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.

ZEEBRUGGE VALLEY AND SEPIA PITS SEISMIC CAMPAIGN 23-27 MARCH 2015

WP1.2.3. E

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1. Framework and objectives

1.1. Framework

In March 2015 128 kilometres of 2D high resolution seismic reflection data were acquired offshore Ostend and the eastern Belgian coast as part 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 Belgica, had multiple objectives:

- Test different seismic sources and receiver configurations in different geological settings of the Belgian Continental Shelf.
- Test different seismic sources on areas with biogenic gas occurrence.
- Test long offset acquisition configurations using two vessels at the same time, one vessel acting as source vessel and the other as receiver vessel.
- Identify archaeological potential of geological layers and seafloor.

2. Study area

The study area comprises three different zones (figure 1): the so-called Sepia Pit 3 as part of the larger Ostend Valley, the central Marginal Platform and the area bordering the *Vlakte van de Raan*.

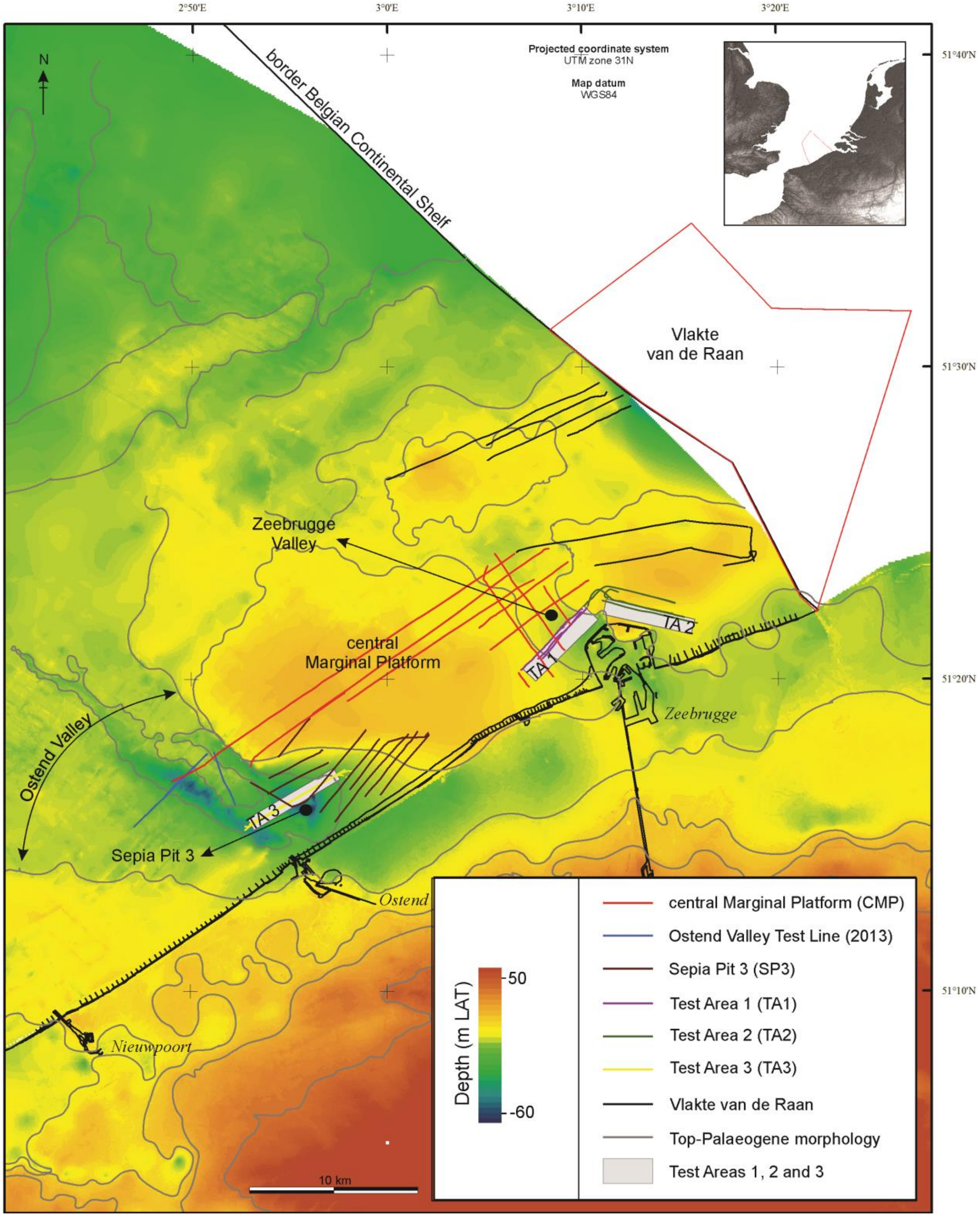

Figure 1 – Study area and performed seismic lines depicted on top of the top-Palaeogene surface.

The seismic grids covering the nearshore area are shown in figure 1. Additionally three small test zones, known for presenting a high concentration of gassy sediments, were defined to explore the efficiency of different source and receiver configurations to characterize the sediments in and below the gas (figure 1). Two of these zones were located offshore the port of Zeebrugge (one west of the harbour, TA1, and the other east of the harbour, TA2). The last test zone was located offshore Ostend (TA3) and is located on top of the Sepia Pit 3 (SP3).

3. List of participants

Name	Organisation	Function	23/03	24/03	25/03	26/03	27/03
Tine Missiaen	RCMG	Chief Scientist	x	x	x	x	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	Geologist	x	x	x	x	x
Vasileius Chademeinos	RCMG	Geophysicist	x	x	x	x	x
Mike van der Werf	Deltares	Engineer	x	x	x	x	x
Christopher Mestag	Deltares	Geophysicist	x	x	x	x	x
Wim Versteeg	VLIZ	Geophysicist	x	x	x	x	x
Gordan Helinger	GSO	Engineer	x	x	x	x	x

4. Data acquisition

4.1. Equipment and seismic characteristics

Different seismic sources were used throughout the campaign: (1) Sleeve gun, (2) Centipede sparker, (3) SIG sparker, (4) Geo-Source 200 sparker, (5) GSO 360 tips sparker and (6) Parametric Echosounder. Each source has a particular frequency range output resulting in high- or low-resolution images with a low- or high-penetration into the subsurface (see Table 1).

Equipment	Frequency range	Vertical Resolution	Penetration
Sleeve gun	150-250 Hz	> 50 cm	Up to 1000m
Geo-Source 200 Sparker	400-800 Hz	50 cm	Up to 200m
GSO 360 tips Sparker	400-800 Hz	50 cm	Up to 200m
SIG sparker	800 - 900 Hz	50 cm	In a sandy sea bottom, up to 100 m
Centipede sparker	1100 – 1200 Hz	> 35 cm	in a sandy sea bottom, up to 50 m
Parametric Echosounder (PES)	6 - 12 kHz / 100 kHz	15 cm	in soft sediments up to 30 m

Table 1 - Characteristics of the equipment used during the survey.
Centipede and GSO sparkers were used only during night shifts

All seismic sources (excluding the parametric echosounder PES) were towed from the middle of the stern of the ship. The longitudinal offset was held at a constant distance of 30m. The parametric echosounder was attached to a specifically designed mounting pole at the port side of the vessel (see Figure 2).

When applicable, two different types of receivers were used to register the data; (1) a single channel streamer (SCS) and (2) a multichannel streamer (MCS; 48 channels). Both streamers were towed behind the vessel and were laterally spaced by four metres. The single channel streamer was towed at port side while the multichannel streamer was always positioned one meter to the starboard side compared to the middle of the stern (figure 2).

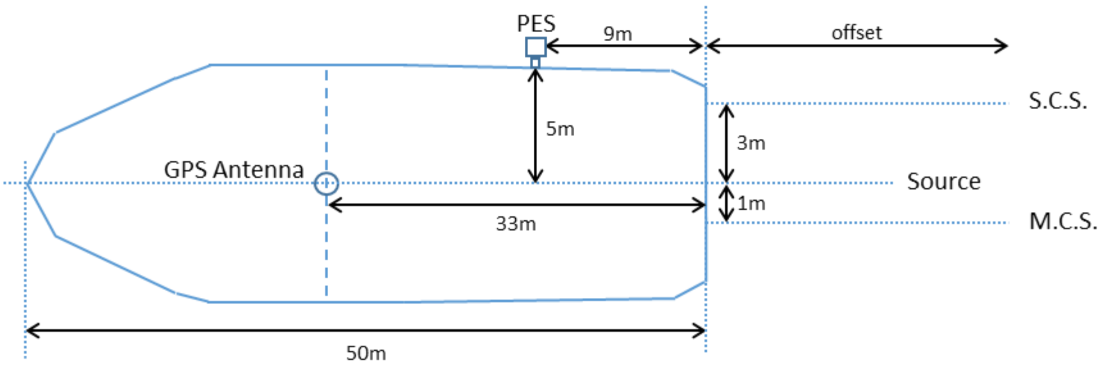

Figure 2 - Sketch of the vessel illustrating the equipment configuration.
SCS = Single Channel streamer; MCS = Multichannel streamer.
Sketch is not to scale

4.2. Recorded data and networks (sub-areas)

4.2.1. Ostend Valley Test Line (TL)

A number of profiles were recorded over the same seismic test line in the Ostend Valley that had previously been used during the 2013 and 2014 campaigns. The test line (OVTL figure 1) was covered three times with two different seismic sources, both of which hadn’t been tested previously, the Sleeve gun and the Geo Source 200 (table 2). This brings the total number of different tested acoustic sources on this test line to nine.

Line No	Source	Source Offset (m)	S. Ch Offset (m)	M. Ch Offset (m)
OVTL_001	Sleeve Gun	10-15	30	30
OVTL_001_t	Sleeve Gun	10-15	30	30
OVTL_002	Geo-Source 200	20-25	30	30

Table 2 - Acquisition configuration in test line TL (Ostend Valley).

4.2.2. Gassy zone Test Areas (TA1-2-3)

As stated previously, different test areas were chosen due to the presence of biogenic gas in the subsurface. The presence of gas in shallow marine environments severely affects the propagation of acoustic energy. This leads to the creation of a variety of seismic signatures on seismic profiles. Acoustic turbidity and blanking are the most frequently cited evidences, but other signatures such as reflectors with enhanced amplitude or reversed polarity, reverberation, and velocity pull-down are also well-known indicators of gas. Zones TA1 and TA2, respectively on the western and eastern side of the harbour of Zeebrugge, are located on top of the Zeebrugge Valley, a smaller outflow of the old paleo-Scheldt river into the North Sea. TA1 is located on the gradual edge of the valley and TA2 is located on the edge of a steep cuesta. Both areas are surveyed in preparation of geotechnical investigations that are planned in this zone in the framework of future construction works. The goal is to test different types of equipment and configurations for their efficiency to penetrate the gassy sediments and image the top-Palaeogene surface and the underlying Tertiary deposits in more detail. Knowledge and good high-resolution imaging here is crucial to plan the geotechnical investigations (deep cores and CPTs) and future harbour works. Zone TA3 corresponds to a section of the Sepia Pits which will be explained in chapter 4.2.3.

Line No	Source	Source Offset (m)	S. Ch Offset (m)	M. Ch Offset (m)
TA1_01	Centipede	25	30	30
TA1_10	Sleeve Gun	10-15	15	30
TA1_11	Sleeve Gun	10-15	15	30
TA1_12	GSO 360 sparker	20-25	30	30
TA2_01	Centipede	25	30	30
TA2_02	Sleeve Gun	10-15	30	30
TA2_03	Sleeve Gun	10-15	15	30
TA2_04	Sleeve Gun	10-15	15	30
TA2_05	GSO 360 sparker	20-25	30	30
TA2_06	Centipede	25	30	30
TA3_01	GSO 360 sparker	20-25	30	30
TA3_02	Sleeve Gun	10-15	30	30
TA3_03	Centipede	25	30	30
TA3_04	Sleeve Gun	10-15	30	30
TA3_10	GSO 360 sparker	20-25	30	N.A.
TA3_11	GSO 360 sparker	20-25	30	N.A.

Table 3 - Acquisition configuration in test areas TA1, TA2 and TA3 (gassy zones).

4.2.3. Sepia Pits seismic network (SP)

The so-called Sepia Pits are three deep scour hollows or pits that are part of the deeper tidal channels present in the Ostend Valley, the largest outflow of the old palaeo-Scheldt in the Belgian part of the North Sea. The northernmost pit is located in the previously recorded Ostend Valley network (see reports of 2013 and 2014) and is thus well studied and has a good seismic coverage. The configuration of the two near coastal pits however is not well known, because of the (partly) presence of biogenic gas and lack of seismic coverage. During this survey it was therefore intended to get a better image of these two pits (e.g. Sepia Pits 2 and 3).

Line No	Source	Source Offset (m)	S. Ch Offset (m)	M. Ch Offset (m)
SP3_01	Centipede	25	30	N.A.
SP3_01_to_04	Centipede	25	30	N.A.
SP3_04	Centipede	25	30	N.A.
SP3_05	Centipede	25	30	N.A.
SP3_05,5	Centipede	25	30	N.A.
SP3_06	Centipede	25	30	N.A.
SP3_07	Centipede	25	30	N.A.

SP3_08	Centipede	25	30	N.A.
SP3_20	Centipede	25	30	N.A.
SP3_21	Centipede	25	30	N.A.

Table 4 - Acquisition configuration on the Sepia Pits.

4.2.4. central Marginal Platform seismic network (CMP)

The central Marginal Platform forms a higher part of the nearshore Top-Palaeogene surface that is bound by the Ostend and the Zeebrugge Valleys in the west and east respectively. The area is marked by the widespread presence of biogenic gas in the subsurface. This, and its location in very shallow water, is the reason why practically no data are available up to now in this area. It was hoped that enough 'gaps' in the gassy sediments would be present so that we are able to image tis part of the Marginal platform in more detail. The latter is of great importance for palaeogeographic reconstructions of the nearshore area of the BCS.

Line No	Source	Source Offset (m)	S. Ch Offset (m)	M. Ch Offset (m)
CMP_01	Centipede	25	30	N.A.
CMP_01_ext	Centipede	25	30	N.A.
CMP_03	Centipede	25	30	N.A.
CMP_03_01	Centipede	25	30	N.A.
CMP_12	Centipede	25	30	N.A.
CMP_13	Centipede	25	30	N.A.
CMP_14	Centipede	25	30	N.A.
CMP_20	Centipede	25	30	N.A.
CMP_22	Centipede	25	30	N.A.

Table 5 - Acquisition configuration on central Marginal Platform.

4.2.5. Vlakte van de Raan (VLR)

The Vlakte van de Raan borders the SW corner of the BCS. As explained before, this area comprises the eastern Marginal Platform and the Zeebrugge Valley and extends a few kilometres northwards. For unknown reason the seismic coverage in this zone has been very low. Closing the 'seismic gap' in this area is important to get a better idea of the connection with the neighbouring Dutch geology and get a better understanding as to what sediments have been preserved in front of the western Scheldt estuary, a present-day equivalent of the buried Ostend Valley.

Line No	Source	Source Offset (m)	S. Ch Offset (m)	M. Ch Offset (m)
VLR_20	Centipede	25	30	N.A.
VLR_20_1	Centipede	25	30	N.A.
VLR_21	Centipede	25	30	N.A.
VLR_22	GSO 360 sparker	25	30	N.A.
VLR_23	GSO 360 sparker	25	30	N.A.
VLR_24	GSO 360 sparker	25	30	N.A.
VLR_25	GSO 360 sparker	25	30	N.A.
VLR_cross	Centipede	25	30	N.A.

Table 6 - Acquisition configuration on the Vlakte van de Raan.

4.2.6. Long offset tests

Long-offset seismic data are typically marked by source-receiver offsets greater than the depth to the target(s). Long offset data illuminate the subsurface differently from conventional short-offset data and therefore contain additional information about the subsurface (see figure 3). The idea behind this test is to image the sediments below the gas horizon. In order to achieve very long offsets the acquisition was performed with two vessels. While RV Belgica deployed the seismic source (Sleeve gun), the other vessel, RV Simon Stevin, deployed the receivers (24 channel streamer).

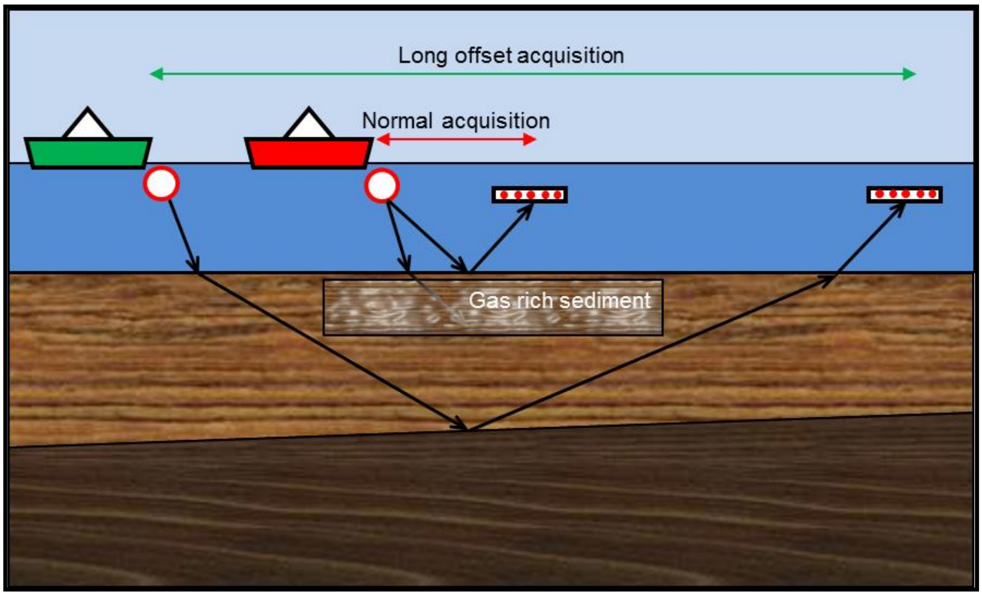

Figure 3 - Long offset acquisition in comparison with normal acquisition.

Three different acquisition configurations were tested:

The first configuration (TAC1) consisted of the two vessels sailing in line separated by a constant distance as depicted in figure 4.

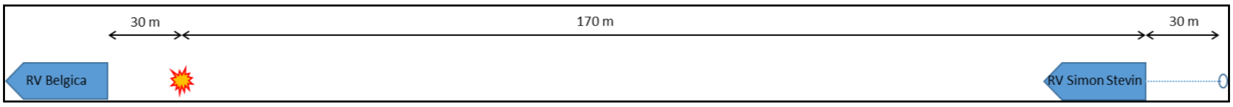

Figure 4 – Long offset acquisition configuration 1 (vessels sailing in line).

The second configuration (TAC2) consisted of the two vessels sailing in parallel separated by a constant distance as depicted in figure 5.

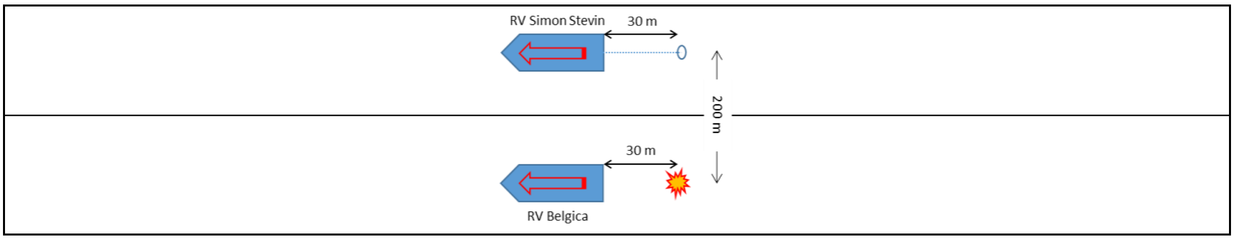

Figure 5- Long offset acquisition configuration 2 (vessels sailing in parallel).

The third configuration (TAC3) tried to replicate a seismic refraction layout, keeping the source (RV Belgica) stationary, while the receiver (RV Simon Stevin) was moving closer and away from the source as shown in figure 6. Four different distances were acquired. This test is aimed at obtaining velocity profiles rather than actually imaging the sediments below the seafloor.

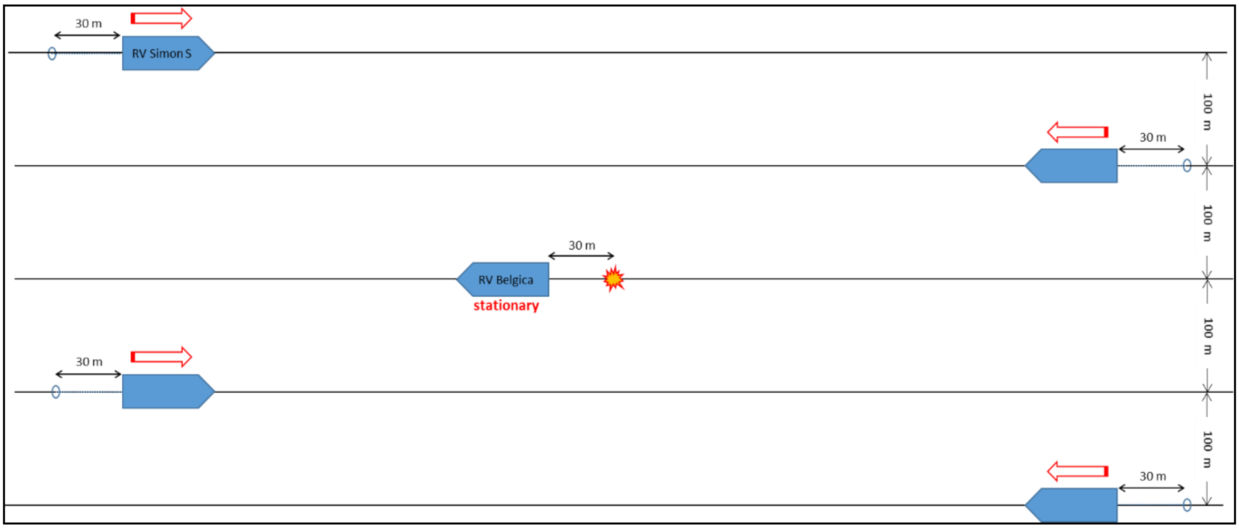

Figure 6 - Long offset acquisition configuration 3 (source vessel stationary and receiver vessels).

In total eight tests were performed as explained in table 7.

Line No	Source	Source Offset (m)	Dist. between vessels (m)	M. Ch Offset (m)	Comments
TAC1_001	Sleeve gun	10-15	200	30	
TAC1_002	Sleeve Gun	10-15	200	30	
TAC2_003	Sleeve Gun	10-15	200	30	
TAC2_004	Sleeve Gun	10-15	300	30	
TAC3_001	Sleeve Gun	10-15	SS 200m north of Belgica	30	
TAC3_002	Sleeve Gun	10-15	SS 100m shout of Belgica	30	
TAC3_003	Sleeve Gun	10-15	SS 100m north of Belgica	30	
TAC3_004	Sleeve Gun	10-15	SS 200m shout of Belgica	30	

Table 7 - Joint acquisition configuration for the long offset tests (configuration 3).

5. Line Summary

Date	Line No	SOL	EOL	Source	Receiver	Shot Interval (s)	Sample Rate (ms)	Wind BFT	Speed KN	Comments
3/23/2015	CMP_03	19:01	19:40	Centipede	SCS	0.5	0.0625	4	5.2	E --> W
3/23/2015	CMP_03_01	19:57	21:08	Centipede	SCS	0.5	0.0625	3	3	W --> E
3/23/2015	CMP_01	21:20	22:55	Centipede	SCS	0.5	0.0625	4	5.5	E --> W
3/23/2015	SP3_01	23:21	23:44	Centipede	SCS	0.5	0.0625	4	5.5	E --> W
3/23/2015	SP3_01_to_04	23:59	00:25	Centipede	SCS	0.5	0.0625	3	4.1	N --> S
3/24/2015	SP3_04	00:26	01:05	Centipede	SCS	0.5	0.0625	3	1.1	W --> E
3/24/2015	SP3_05	01:15	02:20	Centipede	SCS	0.5	0.0625	3	3	E --> W
3/24/2015	SP3_06	02:30	03:15	Centipede	SCS	0.5	0.0625	3	5	W --> E
3/24/2015	SP3_07	03:30	04:59	Centipede	SCS	0.5	0.0625	3	1.5	E --> W, High speed counter currents
3/24/2015	SP3_08	05:09	05:41	Centipede	SCS	0.5	0.0625	3	3	W --> E
3/24/2015	SP3_05,5	05:45	06:48	Centipede	SCS	0.5	0.0625	3	3.2	E --> W
3/24/2015	TA3_01	09:15	10:46	GSO 360 sparker	MCS / SCS	2	0,125 /	3	2.5	W --> E / 1000J
3/24/2015	TA3_02	11:39	12:30	Sleeve gun	MCS / SCS	2	0,125 /	2	3	E --> W (problems with trigger)
3/24/2015	TA3_03	12:53	13:38	Centipede	MCS / SCS	0.5	0,125 /	2	4	W --> E
3/24/2015	TA3_04	14:28	15:47	Sleeve Gun	MCS / SCS	2	0,125 /	3	2	E --> W
3/24/2015	OVTL_001_t	15:59	16:22	Sleeve Gun	MCS / SCS	2	0,125 /	3.5	2.5	S --> N
3/24/2015	OVTL_001	16:31	17:28	Sleeve Gun	MCS / SCS	2	0,125 /	4	3	E --> W
3/24/2015	OVTL_002	17:56	18:57	Geo-Source 200	MCS / SCS	1	0,125 /	5	3.5	W --> E
3/24/2015	SP3_20	20:19	21:23	Centipede	SCS	0.5	0.0625	4	3.5	W --> E
3/24/2015	SP3_21	21:35	22:10	Centipede	SCS	0.5	0.0625	4	3.5	E --> W
3/24/2015	CMP_01_ext	22:40	00:20	Centipede	SCS	0.5	0.0625	4	3.5	W --> E
3/25/2015	CMP_20	00:45	02:35	Centipede	SCS	0.5	0.0625	4	3	weather changed during acquisition

3/25/2015	CMP_14	02:40	02:58	Centipede	SCS	0.5	0.0625	5	4.5	
3/25/2015	CMP_13	03:18	04:47	Centipede	SCS	0.5	0.0625	5	3	
3/25/2015	CMP_12	04:56	06:04	Centipede	SCS	0.5	0.0625	5	3.8	
3/25/2015	CMP_11	06:22	06:38	Centipede	SCS	0.5	0.0625	5	2.5	Line aborted due to time schedule
3/25/2015	TA1_01	06:43	08:28	Centipede	SCS	0.5	0.0625			
3/25/2015	TA2_01	10:26	11:10	Sleeve Gun	MCS / SCS	2	0,125 /			W --> E
3/25/2015	TA2_02	11:23	11:37	Sleeve Gun	MCS / SCS	2	0,125 /	5	4.5	E --> W (gun defective)
3/25/2015	TA2_03	12:03	12:37	Sleeve Gun	MCS / SCS	2	0,125 /	4	3	W --> E (SCS started recording @ 12:13)
3/25/2015	TA2_04	12:48	13:35	Sleeve Gun	MCS / SCS	2	0,125 /	4	4	E --> W
3/25/2015	TA1_10	-	-	Sleeve Gun	MCS / SCS	-	-	-	-	Line interrupted
3/25/2015	TA1_11	14:27	15:53	Sleeve Gun	MCS / SCS	2	0,125 /	4	2	E --> W (MCS started recording @ 14:30)
3/25/2015	TA1_12	16:15	16:50	GSO 360 sparker	MCS / SCS	2	0,125 /	4	4	W --> E (Source on channel 3)
3/25/2015	TA2_05	16:53	17:49	GSO 360 sparker	MCS / SCS	2	0,125 /	5	3	W --> E (Source on channel 3)
3/25/2015	TA2_06	18:10	18:58	Centipede	MCS / SCS	0.5	0,125 /			E --> W
3/25/2015	VLR_20	20:57	22:52	Centipede	SCS	0.5	0.0625	2	2.5	W --> E
3/25/2015	VLR_20_1	22:53	23:16	Centipede	SCS	0.5	0.0625	2	2	E --> W
3/25/2015	VLR_cross	23:45	00:00	Centipede	SCS	0.5	0.0625	3	3.5	
3/26/2015	VLR_21	00:02	01:45	Centipede	SCS	0.5	0.0625	3	4	
3/26/2015	CMP_22	01:46	06:01	Centipede	SCS	0.5	0.0625	3	4.4	
3/26/2015	TAC1_001	10:40	11:01	Sleeve Gun	MCS / SCS	3	0.5			E --> W (Synchronization achieved @ 10:39)
3/26/2015	TAC1_002	11:13	11:46	Sleeve Gun	MCS / SCS	3	0.5			W --> E
3/26/2015	TAC2_003	12:00	12:21	Sleeve Gun	MCS / SCS	3	0.5			E --> W
3/26/2015	TAC2_004	12:31	12:56	Sleeve Gun	MCS /	3	0.5			W --> E

					SCS					
3/26/2015	TAC3_001	14:10	14:25	Sleeve Gun	MCS / SCS	3	0.5		4.5	Simon Stevin 200m north of RV Belgica
3/26/2015	TAC3_002	14:30	14:50	Sleeve Gun	MCS / SCS	3	0.5		3.5	Simon Stevin 100m south of RV Belgica
3/26/2015	TAC3_003	14:55	15:09	Sleeve Gun	MCS / SCS	3	0.5		4.5	Simon Stevin 100m north of RV Belgica
3/26/2015	TAC3_004	15:16	15:45	Sleeve Gun	MCS / SCS	3	0.5		3	Simon Stevin 200m south of RV Belgica
3/26/2015	TA3_10	19:09	19:33	GSO 360 sparker	SCS					
3/26/2015	TA3_11	19:55	20:19	GSO 360 sparker	SCS					
3/26/2015	VLR_22	22:24	01:08	GSO 360 sparker	SCS	0.5	0.0625	6	3	Sparker stop at 00:37
3/27/2015	VLR_23	01:14	02:54	GSO 360 sparker	SCS	0.5	0.0625	6	2.5	
3/27/2015	VLR_24	03:02	04:09	GSO 360 sparker	SCS	0.5	0.0625	6	3.8	
3/27/2015	VLR_25	04:17	05:46	GSO 360 sparker	SCS	0.5	0.0625	6		

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

Appendix A

Survey photos

Figure 8 - Sleeve gun (on the right) on the deck of RV Belgica. On the left the floating frame can be seen.

Figure 9 - Deployment of Sleeve gun and floating frame on RV Belgica.

Figure 10 - GSO 360 tips sparker attached in its floating frame

Figure 11 - RV Belgica leaving the port of Ostend for the long offset tests.

Figure 12 - RV Simon Stevin during the long offset tests.

Appendix B

Survey log (in local time, GMT+1)

Friday 20th March

16:00 Arrival of Deltares equipment to Zeebrugge harbour

Monday 23th March

09:00 Embarking and installation of equipment on board of RV Belgica
18:00 Installation completed
19:00 Transit to seismic network CMP
20:00 Arrival at site. Centipede sparker and single-channel streamer (SCS) in water; start seismic measurements on line CMP_03

Tuesday 24th March

00:00 Continuation of seismic networks CMP and SP.
08:00 End of night shift acquisition.
08:30 Deployment of air gun. Testing failed.
10:00 GSO 360 Sparker, multi-channel streamer (MCS) and SCS in water.
10:15 Start of testing on area TA3.
12:30 Start test line with air gun; problems with trigger. Line continued with Centipede.
15:30 Start final test line with sleeve gun.
16:45 End of testing on area TA3 and transit Ostend Valley Test Line
17:00 Start of Ostend Valley Test Line with sleeve gun (OVTL_001)
18:25 End of Ostend Valley Test Line 001
19:00 Start of Ostend Valley Test Line with Geo-Source 200 sparker (OVTL_002)
20:00 End of Ostend Valley Test Line 002 and transit to seismic network SP.
21:20 Arrival at site. Centipede sparker and single-channel streamer (SCS) in water; start seismic measurements on line SP3_20

Wednesday 25th March

00:00 Continuation of seismic networks SP and CMP.
09:30 End of night shift acquisition; transit to Zeebrugge harbour for installation of PES.
11:00 Installation completed and transit to Test Area 2.
11:30 PES, sleeve gun, multi-channel streamer (MCS) and SCS in water.
17:00 Sleeve gun recovered and GSO 360 tips sparker deployed.
18:45 End of acquisition with GSO 360 tips sparker.
19:00 Centipede sparker deployed.
20:00 End of acquisition with Centipede sparker and transit to Zeebrugge to dismount the PES pole.
21:00 PES dismounted. Transit to seismic network VLR.
22:00 Arrival at site. Centipede sparker and single-channel streamer (SCS) in water; start seismic measurements on line VLR_20.

Thursday 26th March

00:00 Continuation of seismic network VLR.
07:00 End of night shift acquisition and transit to port of Ostend.
08:00 Arrival at port of Ostend and transfer of relevant equipment from RV Belgica to RV Simon Stevin.
10:00 Installation of equipment on RV Simon Stevin completed and transit to test Area 3.
10:30 Arrival at test location and beginning of communication and synchronization tests.
11:30 Tests achieved.
11:40 Beginning of joint operations with two vessels.
16:45 End of joint operations and return to port of Ostend.
17:45 Arrival at port of Ostend and transfer of equipment from RV Simon Stevin back to RV Belgica.

19:00 End of transfer and transit to Test Area 3.
19:45 Arrival at site. GSO sparkers and single-channel streamer (SCS) in water.
21:15 End of tests and transit to seismic network VLR.
23:00 Centipede sparker and single-channel streamer (SCS) in water; start seismic measurements on line VLR_22

Friday 27th March
00:00 Continuation of seismic network VLR.
07:00 End of seismic measurements.; sparker and streamers hauled in; transit to Zeebrugge.
09:00 Arrival at the quay in Zeebrugge.
09:00 – 12:00 Demobilization of equipment from RV Belgica