Hollandse Kust (zuid) – Maasvlakte export cable routes
Subbottom Profiler Assessment of Magnetic Anomalies

Authors

R. van Lil and S. van den Brenk

At the request of

TenneT TSO B.V.
Postbus 718
6800 AS Arnhem

Document Control	
Document 18A014-01 Hollandse Kust (zuid) – Maasvlakte export cable routes, Subbottom Profiler Assessment of Magnetic Anomalies	
Revision	2.1 (FINAL)
Date	06-09-2018
Periplus Archeomare Reference	18A014-01
Tennet reference	

Reviewers	
Organization	Name
TenneT	B. van Boxmeer, J. Grooten
Rijkswaterstaat	R. Duijts, W. Helmich
Rijksdienst voor het Cultureel Erfgoed	M. Snoek, B. Smit

Colophon

Periplus Archeomare Report 18A014-01
Hollandse Kust (zuid) – Maasvlakte export cable routes Subbottom Profiler Assessment of Magnetic Anomalies

Authors: R. van Lil and S. van den Brenk

At the request of TenneT TSO B.V.
Contacts: B. van Boxmeer en J. Grooten

© Periplus Archeomare, September 2018
Photographs and drawings are owned by Periplus Archeomare, unless specified differently

All rights reserved. No part of this publication may be reproduced in any form or by any means without the prior permission of the Publisher. Periplus Archeomare BV does not accept any liability for damage resulting from the advice or the use of the results from this investigation.

ISSN 2352-9547

Revision details

Revision	Description	Authors	Checked by	Authorization	Date
2.1	FINAL small textual edits	RvL/SvdB	BvM	BvM	06-09-2018
2.0	FINAL	RvL/SvdB	BvM	BvM	25-06-2018
1.1	Client Comments Addressed	RvL/SvdB	BvM	BvM	28-05-2018
1.0	For Client Comments	RvL/SvdB	BvM	BvM	02-05-2018

Authorization:

B.E.J.M. van Mierlo

Periplus Archeomare
Kraanspoor 14
1033 SE - Amsterdam
Tel: 020-6367891
Email: info@periplus.nl
Website: www.periplus.nl

Content

Table 1. Administrative details

Location:	North Sea	
Toponym Dutch:	Hollandse Kust (zuid) – Maasvlakte export cable routes	
Chart:	1801-07	
Coordinates (enveloping framework) Geodetic datum: ETRS89 Projection: UTM31N	Centre	E 572 042 N 5 778 372
	North	E 570 995 N 5 797 579
	South	E 571 248 N 5 759 691
Depth (LAT):	10.0 to 28.3; average 20.4 meter	
Surface area	63.8 km^2	
Environment:	Tidal currents, salt water	
Area use:	Shipping lane, fishing and recreation, sand extraction	
Competent Authority Water Permit:	Rijkswaterstaat Sea and Delta	
Coordinating Competent Authority RCR Procedure:	Ministry of Economic Affairs & Climate	
Advisor authorities	Dutch Cultural Heritage Agency	
ARCHIS3 research CIS-code:	4010360100	
Periplus-project reference:	18A014-01	
Survey period	2017	

1 Introduction

1.1 Background

Periplus Archeomare conducted an archaeological assessment of geophysical survey data acquired in 2017 by Fugro Survey BV. The survey was carried out in the course of the planned installation of export cables from the future Wind Farm Zone Hollandse Kust (zuid)[1] to the Maasvlakte (Periplus report 16A021-01).

Within the surveyed area, a total of 63 large magnetic anomalies (> 500 nT) were reported. These anomalies could neither be correlated to known objects (cables or pipelines) nor to the structures and objects found exposed at the seabed in the side scan sonar and multibeam records. These anomalies are therefore related to unknown ferrous objects buried in the seabed which are potentially of archaeological interest. It should be stressed that the origin of the magnetic anomalies is unknown and apart from possible archaeological remains any type of man-made objects can be encountered including unexploded ammunition, anchors, pieces of chains and cables, debris, etcetera.

As long as the archaeological value of these objects is not determined, it was advised not to carry out cable trenching or other activities disturbing the seabed near the potential archaeological objects including a buffer zone of 100 meters around. The buffer zones of 26 anomalies conflict with the proposed cable routes (version RPL07, see figure 1).

During a meeting with the RCE in February 2018 it was concluded that a reroute around all the buffer zones was not feasible. In order to reduce the 100 meter buffer zone, more details on the nature of the magnetic anomalies was needed.

1.2 Assignment

In order to obtain additional information of the character of the objects or structures inducing the magnetic anomalies TenneT has contracted Periplus Archeomare BV to analyse raw subbottom profiler data of the export cable routes.

[1] abbreviation Wind Farm Zone Hollandse Kust (zuid) = HKZ WFZ.

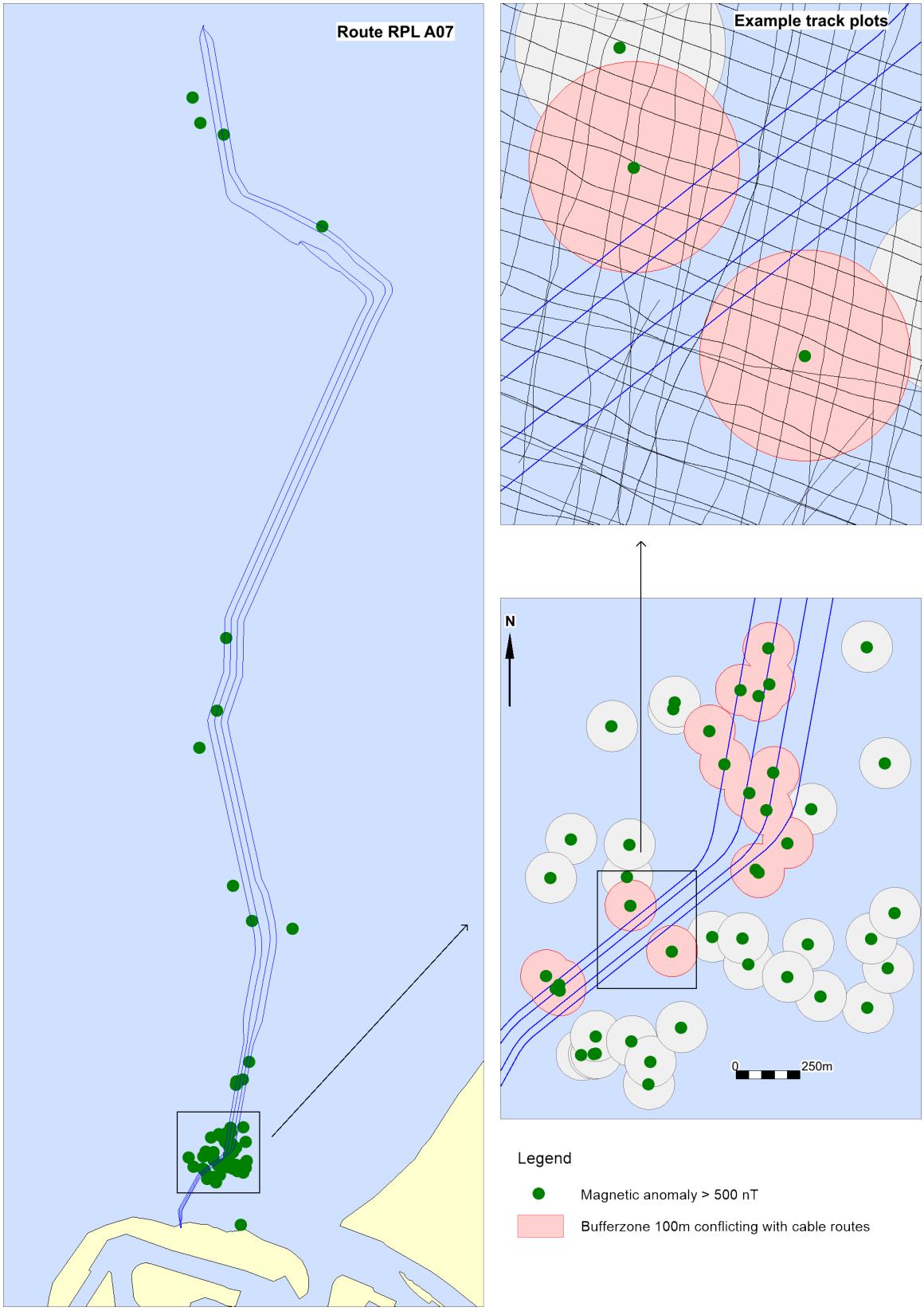


Figure 1. Magnetic anomalies found during the 2017 survey campaign

2 Methodology

At the time, the subbottom profiler records were interpreted by the Fugro for geological purposes. The data was processed to identify geological units and determine the vertical and lateral occurrence and continuity of those units. The level of detail during geological interpretation does not comply with the required level of detail for archaeology. Therefore a renewed analysis and interpretation of the raw subbottom profiler records is carried out as follows.

The data were collected with an Innomar 200 medium sub bottom profiler. The data output (Innomar .RAW and .SES-files) was converted on board into SEG-Y formatted. On request Fugro supplied Periplus with the original raw data (.RAW files) for this analysis. All the sailed subbottom lines crossing the 100 meter buffer zones of the 26 magnetic anomaly locations were selected for in detail analysis. A listing the survey lines is included in Appendix 1.

The assessment of the raw Innomar data should enable identifying and exclude large archaeological objects such as wooden wrecks. In order to acquire the additional information needed all subbottom profiler data within a 100 meter radius around the magnetic anomalies were analysed to identify wrecks of aircrafts, shipwrecks or other associated objects.

In order to meet the goal of identifying ship wreck and associated objects in the data set focus is be put on:

- discontinuities in sedimentary layering
- infill of possible historical buried scours
- acoustic blanking generated by objects
- hyperbola's indicating buried objects

The analysis is executed in April 2018 by R. van Lil (KNA senior prospector) according to specifications set up within the Dutch Quality Standard for Archaeology (KNA Waterbodems 4.0; protocol 4103).

The draft results of this assessment have been presented to, and discussed with the Dutch Cultural Heritage Agency on April 17, 2018. The comments which came forward from this meeting have been addressed in this report.

The export cable route survey was executed by several survey vessels:

Survey vessel	**Area**	**Period**
MV Meridian	Block 1 and 2a (northern area)	6 to 20 January 2017
Fugro Helmert	Blocks 3 and 4 (southern area)	6 to 27 January 2017
Fugro Seeker	Maasmond and Yangtze canal	28 January to 10 April 2017
Valkyrie	Maasmond and Yangtze canal	8 to 25 January 2017
MV Meridian	Additional landing area Maasmond	January 2017

Table 2. Survey vessels employed

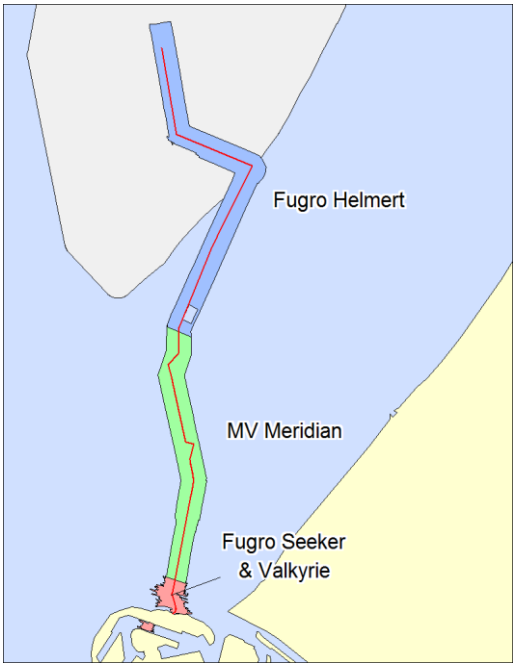


Figure 2. Overview of the suvey areas by the different vessels

part of route	**corridor width**	**line spacing**	**number of parallel lines**
north (HKZ WFZ)	1400m	25m	57
centre	1600m	25m	65
south (up to Eurogeul)	1300m	25m	53

Table 3. Number and spacing of survey lines along the cable route

For all lines the *multibeam*, *side scan sonar*, *subbottom profiler* and *magnetometer* were used simultaneously. Multichannel seismic survey MCS data were acquired with a line spacing of 30/100/200 m. The cross lines were planned with a line spacing of 1000 m.

3 Results

3.1 Data Quality

Overall the subbottom profiler data is of good quality. The high quality is illustrated by figure 3 which shows the seismic profile over the 22" Gas Pipeline from P15-D to the Maasvlakte. In this survey line (20170122_151749) the pipeline is found exposed at the seabed. The high reflective pipeline shows as a hyperbole in the seismic data. The pipeline was also found buried in other survey lines. The seabed is flat without sedimentary structures such as current ripples. In the example shown below the heave of the vessel was compensated very well. In other survey lines the heave compensation was less adequate which is indicated by an undulating seabed which in fact is known from multibeam records to be flat. The penetration depths obtained by the employed 8kHz acoustic signal ranged up to more than 5 meter below the seabed.

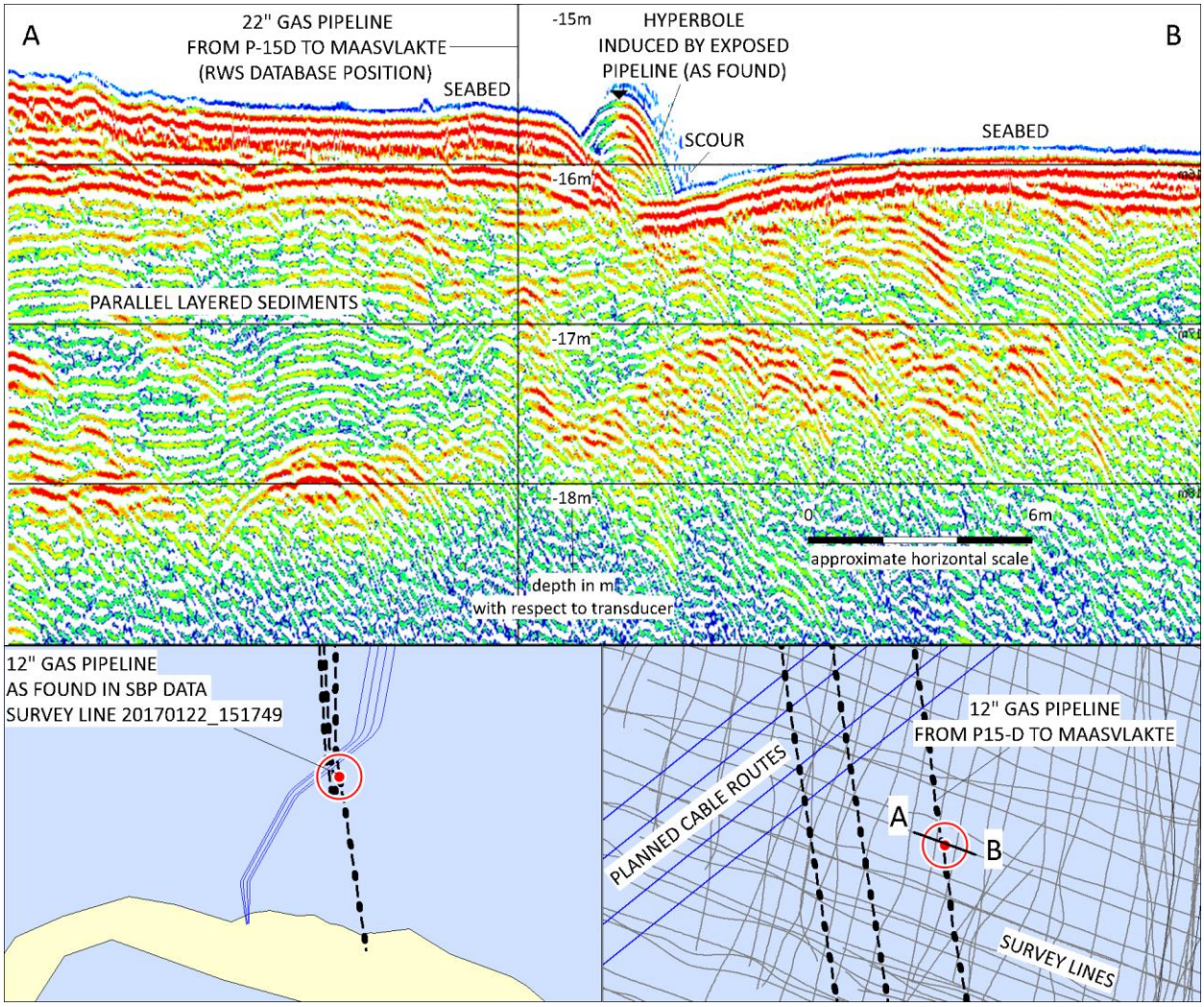


Figure 3. 22" Gas pipeline from P15-D to Maasvlakte As Found in SBP survey line 20170122_151749

3.2 Assessment of magnetic anomalies

An archaeological assessment of the subbottom profiler data has been carried out for the 26 magnetic anomalies over 500nT of which the 100m buffer zones is crossed by one or more export cables.

The assessment has resulted in the identification of two locations where the presence of archaeological objects cannot be excluded (see table 4 below).

nr	ETRS_E	ETRS_N	Assessment
CT_01468*	571126	5761570	Location of potential archaeological interest Subsurface discontinuity with boulder-like objects at seabed surface can laterally be traced in multiple subbottom lines. It cannot be excluded that the magnetic anomalies and related structures represent archaeological objects.
CT_01486*	571087	5761619	
CT_01532*	571141	5761561	
CT_01471	571140	5761584	No objects of archaeological interest
CT_03034	571417	5761892	No objects of archaeological interest
CT_03092	571579	5761714	No objects of archaeological interest
CT_04454	571918	5762023	No objects of archaeological interest
CT_04455	571908	5762034	No objects of archaeological interest
CT_04653	572031	5762137	No objects of archaeological interest
CT_04738	571950	5762267	No objects of archaeological interest
CT_04792	571882	5762333	No objects of archaeological interest
CT_04891	571786	5762445	No objects of archaeological interest
CT_04894	571976	5762413	No objects of archaeological interest
CT_05025	571726	5762575	No objects of archaeological interest
CT_05188	571918	5762711	No objects of archaeological interest
CT_05202	571848	5762734	No objects of archaeological interest
CT_05249	571959	5762758	No objects of archaeological interest
CT_05364	571956	5762897	No objects of archaeological interest
CT_06031	572117	5764219	No objects of archaeological interest
CT_06072	572138	5764324	No objects of archaeological interest
CT_06109	572333	5764392	No objects of archaeological interest
CT_06323	572524	5764939	Location of potential archaeological interest Burried object possibly within old scour and covered by younger sediments. The origin of the object is unknown. The image resembles that of a trenched pipeline, although the presence of another type of object (including an archaeological object) cannot be excluded.
CT_07619	572613	5769305	No objects of archaeological interest
CT_08461	571523	5775827	No objects of archaeological interest
CT_08695	571808	5778085	No objects of archaeological interest
CT_11395	571734	5793707	No objects of archaeological interest

Table 4. Result summary

The first location comprises a cluster of three magnetic anomalies: CT_01468, CT_01486 and CT_01532. The second location correlates with one isolated magnetic anomaly: CT_06323. The results for those two locations are summarized below.

CT_01468, CT_01486 and CT_01532 (combined location) Results

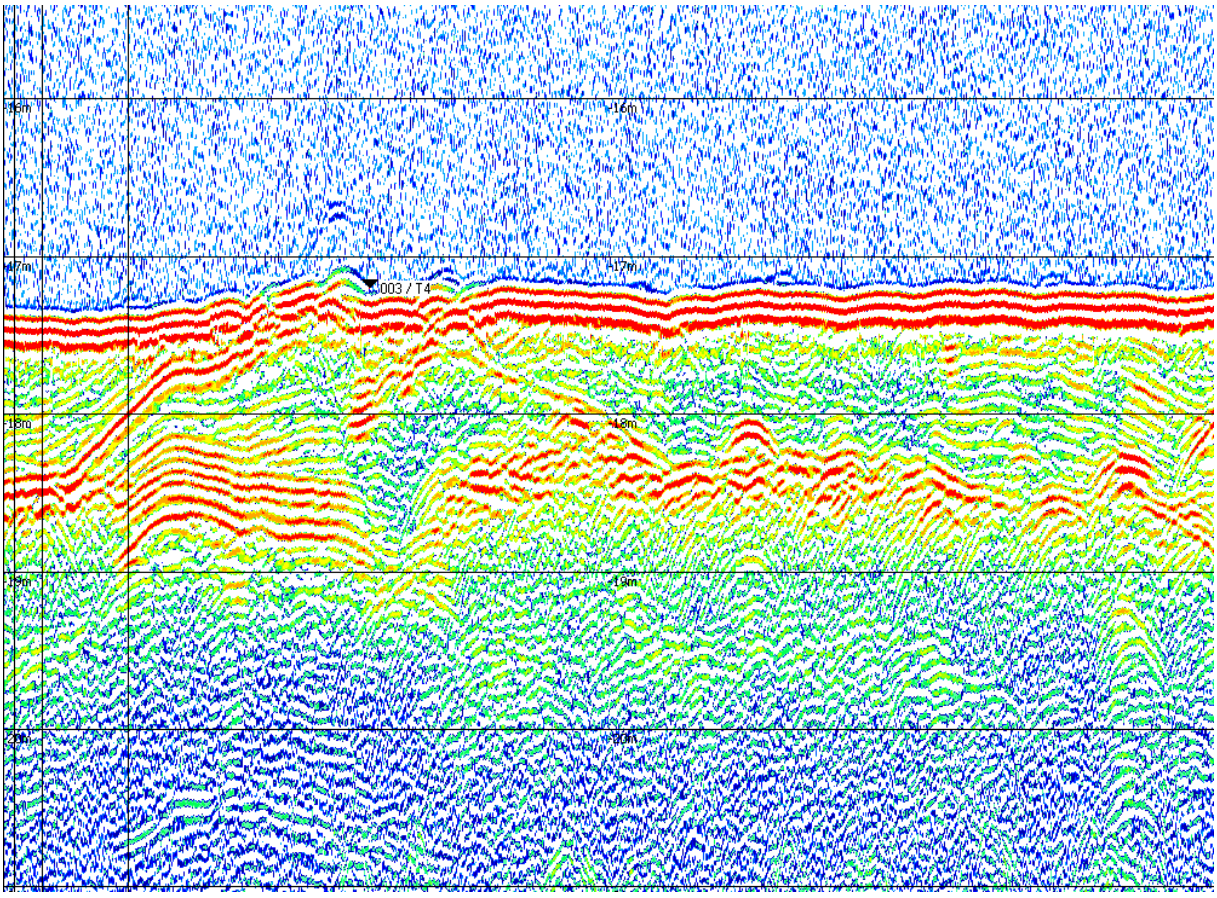
Description

In multiple subbottom profiler lines subsurface discontinuities were found. The discontinuities can laterally be traced and coincide with morphological phenomena visible in multibeam images. Related boulder-like objects have been encountered at seabed surface. The width of the structure shown in image 20170120_162248_T4 is 46m. The trend deduced from multibeam images is north-northeast. Because the subbottom profiler line crosses the structure at an angle of 45˚, the actual with is approximately 32m.

Image

Nr: 20170120_162248_T4

Location: 571158E; 5761504N



Coherent contacts within combined buffer zone

20170120_160202_T3.gif

20170122_134146_T6.gif

Archeological interpretation

The objects and structures found are likely related to the identified magnetic anomalies. The origin of the objects is unknown. It cannot be excluded that those objects represent archaeological objects.

CT_6323 Result summary

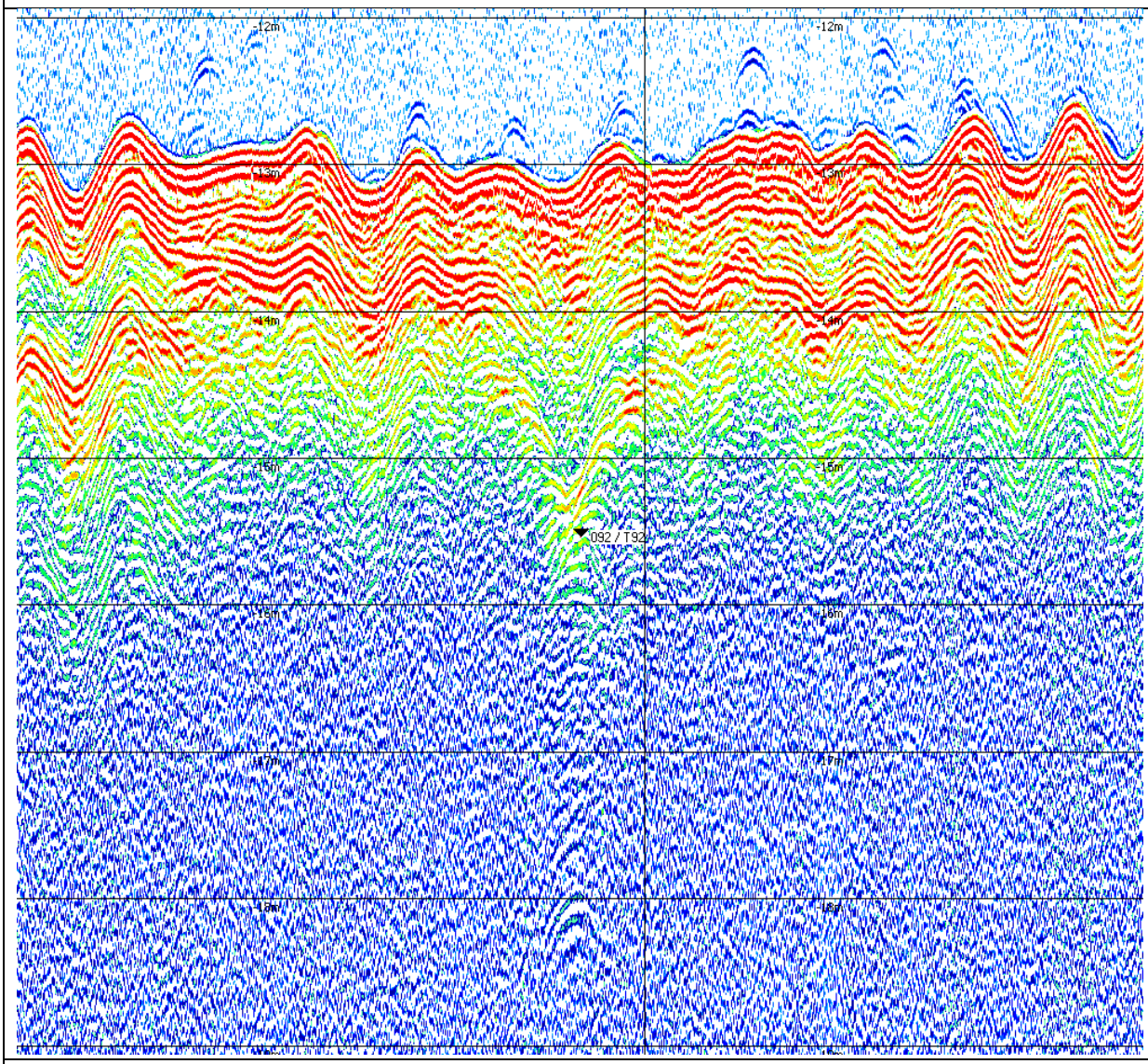
Description

Significant hyperbole located at 2.5m below seabed underneath a trench-like structure.

Image

Nr: Tennet_2016_MD_B01_20170110_224256_T92

Location: 572523E; 5764960N



Coherent contacts within combined buffer zone

none

Archaeological Interpretation

Burried object possibly within old scour and covered by younger sediments. The origin of the object is unknown. The image resembles that of a trenched pipeline or object, although the presence of another type of object, such as an archeological object cannot be excluded.

Figure 4 below shows the locations of potential archaeological interest. The locations in green indicate the initial suspected locations which were written off as potential archaeological locations after the assessment of the subbottom data. The areas in red contain the remaining suspected archaeological locations.

The area which has been interpreted to represent the limit of the potential site is indicated with a greyish infill. CT_01471 is not included in this area, but it should be noted that the 910nT magnetic anomaly does indicate the presence of a significant object.

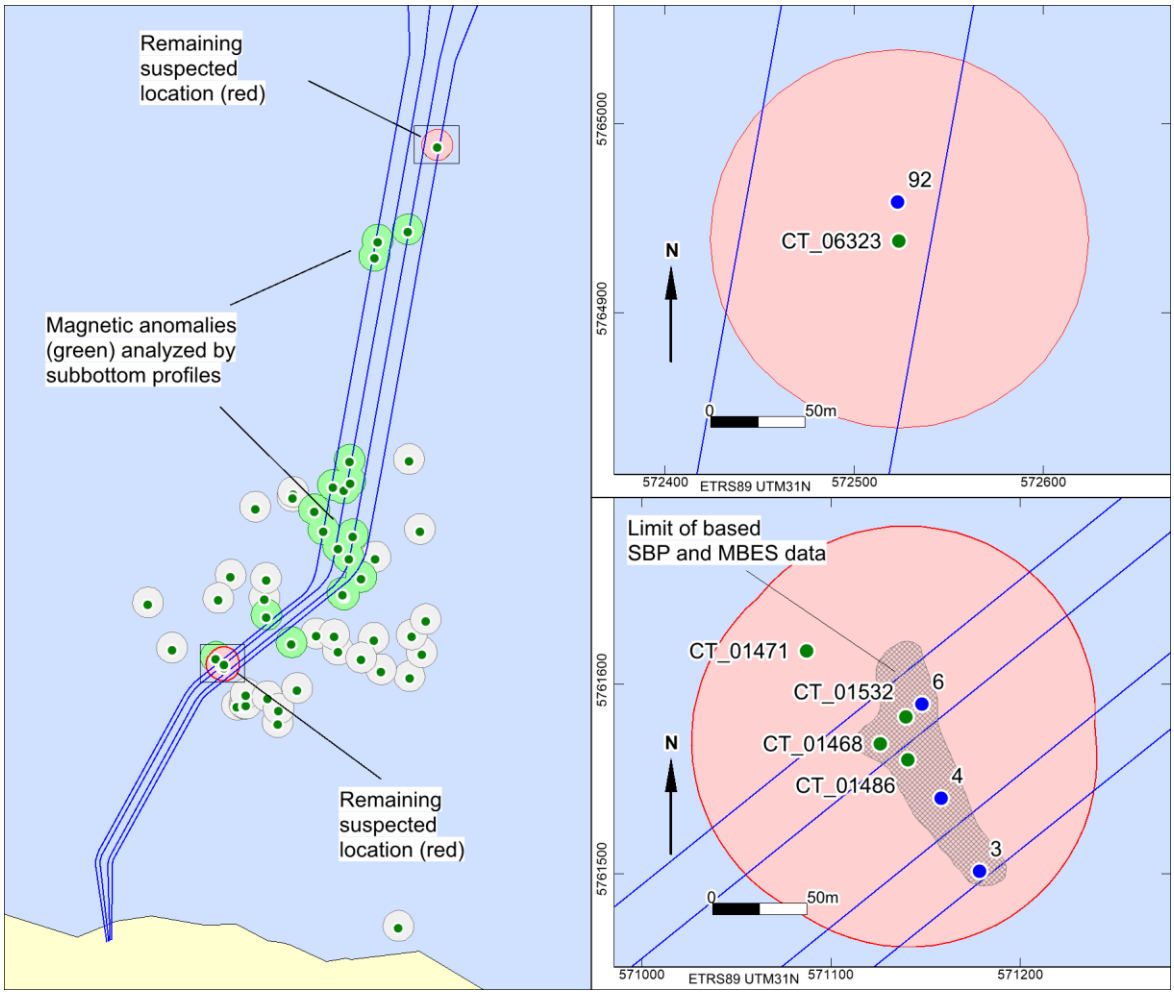


Figure 4. Locations of potential archaeological interest

4 Conclusions and recommendations

The in detail analysis of raw subbottom profiler data has resulted in the identification of two locations of potential archaeological interest. The first comprises an area in including three magnetic anomalies; the second an isolated location. Locations details are listed in table 5 below.

Loc	Area Location			Magnetic Anomaly	Point location		SBP Target	Point location	
		E	N		E	N		E	N
1	centre	571 153	5 761 558	CT_01486	571 126	5 761 570	03	571 179	5 761 502
	bottom left	571 113	5 761 493	CT_01468	571 141	5 761 561	04	571 158	5 761 541
	top right	571 193	5 761 558	CT_01532	571 140	5 761 584	06	571 148	5 761 590
2	n/a			CT_06323	572 524	5 764 939	92	572 523	5 764 960

Table 5. Coordinates of locations of potential archaeological interest

To date the actual character of the objects and structures present at location site is unknown. This means that apart from archaeological remains recent man-made debris and hazardous objects such as unexploded ammunition can be present at those sites.

It is recommend to reroute the export cables to avoid disruption of the potential archaeological remains.

During the installation of export cables archaeological remains may be encountered that were not as such during the geophysical survey. In accordance with the Dutch Monuments Act it is required to report those findings to the competent authority. In this case Rijkswaterstaat (RWS) is the Competent Authority. This notification for archaeological finds should be included in the specifications or scope of work.

List of figures

List of tables

References

- Beets, D.J., and A.J.F. Van der Spek, 2000: The Holocene evolution of the barrier and the back-barrier basins of Belgium and the Netherlands as a function of late Weichselian morphology, relative sea-level rise and sediment supply, Geologie en Mijnbouw / Netherlands Journal of Geosciences, 79(1), 3-16.
- Chisholm, J. 2010: Route survey proposed 16-inch CO2 pipeline from platform P18-A to Maasvlakte, Nootdorp, Volume 1 of 2, Geophysical and Operational Report, Fugro Report No. GH040.
- Gaffney, V.L., K. Thomson en S. Fitch, 2005: The Archaeology and geomorphology of the North Sea, Kirkwall.
- Haan, L. de, 2010: Route survey proposed 16-inch CO2 pipeline from platform P18-A to Maasvlakte, Nootdorp, Volume 1 of 2, Geotechnical Report, Fugro Report No. GH040.
- Heteren, S. van, A.J.F. van der Spek and B. van der Valk, 2011: Evidence and implications of Middle- to Late Holocene shoreface steepening offshore the western Netherlands. Confrence paper.
- Hijma, M.P., 2009: From river valley to estuary, The early-mid holocene transgression of the Rhine-Meuse valley, The Netherlands, Netherlands Geographical Studies 389, Utrecht.
- Hijma, M.P., A.J.F. van der Spek and S. van Heteren, 2010: Development of a mid-Holocene estuarine basin, Rhine–Meuse mouth area, offshore The Netherlands. Marine Geology 271, p. 198-211.
- Lil, R. van, E.A. van den Oever and S. van den Brenk, 2016: Bureauonderzoek Net op zee, Hollandse Kust zuid – offshore tracés. Amsterdam, Periplus Archeomare rapport 15A036-01.
- Lil, R. van, and S. van den Brenk, 2017: Hollandse Kust (zuid) – Maasvlakte export cable routes: An archaeological assessment of geophysical data. Amsterdam, Periplus Archeomare Report 16A021-01.
- Rieu, R., van Heteren, S., van der Spek, J.F., and de Boer, P.L., 2005: Development and preservation of a Mid-holocene Tidal-Channel Network Offshore the Western Netherlands. Journal of Sedimentary Research, 75-3, p 409-419.
- Rijsdijk, K.F, S. Passchier, H.J.T. Weerts, C. Laban, R.J.W. van Leeuwen & J.H.J. Ebbing, 2005: Revised Upper Cenozoic stratigraphy of the Dutch sector of the North Sea Basin: towards an integrated lithostratigraphic, seismostratigraphic and allostratigraphic approach. Netherlands Journal of Geoscience 84-2, p 129-146.
- Van den Brenk, S. en van Lil, R., 2013. Offshore Windmolenpark en exportkabeltracé Eneco Luchterduinen. Bureauonderzoek en inventariserend veldonderzoek. Periplus Archeomare rapport 13A029.
- Van den Brenk, S. en van Lil, R., 2014. Archeologisch bureauonderzoek en inventariserend veldonderzoek Zandwingebied Q10R. Periplus Archeomare rapport 14A040.
- Van Mierlo, B.J.E.M., van den Brenk, S. and Waldus, W.B., 2009. Pijpleiding toekomstig platform Zaan naar toekomstig platformlocatie Amstel en toekomstig platform Amstel naar bestaand platformlocatie P15-C. Gecombineerd bureauonderzoek en inventariserend veldonderzoek (opwaterfase). Periplus Archeomare rapport 09A005
- Verhart, L., 2005: Een verdronken land. Mesolithische vondsten uit de Noordzee, in: Louwe Kooijmans, L.P. e.a. (red.), de Prehistorie van Nederland, 157-160.

Appendix 1. Subbottom files analyzed

Vessel	Runline	1468	1471	1486	1532	3034	3092	4454	4455	4653	4738	4792	4891	4894	5025	5149	5188	5202	5364	6031	6072	6109	6323	7619	8461	8695	11395
VK	MK_20170120_151814	x		x	x																						
VK	MK_20170122_155516						x																				
VK	MK_20170123_93743					x																					
VK	MK_20170120_153843	x		x	x																						
VK	MK_20170122_162440					x	x																				
VK	MK_20170120_160202	x	x	x	x																						
VK	MK_20170123_91318					x																					
VK	MK_20170120_162248	x	x	x	x																						
VK	MK_20170123_92702					x																					
VK	MK_20170122_132711	x		x	x																						
VK	MK_20170123_94222					x																					
VK	MK_20170122_134146	x	x	x	x																						
VK	MK_20170122_135826	x		x	x																						
VK	MK_20170122_140902			x	x																						
VK	MK_20170122_151749						x																				
VK	MK_20170122_152802						x																				
VK	MK_20170122_154446						x		x																		
VK	MK_20170122_161319					x	x																				
VK	MK_20170123_85951					x																					
VK	MK_20170123_112114					x	x																				
VK	MK_20170125_81752							x	x																		
VK	MK_20170125_94012						x																				
VK	MK_20170125_83205							x	x																		
VK	MK_20170125_84702							x	x																		
VK	MK_20170125_90119					x	x																				
SK	MK_20170407_M_507	x	x	x	x																						
SK	MK_20170409_M_506_02						x																				
SK	MK_20170401_M_BA403_rerun	x	x	x	x																						
SK	MK_20170401_M_BA404	x	x	x	x																						
SK	MK_20170402_M_BA402	x	x	x	x																						
SK	MK_20170408_M_BA405_1	x	x	x	x																						
SK	MK_20170409_M_BA406_1																										
MD	B01_20170106_184814																							x			
MD	B01_20170110_224256																						x				
MD	B01_20170110_234956																x	x									
MD	B01_20170107_23249																						x				
MD	B01_20170107_212102																							x			
MD	B02_20170116_220344																							x			
MD	B01_20170107_230059																							x			
MD	B01_20170120_446										x	x	x	x		x	x	x	x	x	x	x					
MD	B01_20170108_20745					x																					

Vessel	Runline	1468	1471	1486	1532	3034	3092	4454	4455	4653	4738	4792	4891	4894	5025	5149	5188	5202	5364	6031	6072	6109	6323	7619	8461	8695	11395
MD	B02_20170116_172136																							x			
MD	B01_20170108_40324					x																					
MD	B02_20170116_180347																							x			
MD	B01_20170108_65746					x																					
MD	B01_20170109_105222									x													x				
MD	B02_20170116_194244																							x			
MD	B02_20170116_200923																							x			
MD	B02_20170116_222242																							x			
MD	B01_20170108_95225					x																					
MD	B01_20170109_95027									x													x				
MD	B01_20170108_122351							x	x	x																	
MD	B01_20170106_174137												x		x		x	x	x	x	x						
MD	B01_20170106_220707												x		x		x	x	x	x	x						
MD	B01_20170106_231906							x	x	x	x	x		x		x						x	x				
MD	B01_20170107_2452							x	x	x	x	x		x		x						x	x				
MD	B01_20170107_12723							x	x	x																	
MD	B01_20170107_33341							x	x	x													x				
MD	B01_20170107_134624							x	x		x	x		x		x	x	x	x	x	x	x					
MD	B01_20170107_152257							x	x		x	x	x	x		x	x	x	x	x	x	x					
MD	B01_20170107_162541							x	x	x													x				
MD	B01_20170108_31212					x																					
MD	B01_20170108_50600					x																					
MD	B01_20170108_55934					x																					
MD	B01_20170108_75715					x																					
MD	B01_20170108_131858											x	x			x	x	x	x	x	x						
MD	B01_20170108_141121											x	x			x	x	x	x	x	x						
MD	B01_20170108_151033						x					x	x			x	x	x	x	x	x						
MD	B01_20170108_161206						x						x		x		x	x	x	x	x						
MD	B01_20170108_173308							x	x		x	x		x		x	x		x			x					
MD	B01_20170108_182411							x	x	x	x	x		x		x						x	x				
MD	B01_20170108_194635							x	x	x	x	x		x		x						x	x				
MD	B01_20170108_204801							x	x	x	x			x								x	x				
MD	B01_20170108_214835							x	x	x	x			x								x	x				
MD	B01_20170120_4446																										
MD	B01_20170109_0									x													x				
MD	B01_20170109_5523						x								x												
MD	B01_20170109_25454						x								x												
MD	B01_20170109_40749						x								x												
MD	B01_20170109_50343						x						x		x			x		x	x						
MD	B01_20170109_63332						x						x		x			x		x	x						
MD	B01_20170109_73653						x						x		x			x		x	x						
MD	B01_20170109_83746							x	x		x	x		x		x	x		x			x					

Vessel	Runline	1468	1471	1486	1532	3034	3092	4454	4455	4653	4738	4792	4891	4894	5025	5149	5188	5202	5364	6031	6072	6109	6323	7619	8461	8695	11395
MD	B01_20170109_120158									x																	
MD	B01_20170109_140405							x	x		x	x		x		x	x		x			x					
MD	B01_20170110_194726								x		x	x	x	x		x	x	x	x	x	x	x					
MD	B01_20170111_923						x																				
MD	B01_20170120_5154									x																	
MD	B02_20170117_082033																								x		
MD	B02_20170117_085641																								x		
MD	B02_20170117_105215																								x		
MD	B02_20170117_114426																								x		
MD	B02_20170117_134434																								x		
MD	B02_20170117_144026																								x		
MD	B02_20170117_155320																								x		
MD	B02_20170117_170713																								x		
MD	B02_20170117_170713																								x		
MD	B02_20170118_114328																									x	
MD	B02_20170118_123119																									x	
MD	B02_20170118_141551																									x	
MD	B02_20170118_150722																									x	
MD	B02_20170118_170217																									x	
MD	B02_20170118_173211																									x	
MD	B02_20170118_200055																									x	
MD	B02_20170118_204937																									x	
FHE	B02_20170107_25432																							x			
FHE	B02_20170107_24227																							x			
FHE	B02_20170107_15901																							x			
FHE	B02B_20170107_213042																								x		
FHE	B02_20170107_133144																								x		
FHE	B02B_20170107_214450																									x	
FHE	B02_20170107_010423																									x	
FHE	B02_20170107_034249																									x	
FHE	B04_20170117_000325																										x
FHE	B04_20170117_010828																										x
FHE	B04_20170117_020631																										x
FHE	B04_20170117_041229																										x
FHE	B04_20170117_051255																										x
FHE	B04_20170117_063457																										x
FHE	B04_20170117_072926																										x
FHE	B04_20170117_090425																										x
FHE	B04_20170106_174741																										x
FHE	B04_20170106_190058																										x

*note: The subbottom profiler data of the survey vessel Seeker was not available for this assessment