RV Langseth Data Reduction Summary

MGL1905

Axial Seamount 3D/2D Survey

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Seattle, Washington to Seattle, Washington

V1.0, 2019-07-16
Lamont-Doherty Earth Observatory, Columbia University

09 Jul7 2019 15:30L

Date	Day of Year	Time	Port
2019-07-09	190	0000 UTC, 0700 L	Seattle, Washington
2019-08-14	227	1800 UTC, 1100L	Seattle, Washington

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I. Background and Scientific Objectives (excerpts from the Science Support Plan)

MGL19-05 is an active seismic survey using both 3D and 2D multichannel streamer modes aboard the *R/V Langseth*. The mission starts out of and ends in Seattle, WA.. The proposed survey would occur within ~ 45.817399° N / 129.739973° W <and> ~46.077207° N / 130.161858° W (Figure 1.1) The principal investigators (PIs) and science party objectives will drive this program on the *Langseth* with the coordination and advisement of the technical staff headed by the Office of Marine Operations (OMO) at Lamont Doherty Earth Observatory (LDEO).

The procedures to be used for the proposed marine geophysical surveys would be similar to those used during previous surveys by L-DEO and would use conventional seismic methodology. The surveys would involve one source vessel, the *Langseth*. The *Langseth* would deploy an array of 36 Source Elements as an energy source with a total volume of ~6600 in^3. The receiving system would consist of initially a 3D towed MCS array consisting of 4 x 6km MCS streamers and then a single 2D MCS configuration consisting of a single 15km MCS streamer.

Other supporting equipment shall consist of a Kongsberg EM122 Multibeam echo sounder, 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.

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 Dr. Adrien Arnulf (UTIG).. He will be onboard for the survey operations, as well as **14** other scientists/students (science party total of **15**), 7 LDEO technicians, 4 contract technicians and 5 Protected Species Observers (PSOs).

The cruise is expected to take 37 days to complete, of which 33 days are at sea; currently mobilization is scheduled to start on 09 July 2019 and completion of demobilization on 14 August, 2019. The ship is scheduled to sail on 11 July, 2019 from Seattle, WA. Scientists will be permitted onboard the vessel on 10 July 2019. Vessel is scheduled to return to Seattle on 12 August, 2019. At the end of the cruise, the scientists must disembark the day after the ship arrives in port.

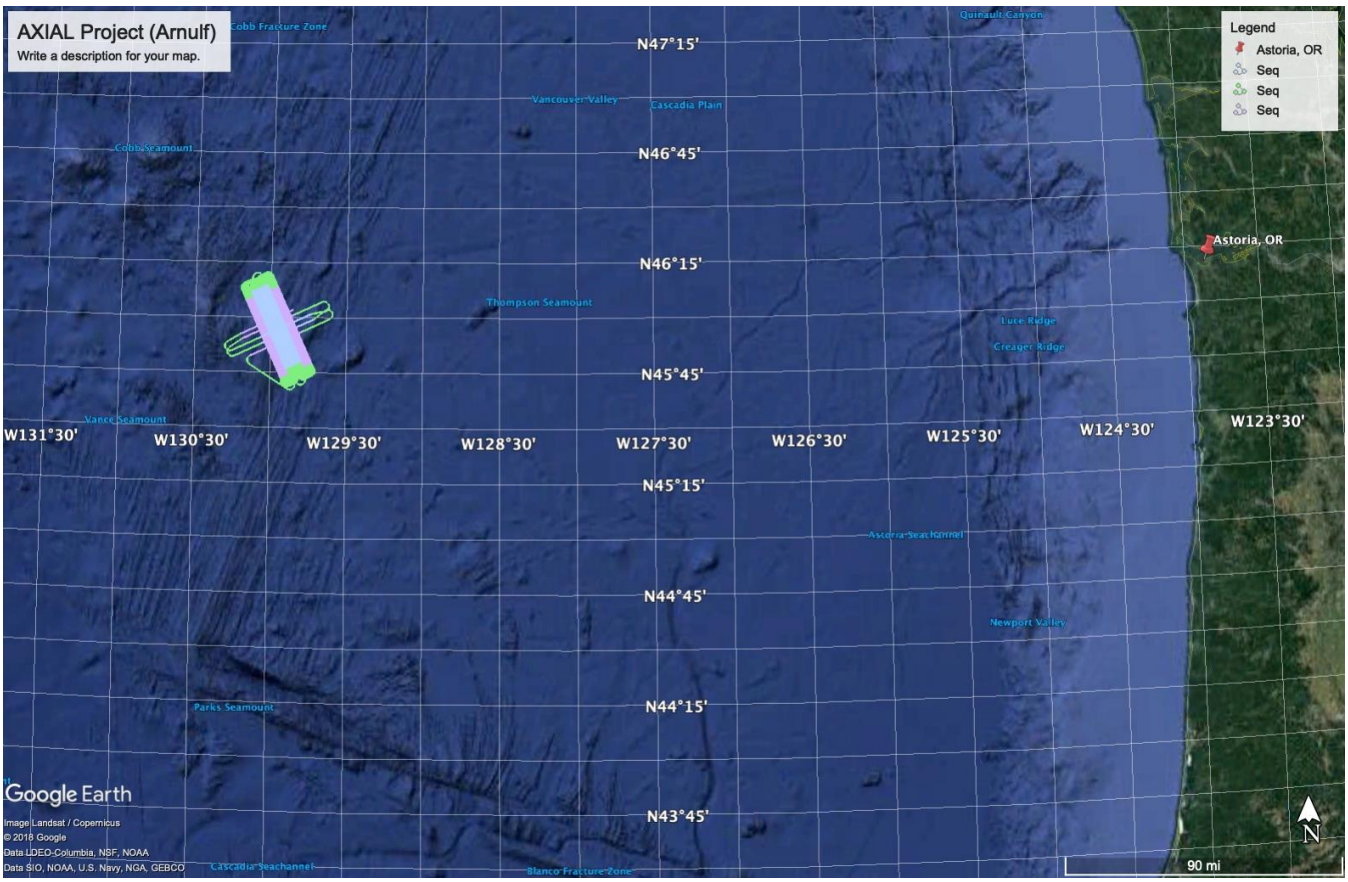
Cruise Objectives

The following information is pulled from the NSF award request submitted by the PI:

This study will obtain a high-resolution three-dimensional map of the internal structure of the underwater Axial Volcano, which is located about 450 km offshore of Washington State. These data will address the age-old question, "How do volcanoes really work?". Axial Volcano is an ideal location to obtain information on the underground magma chamber because a lot of other data have already been collected there. The surface features of Axial Volcano have been mapped in detail and the volcano is monitored in real-time through the Ocean Observatory Initiative Seafloor (OOI) Observatory. Obtaining an image of the magma chamber structure will complement existing data and the real-time data being provided by OOI, and allow a much better understanding of how Axial Volcano works and when it might erupt. This study will advance understanding of volcanoes both on land and underwater world wide. The project provides training for graduate students and early career scientists. Access to the data will be open.

This project will complete a comprehensive 3-D multichannel seismic survey of Axial Volcano and associated rift axes aboard the R/V Marcus Langseth. In addition, eight 15-km-long source-receiver offset 2-D reflection profiles will be collected to look at deep-seated structure of magma delivery. A sophisticated set of seismic imaging tools focused on multichannel seismic data collected in underwater volcanic terrains has been developed. This algorithm approach has been used in a number of marine environments in 2-D, with the greatest success thus far at Axial Volcano, where the roof and floor of the underlying magma chamber have been clearly imaged, along with fractures/conduits in the upper crust connecting the magma chamber to nearby hydrothermal vent fields. Despite this success, Axial Volcano is inherently 3-D in nature, thus requiring a 3-D approach to map the complex connections between the magma plumbing system at depth with eruption dynamics at the seafloor. For example, this approach is needed to understand (1) how 3-D fracture sets are associated with magma inflation/withdrawal, rifting, and gravitational spreading/collapse in the upper crust; (2) the geometry and interconnection of complex magma bodies of varying amounts of melt/mush; (3) the relationship between internal structure and seafloor observables such as hydrothermal fields and lava flows.

MGL1905 map of operations



II. Personnel

Shipboard Technical Staff

Participant	Group/Affiliation	Position
Todd Jensvold	L-DEO OMO	Chief Science Officer
David Martinson	L-DEO OMO	Chief Science Officer
Alan Thompson	L-DEO OMO	Science Technical Support Staff
Shaun Shaver	L-DEO OMO	Science Technical Support Staff
Gilles Guerin	L-DEO OMO	Science Technical Support Staff
Tom Spoto	L-DEO OMO	Science Technical Support Staff
Matt Dietrich	Contractor	Science Technical Support Staff
Edward St Amant	Contractor	Science Technical Support Staff
Chris Abdouch	Contractor	Science Technical Support Staff
Mike Jennings	Contractor	Science Technical Support Staff

Ship's Crew

1	Landow, Mark C.	Master
2	Crum, Breck C.	Chief Mate
3	Reed, Reece W.	2nd Mate
4	Quinn, Tara J.	3rd Mate
5	Cereno, George G.	Bosun
6	Robison, William J.	AB
7	Purves Roderick M.	AB
8	Davis Jr. Steve P.	AB
9	Donohoe, Maelcom M.	OS
10	Perito, Christian A.	OS
11	Tucke, Matthew S.	Chief Engr.
12	Levine, Isaac D.	1st Asst. Engr.
13	Rodriguez, Vincente L.	2nd Asst. Engr.
14	Valdiconza, Luke A.	3rd Asst. Engr.
15	Kononchik, Gregory R.	Oiler
16	Florendo, Rodolfo A.	Oiler
17	Hempstead, Barry K.	Oiler
18	Rosson, Eric J.	Steward
19	Matires, Leonicio R.	Cook

PSO

Participant	Group/Affiliation	Position
Andrea Zavala	RPS	Lead PSO
Amanda Dubuque	RPS	PAM operator / PSO
Ana Hernandez	RPS	PSO
Veronica Gonzales	RPS	PSO
Karla Medina	RPS	PSO
Bianca Mares	RPS	PSO

Science Party

	Participant	Group/Affiliation	Function	Gender	Email Address
1	Adrien Arnulf	UTIG	PI	M	aarnulf@ig.utexas.edu
2	Alistair Harding	SIO	PI	M	aharding@ucsd.edu
3	Steffen Saustrup	UTIG	PI	M	steffen@utig.utexas.edu
4	Michelle Lee	LDEO	Student	F	mlee@ldeo.columbia.edu
5	Axelle Cap	UBO	Student	F	cap.axelle@laposte.net
6	Shelby Brandt	University of Ottawa	Student	F	shelbybrandt1@gmail.com
7	Morgane Goulain	Paris School of Mine	Student	F	goulain@gmail.com
8	Victoire Lucas	UBO	Student	F	Victoire.LUCAS@etu.unilsalle.fr
9	Samuel Mitchell	University of Bristol	PHD	M	samjm@hawaii.edu
10	Matthew Griffiths	Carelton University	Student	M	Matt.griffiths@earthphysics.ca
11	Massimo Bellucci	UBO-Ifremer	Student	M	Massimo.bellucci@brest.fr
12	Tanner Eischen	ELU	Student	M	eischen@students.elu.edu
13	Brian Oller	SIO	Student	M	oller@ucsd.edu

III. Instrumentation Summary

All science instruments aboard the Langseth are listed below with data formats in section VII. Summary notes on operation during this cruise are listed below. Seismic equipment is not listed here; refer to Part IV for the seismic summary.

Instrument Data Files

Instrument	Description	Data Set	Data Outputs	Files	Interval
FE700	Furuno FE700 Echosounder	Not used	serial logs	MGL-bath01.*	N/A
EM122	Kongsberg EM122 Multibeam Sonar	Full	Center beam data	MGL-bath02.*	variable
KNUDSEN	Knudsen Engineering 3260 Sub-bottom Profiler	Full	KEA, KEB, SEG-Y	See below	variable
DS80	Furuno DS80 Doppler Speed log	Full	serial logs	MGL-slog01.*	1s
XBT/XCTD	Sippican MK21 XBT/XCTD Launcher	134 drops	raw output to file	See below	n/a
TSG	SeaBird SBE45 Thermosalinograph	Full	raw serial logs	MGL-tsgraw.*	1s
CNAV	C&C Tech. CNAV 2000 DGPS Receiver	Full	serial logs	MGL-cnav.*	1s
CNAV3050	C&C Tech. CNAV 3050 DGPS Receiver	Full	raw serial logs	MGL-cnav3050all.*	1s
MAG01	Geometrics 882 Magnetometer	On deploy	serial logs	MGL-mag01.*	1s
BGM	Bell Aerospace BGM-3 Gravimeter	Full	serial logs	MGL-vc01.*	1s
GYRO	Simrad GC80 Gyrocompass/AD100	Full	serial logs	MGL-gy01.*	1s
POSMV	POSMV Inertial Navigation System	Full	serial logs	MGL-posmv*	ls
SEAPATH	Seapath 330 Inertial Navigation System	Full	serial logs	MGL-seapath.*	1s
MICROSV	Applied Microsystems Sound Velocity USS Unit	Full	serial logs	MGL-svuss01.*	1s
ADCP	RDI Current Profiler	Full	serial logs	MGL-adcp.*	variable
PCO2	LDEO PCO2 System	N/A	serial logs	MGL-pco2.*	Variable
Vaisala1	Vaisala WXT-520 Ultrasonic Weather Station	Full	serial logs	MGL-vaisala1.*	1s

All timestamps in this report are presented using UTC time and day of year in order to avoid confusion with local time changes.

Science Navigation Instrumentation

FE700 - Not in use on MGL1905

The FE700 was not in use on MGL1905.

EM-122 Multibeam

The EM122 multibeam sonar was operated throughout the cruise. The system is designed for deeper water, and does not track ground well in less than 50m of water.

EM122 swath data is saved to the cruise archive under MGL1905/raw/multibeam. Center beam depth is recorded separately to serial log. A daily built in self test (BIST) is done on the EM122 at which time logging of data is secured. Data gaps are approximately 8-12 minutes in duration, and every effort is made to schedule them during turns or areas where coverage already exists. See MGL1905/docs/elog for times and durations of tests.

File id: bath02
Logging interval: variable with water depth

bath02 data format:

```
bath02  2008:192:00:00:12.6663  $KGDPT,2938.25,0.0,12000.0*4a
bath02  2008:192:00:00:30.3301  $KGDPT,2954.08,0.0,12000.0*4f
```

Knudsen Engineering 3260 Sub-bottom Profiler

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler.

File id: n/a
Logging interval: Variable with water depth

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler. It was in operation for the length of the cruise. Data written in proprietary KEB, KEA, and converted to SEGY format (if requested). Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

DS80 Speedlog

The Furuno DS-80 is a Doppler speed log. It was in operation for the duration of the cruise.

File id: slog01
Logging interval: 1 second

slog01 data format:

```
slog01  2008:231:00:00:00.0744  $VDVHW,,T,,M,09.68,N,17.93,K*4C
slog01  2008:231:00:00:00.1906  $VDVBW,009.68,000.09,A,009.68,000.09,V*46
slog01  2008:231:00:00:00.1908  $VDVLW,0005960.30,N,0005960.30,N*5F
```

CNAV2000

The C-NAV is a global satellite-based differential receiver. This was used as a secondary GPS system on the ship. This system was operational during the cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: cnav
Logging interval: 1 second

cnav data format:

```
cnav    2008:231:00:00:00.6936 $GPGGA,000000.00,1434.94372,N,10444.85748,W,2,8,1.1,15.52,M,-
20.60,M,9,0108*65
cnav    2008:231:00:00:00.7137  $GPVTG,006.5,T,,M,9.64,N,17.85,K*53
```

CNAV3050

The C-NAV 3050 is a global satellite-based differential receiver. This is the best individual receiver currently on the ship. This system was operational during the cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: cnav3050
Logging interval: 1 second

cnav3050 data format:

```
cnav3050        2011:132:00:00:00.0717
        $GNGGA,000000.00,0842.538264,N,08427.839561,W,2,16,0.9,28.395,M,0.0,M,9.0,0358*48
cnav3050        2011:132:00:00:00.0877  $GNVTG,338.4,T,,M,5.78,N,10.71,K,D*27
```

GC80 Gyrocompass

The GC80 gyrocompass is installed on the bridge and used for ship and seismic navigation. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: gy01
Logging interval: 1 second

gy01 data format:

gy01	2008:231:00:00:00.4110	$PTKM,HEALM,0000,0,G1*09
gy01	2008:231:00:00:00.6395	$HEHDT,005.8,T*22
gy01	2008:231:00:00:00.6396	$HEROT,-005.25,A*34
gy01	2008:231:00:00:01.6394	$HEHDT,005.7,T*2D
gy01	2008:231:00:00:01.6395	$HEROT,-004.53,A*34

POSMV Inertial Navigation System

The POS/MV is a receiver that uses CNAV input in addition to its own antennae, an inertial sensor and optional RTG, WTC, or WAAS corrections and a Kalman filter to produce a smooth navigation output and very accurate heading. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: posmv
Logging interval: 1 second

posmv data format:

posmv	2008:231:00:00:00.0885	$INGGA,235959.842,1434.95002,N,10444.85734,W,2,,1.1,12.71,M,,,9.0,0108*2E
posmv	2008:231:00:00:00.0889	$INHDT,15.0,T*11
posmv	2008:231:00:00:00.2047	$INVTG,7.0,T,,M,9.7,N,17.9,K*46
posmv	2008:231:00:00:00.3208	$INGST,235959.842,,0.9,0.9,0.0,0.9,0.9,2.5*51
posmv	2008:231:00:00:00.4411	$PASHR,235959.842,15.05,T,-0.58,0.48,0.15,0.069,0.069,0.045,2,0*05
posmv	2008:231:00:00:00.4412	$INZDA,235959.0000,17,08,2008,,*73

SeaPath 330 Inertial Navigation System

The Kongsberg Seapath is an inertial navigation system. Operational for the duration of the cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: seapath
Logging interval: 1 second

seapath data format:

```
seapath  2008:231:00:00:00.0504   $INZDA,235959.99,17,08,2008,,*73
seapath  2008:231:00:00:00.1686   $INGGA,235959.99,1434.953109,N,10444.859147,W,2,08,1.1,-
16.30,M,,M,1.0,0291*70
seapath  2008:231:00:00:00.1687   $INVTG,5.97,T,,M,9.7,N,,K,D*03
seapath  2008:231:00:00:00.1688   $INHDT,5.82,T*1A
```

Geometrics 882 Magnetometer

The Geometrics 882 magnetometer is towed behind the ship. Raw serial output is logged using LDS. Deployment is dependent upon seismic operations. Data collected only when Magnetometer is deployed. Reference MGL1905/docs/elog for information on any data gaps or degraded operation. The magnetometer was in use only during the 2D portion of the cruise on MGL1905.

Logging interval: 1 second

File id: mag01
mag01 data sample:

```
mag01   2015:329:00:00:01.2776   $ 45499.940,0881,0691
mag01   2015:329:00:00:01.3735   $ 45500.167,0879,0691
mag01   2015:329:00:00:01.4695   $ 45499.940,0874,0691
```

SBE-45 Thermosalinograph

The Seabird TSG output is logged by LDS to the "tsgraw" set. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: tsgraw
Logging interval: 1 second

tsgraw data sample:

```
tsgraw   2015:337:00:01:15.3000   t1= 18.9500, c1= 5.17155, s= 39.1095, sv=1522.706, t2= 18.7851
tsgraw   2015:337:00:01:25.3004   t1= 18.9526, c1= 5.17196, s= 39.1105, sv=1522.715, t2= 18.7878
tsgraw   2015:337:00:01:35.3018   t1= 18.9539, c1= 5.17219, s= 39.1113, sv=1522.720, t2= 18.7892
```

BGM-3 Gravimeter

The Bell Aerospace BGM-3 Gravimeter operated normally during the length of this cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: vc01
Logging interval: 1 second

vc01 data format:

```
vc01   2011:130:00:00:08.2866   01:024436 00
vc01   2011:130:00:00:09.2926   01:024548 00
```

AML Oceanographic – Micro-X SV-Xchange sensor Unit

The AML Micro-X SV probe operated normally during the length of this cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: svuss01
Logging interval: 1 second

svuss01 data format:

```
svuss01  2015:338:00:00:15.1382    1521.897
svuss01  2015:338:00:00:16.1282    1521.900
```

LDEO PCO2 System

The LDEO PCO2 system output is logged by LDS to the "pco2" set. The LDEO PCO2 system was not in operation for the duration of the cruise.

File id: pco2
Logging interval: ~180 seconds

pco2 data format:

```
pco2    2011:130:00:27:11.9162  2011130.02002   2370.39     37.54   1007.07     404.51
28.42     386.9 5000.00   19      0       Equil

pco2    2011:130:00:30:00.5374  2011130.02198   2370.02     37.53   1007.14     404.42
28.46     386.8 5000.00   19      0       Equil
```

Mk21 XBT System

Files: *.RDF,*.EDF

XBT drops were made during this cruise. The data set(s) are saved to the raw/XBT directory in the cruise archive. Refer to the MGL1905 Expendable Drops.xls spreadsheet in the docs/operations directory of the cruise archive for more information.

Sonobuoy System

Files: *.SEG, *.SEGY
Sonobuoy not in use on MGL1905.

Vaisala Meteorological Ultrasonic Integrated Weather

The weather station is used to log wind speed, direction, air temperature, relative humidity, precipitation, dew point, and barometric pressure. The unit was operational for the duration of the cruise. Reference MGL1905/docs/elog for information on any data gaps or degraded operation.

File id: vaisala
Logging interval: 1 second

vaisala data format:

```
vaisala   2015:346:00:00:00.0038 $WIMWV,129,R,15.7,N,A*04
vaisala   2015:346:00:00:00.9930 $WIXDR,A,125,D,0,A,129,D,1,A,134,D,2,S,15.3,N
,0,S,15.7,N,1,S,16.5,N,2,C,14.2,C,0,C,14.4,C,1,H,52.9,P,0,P,1018.3,H,0,V,0.00,M,0,Z,0,s,0,R,0.0,M,0,V,0.0,M,1,Z,0,s,1,R,
0.0,M,1,R,66.5,M,2,R,0.0,M,3*6D
```

IV. Seismic Summary

A. Acquisition Parameter Table

Acquisition Parameter Table 1	
FieldActivityID	MGL1905
Acquisition_sequence(s)	Seq 1 through 46
ReceiverType	Towed Hydrophone
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point (primary GPS antenna)	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	280 m
Source_to_Near_Channel	175 m
Number_of_channels_recorded	1872
Number_of_cables	4
Number_of_channels_each_cable	468
Channel_length	12.5
Cable_length	5850 m
Cable_spacing	150 m
Near_Channel_Number	Str. 1 – 1, Str. 2 – 469, Str. 3 – 937, Str. 4 - 1405
Cable_depth	16 m
Number_sources	2
Sub-arrays_per_source	2
Flipflop_shooting (dual source alternating)	True
Source_separation	75 m
Sub-array_separation	6.0 m
Source_volume	3300 cu in
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12.0 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	12 s
Compass_birds	84
Recording_delay	False
Active_tail_buoy	True
Multiple_ships	False

Acquisition Parameter Table 2

FieldActivityID	MGL1905
Acquisition_sequence(s)	Seq 47 through Seq 68 (streamer 4 not in use)
ReceiverType	Towed Hydrophone
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	280 m
Source_to_Near_Channel	175 m
Number_of_channels_recorded	1404
Number_of_cables	3
Number_of_channels_each_cable	468
Channel_length	12.5 m
Cable_length	5850 m
Cable_spacing	150 m
Near_Channel_Number	Str. 1 - 1, Str. 2 - 469, Str. 3 - 937
Cable_depth	16 m
Number_sources	2
Sub-arrays_per_source	2
Flipflop_shooting (dual source alternating)	True
Source_separation	75
Sub-array_separation	6.0 m
Source_volume	3300 cu in
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12.0 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	12 s
Compass_birds	63
Recording_delay	False
Active_tail_buoy	True
Multiple_ships	False

Acquisition Parameter Table 3

FieldActivityID	MGL1905
Acquisition_sequence(s)	Seq 69
ReceiverType	Towed Hydrophone
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	189.7 m
Number_of_channels_recorded	936
Number_of_cables	1
Number_of_channels_each_cable	936
Channel_length	12.5 m
Cable_length	11700 m
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	16 m
Number_sources	1
Sub-arrays_per_source	4
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	6.0 m
Source_volume	6600 cu in
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12.0 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	14
Compass_birds	41
Recording_delay	No
Active_tail_buoy	Yes
Multiple_ships	No

Acquisition Parameter Table 4	
FieldActivityID	MGL1905
Acquisition_sequence(s)	Seq 70 through Seq 78
ReceiverType	Towed Hydrophone
SourceType	Airgun
Acquisition System Name	Sercel Seal 408
Acquisition System Type	MCS
Seismic_Nav_System	C-Nav 3050 primary
Survey_datum	WGS84
Navigation Reference Point	Fore/Aft+29.5 m, Stb/pt +0.00 m, vertical +16.9 m Keel, centerline, ~frame 42 (Seapath 330 calculated center of gravity) waterline
Antenna(NRP)_to_source	230 m
Source_to_Near_Channel	189.7 m
Number_of_channels_recorded	936
Number_of_cables	1
Number_of_channels_each_cable	936
Channel_length	12.5 m
Cable_length	11700 m
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	16 m
Number_sources	1
Sub-arrays_per_source	4
Flipflop_shooting (dual source alternating)	False
Source_separation	Applicable to flipflop (dual source alternating) only
Sub-array_separation	6.0 m
Source_volume	6600 cu in
Source_pressure	2000 psi nominal
Source_make,model	Bolt 1500LL & 1900LL
Source_element_number	36 + 4 spare
Source_depth	12.0 m
Shot_control	Distance
Shot_Interval	37.5 m
Sample_interval	2 ms
Record_length	12
Compass_birds	41
Recording_delay	No
Active_tail_buoy	Yes
Multiple_ships	No

Physical Configuration

The towing configuration for the air guns, streamers, antennas, and in-water offsets are detailed in the document titled ***MGL1905_Offsets_MCS_Line.xls.***

Spectra

Spectra was used for all timing and navigation during the cruise. Spectra generated UKOOA P294 and P190 files for the MCS line(s) acquired.

Sprint

Sprint was used for post processing of Spectra UKOOA P294 files to produce UKOOA P190 files with improved positioning.

V. RV Langseth Gravity Tie Information

Please refer to the documents located under MGL1905/docs/gravity_tie for detailed records.

VI. Archive Contents

MGL1905/docs	**Cruise documents**
MGL1905/docs/elog	**Cruise elog**
MGL1905/docs/gravity_tie	**Gravity Tie information**
MGL1905/docs/map	**Cruise maps, track map**
MGL1905/docs/offsets	**Vessel/sensor offsets**
MGL1905/docs/operations/	**Operations documents**
MGL1905/docs/operations/Daily_Reports	**Cruise Daily Reports**
MGL1905/docs/operations/NavLogs	**Spectra Nav logs**
MGL1905/docs/operations/ObsLogs	**MCS/Source logs**
MGL1905/docs/operations/MGL1905_B15-log	**Master line log table**
MGL1905/docs/operations/Seal_reports	**Seal 408 line logs**
MGL1905/docs/permits	**Associated permitting**
MGL1905/docs/waypoints	**Waypoint files**
MGL1905/docs/personnel	**Rosters, org charts etc.**
MGL1905/docs/reports	**Associated reports**
MGL1905/docs/reports/MGL1905_DataReport_v1.0.doc	**This file**
MGL1905/docs/offsets/MGL1905_Offsets_MCS.xls	**Vessel/sensor offsets**
MGL1905/docs/screencaps	**Screen captures**
MGL1905/processed	**Processed data**
MGL1905/processed/knudsen	**Knudsen segy**
MGL1905/processed/reflex	**Spectra reflex files**
MGL1905/processed/obsip	**OBS Shot log files**
MGL1905/processed/sprint	**Sprint UKOOA P190s**
MGL1905/processed/svp	**Sound velocity profiles**
MGL1905/raw	**Raw data**
MGL1905/raw/adcp	**Raw ADCP data**
MGL1905/raw/knudsen	**Raw Knudsen data**
MGL1905/raw/MarkeyWinch	**DESH-5 winch data**
MGL1905/raw/multibeam	**Raw EM122 data**
MGL1905/raw/serial	**Underway serial data**
MGL1905/raw/sonobuoy	**Raw sonobuoy data**
MGL1905/raw/spectra/P1	**Spectra underway p190**
MGL1905/raw/spectra/P2	**Spectra UKOOA p294**
MGL1905/raw/XBT	**Raw XBT data**

VII. Data Formats

Gravimeter data

The gravimeter serial data is output in the following format:

01:025610 01

01:xxxxxx ff

Item	Definition	Units
01	output frequency	Hz
xxxxxx	raw counts	n/a
ff	sensor status	n/a

CNAV GPS receiver data

CNAV outputs data in NMEA 0183 compatible format. Currently* the following sentence types are enabled:

- $GPVTG-GPS Velocity, Track made good and Ground speed data (computed by the CNAV GPS receiver).
- $GPGGA-Gobal Positioning System Fix data (computed by the CNAV GPS receiver).

*Note: there are other sentence types available from CNAV. Please consult the software manual for more options.

$GPVTG, xxx.x, T,, M, m.mm, N, n.nn, K*hh

$GPVTG Sentence Fields

Item	Definition	Units
xxx.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
M	COG	Degrees from Magnetic North
m.mm	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that the speed over ground is in knots	n/a
n.nn	SOG	km/h
K	Indicates that the SOG is in km/h	n/a /td>
*hh	Checksum (hexadecimal representation)	n/a

$GPGGA,hhmmss.ss, ddmm.mmmmm, a, ddmm.mmmmm, a, x, xx, x.x, xx.xx, M, xx.xx, M, x.x, xyy*hh

$GPGGA Sentence Fields

Item	Definition	Units
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude N = North S = South	n/a
ddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude E = East W = West	n/a
x	GPS Quality indicator 0 = fix not valid 1 = GPS Autonomous fix 2 = GcGPS Corrected Fix	n/a
xx	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
xx.xx	C-NAV GPS receiver antenna altitude reference to Mean Sea Level (MSL)	n/a
M	Altitude units--M indicates meters	n/a
xx.xx	WGS-84 Geoidal separation distance from MSL based on the NIMA/NASA EGM96 15-minute (Earth Gravity Model)	Meters
M	Geosoidal separation units--M indicates meters	n/a
x.x	Age of GcGPS corrections used in solution fix	n/a
xyy	C-NAV GPS receiver reference identification	x is downlink satellite communication beam in use yy is the GPS correction signal mode/type being used
*hh	Checksum (hexadecimal representation) followed by CRLF terminator pair	n/a

CNAV 3050 GPS receiver data

CNAV 3050 outputs data in NMEA 0183 compatible format. Currently* the following sentence types are enabled:

- $GPVTG-GPS Velocity, Track made good and Ground speed data (computed by the CNAV GPS receiver).
- $GPGGA-Gobal Positioning System Fix data (computed by the CNAV GPS receiver).

  *Note: there are other sentence types available from CNAV. Please consult the software manual for more options.

$GPVTG, xxx.x, T,, M, m.mm, N, n.nn, K*hh

$GPVTG Sentence Fields

Item	Definition	Units
xxx.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
M	COG	Degrees from Magnetic North
m.mm	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that the speed over ground is in knots	n/a
n.nn	SOG	km/h
K	Indicates that the SOG is in km/h	n/a /td>
*hh	Checksum (hexadecimal representation)	n/a

$GPGGA,hhmmss.ss, ddmm.mmmmm, a, ddmm.mmmmm, a, x, xx, x.x, xx.xx, M, xx.xx, M, x.x, xyy*hh

$GPGGA Sentence Fields

Item	Definition	Units
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude N = North S = South	n/a
ddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude E = East W = West	n/a
x	GPS Quality indicator 0 = fix not valid 1 = GPS Autonomous fix 2 = GcGPS Corrected Fix	n/a
xx	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
xx.xx	C-NAV GPS receiver antenna altitude reference to Mean Sea Level (MSL)	n/a
M	Altitude units--M indicates meters	n/a
xx.xx	WGS-84 Geoidal separation distance from MSL based on the NIMA/NASA EGM96 15-minute (Earth Gravity Model)	Meters
M	Geosoidal separation units--M indicates meters	n/a
x.x	Age of GcGPS corrections used in solution fix	n/a
xyy	C-NAV GPS receiver reference identification	x is downlink satellite communication beam in use yy is the GPS correction signal mode/type being used
*hh	Checksum (hexadecimal representation) followed by CRLF terminator pair	n/a

EM122 Center Beam Depth

This page describes the EM122 centerbeam depth serial output, used for real-time depth display. For fulll multibeam data, please see the multibeam page.

The EM122 outputs serial data in the following formats:

- KIDPT - Depth below transducer

$KIDBT,x.x,x.x,x.x,*hh

SDDBT sentence format

Item	Definition	Units
x.x	Water depth	feet
x.x	Water depth	meters
x.x	Water depth	fathoms
*hh	Checksum	n/a

FE700 Navigational Echosounder data

The FE700 Navigational Echosounder outputs data in the following formats

- $PFEC - unspecified
- $SDDBT - Depth Below Transducer
- $SDDBS - Depth Below Surface

$PFEC ,aaaa,x,x*hF

PFEC sentence format

Item	Definition	Units
aaaa	unspecified	unspecified
x	unspecified	unspecified
x	unspecified	unspecified
*hF	unspecified	unspecified

$DBT,x.x,f,x.x,M,x.x,F*hh

SDDBT sentence format

Item	Definition	Units
x.x	Water depth	feet
f	f = feet	n/a
x.x	Water depth	meters
M	M = meters	n/a
x.x	Water depth	fathoms
F	F = fathoms	n/a
*hh	Checksum	n/a

$DBS,x.x,f,x.x,M,x.x,F*hh

SDDBS sentence format

Item	Definition	Units
x.x	Water depth	feet
f	f = feet	n/a
x.x	Water depth	meters
M	M = meters	n/a
x.x	Water depth	fathoms
F	F = fathoms	n/a
*hh	Checksum	n/a

Furuno GC80 Gyroscope data

The gyroscope serial data is output in the following sentence formats:

- PTKM,HEALM -- Unspecified
- HEHDT -- Heading - True
- HEROT -- Rate Of Turn

$PCICM,HEALM,xxxx,x,xx*hh

ALM sentence format

Item	Definition	Units
xxxx	unspecified	n/a
x	unspecified	n/a
*hh	unspecified	n/a

$HEHDT,xxx.x,T*hh

HDT sentence format

Item	Definition	Units
xxx.x	Heading true	degrees
T	T = true	n/a
*hh	Checksum	n/a

$HEROT,-xxx.x,A*hh

HEROT sentence format

Item	Definition	Units
xxxx.x	Rate of turn	Degrees per minute, Note: "-" means bow turns to port
A	A = data valid	n/a
*hh	Checksum	n/a

Geometrics 882 Magnetometer Data

The magnetometer serial data is output in the following format:

$ 53863.927,0652

$ xxxxx.xxx,vvvv

Item	Definition	Units
xxxxx.xxx	Magnetic field intensity	nT
vvvv	Reserved for future use	n/a

OBSIP Shotlog Format

Each OBSIP shotlog contains a header followed by shot records:

```
#obsipshotfile v1.0
#shotnumber date time sourceLat sourceLon shipLat shipLon waterDepth sciTag
0001280 2009-08-27 05:08:49.807873  48.495334 -129.201444  48.494097 -129.203017 2530.6 MGL0910_05
0001279 2009-08-27 05:12:33.961869  48.491860 -129.204474  48.490060 -129.205425 2526.4 MGL0910_05
0001278 2009-08-27 05:16:36.302883  48.488608 -129.206115  48.486807 -129.206944 2530.3 MGL0910_05
0001277 2009-08-27 05:19:51.053880  48.485157 -129.209212  48.483406 -129.209755 2526.1 MGL0910_05
0001276 2009-08-27 05:24:01.863875  48.480813 -129.212118  48.479293 -129.213152 2516.1 MGL0910_05
```

Shot records are in the following format:

```
0001276 2009-08-27 05:24:01.863875  48.480813 -129.212118  48.479293 -129.213152 2516.1 MGL0910_05
sssssss yyyy-mm-dd hh:mm:ss.ssssss  xx.xxxxxx  yyy.yyyyyy  vv.vvvvvv  www.wwwwww dddd.d lllllllllllllll
```

OBSIP record format

Item	Definition	Units
sssssss	shot number	n/a
yyyy-mm-dd	date	ISO8601 format
hh:mm:ss.ssssss	time	ISO8601 format
xx.xxxxxx	source lat	degrees, WGS84
yy.yyyyyy	source lon	degrees, WGS84
vv.vvvvvv	vessel lat	degrees, WGS84
ww.wwwwww	vessel lon	degrees, WGS84
dddd.d	depth	meters
lllllllllllllll	linename	n/a

LDEO PCO2 System
PCO2 outputs data in the following sentence format:

yyyyjjj.jjj aaaa.aa bb.bb cccc.cc ddd.dd e.ee fff.f gggg.gg hh i k

PCO2 Data

Item	Definition	Value	Units
yyyyjjj.jjj	pco2 Computer Date/Time	n/a	Year/Julian Day.decimal Four fixed digits of year. Three fixed digits of julian day. Five fixed digits for decimal fractions of a julian day.
aaaa.aa	CO2 Raw Signal	n/a	mVolts
bb.bb	CO2 Analyzer Cell Temperature	n/a	Celcius
cccc.cc	PCO2 Barometer	n/a	mbar
ddd.dd	VCO2	n/a	ppm
e.ee	Equilibrator Water Temp	n/a	Celcius
fff.f	pCO2	n/a	uatm
gggg.gg	Flow Controller	n/a	mVolts
hh	Flow Meter	n/a	cc/min
i	Sample ID #	0 to 16	integer
k	Sample ID	Equil, Atmos, Nitrogen, CC18798, CA07163, CC15551, or CC63668	alphanumeric

LDEO PCO2 + CNav + TSG + WX01 + SBE38 Systems
PCO2 merge is a combination of outputs of various serial data in the following sentence format:

yyyyjjj.jjj aaaa.aa bb.bb cccc.cc ddd.dd e.ee fff.f gggg.gg hh i k, llll.llllllm, nnnnn.nnnnnno, pppp.pp, q.qq, r.rr, s.ss, tt.tt, uu.u, vvv, w.w, xxx.x, y.yy, zzz.z, @@.@@@@

PCO2 Data

Item	Definition	Value	Units
yyyyjjj.jjj	pco2 Computer Date/Time	n/a	Year/Julian Day.decimal Four fixed digits of year. Three fixed digits of julian day. Five fixed digits for decimal fractions of a julian day.
aaaa.aa	CO2 Raw Signal	n/a	mVolts
bb.bb	CO2 Analyzer Cell Temperature	n/a	Celcius
cccc.cc	PCO2 Barometer	n/a	mbar
ddd.dd	VCO2	n/a	ppm
e.ee	Equilibrator Water Temp	n/a	Celcius
fff.f	pCO2	n/a	uatm
gggg.gg	Flow Controller	n/a	mVolts
hh	Flow Meter	n/a	cc/min
i	Sample ID #	0 to 16	integer
k	Sample ID	Equil, Atmos, Nitrogen,CC18798, CA07163, C15551, or CC63668	alphanumeric
llll.llllllm	CNav Latitude	0 to 90, N/S	degrees/minutes.decimal/direction
nnnnn.nnnnnno	CNav Longitude	0 to 180, E/W	degrees/minutes.decimal/direction
pppp.pp	TSG Speed of Sound	n/a	m/s
q.qq	TSG Internal Temperature	n/a	Celcius
r.rr	TSG External Temperature	n/a	Celcius
s.ss	TSG Conductivity	n/a	S/m
tt.tt	TSG Salinity	25 to 40	ppm
uu.u	WX01 Bird 1 Wind Speed 60 sec avg	n/a	knots
vvv	WX01 Bird 1 Wind Direction 60 sec avg	0 to 360	degrees
w.w	WX01 Temperature Instantaneous	n/a	Celcius
xxx.x	WX01 Ship Barometer Instantaneous	n/a	mbar
y.yy	CNav Speed Over Ground / Speed Made Good	0 to 15	knots
zzz.z	CNav Course Made Good	0 to 360	degrees
@@.@@@@	SBE38 Temperature Probe	n/a	Celcius

POS/MV Inertial Navigation System

POS/MV outputs data using the NMEA 0183 format at rates of up to fifty sentences per second. The following seven different sentence formats are available.

- 1. $INGGA-Global System Position Fix Data
- 2. $INHDT-Heading - True data
- 3. $INVTG-Course over ground and Ground speed data
- 4. $INGST-GPS pseudorange noise statistics
- 6. $PRDID-Attitude data
- 7. $INZDA-Time and date

$INGGA, hhmmss.sss, llll.lllll, a, yyyyy.yyyyy, b, t, nn, v.v, x.x, M,,,c.c,rrrr*hh

$INGGA-Global System Position Fix Data

Item	Definition	Value	Units
$INGGA	Header	$INGGA	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. Two fixed digits of hours. Two fixed digits of minutes. Two fixed digits of seconds. Three digits for decimal fractions of a second.
llll.lllll	Latitude	-90 to +90	DegreeslMinutes.decimal. Two fixed digits of degrees Two fixed digits of minutes Five digits for decimal minutes.
a	N (north) or S (south)	N or S	
yyyyy.yyyyy	Longitude	-180 to +180	Degrees/Minutes.decimal. Three fixed digits of degrees. Two fixed digits of minutes. Five digits for decimal minutes.
b	E (east) or W (west)	E or W	
t	GPS Quality Indicator	0 = Fix not available or invalid 1 = CIA standard GPS; fix valid. 2 = DGS mode; fix valid. 3 = PPP mode; fix valid. 4 = RTK fixed 5 = RTK float 6 = free inertial	
nn	Number of satellites used in fix	0 to 32	
v.v	Horizontal dilution of precision		
x.x	Altitude of the IMU above or below the	n/a	Metres

	mean sea level. A negative value indicates below sea level.		
M	Units of measure = metres	M	
Null	Null		
Null	Null		
c.c	Age of differential corrections in records since last RTCM-104 message.	0 to 99.9	Seconds
rrr	DGPS reference station identity	0000 to 1023	
*hh	Checksum	00 - FF	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of the HDOP, IMU altitude and age of differential connections, POS/MV adds leading digits as required (i.e. if the value exceeds 9.9). Also, note that commas separate all items, including null fields. The information is valid at the location of the vessel frame.

$INHDT, x.x, T*hh

$INHDT-Heading - True data

Item	Definition	Value	Units
$INHDT	Header	$INHDT	
x.x	True vessel heading in the vessel frame	o to 359.99	degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

$INVTG, x.x, T,, M, n.n, N, k.k, K*hh

$INVTG-Course over ground and Ground speed data

Item	Definition	Value	Units
%INVTG	Header	$INVTG	
x.x	True vessel track in the vessel frame	0 to 359.99	degrees
T	True	T	
null	Not supported	null	
M		M	
n.n	Speed in the vessel frame	n/a	Knots
N	Knots	N	
k.k	Kilometres	K	
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of the track and the speed fields, POS/MV adds the leading digits as required (i.e. if the value exceeds 9.9). ALso, note that commas separate all items in the including null fields.

$INGST, hhmmss,sss,,smjr.smjr,smnr.smnr, o.o, l.l, y.y, a.a *hh

$INGST-GPS pseudorange noise statistics

Item	Definition	Value	Units
$INGST	Header	$INGST	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours. 2 fixed digits of minutes. 2 fixed digits of seconds. Three digits for decimal fractions of a second.
null	Not supported	null	
smjr.smjr	Standard Deviation of semi-major axis of error ellipse	n/a	Metres
smnr.smnr	Standard deviation of semi-minor axis of error ellipse	n/a	Metres
o.o	Orientaion of semi-major axis ellipse	0 to 359.9	Degrees from true north
l.l	Standard deviation of latitude	n/a	Metres
y.y	Standard deviation of longitude	n/a	Metres
a.a	Standard deviation of Altitude	n/a	Metres
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that, in the case of all fields POS/MV adds leading digits as required (i.e. if the value exceeds 9.9). Also, note that commas separate all items, including null fields. The information is valid at the location of the vessel frame.

Note that commas separate all items

Two attitude data strings are available. The strings are identical except for the definition of roll and pitch angles. One string uses Tate-Bryant angles and the

other uses TSS angles. Use the POS/MV Controller program to set the required angle convention.

$PRDID, PPP.PP, RRR.RR, xxx.xx*hh

$PRDID-Attitude data

Item	Definition	Value	Units
$PRDID	Header	$PRDID	
PPP.PP	Pitch	-90.00 to +90.00	Degrees
RRR.RR	Roll	-90.00 to +90.00	Degrees
xxx.xx	Sensor heading	0 to 359.99	Degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

Note that commas separate all items

Two attitude data strings are available. The strings are identical except for the definition of roll and pitch angles. One string uses Tate-Bryant angles and the other uses TSS angles. Use the POS/MV Controller program to set the required angle convention.

$INZDA, hhmmss.ss, DD, MM, YYYY,, *hh

$INZDA-Time and date

Item	Definition	Value	Units
$INZDA	Header	$INZDA	
hhmmss.sss	UTC time	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours 2 fixed digits of minutes 2 fixed digits of seconds Three digits for decimal fractions of a second
DD	Day of month	01 to 31	
MM	Month of year	01 to 12	
YYYY	Year		
Null	Null		
Null	Null		
*hh	Checksum	n/a	/CR/LF

Seabird SBE-45 Thermosalinograph Data

Data from the SBE-45 TSG is output in the following format:

2012:050:06:02:01.0294 27.2958, 5.51684, 34.7768

yyyy:ddd:hh:mm:ss.ssss tttt, cccc, xxxx

Item	Definition	Units
yyyy	year	n/a
ddd	day of year	n/a
hh	hours	n/a
mm	minutes	n/a
ss.ssss	seconds	n/a
tttt	Raw internal temperature sensor data	n/a
cccc	Raw conductivity sensor data	n/a
xxxx	Raw salinity sensor data	n/a

SEAPATH 330 Intertial Navigation System

SEAPATH outputs data in NMEA format using the following sentence formats:

- 1. $INGGA-Global System Position Fix Data
- 2. $INHDT-Heading - True data
- 3. $INVTG-Course over ground and Ground speed data
- 4. $INZDA-Time and date

$INGGA, hhmmss.sss, llll.llll, a, yyyyy.yyyyy, b, t, nn, v.v, x.x, M,,,c.c,rrrr*hh

$INGGA-Global System Position Fix Data

Item	Definition	Value	Units
$INGGA	Header	$INGGA	
hhmmss.sss	UTC time of position	n/a	Hours/Minutes/Seconds.decimal. Two fixed digits of hours. Two fixed digits of minutes. Two fixed digits of seconds. Three digits for decimal fractions of a second.
llll.llll	Latitude	-90 to +90	DegreeslMinutes.decimal. Two fixed digits of degrees Two fixed digits of minutes Five digits for decimal minutes.
a	N (north) or S (south)	N or S	
yyyyy.yyyyy	Longitude	-180 to +180	Degrees/Minutes.decimal. Three fixed digits of degrees. Two fixed digits of minutes. Five digits for decimal minutes.
b	E (east) or W (west)	E or W	
t	GPS Quality Indicator	0 = Fix not available or invalid 1 = CIA standard GPS; fix valid. 2 = DGS mode; fix valid. 3 = PPP mode; fix valid. 4 = RTK fixed 5 = RTK float 6 = free inertial	
nn	Number of satellites used in fix	0 to 32	
v.v	Horizontal dilution of precision		
x.x	Altitude of the IMU above or below the mean sea level. A negative value indicates below sea level.	n/a	Metres
M	Units of measure = metres	M	
Null	Null		
Null	Null		

c.c	Age of differential corrections in records since last RTCM-104 message.	0 to 99.9	Seconds
rrr	DGPS reference station identity	0000 to 1023	
*hh	Checksum		
/CR/LF	Carriage return and line feed	/CR/LF	

$INHDT, x.x, T*hh

$INHDT-Heading - True data

Item	Definition	Value	Units
$INHDT	Header	$INHDT	
x.x	True vessel heading in the vessel frame	o to 359.99	degrees
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

$INVTG, x.x, T,, M, n.n, N, k.k, K*hh

$INVTG-Course over ground and Ground speed data

Item	Definition	Value	Units
$INVTG	Header	$INVTG	
x.x	True vessel track in the vessel frame	0 to 359.99	degrees
T	True	T	
null	Not supported	null	
M		M	
n.n	Speed in the vessel frame	n/a	Knots
N	Knots	N	
k.k	Kilometres	K	
*hh	Checksum	n/a	
/CR/LF	Carriage return and line feed	/CR/LF	

$INZDA, hhmmss.ss, DD, MM, YYYY,, *hh

$INZDA-Time and date

Item	Definition	Value	Units
$INZDA	Header	$INZDA	
hhmmss.sss	UTC time	n/a	Hours/Minutes/Seconds.decimal. 2 fixed digits of hours 2 fixed digits of minutes 2 fixed digits of seconds Three digits for decimal fractions of a second
DD	Day of month	01 to 31	
MM	Month of year	01 to 12	
YYYY	Year		

Null	Null	
Null	Null	
*hh	Checksum	n/a
/CR/LF	Carriage return and line feed	/CR/LF

DS 80 Speed log data

Speed log data is formatted in the following sentences:

- VHW - Water speed and heading
- VBW - Dual Ground/Water Speed

$VHW,x.x,T,x.x,M,x.x,N,x.x,K*hh

VHW sentence fields

Item	definition	units
x.x	degrees true	?
T	T=true	n/a
x.x	degrees Magnetic	?
M	M = Magnetic	n/a
x.x	Speed of vessel relative to water	Knots/hour
N	N = Nots	n/a
x.x	Speed of vessel relative to water	Km/hour
K	K = Kilometers	n/a
*hh	Checksum	n/a

$VBW,x.x,x.x,A,x.x,x.x,A*hh

VBW sentence fields

Item	Definition	Units
x.x	Longitudinal water speed, "-" means astern	?
x.x	Transverse water speed, "-" means port	?
A	A = Data Valid	n/a
x.x	Longitudinal ground speed, "-" means astern	?
x.x	Transverse ground speed, "-" means port	?
A	A = data valid, V = data invalid	n/a
*hh	Checksum	n/a

AML Oceanographic Micro-X XChange Sound Velocity Probe Data

The sound velocity probe serial data is output in the following format:

1479.35

xxxx.xx

Item	Definition	Units
xxxx.xx	Sound Velocity	m/s

Seabird SBE38 Thermometer Probe Data

The sound velocity probe serial data is output in the following format:

8.2221

xx.xxxx

Item	Definition	Units
xx.xxxx	Temperature	Celcius

Viasala Ultrasonic Meteorological Station Data

The meteorological data from the Viasala integrated ultrasonic weather station is output in the following sentence format:

$WIMWV,105,R,3.8,N,A*32
$WIMWV,x.x,R,y.y,N,A*32

Item	Definition	Units
x.x	Wind direction value: Wind direction is given in relation to the devices north-south axis.	Degrees
R	Wind direction unit (R = relative)	n/a
y.y	Wind speed value	Knots
N	Wind speed unit (knots	n/a
A	Data status: A = valid, V = Invalid	n/a

$WIXDR,A,105,D,0,A,105,D,1,A,105,D,2,S,3.7,N,0,S,3.8,N,1,S,3.9,N,2,C,27.2,C,0,C,28.4,C,1,H,70.5,P,0,P,1013.5,H,0,V,0.00,M,0,Z,0,s,0,R,0.0,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,1.7,M,2,R,0.0,M,3*6D

$WIXDR,A,xxx,D,0,A,xxx,D,1,A,xxx,D,2,S,x.x,N,0,S,x.x,N,1,S,x.x,N,2,C,xx.x,C,0,C,xx.x,C,1,H,xx.x,P,0,P,xxxx.x,H,0,V,x.xx,M,0,Z,0,s,0,R,x.x,M,0,V,x.x,M,1,Z,0,s,1,R,x.x,M,1,R,x.x,M,2,R,x.x,M,3*6D

Item	Definition	Units
A	**Transducer id 0 type (Wind Direction)**	**n/a**
xxx	Transducer id 0 data (min wind direction)	Degrees

D	Transducer id 0 units (degrees, min wind direction)	n/a
0	Transducer id for min wind direction	n/a
A	Transducer id 1 type (wind direction)	n/a
xxx	Transducer id 1 data (average wind direction)	Degrees
D	Transducer id 1 units (degrees, average wind direction)	n/a
1	Transducer id for average wind direction	n/a
A	Transducer id 2 type (wind direction)	n/a
xxx	Transducer id 2 data (max wind direction)	Degrees
D	Transducer id 2 units (degrees, max wind direction)	n/a
2	Transducer id for max wind direction	n/a
S	**Transducer id 0 type (wind speed)**	**n/a**
x.x	Transducer id 0 data (min wind speed)	Knots
N	Transducer id 0 units (Knots, min wind speed)	n/a
0	Transducer id for min wind speed	n/a
S	Transducer id 1 type (wind speed)	n/a
x.x	Transducer id 1 data (average wind speed)	Knots
N	Transducer id 1 units (Knots, average wind speed)	n/a
1	Transducer id for average wind speed	n/a
S	Transducer id 2 type (wind speed)	n/a
x.x	Transducer id 2 data (max wind speed)	Knots
N	Transducer id 2 units (Knots, max wind)	n/a
2	Transducer id for max wind speed	n/a

C	**Transducer id 0 type (Temperature)**	**n/a**
xx.x	Transducer id 0 data (Temperature)	Celcius
C	Transducer id 0 units (C, Temperature)	n/a
0	Transducer id for Temperature	n/a
C	**Transducer id 1 type (temperature)**	**n/a**
xx.x	Transducer id 1 data (Tp internal temperature)	Celcius
C	Transducer id 1 units (C, Tp internal temperature)	n/a
1	Transducer id for Tp internal temperature	n/a
H	**Transducer id 0 type (Humidity)**	**n/a**
xx.x	Transducer id 0 data (Humidity)	% Reletive Humidity
P	**Transducer id 0 units (%, Humidity)**	**n/a**
0	Transducer id for Humidity	n/a

P	**Transducer id 0 type (Pressure)**	**n/a**
xxxx.x	Transducer id 0 data (Pressure)	hPA
H	Transducer id 0 units (hPa, Pressure)	n/a
0	Transducer id for Pressure	n/a

V	**Transducer id 0 type (Accumulated rainfall)**	**n/a**
x.xx	Transducer id 0 data (Accumulated rainfall)	millimeters
I	Transducer id 0 units (mm, Accumulated rainfall)	n/a
0	Transducer id for Accumulated rainfall	n/a
Z	**Transducer id 0 type (Rain duration)**	**n/a**
xx	Transducer id 0 data (Rain duration)	seconds
s	Transducer id 0 units (s, Rain duration)	n/a
0	Transducer id for Rain duration	n/a
R	**Transducer id 0 type (Rain intensity)**	**n/a**
x.x	Transducer id 0 data (Rain intensity)	mm/hr
M	Transducer id 0 units (mm/h, Rain intensity)	n/a
0	Transducer id for Rain intensity	n/a
V	**Transducer id 1 type (Hail accumulation)**	**n/a**
x.x	Transducer id 1 data (Hail accumulation)	hits/cm2
M	Transducer id 1 units (hits/cm2, Hail accumulation)	n/a
1	Transducer id for Hail accumulation	n/a
Z	**Transducer id 1 type (Hail duration)**	**n/a**
x	Transducer id 1 data (Hail duration)	seconds
s	Transducer id 1 units (s, Hail duration)	n/a
1	Transducer id for Hail duration	n/a
R	**Transducer id 1 type (Hail intensity)**	**n/a**
x.x	Transducer id 1 data (Hail intensity)	hits/cm2h
M	Transducer id 1 units (hits/cm2h, Hail intensity)	n/a
1	Transducer id for Hail intensity	n/a
R	**Transducer id 1 type (Rain peak intensity)**	**n/a**
x.x	Transducer id 1 data (Rain peak intensity)	mm/h
M	Transducer id 1 units (mm/h, Rain peak intensity)	n/a
2	Transducer id for Rain peak intensity	n/a
R	**Transducer id 1 type (Hail peak intensity)**	**n/a**
x.x	Transducer id 1 data (Hail peak intensity)	hits/cm2

M	Transducer id 1 units (hits/cm2, Hail peak intensity)	n/a

VIII. Log file(s) Descriptive

BirdLogs

The directory /docs/operations/BirdLogs/ contains meta-data (when logged) for the Digicourse compass/cable levelers (birds). Attributes (when logged) are “fin angle”, “depth”, and “battery”.

Daily_Reports

The directory /docs/operations/Daily_Reports/ contains the daily production report compiled by the CSO.

GunLogs

The directory /docs/operations/GunLogs/ contains source errors/changes in “source only” operations.

NavLogs

The directory /docs/operations/NavLogs/ contains line logs for the Spectra Integrated Navigation System on a sequence by sequence basis.

Seismic_Support_Plan

The directory /docs/operations/Seismic_Support_Plan/ contains all of the revisions of the plan which details the intended survey activity.

Seal_Report

The directory /docs/operations/Seal_report/ contains sequence by sequence logs for the Seal408 MCS system detailing critical attributes ie: file number, shotpoint, source volume, etc.

Standing_orders

The directory /docs/operations/Standing_orders/ contains watch-stander duties and responsibilities documents and log syntax documentation.

StreamerSheets

The directory /docs/operations/StreamerSheets/ contains serial number and configuration documentation for each streamer deployed during the cruise.