

# RV Langseth

## Data Reduction Summary



## MGL1806 – Shillington 2D

**Dr. Donna Shillington – Dr. Robert Dunn – Dr. Anthony Watts**  
**Hawaii Emperor Seamount Phase 1**  
**Honolulu, Hawaii – Honolulu, Hawaii**

V1.0, 2018-10-18  
Lamont-Doherty Earth Observatory, Columbia University

**11 September 2018 15:30L**

Date	Day of Year	Time	Port
2018-09-11	254	0000 UTC, 1400 L	Honolulu, Hawaii
2018-10-21	295	1800 UTC, 0800L	Honolulu, Hawaii

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

### Cruise Overview

MGL18-06 is an active seismic survey using both ocean bottom seismometers and multichannel streamer from the *R/V Langseth*, in the Central Pacific, off the coast of the Hawaii Island. The proposed Hawaii survey would occur within ~18–24°N, ~153–160°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 main goal of the survey proposed by L-DEO and the University of Hawaii is to gain fundamental insight into the formation and evolution of Hawaiian-Emperor Seamount chain and inform a more comprehensive assessment of geohazards for the Hawaiian Islands region. The Hawaii-Emperor Seamount Chain is the most well-known example on Earth of hotspot magmatism, where volcanoes form far from the boundaries between tectonic plates above hot regions in the underlying mantle. Seismic data acquired during the proposed study would image faults within the volcanic edifice and in the surrounding oceanic crust that could be used to evaluate earthquake, tsunami, and submarine landslide hazards.

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<sup>3</sup>. The receiving system would consist of 70 OBSs and a single hydrophone streamer 15 km in length towed by the *Langseth*. A longer streamer provides opportunities to suppress unwanted energy that interferes with imaging targets, allows for accurate measurements of seismic velocities, and provides a large amount of data redundancy for enhancing seismic images during data processing. As the Source array is towed along the survey lines, the OBSs would receive and store the returning acoustic signals internally for later analysis, and the hydrophone streamer would transfer the data to the on-board processing system.

The *Langseth* would first deploy all 70 OBSs required for the refraction profiling – the vessel would transit from Honolulu to the north end of Line 1, deploy 35 OBSs along Line 1, ~15 km apart, and then transit to the south end of Line 2 to deploy 35 OBSs (~15 km apart) along Line 2. The streamer and source array would then be deployed. Refraction data would then be acquired from north to south on Line 1 followed by MCS profiling along the same line.

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.

In addition to the operations of the air-sound-source array, a Multi-beam echo sounder (MBES) and a Sub-Bottom Profiler (SBP) will also be operated from the *Langseth*. 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. Donna Shillington (LDEO). She will be onboard for the survey operations, as well as Dr. Robert Dunn, Dr. Anthony Watts, and 9 students (science party total of 12), 7 LDEO/contract technicians and 5 Protected Species Observers (PSOs).

Added on to this mission is a RAPID OBS recovery effort for the NSF (PI – Dr. Jackie Caplan-Auerbach/WWU). 4 (four) days will be added to the mission science days total, bringing total “at seas” days to 40.

The cruise is expected to take 43 days to complete; currently mobilization is scheduled to start on 10 September 2018 and completion of demobilization on 23 October, 2018. The ship is scheduled to sail on 12 September, 2018 from Honolulu, Hawaii. Scientists will be permitted onboard the vessel on 11 September 2018. At the end of the cruise, the scientists must disembark the day after the ship arrives in port. Honolulu, Hawaii is the planned port call location.

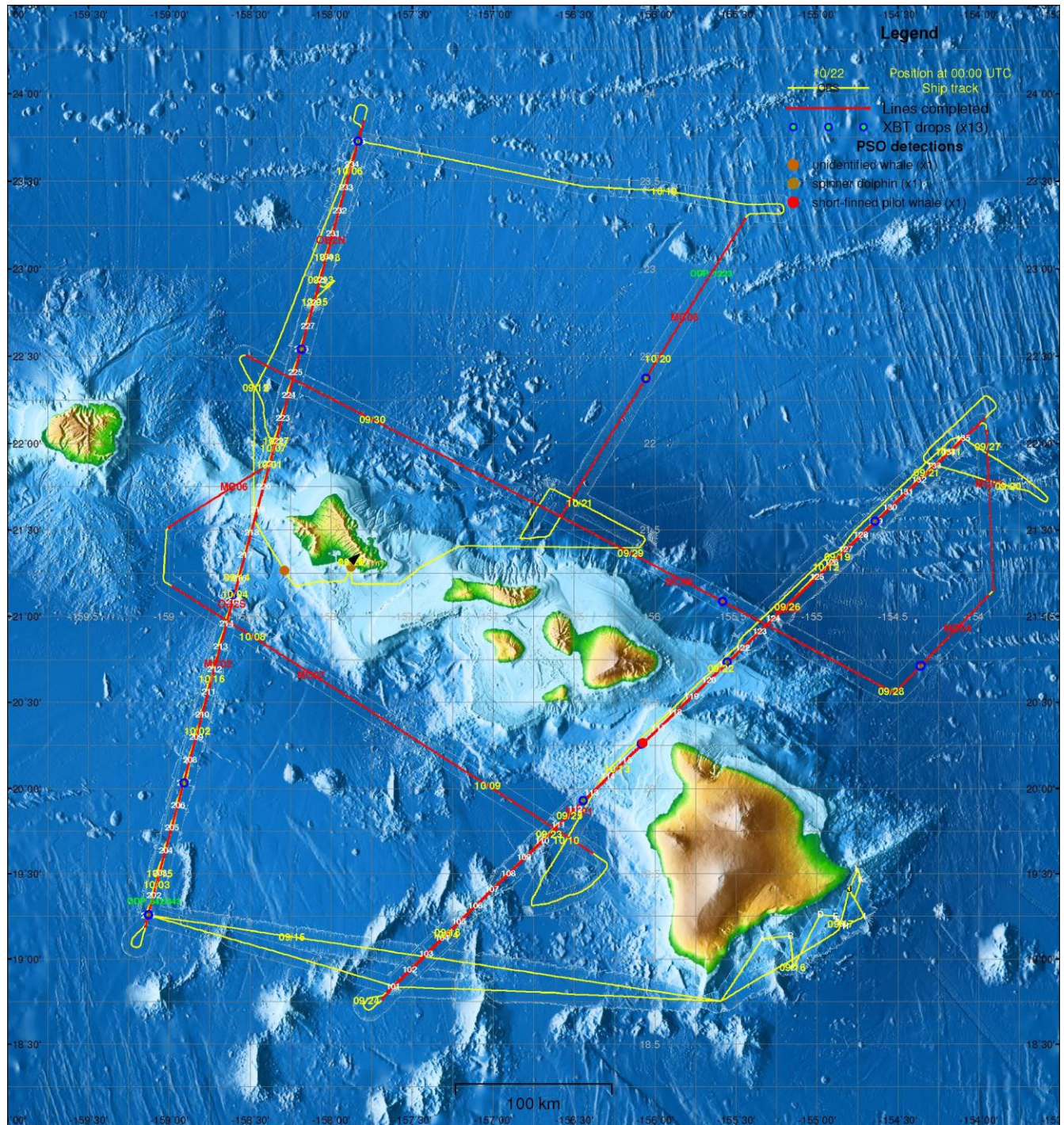
**Port –**

Honolulu, Hawaii – departed 11 September 2018

Honolulu, Hawaii – returned 21 October 2018



## MGL1806 map of operations





## II. Personnel

### Shipboard Technical Staff

Participant	Group/Affiliation	Position
Martinson, David M.	L-DEO OMO	Chief Science Officer
Jensvold, Todd P.	L-DEO OMO	Science Officer
Thompson, Alan J.	L-DEO OMO	Marine Tech
Guerin, Gilles M.	L-DEO OMO	Lamont Research Scientist
Spoto, Thomas R.	L-DEO OMO	Chief Source Mechanic
Kasinger, Joshua D.	L-DEO OMO	Source Mechanic
Shaver, Shaun R.	Atlas Personnel	Source Mechanic

### Ship's Crew

1	Landow, Mark C.	Master
2	Crun, Breckenridge C.	Chief Mate
3	Quinn, Tara J.	3rd Mate
4	Woronowicz, Jason J	3rd Mate
5	Redito, Ricardo, M.	Bosun
6	Orias, Anthony M.	AB
7	Robison, William J.	AB
8	White, Joselyn N.	AB
9	Kurek, Ann P.	OS
10	Tucke, Matthew S.	Chief Engr.
11	Levine, Isaac D.	1st Asst. Engr.
12	Nasta, Joseph R.	2nd Asst. Engr.
13	Nasta, Joseph R.	3rd Asst. Engr.
14	Kononchik, Greg J.	Oiler
15	Florendo, Rodolfo A.	Oiler
16	Hempstead, Barry K.	Oiler
17	Hill, Michael D,	Electrician
18	Rosson, Eric J.	Steward
19	Rios, Ricardo	Cook

**PSO**

<b>Participant</b>	<b>Group/Affiliation</b>	<b>Position</b>
Dubuque, Amanda	RPS-Geocet	Lead PSO
Carrera, Lori	RPS-Geocet	PAM operator / PSO
Mares, Bianca	RPS-Geocet	PSO
Moldonado, Diana	RPS-Geocet	PSO
De Leon, Grace	RPS-Geocet	PSO

**Science Party**

	<b>Participant</b>	<b>Group/Affiliation</b>	<b>Function</b>
1	Donna Shillington	LDEO	Chief Scientist
2	Robert Dunn	U of Hawaii	Co-chief
3	Anthony Watts	Oxford	Co-chief
4	Bridgit Boulahanis	LDEO	Graduate student
5	Dan Sousa	LDEO	Graduate student
6	Charu Lata	U of Hawaii	Graduate student
7	Nipaporn Nakrong	U of Hawaii	Graduate student
8	Laney Hart	U of Washington	Graduate student
9	Jingxuan Wei	TAMU	Graduate student
10	Suyapa Rodriquez	LSU	Graduate student
11	Xiaozhuo Wei	URI	Graduate student
12	Mark McClernan	U of Alaska	Graduate student

### 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*	1s
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 MGL1806

The FE700 was not in use on MGL1806.

### 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 MGL1806/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 MGL1806/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 SEG Y format (if requested). Reference MGL1806/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 MGL1806/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 MGL1806/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 MGL1806/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 MGL1806/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 MGL1806/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 MGL1806/docs/elog for information on any data gaps or degraded operation.

**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 MGL1806/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 MGL1806/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 MGL1806/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 MGL1806 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 MGL1806.

## 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 MGL1806/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	MGL1806
Acquisition_sequence(s)	Seq 2, 3, 4, 5, 7, 9, and 10
ReceiverType	Sercel Sentinel Streamer
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	220 m
Source_to_Near_Channel	218 m
Number_of_channels_recorded	1200
Number_of_cables	1
Number_of_channels_each_cable	1200
Channel_length	12.5 m
Cable_length	15000 m
Cable_spacing	Applicable to multi-streamer MCS only
Near_Channel_Number	1
Cable_depth	12 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	62.5 m
Sample_interval	2
Record_length	26
Compass_birds	57
Recording_delay	False
Active_tail_buoy	True
Multiple_ships	False

**Acquisition Parameter Table 2**

<b>FieldActivityID</b>	MGL1806
<b>Acquisition_sequence(s)</b>	Seq 1, 6, and 8
<b>ReceiverType</b>	Sercel Sentinel Streamer/OBS
<b>SourceType</b>	Airgun
<b>Acquisition System Name</b>	Sercel Seal 408
<b>Acquisition System Type</b>	MCS/OBS
<b>Seismic_Nav_System</b>	C-Nav 3050 primary
<b>Survey_datum</b>	WGS84
<b>Navigation Reference Point</b>	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
<b>Antenna(NRP)_to_source</b>	220
<b>Source_to_Near_Channel</b>	218
<b>Number_of_channels_recorded</b>	1200
<b>Number_of_cables</b>	1
<b>Number_of_channels_each_cable</b>	1200
<b>Channel_length</b>	12.5 m
<b>Cable_length</b>	15000 m
<b>Cable_spacing</b>	Applicable to multi-streamer MCS only
<b>Near_Channel_Number</b>	1
<b>Cable_depth</b>	12 m
<b>Number_sources</b>	1
<b>Sub-arrays_per_source</b>	4
<b>Flipflop_shooting (dual source alternating)</b>	False
<b>Source_separation</b>	Applicable to flipflop (dual source alternating) only
<b>Sub-array_separation</b>	6.0 m
<b>Source_volume</b>	6600 cu in
<b>Source_pressure</b>	2000 psi nominal
<b>Source_make,model</b>	Bolt 1500LL & 1900LL
<b>Source_element_number</b>	36 + 4 spare
<b>Source_depth</b>	12.0 m
<b>Shot_control</b>	Distance
<b>Shot_Interval</b>	390 m
<b>Sample_interval</b>	4.0 ms
<b>Record_length</b>	55 s
<b>Compass_birds</b>	57
<b>Recording_delay</b>	False
<b>Active_tail_buoy</b>	True
<b>Multiple_ships</b>	False

**Acquisition Parameter Table 3**

<b>FieldActivityID</b>	MGL1806
<b>Acquisition_sequence(s)</b>	Seq 11
<b>ReceiverType</b>	Sercel Sentinel Streamer
<b>SourceType</b>	Airgun
<b>Acquisition System Name</b>	Sercel Seal 408
<b>Acquisition System Type</b>	MCS
<b>Seismic_Nav_System</b>	C-Nav 3050 primary
<b>Survey_datum</b>	WGS84
<b>Navigation Reference Point</b>	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
<b>Antenna(NRP)_to_source</b>	220
<b>Source_to_Near_Channel</b>	192
<b>Number_of_channels_recorded</b>	504
<b>Number_of_cables</b>	1
<b>Number_of_channels_each_cable</b>	504
<b>Channel_length</b>	12.5 m
<b>Cable_length</b>	6300 m
<b>Cable_spacing</b>	Applicable to multi-streamer MCS only
<b>Near_Channel_Number</b>	1
<b>Cable_depth</b>	12 m
<b>Number_sources</b>	1
<b>Sub-arrays_per_source</b>	4
<b>Flipflop_shooting (dual source alternating)</b>	False
<b>Source_separation</b>	Applicable to flipflop (dual source alternating) only
<b>Sub-array_separation</b>	6.0 m
<b>Source_volume</b>	6600 cu in
<b>Source_pressure</b>	2000 psi nominal
<b>Source_make,model</b>	Bolt 1500LL & 1900LL
<b>Source_element_number</b>	36 + 4 spare
<b>Source_depth</b>	12.0 m
<b>Shot_control</b>	Distance
<b>Shot_Interval</b>	50 m
<b>Sample_interval</b>	2.0 ms
<b>Record_length</b>	20 s
<b>Compass_birds</b>	25
<b>Recording_delay</b>	False
<b>Active_tail_buoy</b>	True
<b>Multiple_ships</b>	False

## Physical Configuration

The towing configuration for the air guns, streamers, antennas, and in-water offsets are detailed in the document titled *MGL1806\_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

Date / Time	Ship Location	Reference Location	Mistie
2017-01-08T13:51	Valparaiso, Chile	SHOA Valparaiso	Valparaiso, Chile
2017-02-17T07:24	Valparaiso, Chile	SHOA Valparaiso	Valparaiso, Chile

Please refer to the documents located under MGL1806/docs/gravity\_tie for detailed records.

## VI. Archive Contents

MGL1806/docs	Cruise documents
MGL1806/docs/elog	Cruise elog
MGL1806/docs/gravity_tie	Gravity Tie information
MGL1806/docs/map	Cruise maps, track map
MGL1806/docs/offsets	Vessel/sensor offsets
MGL1806/docs/operations/	Operations documents
MGL1806/docs/operations/Daily_Reports	Cruise Daily Reports
MGL1806/docs/operations/NavLogs	Spectra Nav logs
MGL1806/docs/operations/ObsLogs	MCS/Source logs
MGL1806/docs/operations/MGL1806_B15-log	Master line log table
MGL1806/docs/operations/Seal_reports	Seal 408 line logs
MGL1806/docs/permits	Associated permitting
MGL1806/docs/waypoints	Waypoint files
MGL1806/docs/personnel	Rosters, org charts etc.
MGL1806/docs/reports	Associated reports
MGL1806/docs/reports/MGL1806_DataReport_v1.0.doc	This file
MGL1806/docs/offsets/MGL1806_Offsets_MCS.xls	Vessel/sensor offsets
MGL1806/docs/screencaps	Screen captures
MGL1806/processed	Processed data
MGL1806/processed/knudsen	Knudsen segy
MGL1806/processed/reflex	Spectra reflex files
MGL1806/processed/obsip	OBS Shot log files
MGL1806/processed/sprint	Sprint UKOOA P190s
MGL1806/processed/svp	Sound velocity profiles
MGL1806/raw	Raw data
MGL1806/raw/adcp	Raw ADCP data
MGL1806/raw/knudsen	Raw Knudsen data
MGL1806/raw/MarkeyWinch	DESH-5 winch data
MGL1806/raw/multibeam	Raw EM122 data
MGL1806/raw/serial	Underway serial data
MGL1806/raw/sonobuoy	Raw sonobuoy data
MGL1806/raw/spectra/P1	Spectra underway p190
MGL1806/raw/spectra/P2	Spectra UKOOA p294
MGL1806/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-Global 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
hhmmss.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-Global 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

<b>Item</b>	<b>Definition</b>	<b>Units</b>
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
*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
hhmmss.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 full 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 yy.yyyyyy vv.vvvvvv www.wwwwww dddd.d llllllllllll
```

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
llllllllllll	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, lll.lllllm, 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
yyyyyjjj.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.lllllm	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, hhhmmss.sss, llll.lllll, a, yyyyyy.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	Degrees/Minutes.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	
yyyyyy.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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
\$INHDT	Header	\$INHDT	
x.x	True vessel heading in the vessel frame	0 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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
%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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
\$INZDA	Header	\$INZDA	
hhmmss.ss	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

<b>Item</b>	<b>Definition</b>	<b>Units</b>
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 Inertial 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, yyyy.yyyy, 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	Degrees/Minutes.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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
\$INHDT	Header	\$INHDT	
x.x	True vessel heading in the vessel frame	0 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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
\$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**

<b>Item</b>	<b>Definition</b>	<b>Value</b>	<b>Units</b>
\$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
<b>S</b>	<b>Transducer id 0 type (wind speed)</b>	<b>n/a</b>
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

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

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

<b>V</b>	<b>Transducer id 0 type (Accumulated rainfall)</b>	<b>n/a</b>
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
<b>Z</b>	<b>Transducer id 0 type (Rain duration)</b>	<b>n/a</b>
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
<b>R</b>	<b>Transducer id 0 type (Rain intensity)</b>	<b>n/a</b>
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
<b>V</b>	<b>Transducer id 1 type (Hail accumulation)</b>	<b>n/a</b>
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
<b>Z</b>	<b>Transducer id 1 type (Hail duration)</b>	<b>n/a</b>
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
<b>R</b>	<b>Transducer id 1 type (Hail intensity)</b>	<b>n/a</b>
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
<b>R</b>	<b>Transducer id 1 type (Rain peak intensity)</b>	<b>n/a</b>
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
<b>R</b>	<b>Transducer id 1 type (Hail peak intensity)</b>	<b>n/a</b>
x.x	Transducer id 1 data (Hail peak intensity)	hits/cm2

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



