IWT SBO PROJECT 120003 "SEARCH"

Archaeological heritage in the North Sea

Development of an efficient assessment methodology and approach towards a sustainable management policy and legal framework in Belgium.

Archeologisch erfgoed in de Noordzee

Ontwikkeling van een efficiënte evaluatiemethodologie en voorstellen tot een duurzaam beheer in België.

SEISMIC CAMPAIGN SIMON STEVIN
13-17 APRIL 2015

WP1.2.3_F

Responsible partners: UG-RCMG, VLIZ
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1. Framework and objectives

1.1. Framework

In April 2015, 395 kilometres of 2D high resolution seismic reflection data were acquired in the Top-Palaeogene Middle and Offshore Platforms of the Belgian Continental Shelf (figure 1) in the framework of the IWT-SBO project SeArch ("Archaeological heritage in the North Sea: development of an efficient methodology and approach towards a sustainable management policy and legal framework in Belgium"). The purpose of this project is to assess the archaeological potential of the Quaternary deposits in the Belgian part of the North Sea. To this date no efficient survey methodology exists that is particularly aimed at archaeological assessment studies. Standard geophysical and remote sensing techniques are mainly used on an *ad hoc* basis (if at all) and these techniques are often not well adapted for archaeological investigations. Moreover they are ineffective in large parts of the nearshore zone due to the presence of biogenic gas in the sediments, and generally cannot be applied appropriately in intertidal areas.

One of the main goals of the SeArch project is to supply a flexible, generic survey methodology through the development and improvement of marine geophysical and remote sensing techniques for seafloor and sub-seafloor imaging, with major focus on acquisition (sources/receivers), data processing and interpretation of high-quality data. This should allow a cost-efficient and accurate assessment of the archaeological potential of the seafloor and sub-seafloor environment.

The acquired data will also be applied in a post-track doctoral research of the SeArch project (IWT PhD grant M. De Clercq). This PhD research aims to develop an 'archaeological potential map' of the Belgian part of the North Sea (BCS) indicating the sensitivity of marine areas to human settlements and their remnants. Such a map will contribute to an increase in cost-efficiency and accurate assessment of marine works at sea regarding the archaeological potential of that working area.

1.2. Survey Objectives

The seismic campaign, carried out on board of the RV Simon Stevin, had multiple objectives:

- Survey areas with low or poor seismic coverage in the Middle and Offshore Platforms.
- Identify archaeological potential of geological layers and seafloor.
- Prospection of suspected fluvial sediments on the Middle and Offshore Scarp, which are presumed to be ancient river terraces from the Meuse and Rhine rivers.

2. Study area

The study area comprises four different zones (figure 1): the Ostend Valley Tidal Channel (OVTC), Ostend Valley-Middle Platform (OVMP), Fairy Bank (FAI) and Thornton Valley-Northern Valley (TVNV).

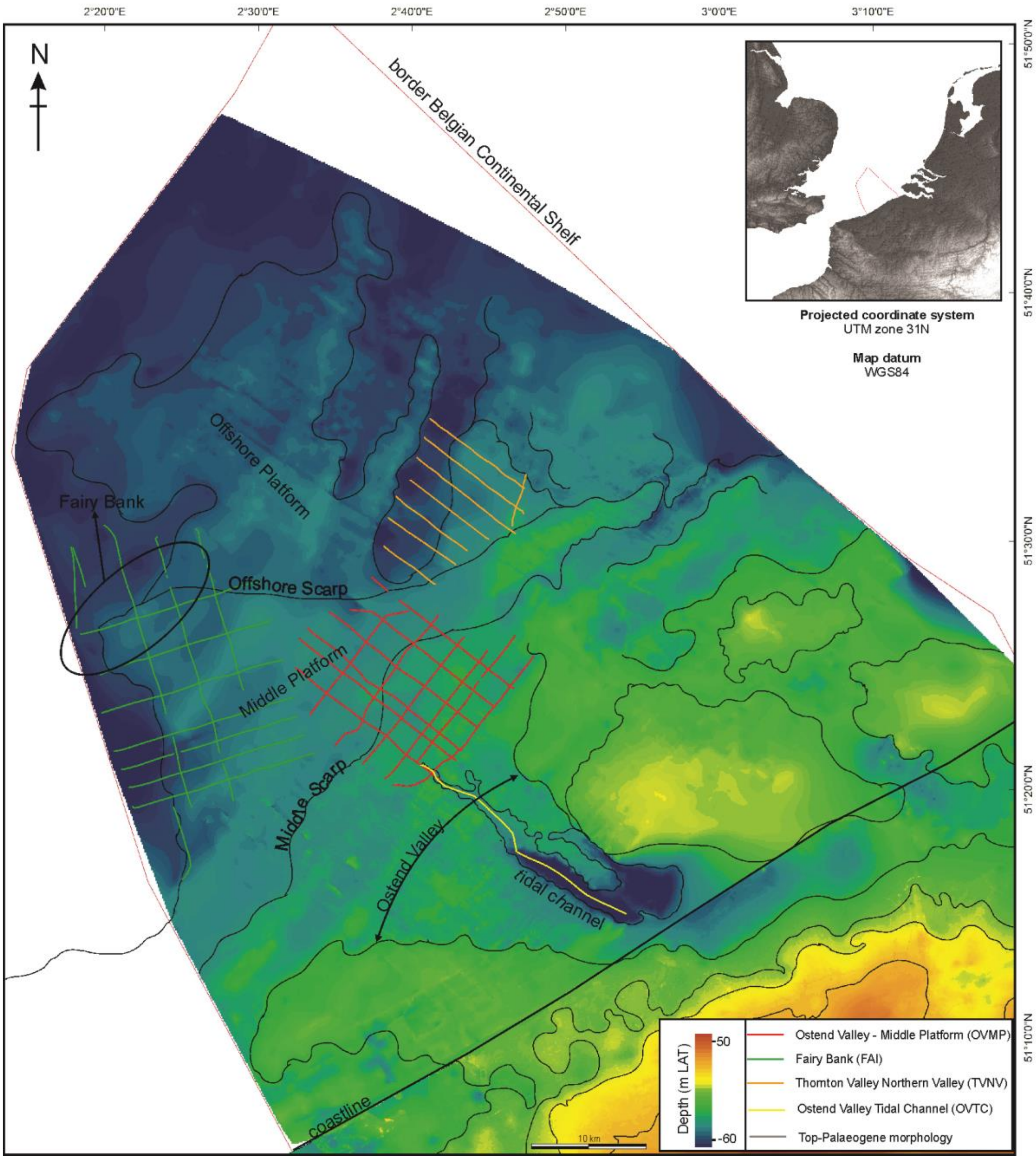

Figure 1 – Study area and performed seismic lines depicted on top of the Top-Palaeogene surface.

3. List of participants

Name	Organisation	Function	13/04	14/04	15/04	16/04	17/04
Tine Missiaen	RCMG	(Chief Scientist 1) Geophysicist	x				
Koen De Rycker	RCMG	Engineer	x	x	x	x	x
Oscar Zurita Hurtado	RCMG	Geophysicist	x	x	x	x	x
Maikel De Clercq	RCMG	(Chief Scientist 2) Geologist	x	x	x		x
Vasileius Chademeinos	RCMG	(Chief Scientist 3) Geophysicist	x	x	x	x	x
Kainan Mao	RCMG	Geologist	x	x	x	x	x
Hanna Beltran	HZS	Student	x	x	x	x	
Wim Versteeg	VLIZ	Geophysicist	x				

Table 1 – List of participants. The position of chief scientist changed during the survey (from 1 to 3) due to early leave of scientific personnel.

4. Data acquisition

4.1. Equipment and seismic characteristics

One seismic source was used throughout the campaign: the GSO 360 tips sparker. We also tested two imaging tools on the first day of the campaign, a video frame, to take video images of the seafloor and a SPI camera, to get images of the first 20 cm bottom sediments.

Equipment	Frequency range	Vertical Resolution	Penetration
GSO 360 tips Sparker	400-800 Hz	50 cm	Up to 200m

Table 1 - Characteristics of the equipment used during the survey.

The seismic source was towed from the middle of the stern of the ship. The longitudinal offset was held at a constant distance of roughly 30m. A single channel streamer (SCS) was towed behind the vessel and was laterally spaced by four metres to the source (see figure 2).

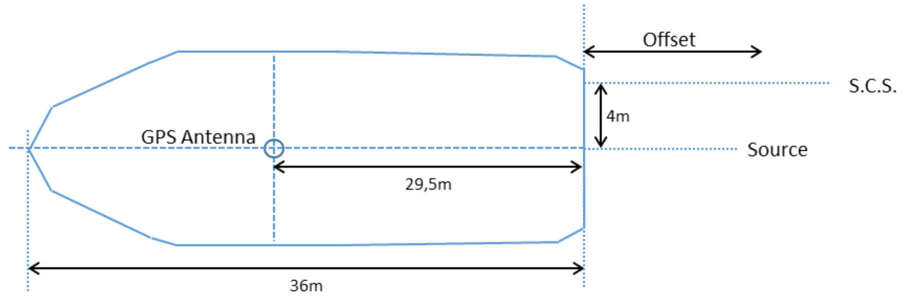

Figure 2 - Sketch of the vessel illustrating the equipment configuration. SCS = Single Channel streamer. Sketch is not to scale.

The video frame was deployed at the port side of the vessel and the SPI was deployed using the A frame located at the stern of the vessel.

Both the video frame and the SPI camera were used on the first day of the campaign as a test. It was however observed that the video frame was not going to be very useful due to problems with currents and algae blooming in this time of the year. The SPI camera was also discarded due to difficulties when penetrating in the upper sediment layers (e.g. bending of the frame).

4.2. Recorded data and networks (sub-areas)

4.2.1. Ostend Valley Tidal Channel (OVTC)

A single line was shot along the western tidal channel in the central part of the Ostend Valley. This line can be regarded as a continuation of previous campaigns within the SeArch project covering the Ostend Valley (see previous reports Oostende Valley seismic campaign 7-9 October 2013 (WP1.2.3_A) and Oostende & IJser Valley seismic campaign 12-16 May 2014 (WP1.2.3_C)). With this line we expect to be able to image the offset changes inside the channel from nearshore to offshore. Until now this has proved challenging because no seismic line ever focused solely on the longitudinal axis of the channel but instead they all cross perpendicular to the tidal channel, are of various sources and resolutions and span a period of 40 years. Now we may be able to track all the different sedimentary facies and the erosional boundaries within the channel and map and visualize them in conjunction with previous data. A question to be resolved is whether this channel is only filled with estuarine sediments or may also contain fluvial sediments from the old palaeo-Scheldt during low sea-level stands such as the Saalian and Weichselian ice ages.

4.2.2. Ostend Valley – Middle Platform (OVMP)

This location was chosen to continue the furthest extensions of the tidal channels within the Ostend Valley. Mathys (2009) interpreted that every morphological feature of the Ostend Valley offshore the Middle Scarp was eroded. However industrial data from the Nemo Link Cable Project showed that these tidal channels continue beyond the Middle Scarp. The question here is how far do these channels extend and what orientation they have. Another hypothesis to be tested here is the presence of the Middle Scarp as a river terrace. This can be recognised by the presence of fluvial sediments on the offshore side of the scarp.

4.2.3. Fairy Bank (FAI)

The Fairy Bank is a Holocene tidal sandbank in the north-western corner of the Belgian Part of the North Sea. Beneath this sandbank a convergence occurs of the Palaeogene Offshore and Middle Platform separated by the Offshore Scarp. West of this convergence zone, following the French-Belgian border southwards, we encounter a deeper area in the Top-Palaeogene surface. Based on current seismic data and literature it is thought that this “channel-like structure” is filled with Pleistocene sediments that could be of fluvial origin of the Meuse and/or Rhine rivers.

4.2.4. Thornton Valley – Northern Valley (TNVN)

This area actually fills up a blank area between the seismic grids of the Hinder Banks to the north and the Thornton Bank and Northern Valley to the east (see previous report Thornton Valley seismic campaign 22-25 April 2014). The area is located north and on the edge of the Offshore Scarp. Again here we can test the hypothesis if the ancient river terrace is still covered with fluvial sediments from the Meuse and/or Rhine rivers.

5. Line Summary

Date	Line No	SOL	EOL	Source	Receiver	Shot Interval (sec)	Sample Rate (ms)	Wind BFT	Speed KN
13/04/2015	OVTC	15:00	17:55	Sparker 360	SCS	1	0,0625		
13/04/2015	OVMP_03	18:00	18:05	Sparker 360	SCS	1	0,0625		
13/04/2015	OVMP_03_01	12:53	19:10	Sparker 360	SCS	1	0,0625		4,5
13/04/2015	OVMP_03_02	19:12	19:18	Sparker 360	SCS	1	0,0625		4
13/04/2015	OVMP_03_03	19:21	19:50	Sparker 360	SCS	1	0,0625		4
13/04/2015	OVMP_01	20:17	22:35	Sparker 360	SCS	1	0,0625		3,5
13/04/2015	OVMP_04	22:49	0:27	Sparker 360	SCS	1	0,0625		4
14/04/2015	OVMP_06	00:33	02:21	Sparker 360	SCS	1	0,0625		4,1
14/04/2015	OVMP_08	02:41	04:41	Sparker 360	SCS	1	0,0625		3,9
14/04/2015	OVMP_10	04:48	06:28	Sparker 360	SCS	1	0,0625		
14/04/2015	FAI_19	06:51	09:07	Sparker 360	SCS	1	0,0625		3,5
14/04/2015	FAI_18	09:19	11:08	Sparker 360	SCS	1	0,0625		4
14/04/2015	FAI_17	11:35	12:45	Sparker 360	SCS	1	0,0625		4
14/04/2015	FAI_17_01	12:51	13:20	Sparker 360	SCS	1	0,0625		4
14/04/2015	FAI_16	13:30	15:30	Sparker 360	SCS	1	0,0625		3,5
14/04/2015	FAI_14	16:03	18:44	Sparker 360	SCS	1	0,0625		
14/04/2015	FAI_12	18:57	20:35	Sparker 360	SCS	1	0,0625		4
14/04/2015	FAI_10	21:00	22:40	Sparker 360	SCS	1	0,0625		
14/04/2015	FAI_10_to_02	22:44	23:14	Sparker 360	SCS	1	0,0625		4
14/04/2015	FAI_02	23:17	02:30	Sparker 360	SCS	1	0,0625	5	4,8
15/04/2015	FAI_03	02:32	05:16	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_03_01	07:35	10:34	Sparker 360	SCS	1	0,0625		4,5
15/04/2015	FAI_04	10:49	13:08	Sparker 360	SCS	1	0,0625		3,5
15/04/2015	FAI_04_01	13:10	13:50	Sparker 360	SCS	1	0,0625		4
15/04/2015	FAI_06	14:21	14:49	Sparker 360	SCS	1	0,0625		4

Date	Line No	SOL	EOL	Source	Receiver	Shot Interval (sec)	Sample Rate (ms)	Wind BFT	Speed KN
15/04/2015	FAI_06_01	-	-	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_06_02	14:51	16:40	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_06_03	16:41	16:42	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_06_04	-	-	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_06_05	-	-	Sparker 360	SCS	1	0,0625		4
15/04/2015	FAI_06_06	-	17:13	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_08	17:38	17:53	Sparker 360	SCS	1	0,0625		
15/04/2015	FAI_08_01	17:57	19:05	Sparker 360	SCS	1	0,0625		4
15/04/2015	OVMP_13	19:41	21:30	Sparker 360	SCS	1	0,0625		4,5
15/04/2015	OVMP_14	21:48	23:46	Sparker 360	SCS	1	0,0625		
15/04/2015	OVMP_15	23:53	01:59	Sparker 360	SCS	1	0,0625		4
16/04/2015	OVMP_17	02:17	04:06	Sparker 360	SCS	1	0,0625		4,5
16/04/2015	OVMP_19	04:25	06:25	Sparker 360	SCS	1	0,0625		
16/04/2015	OVMP_21	06:41	08:03	Sparker 360	SCS	1	0,0625		
16/04/2015	OVMP_21_01	08:20	08:34	Sparker 360	SCS	1	0,0625		
16/04/2015	TVNV_28	08:59	09:33	Sparker 360	SCS	1	0,0625		
16/04/2015	TVNV_27	09:51	10:41	Sparker 360	SCS	1	0,0625		
16/04/2015	TVNV_26	10:50	11:56	Sparker 360	SCS	1	0,0625		4
16/04/2015	TVNV_25	12:10	13:08	Sparker 360	SCS	1	0,0625		4
16/04/2015	TVNV_24	13:15	14:35	Sparker 360	SCS	1	0,0625		
16/04/2015	TVNV_23	14:54	16:08	Sparker 360	SCS	1	0,0625		
16/04/2015	TVNV_22	16:28	17:45	Sparker 360	SCS	1	0,0625		
16/04/2015	TNVN_39	18:01	18:26	Sparker 360	SCS	1	0,0625		

Table 8 - Representation of the characteristics of the recorded seismic lines during the March 2015 survey.

Appendix A

Survey photos

Figure 3 – GSO sparker and SC streamer towed behind the RV Simon Stevin

Figure 4 – Recording laboratory

Appendix B

Survey log (in local time, GMT)

Monday 13th April
09:00 Embarking and installation of equipment on board of RV Simon Stevin
12:00 Installation completed
12:30 Transit to Sepia Pit 3
13:15 Arrival at location and deployment of SPI and videoframe
13:30 Start of testings
14:15 Tests completed and return to Ostend harbour.
14:30 Arrival at Ostend harbour. Wim Versteeg and Tine Missiaen left the vessel.
15:00 Departure from Ostend harbour and deployment of seismic equipment. Transit to OVMP survey area was done while acquiring seismic data.
17:55 Arrival at site. End of Line OVTC
18:00 Start seismic measurements on line OVMP_03

Tuesday 14th March
00:00 Continuation of seismic networks OVMP
06:30 End of night shift acquisition.
07:00 Start seismic measurements on site FAI with line FAI_19
12:00 Continuation of seismic network FAI with line FAI_17
18:00 Continuation of seismic network FAI with line FAI_12

Wednesday 15th March
00:00 Continuation of seismic network FAI with line FAI_02
06:00 Continuation of seismic network FAI with line FAI_03
12:00 Continuation of seismic network FAI with line FAI_04
18:00 Continuation of seismic network FAI with line FAI_08
19:05 End of acquisition on network FAI
19:40 Start seismic measurements on site OVMP with line OVMP_13

Thursday 16th March
00:00 Continuation of seismic network OVMP with line OVMP_15
06:00 Continuation of seismic network OVMP with line OVMP_19
08:35 End of acquisition on network OVMP
09:00 Start seismic measurements on site TNVN with line TNVN_28
18:30 End of seismic measurements due to bad weather; sparker and streamer hauled in; transit to Ostend.
20:30 Arrival at the quay in Ostend.

Friday 17th March
08:00 – 11:00 Demobilization of equipment from RV Simon Stevin.

Literature

Mathys, M., 2009. The Quaternary geological evolution of the Belgian Continental Shelf, southern North Sea, PhD thesis, Ghent University, Belgium.