of seismic research in solving a variety of important societal challenges. This will be done through blog posts for AGU, social media and other Social Network Service (SNS)s, etc.

Mentor Team

We have selected a team with a broad range of seismic expertise and levels and areas of seismic specialization who will interact well with the non-specialist participants we anticipate.

Masako Tominaga is a geophysicist and will oversee the preparation, operation and archiving of the ECS effort. She is an Assistant Professor at Texas A&M University. She has logged nearly 600 sea days (including one co-chief and two chief scientist cruises) to conduct a variety of marine geophysical surveys guided by her supervisors, mentors, as well as the community as a whole. Theses cruises took place onboard UNOLS vessels and the JOIDES Resolution. She has previous experience with the SIO portable system as a non-seismic specialist, i.e. Ninetyeast ridge (2008, co-chief scientist) and Jurassic Quiet Zone (2011, chief scientist) cruises. She was recently involved in Science Verification Cruises of R/V Sikuliaq (shipboard geophysics and AUV trial legs), R/V Armstrong (shipboard geophysics and AUV/ROV legs). She will be serving as a chief scientist on R/V Sally Ride Geophysics Ship Verification Cruise (SVC) in early 2017. She has actively engaged with outreach effort, including instructing undergraduate and graduate students from diverse background during marine geophysics cruises and hosting ascience writer workshop onboard R/V Sally Ride (SVC SR 1703).

Anne Trehu is seismologist at Oregon State University (OSU) with nearly 4 decades of experience using a variety of seismological techniques. She has used the SIO portable system in 2007 and 2009 on the Cascadia margin, in 2012 offshore south-central Chile, and in 2015 in the Hikurangi forearc. She has also acquired crustal-scale MCS data on the R/V Gyre, Ewing and Langseth and high-resolution 3D on the R/V Thompson. She also has considerable experience with acquisition and modeling of large aperture data acquired using marine sources recorded on portable onshore instruments as well as on ocean-bottom seismometers, and will introduce the students to the broad range of marine seismological techniques. She

will also mentor and oversee the "hands-on teaching" activities by two OSU seismologist postdocs who will help us operating the workshops and cruise.

Mitch Lyle is a paleoceanographer at Oregon State University who has organized and run seismic reflection surveys to site Ocean Drilling Program and Integrated Ocean Drilling (now Discovery) Program expedition drilling, processed high-resolution seismic data, and submitted ODP and IODP drilling proposals. He has experience with a variety of seismic acquisition systems including the SIO portable system. He has performed seismic reflection and coring surveys for ODP Legs 167, 199, and 202, IODP Expeditions 320/321 as well as the upcoming IODP Exp 378. He is also experienced with core-seismic physical properties data integration through well logging.

Gregory Mountain is a marine stratigrapher who spent 20 years in the MCS group at Lamont-Doherty before taking his present position as Professor at Rutgers University in 2002. He has participated in 18 marine seismic surveys, serving as Chief/CoChief scientist on 14 of them; 5 utilized the Lamont, and more recently the SIO, portable MCS system on 5 different UNOLS vessels. He specializes in high-resolution techniques that provide ties between reflection profiles and drill core data, and 9 of his MCS surveys have contributed to the planning and location of IODP drill sites. He teaches a graduate course that introduces students to seismic reflection principles, processing and visualization using much of the same software we propose to use for instructing Early Career Scientists.

Rebecca Fowler is a science writer and outreach/education specialist who has written for *The Wall Street Journal*, *Eos*, the AGU blogs, and other outlets. She sailed as "educator at sea" on two Southern Ocean cruises aboard the R/V Melville and Revelle (2011 and 2012), has participated in land-based geoscience fieldwork, and collaborated with scientists from Lamont-Doherty Earth Observatory, Bigelow Laboratory for Ocean Sciences, and Texas A&M University on science-based education and outreach activities. She will be involved in all stages of this ECS effort and provide real-time documentation and dissemination of our activities to the public.

Science Targets

Our proposed survey regions are on the active continental margin of the west coast of the United States, where a variety of sedimentary and tectonic settings are available, providing targets of interest to a wide range of participants. Potential targets are the subducting plate and the Astoria Fan, as well as accretionary ridges hosting gas hydrate and pockets of hemipelagic sediment containing paleo-oceanographic information; and the San Andreas fault system as well as paleo-oceanographic targets, both of which have implications for addressing important societally relevant questions, such as earthquake hazards and paleoclimate records in basins. There will also be potential for using seismic techniques to reveal real-time, fine-structure within the water column around upwelling regions associated with the northeastern Pacific coastal boundary currents. We will make all the data open to the public as soon as they are archived; hence, a broader community will have access to the data to augment on-going and near-future science. The proposed survey area also has the advantage of being near to Scripps or other classroom facility so that a cruise would be easy for mobilization or demobilization.

We propose to acquire the data in some areas that have excellent potential for achieving relevant, exciting science goals; however the specific targets and detailed ship tracks will be defined by the participants as part of this training course. Here we highlight some of the potential opportunities in the offshore continental margin off Oregon (Figure 1), an optimal location for exploiting highly relevant science objectives and the best logistics for *R/V Revelle* s summer-autumn 2017 schedule.

Cascadia Survey Area and justification

The broad survey area we propose off Oregon is around the mouth of the Columbia River and the Astoria fan, with a second possible field site off the southern Oregon margin. Figure 1A shows digital seismic data across the Cascadia accretionary wedge and adjacent Juan de Fuca plate. The 2012 Ridge-to-Trench

experiment (e.g. Carbotte et al., 2013; Han et al., 2016) is shown in blue. Dense grids of lines across the deformation front and outer accretionary wedge of Oregon and Vancouver Island were acquired in 1989 as a site survey for ODP Leg 146 (e.g. Carson et al., 1995; Kennet et al., 1995). A grid of lines off Washington was acquired by the 2012 COAST project (e.g. Holbrook et al., 2012). One of the target regions for this area would be to fill in between these two surveys, where only a single MCS profile (acquired in 1996 during ORWELL) is available across the deformation front (e.g. Flueh et al., 1998).

Figure 1B illustrates one of the reasons this region is of interest. The sediment thickness and dip of the oceanic crust at the deformation front (red dots) are well defined in the regions of the COAST and ODP site survey. It is also well defined along the Ridge-to-Trench line on the Juan de Fuca plate immediately seaward of the deformation front. The one ORWELL profile between these two surveys, however, suggests a sharp increase in sediment thickness and in the dip of the oceanic plate beneath the Astoria fan. Better knowledge of the sedimentary structure in the fan and outer wedge and of the dip of the underlying plate can contribute to a variety of scientific questions of relevance to the geology and geodynamics of this region. Prior experience with the SIO portable seismic reflection system using 2 GI guns as a source suggests that we should achieve sub seafloor penetration of at least (and possibly significantly more than) 1.5 s two-way travel time in trench deposits. Penetration with similar systems can be configured to reach ~3 s two-way time.

If this cruise plan is implemented, a survey can also be acquired to image the structures feeding a methane vent on Kulm Ridge, identified on the basis of swath bathymetry and seafloor camera tows (Figure 1C). No seismic profiles (including no legacy industry or USGS profiles) cross this structure. In addition, the slope basins between the ridges shown in Figure 1C provide an opportunity to identify hemipelagic deposits that might be used to study Pacific Northwest climate and Columbia River flow.

A separate potential survey area along the Oregon margin is farther to the SW (Figure 1D), which would target buried topography on the Juan de Fuca plate. In particular, we could explore the subsurface structure of Diebold Knoll, a recently named complex seamount structure ~50 km west of the Cascadia deformation front, including defining its volume and the relationship to the sediments that drape over it. We could also investigate other buried structures on the Juan de Fuca plate and the structure of the deformation front along this poorly imaged segment of the Cascadia subduction zone, which has been marked by major slope instability in the past. The Oregon margin and vicinity offer more than enough imaging targets and science questions for course participants to easily develop surveys to address a wide range of science questions.

Training Cruise Structure

Step-1: Call for Participants

We will present this opportunity at AGU Fall 2016 meeting during the MLSOC meeting. We will broadcast a call for applicants to attend **a series of three webinars** that are designed to teach the entire flow of a seismic cruise. To attract a diverse group of potential participants, we will share the advertisement on science listservs (i.e. UNOLS, GeoPRISMS, IODP, etc.) with the mailing list collected from the MSQ, and with professional organizations and networks whose aim is to increase the participation of underrepresented minorities and women in STEM, such as SACNAS (Society for Advancement of Chicanos/Hispanics and Native Americans in Science) and ESWN (Earth Science Women's Network).

Step-2: Participant Selection Criteria and Webinars (Due to Mentor Team's availability (all of us will be at sea Jan. - Feb.!), early March would be the earliest)

The webinars will be open to graduate students, post-docs, and/or ECS scientists from U.S. institutions. We will make it clear that the course is intended primarily for individuals without extensive prior

experience with marine seismology. During the Webinars, We will provide prospective applicants all the information necessary to formulate their **2-page science proposal**.

Webinar topics will include developing science questions, securing NSF funding, designing the survey, planning logistical support phases of the cruise, identifying shipboard responsibilities, managing the data handling, computing, data processing, and properly archiving the data.

In detail, **the webinars** will be constructed as follows:

1. "How to develop science hypotheses and address them with marine seismics": We will begin with a cruise planning primer, including a) background geology of the upcoming field area and potential science questions to pursue; b) description of shipboard geophysics tools that will be available and needed to address marine seismic research (including navigation, 3.5 kHz, swath bathymetry, etc.) and c) a primer on MCS theory, particularly focusing on the advantages and limitation of different sources and receivers, and equipment configurations.

2. "How to develop marine seismic proposals": Seismic-related Proposal Writing including a) a primer by MGG program directors via Webinar; b) Data Management for both underway and archived seismic data by one of the R2R PIs from SIO and/or LDEO/IRIS/MGDS/MSDC etc. via Webinar; and c) an introduction to securing permits for using active source seismology in regions of protected marine species by Holly Smith at NSF. The timing of the application solicitation process would likely be taken place after us going forward with IHA permit; nevertheless, we will make all the steps involved in the IHA permit-related processes transparent to the selected participants as a part of their chief scientist training.

3. "How to develop a marine seismic acquisition plan": This will include a) an introduction of open source tools/software (e.g. Seismic Unix, OpenDtect), and b) cruise logistics. Upon completion of this webinar, prospective participants will be ready to organize their research ideas and prepare a 2-page science proposal.

All applications will be distributed to the PIs of this proposal who will act as a review panel (i.e. part of acquainting applicants with the NSF proposal review system). These evaluations will be a significant factor in selecting the final list of sea-going participants. In addition to the science proposal, we will require individuals to include the following in their application package: (i) a full CV, (ii) two names of reference if the applicants are students or post-docs; (iii) prior sea-going experience, (iii) prior experience with processing and interpretation of seismic data.

We will select 16 participants with a few alternates in the case initially selected participants will withdraw from the training. We will give preference to individuals specializing in non-seismic disciplines that build on the seabed characterization and regional context that marine MCS provides. These could include (but are not limited to) paleoceanography, sedimentology, structural geology, hydrogeology, as well as non-seismic geophysics. We will prioritize candidates whose career goals are in marine research. We may decline some applicants who are better suited for a course designed for "specialists." These applicants will likely have such an opportunity soon.

Once selected, participants will further communicate and discuss their cruise plans with PI team prior to the in-person pre-cruise workshop via several telepresence meetings (e.g. via Zoom); then during a 2-day workshop immediately before the cruise, the participants will finalize the cruise plan under the PI teams' guidance.

Step 4 - Pre-cruise shipboard familiarization
On-site Day 1

Cruise planning (participants will discuss and make final decisions concerning survey track, acquisition parameters, and reviewing/assigning responsibilities based on the telepresence meetings prior to this session)

On-site Day 2

Morning: Mobilization, ship tour, setting up computer and data logging systems, delegating cruise report writing and education/outreach tasks.

Afternoon: meetings with ship captain, crew, and techs where participants will present and organize their cruise plans (i.e. transit, way points, gear deployment, shipboard geophysics data acquisition, etc.).

Note: the pre- and post-workshop locations will be movable depending on the duration of the transit. The Day 1, in-person pre-cruise meeting near the port of call should be held regardless.

Step-5: Cruise

Onboard vessel days 3-10 (including transit and 4 days of seismic acquisition) Chief Science Training Component while conducting seismic experiments: communicate with ship, data acquisition, watch standing, onboard data processing, communicate with outreach specialist, **completing a cruise report** where all the shipboard activities are documented and many tabulated plots from the processed data are included.

Step-6: Post-cruise Workshop Structure

We will conduct the post-cruise data processing workshop where a few teams of participants will process and interpret their profiles and present their results.

Day-1 1 - data prep for loading shipboard processed lines + navigation into workstation running IHS Kingdom; 2 - loading data into a Kingdom project; 3 - review of MCS results and techniques for their interpretation; 4 - integration with core/log data where available; break into small groups that develop their own interpretation of the data.

Day-2 Morning: finalizing processing and interpretation

Afternoon: Team report, discuss different processing approaches and interpretation among the teams. Wrap up the training cruise with list of post-cruise "tasks" allocated, i.e. finalizing cruise report, re-organizing (processing) all the data by postdocs for proper archives, and drafting up a potential manuscript from the survey.

Our proposed cruise is a part of community effort, and hence, we will open the data as soon as the post-cruise workshop (2 days after the end of the cruise) without requesting a moratorium period. A fully processed (stacked and migrated) MCS data may have slight delay to be archived, for we would like to make sure the quality and consistency of processed data (i.e. after the post-cruise processing workshop, the postdoc instructors will organize the best processed data for archive).

***Broader Impact**: Outreach, Data Management, and Post-cruise Evaluation*

We propose to bring an education/outreach officer, Rebecca Fowler, on the cruise to report on the wholesale cruise effort to the scientific community and the public. The goals of the education and outreach activities are to: (1) facilitate understanding of marine seismology through engagement with graduate students and the public, and (2) expose graduate students and the public to scientific inquiry, interdisciplinary ship-based research, the technologies scientists use, and the types of data they collect. These goals will be met through direct interactions among the PIs, the cruise participants, the education officer, and in collaboration with the AGU. Fowler will also look for opportunities to work with students

and teachers in the greater College Station, TX area, where she and PI Tominaga live, and encourage other PIs and participants to connect with their local networks.

Fowler has a well-established relationship with the AGU communications department, and will write posts for the AGU GeoSpace blog (each post averages 400-500 readers) and share images on the AGU Instagram account (5,200 followers as of 11/2016). She will participate in every step of this effort to document and archive the participants and mentors' activities including: webinar series, pre- (during-transit) and post cruise workshops as well as the cruise. She will also provide on-board training to participants on how to write about their research and various outlets available for doing so. Participants will gain firsthand experience communicating and collaborating with an outreach/education specialist, and learn how to disseminate their research results to the public. The results of the education and outreach activities will be presented at a future AGU meeting.

Important deliverables from the pre-cruise and onboard activities to the community are to (1) establish and provide "cookbook" of the **open source** software used during this cruise (in addition to SeioSEIS and SeisUnix cookbooks provided by Anne Trehu's lab; OpenDtect cook book provided by Masako Tominaga's lab); (2) make the data acquired from the cruise **open immediately after the post cruise workshop adjourns** at the publically accessible archives, e.g. Marine Seismic Data Portal and Marine Geoscience Data System; and (3) publish and widely disseminate both training effort and scientific outcome in peer reviewed magazines (e.g. AGU EOS) and journals (e.g. Geophys. Res. Lett.). The seismic data should be archived in the format of raw, brute stack, and migrated profilesusing water velocity. We will conduct a post-cruise survey in collaboration with the UNOLS office to obtain feedback from the participants and encourage the participants to write NSF proposals — the number of which will be the direct and ultimate measurement of the success of this ECS.

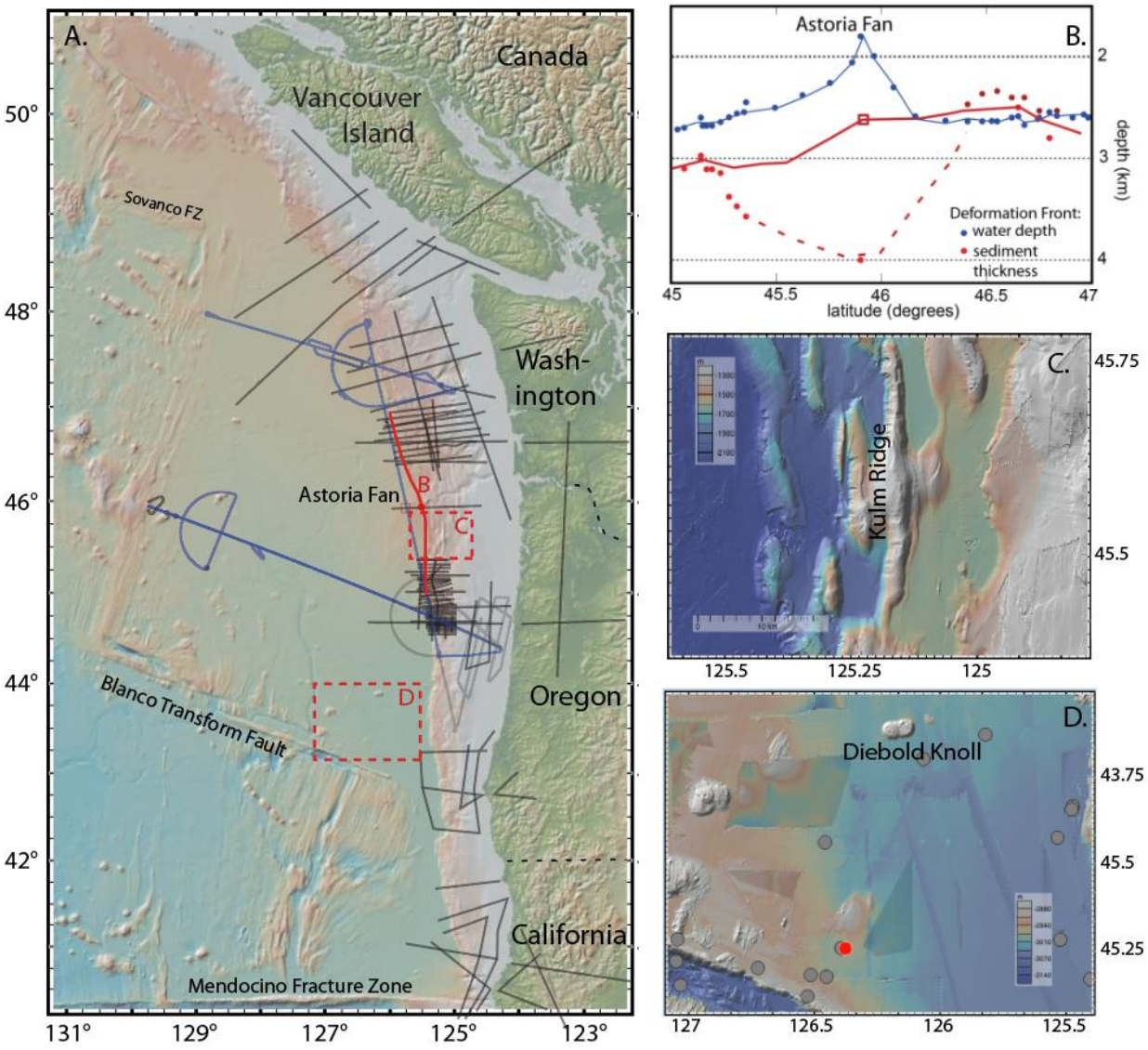


Figure 1. A. Seismic reflection data from the Cascadia margin. The track line for the 2012 Ridge-to-Trench survey is shown in blue; others are shown in black. Industry surveys of the shelf and upper slope are not included on this figure because they generally do not cross the lower slope, deformation front and adjacent Juan de Fuca plate, which are the focus of this proposal. However, instruction on how to explore the available industry database through the USGS NAMSS, as well as complementary core databases will be included as part of the proposed training class. B. Plot of water depth (digitized from GeoMapApp) in blue and sediment thickness (red dots) at the deformation front. Sediment thickness was determined from all available seismic reflections lines crossing the deformation front. Also shown is the sediment thickness along the Ridge-to-Trench line, which is close to the deformation front south of 45.2°N and north of 46.2°N but departs from it in the region of the Astoria fan. One dip line across the Astoria fan (ORWELL line 109; unpublished data courtesy of Dirk Klaeschen, GEOMAR) suggest that the thick sediment of the fan flexes the subducting plate. C. Detailed view of Kulm Ridge. D. The southeast corner of the Juan de Fuca plate. Diebold Knoll, which rises ~750 m above the seafloor, is a possible target for imaging. Dots indicate the position of sediment cores. The red dot is a core that was used to constrain the climate history of the Pacific Northwest. Another target would be acquire the data needed to put these cores in a historic context.

Appendix-2 IHA preparation (02.03.2017)

INFORMATION REQUIRED FOR EA AND IHA APPLICATIONS

Under the terms of the Marine Mammal Protection Act (MMPA) of 1972, an Environmental Assessment (EA) and an Incidental Harassment Authorization (IHA) are required for each seismic program conducted from a U.S. research vessel. The Chief Scientist is asked to provide the following information about the cruise:

1. Name of project and NSF proposal number:

Understanding the sediment and crustal structure from Astoria Fan to Diebold Knoll, Cascadia continental margin (1714168)

2. Name(s), affiliation(s), and e-mail addresses of PI(s):

PIs – sailing:
Masako Tominaga (Texas A&M)
Anne Trehu and Mitch Lyle (Oregon State Univ.)

PIs –not sailing, but will be fully involved in processing and interpretation of data:
Greg Mountain (Rutgers)

3. Designated contact for further information, if needed:

Masako Tominaga (Texas A&M), Anne Trehu and Mitch Lyle (Oregon State Univ.)

4. Ship and sailing dates:

R/V Revelle
Sept. 25-Oct 1st (8 days, scheduled. Date range needs to be re-confirmed with SIO ship operation).

5. Short (one paragraph) overview description of the activity:

We plan to conduct MCS, multibeam and chirp sonar surveys on R/V Revelle at multiple locations off Oregon continental margin to understand the subsurface sediment and crustal structure. Our science goal is to understand a variety of sedimentary and tectonic settings of the Cascadia continental margin, from Astoria Fan in north to Diebold Knoll in south. Within this extended continental margin off the coast of Oregon, the seismic reflection profiles acquired, processed, and archived from this cruise can be used to image the subducting plate and the Astoria Fan, as well as accretionary ridges hosting gas hydrate and pockets of hemipelagic sediment containing paleo-oceanographic information. Our targets have implications for addressing important societally relevant questions, such as earthquake hazards and paleoclimate records in basins. There will also be potential for using seismic techniques to reveal real-time, fine-scale within the water column around upwelling regions of the northeastern Pacific Ocean boundaries.

6. Purpose and Need, a more detailed (2–3 paragraphs) project description:

Our proposed survey regions are on the active continental margin of the west coast of the United States, where a variety of sedimentary and tectonic settings are available, providing targets of interest to a wide range of participants. Potential targets are the subducting plate

and the Astoria Fan, as well as accretionary ridges hosting gas hydrate and pockets of hemipelagic sediment containing paleo-oceanographic information; and the San Andreas fault system as well as paleo-oceanographic targets, both of which have implications for addressing important societally relevant questions, such as earthquake hazards and paleoclimate records in basins.

The broad survey area we propose off Oregon is around the mouth of the Columbia River and the Astoria fan, with a second possible field site off the southern Oregon margin. Figure attached in *Question 9* below shows digital seismic data across the Cascadia accretionary wedge and adjacent Juan de Fuca plate.

There are two proposed surveys - one in area D from the proposal and one in area B/C. Each is long enough to fill the entire cruise (and a bit more). Each has several science targets. The class can be responsible for modifying the survey to fit the allocated time while meeting the science objectives of the students, including choosing between the two surveys.

Area D includes the paleo objectives, a long plate transect that crosses Diebold Knoll, and a detailed survey of the megaslump segment of the Cascadia subduction zone, which does not have any seismic data crossing it. Total survey length is 547 nm, with 171 nm of transit to reach the beginning (wp 3) and return from the end (wp 30). At 5 kts for seismic and 10 kts for transit, this is 5.3 days.

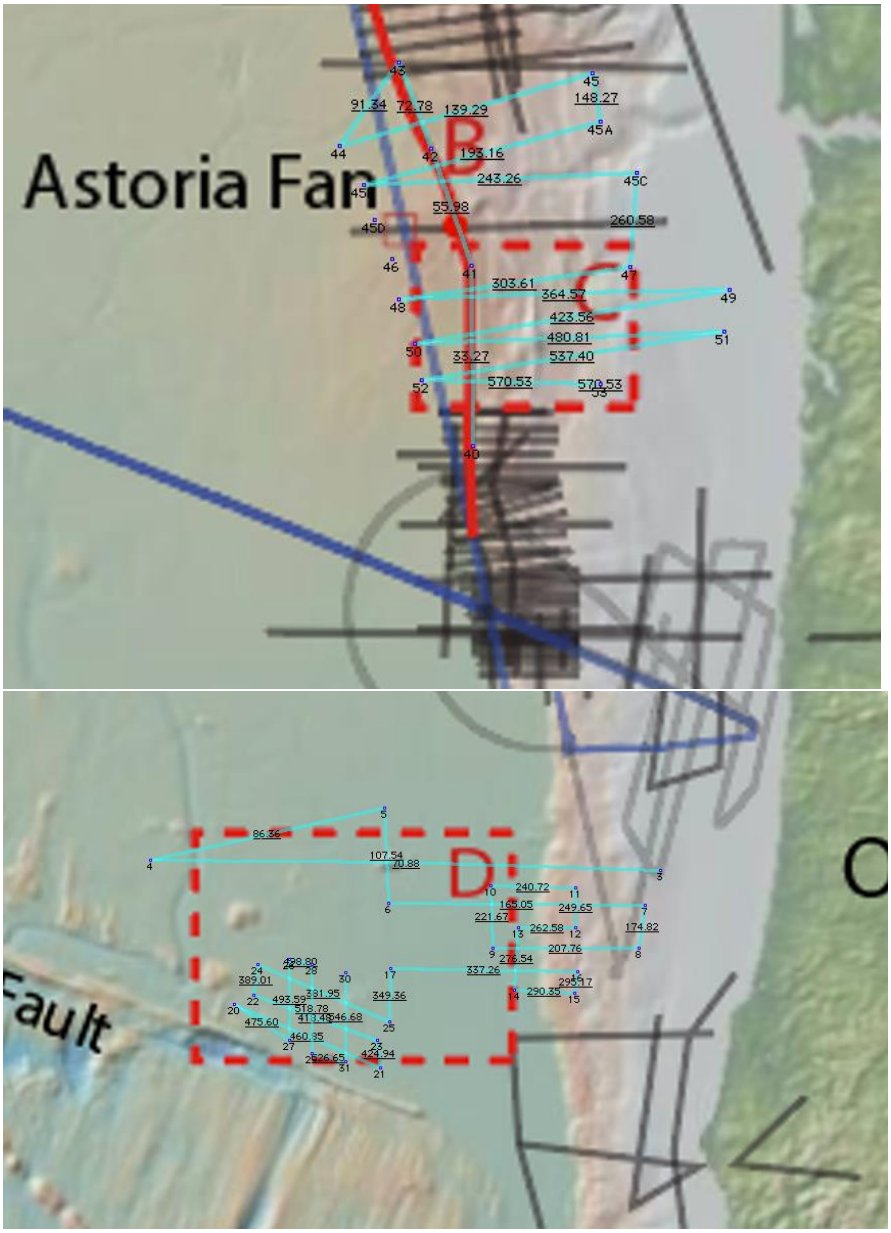
Area B/C includes plate flexure, accretionary wedge mechanics and gas hydrates as objectives. It also covers a major seismic gap. It includes 571 nm of survey and 125 nm of transit, for a total survey time of 5.5 days.

7. Seismic source(s) that will be used during the seismic survey, including mitigation gun (see further in #10, below). If more than one source is to be used, which lines will be shot with each source:
N/A

8. Length and number of streamers to be used (not considered a source of harassment, but a limit on maneuverability of the vessel):

48 channel, 2 GI guns (total 2x 45 inch^3 effective power 45 – 105 configuration for the cleanest).

9. Track charts or waypoint coordinates (a digital file overlaid on bathymetry is ideal):
[please see the way points at the end of this document]



10. Power-down strategy, if any. (A complete seismic source shut down of more than a few minutes requires a 30-min prestart visual observation period followed by a gun ramp-up period, and start up at night or in poor visibility may not be allowed. The number of guns can be reduced in turns [a requirement in several recent IHAs involving large airgun arrays], but generally not for short turns with small sources.):

No shut down during turns.

11. Estimated days (or hours) of seismic shooting, including turns:

4 -5 days

12. Shot interval:

20-25m (shoot on distance)

13. Contingency lines/times, if any, separate from the primary lines, and estimated probability of using them:

These are included in the requested

14. Ports of departure and arrival and estimated transit times:
Departure and arrival: Newport, OR
Estimate transit: 2-3 days.

15. OBS description and deployment time, if any:
N/A

16. Strategy for use of other sound sources such as multibeam and sub-bottom profiler, e.g., for the entire cruise?:
We plan on conducting shipboard multibeam and chirp sonar systems when seismic acquisition is active.

Format: DDD M/D/Y H:M:S -7.00 hrs Datum[121]: WGS 84

ID	Name	Comment	Date Time	Latitude	Longitude
R	1	OPTION-1			
W	3		00:00.0	43.85045	-124.75485
W	4		00:00.0	43.87452	-126.3875
W	5		00:00.0	44.08269	-126.17647
W	6		00:00.0	43.72997	-126.15426
W	7		00:00.0	43.72193	-124.8326
W	8		00:00.0	43.56088	-124.86592
W	9		00:00.0	43.56088	-125.62115
W	10		00:00.0	43.79253	-125.62954
W	11		00:00.0	43.78593	-125.19122
W	12		00:00.0	43.63714	-125.19122
W	13		00:00.0	43.63714	-125.488
W	14		00:00.0	43.40495	-125.51083
W	15		00:00.0	43.39166	-125.19578
W	16		00:00.0	43.47138	-125.18209
W	17		00:00.0	43.48466	-126.14548
W	25		00:00.0	43.283	-126.15
W	24		00:00.0	43.5	-126.833
W	22		00:00.0	43.383	-126.85
W	23		00:00.0	43.217	-126.217
W	21		00:00.0	43.11	-126.2
W	20		00:00.0	43.35	-126.95

W	27	00:00.0	43.217	-126.667
W	26	00:00.0	43.517	-126.667
W	28	00:00.0	43.5	-126.55
W	29	00:00.0	43.167	-126.55
W	31	00:00.0	43.133	-126.377
W	30	00:00.0	43.467	-126.377

R	2	OPTION-2		
W	40	00:00.0	45.25	-125.42774
W	41	00:00.0	45.80439	-125.43492
W	42	00:00.0	46.16253	-125.61005
W	43	00:00.0	46.42385	-125.75443
W	44	00:00.0	46.17023	-126.00988
W	45	00:00.0	46.39094	-124.90255
W	45A	00:00.0	46.24368	-124.8647
W	45B	00:00.0	46.05329	-125.90549
W	45C	53:31.0	46.09002	-124.70737
W	47	53:46.0	45.80217	-124.7369
W	48	00:00.0	45.70129	-125.75105
W	49	00:00.0	45.7334	-124.30173
W	50	00:00.0	45.56778	-125.68314
W	51	00:00.0	45.60426	-124.32538
W	52	00:00.0	45.45488	-125.65002
W	53	00:00.0	45.4427	-124.86589
W	53	00:00.0	45.4427	-124.86589

Appendix-3: Webiner Agenda (04.07.2017)

Final Agenda

Title: *How to Develop Science Hypotheses and Address Them with Marine Seismics*
Date: Monday 4/10 (4:30-6pm EDT):
Topics: Introduction to the ECS opportunity and application process *(Tominaga)*
Introduction to the outreach part of this ECS project (Fowler)
Introduction to US seismic facility (Higgins)
Introduction to science in the Cascadia Margin and SIO portable system (Trehu and Lyle)
Seismic Primer-1: Useful database, software, etc. for planning science (Tominaga)

Title: *How to Develop Marine Seismic Proposals*
Date: Tuesday 4/11 (4:30-6pm EDT):
Topics: Introduction (Tominaga)
Writing tips for NSF/seismic proposal (Ransom)
IHA permit process (Ellet)
Seismic Primer-2: Introduction of Multichannel Seismic Reflection Data Acquisition and Processing (Mountain)

Title: *How to Develop a Marine Seismic Acquisition Plan*
Date: Wednesday 4/12 (4:30-6pm EDT):
Topics: Introduction (Tominaga)
Introduction to the UNOLS Ship Time Request System (Alberts)
Management of marine data:
R2R Management of underway environmental data (Stocks)
IDEA:ASP Management of seismic data (Carbotte)
Introduction to underway multibeam: data acquisition, processing, and GMRT (Ferrini)

Seismic Primer-3: Q&A session

Appendix-4: Apply to Sail (web application form 04.09.2017)

Apply to sail:

Application deadline May 31st 5PM EDT (successful candidates will be contacted starting on June 21st)

** *This opportunity is specifically for those who are affiliated with US institutions***

Please upload a single PDF or Word document including all of the following materials:

(1) A cover letter that include your previous cruise participation, seismic experiences (i.e. data acquisition on land and at sea, data processing and interpretation in classroom and/or research projects, etc.), and expected outcome from this opportunity (i.e. NSF proposal writing, incorporating current project, establishing hands-on classroom exercise materials, etc.).

(2) A CV (including contact information for a faculty reference if applicant is graduate student)

(3) A brief (maximum 1 page with figures) scientific proposal that discusses a scientific problem you would like to investigate using new data acquired during this cruise. As discussed in the webinars, we will have flexibility to modify endpoints within the boxes on the map submitted for the permit application (see below, but subject to change during the IHA permit process. We are budgeted ~96 hrs of data acquisition using Scripps Portable multichannel seismic reflection system.

(4) A brief (maximum 1 paragraph) outreach/science communication proposal (ideas and suggestions) that describe how you envision contributing to and/or amplifying outreach efforts during this cruise (Note: if this plan requires internet connection from the ship, please consider whether the plan can be accomplished with the limited bandwidth available on the ship).

Upload the form [.pdf .doc only]

Demographic Information
:
:
:

SUBMIT Button

Useful links:
GeoMapApp (an earth science exploration and visualization application that is continually being expanded as part of the Marine Geoscience Data System (MGDS)) http://www.geomapapp.org/

Academic Seismic Portal
http://www-udc.ig.utexas.edu/sdc/

Cascadia Initiative - Earth Scope US Array
http://www.usarray.org/researchers/obs/cascadia

Scientific Drilling Sites in Cascadia Margin (ODPLeg 204)
http://www-odp.tamu.edu/publications/204_SR/204TOC.HTM

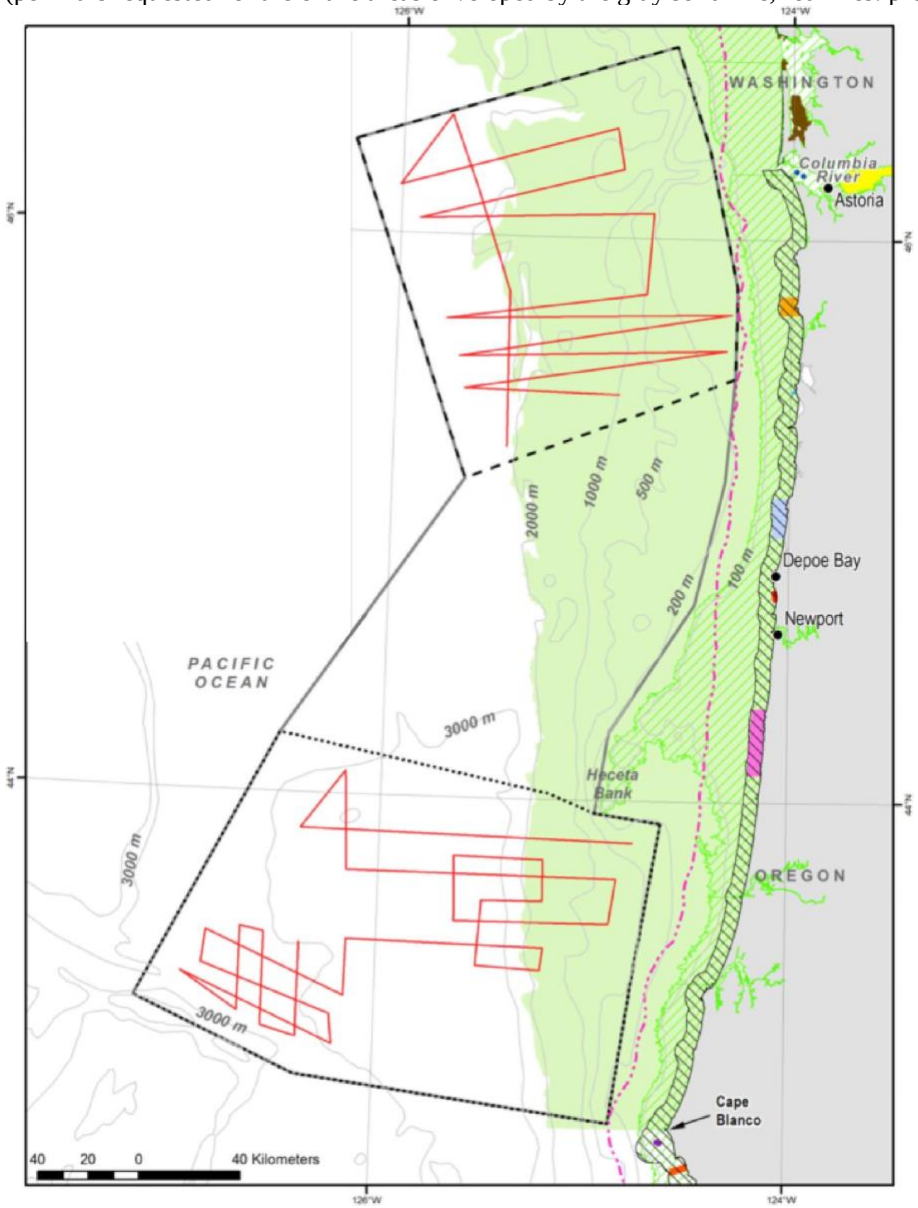
Google Earth
https://www.google.com/earth/

QGIS
http://qgis.org/en/site/

OpenDtect
https://www.opendtect.org/

** step-by-step instructions on how to use OpenDtect and QGIS for Cascadia data are sent to registrants

Locations of the proposed low-energy seismic surveys
(permit is requested for the entire areas enveloped by the gray solid line; red lines: proposed survey lines).



Appendix-5: Acceptante Letter (07.04.2017)

July 4, 2017

Congratulations! You have been selected to participate in the Early Career Scientist Multichannel Seismic Data Training Cruise. The cruise will be preceded by a 1.5-day workshop on shore (September 24-25) before our departure from Newport OR on September 26. We return to port October 2, and will complete the project with a 2-day workshop on October 3 and 4 at the OSU Marine Facility in Newport, OR.

Once we have a final roster for the cruise, we will be dividing participants into working groups based on scientific interests as described in their proposals. These working groups will be charged with proposing a realistic track line defined by specific waypoints that can be achieved within a specified number of hours. Most of the discussions leading up to these plans will occur in August via video conference because we need to submit a cruise plan to the technical personnel responsible for the cruise a few weeks before we sail. Details of the plan can be adjusted during the pre-cruise workshop, and even during the cruise if necessary. Those who are selected will be strongly encouraged to download and install the following software on their own laptops for the workshops and cruise: Seismic Unix (http://www.cwp.mines.edu/cwpcodes/), OpendTect (https://www.opendtect.org/), and GMT (http://gmt.soest.hawaii.edu/).

Please let us know by July 10 (via email to: masako.tominaga@tamu.edu) whether you will be able to join us on this scientific endeavor. Additional information on working group responsibilities and life at sea, and instructions for arranging travel will be distributed to all participants in mid July.

Best wishes, The 2017 ECS-MCS training cruise team Masako Tominaga (TAMU), Anne Trehu and Mitch Lyle (OSU), and Greg Mountain (Rutgers)

Appendix-6: Cruise Planning Information (07.27.2017)

Dear all,

Welcome to the Early Career Seismic Chief Scientist Training Cruise 2017 (Our cruise ID is RR1717). We are pleased to announce that a total of 19 participants will be joining this endeavor! As we have promised in the invitation letter, we would like to start working together from now on to make the cruise successful.

One of the most important tasks as you being a chief scientist would be **cruise planning** What would be your answer when captain says: "Hello, nice to meet you. So, what are our first few way points (where are we sailing to)?" – what will we really do once we are on R/V Revelle??

> (**Please note that, as you were introduced by the Webinars, many detail steps are necessary to get where we are today – communicating with funding agency, proposal writing (science target) and submission, getting funded, communicating with ship and facility operators, requesting seismic permit, and participant solicitation – and these are all done by the PI team. We hope that you will do the same when you will propose your science in the near future!).

The reality is that a chief scientist should have cruise plan BEFORE you even start traveling to the port. Closely communicating this information with facility and ship operator (captains, shipboard technicians, etc.) is crucial for the success of your cruise.

Let's imagine that you are sailing on a muliti-PIs expedition (which often happen due to ship schedule, geography, etc.) where each of the PI has his/her own science objective but a total ship time would be very limited.

And here are the tasks for each of you -

1. Based on your proposed science (and specified geographic regions), we made four PI groups as indicated below. **Communicate among the teammates and your mentor (email addresses are below), and discuss and propose the seismic line that can be "plan A" and "plan B" of the group (24 hrs @ 4.5 knots max for each).** Also, please designate a team representative.

2. We will have a all-hands (ish) tele meeting ("pre-pre cruise workshop") in the week of 13th of August (TBD), the agenda of which may be: (1) presenting the seismic lines from each group; (2) introduction to life on the ship; (3) some remarks for outreach effort.

There are a couple of house keeping items that should be introduced:

A. We will cover your round trip flights from your home port to Portland, OR (or if you will take train and/or personal car, please let me know), ground shuttle from the airport to Corvallis, and transportation to Newport, lodging (a night in Corvallis if necessary, and Marine Science Center at Newport), and daily meals during the workshop (up to Newport, OR, per diem rate). We will try and coordinate everybody's inbound trip as close as possible so that we could gather everybody in Corvallis by the morning of 24th; then drive down to Newport together. Please start planning your travel. We will contact you after the all-hands tele meeting to start booking flights (TAMU travel will book your flight). To maximize the impact of the training cruise, we have invited more than originally planned, so please look into the lowest fares within some suggested arrival timeframes, except for any special circumstances. **Personal travel will be allowed if the ticket price will be lower than the cruise-only travel (quote is required) and if planned *AFTER* the post-cruise workshop.**

We will start pre-cruise workshop at 1pm on September 24th. Those who are driving up from the close enough proximity,

We will move to the ship around the end of ship's lunch time on 25th, and continue the pre-cruise workshop and ship introduction, stay overnight on the ship, then set sail on 26th.

We will be back in the port sometime on October 2nd and stay on the ship for the night. We will have the post-cruise workshop on 3rd and 4th (we will stay at the marine center for the nights of 3rd and 4th), and the workshop should be adjourned by 5pm on the 4th.

B. We will send you a link to log in Scripps's cruise portal where you are required to fill in some personal information (this is so called "cruise form"). Please pay attention to emails with subject line, something like " ".

C. Tentative workshop schedule:
24th 13:00 – 17:00 – pre-cruise workshop: science planning (final)
25th 9:00 – 12:00 –pre-cruise workshop: outreach
*move to the ship AFTER ship's lunch time
13:00 – 17:00 – pre-cruise workshop: 1. Ship introduction (including tour); 2. Safety briefing (safety video, etc.); 3. Seismic system introduction; 4. Set up the lab and work stations.

Cheers,
Masako, Anne, Mitch, Greg, and Rebecca

PI groups for RR1717 cruise (and mentors for cruise planning):

Group-A) North-section - History of the Astoria fan (Mentor: Mountain)
Maureen Walczak (mwalczak@ceoas.oregonstate.edu)
Brendan Reilly (breilly@coas.oregonstate.edu)
William Schmeltz (wjs107@eps.rutgers.edu)
Brandi Lenz (lenz.60@buckeyemail.osu.edu)
Collin Brandl (collincbrandl@gmail.com)

Group-B) Middle section 1 – tie to drilled holes, slope stability, large tectonics (Mentor: Tominaga)
Srisharan Shreedharan (srisharan@psu.edu)
Kittipong Somchat (dookdikman@tamu.edu)
Subbarao Yelisetti (Subbarao.Yelisetti@tamuk.edu)
Irina Filina (ifilina2@unl.edu)

Group-C) Middle section 2 - accretionary wedge structure/tectonics, hydrate ridge (Mentor: Trehu)
Valerie Sahakian (vsahakian@usgs.gov)
Jessie Saunders (jksaunde@ucsd.edu)
Alexis Wright (alexiswright@mymail.mines.edu)
Brendan Philip (btphilip@uw.edu)
Emily Schottenfels (erschott@bu.edu)

Group-D) Southern section hydrogeology and large-scale tectonics (Mentor: Lyle)
Casey Hearn (caseyhearn@uri.edu)
Estefania Ortiz (estef30@tamu.edu)
John DeSanto (jdesanto@ucsd.edu)
Parker Sprinkle (dpsprink@ncsu.edu)
Ashley Long (amlong5@coastal.edu)

Appendix-7: Cruise Planning Summary

Pre-cruise communications officially began on July 27th with a welcome email composed by the cruise PI's. This email kicked off the cruise planning exercise by assigning participants to one of four sub-groups, which were defined by regional focus. The task for each group was to synthesize their proposals and create a 24-hour cruise plan that satisfied the main goals of each proposal. Each group was also tasked with developing an alternate plan that could be enacted should weather deteriorate or if we experienced significant loss of ship time. Groups were given until August 17th to compile their track lines. Also included in this initial communication was a broad outline of important dates regarding pre- and post-cruise workshops, and ship departure and return dates. To enable collaboration across and within groups, a Dropbox folder named "Discussion_SeismicECS_Cruise_Plan" was created and shared amongst all participants.

An all-hands tele-meeting was held from 1-3 PM EDT on August 17th, where a representative from each group summarized their group's science objectives and discussed their proposed lines. During this discussion, groups C and D determined that there was enough overlap in their respective science objectives to warrant collaboration on the next round of track line refinement. The four representatives were then tasked with combining each group's proposal into one full cruise track, with the expectation that this would be turned over to the PI's in time for their formal pre-cruise meeting on August 28th. Also discussed during this pre-cruise tele-meeting were sea-going basics (e.g. clothing, vessel capabilities), watch standing expectations (8 hours per day with duties including MCS and multibeam processing, eLog, and a rotating chief scientist), as well as a primer on the SIO portable MCS system, delivered by Lee of SIO.

Appendix-8: Outreach Workshop Preparation (08.24.2017)

Hi everyone,

Nice job on finalizing the cruise plan. I'm impressed by your enthusiasm and the ease in which you 19 (!) PIs came together to do this.

I'm writing to welcome you to the great science communication workshop we have coming up in September. I'm your instructor, Rebecca Fowler, a freelance science writer. Most of my current work is about climate science for Lamont-Doherty Earth Observatory, and I often join researchers in the field to report on their research. You can find out more about what I do on my website.

I'm looking forward to a productive, busy time when we're together — both in terms of research and writing.

To start, I want to outline our central outreach tasks: figuring out how to distill your research down into a clear, concise message, and learning how to effectively communicate that message.

You're coming to the cruise with various levels of experience, but no matter where you're at with writing and outreach, it's always helpful to revisit these two concepts. They're essential to engaging your audience, whether you're doing so with a tweet, video, blog post, or podcast.

You'll practice getting your message down and communicating it during our time together by writing a 500-700 word blog post about your cruise research. With your permission, we'll post these on the cruise website and select some of them to appear on the AGU's fieldwork blog.

If interested, you'll also have the chance to contribute photos and captions to the AGU's Instagram account; we're taking it over from September 27-October 3. More on that later.

So, we have a three-hour workshop on September 25, where we'll cover these three things via talks and activities:

- How to determine your message
- How to tell a story and write about your research
- The ethics of reporting and writing about science

One of the exercises we'll do during the workshop is based on the COMPASS "message box" model — some of you may be familiar with this. You may wish to check it out online before we meet.

I'd also like to suggest you bring an example of science writing that you value or that you don't like. We'll talk about why.

During our time at sea, we'll meet in small groups at least once. This will be a chance for you to share a draft of your blog post and get feedback on it from your peers and me. I'll also be available to meet with you one-on-one to discuss your post or other communications-related topics.

Some of you proposed to do creative outreach during the cruise and we're grateful for your ideas and interest. Unfortunately, some of these won't be feasible due to limited bandwidth and/or safety concerns. I'll reach out to each of you who proposed something unique or feel free to write to me with any questions or ideas.

See you soon —

Appendix-9: Questionnaire (08.29.2017)

Questionnaire for the Early Career Scientist Seismic Training Cruise:

Will you have a laptop you can use for processing data and/or document preparation? (Yes/No)

If Yes, what operating system do you use (OSX, Windows, Unix – list all that apply)?

Do you have prior experience with the following software? Please indicate Yes or No for each. If Yes, please rate your skill level on a scale of 1 (novice) – 3 (expert).
If Yes and you are bringing a laptop, do you have this software installed (with a license, if needed)?

- Scripting languages such as python, awk, perl, csh, sh, and/or bash?
- Matlab (commercial modeling and data processing software)
- MBSystem (freeware for processing swath bathymetry)
- Caris (commercial swath bathymetry processing software)
- FMmidwater (commercial software for processing water column data acquired with swath bathymetry)
- SeismicUnix (freeware for processing seismic data)
- Sioseis (freeware for processing seismic data)
- SeisSpace/ProMAX (commercial seismic processing software)
- Focus/Echoes (commercial seismic processing software)
- OpendTect (freeware for seismic interpretation)
- KingdomSuite (commercial software for seismic interpretation)
- GoogleEarth (free map-making software)
- GMT (free map-making software)
- GeoMapApp (free map-making software linked with extensive databases)
- QGis (free GIS software)
- ArcGIS (commercial GIS software)
- Erdas (commercial GIS software)
- Microsoft Word/Excel (commercial word processing and spreadsheet software)
- Adobe Photoshop/Illustrator (commercial graphics and image processing)

Appendix-10 : Pre-Cruise Communications (participants' perspective)

On September 12th, the final ECS cruise and pre-cruise activity schedule was circulated by M. Tominaga. That schedule is replicated below:

Sept 23rd Travel day
Those who are flying in PDX and stay overnight in Corvallis, it is YOUR responsibility to arrange the transportation from PDX to Corvallis. Hut shuttle (http://www.hutshuttle.com/) will directly take you from the airport to the Hilton Garden Inn, Corvallis where all of you should have received the hotel room confirmation.

Sept. 24th Corvallis Hatfield Marine Center, Newport, OR.

10:00 AM, meet at the front of Hilton Garden Inn, Corvallis.
The following people are designated drivers: Trehu, Lyle, Fowler, Reilly, Phrampus and Davenport.

Please arrange breakfast/lunch on your own.

1:00PM Pre-cruise meeting [coffee and snack catering provided]
1:00 – 1:30PM Introduction (introducing ourselves, wholesale schedule,
watch standing, berthing plan, nearby eateries, other house keeping items)

1:30 – 2:00 PM (ish) Science plan briefing by group rep and Anne – and so make
sure that whichever the watch standing group communicates with the ship regarding first few way points.

2:00 (ish) – 3:00 PM (ish) Ben and Kathy – processing primer

Break
3:30PM (ish) Science talks
5 PM workshop adjourned
Please arrange dinner on your own.

Sept. 25th Hatfield Marine Center, Newport, OR. R/V Revelle
[Breakfast and Lunch provided. I will take counts for those who would like to have dinner onboard ship; otherwise, please arrange dinner on your own.]

9AM – 12PM Science Outreach workshop
1PM ~ Move to the ship. Ship orientation, safety briefing, lab setup, etc.

Sept. 26th -- Oct. 2nd R/V Revelle
Oct. 2nd R/V Revelle Hatfield Marine Center, Newport, OR
[Demobilization; Lunch onboard the ship]
Staging and starting the postcruise workshop (agenda TBA)

Please arrange dinner on your own.

Oct. 3rd Postcruise Workshop contd. (breakfast/lunch/dinner will be provided.)
Group dinner and post-cruise outreach workshop at Oregon Coastal Aquarium.

Oct. 4th ~ 12PM (3PM the latest) Workshop adjourned. (breakfast and boxed lunch provided.)

Those who are taking redeyes on 10/4, Fowler and Mountain will take you to the PDX after the workshop/lunch. Those who are staying overnight in Corvallis – we will have some designated drivers who could take you back to Corvallis; and it is your responsibility to arrange the transportation from Corvallis to PDX on the 5th (e.g. http://www.hutshuttle.com/).

The final pre-cruise communications centered around installing Seismic Unix on participant's personal computers. This was coordinated by G. Mountain, who provided installation instructions and example MCS files; these files were hosted on the Dropbox folder "Discussion_SeismicECS_Cruise_plan". There are no further pre-cruise communications of note to report. Participants convened at the Hatfield center in Newport for the pre-cruise workshop at noon on Sunday, September 24th.

Appendix-11: Pre-Cruise Workshop

Two days were allotted before the start of the expedition for a pre-cruise workshop at the Hatfield Marine Science Center in Newport, OR. This allowed the participants to finally meet in person. The main objectives of the workshop were to finalize the cruise plan, review the processing software and background information of the Cascadia margin, learn effective techniques for outreach communication, and mobilize onto the ship.

a. Sunday, September 24

10:00 AM - Meet at the front of Hilton Garden Inn, Corvallis, OR. Designated drivers transport everyone to Newport, OR.

12:00 PM - Arrive at Hatfield Marine Science Center, Newport, OR. Get situated in the dorm area. Followed by Lunch.

2:00-2:30 PM - General introduction to the cruise. We went around the room introducing ourselves. Masako presented a schedule of the workshops and the expedition. She told us the watch groups and what is expected during each watch standing shift. The watch groups were determined beforehand based on assigned group number and computer expertise according to a brief survey sent to the participants the previous week. Each day, the members of the watch shift are supposed to rotate responsibilities so each person gets a chance to learn each role. Masako also showed us the berthing plan for when we are on the ship.

2:30-4:00 PM - Science plan briefing and finalizing survey lines. We confirmed the first waypoints and discussed where we should place an additional deployment waypoint before the first science target waypoint. The task at hand: We are leaving port at 11:00 AM because of the tides, so we need to determine where to put the deployment waypoint without adding significant time to the survey plan but still be able to deploy the equipment (approximately 1.5-2 hours) and start the survey before dark. We worked collectively to determine the deployment waypoint.

4:00-4:30 PM - Kathy presented an overview of data processing with Seismic Unix. Only a handful of participants were able to properly install Seismic Unix before the meeting. It would have been helpful to have an additional portion of the pre-cruise workshop dedicated to installing Seismic Unix so participants could follow along with the example Kathy used in her presentation.

4:30-5:00 PM - Ben presented an overview of gas hydrate, bottom simulating reflectors (BSRs), and examples of these features in past multi-channel seismic (MCS) data for the Cascadia Margin. We expect BSRs to be present in a majority of the data that covers the margin, so it was good to have an introduction to what these features look like before the expedition.

5:00-5:30 PM - We walked to the tsunami evacuation area to become familiarized with the route.

Adjourn for the day. Dinner on own.

Originally, Sunday's schedule included short science talks prepared by student volunteers to discuss their research and how it can connect to the survey. Because discussion of the deployment waypoint took longer than expected, the science talks were delayed to be during the All Hands science meetings during the expedition. This worked better than the original plan because the students who were originally asked to prepare short talks presented during the first half of the cruise and additional students who wanted to present had enough time to put together presentations for the meetings during the second half of the cruise.

b. Monday, September 25

9:00 AM – 12:00 PM - Science Outreach workshop, led by Rebecca Fowler. She introduced our outreach assignment for the cruise. We discussed how to figure out our messages, and compared the academic writing style to the "inverted pyramid" approach to journalism articles. We learned about the message box approach, and spent about 20 minutes filling out message boxes to explain our research, which we then discussed with other participants at our tables. Afterwards, we talked about good and bad approaches to telling a story and writing about science. We shared pieces of scientific writing we found before the workshop and said what we liked or did not like about it.

12:00 – 12:30 - Science talk by Tamara Baumberger, NOAA. She showed us images and videos of methane gas seeps that are prevalent in the Cascadia Margin. We would likely see signatures of the seeps in the multibeam and MCS data, and it was helpful to see what these features look like.
12:30 - Lunch.
1:00-4:00PM - Move to the ship. We assembled in the main lab area for ship orientation and a safety briefing by the Senior Resident Technician. We took a brief break to put belongings in rooms, and then reassembled in main lab area. We divided into two groups and were given tours of the deck and the equipment as well as the computer lab where we will be during watch standings. Afterwards, we brought other equipment onto the ship and set up the general-use computers.

Dinner on ship or on own. A show of hands was taken in the morning for the people interested in dinner on the ship, and this number was relayed to the crew.

Appendix-12: Pre-cruise outreach workshop (09.25.2017)

Organizing blog posts:

“ Here's the UNOLS cruise website where the daily reports and your blog posts will appear: http://csw.unols.org/

We're also taking over the UNOLS training cruise Facebook page (it needs more followers, so tell your friends): https://www.facebook.com/UNOLSCSW/

Some of your posts will go on the AGU fieldwork blog — http://blogs.agu.org/thefield — during and after the cruise. We're also taking over the AGU Instagram account from October 3-7 so you'll have the chance to share your photos there.

For social media users, the cruise hashtag #SeismicECS. If you have doubts about the appropriateness of what you're posting with the hashtag, please don't use it.”

Editorial check schedule for blog posts:

“Here’s the schedule for the blog posts. You should get your post to me by 8PM on your assigned day. You can send it earlier if it's ready. When you send it, also let me know if you’re interested in having it appear on the AGU blog.

September 30
Irina Fiina
Jessie Saunders
John DeSanto
Srisharan Shreedharan
Brendan Reilly
Emily Schottenfels

October 1
Brendan Philip
Estefania Ortiz
Subbarao Yelisetti
Parker Sprinkle
Collin Brandl
William Schmeltz

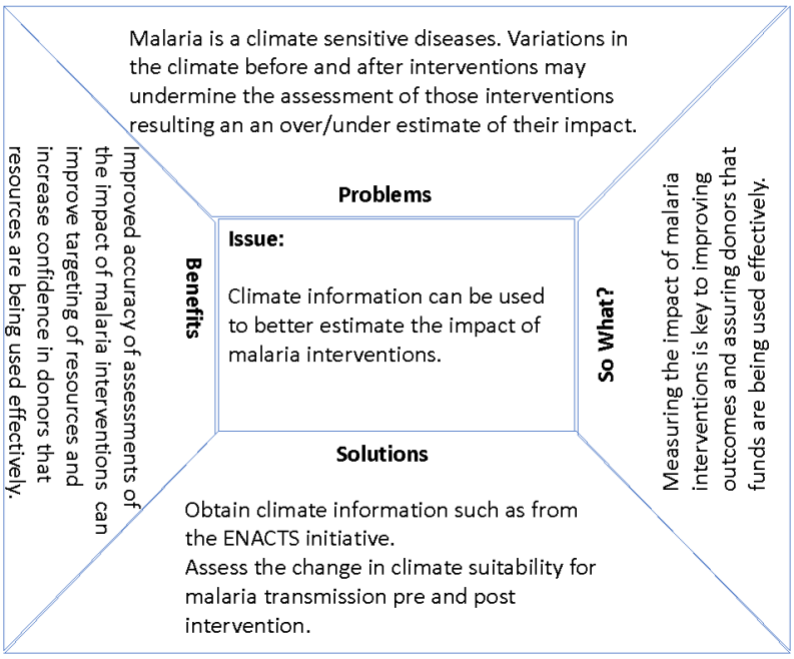
October 2
Ashley Long
Somchat Kittipong
Brandi Lenz
Valerie Sahakian
Alexis Wright
Casey Hearn

Please check in with me about your post (in person) by 9PM on Thursday, 9/28. You can schedule a time or track me down when you have a few minutes free. This is just to talk briefly about your topic, talk about your draft if you have one, any issues you're having, etc.

If your assignment due date comes around and you’d like more time, let’s talk. We might be able to arrange an extension. But don’t assume that you’ll get one!

Let me know if you have questions.”

Audience: *global health researchers, policy makers, practitioners and donors*



ECS Science Communication Workshop

#SeismicECS

Rebecca Fowler
September 25, 2017

Today's agenda.

- Overview: 9:00-9:20
- How to figure out your message: 9:20-10:30
- Break: 10:30-10:40
- How to write about science: 10:40-11:20
- Best practices for science writing: 11:20-11:45
- Wrap-up, questions: 11:45-12:00

Your assignments.

Required

Write a 500-700 word blog post that summarizes your scientific knowledge, ideas, and research for a non-expert. This will be posted on the cruise website and possibly the AGU fieldwork blog.

Optional

Submit one photo and short caption, written for non-experts, for the AGU Instagram takeover (Oct. 3-7). Send me your photo, caption and Instagram handle, if you have one.

What do you want to learn about science communication?

Don't aim for perfection, aim to LEARN and PRACTICE.

1

How to figure out your message.

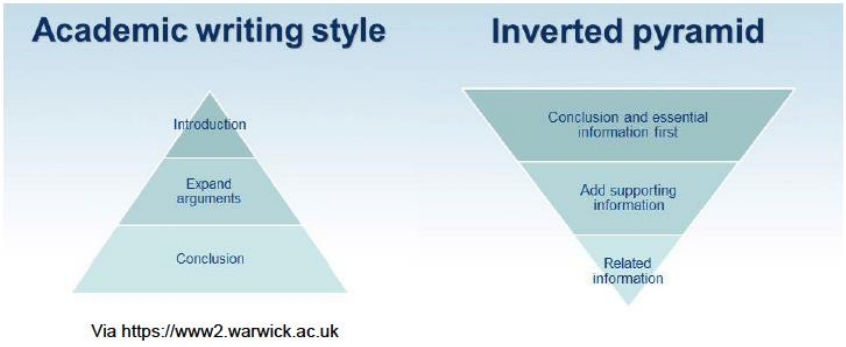
This message is the foundation of your story.

?

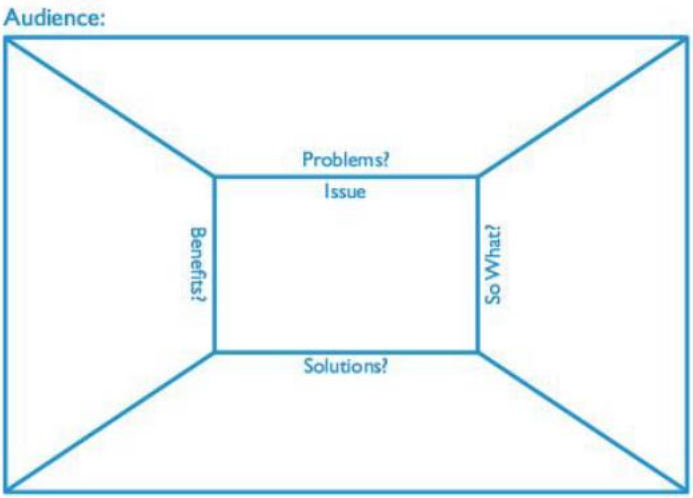
Why should scientists share their work with the public?

Why is your message important?

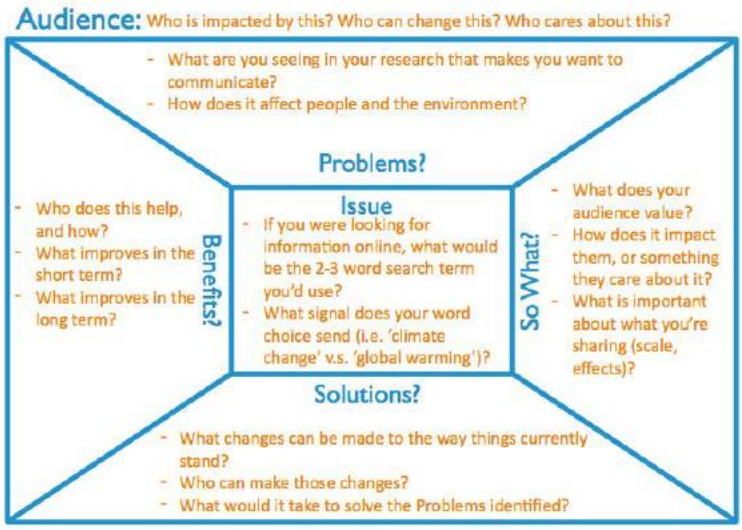
Ways of delivering information.



Via https://www2.warwick.ac.uk



www.compasssicomm.org



The "So What?" Prism. Adapted from *Escape from the Ivory Tower: A Guide to Making Your Science Matter*, by Nancy Baron (Island Press, 2010).

Activity I

Review the two message box examples. Consider these questions:

- What's effective?
- What did you find confusing?
- Is there jargon?
- Is there too much, or too little, detail?

Activity II

Complete a message box and then present it your group. They'll give you feedback, which you can use to refine your message.

- What works well?
- What did you find confusing?
- Is there jargon?
- Is there too much, or too little, detail?

---

2 How to tell a story and write about science.

Now you have a message. What are you going to do with it?

Getting results.

Good, effective writing is all about tools, or the elements of the story, and practice in using them.

The elements of a story.

- Narrative arc
- Strong characters (protagonist + antagonist) — these are the eyes through which the reader views the material
- A goal — Use the goal to make the subject relevant to the target audience.
- A conflict or problem
- The resolution of the problem, or reveal

Things to consider when writing.

Conducting interviews.

- What questions to ask?
- Interaction with your subject(s)
- For audio: Stepping on your audio + keeping responses in complete sentences

Activity: Conduct a two-minute interview with a partner. Ask only 2-3 questions.

3 Best practices for science writing.

What to do. And what not to do.

Avoid jargon.

Report facts, and get them right.

Know what to keep confidential.

Check your sources' credentials.

Are there conflicts of interest?

Use common sense.

Things to be aware of when writing about this cruise.

Sensitivites around seismic research

Things to keep confidential.

When in doubt, ask.

Recommended reading:

- On Writing Well – William Zinsser
- Several Short Sentences About Writing – Verlyn Klinkenborg
- Don't Be Such a Scientist – Randy Olson
- A Scientists' Guide to Talking with the Media – Richard Hayes
- The Science Writer's Handbook – Nijuhuis, Hayden, et al.

Questions?

You can find me at:
rebafowler@gmail.com and @by_rebecca

Appendix-13: Post Cruise Workshop

Upon our return to Newport, we had two days for a post-cruise workshop led by Greg Mountain at the Hatfield Marine Science Center. The focus of the workshop was discussing the results of the cruise and future research plans to utilize the data we acquired.

Monday, October 2

15:00 – Research group presentations
The cruise participants returned to their pre-cruise research groups to provide updates on the outcomes of the cruise as related to their original science goals. Each group summarized their project objectives, reviewed the changes that were made to their portion of the acquisition plan while the cruise was underway, and discussed ways the data acquired on the cruise could be used to address their research questions.

16:00 – Presentation from Greg on understanding and interpreting seismic reflection data. Topics included basic seismic wave/ray propagation, understanding the assumptions involved in collecting and processing seismic data, and the basics of interpretation. The discussion on artifacts and migration effects was of particular interest for our data set, especially for those interested in using the data to plan drilling locations. Greg showed examples that illustrated how features in a seismic section may move or change in unmigrated, poorly migrated, or properly migrated sections.

17:00 – Adjourn for the day. Dinner on our own.

Tuesday, October 3

MORNING: Science presentations from Greg, Anne, and Ben
08:30 – Breakfast

09:00 – Presentation by Greg on continental shelf profiles and submarine fans, and the basics of seismic stratigraphy. Greg showed examples of fan environments from around the world, including the Mississippi, Amazon, and Bengal fans, and compared them to the Astoria fan in our research area. He also presented the classic "slug model" for seismic stratigraphy, and described how it does not explain features at the scale of the continental shelf.

10:00 – Presentation from Anne on the Cascadia margin. Anne invited everyone to participate in the discussion, describing her presentation as "free-form jazz" compared to Greg's "symphony". She presented an overview of the geologic structure of the Cascadia margin, including the vocabulary of deformation front tectonics, the poorly understood transition from landward vergence off the coast of Washington to more seaward vergence off Oregon, and examples of accretionary prism data from the Ocean Drilling Program (ODP) Legs 190 and 196.

Anne's presentation led into a discussion about resources for publicly available geophysical data. Mitch and Anne reviewed the features available in GeoMapApp (www.geomapapp.org), including bathymetry and map overlays of geophysical data. Everyone

was reminded that non-seismic data from UNOLS cruises are generally available from the Rolling Deck to Repository (R2R) (www.rvdata.us), while seismic data are available through the Academic Seismic Portal. Raw data are maintained by LDEO (www.marine-geo.org/portals/seismic) and processed data by UTIG (www-udc.ig.utexas.edu/sdc). We also discussed issues concerning variations in data quality and how to evaluate pre-existing data.

11:30 – Review of BSRs by Ben, with examples from our newly acquired seismic data. The discussion focused on evidence for high levels of fluid flow in our study region.

12:00 – Lunch

AFTERNOON: Small group discussions and software demonstrations
13:00 – 17:00

Most of the afternoon was spent in small group breakout discussions focused on establishing research interests and plans for future work. Participants were encouraged to break out of their original research groups and talk with others who have similar interests. Groups discussed research topics, ideas for papers or proposals based on the cruise data, and the logistics for each person's personal schedule and availability.

We took breaks from the small group discussions for everyone to look at some of the key lines from the new data together. We also had software tutorial demonstrations on Kingdom Suite by John S. and OpendTect by Fani.

The afternoon concluded with the breakout groups sharing their ideas and plans for ongoing research, papers, and/or proposals with the rest of the group. Details on ongoing research are in the MOU.

18:30 – 21:00
Science party catered dinner at the Oregon State Aquarium. Everyone had the opportunity to relax and celebrate the success of the cruise while viewing sea lions, sharks, and other exhibits at the aquarium.

Wednesday, October 4

MORNING: Logistics, wrap up, and advice for future work
08:30 – Breakfast

09:00 – Housekeeping and logistics, including information from Masako on travel reimbursements and planning the carpools for leaving Newport.

09:30 – Discussion about publications and data dissemination for the cruise.
We reviewed the responsibilities of the research topic groups in the Memorandum of Understanding (MOU) and how we want to handle collaborations during future work. We discussed assigning authorships for future papers, and agreed that papers that use the ship-board processed data would not include other cruise members as co-authors unless they are directly

involved in the paper. Any work that involves additional data processing (seismic, bathymetry, etc) may also include the processor(s) as co-authors, if the contribution is significant. Masako will write an EOS article about the training cruise and try to include the ECS research group in the author list.

10:00 – Advice on writing proposals and paper reviews
The PIs and Rebecca provided insights and advice on the process of writing a good proposal. Topics included clarifying your science goals, planning logistics (permitting, ship time, choice of equipment, personnel), how to write an effective broader impacts statement, and getting to know your NSF Program Director.

11:30 – Final wrap up. Parker set up a Google Drive for cruise report document sharing. We agreed to use email for small-group communications and Slack for ongoing information sharing among the entire group.

12:30 – Lunch

14:00 – Cars began departing to return everyone to Portland or Corvallis

Footnote:

** Participants were all encouraged to fill out PCAR
*** Collin Brandle will contribute to organizing the cruise T_shirts.

Appendix-14: Blogs (Outreach Products)

All the participants wrote at least one blog post. Three are translated into Spanish by Estefania Ortiz (Texas A&M University) and this was her "outreach project".

http://sites.udel.edu/chiefscientistworkshop/agua-hielo-y-fuego-desde-las-profundidades-de-cascadia/

http://sites.udel.edu/chiefscientistworkshop/por-que-yo-exploro/

http://sites.udel.edu/chiefscientistworkshop/de-estudiante-de-geofisica-a-jefe-cientifico-por-un-dia/

Appendix-15: Post-cruise data QA/QC (with timeline)

The post-cruise data QA/QC has conducted by Drs. Ben Phrampus and Kathy Davenport (postdoc mentors for the RR1718 cruise) at Oregon State University.

10/26/2017 ~ Ben and Kathy have started communicating with all the participants about data QA/QC.

11/20/2017 - 02/28/2018 Overall data QA (including Line 21) between Ben/Kathy and Scripps.

02/07/2018 Processed SEGY files transferred to UTIG server.

02/19/2018 Navigation data QA for the processed seismic data.

02/20/2018 Academic Seismic Portal at UTIG has announced that the RR1718 processed seismic data are archived and the doi was issued (10.1594/IEDA/500194).

Appendix-16: UNOLS-PCAR and post-cruise survey

*7 out of 19 Early Career participants filled out UNOLS post cruise assessment report (first received on 10/6/2017; last received on10/12/2017).

**Post cruise survey has been distributed by UNOLS office on 10/6/2017. 16 ECS participants have replied. The survey results are available through UNOLS office.