

R/V Marcus G. Langseth Data Reduction Summary

MGL2316 – Puerto Rico Trench OBS

Dr. Pablo Canales, WHOI

San Juan, PR, to San Juan, PR

Lamont-Doherty Earth Observatory, Columbia University

Sailing dates:

Date	Day of Year	Time	Port
2023-11-21	325	11:00 UTC	San Juan, PR
2023-12-15	349	13:20 UTC	San Juan, PR

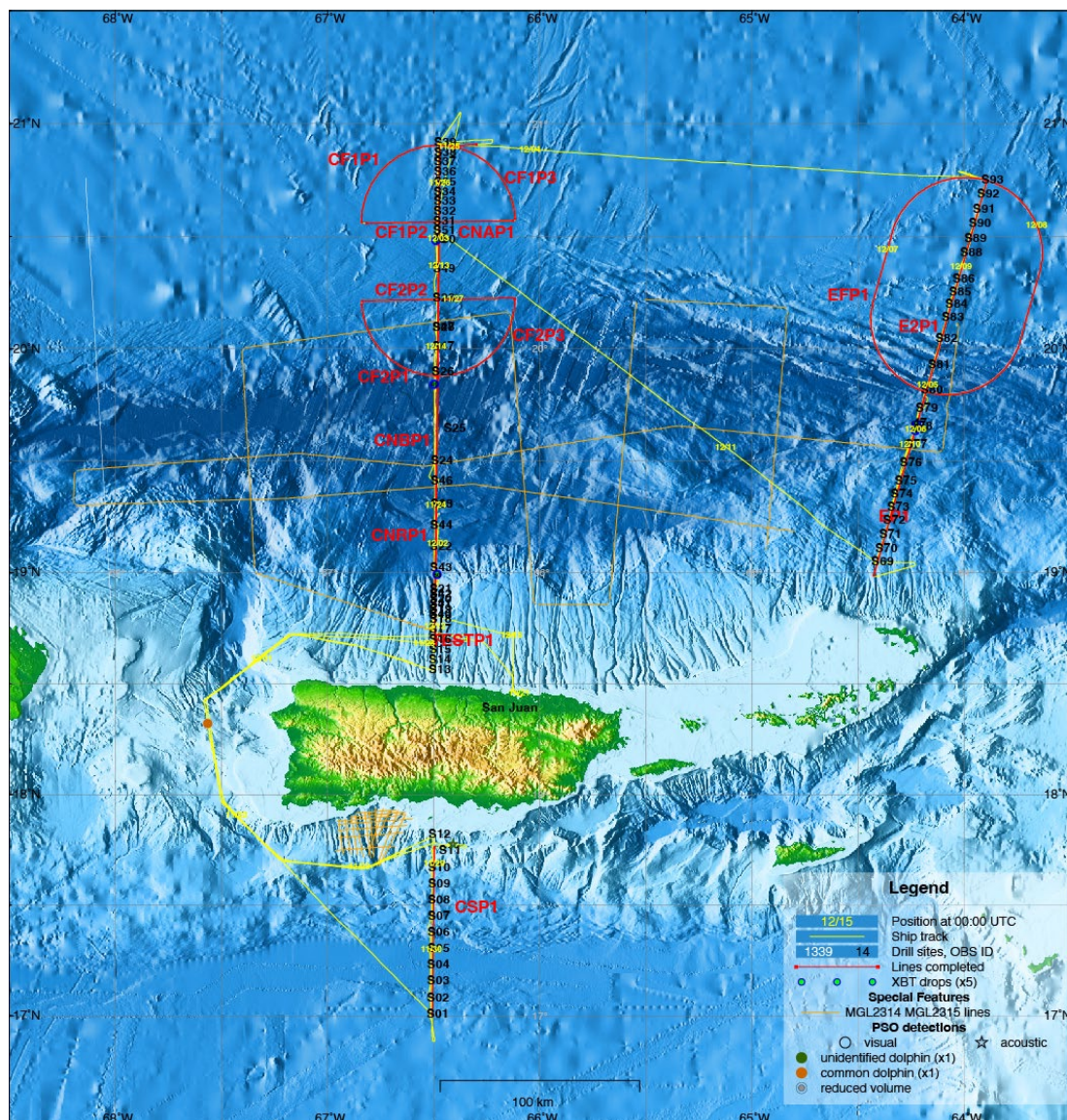
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I. Background and Scientific Objectives

Old Atlantic lithosphere subducts obliquely at the Puerto Rico Trench (PRT) under the Caribbean plate at <20 mm/yr. The PRT is associated with anomalous, and hitherto unexplained characteristics, such as the widest trench (below 6,000 m), the strongest negative gravity anomaly on Earth, and anomalous subsidence of the Puerto Rican north coast. Furthermore, the slab may be segmented and possibly torn. The proposed experiment aims at exploring three questions: (1) What is the shallow geometry of the subducting slab and its lateral continuity along the 500-km section of the trench, and what is the potential for the PRT to generate a mega-earthquake and mega-tsunami impacting the Caribbean and U.S. Atlantic margins. (2) What is the degree and spatial extent of hydration of the Atlantic lithosphere entering the Puerto Rico Trench? (3) Does the oceanic divergent thrust system represent double-sided subduction or a crustal retro-wedge of one-sided subduction? The later structure could be formed in response to compression of the rigid arc crust. This project should provide a detailed velocity structure of the crust and slab of the entire arc and the seismically active region of Puerto Rico and the Virgin Islands. This second leg of the project deployed short-period OBSs along two lines across the trench, as well as south of the Island, and used the Langseth acoustic arrays over each line before recovering the instruments.



II. Personnel

Science Party

Participant	Affiliation	Position
Pablo Canales	WHOI	PI
Nick Harmon	WHOI	Scientist
Liam Moser	WHOI	Student
Hannah Brewer	WHOI	OBS Technician
Tim Kane	WHOI	OBS Technician
Andrew Farmer	WHOI	OBS Technician
Gavin McCarthy	WHOI	OBS Technician
Arne Shwenk	GEOMAR	OBS Technician
Lisa Sokolkova	GEOMAR	OBS Technician

Shipboard technical staff

Participant	Group/Affiliation	Position
Todd Jensvold	LDEO	Chief Science Officer
Gilles Guérin	LDEO	Marine Science Technician
Brian Agee	LDEO	Chief Source Mechanic
Jacob Greenberg	UNOLS	Marine Technician/Mechanic
Aaron Martin	Contractor	Navigator
Ian Davis	Contractor	Observer
Ray Atton	Contractor	Mechanic
Mark Walker	Contractor	Mechanic
Sean Seekins	Contractor	Mechanic

Protected Species Observers

Participant	Group/Affiliation	Position
Amanda Dubuque	RPS	Lead PSO/PAM
Cassandra Frey	RPS	PSO/PAM
Elizabeth Breton	RPS	PSO/PAM
Maria Sandoval	RPS	PSO/PAM
Tiffany Ramdoo	RPS	PSO/PAM

Ship Crew

Participant	Position
Mark Landow	Master
Mark Stinziano	Chief Mate
Joselyn White	2nd Mate
Sebastian Uriarte	3rd Mate
George Cereno	Bosun
Robert Hammond	AB
William Robison	AB
DeQuan Smith	AB
Marquise Brown	OS
Rodolfo Florendo	Oiler

Participant	Position
Gerald Butler	Chief Engineer
Marlin Carpenter	1st A/E
Dylan Labun	2nd A/E
Vincente Rodriguez	3rd A/E
Joe Walsh	Electrician
Ryan Dries	Oiler
AJ Hoggard	Wiper
Christina DeLorenzi	Steward
Elijah Cox	Cook
Matrik Stein	OS Utility

III. Instrumentation Summary

All science instruments aboard the Langseth that were used and generated data during the cruise are listed below. File names and samples are in section IV, and details of serial formats in section VIII.

General Instrumentation

Instrument	Description	Data Set	Data Outputs	Files	Sampling rate
ADCP	Teledyne Ocean Surveyor 75 Doppler Current Profiler	Full	various	See below	variable
BGM	Bell Aerospace BGM-3 Gravimeter	Full	serial log	MGL-vc01.*	1s
CNAV	Oceaneering C-Nav3050 DGPS - Stern	Full	serial log	MGL-cnav.*	1s
CNAV3050	Oceaneering C-Nav3050 DGPS - Main	Full	serial log	MGL-cnav3050all.*	1s
DS80	Furuno DS-80 Doppler Speed log	Full	serial log	MGL-slog01.*	3s
EM122	Kongsberg EM122 Multibeam Sonar	Full	various	See below	variable
GYRO	Simrad GC80 Gyrocompass	Full	serial log	MGL-gy01.*	0.1s
KNUDSEN	Knudsen 3260 Sub-bottom Profiler	Full	kea, keb, segy, serial log	See below	variable
MAG01	Geometrics 882 Magnetometer	On deploy	serial log	MGL-mag01.*	0.1s
MICROSV	AML Oceanographic Micro-X SV Xchange velocity probe	Full	serial log	MGL-svuss01.*	1s
PCO2	General Oceanics PCO2 sea surface monitoring system	Partial	serial log	MGL-pco2.*	variable
POSMV	Applanix POSMV Inertial Navigation system	Full	serial log	MGL-posmv*	0.5s
SEAPATH	Kongsberg Seapath 330+ Inertial Navigation System	Full	serial log	MGL-seapath.*	1s
TSG	SeaBird SBE45 MicroTSG Thermosalinograph	Full	serial log	MGL-tsgraw.*	10s
Vaisala	Vaisala WXT-520 Weather Station	Full	serial log	MGL-vaisala1*	1s
XBT	Lockheed Martin Sippican Expendable BathyThermographs	5 drops	Raw data	See below	n/a

Seismic Instrumentation

Instrument	Description	Data Set	Data Formats	Files
Gunlink	Seamap Gunlink 2000 source control system	Full	SEGD	See below
Orca	Sercel Orca Seismic navigation system	Full	various	See below

IV. Data Files and Data Strings

The outputs of all the science instruments listed in the previous section are described below, in the same alphabetical order for instrument names as the previous table.

For all serial data, the files are named MGL-*inst.yYYYYdjjj*, after the code or ID of the instrument (*inst*), the year (YYYY) and the julian day (*jjj*) when they are recorded, with a new file created every day. Each data sentence is preceded by its ID and a UTC time stamp, added by the Lamont Data System (LDS).

The description of the sentence formats is in section VIII.

See [docs/elog/MGL2316_r2relog.csv](#) for information on any data gaps or degraded operation.

General Instrumentation

ADCP: Teledyne Doppler Current Profiler

ADCP data were collected during most of the cruise, with an interruption during the first phase of recovery (11/30-12/03) to limit interference with OBS communication protocols. It was established that it wasn't an issue for the following recoveries.

Data are delivered as a replication of its acquisition directory structure, including raw and processed data, reports, figures and binary data in clearly labeled folders.

BGM: Bell Aerospace BGM-3 Gravimeter

The Bell Aerospace BGM-3 Gravimeter operated normally during the length of this cruise.

Serial file id: vc01

Logging interval: 1 second

vc01 data sample:

```
vc01 2023:328:00:00:00.3245 04:025660 00
```

CNAV: C-Nav3050 DGNSS Receiver

The C-Nav3050 is a global satellite-based differential receiver. Two units are used: the unit located on the ship tower is used as the primary reference, while the unit at the stern is used as a secondary system. Both units were operational during the entire cruise.

Primary unit (tower)

Serial file id: cnav3050all

Logging interval: 1 second

cnav3050all data sample:

```
cnav3050all 2023:328:00:00:00.1779 $GNGGA,000000.00,1918.2187,N,06629.4506,W,2,15,0.7,-48.4,M,0.0,M,5.0,0446*69
cnav3050all 2023:328:00:00:00.1780 $PNCTGGA,000000.00,1918.218748,N,06629.450550,W,2,15,0.7,-48.443,M,0.000,M,5.0,
0536*62
cnav3050all 2023:328:00:00:00.2298 $GNGLL,1918.218748,N,06629.450550,W,000000.00,A,D*6B
cnav3050all 2023:328:00:00:00.2897 $GNRMC,000000.00,A,1918.218748,N,06629.450550,W,2.47,140.3,241123,,P,S*07
cnav3050all 2023:328:00:00:00.2898 $GNVTG,140.3,T,M,2.47,N,4.57,K,P*03
cnav3050all 2023:328:00:00:00.2899 $GNZDA,000000.00,24,11,2023,00,00*7D
cnav3050all 2023:328:00:00:00.3364 $GNGSA,A,3,02,07,08,09,14,16,17,21,27,30,,,1.2,0.7,1.0,1*31
cnav3050all 2023:328:00:00:00.3365 $GNGSA,A,3,75,76,86,87,88,,,,,1.2,0.7,1.0,2*35
cnav3050all 2023:328:00:00:01.1226 $GNDTM,999,,,,,999*54
cnav3050all 2023:328:00:00:01.1227 $PNCTDTM,ITR,,,,,ITR*54
```

Secondary unit (stern)

Serial file id: cnav

Logging interval: 1 second

cnav data sample:

```
cnav 2023:328:00:00:00.2492 $GPGGA,000000.00,1918.2215,N,06629.4678,W,2,17,0.6,16.1,M,-68.3,M,5.0,0446*45
cnav 2023:328:00:00:00.3203 $GPVTG,133.7,T,,M,2.81,N,5.19,K,P*1C
cnav 2023:328:00:00:01.2494 $GPDTM,999,,,,,,999*4A
```

DS80: Furuno DS-80 Doppler Speed log

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

Serial file id: slog01

Logging interval: 3 seconds

slog01 data sample:

```
slog01 2023:328:00:00:02.4046 $VDVLW,167575.43,N,483.35,N*66
slog01 2023:328:00:00:02.9194 $VDVBW,2.2,,A,,,V*68
```

EM122: Kongsberg EM122 Multibeam Sonar

The EM122 multibeam sonar was operated throughout the cruise, except during the three phases of OBS recovery operations. See [docs/elog/MGL2316_r2relog.csv](#) for times and durations of any interruption.

EM122 swath data is saved to the cruise archive under **raw/multibeam**. Data in Kongsberg raw formats (*.all, *.wcd, *.asvp, *.abs) are replicated in the original directory structure, named by time stamps and sorted by day of acquisition. Center beam depth is recorded separately to serial log.

Serial file id: bath02

Logging interval: variable with water depth

bath02 data sample:

```
bath02 2023:328:00:00:30.6801 $KIDPT,7593.81,7.62,12000.0*71
```

GYRO: Simrad GC80 Gyrocompass

The GC80 gyrocompass is installed on the bridge and is used for ship and seismic navigation. It was in operation for the duration of the cruise.

Serial file id: gy01

Logging interval: 0.1s

gy01 data sample:

```
gy01 2023:328:00:00:00.7877 $HEROT,-006.19,A*38
gy01 2023:328:00:00:00.8848 $HEHDT,096.1,T*21
gy01 2023:328:00:00:01.0828 $HEHDT,096.1,T*21
gy01 2023:328:00:00:01.0828 $PTKM,HEALM,0000,0,G1*09
```

KNUDSEN: Knudsen Engineering 3260 Sub-bottom Profiler

The Knudsen 3260 is a chirp echosounder/sub-bottom profiler. Its 3.5kHz channel was in operation at the beginning of the cruise, but was stopped on 11/24 for the rest of the cruise because of interference with the EM122 multibeam. Data are written in proprietary KEB, KEA, and in SEG Y format. The depth is also broadcast as UDP and recorded as a serial log.

Serial file id: bath01

Logging interval: variable with water depth

bath01 data sample:

```
bath01 2023:328:00:09:45.1016 $SDDP,2835.29,000.00,0500.00*67
```

MAG01: Geometrics 882 Magnetometer

The Geometrics 882 magnetometer is towed behind the ship. Deployment Data are collected only when the Magnetometer is deployed, which is dependent upon seismic operations and sea state. See [docs/elog/MGL2316_r2relog.csv](#) for when it was deployed.

Serial file id: mag01

Logging interval: 0.1 second

mag01 data sample:

```
mag01 2023:328:18:07:14.8328 $ 38003.922,1179,0959
```

MICROSV: AML Oceanographic Micro-X SV Xchange velocity probe

Because of issues with the uncontaminated sea water pump at the beginning of the cruise, the AML Micro SV probe started operating only at 17:22 UTC, Oct 30, ~24hrs after sailing from San Juan. It operated normally through the rest of the cruise.

Serial file id: svuss01

Logging interval: 1 second

svuss01 data sample:

```
svuss01 2023:328:00:00:05.5958 1543.280
```

PCO2: General Oceanics PCO2 sea surface monitoring system

This was the first operational deployment of the new PCO2 monitoring system. It started recording data on November 23 and was operational for the rest of the cruise. Processed data are replicated every day under raw/pco2 in the cruise data folder, and some raw data were broadcast to UDP, in a non-NMEA format, and recorded by the LDS system for real time monitoring. To avoid misrepresentation of the data, the format of these raw data is not relevant and not provided in section VIII.

Serial file id: pco2

Logging interval: variable

PCO2 data sample:

```
pco2 22:53:28 EQU,0,24/11/23,22:53:28,2023-11-24T22:53:29Z,20.9062,-66.3359,NaN,28.34,2390.80,409.14,
269.33,1.83,42.30,1016.70,4.72,1.77,85.43,59.00,0.30,9.97,9.97,9.94,0.55,5.00,30.06,28.337, 5.84227,36.2842,228.69,
94.2,28.379,27.2,71.4,1014.5,203,9.5
pco2 22:57:50 STD5,0,24/11/23,22:57:50,2023-11-24T22:57:51Z,20.9058,-66.3426,0.00,28.20,201.25,-
0.22,10.37,0.06,42.27,1016.70,4.72,1.78,76.31,59.00,-1.29,9.97,9.97,9.94,0.55,5.06,30.00,28.192,5.79674,36.0756,
228.82,94.1,28.258,27.2,71.4,1014.4,192,11.2
```

POSMV: Applanix POS-MV Inertial Navigation System

The POS/MV is an inertial navigation system using two antennas and an IMU to produce full six degrees-of-freedom position and orientation solutions for the vessel. It was operational during the entire cruise except for a short interruption due to a power failure on Dec06.

Serial file id: posmv

Logging interval: 0.5-1 second, depending on sentence

posmv data sample:

```
posmv 2023:328:00:00:00.1347 $INZDA,000000.0024,24,11,2023,,*75
posmv 2023:328:00:00:00.1349 $PASHR,000000.034,94.90,T,1.13,1.52,1.24,0.020,0.020,0.013,2,1*20
posmv 2023:328:00:00:00.2531 $PRDID,1.52,1.13,94.90*48
posmv 2023:328:00:00:00.2532 $INGST,000000.034,,0.7,0.4,1.6,0.8,0.4,0.8*5E
posmv 2023:328:00:00:00.3466 $INGGA,000000.034,1918.21676,N,06629.44462,W,2,18,0.8,-18.18,M,,141,0134*19
posmv 2023:328:00:00:00.3466 $INHDT,94.9,T*11
posmv 2023:328:00:00:00.3467 $INVTG,131.7,T,,M,2.0,N,3.8,K,D*15
```

SEAPATH: Kongsberg SeaPath 330 Inertial Navigation System

The Kongsberg Seapath 330 is another inertial navigation system using two antennas and an IMU to produce full six degrees-of-freedom position and orientation solutions for the vessel. It was operational for the duration of the cruise.

Serial file id: seapath

Logging interval: 1 second

seapath data sample:

```
seapath 2023:328:00:00:00.3788 $INGGA,000000.14,1918.218996,N,06629.450226,W,2,10,0.8,-24.04,M,-44.34,M,1.4,
0001*7E
seapath 2023:328:00:00:00.6113 $INGLL,1918.218996,N,06629.450226,W,000000.14,A,D*6B
seapath 2023:328:00:00:00.6114 $INVTG,132.24,T,,M,1.9,N,3.6,K,D*23
seapath 2023:328:00:00:00.6115 $INHDT,95.12,T*2A
seapath 2023:328:00:00:00.6116 $PSXN,20,0,0,0,0*3B
seapath 2023:328:00:00:00.6815 $PSXN,23,1.30,1.44,95.12,-0.70*2E
```

TSG: SBE-45 Thermosalinograph

The Seabird TSG was operational through the entire cruise. Data are broadcast and recorded in a non-NMEA format.

Serial file id: tsgraw

Logging interval: 10 seconds

tsgraw data sample:

```
tsgraw 2023:328:00:00:39.9142 t1= 28.5989, c1= 5.71034, s= 35.1665, sv=1542.199, t2= 28.3164
```

Vaisala: Vaisala Meteorological Ultrasonic Integrated Weather Station

One weather station was used to log wind speed, direction, air temperature, relative humidity, precipitation, dew point, and barometric pressure. The station is located on top of the tower and was operational during the entire cruise.

Serial file id: vaisala1

Logging interval: 1 second

vaisala data sample:

```
vaisala1 2023:328:00:00:00.0324 $WIMWV,011,R,16.5,N,A*0F
vaisala1 2023:328:00:00:00.5883 $WIXDR,C,27.4,C,0,C,27.4,C,1,H,78.1,P,0,P,1013.3,H,0*5F
```

XBT: Lockheed Martin Sippican eXpendable BathyThermographs

5 XBT drops were made during this cruise. The data sets produced by the MK21 Oceanographic Data Acquisition System were saved to the raw/XBT directory in the cruise archive and were imported into the EM122 acquisition software when reaching sufficient depth to provide reliable velocity profiles through the water column. See the **docs/MGL2316_Expendable_Drops.xls** spreadsheet for more information. The sequence numbers were a continuation of the previous two cruises.

Files: *.RDF, *.EDF

Seismic Instrumentation

Gunlink

Seamap Gunlink 2000 was used to control the sources used during seismic acquisition. For each shot point, it generated a segd file including the signatures of the hydrophones active on the source arrays. Files are named with the associated shotpoint number, sorted in separate folders for each sequence, under **raw/gunlink**.

Files: *ShotPoint.segd*

Orca

Sercel's Orca software was used for all timing and navigation during the cruise. Orca generated UKOOA P294 and P211 files for each sequence. File names are made of the cruise name (MGL2316), the sequence number (*Seq*), the name of the line (*Line*), and an additional identifier (*Pid*) for pass number, reshoot or segmented lines.

Files: *MGL2316SeqLinePid.p294*, *MGL2316SeqLinePid.p211*

Serial file id: orcahdr

For each shot point, Orca outputs to UDP a general navigation header combined with the Gun Controller String for the shot:

```
orcahdr 2023:328:22:48:12.6201 $11019000303224810.56101220231124UTC000968 MGL2316001CF1P1 20.906743 -
66.3275245450.3 20.906942 -66.324860266.4267.0
5.4001*GCS900900001CF1P100000009680fE23/11/24:22:48:101436350000000060624000.000.103
1929"(JN193119271926193401AP1N 000138499-01127020P1N 00000099900012703AP1N 000119499-0112504AP1N
00014550100112305AP1N 00010550000012406AP1N 00013050000012407AP1N 00011150000012408AP1N 00015650000012509AP1N
00015650000012510AP1N 00013950100112711AP1N 00014550000012712AP1N 00011450000012613AP1N 00014650000012414AP1N
00010750000012415AP1N 00009950100112316AP1N 00011250000012217AP1N 00016050100112218AP1N 000156499-0112219AP1N
000145497-0311820AP1N 00015750200211821AP1N 00011050000012122AP1N 00015250000012223AP1N 00011450100112224AP1N
00009850000012225AP1N 00011650000012226AP1N 000150499-0112227AP1N 00016950300312228AP1N 00013250000012629AP1N
000137499-0112630AP1N 00011450000012531AP1N 000135498-0212532AP1N 00010650000012433AP1N 00011750000012434AP1N
00010950100112335AP1N 00014550000012336AP1N 000153500000123
```

Navigation Post Processing

Onboard navigation post processing of the P294 files was performed with Iris, as part of the Orca suite, to produce UKOOA P190 files with improved positioning. Naming convention is the same as for the raw p294 data: File names are made of the cruise name (MGL2316), the sequence number (*Seq*), the name of the line (*Line*), and an additional identifier (*Pid*) for pass number, reshoot or segmented lines. Because a glitch in Orca/Iris suppressed a couple of shots in these sequences, sequences 1, 2, and 9 were reprocessed with SeisPos,

Files: *MGL2316SeqLinePid.p190*

V. Seismic Acquisition Parameters

Acquisition Parameters Table 1

(35 active source elements out of 36 - 6240 in³; shot spacing = 300 m)

Field Activity ID	MGL2316
Acquisition sequence(s)	1-8
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	OBS
Acquisition System Type	OBS
Seismic Navigation System	Orca
Survey datum	WGS84
Navigation Reference Point (primary GPS antenna)	C-Nav3050: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	276 m
Source to Near Channel	N/A
Number of channels recorded	N/A
Number of cables	N/A
Number of channels each cable	N/A
Channel length	N/A
Cable length	N/A
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	N/A (only one array)
Source volume	6240 in ³
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	35
Source depth	12 m
Shot control	Distance
Shot Interval	300 m
Sample interval	N/A
Record length	N/A
Compass birds	N/A
Recording delay	N/A
Active tail buoy	N/A
Multiple ships	False

Acquisition Parameters Table 2

(35 active source elements out of 36 - 6240 in³; shot spacing = 120 m)

Field Activity ID	MGL2316
Acquisition sequence(s)	9
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	OBS
Acquisition System Type	OBS
Seismic Navigation System	Orca
Survey datum	WGS84
Navigation Reference Point (primary GPS antenna)	C-Nav3050: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	276 m
Source to Near Channel	N/A
Number of channels recorded	N/A
Number of cables	N/A
Number of channels each cable	N/A
Channel length	N/A
Cable length	N/A
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	N/A (only one array)
Source volume	6240 in ³
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	35
Source depth	12 m
Shot control	Distance
Shot Interval	120 m
Sample interval	N/A
Record length	N/A
Compass birds	N/A
Recording delay	N/A
Active tail buoy	N/A
Multiple ships	False

Acquisition Parameters Table 3

(36 active source elements - 6600 in³; shot spacing = 300 m)

Field Activity ID	MGL2316
Acquisition sequence(s)	10,11,12
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	OBS
Acquisition System Type	OBS
Seismic Navigation System	Orca
Survey datum	WGS84
Navigation Reference Point (primary GPS antenna)	C-Nav3050: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	276 m
Source to Near Channel	N/A
Number of channels recorded	N/A
Number of cables	N/A
Number of channels each cable	N/A
Channel length	N/A
Cable length	N/A
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	N/A (only one array)
Source volume	6600 in ³
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	36
Source depth	12 m
Shot control	Distance
Shot Interval	300 m
Sample interval	N/A
Record length	N/A
Compass birds	N/A
Recording delay	N/A
Active tail buoy	N/A
Multiple ships	False

Acquisition Parameters Table 4

(36 active source elements - 6600 in³; shot spacing = 120 m)

Field Activity ID	MGL2316
Acquisition sequence(s)	13,14
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	OBS
Acquisition System Type	OBS
Seismic Navigation System	Orca
Survey datum	WGS84
Navigation Reference Point (primary GPS antenna)	C-Nav3050: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	276 m
Source to Near Channel	N/A
Number of channels recorded	N/A
Number of cables	N/A
Number of channels each cable	N/A
Channel length	N/A
Cable length	N/A
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	N/A (only one array)
Source volume	6600 in ³
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	36
Source depth	12 m
Shot control	Distance
Shot Interval	120 m
Sample interval	N/A
Record length	N/A
Compass birds	N/A
Recording delay	N/A
Active tail buoy	N/A
Multiple ships	False

VI. Gravity Tie Information

No gravity ties were performed immediately before or after the cruise. Data are provided for the most recent tie, recorded at WHOI on October 15.

VII. Cruise Data Archive Contents

docs	Cruise documents and logs
docs/elog	Cruise elog files
docs/elog/MGL2316_r2relog.csv	Cruise elog report
docs/gravity_tie	Gravity ties
docs/map	Cruise maps
docs/offsets	Vessel/sensor offsets
docs/operations	Operations documents
docs/operations/Daily_Reports	Cruise daily reports from
docs/operations/NavLogs	Seismic Navigation logs (orca)
docs/operations/ObsLogs	Seismic Acquisition logs
docs/operations/MGL2316_B15_line_log.xls	Master line log table
docs/operations/MGL2316_Expendable_Drops.xls	XBT drops summary table
docs/operations/MGL2316_line_configuration_by_sequence.xls	Seismic Acquisition configuration
docs/permits	Clearance documents
docs/reports	Associated reports
docs/reports/MGL2316_DataReport.doc	This file
docs/reports/orca_EOL_reports	End Of Line Orca reports (csv and pdf formats)
docs/waypoints	Waypoint and planning files
processed	Processed data
processed/obsip	Shotlog/OBSIP files from processed P190
processed/navigation	Processed navigation data (UKOOA P190)
raw	Raw data
raw/adcp	Raw ADCP data
raw/gunlink	Hydrophone data from Gunlink (SEGD)
raw/knudsen	Raw Knudsen sub-bottom profiler data
raw/multibeam	Raw EM122 multibeam data
raw/obsip	Shotlog and source data from raw navigation
raw/orca/P2	Raw seismic navigation (UKOOA P294)
raw/PCO2	Daily shipboard PCO2 data
raw/serial	Underway serial data
raw/XBT	XBT data

VIII. Serial Data Formats

Unless specified otherwise, all serial data sentences are in NMEA 0183 compatible format.

On each line, the data sentences generated by the instrument follows the instrument ID and time stamp added by the Lamont Data Logger (LDS) system.

In the following format descriptions, unless specified otherwise, x.x stands for floating point values, n for integer, and a for character. When fixed, the number of characters and precision are indicated (e.g. x.xx = two decimal point precision; nnnn = 4 integers).

In all sentences with a mode indicator associated with the checksum in the last word, if nothing else is specified, the options are: A: Autonomous mode; D: Differential mode; E: Estimated (dead reckoning) mode; M: Manual Input mode; S: Simulator mode; N: Data not valid.

MGL-bath01.*

The Knudsen 3260 depth is output to files *MGL-bath01.yYYYYdjjj* using the following format:

\$SDDPT, x.xx, x.xx, x.xx*hh		
Item	Definition	Units / Options
x.xx	Water depth relative to transducer	m
x.xx	Offset from transducer	m; positive means from transducer to water line
x.xx	Range in use	m
*hh	Checksum	n/a (hexadecimal)

MGL-bath02.*

The EM122 center beam depth is output to files *MGL-bath02.yYYYYdjjj* using the following format:

\$KIDPT, x.x, x.x, x.x*hh		
Item	Definition	Units / Options
x.x	Water depth	m
x.x	Offset from transducer	m; positive means from transducer to water line
x.x	Maximum range scale in use	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-cnav.*

The C-Nav3050 GPS at the stern outputs data to files *MGL-cnav.yYYYYdjjj*. The following sentence types were recorded:

- \$GPGGA: Global Positioning System Time, position and fix related data.
- \$GPD TM: Datum reference information
- \$GPVTG: Track made good and Ground speed data.

\$GPD TM sentence

\$GPD TM, a, a, mm.mmmmm, a, mm.mmmmm, a, 0, aaa*hh		
Item	Definition	Units / Options
a	Local datum code	n/a
a	Local datum subcode	n/a

mm.mmmmm	Latitude offset	minutes
a	Latitude offset mark (N: +; S: -)	n/a
mm.mmmmm	Longitude offset	minutes
a	Longitude offset mark (E: +; W: -)	n/a
0	Altitude offset (always 0)	m
aaa	Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

\$GPGGA sentence

\$GPGGA, hhmmss.ss, ddmm.mmmmm, a, dddmm.mmmmm, a, x, nn, x.x, x.x, M, x.x, M, x.x, nnnn*hh

Item	Definition	Units / Options
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
dddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude: E = East; W = West	n/a
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: Corrected fix
nn	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision (HDOP)	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Altitude units--M indicates meters	n/a
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units--M indicates meters	n/a
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	n/a
*hh	Checksum	n/a (hexadecimal)

\$GPVTG sentence

\$GPVTG, x.x, T, mmm.m, M, x.x, N, x.x, K, a*hh

Item	Definition	Units / Options
x.x	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
x.x	COG relative to magnetic north	Degrees from Magnetic North
M	Indicates course relative to magnetic north	n/a
x.x	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that SOG is in knots	n/a
x.x	SOG	km/h
K	Indicates that SOG is in km/h	n/a
a	Mode Indicator	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-cnav3050all.*

The main C-Nav3050 GPS receiver outputs data to files MGL-cnav3050all.yYYYYdjjj. The following sentence types were recorded:

- \$GNDTM: Datum reference information
- \$GNGGA: Global Positioning System Time, position and fix related data
- \$GNGLL: Position data: position fix, time of position fix, and status
- \$GNGSA: GPS Dilution of Precision (DOP) and active satellites
- \$GNVTG: Track made good and Ground speed data
- \$GNZDA: UTC day, month, and year, and local time zone offset
- \$PNCTDTM: C-Nav proprietary Datum reference information
- \$PNCTGGA: C-Nav proprietary GPS Time, position and fix related data

\$GNDTM sentence

\$GNDTM,aaa,a,mm.mmmmm,a,mm.mmmmm,a,0,aaa*hh

Item	Definition	Units / Options
aaa	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmmm	Latitude offset	minutes
a	Direction of Latitude	N: North; S: South
mm.mmmmm	Longitude offset	minutes
a	Direction of Longitude	E: East; W: West
0	Altitude offset	m (always 0)
aaa	Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

\$GNGGA sentence

\$GNGGA,hhmmss.ss,ddmm.mmmmm,a,dddmm.mmmmm,a,x,n,x.x,x.x,M,x.x,M,x.x,a*hh

Item	Definition	Units / Options
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: Corrected fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Altitude units--M indicates meters	n/a
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	n/a
*hh	Checksum	n/a (hexadecimal)

\$GNGLL sentence

\$GNGLL, dddmm.mmmmm, a, dddmm.mmmmm, a, hhmmss.ss, a, a*hh		
Item	Definition	Units / options
dddmm.mmmmm	Latitude	Degree, decimal minute
a	Latitude direction	N: North; S: South
dddmm.mmmmm	Longitude	Degree, decimal minute
a	Longitude direction	E: East; W: West
hhmmss.ss	UTC time	Hour/minute/Sec.dec
a	Status indicator	A: valid; V: not valid
a	Mode Indicator	n/a
*hh	Mode*Checksum data	n/a (hexadecimal)

\$GNGSA sentence

\$GNGSA, A, 3, nn, nn, nn, nn, nn, nn, nn, nn, nn, nn, nn, nn, x.x, x.x, x.x, 1*3D		
Item	Definition	Units / options
a	Mode	M: Manual; A: Automatic
n	Solution	1: N/A; 2: 2D; 3: 3D
nn	ID (PRN) of satellites used	Up to 12 values
x.x	Position (3D) of Dilution of Precision (PDOP)	N/A
x.x	Horizontal Dilution of Precision (HDOP)	N/A
x.x	Vertical Dilution of Precision (VDOP)	N/A
n	System ID	1 = GPS
*hh	Checksum	n/a (hexadecimal)

\$GNVTG sentence

\$GNVTG, xxx.x, T, xxx.x, M, x.xx, N, x.xx, K, a*hh		
Item	Definition	Units / Options
ttt.t	Course over ground (COG)	Degrees from True North
T	Indicates course relative to True North	n/a
mmm.m	COG relative to magnetic north	Degrees from Magnetic North
M	Indicates course relative to magnetic north	n/a
x.xx	Speed over ground (SOG)	Nautical miles per hour (knots)
N	Indicates that SOG is in knots	n/a
x.xx	SOG	km/h
K	Indicates that the SOG is in km/h	n/a
a	Mode Indicator	n/a
*hh	Checksum	n/a (hexadecimal)

\$GNZDA sentence

\$GNZDA, hhmmss.sss, dd, mm, yyyy, hh, mm*hh		
Item	Definition	Units / options
hhmmss.sss	UTC time	Hour/minute/Sec.dec
dd	Day	01-31
mm	Month	01-12

yyyy	Year	
hh	Local time zone offset from GMT, hours	00-13
mm	Local time zone offset from GMT, minutes	00-59
*hh	Checksum	n/a (hexadecimal)

\$PNCTDTM sentence

\$PNCTDTM,aaa,,,,,,,,,aaa*54

Item	Definition	Units / Options
aaa	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmmm	Latitude offset	minutes
a	Latitude direction	N: North; S: South
mm.mmmmm	Longitude offset	minutes
a	Direction of Longitude	E: East; W: West
0	Altitude offset from reference	m
aaa	Reference Datum code	n/a
*hh	Checksum	n/a (hexadecimal)

\$PNCTGGA sentence

\$PNCTGGA,hhmmss.ss,ddmm.mmmmmmm,a,dddmm.mmmmmmm,a,n,n,x.x,x.x,M,x.x,M,x.x,iijj*hh

Item	Definition	Units / Options
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: GPS SPS fix; 2: DGPS SPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Antenna altitude from Mean Sea Level (MSL)	m
M	Antenna Altitude units	n/a (M indicates meters)
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
iijj	Differential GPS reference ID	ii:satellite beam; jj: correction type
*hh	Checksum	n/a (hexadecimal)

MGL-gy01.*

The Simrad GC80 Dual Gyro Compass output to files *MGL-gy01.yYYYYdjjj*. The following sentence types were recorded:

- HEHDT: True Heading
- HEROT: Rate Of Turn
- PTKM: Alarm

\$HEHDT Sentence

\$HEHDT, x.x, T*hh

Item	Definition	Units / Options
x.x	Heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

\$HEROT Sentence

\$HEROT, x.x, T*hh

Item	Definition	Units / Options
x.x	Rate of turn	Degrees per minute; "-" = bow turns to port
a	Status	n/a; A: Valid data
*hh	Checksum	n/a (hexadecimal)

\$PTKM Sentence

\$PTKM, aaaa, nnnn, n, a*hh

Item	Definition	Units / Options
HEALM	Almanac code	n/a
nnnn	unspecified	n/a
n	unspecified	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-mag01.*

The Geometrics 882 magnetometer outputs serial to files *MGL-mag01.yYYYYdjjj* in the following format, which doesn't follow the NMEA standard.

\$ xxxxx.xxx, nnnn, nnnn

Item	Definition	Units / Options
xxxxx.xxx	Magnetic Field Intensity	nT
nnnn	Signal level	Internal format
nnnn	Additional A/D channel	Internal format

MGL-orcahdr.*

The Orca navigation system outputs for each shot point its trigger header informations, combined with the Gunlink Gun Controller String to serial files *MGL-orcahdr.yYYYYdjjj*, which doesn't follow the NMEA standard. It is used to produce the raw obsip/shotlog files.

The first 125 characters are the general navigation header, with words of specific length:

```
$10615000303000143.82501620230602UTC183098 MGL2309057P49 34.263647 -75.789171 500.3 34.265851 -75.787189218.2213
.1 2.6001
```

Columns	Format	Definition
1-2	\$1	Start of general navigation header
3-6	nnnn	Length of header (bytes)
7-10	0003	Program revision – 0003 default for Orca
11-12	03	Line status 03=online
13-33	hhmmss.ssssssYYYYMMDD	High precision shot time and date (UTC)
34-36	UTC	Time reference
37-42	nnnnnn	Shot number
43-58	MGL2316aaaaaaaa	Line Name
59-69	dddd.dddddd	Master Latitude (Degrees.decimal)
70-80	dddd.dddddd	Master Longitude (Degrees.decimal)
81-86	nnnn.n	Water depth (m)
87-97	dddd.dddddd	Source Latitude (Degrees.decimal)
98-108	dddd.dddddd	Source Longitude (Degrees.decimal)
109-113	ddd.d	Master gyro (degrees.decimal)
114-118	ddd.d	Master Course Made Good (Degrees.decimal)
119-122	nn.n	Master speed (knots)
123-125	001	ID of the vessel (001)

The next part of the sentence is made of the formatted gun section, starting with *GCS90. Following are some of the most relevant words:

```
*GCS90049606057P49000018309803E23/06/02:00:01:431218180000000080330000.040.195 1958
```

Columns	Format	Definition
1-6	*GCS90	Start of formatted gun section
6-10	nnnn	Length of gun section (bytes)
11-18	aaaaaaaa	Line name
23-28	nnnnnn	Shot number
29-30	nn	Active array mask
31	a	Trigger mode (I: Internal; E: External)
32-48	YY/MM/DD:HH:MM:SS	Date and time
49	n	Sequence number (flipflop)
50	n	Number of subarrays
51-52	nn	Number of guns in array
53-54	nn	Number of active guns
64-68	nnnnn	Total volume fired (in ³)
83-86	nnnn	Manifold pressure (psi)

The rest of the sentence is made of detailed information for each gun in the array. Here are the details

for one gun:

Columns	Format	Definition
1-2	nn	Gun number
3	a	Mode (A: Auto; M: Manual; S: Spare; O: off)
4	a	Detect (P: Peak; Z: Zero)
5	n	Sequence number (flipflop)
6	a	Autofire (Y/N)
8-10	nnn	Static offset (1/10 msec)
11-13	nnn	Gun delay (1/10 msec)
14-16	nnn	Gun fire time (1/10 msec)
17-19	nnn	Delta (1/10 msec)
20-22	nnn	Depth (1/10 meters)

MGL-posmv.*

Data from the POS/MV inertial navigation system are recorded in files *MGL-posmv.yYYYYdjjj*. The following sentences were recorded. Two attitude data strings are available.

- \$INGGA: Global Positioning System Time, position and fix related data
- \$INGST: GPS Pseudorange Noise Statistics
- \$INHDT: True Heading
- \$INVTG: Course over Ground and Ground speed Data
- \$INZDA: GPS Time and Date
- \$PASHR: Proprietary Attitude data
- \$PRDID: Proprietary Attitude data

\$INGGA sentence

Item	Definition	Units / Options
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: DGS fix; 3: PPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Altitude of IMU from Mean Sea Level (MSL)	M; "-" indicates below seal level
M	Altitude units--M indicates meters	n/a
Null		
Null		
n	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	0000 to 1023
*hh	Checksum	n/a (hexadecimal)

\$INGST sentence

\$INGST, hhmmss.sss, , x.x, x.x, x.x, x.x, x.x, x.x*hh

Item	Definition	Units / Options
hhmmss.sss	UTC time of position	Hours/Minutes/Seconds.decimal.
Null	Null	
x.x	Std deviation of semi-major axis of error ellipse	m
x.x	Std deviation of semi-minor axis of error ellipse	m
x.x	Orientation of semi-major axis of error ellipse	Degrees from true north
x.x	Std deviation of latitude	m
x.x	Std deviation of longitude	m
x.x	Std deviation of altitude	m
*hh	Checksum	n/a (hexadecimal)

\$INHDT sentence

\$INHDT, x.x, T*hh

Item	Definition	Units / Options
x.x	Vessel heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

\$INVTG sentence

\$INVTG, x.x, T, , M, x.x, N, x.x, K, a*hh

Item	Definition	Units / Options
x.x	True vessel track in the vessel frame	Degrees
T	T = Preceding value is True heading	n/a
Null		
M		M: Magnetic
x.x	Speed in the vessel frame	Knots
N	Preceding value is in Knots	N: Knots
x.x	Speed in the vessel frame	km/h
K	Preceding value is in km/h	K: km/h
a	Mode indicator	n/a
*hh	Checksum	n/a (hexadecimal)

\$INZDA sentence

\$INZDA, hhmmss.sss, dd, mm, yyyy, , *hh

Item	Definition	Units / options
hhmmss.sss	UTC time	Hour/minute/Sec.dec
dd	Day	01-31
mm	Month	01-12
yyyy	Year	
Null		
Null		
*hh	Checksum	n/a (hexadecimal)

\$PASHR sentence

\$PASHR, hhmmss.sss, x.xx, T, x.xx, x.xx, x.xx, x.xxx, x.xxx, x.xxx, n, n*3B

Item	Definition	Units / options
hhmmss.sss	UTC time of position	Hours/Minutes/Seconds.decimal.
x.xx	True Vessel Heading	Degrees
T	T = Preceding value is True heading	n/a
x.xx	Roll	Degrees
x.xx	Pitch	Degrees
x.xx	Heave	m
x.xxx	Roll Accuracy	Degrees
x.xxx	Pitch Accuracy	Degrees
x.xxx	Heading Accuracy	Degrees
n	Flag: Accuracy Heading	0: no aiding; 1: GNSS; 2:GNSS & GAMS
n	Flag: IMU	0: IMU out; 1: IMU satisfactory
*hh	Checksum	n/a (hexadecimal)

\$PRDID sentence

\$PRDID, x.x, x.x, x.x*hh

Item	Definition	Units / options
x.x	Pitch	Degrees
x.x	Month	Degrees
x.x	Sensor Heading	Degrees
*hh	Checksum	n/a (hexadecimal)

MGL-seapath.*

The Seapath 330 Inertial Navigation System outputs data to the MGL-seapath.yYYYYdjjj files. The following sentences were recorded:

- \$INGGA: Global Positioning System Time, position and fix related data
- \$INGLL: Geographic Position - Latitude/Longitude
- \$INHDT: True Heading
- \$INVTG: Course over Ground and Ground speed Data
- \$PSXN,20: Proprietary QC data
- \$PSXN,23: Proprietary Attitude

\$INGGA sentence

\$INGGA, hhmmss.sss, ddmm.mmmmm, a, dddmm.mmmmm, a, n, n, x.x, x.x, M, x.x, M, n, nnnn*hh

Item	Definition	Units / Options
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
n	GPS Quality indicator	0: not valid; 1: Auto fix; 2: DGS fix; 3: PPS fix
n	Number of GPS satellites used in solution fix	n/a
x.x	Horizontal Dilution of Precision	n/a
x.x	Altitude of IMU from Mean Sea Level (MSL)	meters; “-“ indicates below seal level
M	Altitude units	n/a (M indicates meters)
x.x	Geoidal separation distance from MSL	m
M	Geoidal separation units	n/a (M indicates meters)
x.x	Age of corrections used in solution fix	s
nnnn	Differential GPS reference station ID	0000 to 1023
*hh	Checksum	n/a (hexadecimal)

\$INGLL sentence

\$INGLL, ddmm.mmmmm, a, dddmm.mmmmm, a, hhmmss.ss, a, a*hh

Item	Definition	Units / Options
ddmm.mmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
hhmmss.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
a	Status	A: valid; V: not valid
a	Mode	A: GPS; D: DGPS; E: dead reckoning; N:invalid
*hh	Checksum	n/a (hexadecimal)

\$INHDT sentence

\$INHDT, x.x, T*hh

Item	Definition	Units / Options
x.x	True vessel heading	Degrees
T	T = Preceding value is True heading	n/a
*hh	Checksum	n/a (hexadecimal)

\$INVTG sentence

\$INVTG, x.x, T, , M, x.x, N, x.x, K, a*hh

Item	Definition	Units / Options
x.x	True vessel track in the vessel frame	Degrees
T	T = Preceding value is True heading	n/a
Null		
M		M: Magnetic
x.x	Speed in the vessel frame	Knots
N	Preceding value is in Knots	N: Knots
x.x	Speed in the vessel frame	Km/h
K	Preceding value is in km/h	K: km/h
a	Mode indicator	n/a
*hh	Checksum	n/a (hexadecimal)

\$PSXN,20 sentence

\$PSXN, 20, n, n, n, n*hh

Item	Definition	Units / Options
20	Sentence ID	20: following words are quality indicators
n	Horizontal position and velocity quality	0: Normal; 1: reduced quality; 2:invalid
n	Height and vertical velocity quality	0: Normal; 1: reduced quality; 2:invalid
n	Heading quality	0: Normal; 1: reduced quality; 2:invalid
n	Roll and pitch quality	0: Normal; 1: reduced quality; 2:invalid
*hh	Checksum	n/a (hexadecimal)

\$PSXN,23 sentence

\$PSXN, 23, x.x, x.x, x.x, x.x*hh

Item	Definition	Units / Options
23	Sentence ID	23: following words are attitude data
x.x	Roll	Degrees
x.x	Pitch	Degrees
x.x	Heading	Degrees
x.x	Heave	m
*hh	Checksum	n/a (hexadecimal)

MGL-slog01.*

The Furuno DS-80 Doppler speed log outputs data to files MGL-slog01.yYYYYdjjj, named after the year YYYY and the julian day jjj. The following sentence types were recorded:

- \$VDVBW: Dual Ground/Water Speed
- \$VDVLW: Distance Traveled through Water

\$VDVBW sentence

\$VDVBW, x.x, x.x, a, x.x, x.x, a*hh		
Item	Definition	Units / Options
x.x	Longitudinal water speed	Knots; - means astern
x.x	Transverse water speed	Knots; - means port
a	Status	A: valid; V: not valid
x.x	Longitudinal ground speed	Knots; - means astern
x.x	Transverse ground speed	Knots; - means port
a	Status	A: valid; V: not valid
*hh	Checksum	n/a (hexadecimal)

\$VDVLW sentence

\$VDVLW, x.x, N, x.x, N*hh		
Item	Definition	Units / Options
x.x	Total cumulative water distance	Nautical miles
N	Indicates distance travelled in nautical miles	n/a
x.x	Water distance since last reset	Knots; - means astern
N	Indicates distance travelled in nautical miles	Knots; - means port
*hh	Checksum	n/a (hexadecimal)

MGL-svuss01.*

The AML Oceanographic Micro-X SV Xchange velocity probe outputs serial data to files MGL-svuss01.yYYYYdjjj in the following format, which doesn't follow the NMEA standard.

xxxx.xxx		
Item	Definition	Units / Options
xxxx.xxx	Sound velocity	m/s

MGL-tsgraw.*

The SeaBird SBE45 MicroTSG Thermosalinograph outputs serial data to files *MGL-tsgraw.yYYYYdjjj* in the following format, which doesn't follow the NMEA standard. Each data item is listed by its code and its value separated by "=".

t1= xx.xxxx, c1= x.xxxxx, s= xx.xxxx, sv=xxxx.xxx, t2= xx.xxxx

Item	Definition	Units / options
t1	Temperature	°C
c1	conductivity	S/m (Siemens/meter)
s	salinity	ppt
sv	Sound velocity	m/s
t2	Remote Temperature	°C

MGL-vaisala1.*

The meteorological data from the Vaisala integrated ultrasonic weather stations is output to files *MGL-vaisala1.yYYYYdjjj*. The following sentences were recorded:

- \$WIMWV: wind speed and angle
- \$WIXDR: all transducers data

\$WIMWV sentence

\$WIMWV,n,a,x.x,a,*hh

Item	Definition	Units / Options
n	Wind direction, referenced to instrument axis	Degrees
a	Reference	R: relative; T: Theoretical
x.x	Wind speed	Defined by next word
a	Wind Speed Unit	N: knots; K: km/h; M: m/s
a	Status	A: valid; V: not valid
*hh	Checksum	n/a (hexadecimal)

\$WIXDR sentence

\$WIXDR,C,x.x,C,0,C,x.x,C,1,H,x.x,P,0,P,x.x,H,0*hh

Item	Definition	Units / Options
C	Transducer id 0 type	C: Temperature
x.x	Transducer id 0 data (Temperature)	°C
C	Transducer id 0 Unit	C: °C
0	Transducer id for temperature	n/a
C	Transducer id 1 type	C: Temperature
x.x	Transducer id 1 data (Internal Temperature)	°C
C	Transducer id 1 Unit	C: °C
1	Transducer id for internal temperature	n/a
H	Transducer id 0 type	H: Humidity
x.x	Transducer id 0 data (humidity)	%
P	Transducer id 0 Unit	P: %

0	Transducer id for humidity	n/a
P	Transducer id 0 type	P: Pressure
x.x	Transducer id 0 data (pressure)	hPa
H	Transducer id 0 Unit	H: hPa
0	Transducer id for pressure	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-vc01.*

The gravimeter serial data is output to files MGL-vc01.yYYYYdjjj in the following format, which doesn't follow the NMEA standard.

04:nnnnnn a		
Item	Definition	Units
04	output frequency	0.25Hz (4 = 4 × clock periods = 1Hz)
nnnnnn	raw counts	n/a
a	sensor status	n/a

IX. Operation and Log files Description

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

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

docs/operations/ObsLogs contains line logs made by the observer on the gun controller and seismic acquisition, on a sequence by sequence basis.

raw/obsip and **processed/obsip** contain files (*.shotlog) for each sequence with the high precision time, the position of the ship and position of the source recorded for each shot point. **raw/obsip** also contain files (*.source.csv) with the number of guns, the total volume and the manifold pressure for each shot point.

All the files are named after the sequence number, line name and pass identifier, MGL2316SeqLinePid.*. The files under raw were created from the orca headers during acquisition, while the processed files are generated from the processed P190 files.

raw/MGL2316_serial_data_1min.csv and **raw/MGL2316_serial_data_10s.csv** are comma separated values (csv) files with record of various key serial data, sampled and filtered every minute and 10 second, respectively.

raw/orca/MGL2316_orca_sequences.csv is a table of sequences automatically generated from the orca database.

raw/orca/MGL2316_orca_shots.csv is an automated list of all the shots triggered by orca, sorted by sequence.

raw/orca/MGL2316_orca_vessel.csv lists the ship positions and acquisition status recorded every minute by orca.