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
09-13 MAY 2016

WP1.2.3_G

Responsible partners: UG-RCMG, VLIZ
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May 2016

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1. Framework and objectives

1.1. Framework

In May 2016, 395 kilometres of 2D high resolution seismic reflection data were acquired in the northern and north-western part 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:

- Increase the data density in areas with scarce seismic coverage in the northern and north-western part of the Belgian Continental Shelf
- Identify the archaeological potential of the buried geological layers and the seafloor

2. Study area

The study area comprises the northern and north-western part of the Belgian Continental Shelf (BCS) extending into the Dutch and British borders (Figure 1). This area is believed to be strongly influenced by fluvial processes by the Rhine and the Meuse during periods of lower sea-level. It is these depositional environments of specifically the last ice age (Weichselian) that have been preserved.

The main aim of this survey was to image these preserved sediments and their environments in high detail. The results will allow a better insight in the different pathways of the

Rhine/Meuse river system (a hot-spot for possible prehistoric habitation), its connection to the Thornton valley system, and its relation with the river trajectories identified on the adjoining Dutch continental shelf.

In total 24 seismic lines were recorded during the survey (16 SW-NE lines, 5 NW-SE lines, 3 transit lines, see Figure 1). A large part of the western survey area coincided with major shipping lanes (a.o. access route to the Scheldt estuary) and in order to prevent any navigation problems long NW-SE oriented lines (crossing the shipping lane) were avoided in this area.

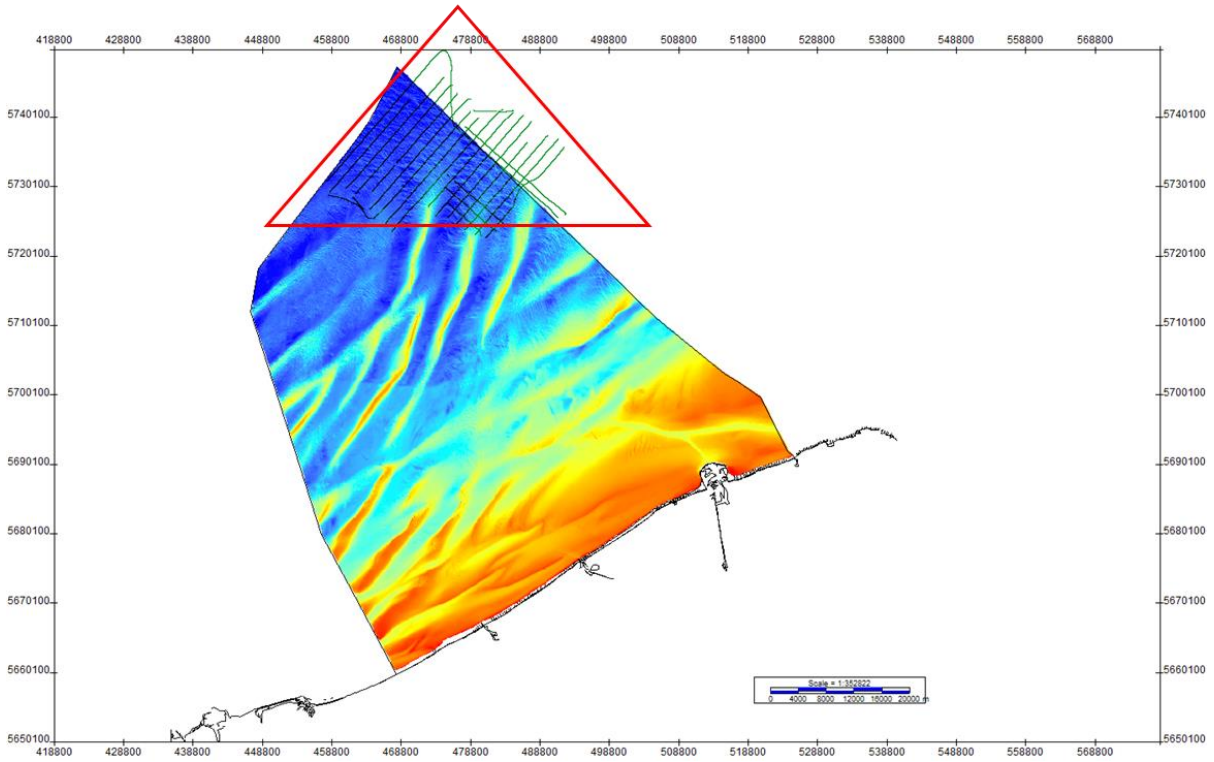

Figure 1 – Study area (red triangle) and recorded seismic profiles (black/greenlines) depicted on top of the seafloor bathymetry.

3. List of participants

Name	Organisation	Function	09/05	10/05	11/05	12/05	13/05
Tine Missiaen *	RCMG	(Chief Scientist) Geophysicist	x	x	x	x	x
Oscar Zurita Hurtado	RCMG	Geophysicist	x	x	x	x	x
Vasileios Chademeinos	RCMG	Geologist	x	x	x	x	x
Ricardo Marte	UGent	Student	x	x	x	x	x
Wim Versteeg	VLIZ	Geophysicist	x	x	x	x	x

*Table 1 – List of participants. Chief scientist is marked with **

4. Operations and data acquisition

4.1. Equipment and specifications

Two seismic sources were used throughout the campaign:

Equipment	Frequency range	Vertical Resolution	Penetration
GSO 360 tips Sparker	400-800 Hz	50 cm	Up to 200m
SIG Sparker 1200	800-900	> 0.50 cm	Up to 200m

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

A single channel (SC) streamer was used to register the data. The 360 tips sparker was rented from the company GSO.

The seismic source was towed at starboard of the ship and the SC streamer was towed at port side. The longitudinal offset was held at a constant distance of roughly 25 m. The source and the streamer were laterally spaced by roughly 6 m (see Figure 2).

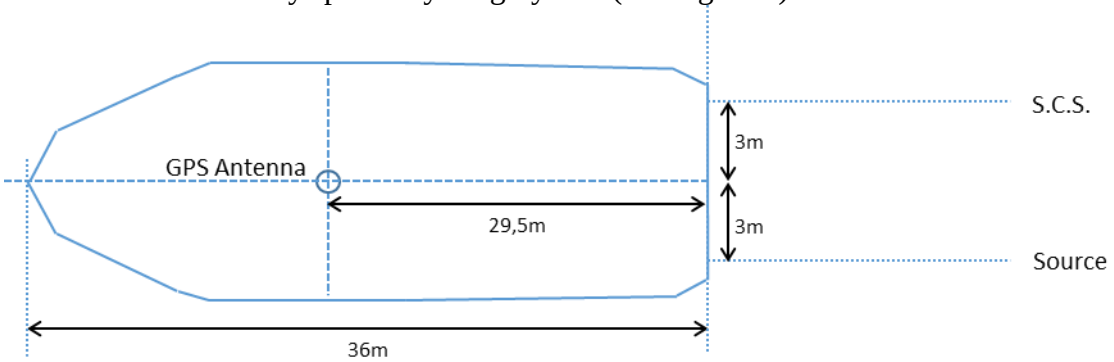

Figure 2 - Sketch of the vessel illustrating the equipment configuration.
SCS = Single Channel streamer. Sketch is not to scale.

4.2. Survey log

Monday 09th May
09:00 Embarking and installation of equipment on board of RV Simon Stevin
13:00 Test of the GSO sparker source in the harbour
14:00 Departure from harbour and transit to survey area
17:15 Arrival at survey area and deployment of seismic instruments in the water
17:30 Start seismic measurements on line DUN16_09

Tuesday 10th May
00:00 – 24:00 Continuation of seismic acquisition

Wednesday 11th March
00:00 – 24:00 Continuation of seismic acquisition

Thursday 12th March
00:00 – 14:00 Continuation of seismic acquisition
14:20 Problems with the GSO power supply; GSO sparker is taken out of the water
15:00 Installation of SIG sparker and RCMG power supply
15:30 Deployment of seismic instruments in the water
16:00 Weather conditions are deteriorating very fast
20:00 End of seismic measurements; sparker and streamer are taken out of the water
20:30 Transit to Ostend
24:00 Arrival at the quayside in Ostend

Friday 13th March
08:00 – 12:00 Demobilization of equipment from RV Simon Stevin

4.3. Wave height average

Figure 3 shows the evolution of the average wave height during the seismic campaign. Marine seismic measurements are optimally performed with wave heights of < 1m. Above 1 m the data quality starts to deteriorate fast. On Thursday evening (12/5) wave heights of 1.2 to 1.5 m were reached and due to the increasingly poor quality of the recorded data the seismic survey had to be stopped.

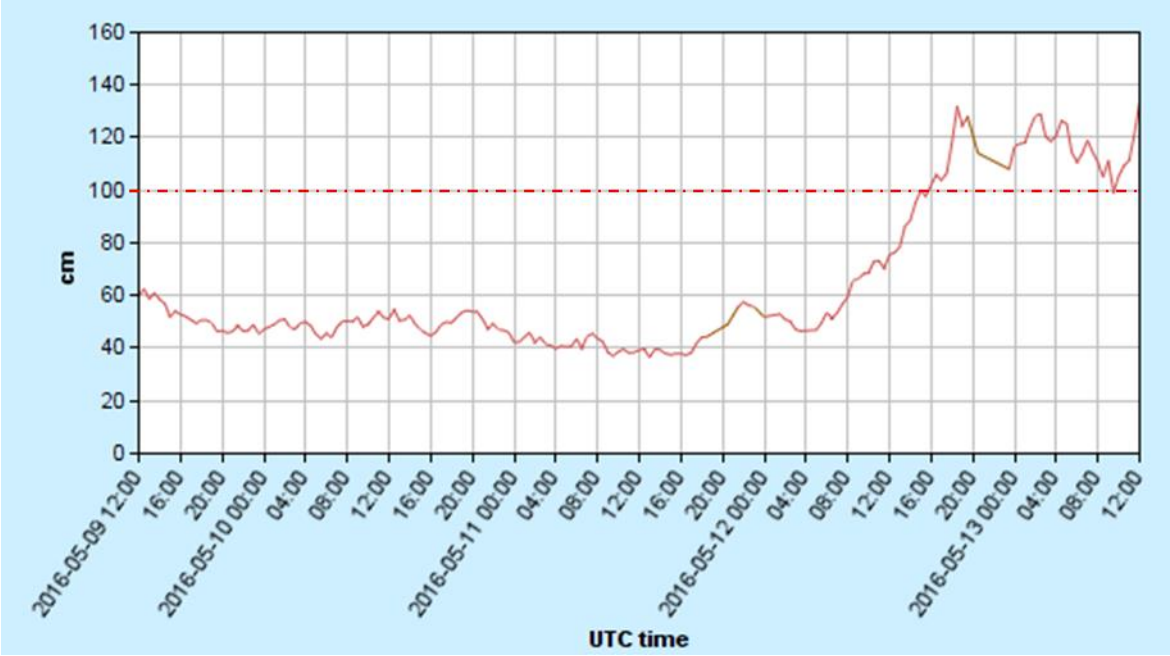

Figure 3 - Wave height measurement obtained from pile Westhinder. Source: VLIZ http://www.vliz.be/.

5. Line Summary

Date	Line No	SOL	EOL	Source	Receiver	Shot Interval (sec)	Sample Rate (ms)	Wind BFT	Speed KN	Direction
09/05/2016	DUN16_09	17:40	20:10	Sparker 360	SCS	0.750	0,1	3	4	SW-NE
09/05/2016	DUN16_06	20:30	23:15	Sparker 360	SCS	0.750	0,1	4	3	NE-SW
09/05/2016	DUN16_trans_06_12	23:20	23:35	Sparker 360	SCS	0.750	0,1	2-3	3	NW-SE
09/05/2016	DUN16_12	23:42	02:48	Sparker 360	SCS	0.750	0,1	3	3-4	SW-NE
10/05/2016	DUN16_15	03:22	06:50	Sparker 360	SCS	0.750	0,1	3	3-4	NE-SW
10/05/2016	DUN16_14	07:00	10:02	Sparker 360	SCS	0.750	0,1	3	4	SW-NE
10/05/2016	DUN16_38	10:24	13:01	Sparker 360	SCS	0.750	0,1	2-3	4	NW-SE
10/05/2016	DUN16_37	13:07	15:31	Sparker 360	SCS	0.750	0,1	2-3	4	SE-NW
10/05/2016	DUN16_trans_37_03	15:39	17:10	Sparker 360	SCS	0.750	0,1	3-4	4	SE-NW
10/05/2016	DUN16_03	17:10	21:40	Sparker 360	SCS	0.750	0,1	4	3-4	NE-SW
10/05/2016	DUN16_05	22:13	02:16	Sparker 360	SCS	0.750	0,1	4	3	SW-NE
11/05/2016	DUN16_36	02:25	03:20	Sparker 360	SCS	0.750	0,1	4	3	NE-SW
11/05/2016	DUN16_04	03:25	06:38	Sparker 360	SCS	0.750	0,1	4	3	NE-SW
11/05/2016	DUN16_trans_04_13	06:43	08:02	Sparker 360	SCS	0.750	0,1	3	3	W-E
11/05/2016	DUN16_13	08:02	11:25	Sparker 360	SCS	0.750	0,1	3	4	SW-NE
11/05/2016	DUN16_trans_13_16_A	11:30	12:19	Sparker 360	SCS	0.750	0,1	3	4	W-E
11/05/2016	DUN16_trans_13_16_B	12:20	12:48	Sparker 360	SCS	0.750	0,1	3	4	W-E
11/05/2016	DUN16_16	12:50	15:07	Sparker 360	SCS	0.750	0,1	3	4	NE-SW
11/05/2016	DUN16_17	15:26	18:14	Sparker 360	SCS	0.750	0,1	4	4	SW-NE
11/05/2016	DUN16_18	18:30	22:10	Sparker 360	SCS	0.750	0,1	4	3	NE-SW
11/05/2016	DUN16_19	22:25	02:05	Sparker 360	SCS	0.750	0,1	4	3	SW-NE
12/05/2016	DUN16_20	02:53	05:48	Sparker 360	SCS	0.750	0,1	5	3	NE-SW
12/05/2016	DUN16_21	06:02	08:49	Sparker 360	SCS	0.750	0,1	5	3	SW-NE
12/05/2016	DUN16_22	09:12	12:05	Sparker 360	SCS	0.750	0,1	5	3	NE-SW
12/05/2016	DUN16_31_A	12:22	14:20	Sparker 360	SCS	0.750	0,1	5	3	SE-NW

Date	Line No	SOL	EOL	Source	Receiver	Shot Interval (sec)	Sample Rate (ms)	Wind BFT	Speed KN	
12/05/2016	DUN16_31_B	15:43	17:00	SIG Sparker	SCS	0.750	0,1	5	4	NW-SE
12/05/2016	DUN16_33	17:13	19:00	SIG Sparker	SCS	0.750	0,1	5	4	SE-NW

Table 8 - Representation of the characteristics of the recorded seismic lines during the May 2016 survey. In local time, GMT + 2

Appendix A

Survey photos

Figure 4 – GSO sparker soure (left) and high voltage power supply units(right)

Figure 5 – GSO sparker and SC streamer towed behind the RV Simon Stevin

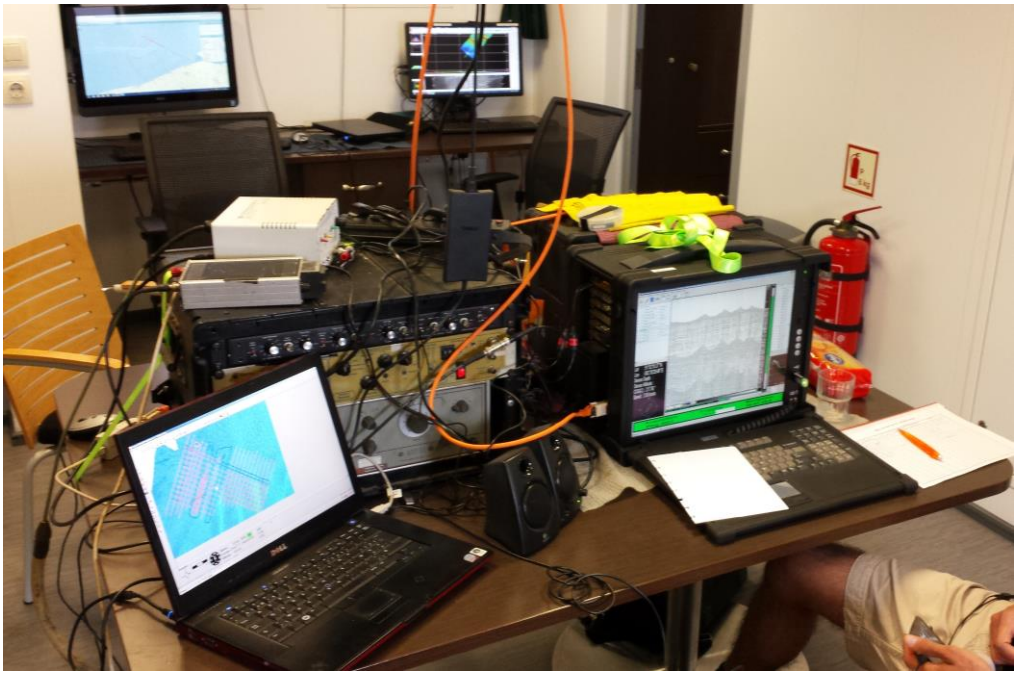

Figure 6 – Recording laboratory on board the RV Simon Stevin