

*Cruise Report*  
*Belgica 09/14a*  
*Belgica GENESIS, Leg 1*  
*"Cabo Ortegal"*



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*May 6 - May 15, 2009*

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# 1. Cruise reference

<b>Belgica 09/14a</b>
<b>Zeebrugge (B) – Cadiz (ES)</b>
<b>6.05.2009 – 15.05.2009</b>

Please refer to this report as:

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## 2. Framework and objectives

### 2.1 Framework

The research programme of Belgica cruise 2009/14a frames into several international and national projects. They all build upon achievements of previous projects such as FWO Genesis, EC FP6 HERMES, ESF EuroDIVERSITY MICROSISTEMS,...

- **EC FP7 IP HERMIONE (2009-2012)**

HERMIONE is the ecological follow-up of the EC FP6 IP HERMES project and stand for "*Hotspot Ecosystem Research and Man's Impact on European Seas*". Together with its 38 partners, it will focus on ecosystem research along key sites on the European margin. It will try to investigate the dimensions, distribution and interconnection of deepsea ecosystems, as well as to understand the influence of climate change, anthropogenic impact and large-scale episodic events (hydrologic or geologic). The results of this projects will be directly coupled to the EU policy (among others).

- **Projecto coordinado CONTOURIBER (2009-2012)**

This Spanish project aims to investigate the evolution and global implications of contourite depositional systems (CDS) generated by the Mediterranean water masses around Iberia. Its objectives are (1) to characterize the contourite sedimentation with special emphasis in its onset and development, (2) to establish the evolution of the CDS in different areas under the influence of the MOW, (3) to determine the recent sedimentary and palaeoceanographic processes in every CDS and (4) to identify the present Mediterranean water masses dynamics and its interrelation with morphologic features of the margin and development of geohabitats. Its activities are related to the oceanic drilling proposal in the Gulf of Cadiz and off West Iberia, within the international program Integrated Ocean Drilling Program (IODP, Proposal -644 "GUCADRILL").

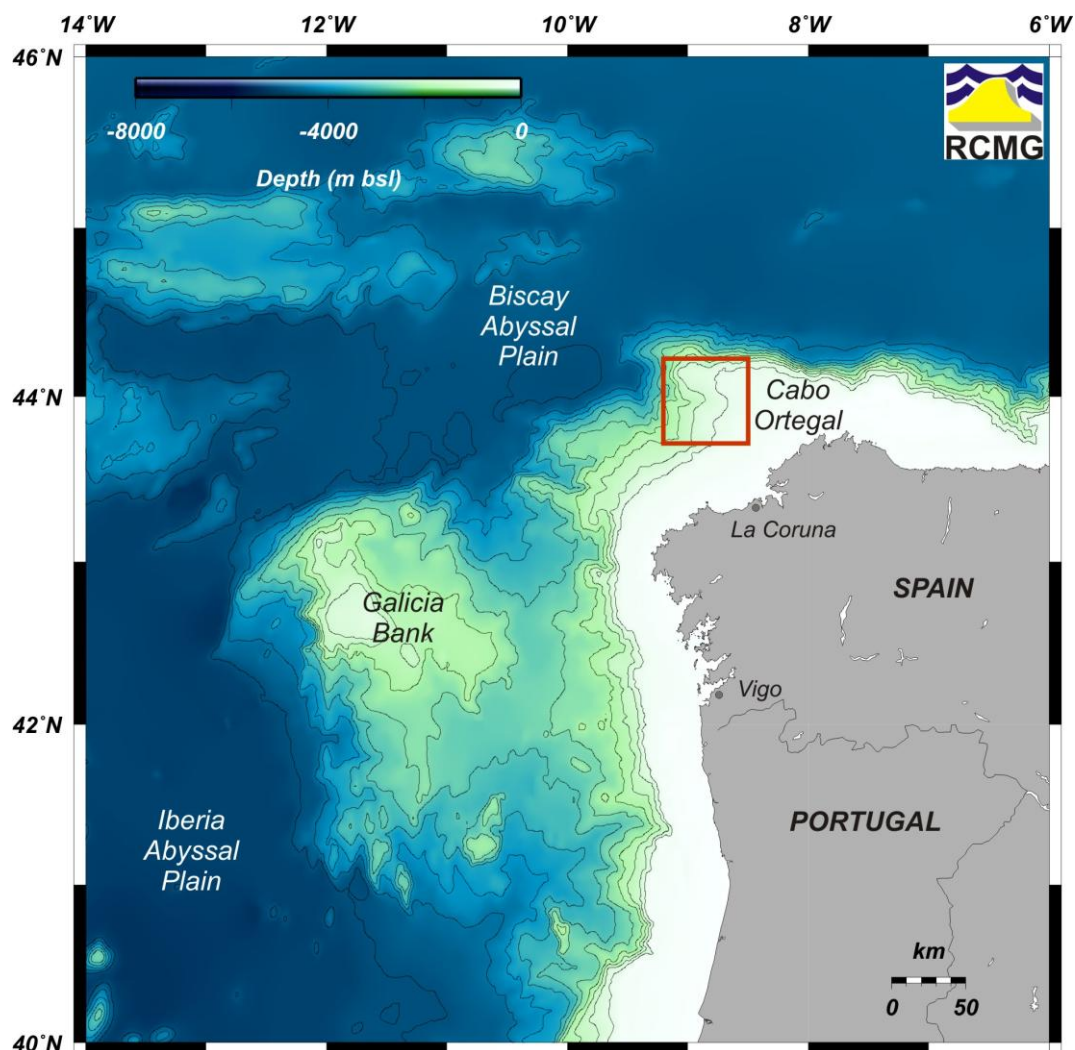
- **FWO post-doctoral project: “Influence on deep-water ecosystems by the Plio-Pleistocene variability of bottom currents generated by intermediary water mass dynamics” (2008-2011)**

This project focuses on three main objectives, studied on less known key sites along the pathway of intermediate water masses such as the MOW;

(a) Determination of the Plio-Pleistocene spatial and temporal variability of bottom currents generated by intermediate water masses.

(b) Assessment of the direct and indirect consequences of this variability on palaeo-ecological level (influence on deep-water ecosystems) and on the level of co-occurrent sedimentary processes (contourite genesis).

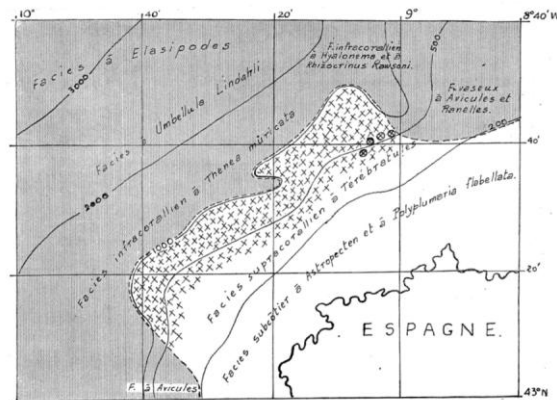
(c) Exploration of poorly-known, drift-associated deep-water coral ecosystems along the entire Central Eastern Atlantic margin, and specifically in the Bay of Biscay.



**Figure 1:** Location map of the study area (red box) during the R/V Belgica GENESIS Ortegal campaign.

## 2.2 Objectives

The Belgica 14a GENESIS 1 “Ortegal” cruise focused, as first one in a series of three cruises, on the “*Massif Galicien de l'Ouest*”, located near the *Cabo Ortegal* in the southern part of the Bay of Biscay (Fig. 1, 2). Within the framework of the EC FP7 IP HERMIONE and the CONTOURIBER projects, these suspected deep-water coral hotspots, earlier described by Le Danois in 1948, will be surveyed using multibeam bathymetry and high resolution seismic profiling. The




**Figure 2:** The “*Massif Galicien de l'Ouest*” off *Cabo Ortegal*, as defined by Le Danois (1948).

study area, located in water depths between 500 and 1500 m is characterized by a vigorously flowing Mediterranean Outflow Water (MOW), which can be observed throughout the sedimentary history in seismic profiles. The hydro- and sediment dynamics of the study area will be studied with respect to their role in steering the present ecosystems. Based on this site survey, ROV Genesis will deploy a lander experiment at the end of Leg 2 (14b) within the surveyed zone. Furthermore, ROV Genesis will be deployed to focus on the detailed visual mapping and sampling of selected sites during Leg 3 (14c). This campaign 14a has focused on the following objectives within the study area (Figs. 1 & 2):

1. **High-resolution single channel sparker seismic profiling:** investigation of the stratigraphic framework and the sedimentary environment. The locations of the seismic profiles are based on very high resolution PARASOUND profiles, acquired by the Spanish R/V Sarmiento de Gamboa in 2008. A more detailed network will be determined during this leg, to be executed during campaign 14c.
2. **Multibeam bathymetry:** using the shipboard EM1002 multibeam bathymetry echosounder, in order to characterize sedimentary features and possible cold-water coral mounds within the study area. Also backscatter imagery will be used for this purpose.
3. **Hydrography:** 2 CTD casts are planned on respectively 1500 and 500 m water depth in order to provide more insight in seasonality of the local hydrography.

This predominantly geophysical campaign was executed in cooperation with the University of Vigo, the Geological Survey of Spain (IGME, Madrid) and the CMIMA-CSIC at Barcelona.

### 3. Departure and arrival of the cruise

Departure: Zeebrugge (B)	06.05.2009, at 10.00h.		Belgica 09/14a
Arrival: Cadiz (ES)	15.05.2009, at 09.30h.		

### 4. Working area

The study area is located on the Galician continental margin in the Bay of Biscay, in water depths between 500 and 1500 m depth, 50 km NW off La Coruna.

#### 4.1 Coordination at Sea

Chief scientist: Dr. David VAN ROOIJ  
Renard Centre of Marine Geology (RCMG),  
Ghent University, Belgium

Co-chief scientist: Matthias BAEYE

#### 4.2 Scientific staff

Dr. David VAN ROOIJ	Ghent University, RCMG,
Matthias BAEYE	Ghent University, RCMG,
Prof. Dr. Francisco Javier HERNANDEZ-MOLINA	University of Vigo (Spain)
Ferran ESTRADA	CMIMA-CSIC (Spain),
Dr. Estefania LLAVE	IGME (Spain),
Lara PEREZ	MSc student, University of Vigo (Spain)
Ing. Koen DE RYCKER	Ghent University, RCMG,
Dr. Ricardo LEON	IGME (Spain),

## 4.3 Operations

### 4.3.1 Seismic survey

The seismic profiling was performed with a SIG sparker source (120 electrodes), and recorded through single channel surface streamer using Delph acquisition software. Initially, the sparker was triggered every 2 s reaching 500 J energy. The sampling frequency was set at 8 kHz and a record length of 1900 ms TWT was used. However, seen the sometimes greater water depths, the deeper seismic profiles were acquired with a 3 s trigger rate and 2900 ms TWT record length. The velocity of the ship during surface sparker seismics was maintained at about 4 knots.

### 4.3.2 CTD measurements

In order to characterize the water mass stratification of the area, two CTD casts were successfully taken at a deep (1500 m) and shallow (500 m) site in the middle of the survey area box. They were acquired with the Seacat SBE-19 deep-water CTD profiler of the MUMM. The resulting data were saved in a raw file (.hex), as well as the configuration settings (.con). These data were converted to ASCII (.cnv) and filtered using the program SBEDataprocessing\_Win32 (v7.18c). In order to acquire correct sound velocity data for the EM1002 system, CTD cast B0913-CTD-1 was taken with the aim to convert the temperature and salinity information to sound speed values using the formula of Chen-Millero. Only the downcast data were chosen, and the information was binned in 2 m intervals. The final file was called '20090509.asvp', and transferred onto the UNIX station. However, it was necessary to edit this file in a UNIX text editor to delete all the windows 'end-of-line' characters. Therefore, during the first day, a proxy file 1506.asvp was used instead. This will be reprocessed using the CARAIBES software.

### 4.3.3 Multibeam survey

The multibeam echosounder used during this cruise is the Simrad EM1002 system from the Belgian Ministry of Economical Affairs, installed permanently on the Belgica. Standard procedures were chosen for its application. Before leaving the port of Zeebrugge, the draft of the ship was measured at four locations, resulting in the average value of 5.529 m.

Once arrived at the study site, the sound absorption coefficient (Fig. 3) in the water was calculated from the temperature and salinity of the surface water, given by the ODAS-II system. No pH measurement was carried out, but an average value of 7.5 was entered in the formulas. An average of 0.75 km was taken for the survey water depth. The calculation of the sound velocity is described above.

INPUT PARAMETERS :		ABSORPTION COEFFICIENT :	
DATE	2009-05-09 07:25	$\alpha$ in dB/km (T > 20°C)	30.51
SOUND SPEED C in m/s =	1502.20	$\alpha$ in dB/km (T ≤ 20°C)	29.78
SEA WATER TEMPERATURE, T in °C =	13.27		31.38
SEA WATER SALINITY, S in ppt =	35.66		
SEA WATER pH, pH =	7.5		
		RATIO ( $\alpha_1/\alpha_2$ ) x 100	105.38
WATER DEPTH in km =	0.75	$\alpha_1$ - 98 KHz	31.38
		$\alpha_2$ - 93 KHz	29.78
FREQUENCY in KHz, f	93		
	98		

Figure 3: Input parameters for the multibeam calibration

At the beginning of the survey a roll calibration was carried out (Fig. 4). Therefore 2 tracks were sailed in opposite direction. No adjustments were necessary. It was chosen to record all possible parameters; position, backscatter image...

EM1002 Installation Menu – VIEW MODE. File: esoEM1002Setup.installation

File Edit Help

TRU Input Interfaces  
Input On: Port 1  
Parity: None (selected), Odd, Even  
Stop Bits: 1 (selected), 2  
Data Bits: 7 (selected), 8  
Baud Rate: 1200, 2400, 4800, 9600 (selected), 19200  
Input Formats, Serial Port 1  
Reset Selections  
 Standard Positioning  
 GGA Positioning  
 GGA - RTK Positioning  
 GKG Positioning  
 GST Pos. Quality  
 HMEA QIC DBS Depth  
 HMEA QIC DPT Depth  
 Height  
 HDT Heading  
 ZDA Clock

Positioning Systems  
Pos. System On: Port 1  
Time To Use: Datagram  
 Pos. Motion Correction  
 Position Delay (s): 0.10  
 Datum: WGS 84  
 Major Axis: 6378137.000  
 Flattening: 298.257223563

Active Systems  
Active Pos. Sys. On: Port 1  
Active Heading On: Port 2  
Motion Sensor On: Port 2

Sensor Location  
All Locations in meters.  

	Forward (X)	Starboard (Y)	Downward (Z)
Pos., Port 1	-12.00	0.65	-24.82
Pos., Port 3	0.00	0.00	0.00
Pos., Port 4	-7.68	-4.04	-17.10
Pos., Ethernet	0.00	0.00	0.00
Transducer:	0.00	0.00	0.00
Motion Sensor:	-1.13	0.00	-3.66
Waterline:			-5.53

Motion Sensor  

	Roll (deg.)	Pitch (deg.)	Heading (deg.)
Offset Angles:	-0.09	0.00	1.50
Delay (ms):	10		
Roll Scaling:	1.000		
Roll Reference:	Rotation(PosMv/MRU)		

Installation Angles  

	Roll (deg.)	Pitch (deg.)	Heading (deg.)
Transducer:	-0.44	-0.42	0.66

Stand-Alone Heading Sensor  
Heading Offset (deg): 0.00

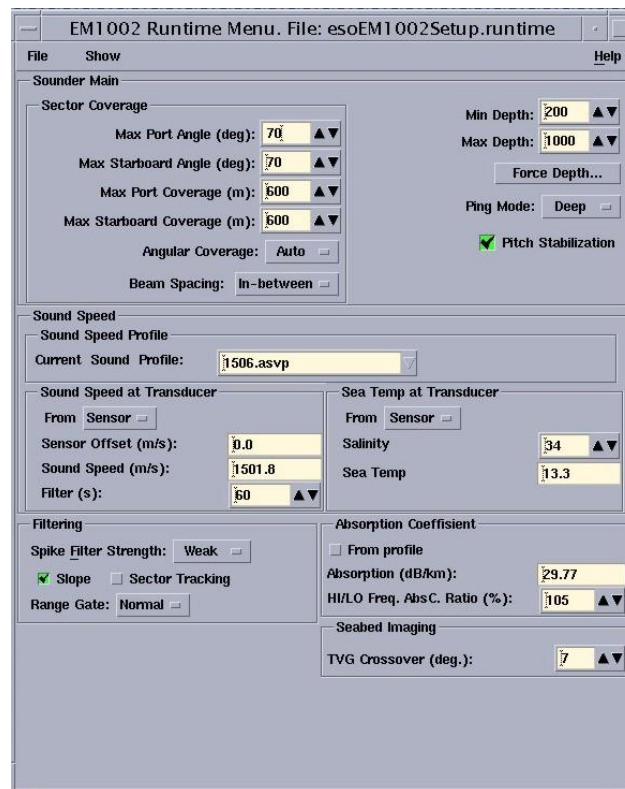
Clock  
Set Source: Active Pos. Sys.  
Clock Offset: 00:00:00  
 1PPS Sync  
 External Triggering

System Parameters  
Hull Unit Included:  Yes  No  
Tilt Offset (deg.): 0.00  
Gain Offset (dB): 0.0  
Hi/Lo Frq. Gain Diff: 2.0  
Outer beam angle offset: 0.50

Figure 4: Screenshot of the multibeam input parameters concerning motion sensors and roll/pitch calibration

During the actual survey we aimed at keeping a 10-20% overlap between the consecutive swaths. This resulted in a line spacing ranging from ca. 800 to 1000 m (maximal swath of 2x600). For most of the time the system was switched to the manual detection of the appropriate working mode (deep). The beam angles were generally chosen at 70°, seen the relatively gentle slope. The beam spacing was chosen as in-between.





**Figure 5:** Screenshot of the multibeam input parameters concerning sound velocity and filtering

During the multibeam survey, it was tried to keep the vessel speed to a minimum of 5 kn (to avoid heavy pitch movement), and a maximum of 8 knots. Generally, N-S lines are of better quality than the S-N lines. Overall, the weather conditions were quite good during the survey, and the data quality was fairly good too, until a water depth of ca. 925 m. In such deep waters the system easily lost the bottom.

During the survey, the “raw” and “proc” data were regularly backed up on external hard drives. Processing of the raw Simrad multibeam and backscatter data was immediately carried out in the CARAIBES software (IFREMER).

#### 4.3.4 Sea acceptance testing of EA400 echosounder

Upon request of the MUMM Ostend, a sea acceptance test for the Simrad EA400 echosounder transducers was carried out (mainly the 38 kHz transducer). The manufacturer had foreseen a bottom detection down to 3000 m water depth. This was tested during 4 occasions:

- Test during transit towards the study area (downslope transect at the Armorican margin)
- First SAT during multibeam calibration lines between the 2 CTD stations located between 500 and 1500 m.

- Second SAT during seismic profiling, down to 2500 m
- Monitoring of EA400 during the transit towards Cádiz

For this occasion, the power of the EA400 38 kHz transducer was increased to maximal strength (2000 W), and the pulse length was also set to maximum (4 ms).

### 4.3.5 Operational Report

It is worth noting that the time used in this cruise report and on the seismic survey sheets is the Belgian Summer time (BRAVO TIME = UTC+2hours). The EM1002 multibeam data were acquired in GMT time.

#### ***Tuesday 05.05.2009***

09:00 Start of mobilisation & installation of equipment on R/V Belgica

13:00 Technical instructions regarding CTD measurements and EA400 echosounder Sea Acceptance Test

15:00 Arrival of the Spanish scientific team members

#### ***Wednesday 06.05.2009***

Meteo: SW, 6 to 7 in a general clear and dry weather.

09:00 Safety briefing for the Spanish participants

10:00 Departure of R/V Belgica towards Cabo Ortegal

11:00 Exercise abandon ship

#### ***Thursday 07.05.2009***

Meteo: SW, 6 to 7 in a general clear and dry weather.

10:00 Scientific briefing in wardroom. It is decided to start with MBES measurements directly after the CTD measurements and SAT for the EA400. Seismic survey can be postponed to leg 14c

17:00 Reception at the occasion of the birthday of Estefania Llave

#### ***Friday 08.05.2009***

Meteo: Westerly veering northeasterly 4 or 5, with large (Atlantic) swell.

10:00 Passage over La Chapelle shelf break. The EA400 33 and 38 kHz echosounder transducers were tracked to a water depth of 1400 m. These data were not correctly

transferred to the ODAS-II display and Transas. This was probably due to the large rolling movements of the ship, which disabled a successful bottom lock. A final SAT will be performed in the study area.

### **Saturday 09.05.2009**

Meteo: Northeasterly 4 or 5, with moderate (Atlantic) swell.

- 07:00 Arrival on study area, site approach of CTD-1 via the western, deeper part for the EA400 sea acceptance test
- 07:45 Both EA400 33 and 38 kHz transducers yield a depth of 1200 m
- 07:57 At 1473 m, the 38 kHz transducer fails and loses bottom lock. Sea acceptance test will be continued later on the campaign in deeper waters during the seismic survey.
- 08:20 Arrival on CTD-1 site, water depth 1480 m (43°57.67'N; 8°59.16'W). CTD is lowered at a velocity of 1 m/s
- 08:52 B0914-CTD-1 reaches its maximum depth; start of upcast profile & recovery
- 09:00 CTD data is processed for input in the MBES system. Failure of acceptance of the asvp file by the EM1002 acquisition system. A proxy file (1506.asvp) is used instead with an averaged velocity.
- 10:36 Start of multibeam calibration line 1, heading 90°
- 11:33 End of multibeam calibration line 1, start of calibration line 2, heading 90°
- 11:48 End of multibeam calibration line 2
- 12:00 Arrival on CTD-2 site, water depth 460 m (43°58.07'N; 8°40.29'W). CTD is lowered at a velocity of 1 m/s
- 12:08 B0914-CTD-2 reaches its maximum depth; start of upcast profile & recovery
- 12:30 Start of multibeam calibration line 4, heading 270°
- 13:41 End of multibeam calibration line 4, start of calibration line 5, heading 270°
- 13:58 End of multibeam calibration line 5, transit to NE corner of MBES survey area
- 15:24 Start of multibeam line 6, heading 180°
- 16:24 End of multibeam line 6, start of multibeam line 7, heading 180°
- 17:24 End of multibeam line 7, start of multibeam line 8, heading 180°
- 17:33 End of multibeam line 8
- 17:41 Start of multibeam line 9, heading 0°
- 18:40 End of multibeam line 9, start of multibeam line 10, heading 0°
- 19:30 End of multibeam line 10, start of multibeam line 11, heading 0°
- 19:31 End of multibeam line 11
- 19:35 Start of multibeam line 12, heading 180°
- 20:35 End of multibeam line 12, start of multibeam line 13, heading 180°
- 21:22 End of multibeam line 13
- 21:29 Start of multibeam line 14, heading 0°
- 22:28 End of multibeam line 14, start of multibeam line 15, heading 0°

23:21 End of multibeam line 15  
23:28 Start of multibeam line 16, heading 180°

**Sunday 10.05.2009**

Meteo: Northeasterly 3 to 4, with moderate swell. Clear weather and good visibility.

00:28 End of multibeam line 16, start of multibeam line 17, heading 180°  
01:22 End of multibeam line 17  
01:29 Start of multibeam line 18, heading 0°  
02:28 End of multibeam line 18, start of multibeam line 19, heading 0°  
03:29 End of multibeam line 19, start of multibeam line 20, heading 0°  
04:06 End of multibeam line 20  
04:13 Start of multibeam line 21, heading 180°  
05:13 End of multibeam line 21, start of multibeam line 22, heading 180°  
05:54 End of multibeam line 22  
06:02 Start of multibeam line 23, heading 0°  
07:02 End of multibeam line 23, start of multibeam line 24, heading 0°  
08:02 End of multibeam line 24  
08:05 Start of multibeam line 25, heading 180°  
09:05 End of multibeam line 25, start of multibeam line 26, heading 180°  
09:50 End of multibeam line 26  
09:57 Start of multibeam line 27, heading 0°  
10:56 End of multibeam line 27, start of multibeam line 28, heading 0°  
11:35 End of multibeam line 28  
11:40 Start of multibeam line 29, heading 180°  
12:39 End of multibeam line 29, start of multibeam line 30, heading 180°  
13:19 End of multibeam line 30  
13:29 Start of multibeam line 31, heading 0°  
14:29 End of multibeam line 31, start of multibeam line 32, heading 0°  
15:23 End of multibeam line 32  
15:29 Start of multibeam line 33, heading 180°  
16:30 End of multibeam line 33, start of multibeam line 34, heading 180°  
17:05 End of multibeam line 34  
17:12 Start of multibeam line 35, heading 0°  
18:12 End of multibeam line 35, start of multibeam line 36, heading 0°  
18:59 End of multibeam line 36  
19:03 Start of multibeam line 37, heading 180°  
20:03 End of multibeam line 37, start of multibeam line 38, heading 180°  
20:49 End of multibeam line 38

- 21:02 Start of multibeam line 39, heading 0°. A new asvp file (20090509.asvp), derived from the B0914-CTD-1 data and edited within UNIX, is successfully introduced to the EM1002 system.
- 22:00 End of multibeam line 39, start of multibeam line 40, heading 0°
- 22:39 End of multibeam line 40
- 22:46 Start of multibeam line 41, heading 180°
- 23:46 End of multibeam line 41, start of multibeam line 42, heading 180°
- 23:58 Problems with the survey display; the current lines and data is not shown. Several test files (line 42-43-44) were made, but ultimately it was decided to start a new survey ST0914a2

### **Monday 11.05.2009**

Meteo: Northeasterly 3 to 4, with a gentle swell. Changes later on the day to 2 beaufort. Slightly overcast weather with some local showers and good visibility.

- 00:04 Start of multibeam line 1, heading 180°
- 00:24 End of multibeam line 1
- 00:30 Start of multibeam line 2, heading 0°
- 01:30 End of multibeam line 2, start of multibeam line 3, heading 0°
- 02:10 End of multibeam line 3
- 02:16 Start of multibeam line 4, heading 180°
- 03:16 End of multibeam line 4, start of multibeam line 5, heading 180°
- 03:58 End of multibeam line 5
- 04:07 Start of multibeam line 6, heading 0°
- 05:07 End of multibeam line 6, start of multibeam line 7, heading 0°
- 06:01 End of multibeam line 7
- 06:10 Start of multibeam line 8, heading 180°
- 07:10 End of multibeam line 8, start of multibeam line 9, heading 180°
- 07:59 End of multibeam line 9
- 08:06 Start of multibeam line 10, heading 0°
- 09:06 End of multibeam line 10, start of multibeam line 11, heading 0°
- 09:47 End of multibeam line 11°
- 09:54 Start of multibeam line 12, heading 180°
- 10:53 End of multibeam line 12, start of multibeam line 13, heading 180°
- 11:38 End of multibeam line 13
- 11:44 Start of multibeam line 14, heading 0°
- 12:44 End of multibeam line 14, start of multibeam line 15, heading 0°
- 13:25 End of multibeam line 15
- 13:30 Start of multibeam line 16, heading 0°
- 14:30 End of multibeam line 16, start of multibeam line 17, heading 0°

- 14:58 Change of direction to 280°, for transit towards start of the first seismic line.
- 15:29 End of multibeam line 17, start of multibeam line 18, heading 280°
- 15:32 End of multibeam line 18 (water depth beyond 925 m)
- 16:16 Approach towards the first waypoint of the seismic survey. Slowing down of R/V Belgica for switch to electric propulsion
- 16:20 Engine problems are encountered during the switch from diesel to electric propulsion
- 16:45 Seen the nature of the problems, diesel propulsion is maintained and it is decided to postpone the seismic survey and to continue the multibeam survey. Return to end point of multibeam line 17
- 17:15 Test of electric propulsion
- 17:40 Switch to electric propulsion seem successful with gradually increasing velocity.
- 17:50 Launch of the seismic equipment (sparker source and streamer)
- 18:00 Start of test shooting of the seismic equipment; start of line GM050901, heading 100° (av. speed 2 knots)
- 18:05 End of line GM090501; start of line GM090501bis, heading 99° (av. speed 3 knots)
- 18:40 Start of simultaneous multibeam & seismic survey. Start of multibeam line 19, heading 90°
- 18:41 A very high-frequency noise was noticed, irregularly superimposed on the seismic traces
- 19:20 End of line GM090501bis, no navigation was recorded (failure)
- 19:21 Start of line GM090501tris, heading 99° (av. speed 4 knots)
- 19:30 The cause of the high-frequency noise was due to a malfunctioning of the used streamer. It was replaced by a backup streamer. Reparations will be carried out during the port call in Cádiz.
- 19:40 End of multibeam line 19, start of multibeam line 20, heading 101°
- 20:18 End of multibeam line 20; end of line GM090501tris
- 20:24 Start of multibeam line 21, heading 275°
- 20:26 Start of line GM090502, heading 254° (av. speed 3.9 knots)
- 21:24 End of multibeam line 21, start of multibeam line 22, heading 280°
- 22:11 End of multibeam line 22 (water depth beyond 925 m)
- 23:02 End of line GM090502
- 23:04 Start of line GM090502b, heading 254° (av. speed 4.1 knots), with a change of record length set to 2.9 s
- 23:10 End of line GM090502b; start of line GM090502c, heading 254° (av. speed 4.1 knots), with a change of shooting interval to 3 s
- 23:56 End of line GM090502c
- 23:59 Start of line GM090503, heading 225° (av. speed 4.6 knots)

**Tuesday 12.05.2009**

Meteo: South 3, with a gentle swell. Slightly overcast weather with some local showers and good visibility.

00:14 Set of pulse length of EA400 38 kHz transducer to 4 ms  
00:44 End of line GM090503  
00:50 Up to now, with the new settings of the EA400 38 kHz transducer, a depth reading of 1900 m (deepest point of survey) was successfully maintained  
00:52 Start of line GM090504, heading 63° (av. speed 4 knots)  
04:27 End of line GM090504  
05:24 Start of line GM090505, heading 243° (av. speed 4 knots), start of multibeam line 23, heading 290°  
06:09 End of multibeam line 23  
07:13 End of line GM090505, cutting of sparker tips  
07:33 Start of line GM090905b, heading 246° (av. speed 4 knots)  
09:00 End of line GM090505b  
09:25 Start of line GM090505c, heading 242° (av. speed 3.6 knots), temporary change of record length to 3.1 s  
09:32 End of line GM090505c, data out of range  
09:34 Start of line GM090506, heading 147° (av. speed 4 knots)  
10:31 End of line GM090506  
10:57 Start of line GM090507, heading 50° (av. speed 4 knots)  
12:11 Start of multibeam line 24, heading 50°  
12:12 End of multibeam line 24 due to system failure. Start of new survey ST0914a3  
12:16 Start of multibeam line 1, heading 50°  
13:15 End of line GM090507 and multibeam line 1, end of seismic survey  
13:20 Seismic equipment is out of the water, full stop of vessel to switch from electric to diesel propulsion  
13:32 Start of multibeam line 2, heading 180°  
14:32 End of multibeam line 2, start of multibeam line 3, heading 180°  
14:39 End of multibeam line 3 (loss of signal due to water depths beyond 925 m)  
14:50 Start of multibeam line 4, heading 180°  
15:49 End of multibeam line 4, start of multibeam line 5, heading 180°  
16:39 End of multibeam line 5  
16:46 Start of multibeam line 6, heading 0°  
17:46 End of multibeam line 6, start of multibeam line 7, heading 0°  
18:34 End of multibeam line 7  
18:40 Start of multibeam line 8, heading 0°  
18:41 End of multibeam line 8  
18:43 Start of multibeam line 9, heading 180°

19:43 End of multibeam line 9, start of multibeam line 10, heading 180°  
20:43 End of multibeam line 10  
20:45 End of survey, full stop of vessel, retraction of EM1002 into the hull, switch off of EM1002 acquisition system  
21:00 Start of transit towards Cadiz, sea safety check for all equipment

### **Wednesday 13.05.2009**

Meteo: South 3 to 4, with a gentle swell. Slightly overcast weather with some local showers and good visibility.

Transit day with permanent monitoring of the EA400 38 kHz echosounder. All acquired datasets were subject to a general backup. Continuation of data processing, interpreting and reporting.

### **Thursday 14.05.2009**

Meteo: Northwesterly 5 to 6. Slightly overcast weather with good visibility.

Transit day. Continuation of data processing, interpreting and reporting. Based upon the conducted survey, a network of seismic lines was created for leg 3 (ST0914c). The waypoints were transmitted to the navigation officer.

### **Friday 15.05.2009**

Meteo: Sunny weather with good visibility.

09:30 Arrival in the port of Cadiz. End of campaign ST0914a  
13:00 Departure of the scientific crew, except for Koen De Rycker and Matthias Baeye

## **4.4 Operational remarks**

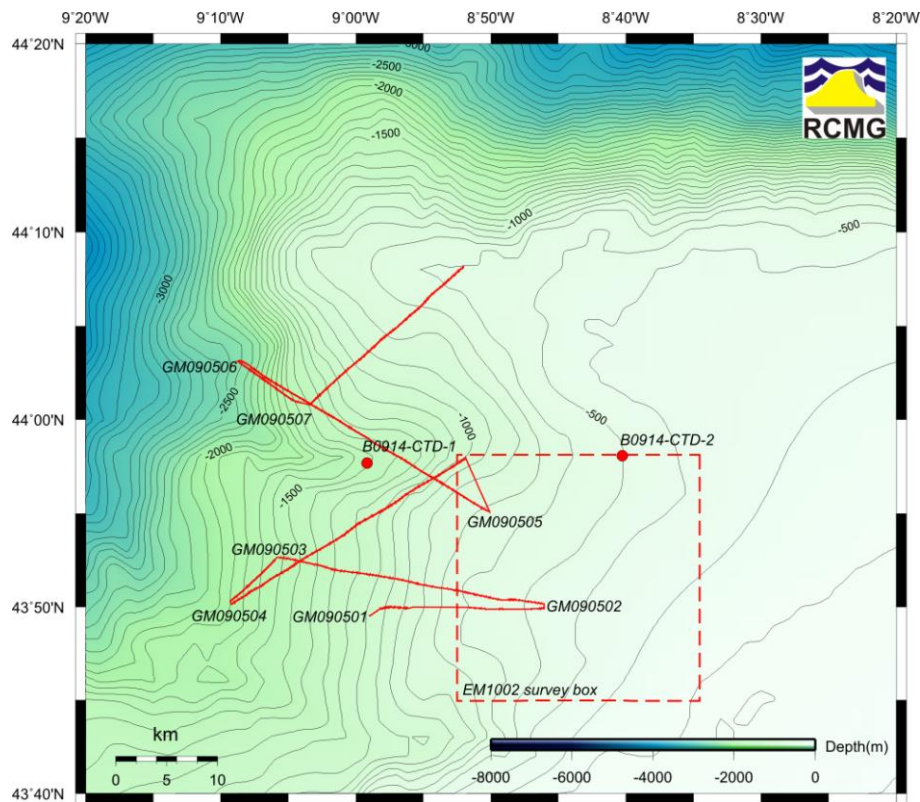
First of all, we want to thank the captain and crew for their tremendous efforts and the fine cooperation for this campaign. The on-board skilfulness really contributed greatly to this success of this campaign. In view of continuing improvements, we would like to formulate some suggestions which could stimulate more success in the future:

- EA400: we would suggest the possibility of recording and obtaining EA400 data after campaign. For example, this could be upon request in the cruise programme (specifying sampling rate and which echosounder).



## 4.5 Data processing and preliminary results

In this section, a brief review is given regarding the obtained datasets during the campaign. The location of these data is given in Fig. 6.



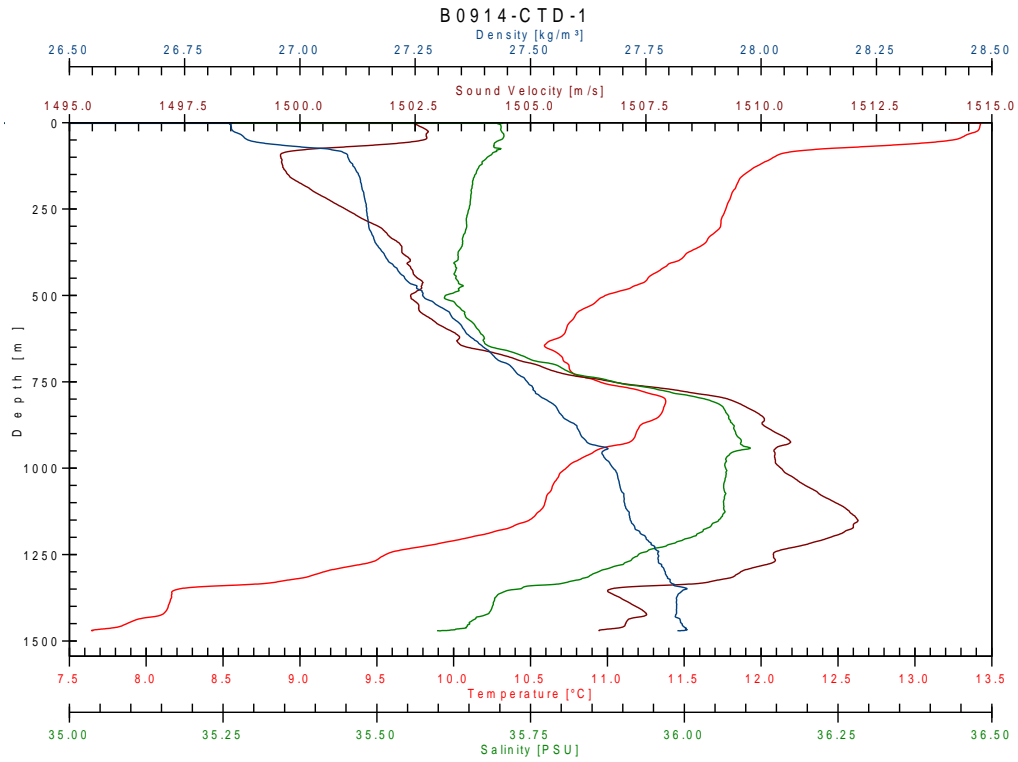
**Figure 6:** Overview of the obtained dataset: CTD casts (red circle), seismic lines (red lines) and the main survey area of the EM1002 multibeam survey (see figure 12).

### 4.5.1 Water mass stratification

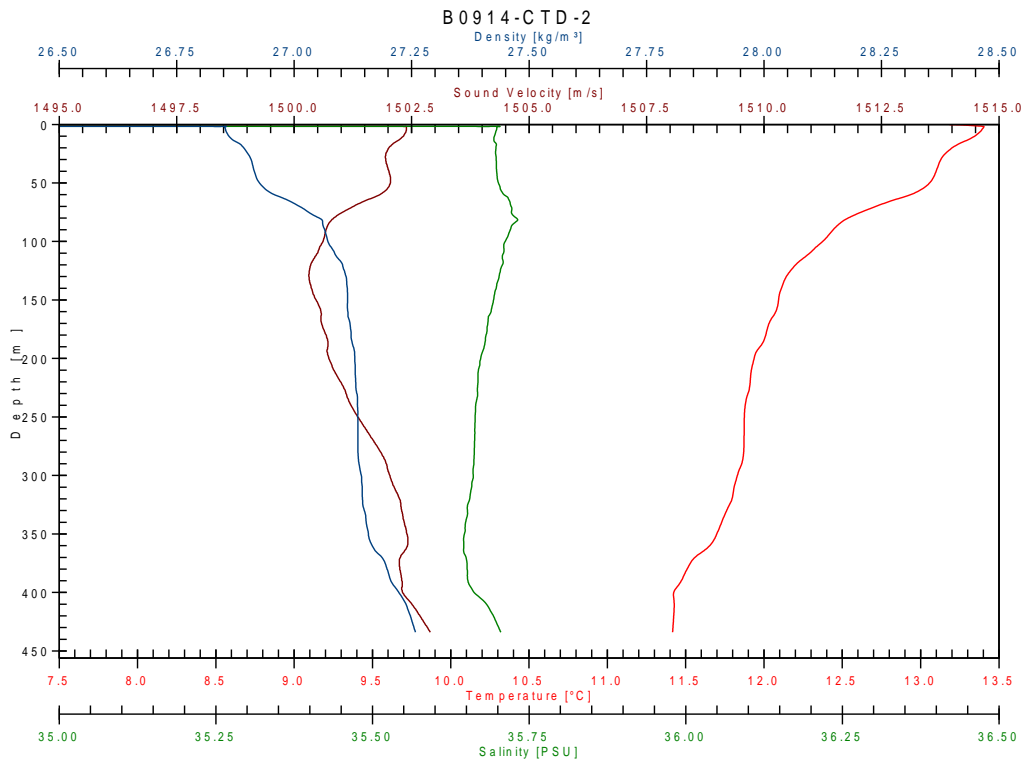
The obtained CTD data have identified the Mediterranean Outflow Water at a water depth between 650 to 1400 m (Fig. 7a). According to Dullo et al. (2008), live cold-water coral ecosystems in the Nordic and Irish margin are located in a potential density envelope between 27.25 and 27.75 sigma-theta. This was confirmed during the R/V Belgica 2008 campaign near the Guilvinec canyon (De Mol et al., 2008). Data from the deepest CTD station (B0914-CTD-1) have placed this envelope in between 500 and 1250 m water depth. The optimal depth for cold-water coral occurrence (27.5 sigma-theta) will be about 750 m ( $\pm$  50 m).

Name	Latitude	Longitude	Water depth	CTD depth
B0914-CTD-1	43°57.67'N	8°59.16'W	1480 m	1472 m
B0914-CTD-2	43°58.07'N	8°40.29'W	460 m	436 m

**Table 1:** Coordinates and depth of the CTD data (position see Fig. 6).



**Figure 7a:** Density, sound velocity, temperature and salinity at B0914-CTD-1.



**Figure 7b:** Density, sound velocity, temperature and salinity at B0914-CTD-2.

## 4.5.2 Processing of the EM1002 data

The EM 1002 multibeam data have been processed with the IFREMER CARAIBES software release 3.4, installed on a Linux laptop. Three survey blocks have been defined in the studied area, and bathymetry tracklines have been processed in eight blocks:

*Block 1:* Calibration line (lines from 1 to 5 of survey ST0914a)

*Block 2:* Lines from 6 to 13 of survey ST0914a.

*Block 3:* Lines from 14 to 26 of survey ST0914a.

*Block 4:* Lines from 27 to 38 of survey ST0914a.

*Block 5:* Lines from 39 to 44 of survey ST0914a.

*Block 6:* Lines from 1 to 16 of survey ST0914a2.

*Block 7:* Lines from 17 to 24 of survey ST0914a2.

*Block 8:* Lines from 1 to 10 of survey ST0914a3.

The multibeam processing has been carried out in three steps. First the Simrad raw (.all) files were imported, followed by a bathymetry analysis and ended with a backscatter mosaic.

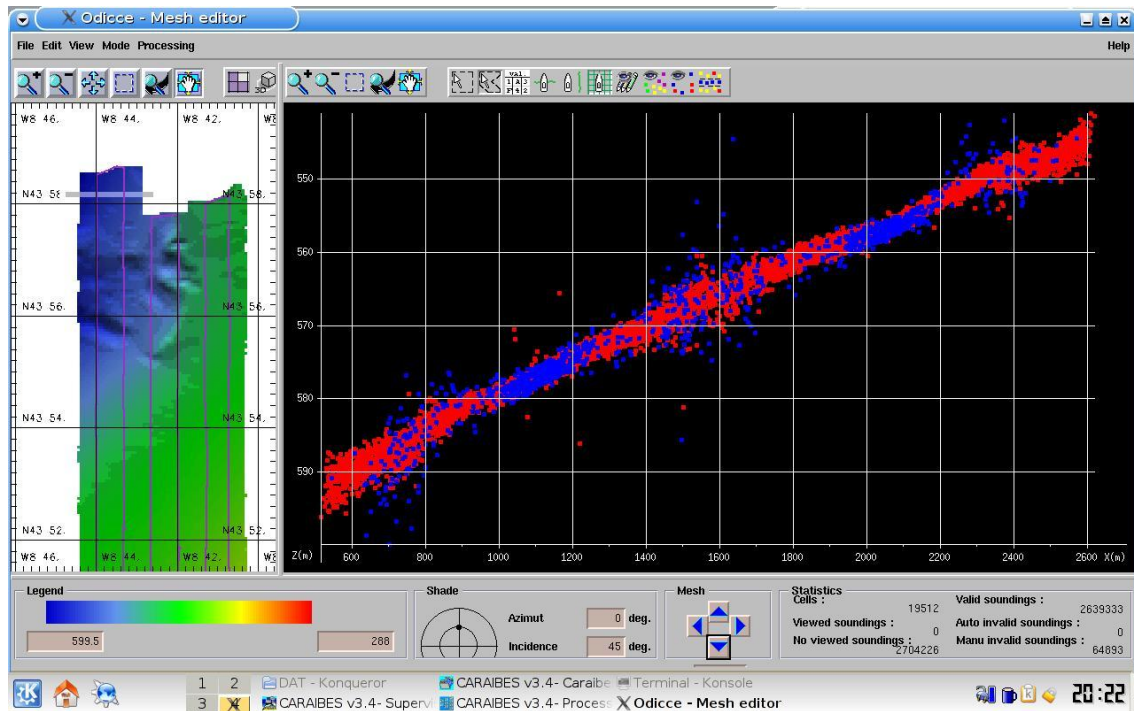
### 1. Importation from Simrad raw files

Simrad raw (.all) multibeam files have been processed by two modules in order to extract bathymetry, navigation celerity and backscatter data. Non-georeferenced bathymetry (\*.mbg), navigation (\*.nvi) and celerity (\*.cel) files have been obtained with Tfm1002 module of CARAIBES. The CARAIBES backscatter imagery files (\*.IM and \*.im) have been extracted from Simrad raw files with TfSmi module of CARAIBES.

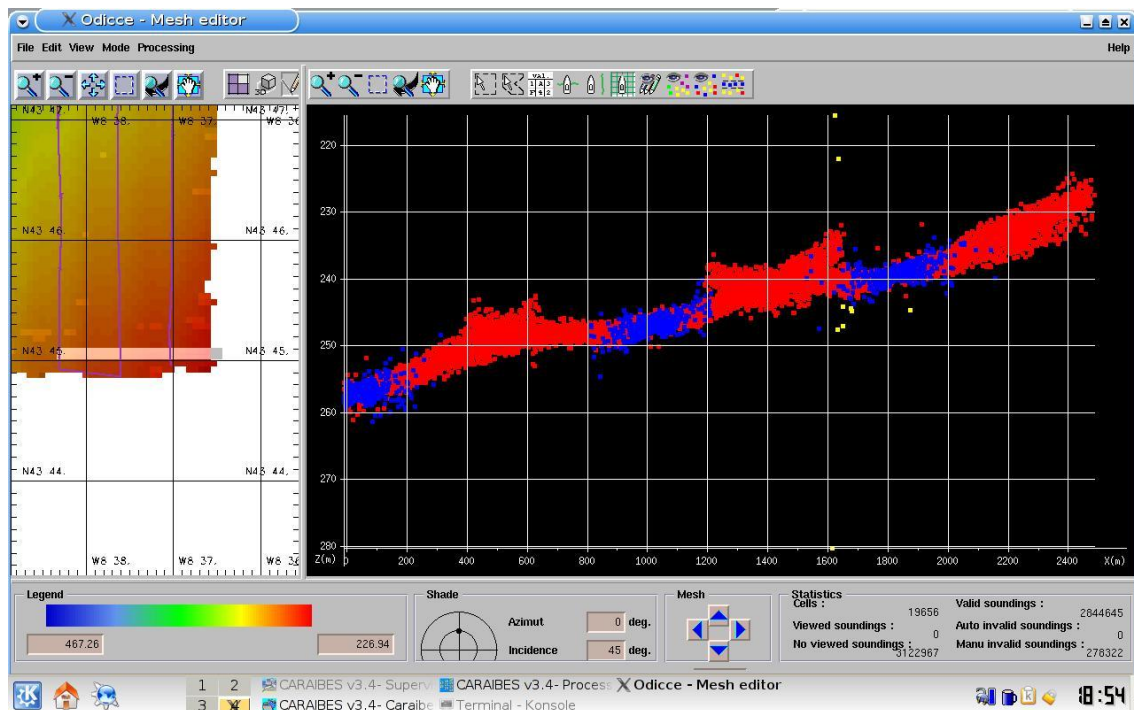
### 2. Bathymetry analysis

A first step was the positional analysis. Positional errors have been deleted with Ananav module and then fused in one single file with Fusnav module. In a second step, the non-georeferenced bathymetry files were fused in only one file with Fusmul module. In a third step, a georeferenced bathymetry file has been created with Creaxy module from non-georeferenced bathymetry, navigation and celerity files. In a final fourth step, the Odicce module was used to delete diffractions and erroneous depth values (Fig. 8).

A wrong sound velocity profile has been detected into the bathymetry lines in blocks from 1 to 3, making a smiling effect along the tracks of the beams (Fig. 9). After filtering of the spikes, the Modcel module has been run in order to re-process the wrong georeferenced bathymetry model and obtain a new with a good sound velocity profile without smiling effect (Fig. 10).



**Figure 8:** Interface of the CARAIBES Odicce module to delete diffractions and other wrong depth values.



**Figure 9:** Smiling effect of the wrong sound velocity profile.

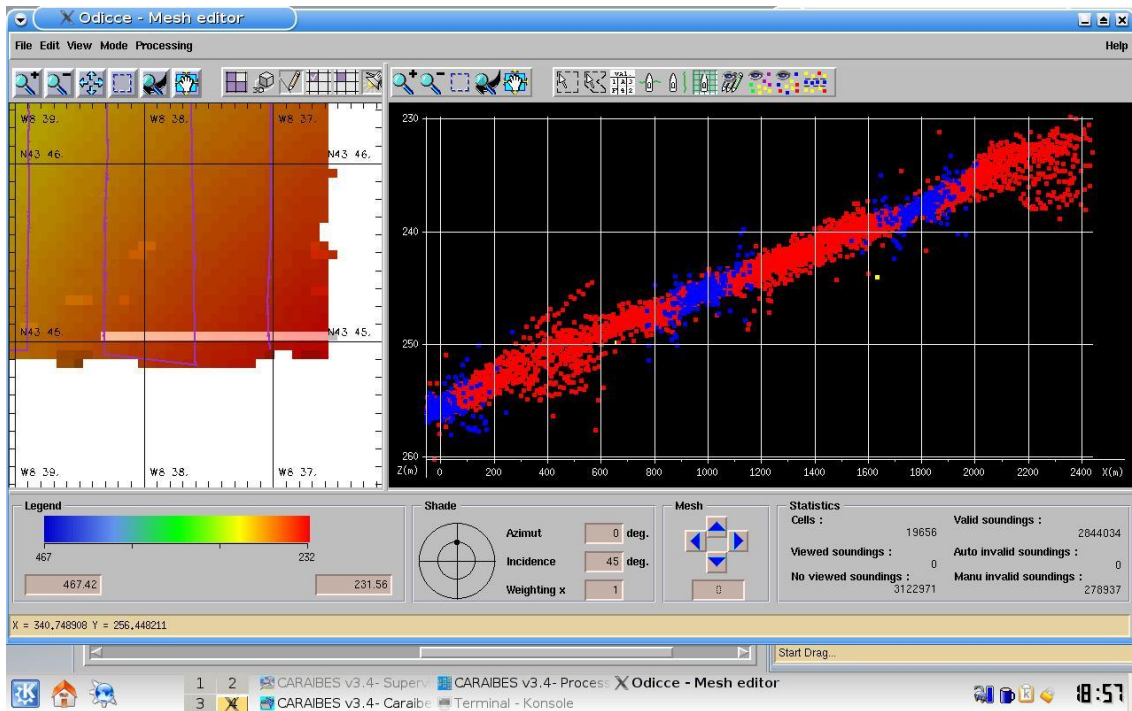


Figure 10: Bathymetry model re-processed with a good sound velocity profile.

### 3. Backscatter mosaic

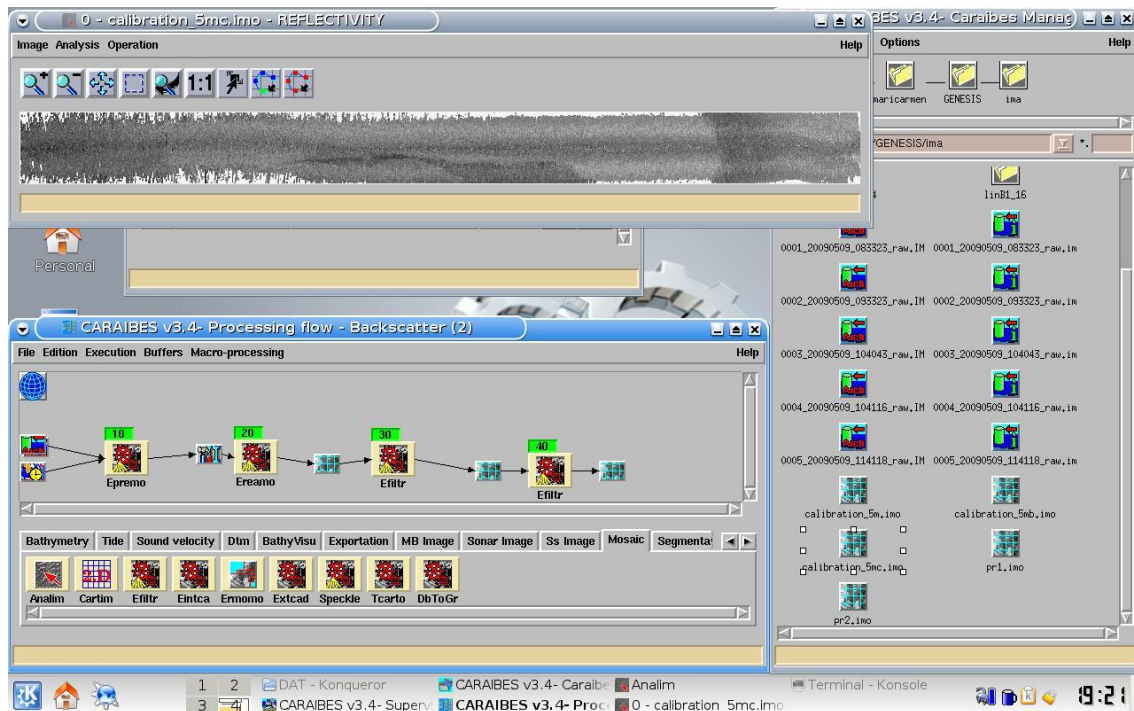


Figure 11: Graphic interface of CARAIBES software for the backscatter analysis.

A raw backscatter mosaic has been built in order to obtain a preliminary document to assist the interpretation of bathymetry and seismic. This has taken into account a mean bathymetry of 500 m, and a 15 m footprint, estimated from the following equation:

$$Footprint = 2 Depth \left( \tan \frac{\theta}{2} \right), \text{ where:}$$

$Footprint$  = footprint

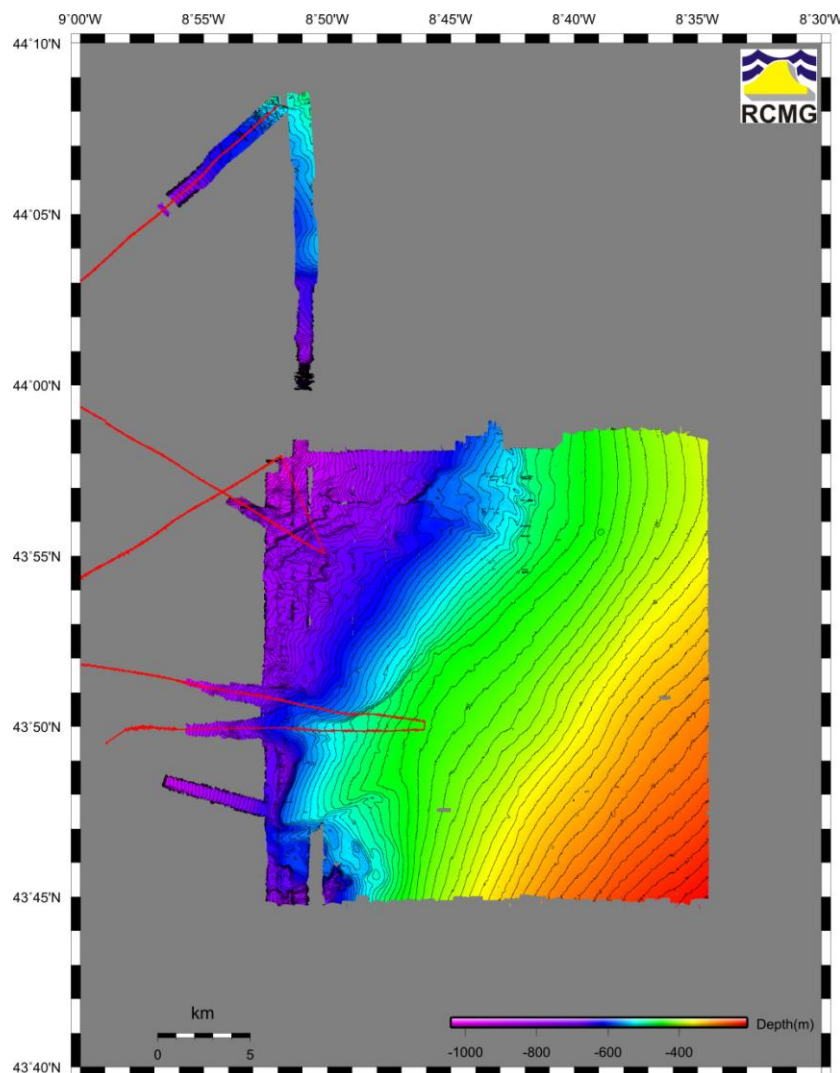
$\theta$  = opening of transducer

$Depth$  = bathymetry

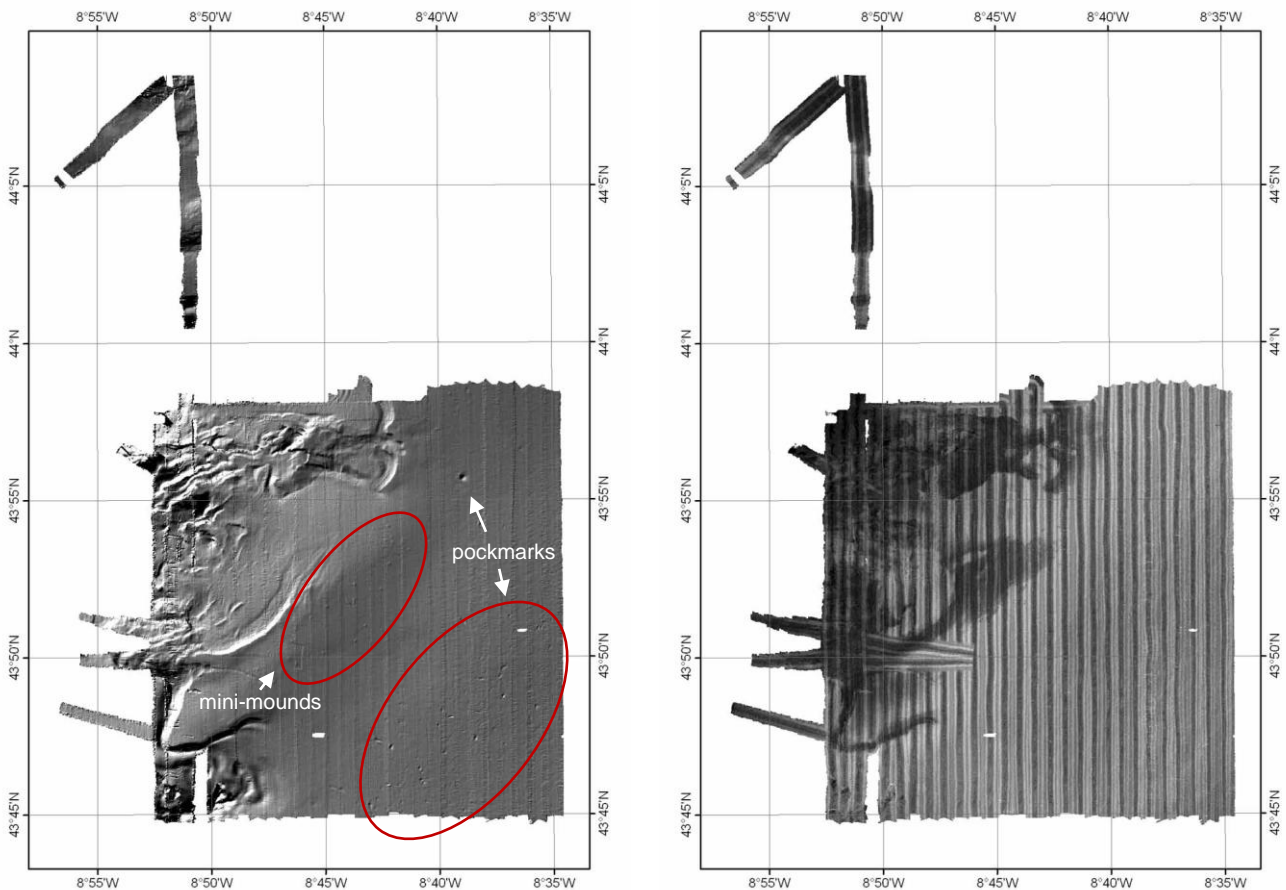
Nevertheless, the backscatter mosaic has been forced to 5 m in precision in order to detect little structures such as patches of deep-water corals or pockmarks. A final raw backscatter model has been build with Epremo and Ereamo molules, without any correction of incident angle, absorption along depth,... (Fig. 11).

### 4.5.3 Preliminary results of the EM1002 multibeam survey

During the course of the campaign, 624 km<sup>2</sup> of multibeam coverage was acquired on the NW slope of the Galician margin (Fig. 12). Also during the seismic survey, multibeam data was acquired (dependant of the water depth).



**Figure 12:** Overview of the acquired multibeam data with position of the seismic profiles (red).

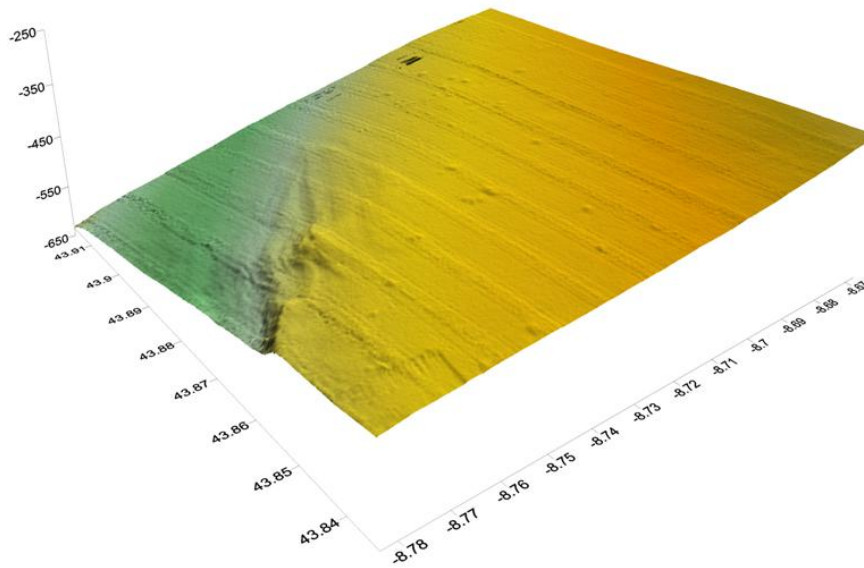


**Figure 13:** *Left;* shaded relief map. *Right;* unprocessed backscatter map.

The multibeam bathymetry and backscatter subdivide the study area in largely three zones. A first zone is defined in between 200 and 400 m water depth, located in the eastern and southeastern part of the study area. This relatively gentle slope is characterized by the presence of many circular and elongated pockmarks (Fig. 13). Their average diameter is about 100 to 250 m with a maximum depth of 5 m. The elongated (probably aligned) pockmarks are 500 to 800 m long. The largest pockmark, located in the north has a diameter of 400 m and a depth of 7 m.

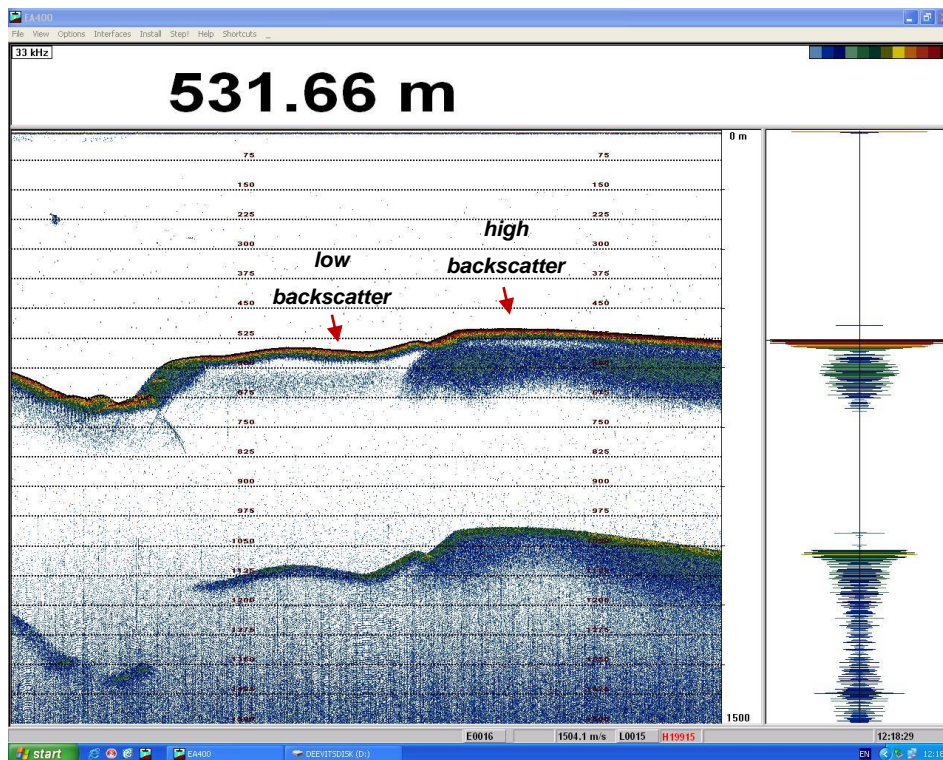
A second zone is defined between 400 and 500 m water depth. Here, about 30 mini-mounds were observed (Fig. 14). These small mounded features are about 200 wide and 2-3 m high. They were also recognized on the backscatter imagery. Similar features were already observed along the Guilvinec (Belgica 2008) and Whittard (MESH 2006) canyon heads in the Bay of Biscay. They are most likely dead or fossil cold-water coral ecosystems.

A third zone is located in the northwestern and western part of the study area below 500 m water depth. This entire zone is affected by the Mediterranean Outflow Water (Fig. 7a). Especially in the northern part, a complex mass-wasting area is observed with two clear slide scars in the shallow part. At this time, we could speculate for the influence of nearby pockmarks. At 43°50'N and 8°50'W, a sharp NE oriented escarpment of about 50 m starts



**Figure 14:** 3D surface map of the minimounds area.

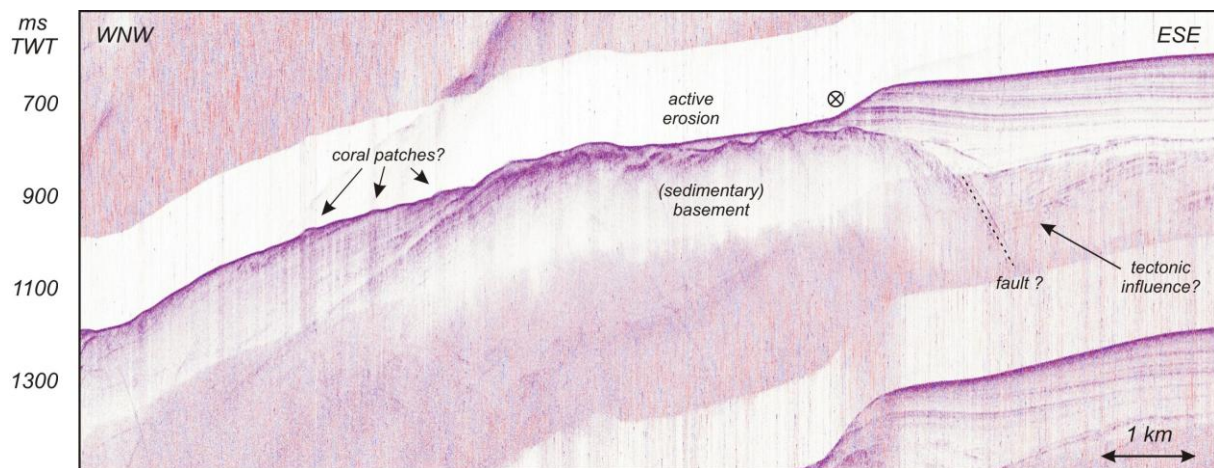
and could indicate the upper zone of MOW turbulence. This area is also characterized by zones of high backscatter. This had a pronounced effect on the EM1002 swath. The high backscatter zones yielded a maximum swath of 1200 m, while in weaker zones the swath was reduced to 800 m. This clear link with the seabed texture was also observed on the 33 kHz echosounder (Fig. 15) where respectively high backscatter zones had strong subseafloor gain and low backscatter only the seabed reflector (hardground?).



**Figure 15:** Screenshot of the EA400 33 kHz echosounder.



#### 4.5.4 Preliminary results of the seismic survey



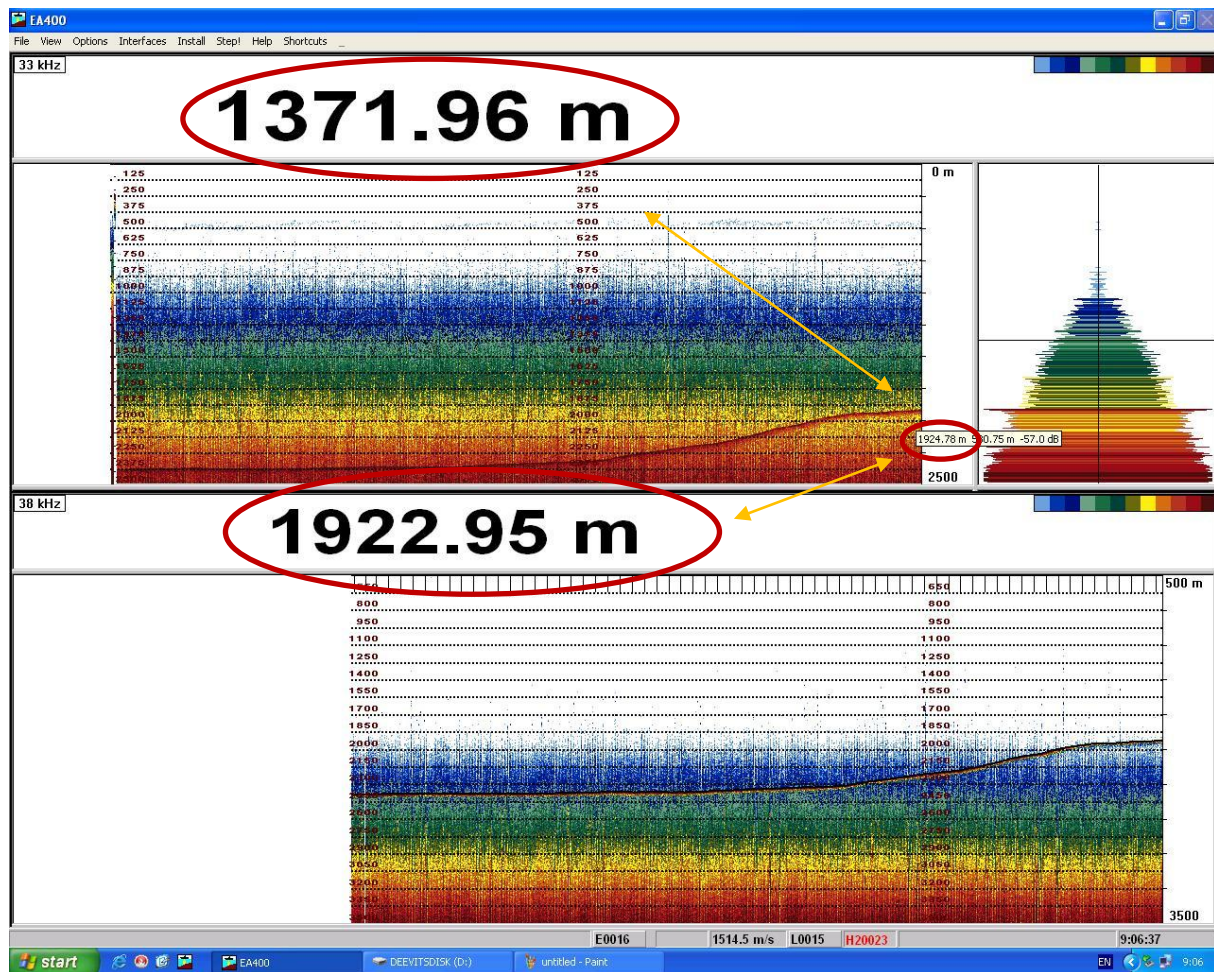
**Figure 16:** Preliminary interpretation of seismic line GM090502 (Location Fig. 6).

During the seismic survey, a total of 7 seismic lines were sailed over a distance of 130 km. The sharp escarpment observed in the multibeam bathymetry has a probably a sedimentary origin where Quaternary sediments are actively eroded by bottom currents from 500 m downwards. This coincides with the upper boundary of the MOW. The vigor of this current is responsible for active erosion on a large part of the slope, sometimes exposing the (sedimentary) basement. Further downwards, recent sediments are deposited as small plastered sediment drifts. Near the upper slope, the seafloor shows the presence of faults and suspected syn-tectonic deposits.

#### 4.5.5 SAT EA400 38 kHz echosounder

The sea acceptance test of the EA400 38 kHz was carried out in 4 steps. The first test over the Armorican margin was not successful seen the bad weather (heavy roll movements of the ship). During the subsequent tests, there was a good operation to 3000 m in good weather conditions.

However, a general problem occurs from the moment the 33 kHz and 38 kHz echosounders become out of range at respectively 1200 and 3000 m water depth. This problem is illustrated in figure 17. The 38 kHz readout gives the correct water depth of 1924 m, while the one of the 33 kHz readout gives an erroneous depth. Manual tracking of the seafloor, however, gives the correct depth. Most probably, the error is located in the EA400 software, since ODAS consequently displays "0" when the echosounder is out of range. A same situation occurs when the 38 kHz echosounder is operated in water depths beyond 3000 m (manual tracking possible to 3200 m).



**Figure 17:** Screenshot of the EA400 33 and 38 kHz echosounder, illustrating erroneous depth readings when the maximum depth range is encountered.

## 5. HERMIONE Blog

Within the framework of EC FP7 IP HERMIONE project, a weblog was made available on <http://www.eu-hermione.net/expeditions/belgicaST0914/index.html>. During this campaign, a report on the scientific and social aspects of the cruise was given over a period of three days. This activity falls under the work package 8 “training and outreach”, with the aim to increase awareness amongst the general public (in its broadest sense) of issues and challenges facing the deep-sea environment and associated ecosystems. This includes the representation of the project’s sea-going activities with video blogs, diaries and stories from scientists and students on board research ships.

## 6. Data storage

During the Belgica 09/14a campaign, 13 seismic lines were acquired over approximately 131 km. These lines were recorded in ELICS format and were converted in a SegY-Motorola format with associated navigation files (these are text files containing shot point, longitude, latitude, date and time). The EM1002 multibeam data also is backed up on DVD, including both the 'raw' and 'proc' data folders. The CTD data has been stored under its original format, but a set of filtered (1-5-10 s) and binned (1 m) files was created and distributed among the shipboard scientists.

The geophysical and CTD data are stored at the RCMG on DVD disks. For more information about these data, please contact

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