R/V Marcus G. Langseth Data Reduction Summary

MGL2514 Guerrero Gap High-Resolution MCS and Heat Flow

Dr Glenn Spinelli, New Mexico University

Manzanillo, Mexico to Manzanillo, Mexico

Lamont-Doherty Earth Observatory, Columbia University

Sailing dates:

Date	Day of Year	Time	Port
2025-12-03	337	00:30 UTC	Manzanillo, Mexico
2025-12-26	360	14:30 UTC	Manzanillo, Mexico

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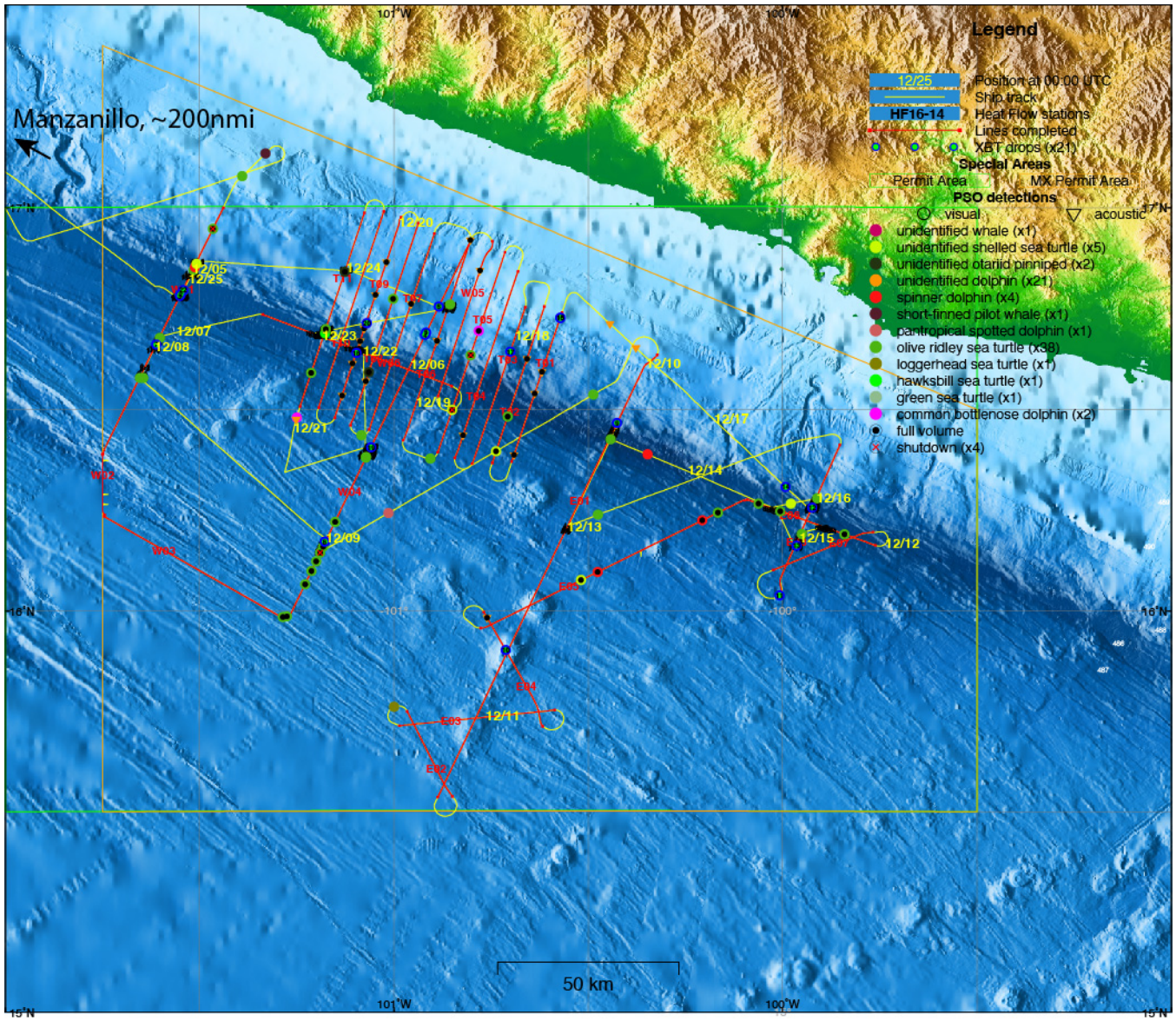
Table of Contents

I. Background and Objectives

MGL2514 aimed to investigate thermal conditions along the southern Mexico subduction zone by integrating seismic reflection data with direct measurements of heat flow in seafloor sediments. 25 multichannel seismic profiles were acquired using the Langseth high-resolution sections and more than 160 in situ sediment temperature measurements were made at 16 stations, with a heat flow probe provided through the U.S. Marine Heat Flow Capability. Together, these datasets will be used to map sediment distribution, quantify fluid circulation in the oceanic crust, and improve estimates of subduction zone temperatures relevant to earthquake hazard assessments.
The research team included investigators and students from New Mexico Tech, the University of New Mexico, and CICESE, with additional participation from early-career scientists.



II. Personnel

Science Party

Participant	Affiliation	Position
Glenn Spinelli	New Mexico Tech	PI
Lindsay Worthington	University of New Mexico	Co-PI
Jeffrey Poort	Sorbonne University	Scientist
Elizabeth Houghton	University of New Mexico	Student
Harol Stiven Buitrago Segura	CICESE	Student
Isabela Macias Iniguez	Universidad Autonoma de Baja California	Student
Joel Aguilar Tomasini	CICESE	Student
Kain Lager-Lowe	University of New Mexico	Student
Lillian Adriana Piña Paez	Cal Institute of Technology	Student
Luis Angel Vega Ramírez	Universidad Autonoma de Baja California	Scientist
Lujendra Ojha	Rutgers	Student
Maddie Hurd	University of New Mexico	Student
Mandy Kiger	Oregon State University	Heat Flow Technician
Estefanía Peña Salinas	UNAM	Student

Shipboard technical staff

Participant	Group/Affiliation	Position
Cody Bahlau	LDEO	Chief Science Officer
Aaron Martin	LDEO	Marine Science Technician
Gilles Guérin	LDEO	Marine Science Technician
Brian Agee	LDEO	Marine Technician/Mechanic
Ray Hatton	Contractor	Mechanic
Jose Ramirez Najera	Contractor	Observer

Protected Species Observers

Participant	Position
Maritza Martinez	Lead PSO
Ana Salomon	PSO
Yessica Vicencio	PSO

Participant	Position
Veronica Balderas	PSO
Lilia Perez	PSO

Ship crew

Participant	Position
Crum, Breckenridge C.	Master
Abbott, David R.	Chief Mate
Jacobs, Samuel S.	3rd Mate
Dabrow, Katherine M.	3rd Mate
Redito, Ricardo M.	Bosun
Curry, Gary R.	AB
Dillon, Jennifer L.	AB
Brown, Maurquise L.	OS
Clay, Marcellus D.	OS

Participant	Position
Butler, Gerald O.	Chief Engr.
Biwer-Paz, Fernando A.	1st A/E
Chernoff, Kyle B.	2nd A/E
Hodges, Trevor D.	3rd A/E
Lewis, Jesse A.	Oiler
Houston, Terrex D.	Oiler
Headd, Robert K.	Oiler
Dreis, Ryan C.	Jr Engr
Davis, James E. III	Steward
Cook, Gabriel C.	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 VIII.

General Instrumentation

Instrument	Description	Data Set	Data Outputs	Files	Sampling rate
ADCP	Teledyne Ocean Surveyor 75 Doppler Current Profiler	Full	various	See below	variable
CNAV	Oceaneering C-Nav3050/X3 DGPS	Full	serial log	MGL-cnav*.*	1s
DS80	Furuno DS-80 Doppler Speed log	Full	serial log	MGL-slog01.*	3s
EM122	Kongsberg EM122 Multibeam Sonar	Full	various	See below	variable
GYRO	Simrad GC80 Gyrocompass	Full	serial log	MGL-gy01.*	0.1s
KNUDSEN	Knudsen 3260 Sub-bottom Profiler	Full	kea, keb, segy, serial log	See below	variable
MAG01	Geometrics 882 Magnetometer	On deploy	serial log	MGL-mag01.*	0.1s
MICROSV	AML Oceanographic Micro-X SV Xchange velocity probe	Full	serial log	MGL-svuss01.*	1s
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
XBT	Lockheed Martin Sippican Expendable BathyThermographs	20 drops	Raw data	See below	n/a

Seismic Instrumentation

Instrument	Description	Data Set	Data Formats	Files
Gunlink	Seamap Gunlink 2000 source control system	Full	SEGD	See below
Orca	Sercel Orca Seismic navigation system	Full	various	See below
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/MGL2514_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.
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.

CNAV: C-Nav 3050 and X3 DGNSS Receivers

The C-Nav3050 and -X3 are global satellite-based differential receivers. The -X3 model, whose antenna is located on the ship tower, is the main reference for the ship. The 3050 unit at the stern should be replaced in the new year. Some minor testing resulted in short interruptions for both units.

Primary unit (tower)
Serial file id: cnavtower
Logging interval: 1 second
cnav3050all data sample:

```
cnavtower  2025:336:00:00:00.4367   $GNDTM,W84,,,,,,W84*54
cnavtower  2025:336:00:00:00.4369   $GNGGA,000000.00,1858.162696,N,10520.032082,W,5,24,0.52,-6.875,M,0.000,M,54,0000*40
cnavtower  2025:336:00:00:00.4912   $GNGLL,1858.162696,N,10520.032082,W,000000.00,A,D*65
cnavtower  2025:336:00:00:00.5564   $GNRMC,000000.00,A,1858.162696,N,10520.032082,W,5.502,121.6,021225,,,D,V*28
cnavtower  2025:336:00:00:00.5565   $GNZDA,000000.00,02,12,2025,00,00*7C
cnavtower  2025:336:00:00:00.5565   $GNVTG,121.6,T,121.6,M,5.502,N,10.189,K,D*0B
cnavtower  2025:336:00:00:00.6115   $GNGSA,M,3,1,6,7,11,13,14,15,17,19,22,30,,1.0,0.5,0.8,1*0F
cnavtower  2025:336:00:00:00.6116   $GNGSA,M,3,73,75,85,86,,,,,,,,1.0,0.5,0.8,2*37
cnavtower  2025:336:00:00:00.6415   $GNGSA,M,3,307,313,315,319,321,327,329,330,334,,,,1.0,0.5,0.8,3*00
```

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

```
cnavstern  2025:336:00:00:00.1670   $PNCTGGA,235952.00,1858.180079,N,10520.055862,W,2,16,0.7,-10.447,M,0.000,M,5.0,0336*66
cnavstern  2025:336:00:00:00.1673   $GNGLL,1858.180079,N,10520.055862,W,235952.00,A,D*63
cnavstern  2025:336:00:00:00.4018   $GNRMC,235952.00,A,1858.180079,N,10520.055862,W,5.41,126.0,011225,,,P,S*0F
cnavstern  2025:336:00:00:00.4019   $GNVTG,126.0,T,,M,5.41,N,10.02,K,P*34
cnavstern  2025:336:00:00:00.6361   $GNZDA,235952.00,01,12,2025,00,00*75
cnavstern  2025:336:00:00:00.6362   $PNCTGST,235952.00,0.1864,0.0755,0.0620,271.8675,0.0620,0.0755,0.1541,1*6C
cnavstern  2025:336:00:00:00.8687   $GNDTM,999,,,,,,999*54
cnavstern  2025:336:00:00:00.8688   $PNCTDTM,ITR,,,,,,ITR*54
```

DGS: Dynamic Gravity Systems (DGS) Advanced Technology Marine Gravity System AT1-44

The DGS AT1A-44 gravimeter was operational during the entire transit. Two types of serial files were recorded: *MGL-dgsraw*.* files captured raw readings that are generated mostly for backup purposes, while *MGL-dgsdata*.* captured the results of the initial filtering and corrections performed by the DGS acquisition system. DGS data are also recorded as daily AT1A-44*_yyyymmdd_jjj*.dat files, named after the year (*yyyy*), month (*mm*), day of the month (*dd*), and julian day (*jjj*), under **raw/gravity** in the cruise folder. A gravity tie was performed at the San Diego Marine facility station on Nov 23, 2025, at the beginning of the transit leading up to the cruise. Results are under **docs/gravity_tie**.

Serial file id: dgsraw
Logging interval: 1 second
dgsraw sample:

```
dgsraw 2025:281:00:00:00.2084 $AT1M_3.64P_2629967,-10530,436,-4202,4070545,540,28225,210,735908,5346,15172,-
10914,330,4830736,0.0000000000,0.0000000000,0.0000,0.0000,1759881595
dgsraw 2025:281:00:00:01.2100 $AT1M_3.64P_2629968,-31947,-15485,-12232,4070892,540,28247,209,910946,8604,33839,-
11161,330,4982452,0.0000000000,0.0000000000,0.0000,0.0000,1759881596
```

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

```
dgsdata   2025:281:00:00:00.2886 8748.873724728775,9210.086498055041,0.033627990917,-0.322741141646,
0.002468353804, 50.999000000000,           20830,         4830736, 28.244490000000, 52.930886000000,
0.053460000000,  7.359080000000,  0.151720000000, -0.109140000000,  9.052826666667,-86.310223333333,
4.724745067773, 53.700000000000, 18.470493030900,2025,10,08,00,00,00.00,2629967
dgsdata   2025:281:00:00:01.2959 8748.883280756505,7603.478950936788, -1.194333576481, -0.939497773587,
0.002882010088, 50.999000000000,           20830,         4982452, 28.244600000000, 52.928404000000,
0.086040000000,  9.109460000000,  0.338390000000, -0.111610000000,  9.052851666667,-86.310190000000,
4.711875311105, 53.500000000000, 18.468355769043,2025,10,08,00,00,01.00,2629968
```

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 2025:354:23:59:51.4309 $VDVLW,255547.29,N,1558.91,N*51
slog01 2025:354:23:59:51.6732 $VDVBW,3.1,,A,,,V*6A
```

EM122: Kongsberg EM122 Multibeam Sonar

The EM122 multibeam sonar was in operation for the entire cruise except during phases of Heat Flow measurements (See **docs/elog/MGL2514_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 Heat Flow measurements, when the 12kHz channel was used in pinger mode (See **docs/elog/MGL2514_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
```

MAG01: Geometrics 882 Magnetometer

The Geometrics 882 magnetometer is towed behind the ship. Data are collected only when the Magnetometer is deployed, which is dependent upon seismic operations and sea state. At various times, the data displayed some odd character, but after Dec 19, the data recorded became unusable likely because of a com error still under investigation. See **docs/elog/MGL2514_r2relog.csv** for when it was deployed.

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

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

MICROSV: AML Oceanographic Micro-X SV Xchange velocity probe

The AML Micro SV probe operated through the cruise, while the uncontaminated sea water pump was running.

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 the entire cruise, but needed to be reset multiple times.

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

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

```
seapath   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 entire cruise, while the uncontaminated sea water pump was running. Data are broadcast and recorded in a non-NMEA format

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

```
tsgraw 2024:021:00:01:00.5831 t1= 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) are 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, and were both operational during the entire cruise.

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

20 XBT drops were made during this cruise. The data sets produced by the MK21 Oceanographic Data Acquisition System were saved to the raw/XBT directory in the cruise archive and were imported into the EM122 acquisition software when reaching sufficient depth to provide reliable velocity profiles through the water column. See the **raw/XBT/MGL2514_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 2 active hydrophones on the source arrays (one per gun). 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 (MGL2514), the sequence number (*Seq*), and the name of the line (*Line*).

Files: raw/orca/P2/MGL2514*SeqLine*.p294, **raw/orca/P2/**MGL2514*SeqLine*.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   2025:353:00:00:04.4292 $10259000303000003.11199820251219UTC059238   MGL2514020T06  16.515509-
100.9427884569.2  16.512758-100.943824 17.6 18.2 4.3001*GCS90014014020T06000005923801E25/12/19:00:00:
03110202000000001003000O.000.000    1896 ;6&189601AP1N 000183499-0103002AP1N 000177498-02028
```

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 (MGL2514), the sequence number (*Seq*) and the name of the line (*Line*).
Because of non-optimal recording conditions (start while turning,...) most sequences 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: processed/navigation/MGL2514*SeqLine*.*ProcSoft*.p190

Seal

Sercel's Seal 428 system was used to acquire, retrieve and record the data from the streamer.
Data were 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 (MGL2514), the sequence number (*Seq*) as three characters (001, 002, etc, …), and the name of the line (*Line*).

Files: MGL2514*SeqLine*.*Seq*/*FFID*.segd

V. Seismic Acquisition Parameters

Acquisition Parameters Table 1
(NRP-COS 298m – record length 8 seconds - 2 active source elements - 90 in^3)

Field Activity ID	MGL2514
Acquisition sequence(s)	1-6
Receiver Type	MCS
Source Type	GI-Gun
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-NavX3: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	298 m
Source to Near Channel	144.65
Number of channels recorded	648
Number of cables	1
Number of channels each cable	648
Channel length	6.25 m
Cable length	4050 m
Cable spacing	N/A
Near Channel Number	1
Cable depth	4 m
Number sources	1
Sub-arrays per source	1
Flipflop shooting	False
Source separation	N/A
Sub-array separation	NA
Source volume	90 in^3
Source pressure	1900 psi nominal
Source make, model	GI-Gun
Source element number	2
Source depth	3 m
Shot control	Distance
Shot Interval	25 m
Sample interval	0.5 ms
Record length	8 s
Compass birds	16
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 2

(NRP-COS 325 m – record length 8 seconds - 2 active source elements - 90 in^3)

Field Activity ID	MGL2514
Acquisition sequence(s)	7-11
Receiver Type	MCS
Source Type	GI-Gun
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-NavX3: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	325 m
Source to Near Channel	117.65
Number of channels recorded	648
Number of cables	1
Number of channels each cable	648
Channel length	6.25 m
Cable length	4050 m
Cable spacing	N/A
Near Channel Number	1
Cable depth	4 m
Number sources	1
Sub-arrays per source	1
Flipflop shooting	False
Source separation	N/A
Sub-array separation	NA
Source volume	90 in^3
Source pressure	1900 psi nominal
Source make, model	GI-Gun
Source element number	2
Source depth	3 m
Shot control	Distance
Shot Interval	25 m
Sample interval	0.5 ms
Record length	8 s
Compass birds	16
Recording delay	False
Active tail buoy	True
Multiple ships	False

Acquisition Parameters Table 3

(NRP-COS 325 m – record length 9 seconds - 2 active source elements - 90 in^3)

Field Activity ID	MGL2514
Acquisition sequence(s)	12-25
Receiver Type	MCS
Source Type	GI-Gun
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-NavX3: Fore/Aft+0.0 m, Stb/pt+0.0 m, Vert.+16.9 m
Antenna (NRP) to source	325 m
Source to Near Channel	117.65
Number of channels recorded	648
Number of cables	1
Number of channels each cable	648
Channel length	6.25 m
Cable length	4050 m
Cable spacing	N/A
Near Channel Number	1
Cable depth	4 m
Number sources	1
Sub-arrays per source	1
Flipflop shooting	False
Source separation	N/A
Sub-array separation	NA
Source volume	90 in^3
Source pressure	1900 psi nominal
Source make, model	GI-Gun
Source element number	2
Source depth	3 m
Shot control	Distance
Shot Interval	25 m
Sample interval	0.5 ms
Record length	9 s
Compass birds	16
Recording delay	False
Active tail buoy	True
Multiple ships	False

VI. Gravity Tie Information

A gravity tie was performed at the San Diego Marine facility station on Nov 23, 2025, at the beginning of the transit leading up to the cruise. Results are under **docs/gravity_tie**.

VII. Cruise Data Archive Contents

docs	Cruise documents and logs
docs/elog	Cruise elog files
docs/elog/MGL2514_r2relog.csv	Cruise elog report
docs/gravity_tie	Most recent gravity ties for the DGS gravimeter
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/MGL2514_line_log.xls	Master line log table
docs/operations/MGL2514_line_configuration_by_sequence.xls	Seismic Acquisition configuration
docs/reports	Associated reports
docs/reports/MGL2514_DataReport.pdf	This file
docs/report/MGL2514_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/MGL2514_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)
raw	**Raw data**
raw/adcp	Raw ADCP data
raw/gravity	Data from the AT1-44 DGS gravimeter
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 two C-Nav DGPS systems, located respectively on the PSO tower and at the stern, output data to files MGL-cnavtower.y*YYYY*d*jjj* and MGL-cnavtstern.y*YYYY*d*jjj*. The PSO tower unit is used as the primary reference for the vessel. The following sentence types are recorded in both files:

- $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
- $GNRMC: Recommended Minimum Navigation Information
- $GNVTG: Track made good and Ground speed data
- $GNZDA: UTC day, month, and year, and local time zone offset

In addition, the unit located at the stern includes the following sentences:

- $PNCTDTM: C-Nav proprietary Datum reference information
- $PNCTGGA: C-Nav proprietary GPS Time, position and fix related data
- $PNCTGST: C-Nav proprietary GPS position error statistics

$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)

$GNRMC sentence

$GNRMC,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.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
x.xx	Speed over ground (SOG)	Nautical miles per hour (knots)
x.x	Course Made Good (CMG)	Degrees from True North
ddmmyy	Date	DayMonthYear
a	Mode Indicator	D, A, N or E
a	Nav Status	S=safe; C=caution; U=unsafe; V=not valid
*hh	*Checksum data	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)

$PNCTGST sentence

$PNCTGST,hhmmss.ss,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,fisher*hh		
Item	**Definition**	**Units / Options**
hhmms.ss	UTC time of position	Hours/Minutes/Seconds.decimal.
x.xxxx	RMS std deviation of ranges in navigation solution	
x.xxxx	Std deviation of semi-major axis of error ellipse	m
x.xxxx	Std deviation of semi-minor axis of error ellipse	m
x.xxxx	Orientation of semi-major axis of error ellipse	True North Degrees
x.xxxx	Std deviation of latitude error	m
x.xxxx	Std deviation of longitude error	m
x.xxxx	Std deviation of altitude error	m
fisher	Fisher test result	n/a
*hh	Checksum	n/a (hexadecimal)

MGL-dgsdata.*

The DGS gravimeter data are output as serial and captured for monitoring as *MGL-dgsdata.yYYYYdjjj*. The format, not in NMEA standard, is similar to the files stored in the gravity folder, with the addition of the LDS tag and time stamp. All floating point values have 12 digits, but only a 9 digit precision.

```
x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,n,n,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,x.xxxx,yyyy,mm,dd,HH,MM,SS
```

Item	Definition	Units / Options
x.xxxx	QC_Gravity: Cross coupling corrected gravity	mGal
x.xxxx	Uncorrected gravity	mGal
x.xxxx	Long accelerometer	Gal
x.xxxx	Cross accelerometer	mGal
x.xxxx	Beam position	V
x.xxxx	Sensor temperature	°C
n	Binary codified status	n/a
n	Checksum	n/a
x.xxxx	Internal sensor pressure	inHg
x.xxxx	Electronics temperature	°C
x.xxxx	Ve Cross coupling monitor	cm/s
x.xxxx	Vcc Cross coupling monitor	cm/s
x.xxxx	Al Cross coupling monitor	
x.xxxx	Ax Cross coupling monitor	
x.xxxx	GPS Latitude	Decimal °
x.xxxx	GPS Longitude	Decimal °
x.xxxx	Vessel speed	m/s
x.xxxx	Course over ground	°
x.xxxx	Mean vertical velocity	cm/s
yyyy,mm,dd,hh,mm,ss.ss	Year,month,day,hour,minute,seconds	n/a
n	Number of lines/seconds since last reset	n/a

MGL-dgsraw.*

The raw DGS data are also output as a serial, recorded as *MGL-dgsraw.yYYYYdjjj*, mostly for monitoring and backup purposes. See the description of the *MGL-dgsdata.** format for more details.

```
$AT1M_a.aaa_nnn,n,n,n,n,n,n,n,n,n,n,n,n,n,x.x,x.x,x.x,x.x,n
```

Item	Definition	Units / Options
a.aaa	Harware version	m
nnn	Number of lines/seconds since last reset	n/a
n,n,n,n	dgravity, dlong, dcross, dbeam from 24-bit AD converter	n/a
n,n	dpressure, dtemp unfiltered from 10-bit AD converter	n/a (hexadecimal)
n,n,n,n	rvcc, rve, ral, rax monitors	n/a
n	status	n/a
n	checksum	n/a
x.x,x.x,x.x,x.x	Latitude, Longitude, speed, course – 0 in raw data	n/a
s	UTC time	s

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:

```
$11019000303132854.7960142024082OUTC006010  MGL25140040PA1  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	MGL2514aaaaaaaaa	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:

```
*GCS90090080040PA100000060100fE24/08/20:13:28:5414363600000000190660000.040.286    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 000146500000056O2AP1N 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)

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, MGL2514*SeqLinePid*.*. The files under **raw** were created from P294 files immediately after acquisition, while the files under **processed** were generated from the processed P190 files.

raw/MGL2514_serial_data_1min.csv and **raw/MGL2514_serial_data_10s.csv** are comma separated values (csv) files with records of various key serial data, sampled and filtered every minute and 10 second, respectively.

raw/orca/MGL2514_orca_sequences.csv is a table of sequences automatically generated from the orca database.

raw/orca/MGL2514_orca_shots.csv is an automated list of all the shots triggered by orca, sorted by sequence.

raw/orca/MGL2514_orca_vessel.csv lists the ship positions and acquisition status recorded every minute by orca.