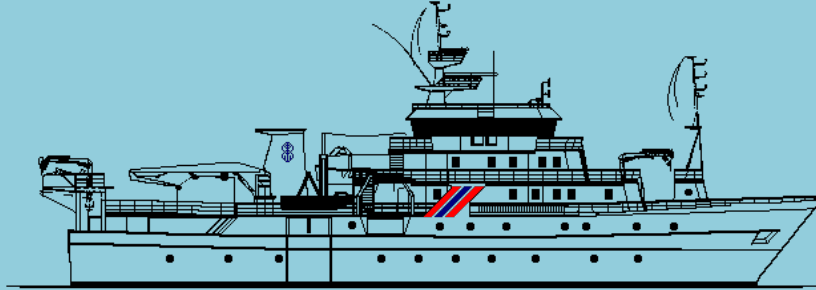


Preliminary Cruise Report "Dr. Fritjof Nansen"



BENTHIC MARINE ENVIRONMENTAL SURVEY Baseline studies of Angola block 38 and 39

June 2013

by

B. Serigstad¹, M. Olsen¹, M.Ostrowski¹, T.M. Ensrud¹

¹Institute of Marine Research
Norway

Instituto Nacional de Investigação Pesqueira
INIP
Luanda

Angolan Recourse Consultants
ARC
Angola

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Summary.

IMR (Institute of marine Research) and ARC (Angolan Recourse Consultants) with assistance from INIP (Instituto Nacional de Investigação Pesqueira), was commissioned by Statoil to start the field work for an environmental baseline assessment study on block 38 and 39 off the coast of Angola.

The main objectives were to collect benthic samples for biological, chemical and geological analysis in compliance with Angolan legislation and to provide video documentation of macrofauna and specified volcanoes' and mud volcanoes' in the area. The field work started out from the INIP port in Luanda and took place between June 4th and June 19th.

11 stations on block 38 and 6 stations on block 39 were fully covered in regards to biological and chemical sampling. 2 stations on block were partly covered in regards to biological and chemical sampling. Video documentation was recorded from 5 sites on block 38 and 2 sites on block 39.

The IMR crew assisted and gave advice in the sampling process. The cruise was conducted without any hazardous incidents.

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List of participants:

Bjørn Serigstad	Cruise leader
Tor Ensrud	Logistics, benthos, cruise log, equipment.
Magne Olsen	Benthos
Marek Ostrowski	Oceanography
Tore Mørk	Instrument chief
Håkon Langøen	Instrument
Kåre Saue	Rov pilot
Jørgen Welde	Rov maintenance and repairs mechanic.
Tim McClurg	Benthos ARC
Erich Koch	Benthos ARC
Andrew Peter Russel	Benthos ARC
Kate Munnik	ARC Team leader
Pedro Panzo	Benthos INIP
Domingos Pedro	Benthos INIP
Silvana Faria	Benthos INIP
Ines Quitumba	Benthos Angola

Objectives

The main objectives of the survey were:

To collect benthic samples and oceanographic data for environmental baseline studies in compliance with the Angolan government's **Executive Decree No. 224/12 of 16 July 2012** on Angolan block 38 and 39 for operator Statoil.

- To collect bottom sediment samples to map benthic fauna.
- to collect bottom sediment for background environmental descriptors (heavy metals, hydrocarbon, grain size etc.)
- to do video monitoring of the sampling area.

- to map the general hydrographic regime by using a CTD to monitor the temperature, salinity and oxygen.
- to facilitate the sampling process for the local consultants.

- on-the-job training on the main survey routines for local participants.

Methods

Sampling regime for benthic samples.

Samples for chemical analysis.

The samples were collected from the top 1-1,5 cm of the sediment in the grab.

Two main types of grabs, single and double chambers, were used they had a sampling area of 0,1m² and 0,15m² respectively.

The double chamber grab is designed to take a quantitative biological sample from 0,1 m² and a sample for chemical analysis from the same grab. The two different fractions were divided by a wall that was placed in a small slot in the grab.

The samples were packed in glass jars. The amount of sediment needed for each analysis was listed by the packing table on the work deck. There was also a small scale for control of the amount of sediment for chemical analysis on the packing table.

The 3 samples for chemical analysis from each station were numbered 1-3 and the parameters to analyze were listed in the sampling journal.

The procedure followed the description in the flow chart on the next pages.

Biology samples.

The samples are to be used for quantitative statistical analysis; the sampling area of the equipment was 0,1m².

The 5 biology samples from each station were numbered 4-8 in the sampling journal.

Soft bottom deep water samples:

The soft sediment surface (top 3-5 cm) in the grab was taken off with a spoon and washed carefully with cold water through a 0,3 mm sieve. Afterwards the rest of the sample were washed with cold water through 5 and 0,5 mm sieves.

The 0,3 mm fraction is put to a bottle marked 1 of x.

The samples were fixed in 4% formaldehyde buffered with Borax.

The procedure followed the description in the flow chart on the next page.

Flow charts concerning the sampling regime are found in the appendix.

Cruise activities.

May 24th 2013. Loading sampling equipment in Dakar Senegal.

May 24th – June 3rd: Transit from Dakar to Luanda and preparation for cruise activity:
Setting up and preparing of ROV sampling equipment.

June 2nd: successful test dive.

June 4th – June 9th first leg, 11 stations were covered. On block 38 2 stations were fully covered and 6 stations were partly covered. The videograb was used on one station.

On block 39 2 stations were fully covered and 1 station were partly covered.

August 10th Crew change in Luanda and service on ROV equipment.

June 11th – June 19th second part of the cruise 14 Stations were covered. On block 38 5 stations were fully covered and 5 stations were partly covered. On block 39 3 stations were fully covered and 1 station were partly covered.

Overall 11 stations on block **38** were fully covered, 12 stations were completed for chemistry (38.19 is missing 2 on biology) and 2 stations were partly covered. (MV1 and 38.11).

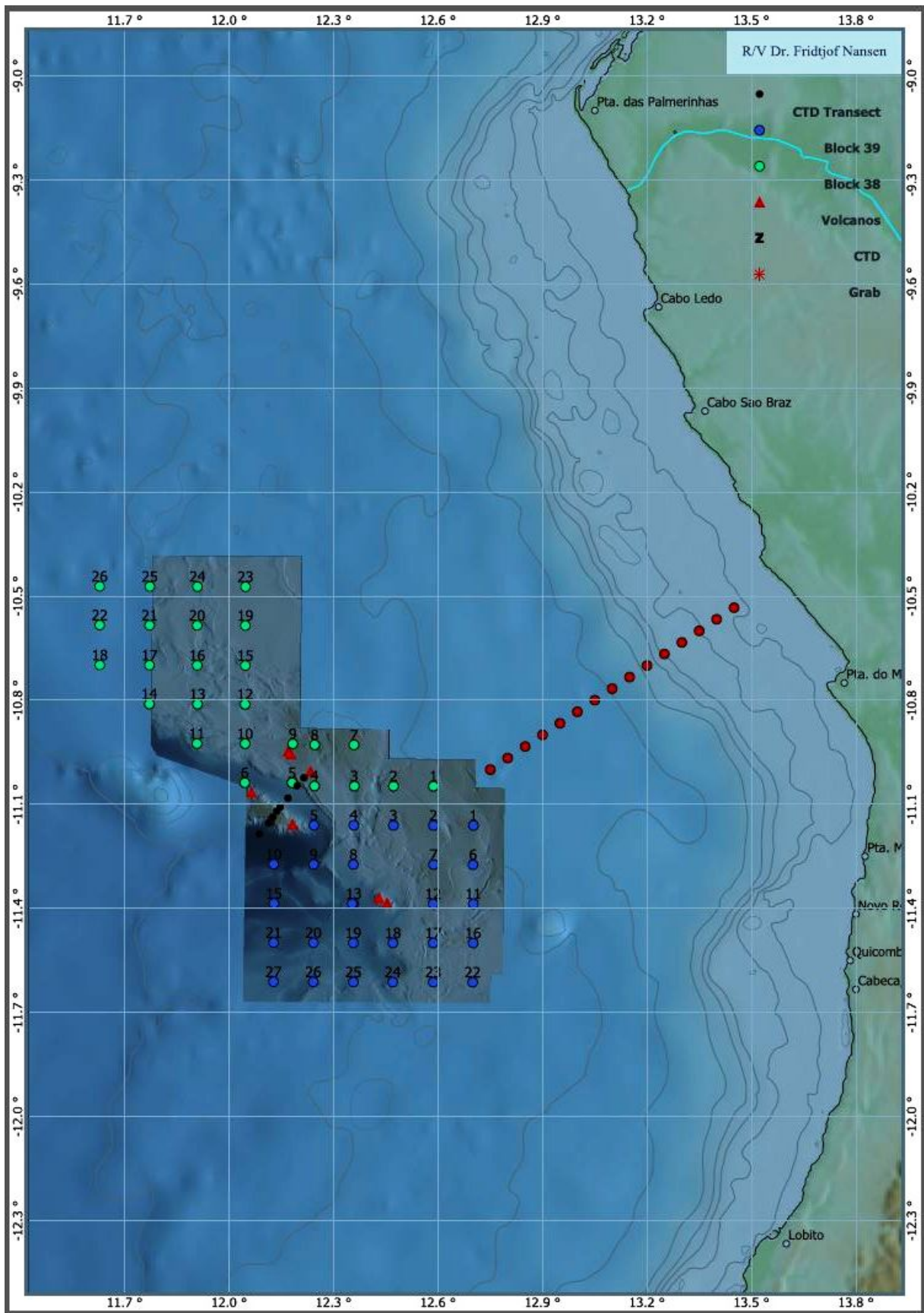
There is video coverage from 5 stations on block 38.

Overall 6 stations on block **39** were fully covered. There is video coverage from 2 stations on block 39. The videograb was used on 8 stations. For more detailed information see table 1 and 2 or the sampling journal in the appendix.

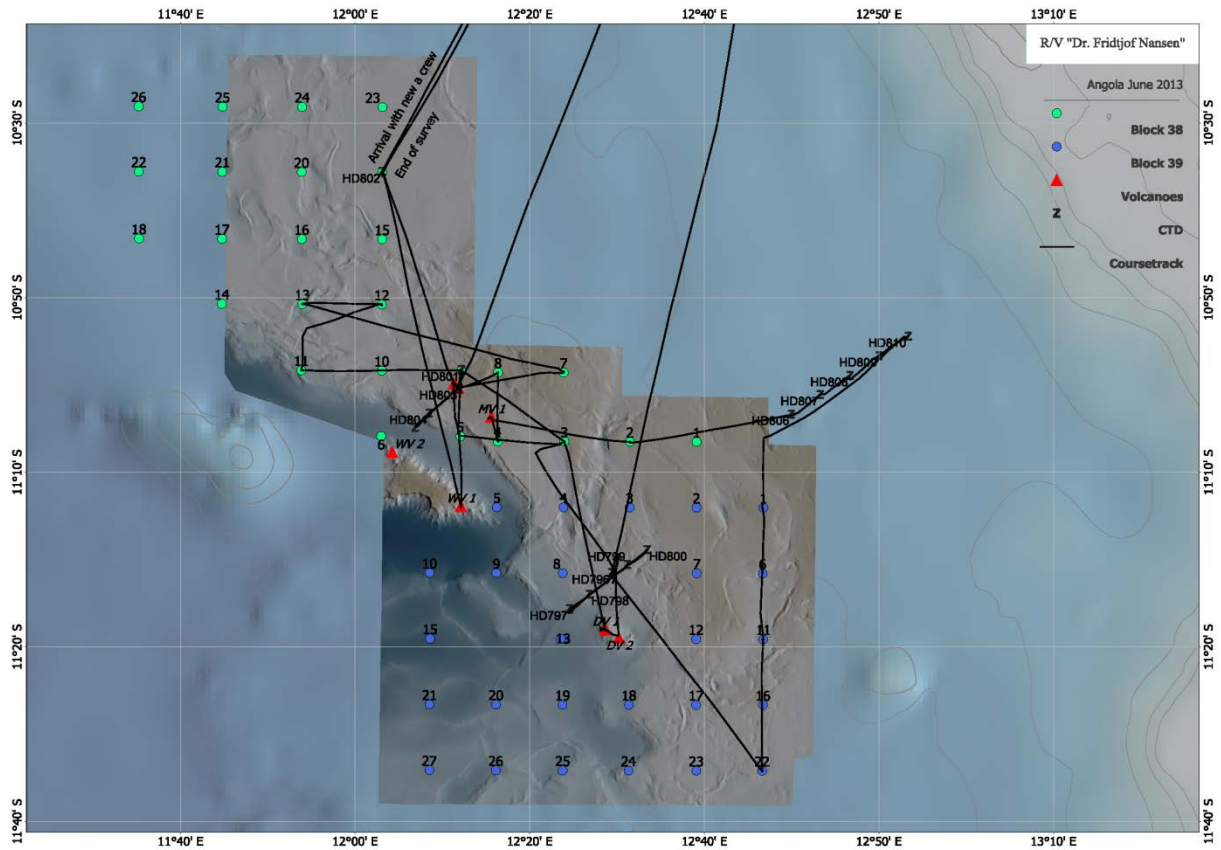
During the cruise period we experienced some technical difficulties operating the ROV equipment. The problems were partly solved when spare parts arrived from Norway during crew change in Luanda on June 10th

One set of Winkler samples was taken to verify the performance of the oxygen sensor.

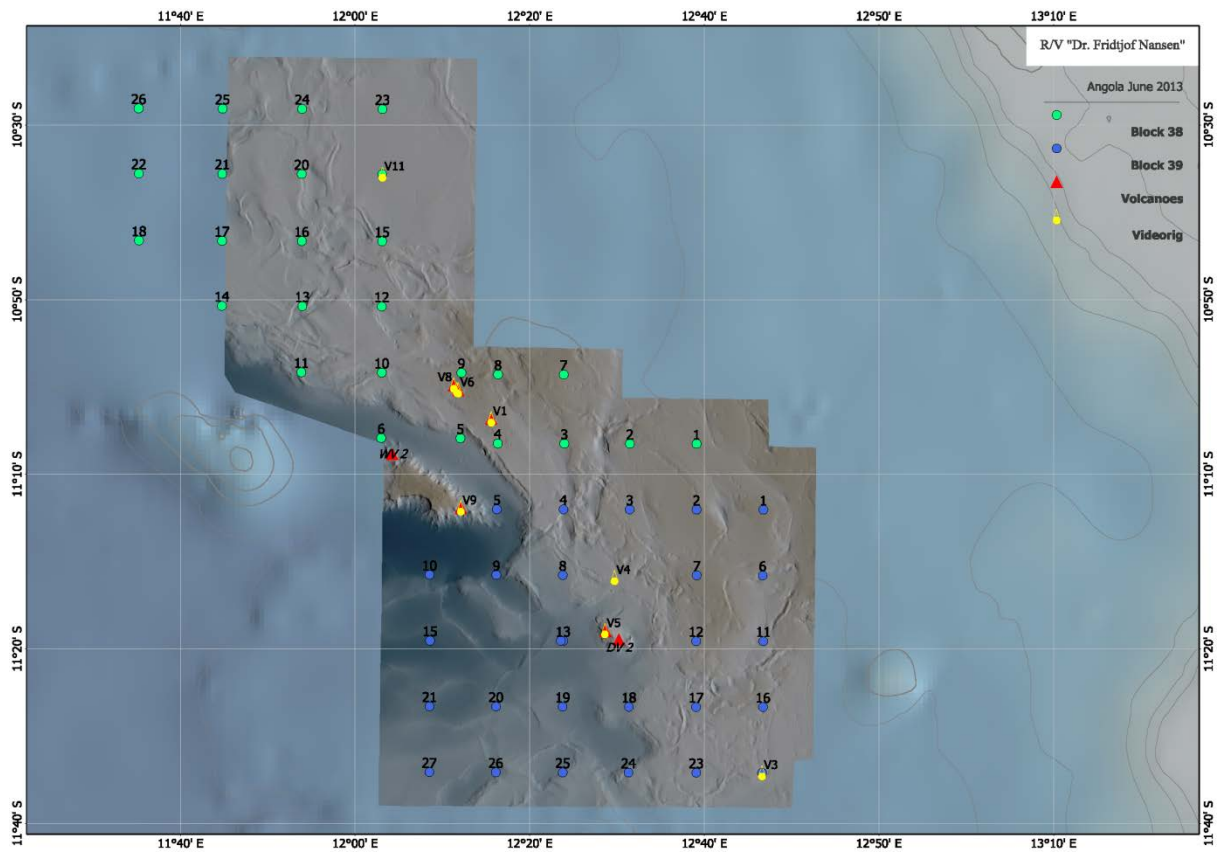
The cruise was conducted without any hazardous incidents.



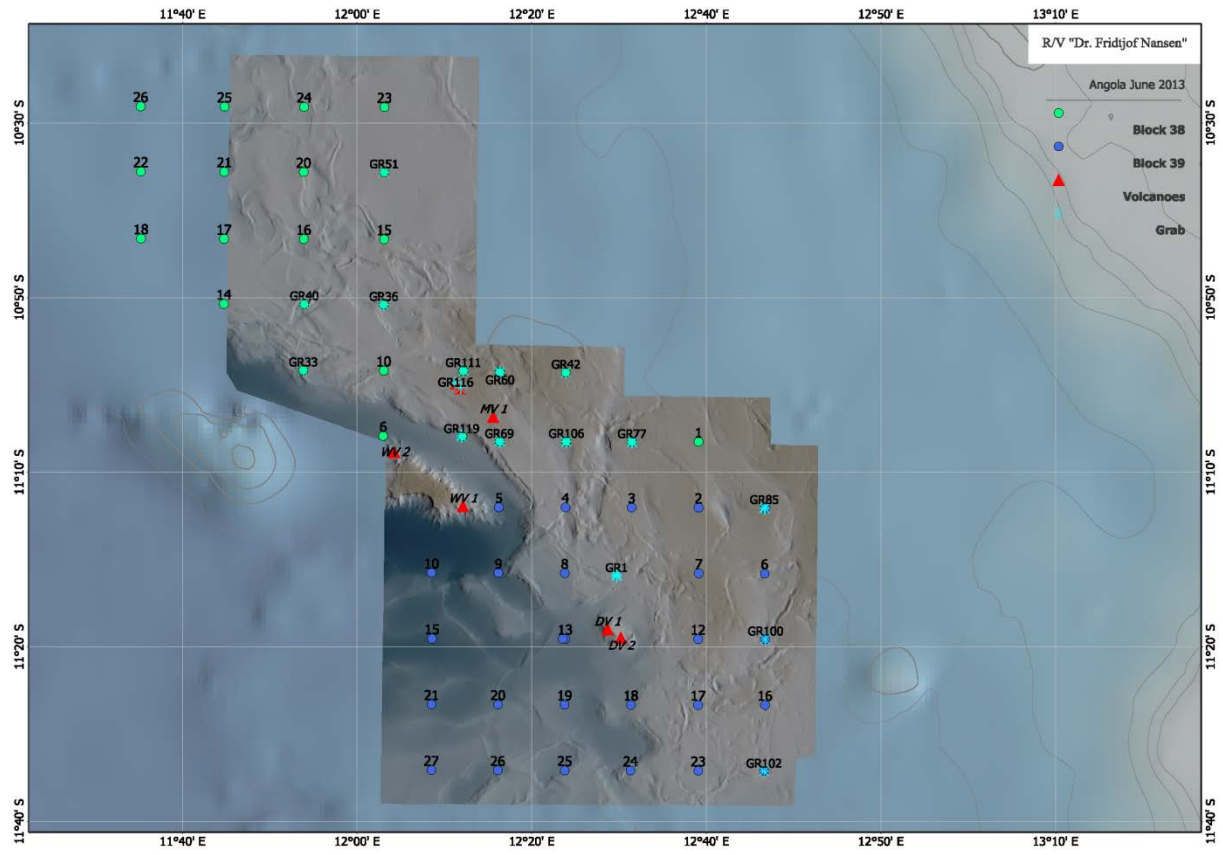
Map of block 38 and 39 based on sampling design from Statoil. Red dots from land out to the sampling area are a fixed transect of CTD stations that will also be sampled by other cruises in this area.



Map showing the course track and CTD stations



Map showing sites where the Video rig was used



Map showing sites where grab samples were collected

Overview of the stations covered.

Stations from Block 38. Biology samples in parenthesis were also sampled for chemical analysis, these samples are not valid as quantitative biological samples.

(* SJ refers to the page in the sampling journal)

Station	Date	Track		LON	LAT	Depth	Bio	Chemical	video
		SJ*							
38.2	14.06.13	16		12,47211	-11,0476	1557	5	3	
38.3	7,17.06.13	4/21		12,35952	-11,0473	1595	(3+)5	3	
38.4	14.06.13	14		12,24517	-11,0472	1629	5	3	
38.5	8,17.06.13	5/25		12,18097	-11,0381	2113	(1+)5	1+2	
38.7	09.06.13	10		12,35854	-10,9288	1522	5	3	
38.8	13.06.13	13		12,24564	-10,9285	1439	5	3	
38.9	08,17.06.13	6/22		12,18264	-10,9257	1541	(2+)5	2+1	
38.11	08.06.13	7		11,90762	-10,9248	2043	1	2	
38.12	08.06.13	8		12,04585	-10,8117	1766	5	3	
38.13	8,9.06.13	9		11,90923	-10,8113	1882	0	0	
38.19	09,18.06.13	11/27		12,04652	-10,5847	1739	(3+)3	5	x

Station	Date	Track SJ*		LON	LAT	Depth	Bio	Chem	video
MV 1	14.06.13	15		12,23388	-11,005	1518		1	x
MV 2	13,17.06.13	12/23		12,17732	-10,9471	1431	5	3	x
MV 3	17.06.13	24		12,1698	-10,9471	1522	5	3	x
WV 1	18.06.13	26		12,1816	-11,1582	1796	5	3	x

Stations from the mud volcano's. MV refers to the mud volcano's and WV, western volcano.

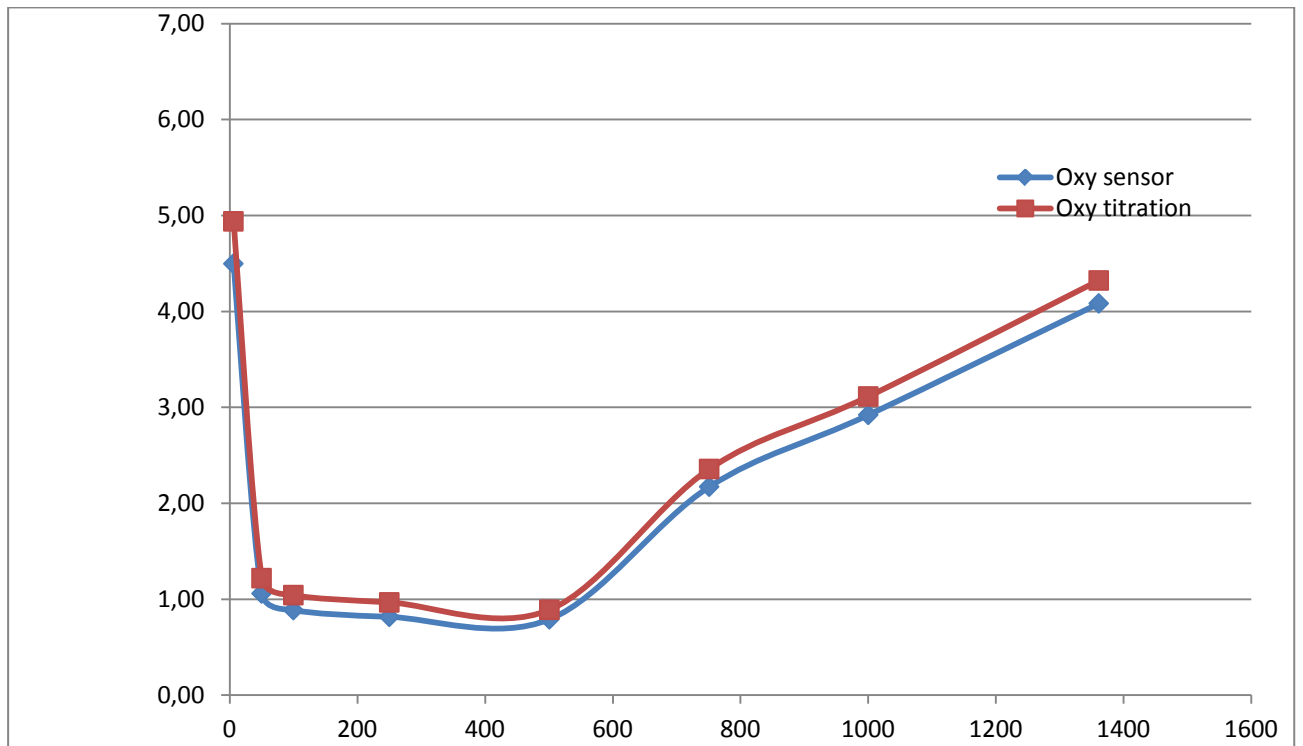
(* SJ refers to the page in the sampling journal)

Station	Date	Track SJ*	LON	LAT	Depth	Bio	Chem	video
39.1	15.06.13	17	12,70157	-11,16081	1471	5	3	
39.11	15.06.13	18	12,70134	-11,38675	1699	5	3	
39.22	16.06.13	19	12,69931	-11,61269	1842	5	3	x
Dilolo Well	6,16.06.13	1/20	12,44579	-11,27668	1785	(3+)6	5	x
Dilolo north	6,7.06.13	2	12,44601	-11,27625	1785	5	3	
Dilolo south	07.06.13	3	12,44582	-11,27905	1787	5	3	
Dilolo Volc.1	16.06.13	-	12,4293	-11,3689	1400			x

Stations from Block 39. Biology samples in parenthesis were also sampled for chemical analysis, these samples are not valid as quantitative biological samples.

(* SJ refers to the page in the sampling journal)

Appendix:



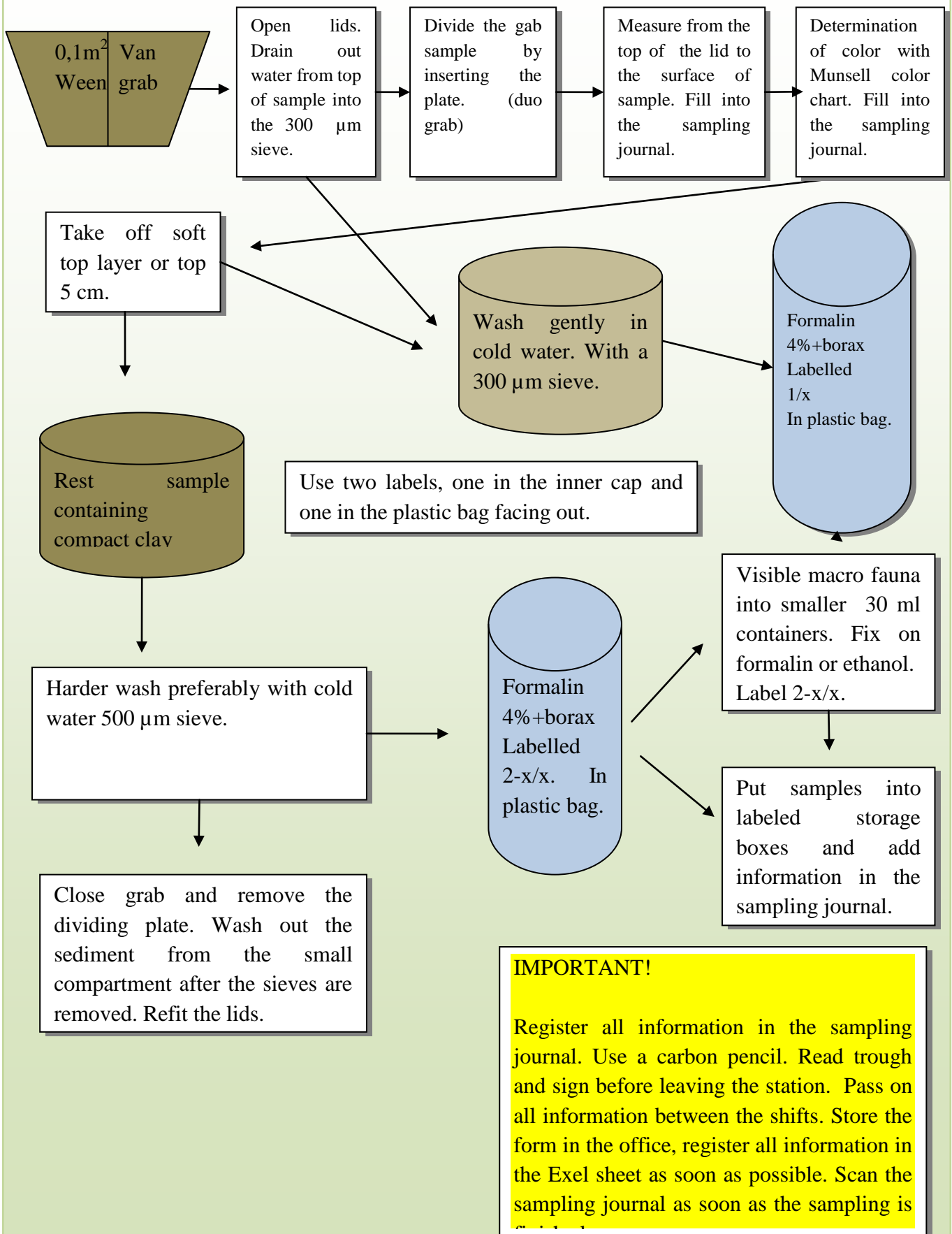
Calibration of Oxygen sensor on station HD 811 close to benthos station 38.1 and 39.1.

Diluting formalin

Date	Formalin 35-40% Liter	Seawater Liter	Solution % Formaldehyde	Komment.	Sign.
4/6-13	2,5 l	225	ca 4%	4 spoons of brack added	T. G

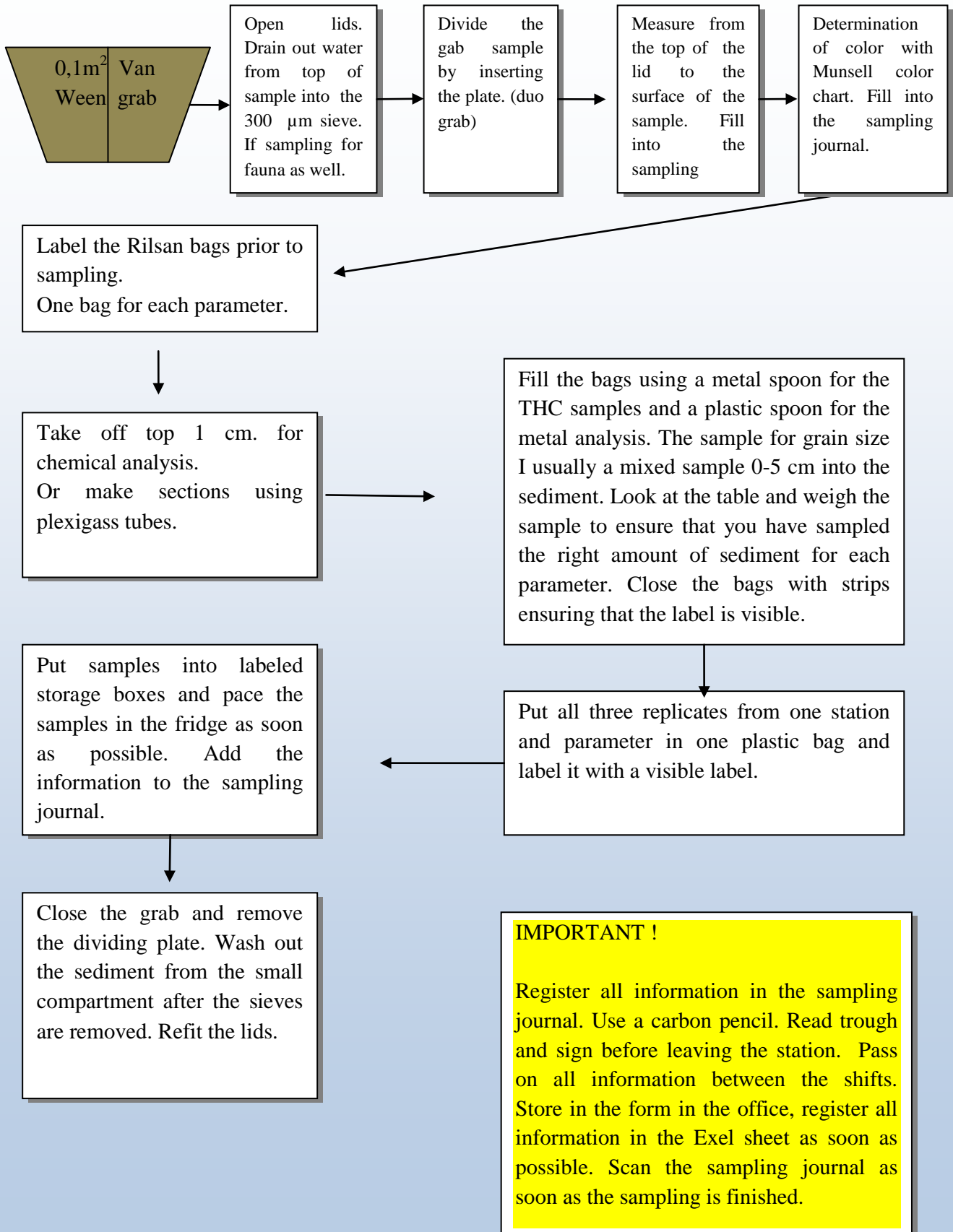
Dilution of formaldehyde.

Benthos samples flow chart macro fauna.



Benthos samples flow chart

Samples for chemical analysis.



Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. Dilolo well	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St. HD 796	June 6 th 2013	-11,2778	12,446	1786 m

Weather: Sunny, cloudy	Wind: slight (2)	Wave : 3
Time Start: 10:51	Time Finish: 21:40	Duration: 10 hr 49 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: Dark mud clay in deeper layers		
Color: Brown, dark brown, grey - black		Odor:
Observation of animals: Polychaetes, clam shells, isopods ?		No. rejected samples:
Observation of oil, waste etc: Shells, organic/wood, maybe some hydraulic oil.		Empty: Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	full	X F	X F	X	X	Gley 1 5/10Y	F= frozen	1		Y
2	full	X F	X F		X	Gley 1 5/10Y		3		Y
3	full	X F	X F		X	Gley 1 5/10Y		2		Y

Sample nr	Vol. (cm)	bottles bio.				Pack Box :	Colour :	Remarks:	Grab nr.	Extra weights
4	full	1				1	Gley 1 5/10Y		1	
5	full	1				1	Gley 1 5/10Y		3	
6	full	1				1	Gley 1 5/10Y		2	
7	full	1				1	Gley 1 4/10Y		LA	4
8	full	1				1	Gley 1 5/10Y	Station 39.2 NB!	LA	4
9	full	1				1	Gley 1 5/10Y		LA	4
10	full	1				1	Gley 1 5/10Y		LA	4

Sign. Out:

SAMPLING JOURNAL

Sign. In:

Page nr: 2 of 27

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. Dilolo North	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St. HD 796	June 6 th and 7 th 2013	-11,2762	12,4460	1785 m

Weather: Sunny, cloudy	Wind: slight (2)	Wave : 3
Time Start: 21:40	Time Finish: 06:30	Duration: 8hr 50 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: clay		
Color: Greenish	Odor:	
Observation of animals: Polychaetes	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	full	X F	X F	X	X	23:20	Gley 1 5/10Y	F= frozen	LA	4	Y
2	full	X F	X F		X	00:20	Gley 1 4/10Y		LA	4	Y
3	4 cm	X F	X F		X	01:20	Gley 1 5/10Y		LA	4	Y

Sample nr	Vol. (cm)	bottles bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	full	1	1	X	02:50	Gley 1 5/10Y		LA	4
5	full	1	1	X	03:40	Gley 1 5/10Y		LA	4
6	full	1	1	X	05:40	Gley 1 5/10Y		LA	4
7	full	1	1	X	06:30	Gley 1 4/10Y		LA	4
8	full	1	1	X	17:51	Gley 1 5/10Y	June 6 th	LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. Dilolo South	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St. HD 796	June 7 th 2013	-11,2791	12,4458	1787 m

Weather:	Wind:	Wave :
Time Start: 06:25	Time Finish: 16:04	Duration: 9hr 39 min
Sample equipment used (bite area, weight) : 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: clay		
Color: Greenish	Odor:	
Observation of animals: Polychaetes	No. rejected samples: 1 twisted	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	full	X F	X F	X	X	08:00	Gley 1 5/10Y	F= frozen	LA	4	Y
2	full	X F	X F		X	09:00	Gley 1 5/10Y		LA	4	Y
3	full	X F	X F		X	10:00	Gley 1 4/10Y		LA	4	Y

Sample nr	Vol. (cm)	bottles bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	5	1	1	X	11:00	Gley 1 4/10Y		LA	4
5	full	1	1	X	12:15	Gley 1 4/10Y		LA	4
6	full	1	1	X	13:10	Gley 1 4/10Y		LA	4
7	full	1	1	X	15:03	Gley 1 4/10Y		LA	4
8	full	1	1	X	16:04	Gley 1 4/10Y		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.3	Date June 7 th and 8 th 2013	Position		Depth (m) 1528 m
		Latitude N/S -11,0472	Longitude E/W 12,3595	

Weather:	Wind:	Wave :
Time Start: 19:21	Time Finish: 22:00	Duration: 2hr 39 min
Sample equipment used (bite area, weight) : 0,1m² Van Veen Grab and 0,5 mm sieve (square holes)		

Type of bottom sediment: Clay + sand More sand than previously		
Color: Brown green	Odor: None	
Observation of animals: Polychaetes, starfish, asteroidean, clay pellets	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	1/3(10)	X F	X F	X	X	19:30	Gley 1 5/10Y	F= frozen	LA	4	Y
2	2/3(5)	X F	X F		X	20:30	Gley 1 5/10Y	ley 1 5/10Y	LA	4	Y
3	1/8(15)	X F	X F		X	22:00	Gley 1 5/10Y		LA	4	Y

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	1/3(10)	1	1	X	19:30	Gley 1 5/10Y		LA	4
5	2/3(5)	1	1	X	20:30	Gley 1 5/10Y	ley 1 5/10Y	LA	4
6	1/8(15)	1	1	X	22:00	Gley 1 5/10Y		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.5	Date June 8 th 2013	Position		Depth (m) 2045 m
		Latitude N/S -11,038	Longitude E/W 12,1801	

Weather:	Wind:	Wave :
Time Start: 22:38	Time Finish: 02:05	Duration: 2hr 39 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color:	Odor: None	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty: 2 open	Stone:
		Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	full	X F	X F	X	X	02:05	Gley1 5/10Y	F= frozen	LA	4	Y
								failed			
								failed			

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	full	1	1	X	19:30	Gley1 5/10Y	Grab 1- 500 g removed for chemical	LA	4
							failed		
							failed		

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.9	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St. HD 801	June 8 th 2013	-10,9256	12,1826	1522 m

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 03:22	Time Finish: 05:50	Duration: 2hr 28 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color:	Odor: None	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty: 1	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.	
1	3	X F	X F	X	X	04:45	5Y 4/2	F= frozen	LA	4	Y	
2	5	X F	X F				05:50	5Y 4/2		LA	4	Y

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	3	1	1	X	19:30	Gley1 5/10Y	Grab 1- 500? g removed for chemical	LA	4
5	5	1	1	X	05:50	Gley1 5/10Y	Grab 2- 500? g removed for chemical	LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.11	Date June 8 th 2013	Position		Depth (m) 2013 m
		Latitude N/S -10,9248	Longitude E/W 11,9076	

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 03:22	Time Finish: 05:50	Duration: 2hr 28 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: Sandy mud			
Color:	Odor:		
Observation of animals: Urchin spines	No. rejected samples: 1		
Observation of oil, waste etc:	Empty:	Stone:	Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	G. nr	Ex. w	Br. Surf.
1	1/3	X F	X F	X	X	10:20	Gley 1 4/10Y	F= frozen	LA	4	Y
2	full	X F	X F			12:40	Gley 1 4/10Y		LA	4	Y

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	full	1	1	X	12:40	Gley 1 4/10Y	Grab 1- 500? g removed for chemical	LA	4
5							Thin layer of reddish deposit (2,4)		

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.12	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
	June 8 th 2013	-10,8118	12,0458	1745 m

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 13:55	Time Finish: 18:30	Duration: 4hr 35 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: clay and sand			
Color: Grey green	Odor: Zero		
Observation of animals: Polychaetes	No. rejected samples:		
Observation of oil, waste etc: plastic pices / pellets	Empty:	Stone:	Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	Meio faun.	G. nr	Ex. w	Br. Surf.
1	8	X F	X F	X	X	15:30	Gley 1 5/10Y	F= frozen	X	1		
2	Full	X F	X F		x	15:30	10GY 5	ROV grab	X	3		
3	4	X F	X F		x	16:30	10GY 5		X	LA		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	8	1	1	X	15:30	Gley 1 5/10Y	ROV grab single chamber	1	
5	Full	1	1	X	15:30	10GY 5	ROV grab	3	
6	4	1	1	X	15:30	10GY 5	ROV grab	2	
7	Full	1	1	X	17:30	10GY 5		LA	4
8	Full	1	1	X	18:30	4/2 5Y		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.13	Date June 8 th and 9 th 2013	Position		Depth (m) 1775 m
		Latitude N/S -10,8112	Longitude E/W 11,9093	

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 19:03	Time Finish: 20:38	Duration: 1 hr 35 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color: Grey green	Odor:	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty: 3	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1								3 attempts				
2								Mowed to 38.7				
3												

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4									
5									
6									
7									
8									

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.7	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
	June 9 th 2013	-10,9287	12,3587	1511 m

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 00:36	Time Finish: 09:25	Duration: 1 hr 35 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: clay, not much sand, blackish sediment in clay.		
Color: Grey green	Odor:	
Observation of animals: Polychaets, urchin spines	No. rejected samples: 1	
Observation of oil, waste etc: Plastics	Empty: 1	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	Full	X F	X F	X	X	02:00	10GY 5		X	LA		
2	Full	X F	X F		X	03:10	10GY 5		X	LA		
3	Full	X F	X F		X	05:00	10GY 5		X	LA		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	Full	1	1	x	06:00	Gley 5/10Y		LA	4
5	Full	1	1	x	06:50	4/2 5Y		LA	4
6	1/8	1	1	x	07:30	Gley1 4/10Y		LA	4
7	Full	1	1	x	08:40	4/2 5Y		LA	4
8	Full	1	1	x	09:25	4/2 5Y		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.19	Date June 9 th 2013	Position		Depth (m) 1729 m
		Latitude N/S -10,5847	Longitude E/W 12,0465	

Weather: 2/2 24°C (weather/sky temp)	Wind: 18/4 (dir/strength)	Wave : 3
Time Start: 18:05	Time Finish: 09:25	Duration: 1 hr 35 min
Sample equipment used (bite area, weight): 0,1m ² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: Sandy clay	
Color: Green-brown	Odor: None
Observation of animals: Polychaets	No. rejected samples: 2
Observation of oil, waste etc:	Empty: Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Colour :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	2	X F	X F	X		18:10	5Y 4/2		X	LA		
2	Full	X F	X F		X	19:15	5Y 4/2		X	LA		
3	Full	X F	X F		X	22:00	5Y 4/2		X	LA		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Colour :	Remarks:	Grab nr.	Extra weights
4	2	1	1	x	18:10	5Y 4/2	Removed 1 kg for chemical	LA	4
5	Full	1	1	x	19:15	5Y 4/2	Removed 750 ml for chemical	LA	4
6	Full	1	1	x	22:00	5Y 4/2	Removed 750 ml for chemical	LA	4
7									
8									

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.3	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St.	June 17 th 2013	-11,0474	12,35974	1526 m

Weather:	Wind:	Wave :
Time Start: 15:19	Time Finish: 18:20	Duration: 3hr 1 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color:	Odor:	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1												
2												
3												

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	1/3	1	2	x	00:05	5Y 5/2		LA	4
5	2/3	1	2	x	01:00	5Y 5/2	Meio fauna	LA	4
6	Full	1	2	x	01:47	5Y 5/2	Meio fauna (extra photo taken)	LA	4
7	2	1	2	x	02:34	5Y 5/2	Meio fauna	LA	4
8	2	1	2	x	03:25	5Y 5/2		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. 38.9	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St.	June 17 th 2013	-10,9253	12,1829	1515 m

Weather:	Wind:	Wave :
Time Start: 04:14	Time Finish: 09:50	Duration: 5hr 36 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color: green- brown	Odor:	
Observation of animals: polychaetes, urchins, shrimps (6) and coral ?	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1												
2												
3	4	X F	X F			5:25	5Y 4/2		x	LA		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	5	1	2	x	06:30	5Y 4/2	Coarse sand	LA	4
5	1/8	1	2	x	07:24	5Y 4/2	Sieved in 0,3mm only	LA	4
6	1/3	1	2	x	08:10	Gley 1 5/5GY	Shrimp	LA	4
7	Full	1	2	x	08:50	Gley 1 5/10Y	Sandy clay	LA	4
8	Full	1	2	x	09:50	Gley 1 5/10Y	Clay	LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr. Mud Volcano 2	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
CTD. St.	June 17 th 2013	-10,9547	12,1758	1442 m

Weather:	Wind:	Wave :
Time Start: 09:35	Time Finish: 16:00	Duration: 6hr 25 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color: green- brown	Odor:	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	1/2	X F	X F	X	x	12:00	5Y 4/2			1		
2	2/3	X F	X F		x	12:00	5Y 4/2			3		
3	1/10	X F	-			16:00	5Y 4/4	Metals from morey rocks kept		1		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	1/2	2	2	x	12:00	5Y 4/2		1	
5	2/3	2	2	x	12:00	5Y 4/2		3	
6	1/3	2	2	x	12:00	5Y 4/2		2	
7	1/5	2	2	x	16:00	5Y 4/4	Center grab	2	
8	Full	8	2,3	x	16:00		Lot of sand	3	

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Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr.	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
Mud Volcano 3	June 17 th 2013	-10,9465	12,1692	1533 m

Weather:	Wind:	Wave :
Time Start: 17:30	Time Finish: 22:10	Duration: 5hr 40 min
Sample equipment used (bite area, weight) : 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment:		
Color:	Odor:	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	Full	X F	X F	X	x	19:52	5Y 5/2		x	1		
2	Full	X F	X F		x	19:50	5Y 5/2		x	3		
3	7	X F	X F		x	19:50	2.5Y 5/3	Middle grab	x	2		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	Full	1	3	x	12:00	5Y 5/2		2	
5	Full	2	3	x	12:00	5Y 5/2		1	
6	Full	1	3	x	20:30	Gley 1 5/5GY		LA	
7	Full	2	3	x	21:20	Gley 1 5/5GY		LA	
8	Full	1	3	x	22:10	Gley 1 5/10Y		LA	

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Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr.	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
38.5	June 17 th and 18 th 2013	-11,0372	12,1791	2053 m

Weather:	Wind:	Wave :
Time Start: 22:18	Time Finish: 07:05	Duration: 8hr 47 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: Soft mud			
Color: green- grey	Odor:		
Observation of animals: polychaetes and urchins	No. rejected samples:		
Observation of oil, waste etc:	Empty:	Stone:	Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1				3								
2	Full	X F	X F		x	23:45	Gley 1 4/10Y		x	LA	4	
3	Full	X F	X F		x	00:30	Gley 1 4/10Y		x	LA	4	

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	2	1	3	x	03:55	5Y 4/2	Pictures labeled 28.13	LA	4
5	1/4	1	3	x	02:55	5Y 4/4		LA	4
6	3	1	3	x	04:57	5Y 4/2		LA	4
7	Full	1	3	x	06:00	Gley 1 4/10Y		LA	4
8	Full	1	3	x	07:05	Gley 1 4/10Y		LA	4

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr.	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
Western volcano 1	June 18 th 2013	-11,1582	12,1816	1796 m

Weather:	Wind:	Wave :
Time Start: 22:18	Time Finish: 07:05	Duration: 8hr 47 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,3 mm sieve (square holes)		

Type of bottom sediment: Mud + sand		
Color: green- grey		Odor:
Observation of animals: polychaetes and urchins		No. rejected samples:
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	Full	X F	X F		x	10:10	5Y 5/2		x	1		
2	9	X F	X F		x	10:10	5Y 5/2		x	3		N
3	Full	X F	X F			10:12	5Y 5/2		x	2		

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	Full	1	3	x	10:10	5Y 5/2		1	
5	9	1	3	x	10:10	5Y 5/2		3	
6	Full	1	3	x	11:50	5Y 5/2		1	
7	Full	1	3	x	11:50	5Y 5/2		3	
8	Full	1	3	x	11:50	5Y 5/2		2	

Sign. Out:

Vessel: Rv. Dr. Fridtjof Nansen	Area: Angola	Project code: 170	Survey nr: 2013405
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Grab station nr.	Date	Position		Depth (m)
		Latitude N/S	Longitude E/W	
38.19	June 18 th 2013	-10,5846	12,0470	1730 m

Weather:	Wind:	Wave :
Time Start: 15:06	Time Finish: 15:53	Duration: 47 min
Sample equipment used (bite area, weight): 0,1m² Van Veen Grab and 0,5 mm sieve (square holes)		

Type of bottom sediment:		
Color:	Odor:	
Observation of animals:	No. rejected samples:	
Observation of oil, waste etc:	Empty:	Stone: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Photo:	Time:	Color :	Remarks:	Meio fauna.	G. nr	Ex. w	Br. Surf.
1	Full	X F	X F		x		5Y 4/3		x	1		
2	Full	X F	X F		x		5Y 4/3		x	3		N
3												

Sample nr	Vol. (cm)	bottle s bio.	Pack Box :	Photo:	Time:	Color :	Remarks:	Grab nr.	Extra weights
4	Full	1	3	x	02:55	5Y 4/3		1	
5	Full	1	3	x	03:55	5Y 4/3		3	
6	1/2	1	3	x	04:57	5Y 4/2		2	
7									
8									

Sign. Out:

STATOILS' EXPLORATION BLOCKS 38 & 39

OFFSHORE ANGOLA

SURVEY 1 SUMMARY REPORT

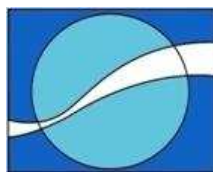
PREPARED FOR

Angola Resources Consulting LDA



PREPARED BY

LWANDLE TECHNOLOGIES (PTY) LTD.



25 July 2013

Job no: LT 13-170

LWANDLE TECHNOLOGIES (PTY) LTD

Constantiaberg Business Park, Princess Vlei Rd, Diep River 7800, South Africa

Directors: C.P. Matthysen, M. Majodina, B.J. Spolander

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MARINE SPECIALIST TEAM:**Robin Carter – Lwandle Technologies, Cape Town****Kate Munnik – Lwandle Technologies, Cape Town****Andrew Russell – Lwandle Technologies, Cape Town****Erich Koch – Lwandle Technologies, Cape Town****Timothy McClurg – Lwandle Technologies, Cape Town**

Report compiled by Kate Munnik

<u>Date</u>	<u>Version</u>	<u>Revised</u>	<u>Reviewed</u>
25/07/13	0.1		R Carter



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1 INTRODUCTION

Prior to the commencement of exploratory drilling for hydrocarbons in exploration Blocks 38 and 39 off the Angolan coast, Statoil commissioned a marine survey to determine the environmental baseline conditions at their proposed sites. This survey was conducted by Lwandle Technologies (Pty) Ltd (Lwandle) under subcontract to ARC Lda Angola. The survey was carried out on the Norwegian Institute of Marine Research's research vessel the *Dr Fridtjof Nansen* from the 3rd until the 19th July 2013. This was the first of three planned surveys which aim to provide an evaluation of the impacts of the proposed exploratory drilling on the marine environment. The second and third surveys will take place after more refined drill positions have been decided on during and after drilling operations.

The details of survey plan and sampling methods are described in (Lwandle 2013¹). Below is a record of activities conducted during the 1st survey.

2 WORK CARRIED OUT

2.1 SAMPLING SCHEDULE

The sampling team arrived in Luanda from Cape Town, South Africa on Saturday 1st June 2013, and boarded the vessel on Tuesday 4th June 2013. Sampling commenced on arrival at Block 39 on Wednesday morning (5th June), and over the next 14 days a total of 37 sites were investigated. Out of these sites 16 were CTD deployments and the remainder (21) were benthic sediment samples sites. At 10 of the benthic sampling sites, Remotely Operated Vehicle (ROV) video transects were carried out to assess mega benthic fauna (organisms >10 mm) diversity in the region.

The ROV had a number of technical faults during the survey and was not able to be deployed as per Statoil's predetermined schedule. In addition to this Statoil amended the survey plan and increased the number of requested sampling sites. To accommodate both the change in available sampling equipment as well as the altered sampling regime the Lwandle staff divided into two teams and worked in shifts. This meant that the field team was working over 24 hours and could utilise the manual Van Veen sediment grab without cutting out too many of the required sampling sites.

¹ Lwandle 2013. Project Execution Plan: Statoil's Exploration Blocks 38 & 39 Offshore Angola. Survey 1. Prepared for Angola Resources Consulting LDA. 19pp.

The breakdown of the daily activities for the cruise is provided below (Table 2-1).

Table 2-1: Summary of daily activities during the Statoil pre-exploration environmental survey on board the Dr Fridjof Nansen (3-19 June 2013) based on the ship's log. Key: HD – CTD, GR – Manual Van Veen Grab, OT – ROV video transect &/or ROV grab.

DATE	Sample number	Statoil reference.	Water depth (m)	Activity	ROV transect
05 June 2013	x	CTD	1797	HD796	
05 June 2013	x	CTD	2307	HD797	
05 June 2013	x	CTD	1953	HD798	
05 June 2013	x	CTD	1669	HD799	
06 June 2013	x	CTD	1649	HD800	
06 June 2013	39.01	Diolo -centre	1786	GR1	Video fail
06 June 2013	39.01	Diolo -centre	1787	GR2	
06 June 2013	39.02	Diolo - north	1786	GR3	
06 June 2013	39.01	Diolo -centre	1786	GR4	
06 June 2013	39.01	Diolo -centre	1785	GR5	
06 June 2013	39.02	Diolo - north	1783	GR6	
06 June 2013	39.02	Diolo - north	1785	GR7	
06 June 2013	39.02	Diolo - north	1785	GR8	
07 June 2013	39.02	Diolo - north	1785	GR9	
07 June 2013	39.02	Diolo - north	1785	GR10	
07 June 2013	39.02	Diolo - north	1785	GR11	
07 June 2013	39.02	Diolo - north	1785	GR12	
07 June 2013	39.02	Diolo - north	1784	GR13	
07 June 2013	39.03	Diolo - south	1786	GR14	
07 June 2013	39.03	Diolo - south	1787	GR15	
07 June 2013	39.03	Diolo - south	1787	GR16	
07 June 2013	39.03	Diolo - south	1787	GR17	
07 June 2013	39.03	Diolo - south	1787	GR18	
07 June 2013	39.03	Diolo - south	1787	GR19	
07 June 2013	39.03	Diolo - south	1788	GR20	
07 June 2013	39.03	Diolo - south	1788	GR21	
07 June 2013	39.03	Diolo - south	1788	GR22	
07 June 2013	38.01	38.03	1527	GR23	
07 June 2013	38.01	38.03	1528	GR24	
07 June 2013	38.02	38.03	1528	GR25	
07 June 2013	38.02	38.05	2045	GR26	
07 June 2013	38.02	38.05	2048	GR27	
08 June 2013	38.02	38.05	2045	GR28	
08 June 2013	x	CTD	1516	HD801	
08 June 2013	38.03	38.09	1521	GR29	
08 June 2013	38.03	38.09	1522	GR30	
08 June 2013	38.03	38.09	1521	GR31	
08 June 2013	38.03	38.09	1522	GR32	
08 June 2013	38.04	38.11	2013	GR33	
08 June 2013	38.04	38.11	2020	GR34	
08 June 2013	38.04	38.11	2013	GR35	
08 June 2013	38.05	38.12	1746	GR36	
08 June 2013	38.05	38.12	1746	GR37	
08 June 2013	38.05	38.12	1745	GR38	
08 June 2013	38.05	38.12	1745	GR39	
08 June 2013	38.06	38.13	1773	GR40	
08 June 2013	38.06	38.13	1777	GR41	
09 June 2013	38.07	38.07	1511	GR42	
09 June 2013	38.07	38.07	1511	GR43	
09 June 2013	38.07	38.07	1511	GR44	



DATE	Sample number	Statoil reference.	Water depth (m)	Activity	ROV transect
09 June 2013	38.07	38.07	1512	GR45	
09 June 2013	38.07	38.07	1512	GR46	
09 June 2013	38.07	38.07	1511	GR47	
09 June 2013	38.07	38.07	1511	GR48	
09 June 2013	38.07	38.07	1511	GR49	
09 June 2013	38.07	38.07	1510	GR50	
09 June 2013	38.08	38.19	1730	GR51	
09 June 2013	38.08	38.19	1730	GR52	
09 June 2013	38.08	38.19	1729	GR53	
09 June 2013	38.08	38.19	1730	GR54	
09 June 2013	38.08	38.19	1729	GR55	
09 June 2013	x	CTD	1729	HD802	
13 June 2013	x	CTD	1479	HD803	
13 June 2013	x	CTD	1724	HD804	
13 June 2013	x	CTD	2301	HD805	
13 June 2013	38.09	38 MV 2	1445	GR56	
13 June 2013	38.09	38 MV 2	1447	GR57	
13 June 2013	38.09	38 MV2	1470	GR58	
13 June 2013	38.09	38 MV2	1464	GR59	
13 June 2013	38.10	38.08	1432	GR60	
13 June 2013	38.10	38.08	1433	GR61	
13 June 2013	38.10	38.08	1437	GR62	
13 June 2013	38.10	38.08	1432	GR63	
13 June 2013	38.10	38.08	1429	GR64	
13 June 2013	38.10	38.08	1429	GR65	
13 June 2013	38.10	38.08	1431	GR66	
13 June 2013	38.10	38.08	1427	GR67	
14 June 2013	38.10	38.08	1430	GR68	
14 June 2013	38.11	38.04	1631	GR69	
14 June 2013	38.11	38.04	1629	GR70	
14 June 2013	38.11	38.04	1632	GR71	
14 June 2013	38.11	38.04	1630	GR72	
14 June 2013	38.11	38.04	1630	GR73	
14 June 2013	38.11	38.04	1628	GR74	
14 June 2013	38.11	38.04	1630	GR75	
14 June 2013	38.11	38.04	1626	GR76	
14 June 2013	38.12	38 MV1	1483	OT1	Transect 1
14 June 2013	38.12	38 MV1	1457	OT1	Transect 1
14 June 2013	38.12	38 MV1	1486	OT2	Video fail
14 June 2013	38.12	38 MV1	1483	OT2	Video fail
14 June 2013	38.13	38.02	1552	GR77	
14 June 2013	38.13	38.02	1553	GR78	
14 June 2013	38.13	38.02	1549	GR79	
14 June 2013	38.13	38.02	1553	GR80	
14 June 2013	38.13	38.02	1553	GR81	
14 June 2013	38.13	38.02	1552	GR82	
14 June 2013	38.13	38.02	1551	GR83	
14 June 2013	38.13	38.02	1549	GR84	
15 June 2013	x	CTD	1429	HD806	
15 June 2013	x	CTD	1384	HD807	
15 June 2013	x	CTD	1366	HD808	
15 June 2013	x	CTD	1330	HD809	
15 June 2013	x	CTD	1260	HD810	
15 June 2013	x	CTD	1302	HD811	
15 June 2013	39.04	39.01	1468	GR85	
15 June 2013	39.04	39.01	1469	GR86	
15 June 2013	39.04	39.01	1468	GR87	
15 June 2013	39.04	39.01	1470	GR88	



DATE	Sample number	Statoil reference.	Water depth (m)	Activity	ROV transect
15 June 2013	39.04	39.01	1467	GR89	
15 June 2013	39.04	39.01	1469	GR90	
15 June 2013	39.04	39.01	1471	GR91	
15 June 2013	39.04	39.01	1470	GR92	
15 June 2013	39.05	39.11	1687	GR93	
15 June 2013	39.05	39.11	1687	GR94	
15 June 2013	39.05	39.11	1688	GR95	
15 June 2013	39.05	39.11	1688	GR96	
15 June 2013	39.05	39.11	1687	GR97	
15 June 2013	39.05	39.11	1687	GR97	
15 June 2013	39.05	39.11	1686	GR97	
16 June 2013	39.05	39.11	1685	GR98	
16 June 2013	39.05	39.11	1686	GR99	
16 June 2013	39.05	39.11	1686	GR100	
16 June 2013	39.05	39.11	1686	GR101	
16 June 2013	39.06	39.22	1847	GR102	
16 June 2013	39.06	39.22	1840	OT3	Transect 2
16 June 2013	39.06	39.22	1837	OT3	Transect 2
16 June 2013	39.06	39.22	1844	GR103	
16 June 2013	39.06	39.22	1847	GR104	
16 June 2013	39.06	39.22	1842	GR105	
16 June 2013	39.07	Diolo -centre	1783	OT4	Transect 3
16 June 2013	39.07	Diolo -centre	1785	OT4	Transect 3
16 June 2013	38.90	38 MV 2	1385	OT5	Transect 4
16 June 2013	38.90	38 MV 2	1419	OT5	Transect 4
16 June 2013	38.16	38.03	1526	GR106	
16 June 2013	38.16	38.03	1526	GR107	
17 June 2013	38.16	38.03	1531	GR108	
17 June 2013	38.16	38.03	1526	GR109	
17 June 2013	38.16	38.03	1523	GR110	
17 June 2013	38.17	38.09	1521	GR111	
17 June 2013	38.17	38.09	1518	GR112	
17 June 2013	38.17	38.09	1519	GR113	
17 June 2013	38.17	38.09	1511	GR114	
17 June 2013	38.17	38.09	1506	GR115	
17 June 2013	38.18	38 MV2	1444	OT6	Transect 5
17 June 2013	38.18	38 MV2	1444	OT6	Transect 5
17 June 2013	38.18	38 MV2	1435	OT7	Transect 6
17 June 2013	38.18	38 MV2	1445	OT7	Transect 6
17 June 2013	38.19	38 MV3	1535	OT8	Transect 7
17 June 2013	38.19	39 MV3	1536	OT8	Transect 7
17 June 2013	38.19	39 MV3	1542	GR116	
17 June 2013	38.19	39 MV3	1508	GR117	
17 June 2013	38.19	39 MV3	1542	GR118	
17 June 2013	38.20	38.05	2067	GR119	
17 June 2013	38.20	38.05	2046	GR120	
18 June 2013	38.20	38.05	2052	GR121	
18 June 2013	38.20	38.05	2055	GR122	
18 June 2013	38.20	38.05	2051	GR123	
18 June 2013	38.20	38.05	2052	GR124	
18 June 2013	38.20	38.05	2050	GR125	
18 June 2013	38.20	38.05	2047	GR126	
18 June 2013	38.14	Western Vol	1794	OT9	Transect 8
18 June 2013	38.14	Western Vol	1795	OT9	Transect 8
18 June 2013	38.14	Western Vol	1798	OT10	Transect 9
18 June 2013	38.14	Western Vol	1795	OT10	Transect 9
18 June 2013	38.15	38.19	1729	OT11	Transect 10
18 June 2013	38.15	38.19	1730	OT11	Transect 10

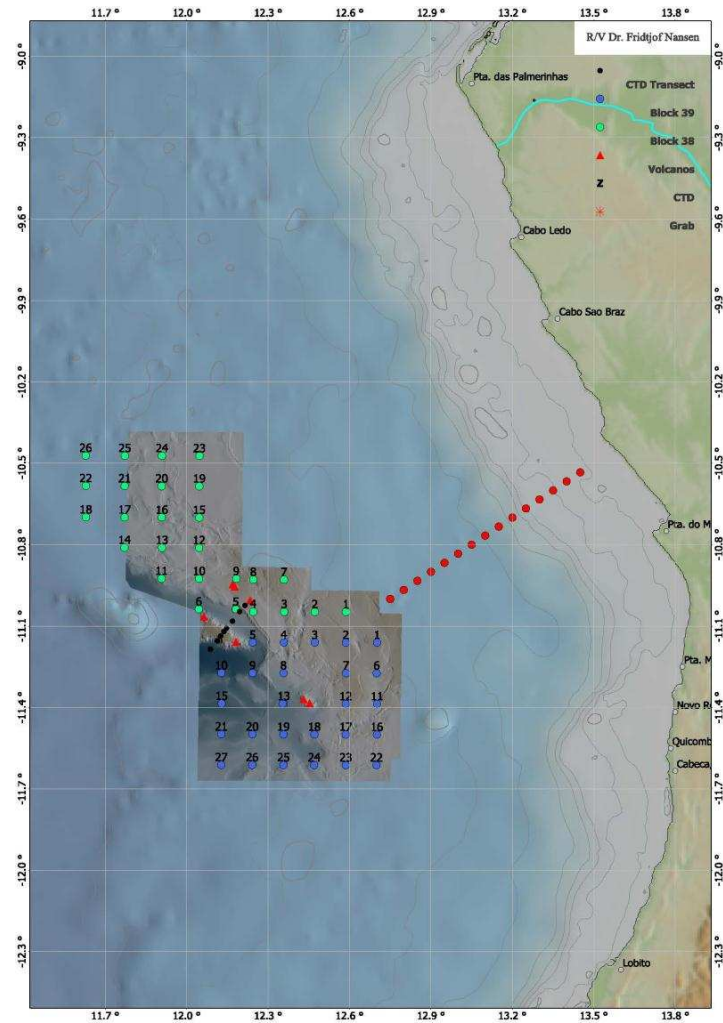


Figure 2-1: The sampling stations as requested by Statoil after the cruise had commenced. Source: Dr Fridtjof Nansen cruise map combined with altered sampling regime from Statoil.

A full set of samples consisting of 3 chemical replicates and 5 benthos replicates were collected at each of the following sites:

- Block 39: Diolo well – centre
- Block 39: Diolo well – north
- Block 39: Diolo well – south
- Block 39: 1
- Block 39: 11
- Block 39: 22
- Block 38/39: Western Volcano
- Block 38: 3
- Block 38: 5
- Block 38: 9
- Block 38: 12
- Block 38: 7
- Block 38: 19
- Block 38: Mud Volcano 2
- Block 38: 4
- Block 38: 8
- Block 38: 2

Stations 38.11, 38.13 and mud volcano 1 (Block 38) were not completed due to mechanical failures and/ or a rocky, sloped or very hard substrate.

2.2 SAMPLING ROUTINE

2.2.1 Sediment grabs:

At each station three grab samples for chemical analysis were collected as well as five for biological analysis, as required by the OSPAR regulations as well as the Angolan Environmental Decree (Executive Decree No. 224/12 of 16 July 2012).

On retrieval of each grab, the following procedures were followed:

2.2.1.1 Physical analysis (on all grabs):

The fullness of the grab was measured using a stainless steel ruler, and noting the space remaining between the upper level of sediment and the lid of the grab. This number was later converted into actual volume, using a pre-determined relationship. A photograph was then taken of the surface of the sediment within the grab (e.g. Figure 2-2). This photograph included a detailed label (station number and grab number at that station) as well as a scale object (the label size remained the same throughout the survey). The label was written on white paper, which then could also serve as a colour comparison between the different sediment samples. Lastly a small sub-sample of each grab was collected and classed according to a Munsell soil colour chart (2011 Edition). All necessary information was recorded on datasheets provided in Appendix 4.1.



Figure 2-2: Example of mostly muddy sediments collected by van Veen grab during the survey. The label shows the station and replicate sample number.

2.2.1.2 Chemical analysis (carried out on 3 out of the 8 grabs collected at each station):

Two sub-samples were collected from each grab dedicated for chemical analysis. The first sub-sample was collected for metal and particle size analysis, using a plastic spatula. This sample was placed into a pre-labelled plastic ziplock bag before being placed into a marked cool box in the vessel's sample storage freezer.

The second sub sample was collected using a metal spatula and was placed into a glass bottle (pre-labelled) as this was for analysis of organic substances. The field team were careful to allow enough headspace in each of the glass bottles, to ensure they did not crack when frozen. As soon as the sub-sampling from each grab was finished, and the necessary details recorded on the datasheets, these samples were placed into the freezer.

From the 13th July onwards, a meiofauna sample was also collected from each of the grabs dedicated to chemistry sampling. This resulted in three meiofauna samples being collected at each site. To collect this sample, 200 ml of sediment was placed into a pre-labelled plastic container and 10% neutralised formalin was added to the same container. The amount of formalin added to the container was equal to the volume of seawater already present in (or on top of) the sample, this then resulted in a final formalin concentration of ~4-5 %.

2.2.1.3 Biological sample processing (carried out on 5 of the 8 grabs collected at each station)

After the physical analysis of each biological grab was completed, the top layer of sediment was carefully scraped into a 300 µm sieve. Then the remainder of the sediment was emptied out of the grab into a plastic crate, and was sieved through first a 5 mm mesh and finally a 500 µm mesh.

By sieving the top layer of the sediment carefully through a 300 µm mesh, the field team were able to preserve more macro benthic organisms than if all of the sediment was sieved through the 500 µm mesh. This is because most benthic organisms, in this region, are thought to live in the top few layers of the sediment.

The sieving process was aided by the used of pre-cooled pressurised (with adjustable pressure) seawater. Using pre-cooled water (<12°C) was important as the sediment samples had been collected from water depths greater than 1 500 m, where the ambient temperature is approximately ~4°C, this prevented the 'burning'/ 'denaturing' of any organisms during the sieving process.

An illustration of the sieving system is shown in Figure 2-3.

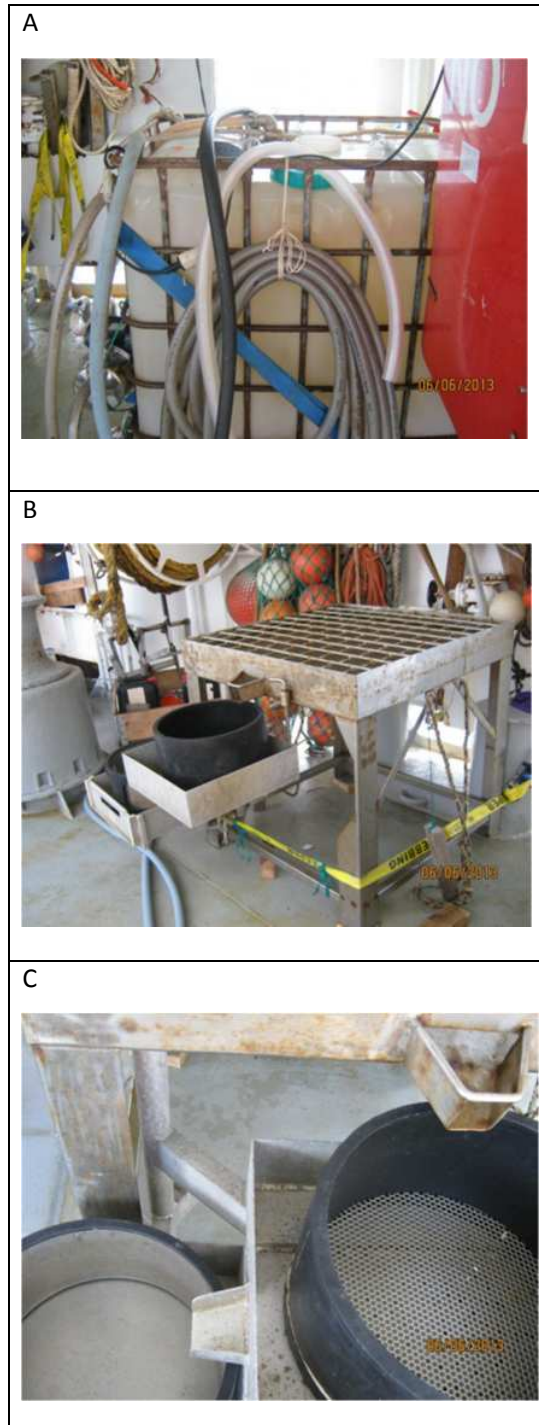


Figure 2-3: Sieving table used to work sediment samples through first a 5 mm and then a 500 µm mesh sieve. A: Pre-cooled seawater tank, B: Sieving table, C: 5 mm and 500 µm mesh sieves.

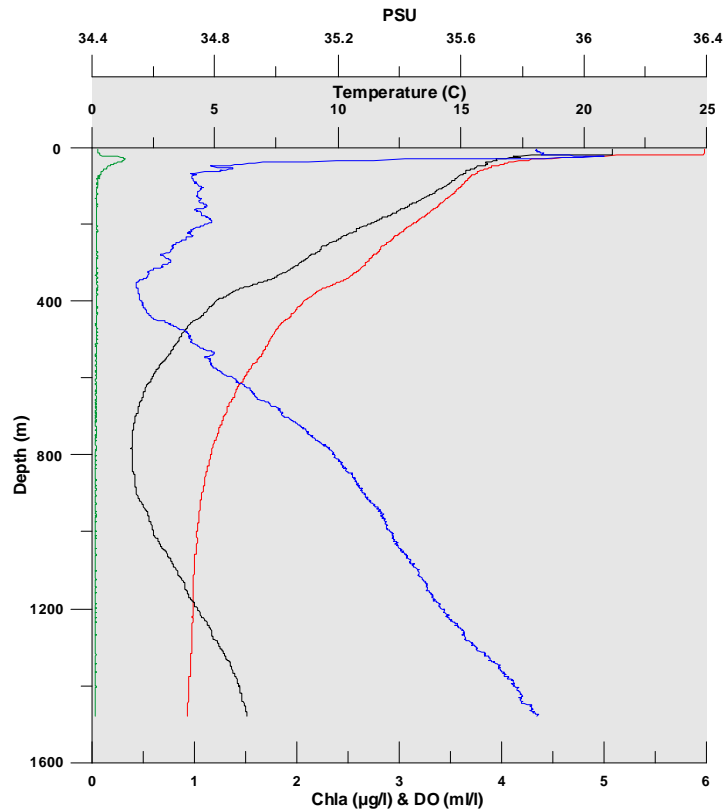


Figure 2-4: Example of CTD profiles obtained during the survey (red = temperature, black = PSU, green = Chlorophyll fluorescence & blue = dissolved oxygen)

2.2.1.4 CTD deployments

A Seabird SBE 9 CTD was deployed at 16 stations (Table 2-1) to obtain water property and water quality variables down the water column. An example of the data retrieved is shown in Figure 2-4.

2.2.1.5 ROV transects and grab samples:

There were a total of 11 occasions where the ROV functioned correctly and allowed 5 grab samples to be collected. These 5 samples were recovered from 3 hydraulically operated Van Veen grabs which were remotely operated from the vessel. On retrieval of the 3 grabs, the top flaps were removed and two of the grabs were divided into two sections. This was done by inserting a stainless steel plate into pre-cut grooves through the top side of the grab. The physical analysis procedure (described above) was then carried out on all of the grabs. For the smaller partitions of the sectioned grabs as well as the centre grab, the physical analysis was followed by the chemical sampling procedure (also described above). Biological sampling (sieving to collect benthic macro fauna) was carried out on the two larger partitions of the sectioned grabs. This resulted in three chemical samples and two biological samples being collected from one ROV dive. A second dive was then required in order to collect a further three biological samples.

On each ROV dive (barring those with technical difficulties), once the dive unit had settled onto the seafloor, the ARGUS ROV device was remotely manoeuvred out of its cage by the ROV operators. The tether between the ROV swimming unit and the dive cage was 40 m. The ROV operators then manoeuvred the swimming unit in transects around the cage. Each video transect lasted ~60 minutes and all mega benthic fauna (organisms >10 mm) were recorded by the field team (see raw data sheets in Appendix 4.2). Each organism was described to the lowest taxonomic level possible and the relevant video frame was labelled with a timestamp, allowing for final identification during post-survey video analysis.

Figure 2-5 shows the ROV and attached hydraulically operated van Veen grabs being recovered to deck after deployment.

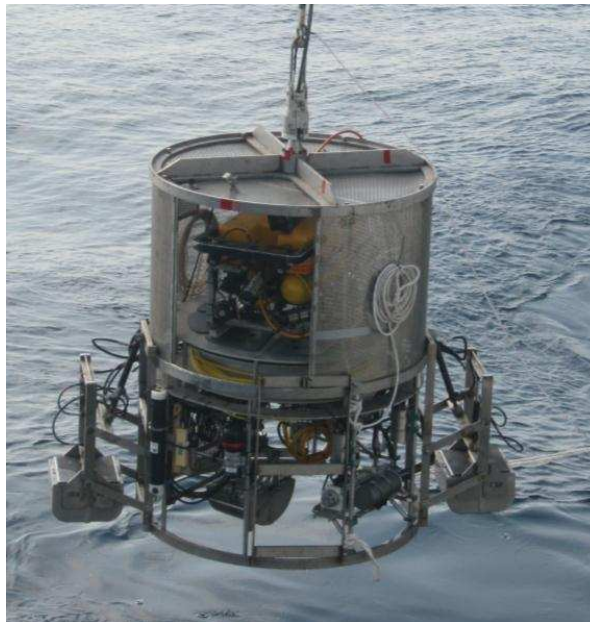


Figure 2-5: The ROV and hydraulic grab section during deployment off the Fridtjof Nansen, during the Statoil environmental baseline survey.

3 SAMPLE CURATION

All collected samples were clearly labelled and stored either in the vessel's freezer or in the vessel's dry-laboratory as required. These boxes or cool boxes have remained on the vessel to be offloaded when the vessel arrives in Cape Town harbour in August 2013.

On arrival in Cape Town, the samples will be sorted and re-labelled where necessary. Those requiring chemical analysis will then be transported to the CSIR laboratories in Stellenbosch, while the biological samples will be taken to Prof. Mark Gibbons at the University of the Western Cape for pre-analysis screening.

4 APPENDICES

4.1 SEDIMENT GRAB SAMPLES AND CTD DECK LOGS

Examples of the grab and CTD deck logs for deployments while on the Fridtjof Nansen between 3 and 19 June 2013 are shown below.

Example of sediment grab sampling deck log (Stn 39.1)

SAMPLING JOURNAL Sign. In: *KATE MUNNIK* Page nr: 1 of 1

Vessel: *Rv. Dr. Fridtjof Nansen* Area: *Angola* Project code: *170* Survey nr: *2013405*

Grab station nr. *39-1* Date *6 June 2013* Position Latitude N/S Longitude E/W Depth (m)

CTD St. *6 June 2013*

Weather: *sunny/cloudy* Wind: *slight* Wave height (m): *~1.2 m*
 Time Start: *08:00* Time Finish: *10:00* Duration: *2h*

Sample equipment used (bite area, weight): *0.1m² Van Veen Grab andmm sieve (..... holes)*

Type of bottom sediment: *dark mud, and clay.*
 Color: *brown, dark brown, green-gray* Odor: *NONE*
 Observation of animals: *Polychaetes, shells* No. rejected samples: *NONE*
 Observation of oil, waste etc: *organic waste (wood/sticks) MAY BE SOME hydrocarbon oil.* Empty: Stains: Open:

Sample nr.	Vol. (cm)	Hydro-carbons	Heavy metals	Sediment granulometry	Sections	Remarks	G. nr	Ex. w	Br. Surf.
<i>1.1</i> ROW ← <i>1</i>	<i>FULL</i>	<i>✓ F</i>	<i>✓ F</i>			<i>Photo 2 colour</i>			
<i>2.1</i> ROW ← <i>2</i>	<i>FULL</i>	<i>✓ F</i>	<i>✓ F</i>			<i>5/104 GREEN</i>			
<i>3.1</i> ROW ← <i>3</i>	<i>FULL</i>	<i>✓ F</i>	<i>✓ F</i>			<i>5/104 GREEN</i>			

Sample nr	Vol. (cm)	bottles bio.	1 litre	0.5 litre	ml	Pack Box	Remarks	Grab nr.	Extra weights
<i>1.2</i> ROW ← <i>4</i>	<i>FULL (MAY)</i>	<i>2</i>				<i>2</i>	<i>1st 1.1</i>		
<i>2.2</i> ROW ← <i>5</i>	<i>FULL</i>	<i>2</i>				<i>2</i>	<i>2-1 2.1</i>		
<i>3.2</i> ROW ← <i>6</i>	<i>FULL (MAY)</i>	<i>2</i>				<i>2</i>	<i>3-1 3.1</i>		
<i>V. VEEN</i>	<i>FULL</i>	<i>2</i>				<i>2</i>	<i>USED FULL VOL (-chem/water) as divider did not fit</i>		
<i>8</i>	<i>FULL</i>	<i>2</i>				<i>2</i>	<i>SOME hydraulic oil in 2nd bottle.</i>		
<i>9</i>	<i>FULL</i>	<i>2</i>				<i>2</i>	<i>TO BE INCLUDED AS 3.2 (B) IN SHIP DRIFT.</i>		
<i>10</i>	<i>FULL</i>	<i>2</i>				<i>2</i>	<i>5/104 GREEN</i>		

Sign. Out:

F = FROZEN

NOTICE: THIS VIAL IS 1/2 FULL. PROBABLY ONLY THE 1st ml. MUST BE ANALYZED.

Station 39.1

Example of CTD deployment log sheet (Station 39.1).



4.2 ROV VIDEO TRANSECTS

An example of the raw deck logs from the video analysis transects carried out by ROV during the Statoil pre-exploration environmental survey is shown below.

Example of ROV deployment and observation deck log.

Dive #1 Volcano → ROV video ROV footage log: 170 Statoil Angola Distribution — at the fine bottom type: Sandy mud - dark material between

Volcano # 1

V. Transect # 1

Block # and Station #	Date	Personnel	Time	Structure/Organism	ID	Notes
St 38, 39	14 June 2013	Andy & Kalle	Beginning ~11:52	Brittle Stars		A lot, white
			11:57:09	Sea cucumber		Red-dark
			~11:55	Shrimp		
			11:57:49	Sandy sea cucumber?		
			12:00:11	Starfish		
			12:00:46	Sandy sea cucumber		
			12:01:00	Rat tail eel		Swampy
			12:01:37	Sandy sea cucumber		
			12:02:27	Eel / Chimera type		
			12:02:57	Eel / Chimera type		
			12:05:58	Sea urchin		
			12:05:40	Shrimp		Red
			12:05:50	Plant / worm		
			12:06:20	Orange worm / plant (from bottom)		
			12:07:15	Plant / worm		
			12:07:45	Rocks / mud clumps		
			12:07:57	Starfish		
			12:08:18	Sea cucumber		lighter red
			12:08:36	Shrimp		Red

1 of 3 pages * 3 grabs were taken at this site. For mud - seems to have similar animals as eg.