R/V Marcus G. Langseth Data Reduction Summary

MGL2309 - Blake Plateau MCS

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Port Canaveral, FL to Charleston, SC

Lamont-Doherty Earth Observatory, Columbia University

Sailing dates:

Date	Day of Year	Time	Port
2023-07-16	197	12:00 UTC	Port Canaveral, Florida
2023-08-19	231	13:00 UTC	Charleston, South Carolina

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2023-10-17

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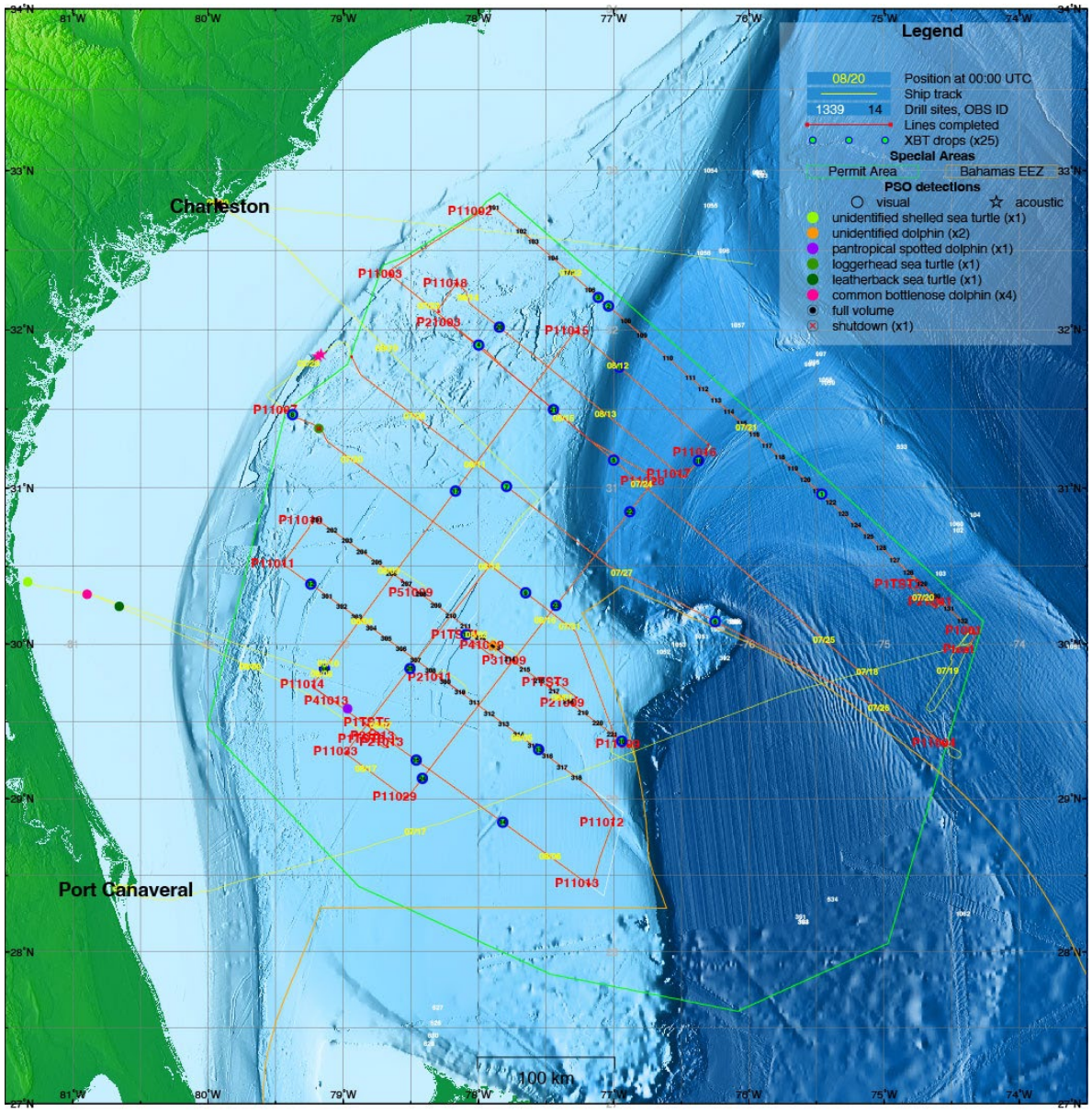
I. Background and Scientific Objectives

The purpose was to investigate the sediments and bedrock offshore the southeastern United States to better understand how the Atlantic Ocean started opening approximately 190 million years ago. In early Jurassic, the continental margins of the Carolina Trough and Blake Plateau separated from northwest Africa, before the Mid-Atlantic Ridge started to accommodate extension by seafloor spreading. Old fault lines and sutures of the Appalachian basement may have been reactivated during this continental stretching phase, and lava flows may have filled the early rift basin. Whether this episode of volcanism was a cause or consequence of the breakup between North America and Africa is not yet clear. With seismic images of the deep sediments and basement, the scientists can determine the relationship between basement faults and lava flows on the Carolina Trough and Blake Plateau. These two sections of the Atlantic continental margin are of particular interest because the Blake Plateau is much wider than the Carolina Trough. Either the Blake Plateau forms a block of continental crust that did not stretch much during continental rifting, or it is a plateau that largely consists of volcanic rock that formed during rupture of the continents. The MCS leg planned to gather 3800 km of 2- D seismic reflection data.



II. Personnel

Science Party

Participant	Affiliation	Position
Harm Van Avendonk	UTIG	PI
Anne Bécel	LDEO	Co-PI
Nathan Bangs	UTIG	Co-PI
Chiara Amadori	University of Pavia	Scientist
Savas Gurcay	University of Alabama	Scientist
Jue-Ying Chen		Scientist
Susie Adams	U. North Carolina Wilmington	Student
Adriana Paez	Caltech	Student
Bright Osuagwu		Scientist
Anastasiia Krysova	Ohio State University	Student

Shipboard technical staff

Participant	Group/Affiliation	Position
Cody Bahlau	LDEO	Chief Science Officer
Gilles Guérin	LDEO	Marine Technician
Riley Lopez	LDEO	Marine Technician
Claire Mayorga	MATE program	Marine Technician
Sara Pierson	MATE program	Marine Technician
Josh Kasinger	LDEO	Chief Source Mechanic
Brian Agee	LDEO	Source Mechanic
Klayton Curtis	Contractor	Contract Observer
Aaron Martin	Contractor	Contract Navigator
Peter Bolt	Contractor	Contract Mechanic
Tafik Mohamed Naas	Contractor	Contract Observer/Mechanic
Leonid Ometcinskii	Contractor	Contract Mechanic

Protected Species Observers

Participant	Group/Affiliation	Position
Amanda Dubuque	RPS	Lead PSO/PAM
Beatriz Cotrim Borgneth	RPS	PSO/PAM
Pablo Curiel Godoy	RPS	PSO/PAM
Avinash Maharajh	RPS	PSO/PAM
Gloria Ponce Garcia	RPS	PSO/PAM

Ship Crew

Participant	Position
Landow, Mark C.	Master
Wolford, David H.	Chief Mate
Loziere, Francis C.	2nd Mate
White, Joselyn N.	3rd Mate
Cereno, George G.	Bosun
Lattish, Clifford W. II	AB
Denard, Bronwyn A.	AB
Morse, Nicole E.	OS
Rillera De Guzman, Marcialleo	OS

Participant	Position
Butler, Gerald O.	Chief Engineer
Romey, Samuel A.	1st A/E
Rodriguez, Vincente L.	2nd A/E
Boro, Tristan M.	3rd A/E
Florendo, Rodolfo A.	Oiler
Hall, David J.	Oiler
Davis, James E. III	Steward
Rios, Ricardo	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 VII.

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	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
POSMV	Applanix POS-MV 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
Vaisala1,2	Vaisala WXT-520 Weather Stations	Full	serial log	MGL-vaisala1,2.*	2s
XBT	Lockheed Martin Sippican Expendable BathyThermographs	25 drops	Raw data	See below	n/a

Seismic Instrumentation

Instrument	Description	Data Set	Data Formats	Files
Gunlink	Seamap Gunlink 2000 source controlling 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 VII.
See **docs/elog/MGL2309_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 cruise, starting shortly after leaving port.
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   2023:155:00:00:05.8030  04:024959 00
```

CNAV: C-Nav3050 DGNSS Receiver

The C-Nav3050 is a global satellite-based differential receiver. Two units were used: the unit located on the ship tower was used as the primary reference, while the unit at the stern ship was 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 2023:152:00:00:00.0854 $GNDTM,999,,,,,,,999*54
cnav3050all 2023:152:00:00:00.0856 $PNCTDTM,ITR,,,,,,,ITR*54
cnav3050all 2023:152:00:00:00.1363 $GNGGA,000000.00,3321.1142,N,07557.8182,W,2,15,0.7,24.1,M,0.0,M,6.0, 0446*62
cnav3050all 2023:152:00:00:00.1364 $PNCTGGA,000000.00,3321.114157,N,07557.818185,W,2,15,0.7,24.146,M,0.000,M,6.0,
0536*69
cnav3050all 2023:152:00:00:00.1941 $GNGLL,3321.114157,N,07557.818185,W,000000.00,A,D*69
cnav3050all 2023:152:00:00:00.1942 $GNVTG,33.5,T,,M,3.09,N,5.72,K,P*3D
cnav3050all 2023:152:00:00:00.2540 $GNZDA,000000.00,01,06,2023,00,00*7C
cnav3050all 2023:152:00:00:00.2541 $GNGSA,A,3,05,10,13,15,18,23,24,27,29,,,,1.2,0.7,1.0,1*36
cnav3050all 2023:152:00:00:00.2674 $GNGSA,A,3,68,69,78,82,83,84,,,,,,,1.2,0.7,1.0,2*34
```

Secondary unit (stern)

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

```
cnav   2023:153:00:00:00.2483 $GPDTM,999,,,,,,,999*4A
cnav   2023:153:00:00:00.2485 $GPGGA,000000.00,3415.8944,N,07547.2883,W,2,16,0.7,17.7,M,-41.8,M,6.0, 0446*40
cnav   2023:153:00:00:00.3198 $GPVTG,218.5,T,,M,2.58,N,4.77,K,P*19
```

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 2023:153:00:00:07.5234 $VDVLW,149673.97,N,2636.88,N*5E
slog01 2023:153:00:00:08.6061 $VDVBW,4.8,,A,,,V*64
```

EM122: Kongsberg EM122 Multibeam Sonar

The EM122 multibeam sonar was operated throughout the cruise. The system is designed for deeper water, and does not track ground well in less than 50m of water.
EM122 swath data is saved to the cruise archive under **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.
A built in self test (BIST) is done regularly, at which time logging of data is interrupted. Data gaps are approximately 8-12 minutes in duration, and every effort is made to schedule them during turns or areas where coverage already exists. See **docs/elog/MGL2309_r2relog.csv** for times and durations of tests.

Serial file id: bath02
Logging interval: variable with water depth
bath02 data sample:

```
bath02 2023:143:00:00:13.4947 $KIDPT,1393.46,6.44,12000.0*7f
```

GYRO: Simrad GC80 Gyrocompass

The GC80 gyrocompass is installed on the bridge and 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   2023:152:00:00:00.0338 $HEROT,004.02,A*1D
gy01   2023:152:00:00:00.1338 $HEHDT,015.8,T*23
gy01   2023:152:00:00:00.3321 $HEHDT,015.8,T*23
gy01   2023:152:00:00:00.3322 $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 length of the cruise. Data are written in proprietary KEB, KEA, and SEGY format. During the cruise, the Knudsen settings were changed to broadcast the depth through UDP.

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

```
bath01 2023:230:00:00:03.3951 $SDDPT,0812.63,000.00,0200.00*69
```

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/MGL2309_r2relog.csv** for when it was deployed.

Serial file id: mag01
Logging interval: 0.1 second
mag01 data sample:

```
mag01   2023:148:00:00:04.2247  $ 46125.158,1707,0688
```

MICROSV: AML Oceanographic Micro-X SV Xchange velocity probe

The AML Micro SV probe operated normally during the length of this cruise, while the uncontaminated sea water pump was active. It was started once in open sea and stopped shortly before getting into port.

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

```
svuss01   2023:148:00:00:00.9020  1534.022
```

POSMV: POS-MV Inertial Navigation System

The POS/MV is a receiver that uses CNAV input in addition to its own antennae, an inertial sensor and optional RTG, WTC, or WAAS corrections and a Kalman filter to produce a smooth navigation output and very accurate heading. It was used for the entire cruise.

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

```
posmv   2023:149:00:00:02.8570  $INGGA,000002.600,3249.52092,N,07541.99386,W,2,16,0.9,-3.25,M,,,7,0134*26
posmv   2023:149:00:00:02.9109  $INHDT,317.2,T*22
posmv   2023:149:00:00:02.9110  $INVTG,290.5,T,,M,3.1,N,5.7,K,D*16
posmv   2023:149:00:00:03.0624  $INZDA,000003.0031,29,05,2023,,*7A
posmv   2023:149:00:00:03.2387  $PASHR,000003.100,316.96,T,-0.91,0.81,0.47,0.021,0.021,0.013,2,0*36
posmv   2023:149:00:00:03.2388  $PRDID,0.81,-0.91,316.96*5E
posmv   2023:149:00:00:03.3563  $INGST,000003.100,,0.4,0.4,42.9,0.4,0.4,0.7*63
```

SEAPATH: Kongsberg SeaPath 330 Inertial Navigation System

The Kongsberg Seapath is an inertial navigation system. It was operational for the duration of the cruise.

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

```
seapath   2023:149:00:00:00.8230  $INGGA,00000.57,3249.513740,N,07541.987988,W,2,08,0.9,-6.82,M,-38.39,M,1.2,0001*4F
seapath   2023:149:00:00:01.0518  $INGLL,3249.513740,N,07541.987988,W,000000.57,A,D*6C
seapath   2023:149:00:00:01.0519  $INVTG,302.24,T,,M,2.8,N,5.2,K,D*22
seapath   2023:149:00:00:01.0520  $INHDT,317.93,T*1A
seapath   2023:149:00:00:01.0522  $PSXN,20,0,0,0,0*3B
```

TSG: SBE-45 Thermosalinograph

The Seabird TSG operated normally during the length of the cruise, while the uncontaminated sea water pump was active, started once in open sea and stopped shortly before getting into port.

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

```
tsgraw 2023:141:00:00:01.5558  t1= 29.8299, c1= 6.00744, s= 36.2923, sv=1540.972, t2= 27.2259
```

Vaisala1,2: Vaisala Meteorological Ultrasonic Integrated Weather Stations

The two weather stations are used to log wind speed, direction, air temperature, relative humidity, precipitation, dew point, and barometric pressure. Both are located on top of the tower. Both units were damaged by lightning on July 29. Vaisala1 was replaced on July 31 with a spare unit, but no replacement was available for the second unit.

Serial file id: vaisala1 and vaisala2
Logging interval: 1 second (vaisala2) and 2 seconds (vaisala1)
vaisala data sample until July 29:

```
vaisala1  2023:146:00:00:01.2765 $WIXDR,A,325,D,0,A,331,D,1,A,334,D,2,S,27.0,N,0,S,27.8,N,1,S,29.1,N,2,C,22.5,C,
0,C,22.6,C,1,H,81.2,P,0,P,1008.3,H,0,V,0.00,M,0,Z,0,s,0,R,0.9,M,0,V,0.0,M,1,Z,0,s,1,R,0.0,M,1,R,152.8,M,2,R,0.0,M,3*
51
vaisala1  2023:146:00:00:01.2768 $WIMWV,331,R,28.3,N,A*05
```

vaisala data sample after July 31:

```
vaisala1  2023:230:00:00:00.0489 $WIMWV,151,R,16.7,N,A*08
vaisala1  2023:230:00:00:00.8469 $WIXDR,C,28.1,C,0,C,28.1,C,1,H,81.4,P,0,P,1012.3,H,0*5D
```

XBT: Lockheed Martin Sippican eXpendable BathyThermographs

25 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 SIS acquisition software when reaching sufficient depth to provide reliable velocity profiles in the water column. See the **docs/MGL2309_Expendable_Drops.xls** spreadsheet for more information.

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 sequences, 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 (MGL2309), the sequence number (*Seq*), the name of the line (*Line*), and an eventual additional identifier for reshoot or segmented lines.

Files: MGL2309*SeqLine*.p294, MGL2309*SeqLine*.p211

Serial file id: orcahdr
For each shot point, Orca outputs to UDP a general header, combined with the Gun Controller String:

```
orcahdr   2023:210:07:21:03.9602 $11019000303072102.04801620230729UTC039998MGL2309008P11007  31.486399 -79.415680
485.8  31.488868 -79.415244188.3127.8
2.3001*GCS90090008P1100700000399980fE23/07/29:07:21:021436150100000540112000.251.300    1925
+N&193419231921192101AP1N 00000099900010302AP1N 00000099900010303AP1N 000116498-0210204AP1N 00000099900010105AP1N
000103499-0110106AP1N 000117497-0310207AP1N 00011350000010208AP1N 00000099900010209AP1N 00000099900010210AP1N
00000099900010711AP1N 00000099900010712AP1N 00011050100110513AP1N 00000099900010314AP1N 00010550000010415AP1N
00011350000010616AP1N 000123499-0110717AP1N 00000099900010918AP1N 00000099900010919AP1N 00000099900010720AP1N
00000099900010721AP1N 00010650000010422AP1N 00000099900010223AP1N 000117498-0210324AP1N 00017755105110325AP1N
000126499-0110426AP1N 00000099900010527AP1N 00000099900010528AP1N 00000099900010429AP1N 00000099900010430AP1N
000113499-0110331AP1N 00000099900010232AP1N 000105497-0310333AP1N 00000099900010334AP1N 00010550000010435AP1N
00000099900010536AP1N 000000999000105
```

Navigation Post Processing

Two positioning programs were used for post processing of the P294 files to produce UKOOA P190 files with improved positioning. Onboard post processing was performed with Iris, as part of the Orca suite. The post processing for several sequences was performed onshore by a contractor using Seispos. See the document **MGL2309_Navigation_Processing.xlsx**, under **processing/positioning** for a list of the sequences processed by each program.
As part of the quality control, files were created for each sequence with the subarray separation between the sources.

Files: MGL2309*SeqLine*.p190, MGL2309*SeqLine*.SubArraySeparation.csv

Seal

Sercel's Seal 428 system was used to acquire, retrieve and record the data from the streamer. All channels were recorded to two types of SEGD files:

- The continuous recording creates new files every 5 seconds at a 1ms sampling rate, with 1 sample overlap between files. These files are controlled by a high precision GPS clock, independently of any trigger from navigation. The file names are based on the raw Field File Identification Numbers (*FFID*), reset to 1 at the beginning of the cruise, and files are sorted in separate folders named for the year, month and day of acquisition (*YYYYMMDD*)

Files: *YYYYMMDD/FFID*.segd

- 'Processed' files are generated from the continuous data, under the control of the navigation triggers sent by Orca, with a record length and sampling interval adjusted to the scientific objectives of the acquisition. File names are based on the processed *FFID*, reset to 1 at the beginning of the cruise, and sorted in separate folders for each sequence, named after the cruise name (MGL2309), the sequence number, the name of the line, and an eventual additional identifier for reshoot or segmented lines.

Files: MGL2309*SeqLine*.*Seq*/*FFID*.segd

V. Seismic Acquisition Parameters

Acquisition Parameters Table 1
(Originally planned configuration)

Field Activity ID	MGL2309
Acquisition sequence(s)	1-7
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	236 m
Source to Near Channel	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	6600 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	36
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 2
(Increased NRP to Center of Source (CS) distance)

Field Activity ID	MGL2309
Acquisition sequence(s)	8-12,14-18,20,28-31
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	4
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	6600 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	36
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 3

(same as Table 2, but only two source subarrays used: 18 guns, 3300 in^3)

Field Activity ID	MGL2309
Acquisition sequence(s)	13
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	2
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	3300 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	18
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 4

(same as Table 2 except for source volume: 6380 in^3, 35 guns)

Field Activity ID	MGL2309
Acquisition sequence(s)	19
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	2
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	6380 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	35
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 5

(same as Table 2 except for source volume: 6560 in^3, 35 guns)

Field Activity ID	MGL2309
Acquisition sequence(s)	21-24
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	2
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	6560 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	35
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 6

(same as Table 2 except for source volume: 5880 in^3, 34 guns)

Field Activity ID	MGL2309
Acquisition sequence(s)	25-27
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	2
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	5880 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	34
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 7

(same as Table 2 except for source volume: 6240 in^3, 35 guns)

Field Activity ID	MGL2309
Acquisition sequence(s)	32-34
Receiver Type	MCS
Source Type	Airgun
Acquisition System Name	Sercel 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	112.2
Number of channels recorded	960
Number of cables	1
Number of channels each cable	960
Channel length	12.5 m
Cable length	12 km
Cable spacing	N/A (Applicable to multi-streamer MCS only)
Near Channel Number	1
Cable depth	12 m
Number sources	1
Sub-arrays per source	2
Flipflop shooting	False
Source separation	N/A (Applicable to flipflop only)
Sub-array separation	6.0 m
Source volume	6240 in^3
Source pressure	2000 psi nominal
Source make, model	Bolt 1500LL & 1900LL
Source element number	35
Source depth	10 m
Shot control	Distance
Shot Interval	50 m
Sample interval	2 ms
Record length	20 s
Compass birds	47
Recording delay	False
Active tail buoy	True
Multiple ships	False

VI. Gravity Tie Information

No gravity ties were performed immediately before or after the cruise, but one was performed on July 1st in Port Canaveral, and one on September 15 in Charleston. See the documents located under **docs/gravity tie** for detailed records.

VII. Cruise Data Archive Contents

docs	Cruise documents and logs
docs/elog	Cruise elog files
docs/elog/MGL2309_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/MGL2309_B15_line_log.xls	Master line log table
docs/operations/MGL2309_Expendable_Drops.xls	XBT drops summary table
docs/operations/MGL2309_line_configuration_by_sequence.xls	Seismic Acquisition configuration
docs/permits	Clearance documents
docs/reports	Associated reports
docs/reports/MGL2309_DataReport.doc	This file
docs/report/MGL2309_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/MGL2309_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/navigation/MGL2309_Navigation_Processing.xlsx	Details on processing for each sequence
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/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:

- $GPGGA: Global Positioning System Time, position and fix related data.
- $GPDTM: Datum reference information
- $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)

$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.mmmmmm	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,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.mmmmmm	Latitude	Degrees/Minutes.decimal.
a	Direction of Latitude	N: North; S: South
dddmm.mmmmmm	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:

```
$10615000303000143.8250162023060 2UTC183098   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	MGL2309aaaaaaaaa	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:

```
*GCS90049606057P49000018309803E23/06/02:00:01:43121818000000008033000 0.040.195    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:

01AP1N 000146500000005602AP1N 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.*, MGL-vaisala2.*

The meteorological data from the Vaisala integrated ultrasonic weather stations is output to files *MGL-vaisala1.yYYYdjjj* and *MGL-vaisala2.yYYYYdjjj*. After being struck by lightning, one of the stations (vaisala1) was replaced, while vaisala2 remained offline. 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 until July 29

```
$WIXDR,A,n,D,0,A,n,D,1,A,n,D,2,S,x.x,N,0,S,x.x,N,1,S,x.x,N,2,C,x.x,C,0,C,x.x,C,1,H,
x.x,P,0,P,x.x,H,0,V,x.xx,M,0,Z,n,S,0,R,x.x,M,0,V,x.x,M,1,Z,n,S,1,R,x.x,M,1,R,x.x,M,
2,R,x.x,M,3*hh
```

Item	Definition	Units / Options
A	Transducer id 0 type	A: Wind direction
n	Transducer id 0 data (minimum wind direction)	Degrees
D	Transducer id 0 Unit	D: Degrees
0	Transducer id for minimum wind direction	n/a
A	Transducer id 1 type	A: Wind direction
n	Transducer id 1 data (average wind direction)	Degrees
D	Transducer id 1 Unit	D: Degrees
1	Transducer id for average wind direction	n/a

A	Transducer id 2 type	A: Wind direction
n	Transducer id 2 data (maximum wind direction)	Degrees
D	Transducer id 2 Unit	D: Degrees
2	Transducer id for average wind direction	n/a
S	Transducer id 0 type	S: Wind speed
x.x	Transducer id 0 data (minimum wind speed)	Knots
N	Transducer id 0 Unit	N: knots
0	Transducer id for minimum wind speed	n/a
S	Transducer id 1 type	S: Wind speed
x.x	Transducer id 1 data (average wind speed)	Knots
N	Transducer id 1 Unit	N: knots
1	Transducer id for average wind speed	n/a
S	Transducer id 2 type	S: Wind speed
x.x	Transducer id 2 data (maximum wind speed)	Knots
N	Transducer id 2 Unit	N: knots
2	Transducer id for maximum wind speed	n/a
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
V	Transducer id 0 type	V: Accumulated rainfall
x.xx	Transducer id 0 data (Accumulated rainfall)	mm
M	Transducer id 0 Unit	M: mm
0	Transducer id for accumulated rainfall	n/a
Z	Transducer id 0 type	Z: Rain duration
n	Transducer id 0 data (rain duration)	seconds
S	Transducer id 0 Unit	S: seconds
0	Transducer id for rain duration	n/a
R	Transducer id 0 type	R: Rain intensity
x.x	Transducer id 0 data (rain intensity)	mm/h
M	Transducer id 0 Unit	M: mm/h

0	Transducer id for rain intensity	n/a
V	Transducer id 1 type	V: hail accumulation
x.x	Transducer id 1 data (hail accumulation)	hits/cm^2
M	Transducer id 1 Unit	M: hits/cm^2
1	Transducer id for hail accumulation	n/a
Z	Transducer id 1 type	Z: hail duration
n	Transducer id 1 data (hail duration)	seconds
S	Transducer id 1 Unit	M: seconds
1	Transducer id for hail duration	n/a
R	Transducer id 1 type	R: hail intensity
x.x	Transducer id 1 data (hail intensity)	seconds
M	Transducer id 1 Unit	M: hits/cm^{2}h
1	Transducer id for hail intensity	n/a
R	Transducer id 2 type	R: rain peak intensity
x.x	Transducer id 2 data (rain peak intensity)	mm/h
M	Transducer id 2 Unit	M: mm/h
2	Transducer id for rain peak intensity	n/a
R	Transducer id 3 type	R: hail peak intensity
x.x	Transducer id 3 data (hail peak intensity)	hits/cm^{2}h
M	Transducer id 3 Unit	M: hits/cm^{2}h
3	Transducer id for hail peak intensity	n/a
*hh	Checksum	n/a (hexadecimal)

$WIXDR sentence after July 31 (vaisala1 only)

$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 Seal acquisition system, on a sequence by sequence basis.

docs/operations/Science_Support_Plan contains all of the revisions of the plan which details the intended survey activity.

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

docs/reports/ MGL2309_streamer_QC.pdf is an automatically generated report with figures to provide a quick QC assessment for each sequence: the streamer tension, the vessel speed through water (STW) and over ground (SOG), the heading and depth of all birds, the source volume, a measure of the noise along the streamer and the display of a single receiver, all displayed along shotpoint numbers.

docs/segd_logs contains listings off all the SEGD files recorded, on a sequence by sequence basis, (MGL2309*SeqLine*.segdlog) for the processed files, and on a daily basis (MGL2309_raw_segd_*YYYYMMDD*.csv) for the continuous files. Informations recorded include the FFID, shot point, time and source volume for each shot, as well as the ID of the continuous files used for each processed SEGD file.

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 and line names, MGL2309*SeqLine*.*. The files under raw were created from the orca headers during acquisition, while the processed files are generated from the processed P190 files.

raw/MGL2309_serial_data_1min.csv and **raw/MGL2309_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/MGL2309_orca_sequences.csv is a table of sequences automatically generated from the orca database.

raw/orca/MGL2309_orca_shots.csv is an automated list of all the shots triggered by orca, sorted by sequence.

raw/orca/MGL2309_orca_vessel.csv lists the ship positions and acquisition status recorded every minute by orca.