Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

Science Support Plan

R/V Marcus G. Langseth

[SURVEY NAME / DESIGNATION]
2016
Cruise No. MGL16-XX
For Principle Investigator (University Affiliation)

Date:	March 01, 2016
Compiled By:	Science Technicians

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3	NSF Technical Services Program Manager	
4	Vessel, Chief Science Officer	
5	Vessel, Captain/Chief Engineer	

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ABBREVIATIONS

2D	Two-dimensional
3D	Three-dimensional
ACQ	Acquisition
ADCP	Acoustic Doppler Current Profiler
CSO	Chief Science Officer
CTD	Conductivity, Temperature, Depth
DA	Designated Authority
DOR	Daily Operations Report
DP	Dynamic Positioning
EEZ	Exclusive Economic Zone
ERP	Emergency Response Plan
GI	Generated Injection
GPS	Global Positioning System
IHA	Incidental Harassment Authorization
LDEO	Lamont-Doherty Earth Observatory, Columbia University
LDS	Lamont Data System
MBES	Multibeam Echo sounder
MCS	Multi Channel Seismic
MGDS	Marine Geoscience Data System
MMO	Marine Mammal Observation
MSL	Mean Sea Level
NSF	National Science Foundation
OBS	Ocean Bottom Seismometer
OMO	Office of Marine Operations, Lamont-Doherty Earth Observatory
OSU	Oregon State University
PAM	Passive Acoustic Monitoring
PI	Principal Investigator
PPE	Personal Protective Equipment
PSO	Protected Species Observer
QC	Quality Control
R2R	Rolling Deck to Repository
SBES	Single beam echo sounder
SBP	Sub-Bottom Profiler
SEGY	Society of Exploration Geophysicists Y Format
SRD	Streamer Recovery Devices
SSS	Side Scan Sonar
SVP	Sound Velocity Probe
TBD	To Be Determined
UNOLS	University-National Oceanographic Laboratory System
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS	World Geodetic System
XBT	Expendable Bathythermograph

1. CRUISE OVERVIEW

MGL16-XX – [ADD SCIENCE OVERVIEW / OBJECTIVES HERE]

Other supporting equipment shall consist of a Kongsberg EM122 Multibeam echosounder, Knudsen 3260 3.5 kHz Sub-bottom Profiler, Bell Aerospace BGM-3 gravimeter, the RDI 75 kHz Acoustic Doppler Current Profiler (ADCP), and the Geometrics 882 magnetometers. LDEO will ensure that the equipment in use meets the manufacturer's specifications, and also meets internal quality requirements. The technicians onboard are proficient in the operations of standard systems, but are not experts. If the investigation requires expertise in any of the acquisition, including data processing, staff the science party accordingly (i.e. sail a data processor equipped with the proper equipment to complete the science objectives, including software). Other science studies will be ongoing, per scientist request and shipboard specifications.

In addition to the operations of the air-sound-source array, a Multi-beam echosounder (MBES) and a Sub-Bottom Profiler (SBP) will also be operated from the Langseth continuously throughout the survey. All planned geophysical data acquisition activities would be conducted by LDEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel for the entire cruise.

The principal investigator (PI) is **[ADD NAME (University Affiliation)].** He will be onboard for the survey operations, as well as **XX** other scientists/students (total of **XX** scientists), **XX** LDEO/contract technicians and **XX** Protected Species Observers (PSOs).

The cruise is expected to take **XX** days to complete; currently mobilization is scheduled to start on **[ADD DATE]** and completion of demobilization on February 24th, 2016. The ship is scheduled to sail on **[ADD DATE]** from **[ADD PORT INFO].** Scientists will be permitted onboard the day before sailing. At the end of the cruise, the scientists must disembark the day after the ship arrives in port. **[ADD PORT INFO]** is the planned port call location.

Table 1.1: Cruise Essential Info

Cruise Date: [ADD DATE]	**Total Days Departure to Arrival: XX**
Departure Port (start of cruise): [ADD PORT INFO]	**Arrival Port (end of cruise): [ADD PORT INFO]**
Seismic Source: 4 Strings, 6600 Cubic Inches	**Total Sail Kilometers of Source Data**
Seismic Streamer: 648 channels (8100m)	**XX OBS Stations (XX deployments of XX)**
Source Depth, Shot spacing	**Geometrics 882 Magnetometer**
EM122 12kHz Multibeam	**Bell Aerospace BGM3 Gravimeter**
Knudsen 3.5 kHz SBP	**RDI ADCP – Not Operational**

1.1. CRUISE OBJECTIVES

(Pulled from IHA application information submitted by the PI)

[ADD SCIENCE OBJECTIVES FOR MISSION]

1.2. CRUISE SCHEDULE

This cruise will consist of one leg, approximately XX days starting in **[ADD DATE]**. It is expected that crew change and resupplying of the vessel will occur during the scheduled port calls, before and after the cruise. The following schedule (Table 1.1) is preliminary and is subject to change depending on the local weather and environmental conditions experienced on site during the survey.

Table 1.2: Proposed cruise schedule

Tentative Date	Activity	Port
[ADD DATE]	Start of survey	**[ADD PORT INFO]**
[ADD DATE]	End of survey	**[ADD PORT INFO]**

More details as this schedule firms, including mobilization and demobilization dates.

Departure from port is typically scheduled for between 0800 and 1000. Arrival back to port is typically scheduled for the same time period (early morning). PIs are requested to direct any requests for sailing time changes to the Captain, who will relay details back to OMO.

The science party will be permitted to move onboard and have access to the ship starting a day before sailing. At the end of the cruise, the scientists may stay onboard for 1 night after the ship arrives in port. Network services will be available until their departure. LDEO will arrange berthing for this size mission group. Doubling of personnel in all applicable cabins will have to be looked at closely and assigned to accommodate the total personnel count. All participants are advised that this will likely be a full ship.

1.3. SCIENCE PARTY CRUISE DETAILS

This section contains some of the cruise details that the science party has requested or needs their attention.

1.3.1. Operations

A number of operational decisions will need to be confirmed with the CSO and the PIs before and during mobilization.

- Survey waypoints and operation plan
- Source configuration
- Streamer configuration
- Other scientific objectives

1.3.2. Safety Gear

Safety is of the utmost importance! The science party will comply with all the vessel safety rules and regulations. In accordance, most personal protective equipment (PPE) will be provided onboard. However, the science party is asked to pack safety toe shoes (composite toes if not steel toes) to work on the back deck. Coveralls or sturdy clothing is recommended for back deck work. Closed toed shoes are necessary in the galley. The PIs may have more safety requirements based on the science objectives (i.e. safety glasses in the rock cutting lab).
PFDs and survival suits, if necessary, are on the vessel.

1.3.3. Equipment

In general, the science party should bring all their own equipment, computers, hard drives, etc. LDEO has some general use computers for Internet, basic tasks, but are not outfitted for most scientific analysis. Please coordinate with onshore OMO if special arrangements (space onboard, special wiring, etc.) for equipment are necessary.

1.4. PROPOSED SURVEY AREAS/PLANS

The following survey area and shooting plan is proposed by the science party:

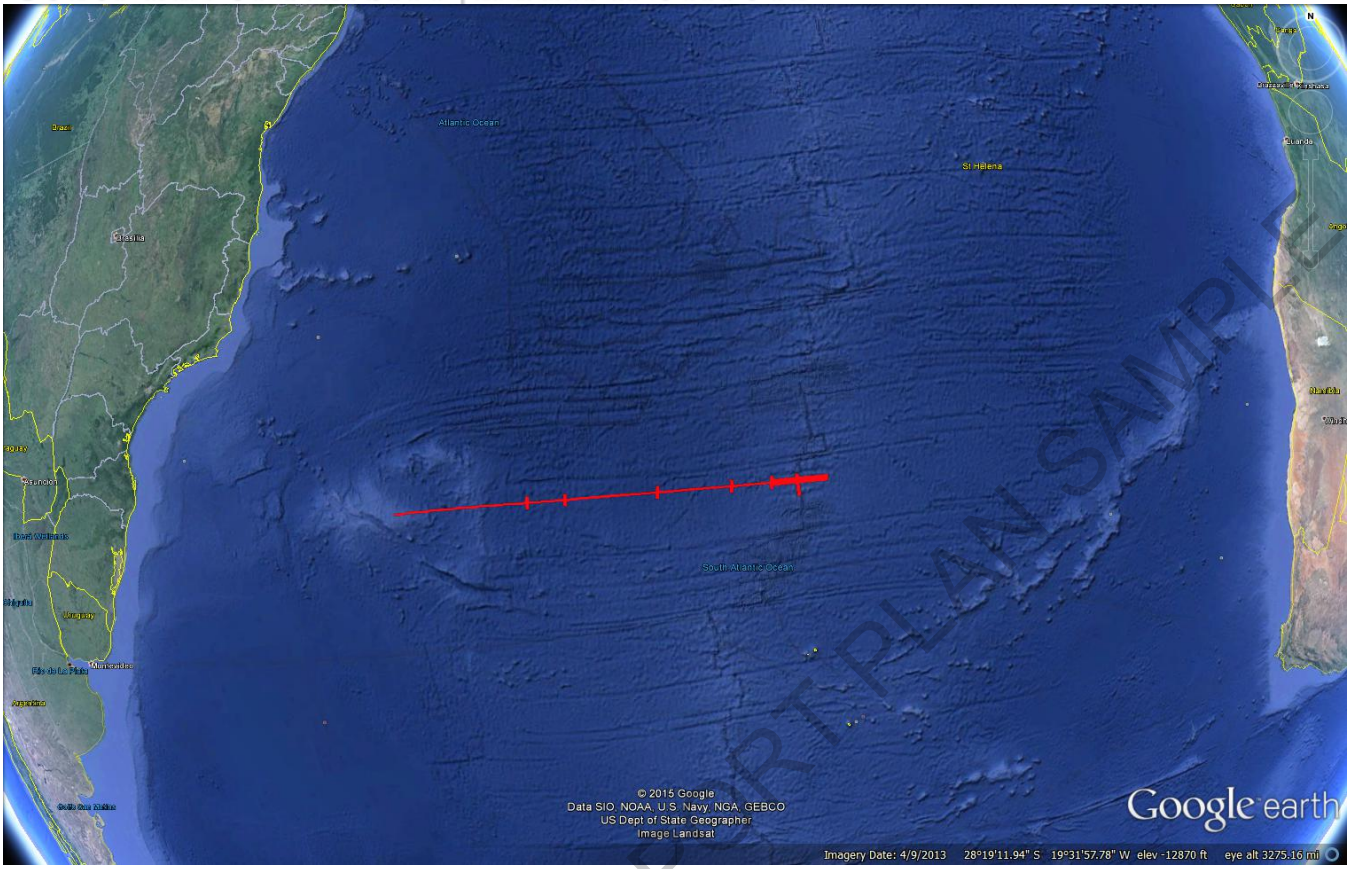

Figure 1.1: General location map and proposed survey area

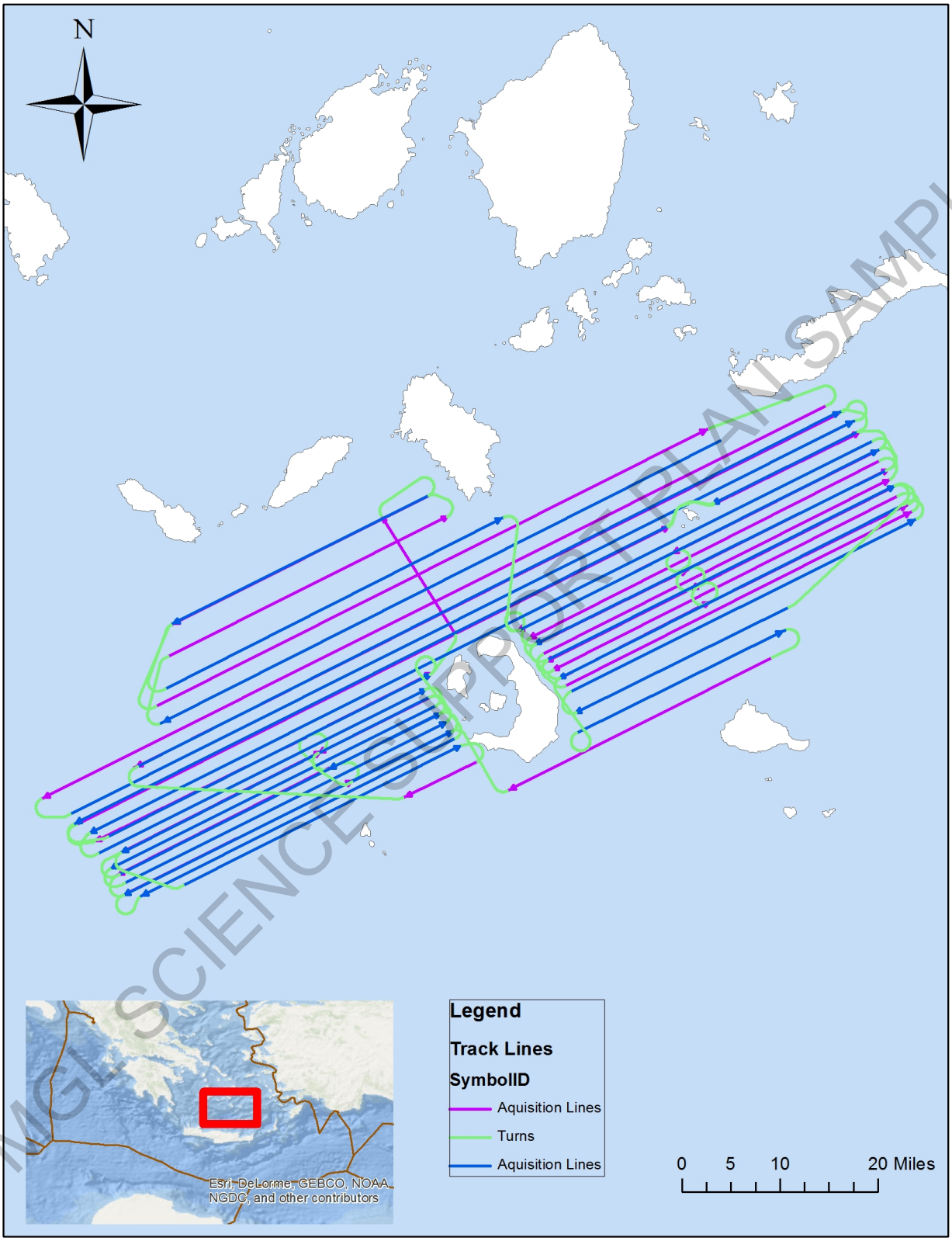

Figure 1.2: General location map with EEZ delineations and proposed survey area

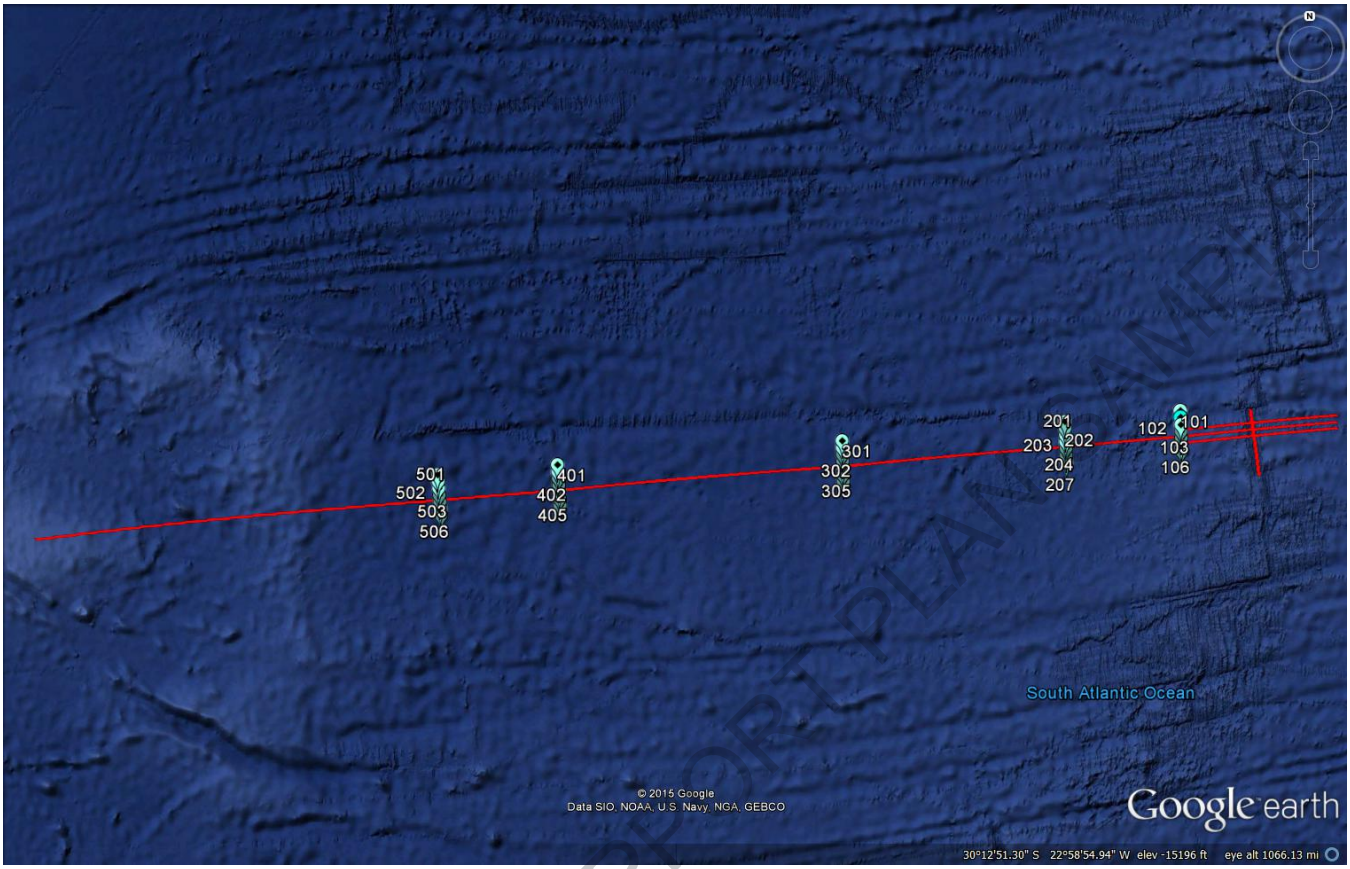

Figure 1.3: Proposed survey plan

Table 1 – [ADD TABLES]

2. OPERATION AND SYSTEM STATUS

At the date of writing, the following pertain to this cruise:

- The IHA (mammal permit) is in process.
- Foreign Clearance permits is not needed.
- The following issues (if applicable) were noted during preceding operations and are currently outstanding:
  - Source/Towing/Handling:
  - IT/Comms/Sonars/Processing:
  - Navigation/Positioning:
  - Syntrak MCS/Acquisition:
  - Seismic air compressors:

3. PERMITS AND ENVIRONMENTAL PLANNING

3.1. PERMITS

Because this is a seismic mission, OMO must comply with the National Environmental Protection Act, the Endangered Species Act and Marine Mammal Protection Act of 1972. Filing of the Incidental Harassment Authorization (IHA) is being handled by OMO. The Protected Species Observers (PSO) Handbook and the IHA will be reviewed via phone with vessel personnel (Captain, Technician in Charge and Lead PSO) and onshore OMO personnel (Mammal permit coordinator, Technical manager and Operations manager) prior to start of seismic operations. *This process will detail the allowed source depths for the duration of this cruise.*

3.2. EXPORT CONTROLS

United States export controls exist to protect the national security and foreign policy interests of this country. Export controls govern the **shipment, transmission, or transfer** of certain sensitive **items, information or software** to foreign persons or entities. Where applicable, they may require authorization from the US Government in the form of an export license. Please see Appendix I for more information.

All personnel will be checked on the consolidated screening list is a list of parties for which the United States Government maintains restrictions on certain exports, re-exports or transfers of items.

Please notify the office if you have any export control items. If you have questions please contact the office before the cruise.

3.3. HAZARDOUS MATERIALS

Science programs requiring the use of hazardous materials including radioactive substances shall coordinate needs with the Office of Marine Operations well in advance of the mission. The *Langseth* is obligated to comply with the University National Oceanographic Laboratory System's (UNOLS) "Research Vessel Safety Standards"; Section 9 details UNOLS requirements for dealing with hazardous material usage onboard the vessel.

"The Chief Scientist will be responsible for the proper transportation, shipping and disposal of hazardous materials and waste, including the empty containers, associated with their project. Transportation and disposal must be carried out in accordance with Federal, State and Local regulations. In no case will this responsibility be passed to the ship's crew or operating institution".

"Proper storage, labeling, and spill response (cleanup) is the responsibility of the user. Anyone using hazardous material should be trained in proper laboratory safety procedures. The Chief Scientist shall be responsible for ensuring that safe laboratory procedures are followed including use of personal protective equipment, prohibiting

the consumption of food and drinks in labs, and other safety precautions as outlined on MSDS and considered standard laboratory procedures".

The vessel has limited storage for small amounts of chemicals; there is no onboard capacity to house large quantities. If large quantities of chemicals are required an appropriate chemical storage van will have to be obtained and installed on the vessel. The vessel does not have a fume hood available. Permits may be required for the acquisition, transport and use of hazardous materials; The Chief Scientist should obtain any permits with copies provided to the Office of Marine Operations (OMO) prior to the start of the mission. *The Marine Operations Office must review and approve any researcher coming aboard the Langseth with hazardous materials/chemicals.*

3.4. SHIPPING, FISHING AND DIVING ACTIVITIES

Significant activities anticipated in the survey area.

3.5. OBSTRUCTIONS AND SHALLOWS

Obstructions and shallows expected in the survey area.

3.6. WEATHER

Weather will be continually monitored while at sea. Weather forecasts will be available from the following systems:
NOAA Weather
NOAA's National Weather Service Marine Forecasts
Buoy Weather
Weather Online (UK)

4. CRUISE PARTICIPANTS

4.1. TECHNICAL STAFF

Survey operations will be based on a 24-hour day and the following offshore personnel will be utilized for this cruise:

Table 4.1: Expected technical personnel

Participant	Group/Affiliation	Position
TBD	L-DEO OMO	Chief Science Officer
TBD	L-DEO OMO	Science Officer – Nav/IT
TBD	L-DEO OMO	Science Officer - Acq
TBD	L-DEO OMO	Chief Source Mechanic
TBD	L-DEO OMO	Marine Science Technician (Nav)
TBD	L-DEO OMO	Marine Science Technician (Acq)
TBD	L-DEO OMO	Source Mechanic
TBD	L-DEO OMO	Source Mechanic

Table 4.2: Expected protected species mitigation personnel

Participant	Group/Affiliation	Position
TBD	RPS-Geocet	Lead PSO
TBD	RPS-Geocet	PAM operator / PSO
TBD	RPS-Geocet	PSO
TBD	RPS-Geocet	PSO
TBD	RPS	PSO

4.1.1. Technical Staff Responsibilities

It is the responsibility of the technician staff to work in accordance with the issued procedures and within the cruise specifications. They are also responsible for maintaining the equipment, keep this in optimum condition and use it in accordance with the applicable procedures, work instructions and manuals. Technicians are responsible for all data gathered, to ensure that it is of maximum achievable quality and properly filed and labeled on the appropriate forms. Technicians will communicate with the Chief Science Officer on a continuous basis to keep him/her up to date with the status and progress of the work.

The technical support staff shall liaise with the science party to ensure that the best quality data obtainable is recorded. The science party is responsible for all geophysical data processing and interpretation. Data processors are NOT included in the technical support staff. The technical staff will assist, when possible, with other science operations including coring. However, the science party is responsible for in situ testing, storage, and transport of all samples to the onshore curation facility.

The technical support staff consists of a Technician in Charge / Chief Science Officer, IT / Navigation Technicians, Data Acquisition Technicians, and Source, Towing & Handling Technicians. Their responsibilities are as follows:

Chief Science Officer / Technician in Charge

The Chief Science Officer (CSO) is the senior technician onboard and is the liaison between the cruise participants, the LDEO / OMO staff, the Captain, the LDEO / OMO office and the port agent. He / she coordinates the support effort among the various parties onboard. The Chief Science Officer is the first contact for issues related to on-board operations, cruise plans, etc. The CSO is responsible for deployment, recovery and trim of all towed seismic equipment.

IT / Navigation Technician

The IT / Navigation Technician (IT /NAV) is in charge of navigation system parameters and operations. The navigation technicians are responsible for ensuring that correct procedures are used during the set-up and calibration of the navigation system, logging of all data and sensor information, correct installation, maintenance and operation of the SBES, MBES and motion sensors.

Data Acquisition Technician

The Data Acquisition Technician (ACQ) assists in deployment; recovery and trim of all geophysical survey equipment, the seismic recording system parameters and operations as well as sound source controller operation. The survey technicians are responsible for the maintenance and operation of the survey equipment. This shall include overseeing that correct procedures are used during calibrations and winch operations, and that the data is logged in the correct format and electronic annotation is correct. This responsibility extends to assisting with installation and maintenance of the navigation and bathymetry spreads. They are also responsible for ensuring that correct procedures are used during the set-up and calibration of the multibeam systems and monitoring of the geophysical data.

Source, Towing & Handling Technician or Mechanic

The Sound Source, Towing and Handling Technician (ST&H) is in charge of deploying, retrieving and maintaining the sound source as well as other seismic towed equipment.

Protected Species Mitigation

The Protected Species Observers (PSO) required for mammal / protected species mitigation this cruise.

4.2. MARITIME CREW

This cruise will include the regular maritime crew of the R/V *Langseth*. The expected number of sailing crew is 20. The Captain is TBD. The Chief Engineer is TBD.

4.3. SCIENCE PARTY

The following science party participants will be granted access to R/V *Langseth*. Next-of-Kin (NOK) forms will be sent to the PIs for distribution to the participants. Completed forms need to be returned to the OMO Manager, Technical Services no later than one (1) week before sailing. Failure to note and detail any participant could delay that participant's access to the vessel.

During operations, 2 members of the science party are needed at the main lab console for online data monitoring, log keeping, and other operational needs that arise (i.e. SVP casts, deployment, etc). These 2 people are asked to provide their undivided attention during their time assigned. The PI will assign shifts for 24 hour coverage. Participation is encouraged at all times, this is "your" science, however science party help is particularly needed during deployment and recovery of gear. Please do not hesitate to join the activity.

Table 4.3: Expected science party members

	Participant	Group/Affiliation	Function	Gender	Email Address
1					
2					
3					
4					
5					
6					
7					
8					
9					

Science party consists of XX females and XX males, for a total of XX scientists

5. GEODETIC PARAMETERS AND POSITIONING

All survey calculations will use the World Geodetic System 1984 datum (WGS84) UTM Zone (TBD at sea) projection. The Global Positioning System (GPS) operates on the WGS84 datum. The vessel's Differential GPS (dGPS) Reference Stations are defined in the WGS84 datum.

In order to obtain optimized navigation, waypoints need to be in decimal degrees (DD) to five (5) decimal points. Decimal degrees express latitude and longitude geographic coordinates as decimal fractions and are used in many Geographic Information Systems (GIS), web mapping applications such as Google Maps, and GPS devices. Negative numbers represent latitudes south of the equator and longitudes west of the Prime Meridian.
Example: 38.88972, -77.00888

5.1. GEODETIC AND PROJECTION PARAMETERS

The geodetic and projection parameters are detailed in the following table:

Table 5.1: Project geodetic and projection parameters

Global Positioning System Geodetic Parameters		
Datum	World Geodetic System 1984 (WGS84)	
Reference Ellipsoid	WGS84	
Semi Major Axis (a)	6378137.0 m	
Inverse Flattening (1/f)	298.257224	
Survey (local) Geodetic Parameters		
Datum	World Geodetic System 1984 (WGS84)	
Reference Ellipsoid	WGS84	
Semi Major Axis (a)	6378137.0 m	
Inverse Flattening (1/f)	298.257224	
Datum Transform Parameters: Global to Survey Datum		
X shift: 0.0 m	X-axis Rotation: 0.0 arcsec	Scale correction: 0.0 ppm
Y shift: 0.0 m	Y-axis Rotation: 0.0 arcsec	
Z shift: 0.0 m	Z-axis Rotation: 0.0 arcsec	
Map Projection (Project Projection Parameters)		
Grid	Universal Transverse Mercator (UTM)	
Projection Type	Universal Transverse Mercator (UTM), Southern Hemisphere	
Projection Zone	**[ADJUST FOR SURVEY SITE]**	
Latitude at Origin		
Longitude at Origin (Central Meridian)		
False Easting		
False Nothing		
Scale Factor at Central Meridian		
Grid Units	Meters	

5.1.1. Gravity Tie Point

Per standard procedure, a gravity tie will be done before and after this cruise. During the cruise, a ship-mounted gravimeter will measure gravity.

5.2. POSITIONING REFERENCE SYSTEMS

Two independent standard multi-station dGPS systems are required for the survey.

Table 5.2: Vessel Positioning Reference Systems

System	Equipment
Primary Nav system	C-Nav 3050 dGPS
Secondary Nav system	Seapath dGPS
Tailbuoy navigation	PosNet rGPS
Source navigation	PosNet rGPS (1 unit per subarray)
Acoustics	DigiCourse
Navigation processing	Concept Sprint 4.3.9
Bird Controller	DigiCourse
Survey-Gyro (Primary)	Simrad GC-80
Ships-Gyro (secondary)	Sperry MK-27
Speed Log	Furuno DS-50
Multibeam	Kongsberg EM-122

5.3. MAGNETIC DECLINATION [UPDATE FOR SURVEY SITE]

Source: www.USGS.gov (http://www.ngdc.noaa.gov/geomag-web/#declination)
Model: IGRF-12
Date: 2016/1/14 (Approx. date vessel will begin acquisition)
Position: 30.67°S, 20.43°W (OBS Location 304 approx. center of survey)
Declination: 25.40° W
Variation: 0.0° E per year

Map for reference purposes only. Magnetic declinations should be calculated for various points using the Mag dec calculator found on www.ngdc.noaa.gov.

5.4. COVERAGE FOR DIFFERENTIAL CORRECTIONS

Below is the map of coverage for differential corrections. Please note the survey area with respect to these coverages. Areas of the survey not inside "Differential Coverage" zones will have positional accuracy degraded. Sub-meter positioning accuracy by the vessel systems is not available in areas outside "Differential Coverage" zones. Accuracy of position will be variable, and is dependent on number of satellites in view and the constellation geometry.

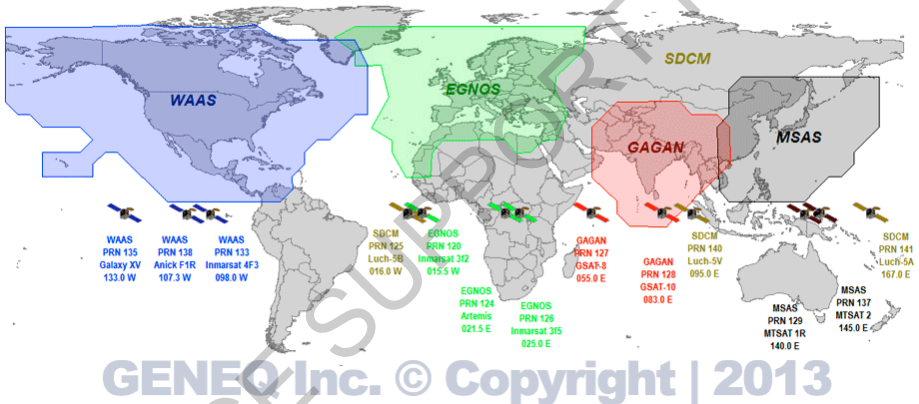

Figure 5.1: Map of coverage for differential corrections

6. SURVEY EQUIPMENT AND OPERATIONS

6.1. SEISMIC

The Source portion of this survey will be acquired using 4 sound-source subarrays, consisting each of Bolt source elements with 1,650 cubic inches (in3); yielding a total of 6600 cubic inches (in^3). Each array will consist of a mixture of Bolt 1500LL and Bolt 1900LLX Elements and will be configured as four identical linear arrays or "strings" (Figure 6.1). Each sub-array will have ten elements; the first and last elements in the sub-array are spaced 16 m apart. Nine elements in each sub-array will be fired simultaneously for a total volume of approximately 6,600 in^3, whereas the tenth element is kept in reserve to be enabled in case of failure of another element should occur. The array will be towed approximately 150 m behind the vessel. Discharge intervals depend on both the ship's speed and Two Way Travel Time (TWTT) recording intervals. The sound sources will be discharged approximately every 150 meters for OBS, based on an assumed boat speed of 4.7 knots. The nominal firing pressure of each array is 2,000 pounds per square inch (psi). During firing, a brief (~0.1 s) pulse of sound is emitted. The sound sources will be silent during the intervening periods.

The tow depth of the sound source arrays will be 12 m (or shallower, as specified by the IHA). Because the actual source is a distributed sound source (9 sound sources) rather than a single point source, the highest sound levels measurable at any location in the water will be less than the nominal single point source level. In addition,

the effective (perceived) source level for sound propagating in near-horizontal directions will be substantially lower than the nominal omni-directional source level because of the directional nature of the sound from the sound source array (i.e. sound is directed downward).

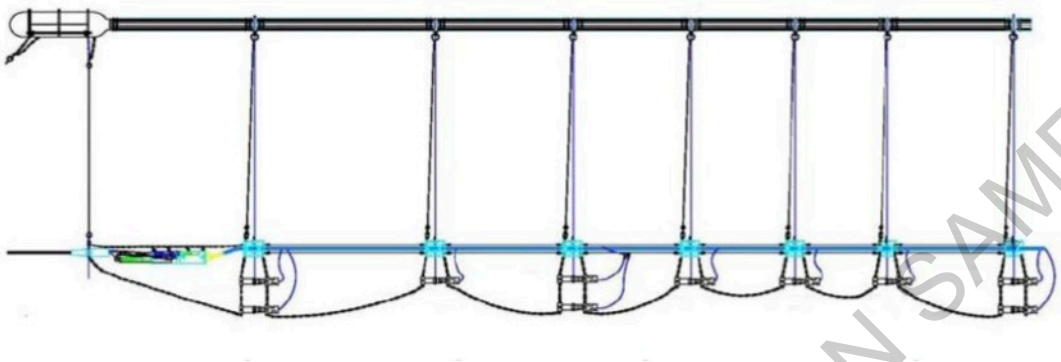

Figure 6.1: Typical Seismic Array Diagram

Flotation will be used to keep the sound sources at a depth of 12 m and the vessel speed during data collection will range from 4 to 5 nautical miles per hour [knots]. Depth indicators are located on each string to verify the depth of the sources during acquisition.

Acoustic transponders will also be present along each streamer, tail-buoy, and sub-arrays. A head and tail network will be configured in the system to aid in the accurate positioning of the in-water equipment.

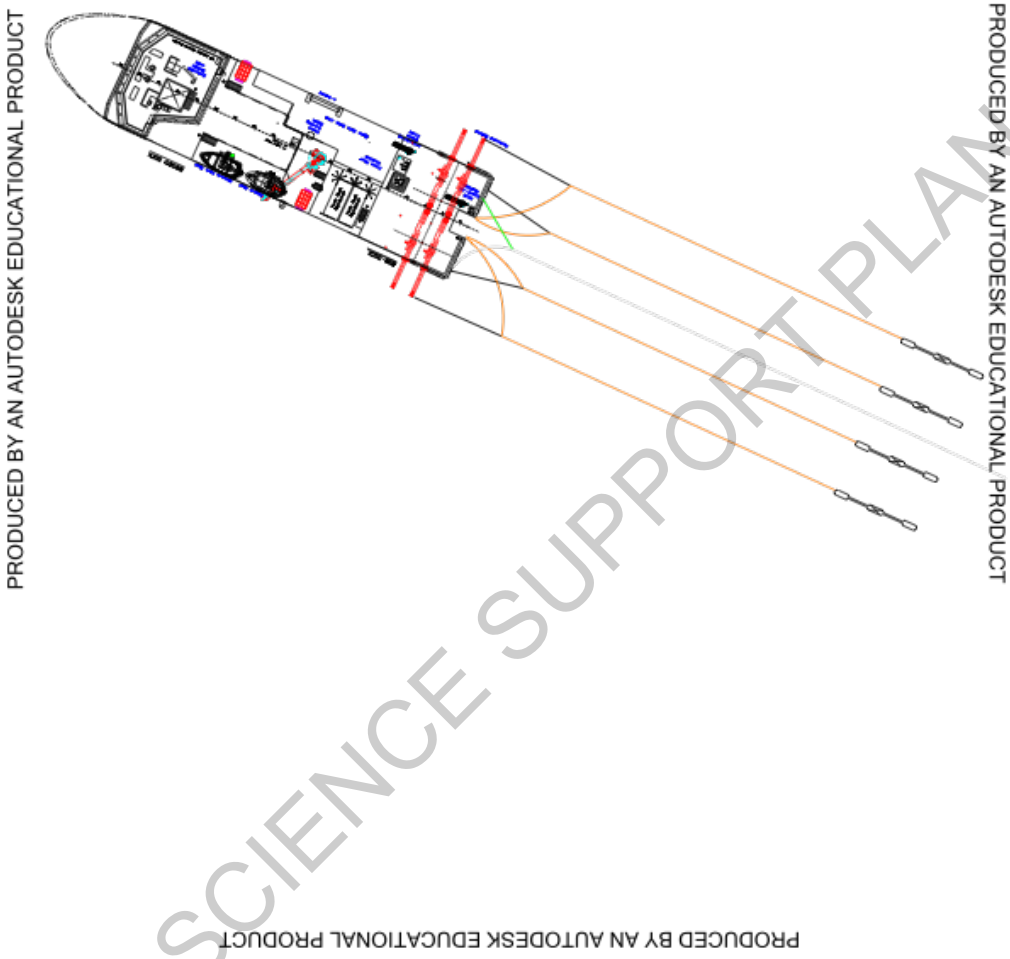

Figure 6.2: Typical configuration for the sound source array and towing strategy

6.1.1. Shooting Plan

A shooting plan will be developed and approved by the PIs and the Chief Science Officer during the cruise mobilization. The shooting plan should not be deviated from without written authorization from both. The plan must take into consideration known issues such as shallows, obstructions, fishing or other activity, protected marine areas, prevailing strong currents, and weather. In some cases the Captain and/or Marine Operation Manager may also have to provide approval if safe operation or safe navigation of the vessel is in question. A copy of each approved version of the shooting plan is kept with the documentation for the science cruise. Any changes to the shooting plan must be discussed with the Chief Science Officer first, then agreed upon changes are brought to the Captain.

Be aware the following:

- Use shot point 1001 for the start of each pre-plot, run-out shot-point is NOT included in pre-plots.
- A 4250 m run-out (85 shot-point) should be added to all lines.
- Run-in should be min. 3 km to ensure that the streamer is straight before start of line (SOL).

6.1.2. Seismic Parameters

[ADD PARAMETERS IF NEEDED]

6.1.3. Seismic Recording Systems

Recording type	Sercel SEAL 408xl
Sample rate	2ms
Recording length	18 seconds w/ no Deep Sea Delay
Low Cut Filter	2.0 Hz Digital Filter / 12 dB/OCT
High Cut Filter	206 Hz Digital Filter /276 dB/OCT w/ linear phase
Data format	SEG-D 8058 Rev1 demultiplexed with External Header.
Media	Data recorded directly to disk

6.1.4. Seismic Streamer

Streamer type	Sercel Sentinel SSAS
No of streamers	1
Streamer length	8100 meters
No of groups	648
Group Interval	12.5m
Group length	12.95m
Streamer depth	Unknown
Near offset	TBD
Spacing of birds	~300meters with extra redundancy at head and tail of streamer

6.1.5. Seismic Source

Source type	BOLT Air-Sound Source
Shot interval	OBS Component: 150m Towed Streamer Component: xxx
Number Sources	1
Source depth	12 m per IHA permit application
Volume	6600 in3
Air pressure	1900 +/- 100 psi
Source separation	0 m
Max timing error	+/- 2 ms

See Appendix 3 for source details.

6.1.6. In Sea Positioning Systems

Tail-buoy (N/A)

A Tail-buoy will be deployed at the tail of each streamer for positioning. Each Tail-buoy is to be fitted with a GPS unit, a radar reflector, a strobe light, and a DigiCourse Acoustic transponder for ranging to the transponders on the tail of each streamer.

Source Positioning

Each Sub-Array float will have a Posnet rGPS Pod installed along with each sub-array having a DigiCourse acoustic pod.

Streamer Positioning

Streamers are positioned using a DigiCourse 5011 compass birds and DigiCourse acoustic transponders.

Magnetic Compasses and birds

The compasses and birds will be mounted at 300 m intervals on the streamer. The depth controllers / compasses will be DigiCourse model 5011. Extra compass birds will be mounted in the front and tail of the streamer for redundancy.

Acoustic Positioning

DigiCourse DigiRange Acoustic Pods will be mounted on the streamer cable. The units mounted at the head of the Streamer will range to the Acoustic Transponder Pods co-located with the rGPS units on the Sub-Array Floats. Other units will be located in the middle of the streamer and will cross range to the units on the other streamers (if applicable). Units are mounted at the tail of the streamer, which will range to the tail-buoy transponder co-located with the rGPS unit and/ or the other streamers (if applicable).

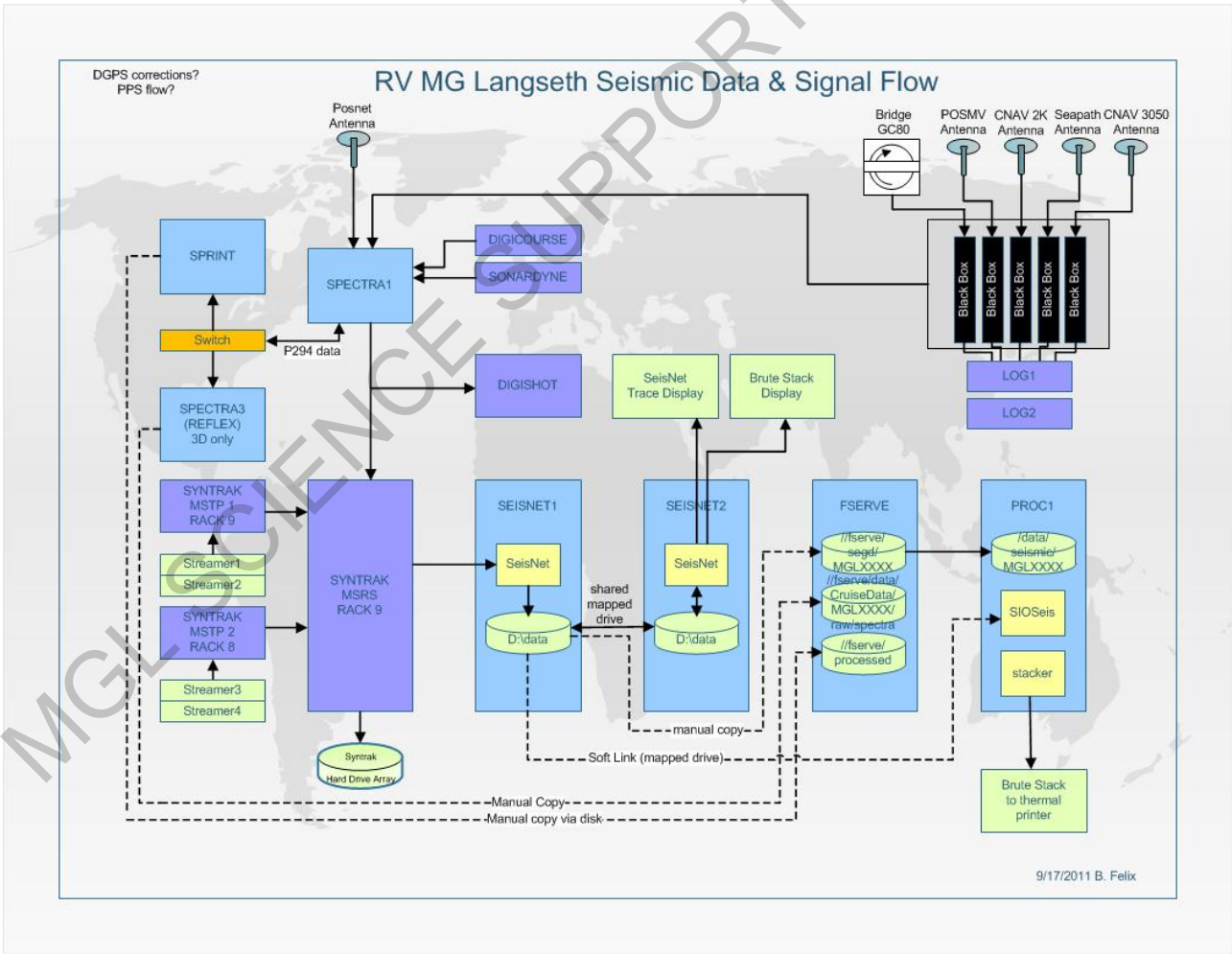

Figure 6.3: Seismic Data Flow Layout

6.1.7. Acoustic Measurements

The strength of the air-sound source pulses can be measured in a variety of ways, but National Marine Fisheries Service (NMFS) commonly uses "root mean square" (in dB re 1µPa [rms]), which is the level of the received air-sound source pulses averaged over the duration of the pulse. The rms value for a given air-sound source pulse is typically 10 dB lower than the peak level, and 16 dB lower than the peak-to-peak level (McCauley et al., 1998, 2000a,b).

The noise modeling for the proposed 3D seismic survey was conducted based on the results of mathematical modeling conducted by Greeneridge Sciences, Inc. (2011). The model results are based upon the sound source specifications provided for R/V Langseth and seafloor characteristic available for the Project area. Safety and Exclusion zone dimensions are based on NMFS definitions for Incidental Harassment Authorizations (IHA). The *Safety Zone is the distance within which received sound levels are modeled to be greater than 160 db and the Exclusion Zone is the distance within which received sound levels are modeled to be greater than 180 db. Table TDB from IHA.*

6.1.8. Seismic QC Processing

The seismic quality control (QC) will be provided by seismic processing team, made up of science party members.

6.2. SONARS

The sonar equipment on vessel include the Kongsberg EM122 12kHz multibeam echo sounder, the Knudsen 3260 3.5 kHz Sub-bottom Profiler, and the RDI OS75 ADCP, are operated continuously throughout every cruise. Staff onboard *Langseth* are proficient in basic operation of these systems, but are not sonar experts. **PI's who require advanced expertise during their cruise will need to bring their own personnel.**

6.2.1. Multibeam Echosounder

The EM122 multibeam echosounder (MBES) is normally run with standard options enabled and automatic parameter adjustments enabled where possible. This configuration should provide good coverage (swath width), but may not provide optimal coverage under all conditions. These settings will not provide the best data quality. Specifically, reducing swath width is often required to attain the best data quality and density. Consult with the technical staff or other authorities if there are specific requirements for your cruise.

Bathymetry data will be acquired (recorded) using a Kongsberg EM-122. The EM122 sound velocity profile (SVP) will be processed from the Expendable Bathythermograph (XBT) data and uploaded to the EM122 system by the technical staff. The updates will occur at the discretion of the technical staff or at PI request, up to once per day, coincident with XBT deployment (see Section 6.4 XBT).

6.2.2. Sub-bottom Profiler

The Knudsen 3.5 kHz Sub-bottom Profiler (SBP) is normally run synchronized with the EM122 MBES. **This sometimes results in a reduction in the Knudsen sampling rate,** but minimizes interference with the EM122. PI's who wish to run the Knudsen without synchronizing to the EM122 must discuss this with the Chief Science Officer. If the multibeam is not in use, the Knudsen will be run in internal sync. Knudsen data is recorded in SEG-Y, KEA, and KEB formats.

6.2.3. Acoustic Doppler Current Profiler

A RDI OS75 Acoustic Doppler Current Profiler (ADCP) is installed on the vessel and has been in operation since 2011 science mission season. The vendor, Teledyne RDI, ran both Harbor Acceptance (done in San Francisco) and Sea Acceptance (done offshore San Diego) tests, completing the commissioning of the system. Dr. Jules Hummon from University of Hawaii joined the *Langseth* for the JMS inspection cruise and fully installed their on-board system for logging, processing and QC of the data. *The ADCP is currently non-operational and not expected to be fixed for the duration of this cruise.*

6.3. MAGNETICS AND GRAVITY

6.3.1. Magnetics

The *Langseth* carries two Geometrics 882 magnetometers. *Langseth* policy is to deploy the magnetometer only in the work area. The magnetometer is not deployed during transits to and from the work area. The magnetometer must be recovered at less than 3 knots.

6.3.2. Gravity

The Langseth is equipped with a Bell Aerospace BGM-3 gravimeter. Gravity data will be handled by the R2R data archive group at LDEO (See Data Distribution below).

6.4. XBT

The *Langseth* carries Sippican T-5 and T-7 Expendable Bathythermograph (XBT) probes, suitable for general oceanography and sound velocity use in the multibeam processing. *Langseth* deploys one probe daily when possible. Science party assistance (one person, ~20 minutes daily) is required for routine probe launch. Multiple people can be trained on probe launch operations. If no science party members are available to assist with deployments, deployments may be reduced as necessary.

Due to space and cost considerations, *Langseth* does not routinely carry probes in excess of these requirements. PI's who require additional probes or probes of a different type must discuss their needs with OMO before the cruise. PI's who have a specific deployment plan should work with shipboard technical staff during the cruise. The standard cut-off limit for XBT probes will be used unless a specific request is made by the PIs (Probe T-5 to 1850 m and Probe T-7 to 700 m). Other MK21 probes, e.g. XCTD's and XSV's, may be deployed using the MK21 system. The LDEO technical staff does not provide these probes. If required, they must be provided by the PIs. Note that during seismic operations, XBT probes often terminate early as they get caught in the gear.

For this cruise, as XBT data are requested as a secondary objective, a written execution plan is recommended. The plan should detail, at a minimum, frequency, location or distance between drops, probe type, and re-shoot specifics.

The science party will supply approx. 30 minutes of personnel time to perform the processing, per profile. Training in processing and uploading the profile to the multibeam will be provided by technical staff.

6.5. CTD

Not Applicable for this mission

6.6. NAVIGATION

The navigation equipment on the vessel is as follows:

- Furuno FE700 echosounder
- Furuno DS50 doppler speedlog
- C-Nav 3050 DGPS
- C-Nav 2000 DGPS
- Simrad GC80 gyrocompass
- Sperry Mark 37 gyrocompass
- POS/MV Integrated Nav System
    - Upgraded February 2013
- Seapath Integrated Nav System
- Spectrum Instruments TM-4 Event Logger

These systems are provided to support seismic operations and the multibeam system. There are no user-configurable options. These systems are operated by the crew and technical staff, and are turned on or secured as

necessary. They are normally operated, unless equipment or permit requirements dictate otherwise. All of these instruments output serial data and are logged using the Lamont Data System (see Section 6.10).

The navigation processing will be performed by the technical staff using the Concept Sprint Navigation Processing System.

Final data format: UKOOA P190
Final data medium: Electronic

6.7. METEOROLOGICAL

Langseth has an RM-Young Weather Station, Viasala WXT520, and Airmar WX200 installed for wind speed/direction, air temp/humidity, and barometric pressure running on NOAA Shipboard Computer Systems (S.C.S.)

6.8. SURFACE SEAWATER

The following meteorological and hydrographical instruments are on the *Langseth* and are routinely operated:

- LDEO PCO2
- SBE-45 TSG
- Applied Microsystems MicroSV
- Sea-bird Electronics SBE38 Temperature Sensor

6.9. CLIENT-PROVIDED INSTRUMENTATION

Set-up and operation of client-provided instrumentation is the responsibility of the Chief Scientist. The technical staff can assist with serial data feeds and network access.

6.10. LAMONT DATA SYSTEM (LDS)

Serial data is logged via the Lamont Data System (LDS). The LDS provides a highly configurable system for receiving, recording, manipulating, and transmitting serial data. Access to this system, either to log data from client-provided instrumentation or to have navigation or other data sent to client instruments or data logging equipment, is possible. Please discuss these needs with the technical staff before the cruise.

LDS data is automatically copied (using rsync) to the cruise directory every six hours.

More details regarding data are in the following data management and distribution section.

7. DATA MANAGEMENT AND DATA DISTRIBUTION

LDEO has implemented a file management system and directory structure that will enable all digital data to be organized and backed up efficiently on the vessel network.

7.1. LINE NAME CONVENTION

Surveyed lines will be labeled in a logical and unique manner.

7.1.1. Navigation and Support Data

Lines names will include the cruise number, then the line number, and lastly the line type. Line numbers will start at one and increment sequentially during the survey. Lines will be identified at the end of the line name as Prime (P), Reshot (R), or Infill (I). The line names can have a maximum of 12 characters.

Example: MGL14081001P

Cruise Number: MGL1408
Line Number: ----------1001
Line Type: ----------P/R/I
P = Prime, R= Reshot, I= Infill

"Infill" lines used only in 3D mode.
CMP Line Numbers will start with 1001 for the first line and increase chronologically. The Pre-Plot (Track Lines) will increment by one (1) because of the number of CMP lines acquired during each pass.

7.1.2. Recording and Other System Data

The format for line names of both of the RECORDS and HEADERS of all other data including the SEG-D and SEG-Y format should follow the full UKOOA 16 character standard to match the navigation data, as above.

7.2. DATA DISTRIBUTION

Upon arrival on the vessel, Chief Scientists shall meet with the Chief Science Officer and the Data Manager to discuss the NSF and *Langseth* data policies. Before departing the vessel, the Chief Scientist will meet again with the Data Manager and sign a data release authorization, which authorizes LDEO to transmit and submit the raw cruise data on their behalf. At this time, certain data sets may be marked for early release. *Langseth* does not routinely collect non-digital data (e.g. water samples, cores) during seismic operations. Should non-digital data be collected, it will be the responsibility of the Chief Scientist to arrange to have the samples removed from the vessel at the end of the cruise and ensure that NSF archiving requirements are met.

7.2.1. Collection

All data acquired from *Langseth* sensors flows to the central *Langseth* fileserver (fserve), where they are stored in a cruise-specific network share, called the 'cruise directory'. All cruise documentation, log files, and records are also stored there. Shipboard researchers can access the cruise directory using a CIFS network share (standard Windows file sharing). *Langseth* technical staff will assist users in accessing the cruise directory. Access to the raw data is read-only, but writable areas are available for users to store documents and files. Users are encouraged to store any cruise-related materials (except seismic processing files) in the cruise directory. Users are also encouraged to load data from non-*Langseth* (i.e., client-provided) instruments in the cruise directory, also.

Multi-channel seismic shot data is recorded directly to RAID disk and is backed up on the central fileserver under a different share, called the 'SEGD directory'.

Note that all shipboard researchers are provided credentials to access the cruise directory and SEGD directory. After the cruise is completed, these directories are archived and are not available to subsequent users. During the cruise, however, all cruise participants have access to all current data. If there are specific data security concerns, these MUST be identified before the cruise.

Toward the end of the cruise (usually the day of arrival), the technical staff will close the cruise directory and no further additions will be possible. Sufficient notice will be made to users to allow completion of work.

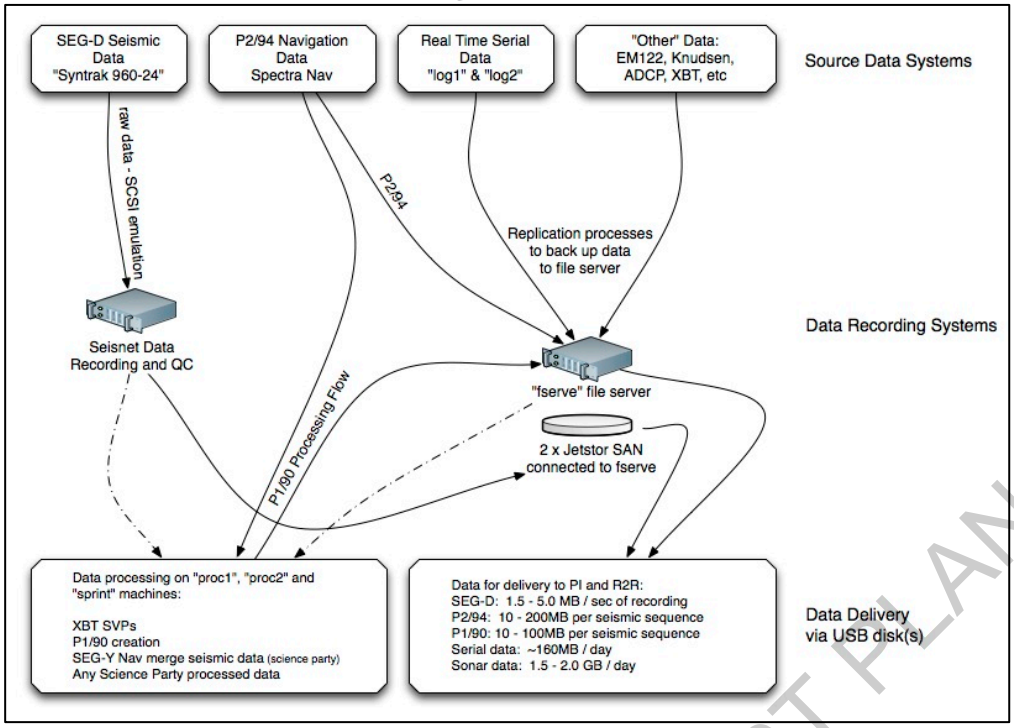

Figure 7.1: Data Flow Layout

7.2.2. Distribution and Transport

Data are logged until arrival at the pier. The data distribution will be finalized the day of arrival and will be ready for packaging the morning after arrival.

The technical staff will provide one set of data copies, including all raw underway digital data to the PI on portable hard drives. The PI can make further copies from these hard drives. The seismic data is made available to scientists via network share, either NFS or CIFS.

If a gravity tie can be completed before the cruise directory is closed out, the gravity tie records will be stored on the cruise directory, including gravimeter data up to and through the gravity tie. If a gravity tie cannot be completed, a gravity addendum will be compiled and made available to scientists at a later date.

7.2.3. Archival and Release

Per NSF policy, all data collected must be made available to the public within two years of collection. NSF has funded several programs to archive and disseminate research data.

Underway Sensor Data

Underway data acquired routinely with the ship's installed sensors (e.g. Multibeam, Sub-Bottom Profiler, ADCP, MET sensors) are submitted to the NSF funded 'Rolling Deck to Repository' (R2R) program. The R2R program is a data clearinghouse which receives raw data from all UNOLS vessels, provides basic data documentation and routine quality assessment, and ensures submission to the appropriate NOAA data center (the National Geophysical Data Center or National Oceanographic Data Center) for long-term archiving and distribution. At completion of the cruise, the technical staff will submit the contents of the cruise directory to R2R.

Multi-Channel Seismic Shot Data

All multi-channel seismic field data collected aboard the *Langseth* are archived with the NSF-supported Academic Seismic Portal at LDEO of the IEDA Marine Geoscience Data System (MGDS). Multi-channel seismic data from most academic surveys conducted with the R/V *Ewing* are also available, as well as data from a number of earlier programs of the R/V *Conrad* and R/V *Vema*.

At completion of each cruise, the technical staff will submit the contents of the SEGD directory as well as all seismic logs and seismic navigation data to the MGDS. The Chief Scientist may request data be made public immediately, however a proprietary hold of 2 years is customary.

OBS Data

All OBS data are archived through the IRIS Data Management Center (DMC) and are submitted to the DMC by OBS Instrument Pool (OBSIP) personnel. Founded in 1984 with support from the National Science Foundation, IRIS (Incorporated Research Institute for Seismology) is a consortium of over 100 U.S. universities dedicated to the operation of science facilities for the acquisition, management, and distribution of seismological data.

Science Party Instruments and Processed Data Created at Sea

Langseth technical staff DO NOT routinely handle the submission of any data acquired with science party instrumentation or created by on-board processing. For example, if the science party processes multibeam bathymetry data during the cruise, that processed data will not be included with the data package submitted by the technical staff to R2R or MGDS. However, these data can be included in the archive submission if the science party makes arrangements for this at the end of the cruise.

Processed seismic data

Processed seismic data (e.g. stacked and migrated sections) from *Langseth* programs are archived at the Academic Seismic Portal at UTIG and are accessible by links from MGDS. Submissions of processed datasets are the responsibility of scientist party, in accordance with the requirements of the funding agency supporting their studies.

8. COMPUTERS AND COMMUNICATIONS

8.1. SHIP'S NETWORK

Langseth's computer network consists of gigabit networking to all lab spaces, with wireless accessibility throughout the ship. Internet access is on a separate, wired network. Only certain spaces have ports to access the Internet. Refer to the Internet Access and Usage policy for details.

8.2. EMAIL, DATA TRANSFERS AND INTERNET ACCESS

Access to email from home institutions is not blocked, and can be received on the internet-enabled network.

Large data transfers can be arranged. Transfers can be done at any time during the cruise but require coordination with the technical staff.

Internet access is a limited resource on ships. While HiSeasNet provides a 24-hour connection, bandwidth is less than that of a typical residential DSL service. Please refer to the Internet access policy (on the internal *Langseth* web site) for information detailing how Internet access is controlled. Any questions or assistance requirements, please contact the technical staff.

8.3. SCIENTIST OWNED COMPUTERS

Scientists may bring their own computers to the vessel. The technical staff will provide support in setting up a network connection and access to email, file services, and printing. Windows XP/Vista/7, Mac OS X, and Linux Redhat/Ubuntu/Debian/Fedora are supported.

Scientists may bring workstation computers. Please discuss beforehand with technical staff during planning stages to ensure enough space is available for all equipment. The tech staff will assist users in setting up workstations.

The technical staff can provide desktop support limited to setting up network access and configuring devices to access network services. Windows XP/Vista/7, Mac OS X, and Linux Redhat/Ubuntu/Debian/Fedora are supported. **Limited break/fix support is provided, on a best-effort basis.**

Updated anti-virus software is required prior to departure. Failing to update on-coming computers' anti-virus software puts the entire vessel network in danger.

8.4. PUBLIC COMPUTERS

Langseth provides workstations and software for seismic processing and general-purpose computing. These are located in the Main Lab. For a list of software available on these systems, please refer to the shipboard internal *Langseth* web site, or email the technical staff. Any questions or assistance requirements, please contact the technical staff.

Internet terminals (at least one) are also provided for crew and science party use. These may be relocated depending on mission requirements. Tech staff will brief the science party on Internet terminal access during orientation.

8.5. VOICE COMMUNICATIONS

Telephone calls for the PIs can be made from any phone on the vessel. Upon arrival at *Langseth*, the PI will be issued a code to allow him/her to access an outside line via Fleet Broadband. On weekends, the Internet may be secured for up to two hours at a time to allow morale calls for all on board. Morale phone calls are in 15-minute slots.

9. SHIPBOARD SAFETY AND SECURITY

9.1. SHIPBOARD SAFETY

The Captain has the final authority for all safety-related matters posing any danger to the ship and/or anyone aboard it. Additionally, if anyone onboard finds that unsafe conditions exist, he or she has the authority to stop any related shipboard science until the situation is corrected. This would include issues of industrial, marine or laboratory safety

Orientation will be conducted for on-coming science party. This will include a safety briefing and vessel walk-through. Each cabin has station billpostings and copies of the UNOLS RVOC Safety Training Manual, Chapter 1.

9.2. MEDICAL CARE

While in port, any non-emergency health or injury needs will be handled by the Captain. Arrangement can be made through either the Captain or the Chief Science Officer, who will pass the request on to the Captain. ***ALL EMERGENCY MEDICAL SITUATIONS NEED TO BE COMMUNICATED TO THE CAPTAIN THROUGH THE QUICKEST MEANS AVAILABE.*** Emergency protocol will be addressed during orientation. Medical Advisory Systems provides medical advice while at sea. The Captain is the primary person to contact for medical care while at sea. Be advised that the infirmary is small and medical supplies are limited. It is the responsibility of all cruise participants to advise the Captain of any medical conditions, and ensure an adequate supply of any and all prescription medication required by that participant.

9.3. SHIPBOARD SECURITY

The R/V *Marcus G Langseth* is a US flagged vessel, and can therefore be subject to MARSEC (marine security). All engineering spaces and vessel safe operation spaces are off limits to non-affiliated and/or non-escorted personnel. All persons intending to board the vessel must provide positive proof of identification. A Passport, US Drivers License, or TWIC (transportation workers identification credential) are accepted. Non-crew cannot enter a US port facility or board the *Langseth* unescorted without a TWIC. A TWIC card is not required. A gangway watch is maintained and all non-crew are required to sign-in and sign-out.

10. SECONDARY VESSELS

10.1. CHASE BOATS

No requests at this present time however may be deemed necessary later in the planning process.

10.2. OBS HANDLING BOATS

Not Requested for this mission, RV Langseth will be conducting Handling of All OBS.

11. CONTACTS AND ADDRESSES

11.1. OFFICE OF MARINE OPERATIONS

Table 11.1: Contact List for OMO

Name	Position	Office	Home	Cell	Email
Paul Ljunggren	OMO Primary Contact / Operations Manager	*REDACTED*	*REDACTED*	*REDACTED*	pwl@ldeo.columbia.edu
Jeff Rupert	OMO Alternate / Tech Services Manager	*REDACTED*	*REDACTED*	*REDACTED*	Rupert@ldeo.columbia.edu
Sean Higgins	OMO Alternate / OMO Director	*REDACTED*	*REDACTED*	*REDACTED*	sean@ldeo.columbia.edu
Martin Klein	Port Engineer		*REDACTED*	*REDACTED*	porteng@ldeo.columbia.edu
OMO office fax number: *REDACTED*					

11.2. PROTECTED SPECIES

Table 11.2: Contact List for Protected Species

Name	Position	Office	Home	Cell	Email
Paul Ljunggren	Operations Manager	*REDACTED*	*REDACTED*	*REDACTED*	pwl@ldeo.columbia.edu
Jeff Rupert	Tech Services Manager	*REDACTED*	*REDACTED*	*REDACTED*	Rupert@ldeo.columbia.edu

11.3. R/V MARCUS G LANGSETH

Contact information for the vessel:

IMO 9010137
Registration NY3360FG
Call Sign WDC6698
MMSI
High Seas Net:
- Bridge Extension 1000
- Lab Extension 1401

Iridium Voice *REDACTED* * Only rings on bridge.
Via Inmarsat C (C-Link email) *REDACTED*
Fleet Broadband *REDACTED*
Ocean Codes: 871 Atlantic East; 872 Pacific; 873 Indian; and 874 Atlantic West
Ship Cell Phones
- Chief Science Officer *REDACTED*
- Captain *REDACTED*
- Chief Engineer *REDACTED*

Email addresses
- Chief Science Officer Roberts@ldeo.columbia.edu
- Science Officers dmartins@ldeo.columbia.edu
- Captain captain@ldeo.columbia.edu
- Bridge Bridge@ldeo.columbia.edu

11.4. AGENTS

[ADD AGENT INFO]

PIs/science party members are advised to ship scientific equipment directly to our handling agent. Clearly mark the package(s) with your name and cruise number. PIs and the science party members are responsible for all costs associated with shipping science party gear and equipment to and from the ship.

12. EXPERIENCE AND FEEDBACK

12.1. UNOLS POST CRUISE ASSESSMENT FORM

The Post Cruise Assessment of the research cruise is part of a program to evaluate how well vessels and personnel of the academic research fleet are supporting the scientific objectives of the research community, and to identify areas that may need better support or guidance to improve the success of future projects. This Assessment should be filled out by the Captain, Chief Science Officer and PI/Co PI for each Cruise. Any other crew member or science party member is welcome to fill out an assessment form as they see fit.

Information provided in this form will be used by:

- Operating Institutions, Ship's Crew, and Technical Support Personnel
  - To make improvements to equipment and procedures on their vessels.
- UNOLS Office
  - To track the overall performance of the academic research fleet.
- Funding Agencies
  - To assess areas that requires more attention.
- Yourself
  - To make constructive suggestions for improvement that will benefit future research projects for yourself and your colleagues and to let ship operators know what they are doing well.

The Technical Service Manager and Marine Operations Manger will evaluate all feedback. Personnel and/or personnel involved in operations affected by the feedback might be contacted to ensure that the feedback is understood correctly.

Based on the feedback given and evaluation and control performed conclusions for improvements are made. Details of improvements found necessary will be passed back to involved personnel and/or Client. The Technical Service Manager or Marine Operations is responsible for activation of the improvements.