

Cruise Report – JC209

Understanding Hazardous Seafloor Sediment Flows in the Congo Submarine Canyon, Offshore West Africa

RRS James Cook – JC209

1 Sept to 22 Oct 2020 (Southampton-Southampton)



Staffing (and CoV-19 measures)

The research cruise occurred during the CoV-19 pandemic. For this reason, only technicians and crew went onboard the vessel in Southampton, and they had to quarantine on departure and arrival. The science party were based onshore, and logged on remotely with the vessel via Teams meetings.

Thus, we would like to particularly thank the technicians, and crew led by captain John Leask, for their exceptional efforts in delivering a very successful cruise, in these challenging circumstances.

Ship-based Technical Team

Jez Evans (Senior Technician)
Mark Maltby (SS technician)
Stephen Corless (OEG Technician)
Ben Pitcairn (OBIC Technician)
Martin Weeks (OBIC Technician)

Shore-based Scientist Team

Pete Talling (PI; Watch leader)
Megan Baker (Watch leader)
Maarten Heijnen (GIS co-lead)
Ed Pope (GIS co-lead)
Sean Ruffell
Florian Pohl

We are also grateful to the Angolan Authorities for permission to work in Angolan Waters, and this forms part of ongoing collaborations led by Rui Faria, Coast Cula and Joao Baptista at Angola Cables.

Cruise Summary and Aims

The primary aim of cruise JC209 was to recover 12 Ocean Bottom Seismometers (OBS) and a Vertically-oriented Hydrophone Array (VHA) from the seabed along the Congo Canyon offshore West Africa. These OBS and VHA had been previously deployed in September 2019 on research cruise JC187, together with 11 oceanographic moorings with ADCPs and other sensors. The moorings were impacted by a very powerful (5-8 m/s) seafloor sediment flow (turbidity current) on 14-16 January 2020, such that the moorings surfaced, and 9 moorings were recovered successfully via other vessels.

The first aim of this cruise (JC209) was therefore to recover the remaining seabed equipment. This recovery cruise was originally scheduled for April 2020, but had to be delayed to September-October 2020 due to the ongoing travel and quarantine restrictions resulting from the CoV-19 global pandemic.

The second aim of the cruise was to complete a series of swath bathymetric surveys of the Congo Submarine Canyon and Channel system, soon after the prodigious submarine flow in January 2020. This post-event survey could then be compared to a survey during the 2019 JC187 cruise, to see how the seabed has changed. This helps us to understand how these submarine flows sculpt the seabed, and thus better understand the hazards to seafloor cables that now carry over 99% of global intercontinental data traffic.

The wider aims of the OBS and VHA deployments are to develop novel low-cost sensor systems that can remotely record submarine turbidity currents, from sites located out of harm's way (and outside the main canyon and channel floor). The need for such sensor systems is well illustrated by damage to the 11 oceanographic moorings by the January 2020 flow, which caused the moorings to surface.

JC209 was very successful, especially in challenging circumstances due to global CoV-19 pandemic. Ten of the twelve OBS, and the Vertical Hydrophone Array, were recovered successfully. Detailed swath bathymetric surveys were completed for the floor of the upper Congo Canyon within Angolan Territorial Waters, and along the deeper-water channel within International Waters. The recovered OBS appear to have successfully recorded the January 2020 submarine flow event, whilst the repeat surveys show significant change to the seabed due to submarine flow(s) between September 2019 and September 2020.

Section 1. Recovery of OBS and Vertical Hydrophone Array

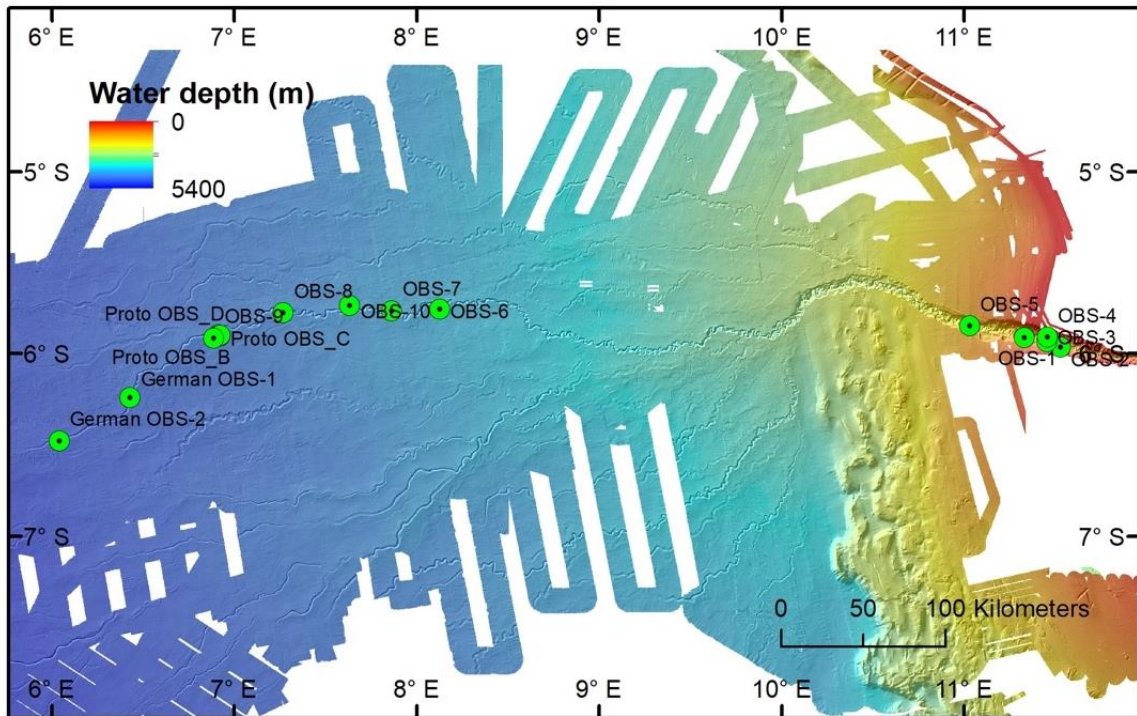


Figure 1: Map of total distribution of OBS. There are 10 OBIC OBSs and 2 German OBS, plus the vertical hydrophone array (which is next to OBS 5).

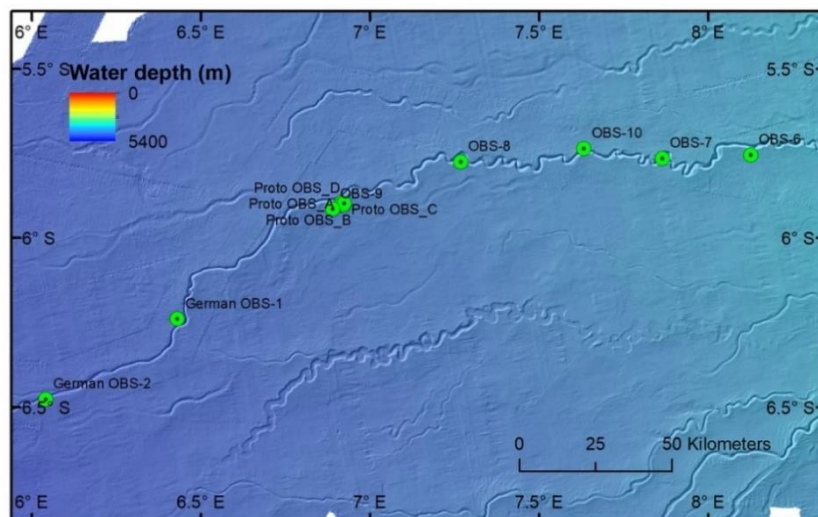


Figure 2: Map of distribution of OBS within International Waters.

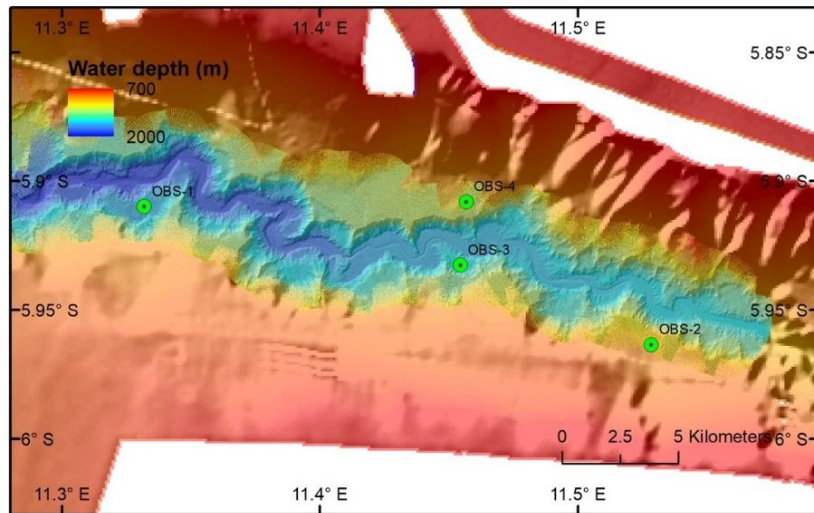


Figure 3: Map of distribution of OBS in upper Upper Canyon within Angolan Waters.

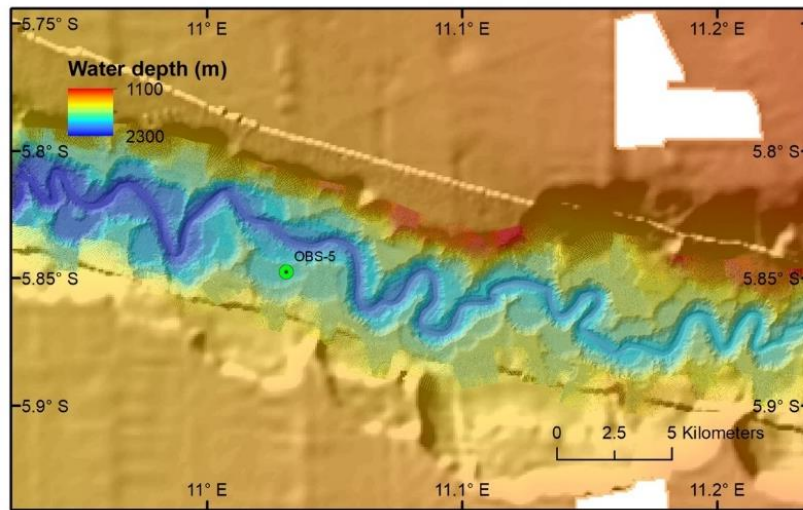


Figure 4: Map of distribution of OBS in lower Upper Canyon within Angolan Waters

Table 1: Expected rise and recovery times of the OBSs [+ what was recovered etc]

Name	Location	Depth (m)	Rise time	Total time	Rise time (mins)	Total time (mins)
German OBS-1	International	4607	1 hr 42	2 hr 42	102	162
German OBS-2	International	4742	1 hr 45	2 hr 45	105	165
OBIC OBS-1	Angola	1670	37 mins	1 hr 37 mins	37	97
OBIC OBS-2	Angola	1131	25 mins	1 hr 25 mins	25	85
OBIC OBS-3	Angola	1567	35 mins	1 hr 35 mins	35	95
OBIC OBS-4	Angola	1260	28 mins	1 hr 28 mins	28	88
OBIC OBS-5	Angola	1945	43 mins	1 hr 43 mins	43	103
OBIC OBS-6	International	4014	1 hr 29 mins	2 hr 29 mins	89	149
OBIC OBS-7	International	4084	1 hr 30 mins	2 hr 30 mins	90	150
OBIC OBS-8	International	4305	1 hr 35 mins	2 hr 35 mins	95	155
OBIC OBS-9	International	4442	1 hr 38 mins	2 hr 38 mins	98	158
OBIC OBS-10	International	4196	1 hr 33 mins	2 hr 33 mins	93	153

Section 2. Swath multibeam bathymetry surveys

The revised the multibeam survey as a result of discussions with a world-leading external expert in seafloor mapping. The discussions led to the external expert reprocessing some of last year's data to evaluate the effectiveness of the along and across lines proposed in the previous survey. The results of the processing got in only recently and has led to the external expert proposing this new revised survey.

The new survey consists of a series of parallel lines following the main trend of the submarine canyon/channel present on the seafloor. With this survey design we will acquire similar quality data in less time, or acquire better data with the same available time. Furthermore, this new revised survey is easier to execute (less turns). Lastly, the new survey is also more flexible as we can change the amount of lines, depending on available time.

Kongsberg EM122 Multibeam set-up

- The aim of the survey is a detailed survey, rather than high coverage.
- Beam width is 1°.
- Swath width was at a fixed angle of 45° either side, making a total of 90°. (The exception was the final survey of the lobe, where the beam angle was set wider).
- The swaths generally have high amounts overlap.
- The survey is performed at 5-6 knots.

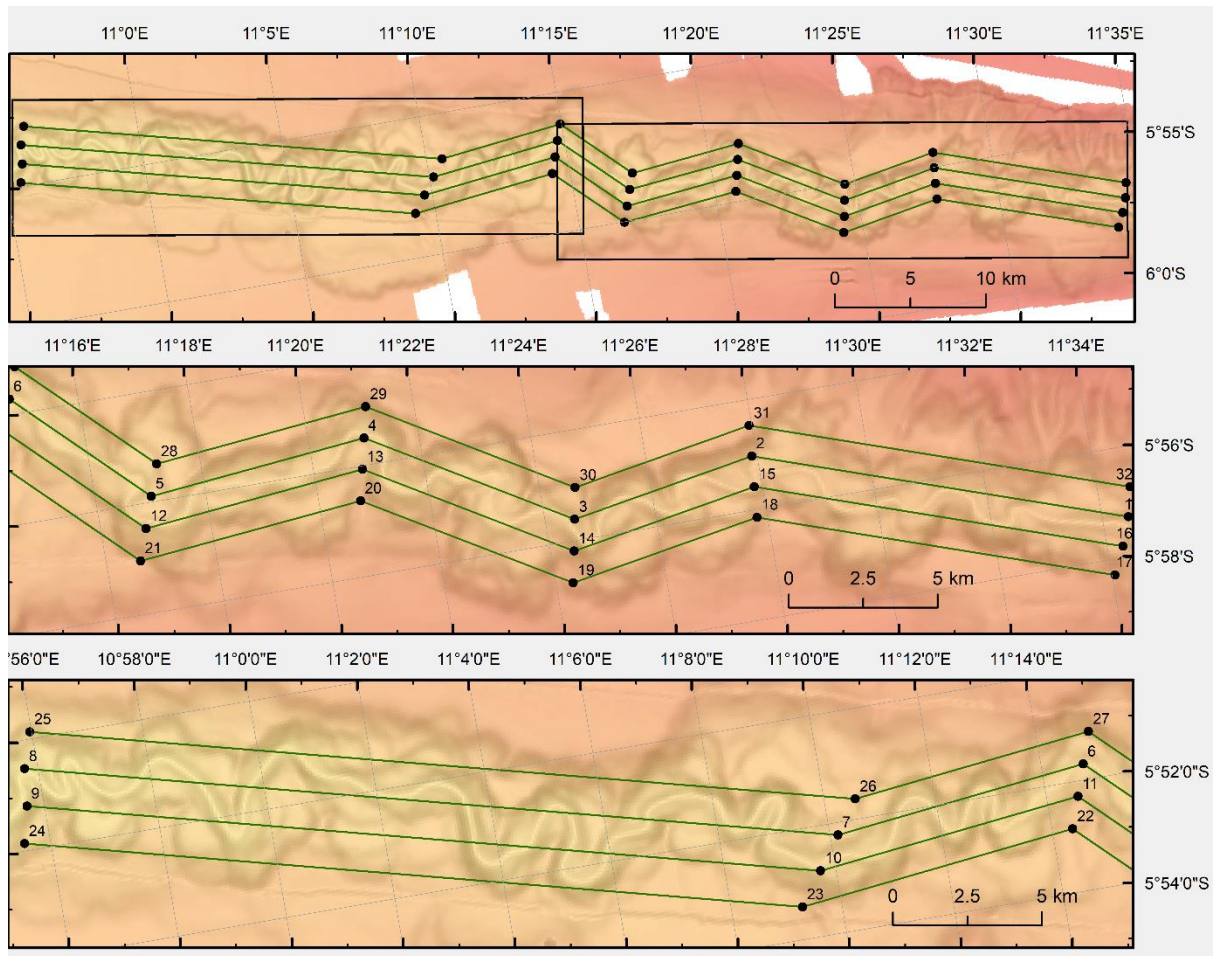


Figure 5: Detailed overview of the upstream survey in Angola Waters. 4-line survey in blue and 3-line survey in green. Numbering is incomplete due to close spacing between the labels in the software.

Table 2. Swath Multibeam Survey – vessel speeds

Survey	Speed
Angolan Waters (Upper Canyon) 4 lines	5 knots
International Waters (Distal Channel) 3 lines	5 knots until waypoint 13 (line 1), then 6 knots
International Waters (Lobe survey)	5.5 to 6 knots (but more significant swell)

Table 3: Angolan Waters survey lines and waypoints (4-line survey)

	Latitude	Longitude
Line 1 (waypoints 1-8)	5° 48.5183 S	10° 55.7585 E
	5° 52.226 S	11° 10.1377 E
	5° 51.7118 S	11° 14.7565 E
	5° 53.8954 S	11° 17.0037 E
	5° 53.5091 S	11° 21.0028 E
	5° 55.6178 S	11° 24.5294 E

	5° 55.0299 S	11° 27.9017 E
	5° 57.2819 S	11° 34.4751 E
Line 2 (waypoints 9-16)	5° 57.7918 S	11° 34.2864 E
	5° 55.5882 S	11° 27.8545 E
	5° 56.1862 S	11° 24.4221 E
	5° 54.0669 S	11° 20.8777 E
	5° 54.4599 S	11° 16.8083 E
	5° 52.2779 S	11° 14.5623 E
	5° 52.817 S	11° 9.7158 E
	5° 49.1992 S	10° 55.6843 E
Line 3 (waypoints 17-24)	5° 49.8628 S	10° 55.5239 E
	5° 53.4097 S	11° 9.2798 E
	5° 52.8438 S	11° 14.3666 E
	5° 55.0245 S	11° 16.6113 E
	5° 54.6253 S	11° 20.7448 E
	5° 56.7557 S	11° 24.3079 E
	5° 56.1463 S	11° 27.8069 E
	5° 58.2857 S	11° 34.0529 E
Line 4 (waypoints 25-32)	5° 56.7479 S	11° 34.594 E
	5° 54.472 S	11° 27.9502 E
	5° 55.0488 S	11° 24.6352 E
	5° 52.9514 S	11° 21.1278 E
	5° 53.3309 S	11° 17.1998 E
	5° 51.1463 S	11° 14.951 E
	5° 51.635 S	11° 10.5598 E
	5° 47.8721 S	10° 55.9672 E

Table 4. Waypoints for swath multibeam survey of distal submarine channel within international waters (3-line survey)

	Latitude	Longitude
Line 1 (waypoints 1-13)	5° 43.3819' S	8° 9.8782' E
	5° 43.6867' S	8° 2.4008' E
	5° 48.2395' S	7° 59.4377' E
	5° 45.1835' S	7° 46.6904' E
	5° 46.8532' S	7° 26.8888' E
	5° 46.1929' S	7° 11.5083' E
	5° 50.0306' S	7° 5.2878' E
	5° 54.9442' S	6° 45.8757' E
	6° 5.0272' S	6° 36.4275' E
	6° 6.5687' S	6° 28.4764' E
	6° 17.8916' S	6° 25.5753' E
	6° 22.0448' S	6° 20.5575' E
	6° 32.1811' S	5° 49.7919' E
Line 2 (waypoints 14-26)	6° 31.1898' S	5° 49.3397' E
	6° 21.0771' S	6° 20.0318' E
	6° 17.2856' S	6° 24.613' E
	6° 5.6372' S	6° 27.5983' E
	6° 4.0309' S	6° 35.8743' E

	5° 53.9713' S	6° 45.3001' E
	5° 49.0169' S	7° 4.8691' E
	5° 45.1027' S	7° 11.212' E
	5° 45.7646' S	7° 26.9292' E
	5° 44.0857' S	7° 46.8291' E
	5° 46.9963' S	7° 58.9705' E
	5° 42.6203' S	8° 1.8184' E
	5° 42.3314' S	8° 8.9412' E
Line 3 (waypoints 27-39)	5° 44.4405' S	8° 10.4433' E
	5° 44.741' S	8° 3.0324' E
	5° 49.5017' S	7° 59.9357' E
	5° 46.2866' S	7° 46.5274' E
	5° 47.9433' S	7° 26.8142' E
	5° 47.2916' S	7° 11.7898' E
	5° 51.0413' S	7° 5.7118' E
	5° 55.9161' S	6° 46.4508' E
	6° 6.0252' S	6° 36.9786' E
	6° 7.5032' S	6° 29.3573' E
	6° 18.5012' S	6° 26.5391' E
	6° 23.0116' S	6° 21.0896' E
	6° 33.1475' S	5° 50.3245' E

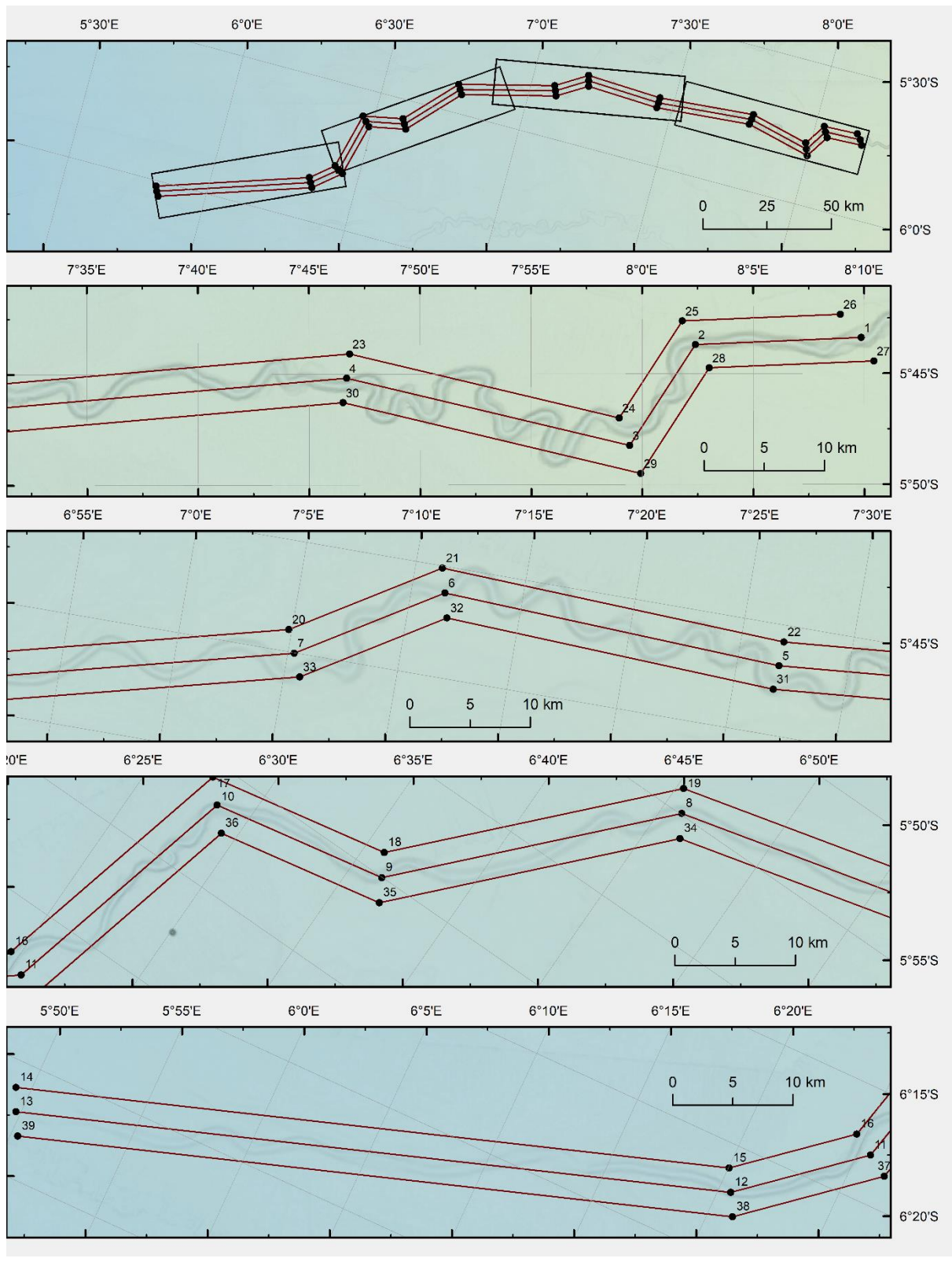


Figure 6: More detailed overview of the upstream survey in International Waters. 4-line survey in red and 3-line survey in yellow. Numbering is incomplete due to close spacing between the labels in the software.

Table 5: Survey of the lobe, beyond the end of the channel, within international waters.

Line 1	6° 37.3744' S	5° 51.4273' E
	6° 45.9736' S	5° 25.3186' E
Line 2	6° 43.4472' S	5° 24.2611' E
	6° 34.4859' S	5° 51.4668' E
Line 3	6° 31.9454' S	5° 50.5245' E
	6° 47.3365' S	5° 3.7974' E
Line 4	6° 44.7702' S	5° 2.9368' E
	6° 24.5102' S	6° 4.4351' E
Line 5	6° 23.3108' S	5° 59.4206' E
	6° 35.7842' S	5° 21.5645' E
Line 6	6° 33.2755' S	5° 20.4878' E
	6° 21.653' S	5° 56.350' E

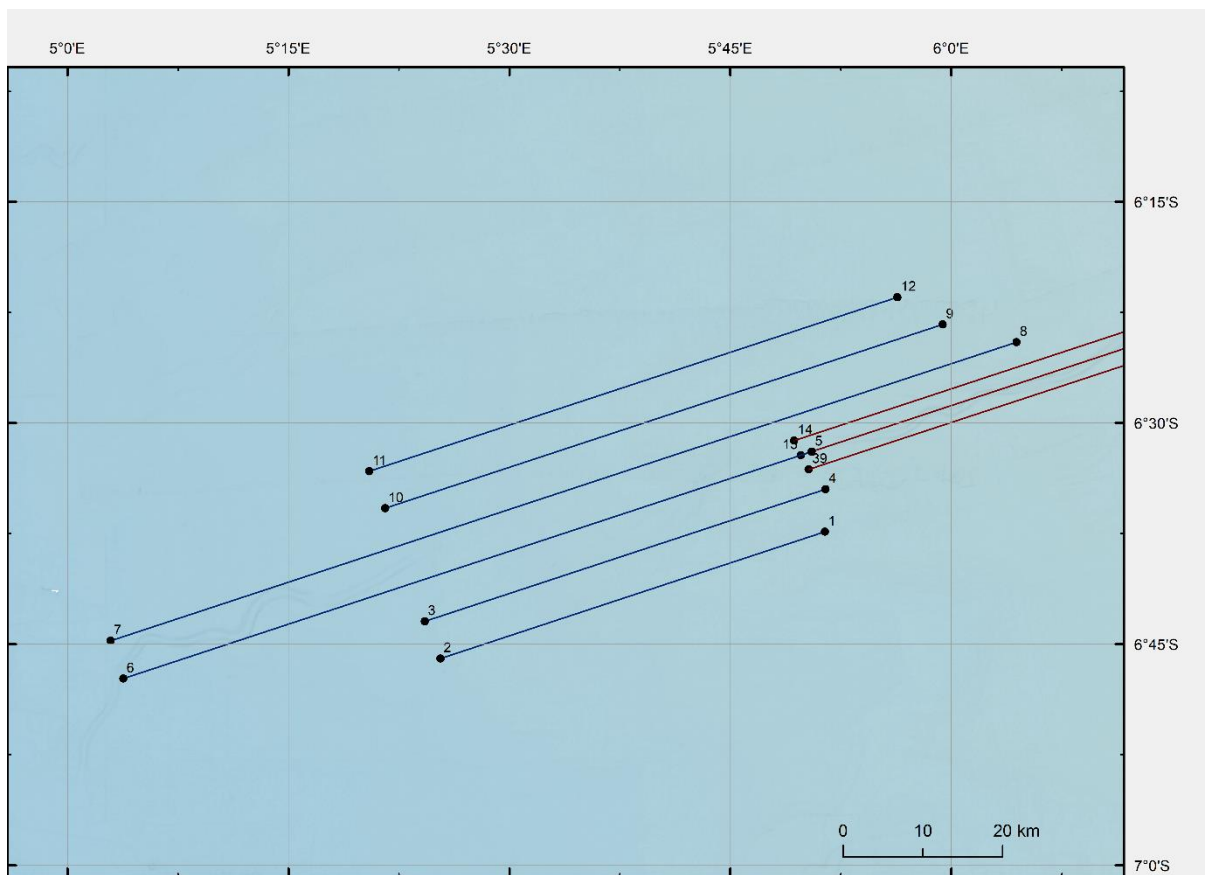


Figure 7: Extension of international waters survey to include the lobe. Red lines are the lobe survey, and blue lines are the previous 3-line channel survey. The lobe survey was conducted from north to south, starting at waypoint 1, and finishing at waypoint 12.

Schedule and Daily Notes (and see Log Sheets that follow these initial figures)



Figure 8: GeoMar OBS-1 on deck 20/09/2020. Light not working, so great effort by OBS team and bridge to track it down.



Figure 9: OBS-8 being recovered 21/09/2020. Appears to have been covered in sediment (fine-grained?)



Figure 10: OBS-10 being recovered 21/09/2020.



Figure 11: Muddy sediment trapped under flotation of OBS-10.



Figure 12: OBS-07 recovered 21/09/2020.



Figure 13: Muddy sediment on OBS-10.



Figure 14: OBS-6 on deck 21/09/2020.



Figure 15: OBS-4 recovered 22/09/2020. OBS-2 and OBS-4 not as muddy as international water OBSs.



Figure 16: OBS-3 back on deck 22/09/2020. "cleaner than other two tonight".



Figure 17: Vertical Hydrophone Array coming back on deck 23/09/2020.

Section 4. JC209 Log Sheets of Events

Date	Time UTC	Station Number	Site No. in 2019 (GIS loc.)	Latitude DDM	Longitude DDM	Event	Comments
01/09/2020	-					Ship leaves Southampton	
02/09/2020	12.00					Planning meeting with ship	Present from ship: John Leask (Master), Jez Evans, Mark Maltby, Ben Pitcairn, Martin Weeks, Stephen Corless; Present from shore: Pete Talling (PI), Ed Pope, Meg Baker, Maarten Heijnen, Sean Ruffell.
18/09/2020	08.30					First daily planning meeting	Present from ship: John Leask (Master), Jez Evans, Mark Maltby, Ben Pitcairn, Martin Weeks, Stephen Corless; Present from shore: Pete Talling (PI), Ed Pope, Meg Baker, Maarten Heijnen, Sean Ruffell.
20/09/20	10:30	Stn. 1	58			German OBS-2	Stop logging EWM-122. Start pinging OBS-2 from 7nm away at 11 knts....
20/9/20	11:21	Stn. 1	58	06 28.18S	06 02.68E	German OBS-2	Vessel all stopped 0.44nm NE of OBS location
20/9/20	11:32	Stn 1.	58	06 28.17S	06 02.67E	German OBS-2	No response from OBS – deploy dunker transducer

20/9/20	11:51	Stn 1	58			German OBS-2	No response – shift vessel to the OBS location.
20/9/20	11:58	Stn 1	58	06.28.48S	06.02.50E	German OBS-2	Heading changed facing south to range OBS – no response from hull or dunker transducers
20/9/20	12:20	Stn 1	58	06 28.48S	06 02.50E	German OBS-2	Disable azi-thruster & ADCP's - no response from hull or dunker transducers
20/9/20	12:35	Stn1	58	06 28.48S	06 02.50E	German OBS-2	Move vessel to approx. 0.5nm SE of OBS location...
20/9/20	12:53	Stn 1	58	06 28.78S	06 02.78E	German OBS-2	On position 0.4 nm SE of OBS location – vessel drifting (ie no thrusters etc) - no response from hull or dunker transducers
20/9/20	13:07	Stn 1	58			German OBS-2	Shift vessel to a position SW of OBS location...
20/9/20	13:29	Stn 1	58	06 29.28S	06 01.78E	German OBS-2	On position approx. 1nm SW of OBS location – vessel drifting (ie no thrusters etc) - no response from hull or dunker transducers
20/9/20	13:46	Stn 1	58			German OBS-2	Relocate to a position approx. 1nm NW of OBS location...
20/9/20	14:07	Stn 1	58	06 27.75S	06 01.74E	German OBS-2	On position approx. 1nm NW of OBS location

							- vessel drifting -
20/09/20	14:17	Stn 1	58	06 27.56S	06 01.69E	German OBS-2	Final release code tx.Wait in vicinity for 1.5 hours
20/9/20	15:40	Stn 1	58	06 28.18S	06 02.30E	German OBS-2	Start EM-122, 10KHz & ADCP.
20/9/20	15:48	Stn 1	58				Depart Station 1, for Station 2
20/9/20	18.00	Stn 2	38	06 17.10S	06 21.17E	German OBS-1	Vessel speed reduced to 5 knts on approach to OBS at 5nm out to start pinging. Stop EM-122, 10Khz and ADCP. Possible range so release command sent..
20/9/20	18.09	Stn 2	38			German OBS -1	Can confirm ascent to surface. Estimated on surface 19.10.
20/9/20	18.55	Stn 2	38	06 13.90 S	06.25.63 E	German OBS -1	Vessel all stopped north of OBS. Estimated on surface 19.05
20/9/20	19.06	Stn 2	38			German OBS -1	OBS on surface. No visual of OBS so vessel moving into range position slowly. .Light not working
20/9/20	19:54	Stn 2	38	06 13.99 S	06.25.49 E	German OBS - 1	OBS on deck. Depart Stn 2 for Stn 3. Start ADCP, 10Khz and Em-122
20/9/20	22.58	Stn 3	37	05 57.79 S	06.49.67 E	OBS 9	Vessel speed reduced to 5 knts on approach

							to OBS at 5nm out to start pinging. Stop EM-122, 10Khz and ADCP. Enable and Release ping sent no reply.
20/9/20	23.20	Stn 3	37			OBS 9	Another release ping sent – no reply
20/9/20	23.37	Stn 3	37			OBS 9	Another enable ping sent – with reply. 3nm away. Release ping sent.- OBS still on seabed
20/9/20	23.56	Stn 3	37			OBS 9	Another release sent as OBS position still on seabed
21/9/20	00.13	Stn 3	37	05 54.18 S	06 53.77 E	OBS 9	Another release sent as OBS position still on seabed
21/9/20	00.33	Stn 3	37			OBS 9	Another release sent as OBS still on seabed
21/9/20	01.13	Stn 3	37			OBS 9	Another release sent as OBS still on seabed
21/9/20	01.32	Stn 3	37			OBS 9	Another release sent as OBS still on seabed
21/9/20	01.50	Stn 3	37			OBS 9	Another release sent as OBS still on seabed
21/9/20	02.07	Stn 3	37			OBS 9	OBS Position still on seabed so we have commenced the surface time wait of approx. 1hr 40 min

21/9/20	03:37	Stn 3	37	05 54.18 S	06 53.76E	OBS 9	Release disabled
21/9/20	03:42			05 54.18 S	06 53.77E		Depart Stn 3. Head to Stn 4 (OBS 8). Restart EM122, 10kHz & ADCP
21/9/20	05:40	Stn 4	102	05 48.21 S	07 11.19E	OBS-8	Slow vessel to 5 knts approx. 5nm down channel from OBS-8. Stop EM-122, 10kHz & ADCP. Enable OBS and send release cmd.
21/9/20	05:54	Stn 4	102	05 47.77 S	07 12.41E	OBS-8	Continue towards OBS ranging and sending release cmd (c. 3.9 nm away)
21/9/20	06:38	Stn 4	102	05 46.25 S	07 15.61E	OBS-8	All stopped 0.5nm to NW of OBS location. No comms established as yet.
21/9/20	06:48	Stn 4	102	05 46.23 S	07 15.68E	OBS-8	Comms established Range = 4029m
21/9/20	07:02	Stn 4	102			OBS-8	OBS rising to surface ETA 08:11
21/9/20	08:14	Stn 4	102			OBS-8	OBS on surface
21/9/20	08:46	Stn 4				OBS-8	OBS on deck
21/9/20	0849			05 46.26S	07 15.69E		Depart Stn 4; heading to Station 5 (OBS-10) EM122, 10kHz & ADCP switch on
21/9/20	09:26			05 45.63S	07 21.59E		En-route to Stn 5

21/9/20	10:34	Stn 5	43	05 44.45S	07 32.87E	OBS-10	Slow to 5knts when 5nm from OBS-10. Switch off EM-122 & 10kHz. Attempt to enable and range on OBS.
21/9/20	11:24	Stn 5	43	05 43.76S	07 36.92E	OBS-10	Comms established approx. 1.2 nm from OBS – continue to position 0.5nm from OBS
21/9/20	11:50	Stn 5	43	05 43.67S	07 37.84E	OBS-10	0.5nm north of OBS-10. Deploy SVP.
21/9/20	13.27	Stn 5	43			OBS - 10	SVP @ -4000m, commence recovery of SVP to surface
21/9/20	14.32	Stn 5	43			OBS - 10	Release ping sent
21/9/20	14.50	Stn 5	43			OBS - 10	Release confirmed – estimated time on surface 16.30
21/9/20	15.05	Stn 5	43			OBS - 10	SVP on surface
21/9/20	16.00	Stn 5	43			OBS - 10	OBS on surface
21/9/20	16.22						OBS on deck
21/9/20	16.26	Stn 5	43	05 43.90S	07 37.85E	OBS - 10	On route from Stn 5 to Stn 6 EM 122, 10Khz and ADCP all on and logging
21/9/20	17.16	Stn 6	101			OBS - 7	7nm west of OBS and range pings to engage

							commenced
21/9/20	17.16	Stn 6	101			OBS - 7	6.1nm west and bridge reports fishing vessels at OBS location – will assess as we move closer
21/9/20	17.47	Stn 6	101			OBS - 7	EM122 – 10Khz off and enable ping sent at 2.1nm
21/9/20	17.52	Stn 6	101			OBS - 7	Estimated on surface 18.45
21/9/20	19.00	Stn 6	101			OBS - 7	OBS on surface
21/9/20	19.30	Stn 6	101			OBS - 7	OBS on deck EM 122, 10Khz switched on. On route to Stn 7
21/9/20	20.41	Stn 7	33	05 45.31S	08 02.44E	OBS - 6	Commence enable ping to OBS
21/9/20	21.06	Stn 7	33			OBS - 6	EM 122 and 10Khz switched off, range OBS, confirm release and ETA on surface 22.10
21/9/20	22.10	Stn 7	33			OBS - 6	OBS on surface
21/9/20	22.35	Stn 7	33	05 45.26S	08 07.45E	OBS - 6	OBS-6 on deck
21/9/20	22.40	Stn 7	33			OBS - 6	Depart for transit to Stn 8 and OBS-5

22/9/20	13:50	-	-			-	Switch on EM-122, 10kHz & ADCP at entry to Angolan waters
22/9/20	17.20	Stn 8	5	05 57.36S	11 30.18E	OBS-2	1nm wets of OBS Em122 and 10Khz off and OBS ping sent for range and release
22/9/20	17.40	Stn 8	5			OBS - 2	Release confirmed and ETA on surface 17.50
22/9/20	17.51	Stn 8	5			OBS - 2	On surface
22/9/20	18.17	Stn 8	5			OBS - 2	On deck – In transit to Stn 9
22/9/20	18.56	Stn 9	105	05 54.99S	11 28.09E	OBS - 4	Release ping sent to OBS – ETA on surface 19.30
22/9/20	19.28	Stn 9	105	05 54.45S	11 27.25E	OBS - 4	On surface
22/9/20	19.45	Stn 9	105			OBS - 4	On deck – In transit to Stn 10
22/9/20	19.46	Stn 10	104			OBS - 3	Release ping sent to OBS – ETA on surface 20.30
22/9/20	20.30	Stn 10	104	05 55.88S	11 27.09E	OBS - 3	On surface
22/9/20	20.46	Stn 10	104			OBS - 3	On deck
22/9/20	20.50	Stn 10	104			OBS - 3	In transit to Stn 11

22/9/20	21.54	Stn 11	87			OBS - 1	Release ping to OBS 1 at 1nm from the west. – ETA on surface 22.35
22/9/20	22.34	Stn 11	87			OBS - 1	On surface
22/9/20	22.48	Stn 11	87			OBS - 1	On deck
22/9/20	22.51	Stn 11	87			OBS - 1	In transit to Stn 12
22/9/20	23:03	-	-	05 53.88S	11 18.40E	-	Switch on EM-122 & 10kHz
23/9/20	00:22	Stn 12	51	05 50.83S	11 04.19E	OBS - 5	2nm from OBS-5 switch off EM122 & 10kHz. Range ping successful
23/9/20	00:28	Stn 12	51			OBS - 5	Release cmd sent – ETA on surface 01:20
23/9/20	01:15	Stn 12	51			OBS – 5	On surface (no light, no VHF)
23/9/20	01:53	Stn 12	51	05 50.47S	11 01.89E	OBS – 5	On Deck.
23/9/20	01:55	Stn 13	-	-	-	Swath 'survey'	Switch on EM-122 & 10kHz. Start swath survey at 5 knts until VHA recovery in morning.
23/9/20	07:06	Stn 13	-	05 50.34S	11 00.78E	Swath 'survey'	End swath survey. Switch off EM-122., Position vessel for VHA recovery

23/9/20	07:50	Stn 14	13	05 50.57S	11 01.05E	VHA	10 kHz switched off. On station approx. 0.5nm north of VHA. Pinged - and range obtained
23/9/20	08:07	Stn 14	13	05 50.53S	11 01.21E	VHA	Release cmd sent and rec'd
23/9/20	08:36	Stn 14	13	05 50.53S	11 01.21E	VHA	On surface
23/9/20	10:00	Stn 14	13			VHA	VHA on deck
23/9/20	10:47	Stn 15	-	05 50.47S	11 01.75E	SVP#2	10kHz switched on. SVP deployed to 1900m w/depth
23/9/20	12:17	Stn 15	-	05 50.46	11 01.75	SVP#2	SVP on deck
23/9/20	12:31	Stn 16					Switch on EM-122 new SVP loaded Stn15_S055046E0110175_thinned.asvp
23/9/20	13:15	Stn 16				Angola Waters 4 line West Swath Survey Start Waypoint 1	New Line 0218 Sea State Calm, low sea, moderate swell
23/9/20	16:03	Stn 16				Waypoint 2	New Line 0221
23/9/20	16:57	Stn 16				Waypoint 3	New Line 0222
23/9/20	17:36	Stn 16				Waypoint 4	New Line 0223

23/9/20	18:23	Stn 16				Waypoint 5	New Line 0224
23/9/20	19.09	Stn 16				Waypoint 6	New Line 0225
23/9/20	19.49	Stn 16				Waypoint 7	New Line 0226
23/9/20	21.04	Stn 16				Waypoint 8	New Line 0227
23/9/20	21.10	Stn 16				Waypoint 9	New Line 0229
23/9/20	22.29	Stn 16				Waypoint 10	New Line 0231
23/9/20	23.07	Stn 16				Waypoint 11	New Line 0232
23/9/20	23.55	Stn 16				Waypoint 12	New Line 0233
24/9/20	00.41	Stn 16				Waypoint 13	New Line 0234
24/9/20	01.19	Stn 16				Waypoint 14	New Line 0235
24/9/20	02:15	Stn 16				Waypoint 15	New Line 0236
24/9/20	04:59	Stn 16				Waypoint 16	New Line 0239
24/9/20	05:10	Stn 16				Waypoint 17	New Line 0240

24/9/20	07:59	Stn 16				Waypoint 18	New Line 0243
24/9/20	08:56	Stn 16				Waypoint 19	New Line 0244
24/9/20	09:30	Stn 16				Waypoint 20	New Line 0245
24/9/20	10:16	Stn 16				Waypoint 21	New Line 0246 Sea state: Calm low sea, moderate swell
24/9/20	11:02	Stn 16				Waypoint 22	New Line 0247
24/9/20	11:39	Stn 16				Waypoint 23	New Line 0248
24/9/20	12:55	Stn 16				Waypoint 24	New Line 0250
24/9/20	13:17	Stn 16				Waypoint 25	New Line 0251
24/9/20	14:35	Stn 16				Waypoint 26	New Line 0253

24/9/20	15:15	Stn 16				Waypoint 27	New Line 0254
24/9/20	16:03	Stn 16				Waypoint 28	New Line 0255
24/9/20	16:49	Stn 16				Waypoint 29	New Line 0256
24/9/20	17:25	Stn 16				Waypoint 30	New Line 0257
24/9/20	18:18	Stn 16				Waypoint 31	New Line 0258
24/9/20	21.09	Stn 16				Waypoint 32	New Line 0261
24/9/20	21.10	Stn 16					End of Angolan waters 4-line survey. Switched off EM 122 and ADCP
24/9/20	21.11	Stn 16					Transit to International Waters
25/9/20	12:38			05 43.33	08 11.94		Switch on EM-122 & ADCP.
25/9/20	12:51	Stn 17				Waypoint 1	Start international waters 3-line survey (load deep water SVP). Sea state calm, low oceanic swell. New Line 0263

25/9/20	14:17	Stn 17				Waypoint 2	New Line 0265
25/9/20	15:25	Stn 17				Waypoint 3	New Line 0267
25/9/20	17:52	Stn 17				Waypoint 4	New Line 0270
25/9/20	21.33	Stn 17				Waypoint 5	New Line 0274
26/9/20	00.28	Stn 17				Waypoint 6	New Line 0277 (Vessel slows down for fishing boat)
26/9/20	01:54	Stn 17				Waypoint 7	New Line 0280
26/9/20	04:05	Stn 17		05 52.85	06 54.16	Between WP's 7 & 8 on Line #1	New Line 0283 Suspend survey and leave line to visit OBS-9 location (approx. 2nm to the south).
26/9/20	04:14	Stn 17					Switch off EM-122 & 10kHz to range on OBS-9

26/9/20	04:33	Stn 17		05 54.62	06 53.90		Stopped at a position 0.3 nm north of OBS-9 location. No response from OBS9
26/9/20	04:43	Stn 17					Still no response from OBS-9. Shift vessel to a position 0.5 nm west of OBS location.
26/9/20	05:10	Stn 17					No comms with OBS-9. Assume it has surfaced since release code on 21/9/20. Start search in area NW of initial location.
26/09/20	07:31			05 35.53	06 40.86		Swath On, on way to start of serach.
27/9/20	05:17			05 47.53	06 50.69		Swath on. Line 0296 Return to swath survey at point we departed on 26/9
27/9/20	05:58	Stn 17		05 52.70	06 54.48	Between WP's 7 & 8 on Line #1	Resume Survey @ 5knts. New Line 0297
27/9/20	07:27	Stn 17				Waypoint 8	New Line 0299
27/9/20	08:17	Stn 17					Switch on 10kHz (stopped ranging for OBS-9)
27/9/20	09:53	Stn 17				Waypoint 9	New Line 0302
27/9/20	11:23	Stn 17				Waypoint 10	New Line 0304

27/9/20	13:39	Stn 17				Waypoint 11	New Line 0307
27/9/20	14:53	Stn 17				Waypoint 12	New Line 0309
27/9/20	20:52	Stn 17				Waypoint 13	New Line 0315
27/9/20	21:05	Stn 17				Waypoint 14	New Line 0316 – Fighting current so slow turn and off the line by 90m – Survey speed increased to 6kts
28/9/20	02:18	Stn 17				Waypoint 15	New Line 0322
28/9/20	03:13	Stn 17				Waypoint 16	New Line 0324
28/9/20	05:11	Stn 17				Waypoint 17	New Line 0326
28/9/20	06:37	Stn 17				Waypoint 18	New Line 0328
28/9/20	08:52	Stn 17				Waypoint 19	New Line 0331
28/9/20	12:12	Stn 17				Waypoint 20	New Line 0335
28/9/20	13:23	Stn 17				Waypoint 21	New Line 0337
28/9/20	16:03	Stn 17				Waypoint 22	New Line 0340
28/09/20	19:16	Stn 17				Waypoint 23	New Line 0344

28/09/20	21.22	Stn 17				Waypoint 24	New Line 0347
28/09/20	22.13	Stn 17				Waypoint 25	New Line 0348
28/09/20	23.23	Stn 17				Waypoint 26	New Line 0350
28/09/20	23.50	Stn 17				Waypoint 27	New Line 0351
29/09/20	01.00	Stn 17				Waypoint 28	New Line 0353
29/09/20	01:59	Stn 17				Waypoint 29	New Line 0354
29/09/20	04:09	Stn 17				Waypoint 30	New Line 0357
29/09/20	07:21	Stn 17				Waypoint 31	New Line 0361
29/09/20	09:47	Stn 17				Waypoint 32	New Line 0364
29/09/20	10:55	Stn 17				Waypoint 33	New Line 0365
29/09/20	14:18	Stn 17				Waypoint 34	New Line 0369
29/09/20	16:34	Stn 17				Waypoint 35	New Line 0372
29/09/20	17:51	Stn 17				Waypoint 36	New Line 0374

29/09/20	19.52	Stn 17				Waypoint 37	New Line 0377
29/09/20	21.02	Stn 17				Waypoint 38	New Line 0379
30/09/20	02:18	Stn 17				Waypoint 39	New Line 0385 - End of 'International 3-line survey'.
30/9/20	02:30						Transit to Geomar OBS-2 site.
30/9/20	03:39	Stn 18	58	06 28.75	06 01.66	German OBS-2	Switch of EM-122 & 10kHz on approach to OBS site. Ping to OBS
30/9/20	03:44	Stn 18	58	06 28.65	06 02.01	German OBS-2	Vessel stopped 0.5nm west of OBS site. Tx on both hull & dunker transducers – no response.
30/9/20	04:16	Stn 18	58	06 29.07	06 02.47	German OBS-2	Vessel stopped 0.5nm south of OBS site. Tx on both hull & dunker transducers – no response.
30/9/20	04:55	Stn 18	58	06 28.57	06 02.96	German OBS-2	Vessel stopped 0.5nm east of OBS site. Tx on both hull & dunker transducers – no response
30/9/20	05:29	Stn 18	58	06 28.19	06 02.46	German OBS-2	Vessel stopped 0.5nm north of OBS site. Tx on both hull & dunker transducers – no response

30/9/20	06:02	Stn 18	58	06 28.53	06 02.47	German OBS-2	Vessel stopped directly over OBS site. Tx on both hull & dunker transducers – no response
30/9/20	06:29	Stn 18	58	06 28.90	06 02.68	German OBS-2	Vessel stand-off OBS-2 site for 1 hr 45 mins (= OBS 'rise time')
30/9/20	08:10	Stn 18	58			German OBS-2	OBS did not surface –start transit to start of 'lobe' survey (WP 12). Switch on EM122 & 10kHz
30/9/20	09:39	Stn 19				Waypoint 12	New Line 0389 Start of 'lobe' survey
30/9/20	13:35	Stn 19				--	EM122 system discovered crashed – turn vessel around to recover survey at the point it stopped 30mins data loss. New Line 0394
30/09/20	14:09	Stn 19				-	Returned to line new line 0395
30/09/20	15:45	Stn 19				Waypoint 11	New Line 0397
30/09/20	16:16	Stn 19				Waypoint 10	New Line 0398
30/09/20	21.20	Stn 19				Waypoint 09	New Line 0404
30/09/20	21.49	Stn 19				Waypoint 08	New Line 0405

01/10/20	06:33	Stn 19				Waypoint 07	New Line 0414
01/10/20	07:03	Stn 19				Waypoint 06	New Line 0415
01/10/20	18:33	Stn 19				Waypoint 05	New Line 0427
01/10/20	19.22	Stn 19				Waypoint 04	New Line 0428
02/10/20	02:19	Stn 19				Waypoint 03	New Line 0435
02/10/20	02:48	Stn 19				Waypoint 02	New Line 0436
02/10/20	09:33	Stn 19				Waypoint 01	New Line 0443 'Lobe' survey complete
02/10/20	09:42	Stn 20				Home Time	New Line 0444
22/10/20						Arrive Back Southampton	