R/V Marcus G. Langseth Data Reduction Summary

MGL2408
IMPULSE OBS & MCS
Reykjanes Ridge, N Atlantic

Dr Stephen Jones, University of Birmingham

Hafnarfjörður, Iceland, to Hafnarfjörður, Iceland

Lamont-Doherty Earth Observatory, Columbia University

Sailing dates:

Date	Day of Year	Time	Port
2024-08-04	217	10:15 UTC	Hafnarfjörður, Iceland
2024-09-09	253	15:45 UTC	Hafnarfjörður, Iceland

Prepared by:
Gilles Guérin
guerin@ldeo.columbia.edu
Revised 2025-11-28

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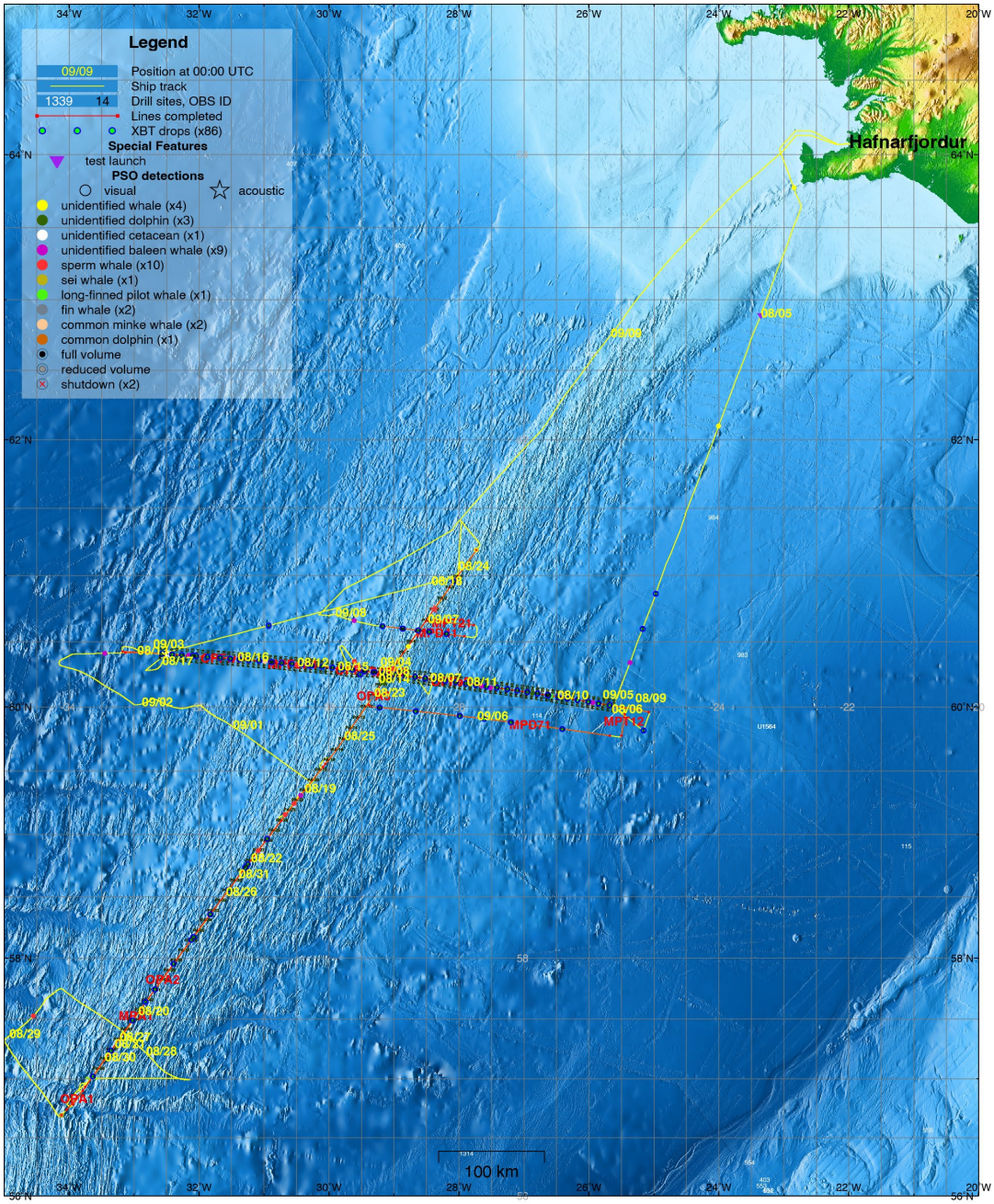
I. Background and Objectives

MGL2408 was the first of three work packages making up the IMPULSE project, the first definitive test of the Thermal Plume Pulsing (TPP) model, which has been suggested as a primary driver of some of the most remarkable perturbations to global climate, ecosystems and the carbon cycle in Earth's history. The specific objective of the cruise were the acquisition of OBS amd MCS data along two profiles: one along a plate spreading flowline coincident with IODP Exp 395 boreholes and the conjugate flowline on the other side of the spreading axis, crossing multiple full ancient conjugate V Shaped Ridges (VSRs) cycles; the second one along the Reykjanes Ridge spreading axis, crossing an entire actively accreting VSR cycle.



II. Personnel

Science Party

Participant	Affiliation	Position
Stephen Jones	University of Birmingham	PI
Tim Henstock	University of Southampton	Co-PI
Hazel Knight	University of Birmingham	Student
Aisling Dunn	University of Cambridge	Student
Philippa Slay	University of Cambridge	Student
Margaret Morris	Scripps	Student
Callum Pearman	University of Cambridge	Student
Aryan Shah	Imperial College London	Student
Jake Bailey	University of Minnesota	Student
Anna Bird	Durham University	OBS Technician
Ben Pitcairn	Durham University	OBS Technician
George Tucker	Durham University	OBS Technician
Stuart Wood	Durham University	OBS Technician

Shipboard technical staff

Participant	Group/Affiliation	Position
Cody Bahlau	LDEO	Chief Science Officer
Koray Ergun	LDEO	Marine Science Technician
Gilles Guérin	LDEO	Marine Science Technician
Riley Lopez	LDEO	Marine Science Technician
Joshua Kasinger	LDEO	Chief Source Mechanic
Brian Agee	LDEO	Marine Technician/Mechanic
Jason Rodham	Contractor	Mechanic
Malcom Moody	Contractor	Mechanic
Tomasz Kranz	Contractor	Mechanic
Leon Da Silva E Souza	Contractor	Mechanic

Protected Species Observers

Participant	Position
Cassandra Frey	Lead PSO
Jorge F Diaz	PAM/PSO
Laura Galvan	PSO
Leticia Lili	PSO

Participant	Position
Robert McShane	PSO
Ana Salomon	PSO
Belen S Toro	PSO
Karen Villegas	PSO

Ship crew

Participant	Position
Landow, Mark C.	Master
Wolford, David H.	Chief Mate
Murphy, Brian P.	2nd Mate
Thielke, Sila A.	3rd Mate
Cereno, George G.	Bosun
Rimando, Inocencio B.	AB
Warnick, Sergio J.	AB
Cisneros, Joshua G.	AB
Brown, Marquise L.	OS
Headd, Robert K.	OS

Participant	Position
Butler, Gerald O.	Chief Engr.
Rodriguez, Vincente L.	1st A/E
Boro, Tristan M.	3rd A/E
Edborg, Samuel C.	3rd A/E
Tsanev, Borislav T.	Oiler
Austin, Oliver E.	Oiler
Dreis, Ryan C.	Oiler
Walsh, Joseph B.	Jr. Engr.
Davis, James E. III	Steward
Martires, Leoncio R.	Cook

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 VI.

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
MICROSV	AML Oceanographic Micro-X SV Xchange velocity probe	Full	serial log	MGL-svuss01.*	1s
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-vaisala1,2*	1s

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
Seal	Sercel Seal 428 Seismic acquisition system	Full	SEGD	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*.y*YYYY*d*jjj*, 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/MGL2408_r2relog.csv** for information on any data gaps or degraded operation.

General Instrumentation

ADCP: Teledyne Doppler Current Profiler

ADCP data were collected during the entire transit.
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. A temporary failure required to restart the system and split the data in two parts, in separate 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 2024:025:00:00:00.397504:024594 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 2024:025:00:00:00.0916$GNDTM,999,,,,,,,999*54
cnav3050all 2024:025:00:00:00.0918$PNCTDTM,ITR,,,,,,,ITR*54
cnav3050all 2024:025:00:00:00.1451$GNGGA,000000.00,2729.2256,N,04523.7930,W,2,14,0.8,15.4,M,0.0,M,5.0,0446*43
cnav3050all 2024:025:00:00:00.1452$PNCTGGA,000000.00,2729.225594,N,04523.793030,W,2,14,0.8,15.449,M,0.000, M,5.0, 0536*45
cnav3050all 2024:025:00:00:00.2048$GNGLL,2729.225594,N,04523.793030,W,000000.00,A,D*6D
cnav3050all 2024:025:00:00:00.2664$GNRMC,000000.00,A,2729.225594,N,04523.793030,W,10.02,113.9,250124,,,P,S*38
cnav3050all 2024:025:00:00:00.2665$GNVTG,113.9,T,,M,10.02,N,18.55,K,P*02
cnav3050all 2024:025:00:00:00.2665$GNZDA,000000.00,25,01,2024,00,00*7A
cnav3050all 2024:025:00:00:00.3095$GNGSA,A,3,02,03,06,09,14,17,19,22,,,,,1.8,0.8,1.6,1*32
cnav3050all 2024:025:00:00:00.3096$GNGSA,A,3,70,71,76,85,86,87,,,,,,1.8,0.8,1.6,2*38
```

Secondary unit (stern)
Serial file id: cnav
Logging interval: 1 second
cnav data sample:

```
cnav 2024:060:00:00:00.2475 $GPDTM,999,,,,,,,999*4A
cnav 2024:060:00:00:00.2477 $GPGGA,000000.00,2649.3846,S,00139.3786,E,2,19,0.7,15.9,M,22.3,M,6.0,0525*68
cnav 2024:060:00:00:00.4823 $GPGLL,2649.384618,S,00139.378551,E,000000.00,A,D*7E
cnav 2024:060:00:00:00.7230 $GPRMC,000000.00,A,2649.384618,S,00139.378551,E,9.71,173.1,290224,,,P,S*16
cnav 2024:060:00:00:00.7231 $GPVTG,173.1,T,,M,9.71,N,17.99,K,P*21
cnav 2024:060:00:00:00.7231 $GPGSA,A,3,02,07,08,09,13,14,17,19,21,22,30,,1.4,0.7,1.2,1*23
```

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    2024:025:00:00:00.3771 $VDVLW,173197.75,N,1711.01,N*50
slog01    2024:025:00:00:01.4749 $VDVBW,9.8,,A,,,V*69
```

EM122: Kongsberg EM122 Multibeam Sonar

The EM122 multibeam sonar was started once in deep enough water (>~50m) and was in operation for the entire cruise except during phases of OBS recovery (See **docs/elog/MGL2408_r2relog.csv**). 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    2024:025:00:00:03.0905 $KIDPT,3842.78,5.76,12000.0*75
```

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 2024:025:00:00:01.3351 $HEROT,-004.91,A*3A
gy01 2024:025:00:00:01.4311 $HEHDT,113.6,T*2A
gy01 2024:025:00:00:01.6311 $HEHDT,113.6,T*2A
gy01 2024:025:00:00:01.6311 $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 for the entire cruise except during phases of OBS recovery (See **docs/elog/MGL2408_r2relog.csv**). Data are written in proprietary KEB, KEA, and in SEGY format. The depth is also recorded as a serial log.

Serial file id: bath01
Logging interval: variable with water depth
bath01 data sample:

```
bath01  2024:025:00:00:00.2556$SDDPT,3826.31,000.00,0500.00*6D
```

MICROSV: AML Oceanographic Micro-X SV Xchange velocity probe

The AML Micro SV probe operated through the cruise, while the uncontaminated sea water pump was running. It was briefly interrupted on August 14 while addressing a leak in the engine room.

Serial file id: svuss01
Logging interval: 1 second
svuss01 data sample:

```
svuss01  2024:025:00:00:00.5959 1531.038
```

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 most of the cruise with some issues: on August 11, it was noted that INGGA record was missing GPS time. It was restarted on August 12 and performed well until 09/55, when its velocity data became unrealistic. It was interrupted for about an hour on 09/06, and performed well for the rest of the trip

Serial file id: posmv
Logging interval: 0.5-1 second, depending on sentence
posmv data sample:

```
posmv  2024:025:00:00:00.0520$INZDA,000000.0017,25,01,2024,,*72
posmv  2024:025:00:00:00.3485$PASHR,000000.149,112.59,T,2.56,0.03,0.32,0.022,0.022,0.013,2,0*11
posmv  2024:025:00:00:00.3486$PRDID,0.03,2.56,112.59*75
posmv  2024:025:00:00:00.3486$INGST,000000.149,,0.6,0.5,47.6,0.5,0.5,0.9*6A
posmv  2024:025:00:00:00.4646$INGGA,000000.149,2729.22306,N,04523.78657,W,2,17,1.4,4.98,M,,,3,0134*01
posmv  2024:025:00:00:00.4647$INHDT,112.6,T*21
posmv  2024:025:00:00:00.4648$INVTG,112.3,T,,M,9.6,N,17.8,K,D*28
```

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 transit.

Serial file id: seapath
Logging interval: 1 second
seapath data sample:

```
seapath  2024:025:00:00:00.3772$INGGA,000000.14,2729.227246,N,04523.792890,W,1,12,0.7,1.46,M,-6.39,M,,*79
seapath  2024:025:00:00:00.6101$INGLL,2729.227246,N,04523.792890,W,000000.14,A,A*6A
seapath  2024:025:00:00:00.6102$INVTG,112.61,T,,M,9.5,N,17.5,K,A*17
seapath  2024:025:00:00:00.6103$INHDT,112.71,T*11
seapath  2024:025:00:00:00.6104$PSXN,20,1,0,0,0*3A
seapath  2024:025:00:00:00.6635$PSXN,23,2.02,0.10,112.71,-0.33*10
```

TSG: SBE-45 Thermosalinograph

The Seabird TSG operated through the transit, while the uncontaminated sea water pump was running. Data are broadcast and recorded in a non-NMEA format. It was briefly interrupted on August 14 while addressing a leak in the engine room, and on August 19 while swapping its dedicated Nport console.

Serial file id: tsgraw
Logging interval: 10 seconds
tsgraw data sample:

```
tsgraw  2024:021:00:01:00.5831t1= 20.5836, c1= 5.00954, s= 36.2862, sv=1524.120, t2= 20.4397
```

Vaisala: Vaisala Meteorological Ultrasonic Integrated Weather Station

Two weather stations (Vaisala1 and -2) were used to log wind speed, direction, air temperature, relative humidity, and barometric pressure. They are both located on top of the tower and record the same data streams. Vaisala1 was operational during the entire cruise, while vaisala2 was installed and activated at 17:29, Jan 26.

Serial file id: vaisala1 and vaisala2
Logging interval: 1 second
vaisala data sample:

```
vaisala2  2024:026:17:29:08.9281$WIXDR,C,21.5,C,0,C,21.5,C,1,H,58.2,P,0,P,1015.3,H,0*58
vaisala2  2024:026:17:29:09.3785$WIMWV,226,R,5.9,N,A*37
```

XBT: Lockheed Martin Sippican eXpendable BathyThermographs

86 XBT drops were made during this cruise, most of them provided by the PI for a thorough Seismic Oceanography study. 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/MGL2408_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 (MGL2408), the sequence number (*Seq*), the name of the line (*Line*), and an additional identifier (*Pid*) for pass number, reshoot or segmented lines.

Files: MGL408*SeqLinePid*.p294, MGL2408*SeqLinePid*.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 2024:246:23:42:55.6211$11019000303234229.12401120240902UTC029779MGL2408008MPFew1 60.415167 -32.7815922401.8 60.415051 -32.786617 89.7
94.8 4.3001*GCS90090008MPFew100000297790fE24/09/02:23:42:29143636000000000606600-0.090.153 1980 >1F197319661966201401AP1N
0001535020021 1702AP1N 0001585020021 1703AP1N 0001135000011604AP1N 0001515010011 1505AP1N 000115498-0211606AP1N 0001165000011707AP1N
0001175010011 1708AP1N 000148497-0311809AP1N 0001345010011 1810AP1N 0001675000011711AP1N 0001435000011712AP1N 0001185000011613AP1N
000169499-0111614AP1N 0001205000011815AP1N 000114499-0111916AP1N 000125499-0112017AP1N 000139496-0412118AP1N 000172497-0312119AP1N
000159498-0212220AP1N 000153497-0312221AP1N 0001215000012222AP1N 000149498-0212323AP1N 0001205000012524AP1N 0001115000012625AP1N
0001145000012826AP1N 000139498-0213027AP1N 0001555000013028AP1N 000166496-0411929AP1N 000150498-0211930AP1N 000117498-0212331AP1N
000140498-0212632AP1N 000111498-0212633AP1N 000110499-0112634AP1N 000118498-0212635AP1N 0001485010011 2536AP1N 000164498-02125
```

Navigation Post Processing

Onboard navigation post processing of the P294 files was performed Near Real Time (NRT) 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 (MGL2408), the sequence number (*Seq*), the name of the line (*Line*), and an additional identifier (*Pid*) for pass number, reshoot or segmented lines. Because of non-optimal recording conditions (start while turning,...) all sequences with streamer were reprocessed with SeisPos. And identifier *ProcSoft* is added in each file name to show whether it was produced by Iris (NRT) or SeisPos (SP).

Files: MGL2408*SeqLinePid*.*ProcSoft*.p190

Seal

Sercel's Seal 428 system was used to acquire, retrieve and record the data from the streamer. Because the number of channels exceeded the limit for continuous recording (> 960), data were only recorded in "traditional" Navigation-triggered mode, where reception of the trigger from the Orca navigation system initiated the recording for each shot point.
File names are based on the file acquisition number (*FFID*) of each shot point, reset to 1 at the beginning of the cruise, and sorted in separate folders for each sequence, named after the cruise name (MGL2408), the sequence number (*Seq*) as three characters (001, 002, etc, …), the name of the line (*Line*), and an additional identifier (*Pid*) for pass number, reshoot or segmented lines.

Files: MGL2408*SeqLinePid*.*Seq*/*FFID*.segd

V. Seismic Acquisition Parameters

Acquisition Parameters Table 1
(27 active source elements out of 36 – 4950 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	1
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	N/A (Applicable to multi-streamer MCS only)
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 (Applicable to multi-streamer MCS only)
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
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	3
Flipflop shooting	False
Source separation	N/A
Sub-array separation	6
Source volume	4950 in^3
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	36
Source depth	12 m
Shot control	Time
Shot Interval	60 seconds
Sample interval	NA
Record length	NA
Compass birds	NA
Recording delay	False
Active tail buoy	False
Multiple ships	False

Acquisition Parameters Table 2

(36 active source elements - 6600 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	2-5
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	N/A (Applicable to multi-streamer MCS only)
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 (Applicable to multi-streamer MCS only)
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
Near Channel Number	N/A
Cable depth	N/A
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A
Sub-array separation	6
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	Time
Shot Interval	60 seconds
Sample interval	NA
Record length	NA
Compass birds	NA
Recording delay	False
Active tail buoy	False
Multiple ships	False

Acquisition Parameters Table 3

(35 active source elements out of 36 - 6240 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	6
Receiver Type	OBS
Source Type	Airgun
Acquisition System Name	N/A (Applicable to multi-streamer MCS only)
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
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	6
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	Time
Shot Interval	60 seconds
Sample interval	NA
Record length	NA
Compass birds	NA
Recording delay	False
Active tail buoy	False
Multiple ships	False

Acquisition Parameters Table 4

(36 active source elements - 6600 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	7,8
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Seal 428 v1.1
Acquisition System Type	MCS
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	178.2
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	N/A
Near Channel Number	1
Cable depth	15 m
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6 m
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	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	58
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 5

(35 active source elements out of 36 - 6540 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	9
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Seal 428 v1.1
Acquisition System Type	MCS
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	178.2
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	N/A
Near Channel Number	1
Cable depth	20 m
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6 m
Source volume	6540 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	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	58
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 6

(35 active source elements out of 36 - 6540 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	10,11
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Seal 428 v1.1
Acquisition System Type	MCS
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	178.2
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	N/A
Near Channel Number	1
Cable depth	15 m
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6 m
Source volume	6540 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	50 m
Sample interval	2 ms
Record length	18 s
Compass birds	58
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 7

(26 active source elements out of 36 - 4890 in^3)

Field Activity ID	MGL2408
Acquisition sequence(s)	12,13
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Seal 428 v1.1
Acquisition System Type	MCS
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	178.2
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	N/A
Near Channel Number	1
Cable depth	15 m
Number sources	1
Sub-arrays per source	3
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6 m
Source volume	4890 in^3
Source pressure	1900 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	26
Source depth	12 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	18 s
Compass birds	58
Recording delay	False
Active tail buoy	True
Multiple ships	False

VI. Gravity Tie Information

Gravity and Land ties were performed in Reikjavik immediately before and after the cruise. Data are provided in the cruise folder, as well as recent ties in NY (June 2024) and Cape Town (March 2024) to address question arising after replacing the acquisition laptop.

VII. Cruise Data Archive Contents

docs	Cruise documents and logs
docs/elog	Cruise elog files
docs/elog/MGL2408_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/StreamerSheets	Streamer configuration(s)
docs/operations/MGL2408_line_log.xls	Master line log table
docs/operations/MGL2408_line_configuration_by_sequence.xls	Seismic Acquisition configuration
docs/permits	Clearance documents
docs/reports	Associated reports
docs/reports/MGL2408_DataReport.doc	This file
docs/report/MGL2408_streamer_QC.pdf	Automated QC report for streamer data
docs/reports/orca_EOL_reports	End Of Line Orca reports (csv and pdf formats)
docs/segd_logs	Seal 428 SEGD files lists
docs/segd_logs/MGL2408_sequences.csv	Time and files for start/end of each sequence
docs/waypoints	Waypoint and planning files
processed	**Processed data**
processed/obsip	Shotlog/OBSIP files from processed P190
processed/navigation	Processed navigation data (UKOOA P190)
processed/processed_along_track	Shipboard processed gravity and mag data
processed/mb_processing	Shipboard-processed multibeam data (.grd file)
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	Data and reports from Orca navigation system
raw/orca/P2	Raw seismic navigation data (UKOOA P294)
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.y*YYYY*d*jjj*. The following sentence types were recorded:

- $GPDTM: Datum reference information
- $GPGGA: Global Positioning System Time, position and fix related data.
- $GPGLL: Position data: position fix, time of position fix, and status
- $GPGSA: GPS Dilution of Precision (DOP) and active satellites
- $GPRMC: Recommended Minimum Specific GNSS Data
- $GPVTG: Track made good and Ground speed data

$GPDTM sentence

$GPDTM,a,a,mm.mmmm,a,mm.mmmm,a,0,aaa*hh		
Item	**Definition**	**Units / Options**
a	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmm	Latitude offset	minutes
a	Latitude offset mark (N: +; S: -)	n/a
mm.mmmm	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.mmmm,a,dddmm.mmmm,a,x,nn,x.x,x.x,M,x.x,M,x.x,nnnn*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude: N = North; S = South	n/a
dddmm.mmmm	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)

$GPGLL sentence

$GPGLL,ddmm.mmmmmm,a,dddmm.mmmmmm,a,hhmmss.ss,a,a*hh		
Item	**Definition**	**Units / options**
ddmm.mmmmm	Latitude	Degree, decimal minute
a	Latitude direction	N: North; S: South
dddmm.mmmm	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)

$GPGSA sentence

$GPGSA,A,3,nn,nn,nn,nn,nn,nn,nn,nn,nn,nn,nn,nn,x.x,x.x,x.x,1*hh		
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)

$GPRMC sentence

$GPRMC,hhmmss.ss,a,ddmm.mmmmmm,a,dddmm.mmmmmm,a,x.xx,x.x,ddmmyy,,,a,a*hh		
Item	**Definition**	**Units / Options**
hhmmss.ss	UTC time	Hour/minute/Sec.dec
a	Status indicator	A: valid; V: not valid
ddmm.mmmmm	Latitude	Degree, decimal minute
a	Latitude direction	N: North; S: South
dddmm.mmmm	Longitude	Degree, decimal minute
a	Longitude direction	E: East; W: West
x.xx	Speed over ground	kts
x.x	Course over ground (COG)	true degrees
ddmmyy	Current date	DayMonthYear(last two digits)
a	Position Mode Indicator	P: Precise
a	Navigation status	S: Safe; C: caution; U: unsafe; V: not valid
*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.y*YYYY*d*jjj*. 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.mmmm,a,mm.mmmm,a,0,aaa*hh		
Item	**Definition**	**Units / Options**
aaa	Local datum code	n/a
a	Local datum subcode	n/a
mm.mmmm	Latitude offset	minutes
a	Direction of Latitude	N: North; S: South
mm.mmmm	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.mmmm,a,dddmm.mmmm,a,x,n,x.x,x.x,M,x.x,M,x.x,a*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.

a	Direction of Latitude	N: North; S: South
dddmm.mmmm	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,ddmm.mmmmmm,a,dddmm.mmmmmm,a,hhmmss.ss,a,a*hh

Item	Definition	Units / options
ddmm.mmmmm	Latitude	Degree, decimal minute
a	Latitude direction	N: North; S: South
dddmm.mmmm	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.mmmm	Latitude offset	minutes
a	Latitude direction	N: North; S: South
mm.mmmm	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.mmmmmm,a,dddmm.mmmmmm,a,n,n,x.x,x.x,M,x.x,M,x.x,iijj*hh

Item	Definition	Units / Options
hhmms.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: 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-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:

```
$11019000303132854.79601420240820UTC006010  MGL2408004OPA1  56.795043 -33.9227082599.0  56.792990 -33.925291 33.9 33.2 4.6001
```

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	MGL2315aaaaaaaaa	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:

```
*GCS9009008004OPA100000060100fE24/08/20:13:28:5414363600000001906600000.040.286   1943#"5F1938193019301974
```

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)
91-93	nnnn	Array 1 pressure (psi)

95-97	nnnn	Array 2 pressure (psi)
99-102	nnnn	Array 3 pressure (psi)
103-106	nnnn	Array 4 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:

01AP1N 00014650000005602AP1N 000140499-0105603AP1N …

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 msecs)
11-13	nnn	Gun delay (1/10 msecs)
14-16	nnn	Gun fire time (1/10 msecs)
17-19	nnn	Delta (1/10 msecs)
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

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

Item	Definition	Units / Options
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	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**
hhmms.ss	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
hhmms.ss	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.mmmm,a,dddmm.mmmm,a,n,n,x.x,x.x,M,x.x,M,n,nnnn*hh

Item	Definition	Units / Options
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	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.mmmm,a,dddmm.mmmm,a,hhmmss.ss,a,a*hh

Item	Definition	Units / Options
ddmm.mmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmm	Longitude	Degrees/Minutes.decimal
a	Direction of Longitude	E: East; W: West
hhmms.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.y*YYYY*d*jjj*, 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.yYYYdjjj* 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-vaisala1,2.*

The meteorological data from the two Vaisala integrated ultrasonic weather stations is output to files *MGL-vaisala1.yYYYdjjj* and *MGL-vaisala2.yYYYdjjj*. The following sentences were recorded:

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

$WIMWV sentence

$WIMWV,n,a,x.x,a,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.y*YYYY*d*jjj* 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, MGL2408*SeqLinePid*.*. The files under raw were created from the orca headers during acquisition, while the processed files are generated from the processed P190 files.

raw/MGL2408_serial_data_1min.csv and **raw/MGL2408_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/MGL2408_orca_sequences.csv is a table of sequences automatically generated from the orca database.

raw/orca/MGL2408_orca_shots.csv is an automated list of all the shots triggered by orca, sorted by sequence.

raw/orca/MGL2408_orca_vessel.csv lists the ship positions and acquisition status recorded every minute by orca.