Cruise Report

Understanding Hazardous Seafloor Sediment Flows

in the Congo Submarine Canyon, Offshore West Africa

RRS James Cook – JC187

Important Note:

*The RRS James Cook's logged time in UTC (= GMT) and this is the timing system adopted here unless otherwise stated***.**

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1 Introduction

Avalanches of sediment along the seafloor (called turbidity currents) dominate sediment transfer into much of the deep ocean, and form the largest sediment accumulations on Earth (called submarine fans). These spectacular underwater flows carve some of the deepest canyons and longest channel systems found on our planet, which can extend for hundreds to thousands of kilometers. The scale of turbidity currents is not the only reason they have global importance. Turbidity currents are sometimes very powerful, and travel with speeds of up to 20 m/s. They can break valuable seabed telecommunications cables that now carry over 99% of global data traffic, and which underpin the internet and many other aspects of our daily lives. These seabed sediment avalanches also play a globally important role in organic carbon transfer and burial, which affects longer-term climate change. Turbidity currents both supply key nutrients and physically disturb deep-sea ecosystems, which include biological diversity hot spots along submarine canyons.

However, despite their importance, there are remarkably few direct observations from turbidity currents in action, and they are thus poorly understood. This is a stark contrast to other major sediment transport processes, such as rivers. Down-canyon changes in turbidity current power, frequency, duration, and runout distance, are therefore hard to predict for geohazard assessment.

However, previous work at 2 km water depth in the Congo Canyon successfully made the first detailed (sub-minute) measurements of turbidity currents in the deep ocean (Cooper et al., 2013, 2016), using acoustic sensors called ADCPs (acoustic Doppler current profilers). These initial measurements produced a major advance in understanding of turbidity currents, including that powerful turbidity currents can be a week long, and are active for ~30% of the time in the upper Congo Canyon (Azpiroz-Zabala et al., 2017). This preliminary work showed that the Congo Canyon was an excellent location for subsequent more-detailed studies of turbidity currents, such as in this project.

Research cruise JC187 on the RRS James Cook is part of a scientific project funded by the UK Natural Environment Research Council (Grants NE/R001952/1 and NE/S010068/1), whose purpose is to measure and thus understand turbidity currents that form the submarine Congo Canyon, which extends into the deep ocean from the mouth of the Congo River (Fig. 1.1). This understanding will help to mitigate hazards to seabed telecommunication cables, or oil and gas pipelines and infrastructure, which cross the Congo submarine canyon. This includes the WAC, ACE and SACS cables that now underpin data transfer (and internet) to much of West Africa.

The scientific project comprises a series of four scientific research cruises using UK research vessels (e.g. RRS James Cook), which are owned by the UK's Natural Environment Research Council (NERC). The NERC-funded scientific project is led by Professor Talling at the University of Durham in the UK, and involves UK colleagues at the Universities of Hull, Southampton and Newcastle, together with the UK's National Oceanography Centre in Southampton. The project includes key partners at IFREMER in France, and GEOMAR in Germany, who are providing extra equipment and their expertise. The project also involves close collaboration with Angola Cables to disseminate results to submarine telecommunication cable operators in the region (e.g. via the West Africa Cable (WAC) consortium). In Angola, the project also involves the MTTI, IPMA and Ministry for Oil and Gas, amongst others.

Research cruise JC187 is the first of four research cruises. Its initial aim is to deploy 11 moorings anchored on the seabed (Figs. 1.1, 1.2, 1.3) that will measure the speed, frequency, runout distance, and character of turbidity currents along the Congo Canyon. Seven moorings were deployed at five locations in the upper canyon, and four moorings were deployed at four sites in the lower canyon-channel. Two ('Aniitra') moorings were provided by IFREMER, with the remaining 9 moorings provided by the NERC project. These 11 moorings will be recovered (along with their data), and then redeployed after a change of battery, by research vessels during future research cruises that are planned for 2020 and 2021. All moorings will be recovered by a research cruise planned for 2023. This will hopefully provide measurements of turbidity currents over a 4-year period (2019-23).

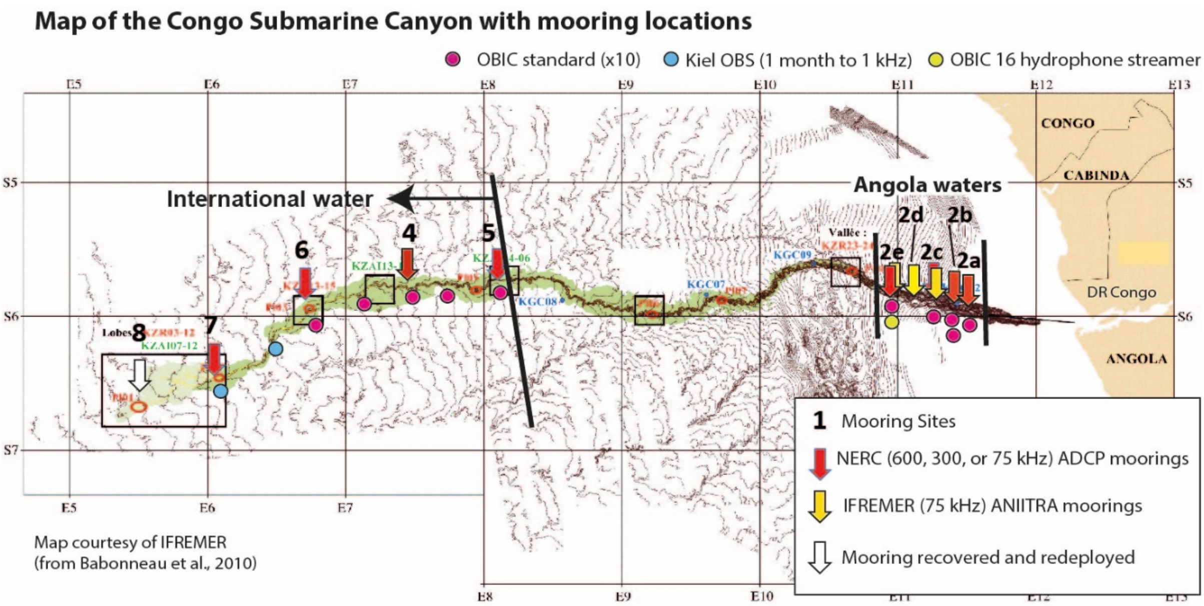


Figure 1.1: *Map of the Congo Canyon, showing locations of the project's ADCP-moorings (arrows), Ocean Bottom Seismometers and 16-hydrophone array (circles). The map shows how moorings are located within two sets. The first set of moorings (2a-d) are in Angolan territorial waters in the upper canyon. The second set of moorings (4, 5, 6, 7 and 8) are situated within deeper international waters.*

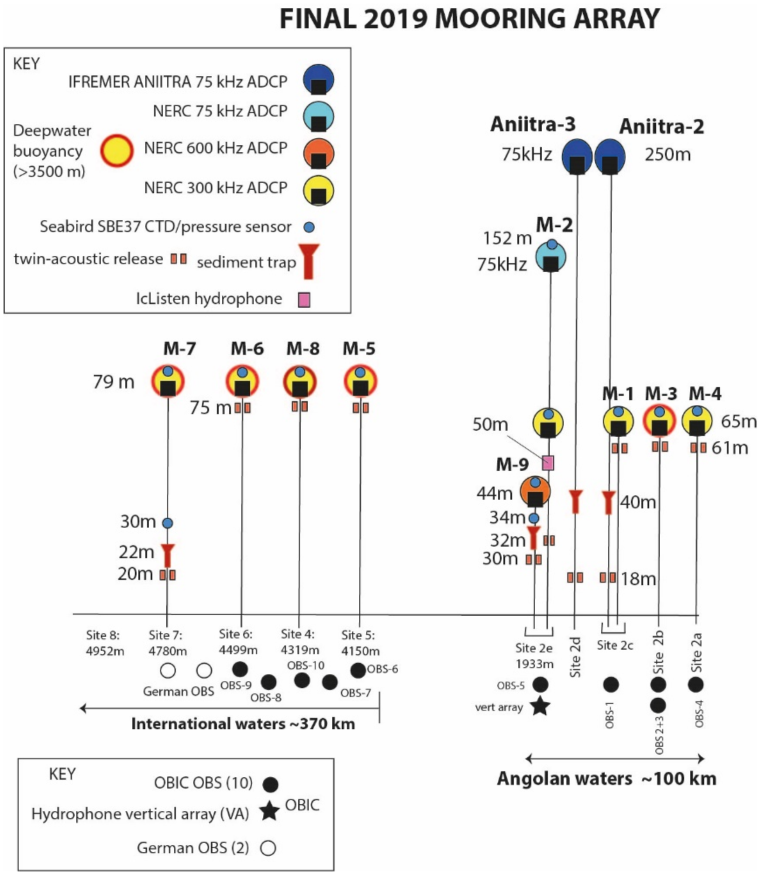


Figure 1.2: *Summary of the planned array of moorings and other sensors along the Congo Submarine Canyon, from shallower water (right) to deeper water (left). The height of each sensor is marked in meters above the seabed. ADCPs (300, 600 or 75 kHz frequency) are shown as black squares, together with sediment traps, CTD (water temperature and salinity) sensors, single hydrophone, and the acoustic releases triggered to recover the moorings (see key).*

The second overall aim of this NERC project is to determine whether turbidity currents can be recorded successfully by hydrophones and geophones, which may then provide the basis for future low-cost systems to measure turbidity current activity. Unlike anchored moorings, hydrophones and geophones can be located outside the flow, and thus out of 'harm's way'. Research cruise JC187 deployed 12 Ocean Bottom Seismometers (OBS) that are typically used to measure offshore earthquakes, which comprise 'frames' that sit on the seabed (Fig. 1.4). Each OBS contains a geophone (to record ground shaking) and hydrophone (to record water-column noise). A prototype mooring with a vertical line of hydrophones was tested and deployed. Hydrophones on this array are located over 300m above the seabed, and thus may have a better 'line of sight' for recording canyon floor flows, than the seabed OBS. A single hydrophone was also located directly above the flows on one of the ADCP-moorings. A series of standard oceanographic CTD (conductivity, temperature and pressure) sensors were placed on moorings (Fig. 1.2) to measure changes in seawater salinity and temperature, and to determine changes in pressure that indicate tilt or movement of moorings into deeper water.

In order to locate moorings in the best placed on the seabed, multibeam echo-sounder (MBES) bathymetric surveys were undertaken between mooring sites. This provided detailed bathymetric maps of the mooring sites needed to identify flatter and wider areas of the canyon floor. Such bathymetric mapping also documented how turbidity current sculpt the seabed, and comparisons to previously collected IFREMER bathymetric surveys may show how that seabed shape had changed.

CTD and SVP (sound velocity profiler) sensors were lowered from the vessel. As is standard practice, they are used to calibrate bathymetric surveys, which need information on sound velocity structure of the water column to obtain the highest resolution. We also tested whether ship-based CTD casts may can provide an extra way to measure active turbidity currents moving along the canyon. Water-column samples taken during these CTD casts tested whether we can directly measure sediment grain-size within moving turbidity currents, or the presence of microplastic particles in these flows.

Figure 1.2 provides a summary of the mooring design, and their locations. Each mooring contains one or more acoustic Doppler current profilers (ADCPs) with different frequencies. Multiple ADCP frequencies are used at the same site because this allows us to estimate sediment concentrations via inversion of ADCP backscatter. The ADCPs are broadly similar to those used in Cooper et al.'s (2013, 2016) in the upper canyon. A subset of 4 moorings also contain a sediment trap to measure the size of sediment carried by the flow. Sediment cores were collected from the canyon floor and terraces to analyse the deposits of sand and mud left behind by turbidity currents within the canyon.

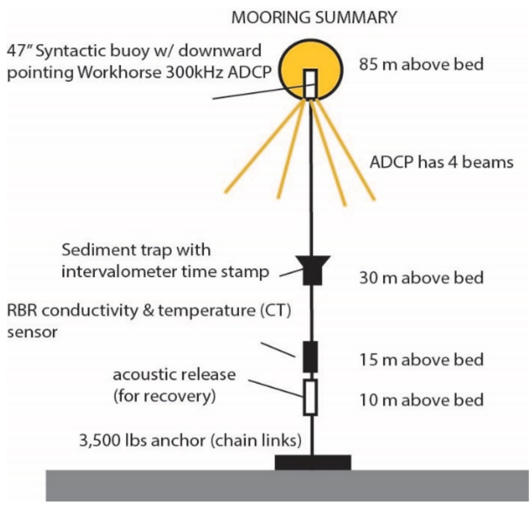


Figure 1.3: *Diagram illustrating a typical mooring design with buoyancy (syntactic buoy), 300 kHz ADCP, sediment trap, CTD sensor and anchor chain. The mooring is lowered (anchor first) to the seabed, and then recovered by triggering the acoustic release from the ship, such that the mooring floats back to the surface.*

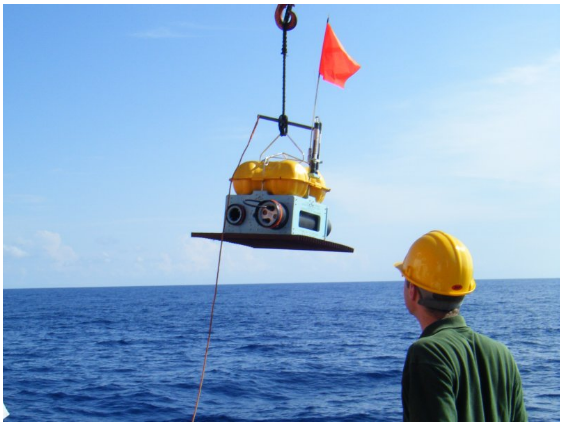


Figure 1.4: *Deployment of an Ocean Bottom Seismometer (OBS) from a NERC vessel. The OBS is lowered to the seabed, and recovered via an acoustic release, triggered from the ship, which causes the OBS to float back to the sea surface (where it is collected).*

2 Overall Aims

The first overall aim of the project is to understand the speed, frequency, runout distance, and character of turbidity currents within the Congo Canyon. We also seek to understand how turbidity currents form seafloor deposits, and sculpt seabed morphology. This information will help with geohazard assessment and planning of future submarine cable routes across the Congo Canyon.

The second overall aim is to determine whether hydrophones or geophones can record turbidity currents, and thus provide information on their frequency, duration or character.

A series of subsidiary aims include the following. The third aim is to understand how organic carbon is transferred, fractionated and buried by turbidity currents. The fourth aim is to test whether turbidity currents transport microplastic particles to the deep sea. A final aim is to understand the distribution and abundance of EPS (Extracellular Polymetric Substances) on the canyon floor, which is a sticky substance secreted by organisms that affect the cohesive properties of the seabed.

3 Executive Summary

Research cruise JC187 was very successful. It deployed 11 ADCP-moorings, 12 OBS and a hydrophone array along the Congo Canyon (Figs. 1.1 & 1.2). This comprises 7 ADCP-moorings at 5 sites in the upper canyon, within Angolan waters (Fig. 1.5). A further 4 ADCP-moorings were then deployed at 4 sites within deeper International Waters (Figs. 1.1 & 1.2). Triangulation showed that all 11 moorings were correctly placed on their targets along the narrow canyon floor. A total of 25 mega-cores (~50 cm long that capture the sediment-water interface) and 20 much longer (up to 15 m) piston cores. Mega-cores show that the canyon floor often has a surface layer of weak (fluid) mud, with sand underneath in the channel axis. Splitting and logging of piston cores did not take place on the vessel, but will provide further useful information. To help locate moorings, detailed (5-15 m horizontal resolution) bathymetric surveys were completed between all 5 mooring sites in Angolan waters, along a ~70 km length of the canyon. Detailed bathymetry was also collected along the entire canyon length within International Waters. These bathymetric surveys helped to locate moorings in wider parts of the canyon floor, and can be compared to previous less detailed surveys collected in 1998 by French colleagues at IFREMER. The moorings will now be recovered by a second NERC-funded cruise in Oct-Dec 2020, and we will see whether the ADCPs and other sensors have recorded the frequency, runout and nature of turbidity currents moving down the canyon. Such data will be valuable for designing future submarine telecommunication cable routes, and assessing hazards to existing cables.

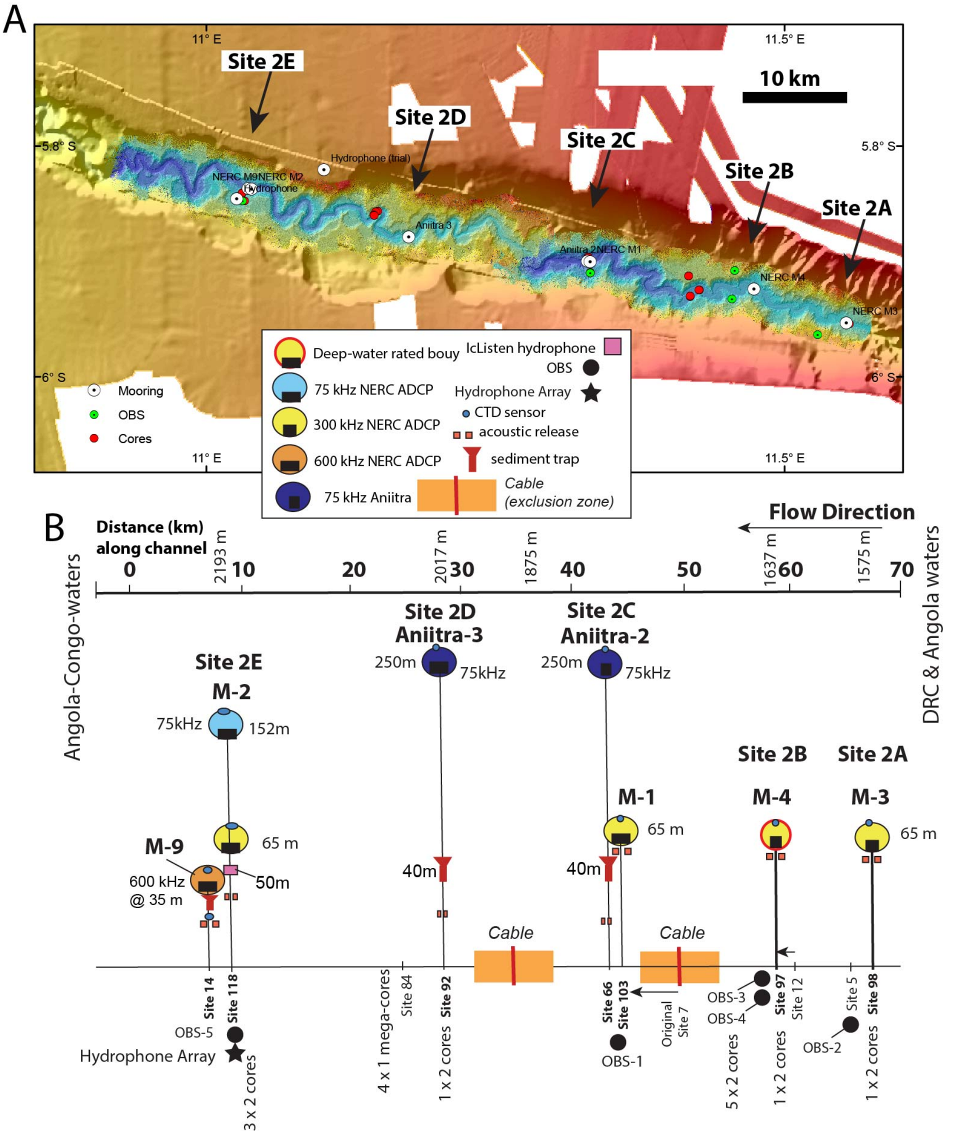


Figure 3.1. *(A) Map of the upper Congo Canyon in the territorial waters of Angola alone. It shows Mooring Sites 2A-to-2E, OBS and core sites, plus the extent of multibeam surveys between sites. (B) Schematic diagram showing array of moorings deployed in Angolan water in the upper canyon, shown as an along canyon transect from shallow water to deep water. Also shown are positions of seabed cables on nautical charts, which we that we had to avoid, together with OBS, vertical hydrophone array, and core positions. The sensors on each mooring are summarised, as set out in the key above.*

4 Permits

We are very grateful to the Angolan authorities for permitting scientific work in their territorial waters, and such permissions are critical for this science. We would also like to thank Joao Baptista, Rui Faria and their team at Angola Cables, who facilitated that process, together with the Angolan Ministry for Telecommunications (MTTI), Ministry for Foreign Affairs, Ministry for Oil and Gas, Hydrographic Office (IMPA), Angolan Navy and others for their assistance in Angola. Hospitality for visits by Talling and Dale Smith to Luanda was much appreciated. Although we did not manage to obtain permits to work in the waters of Gabon, Congo and Democratic Republic of Congo, we thank those who helped to submit those applications. We also thank Costa António Cula (Angola Cable Company), Ducerolde Carlos Nunes Neto (Faculty of Science), and Tresor Ilola Jorge (National Institute of Biodiversity and Conservation Areas (INBAC); Ministry of the Environment) for being a key part of JC187 as Observers.

5 People on Board

5.1 *Scientific Team*

Day Shift (7am – 7pm)	**Night Shift (7pm – 7am)**
Peter Talling (Durham University, U.K.) - Project Principle Investigator Ed Pope (Durham University, U.K.) Megan Baker (Durham University, U.K.) Steve Simmons (Hull University, U.K.) Kate Heerema (Durham University, U.K.) Sean Ruffell (Durham University, U.K.)	Ricardo de Silva Jacinto (IFREMER, Brest, France) – Watch leader Maarten Heijnen (National Oceanography Centre, U.K.) Sophie Hage (National Oceanography Centre, U.K.) Claire McGee (Newcastle University, U.K.) Martin Hasenhündl (TU Wien, Austria) Ronan Apprioual (IFREMER, Brest, France) Anthony Ferrant (IFREMER, Brest, France)

Observers: Costa António Cula (Angola Cable Company), Ducerolde Carlos Nunes Neto (Facilty of Science), Tresor Ilola Jorge (National Institute of Biodiversity and Conservation Areas (INBAC), Ministry of the Environment)

5.2 *Technicians*

Paul Provost – Head mooring
Jez Evans – Head coring
Mark Maltby – Geophysical surveying
Steve Whittle – Moorings
Dave Childs – Moorings
Tim Powell – Moorings
Will Richardson – Coring
Andy Cotmore – Coring
Andy Leadbeater – Coring
Ben Pitcairn – OBIC
Andy Clegg – OBIC
Martin Weeks – OBIC

5.3 *Crew*

Jim Gwinnell – Master
Andy Mahon – Chief Officer (security)
Mike Hood – Second Officer (medical)
Bryn Beaurain – Third Officer
Chris Uttley – Chief Engineer (safety)
Mick Murray – Second Engineer
Stewart Smith – Third Engineer
Gary Slater – Third Engineer
Conrad Laversuch – Electrician
Paul Lucas – Purser
Martin Harrison – Chief Petty Officer (science)
Steve Duncan - Chief Petty Officer (deck)
Brian (Burt) Burton – Petty Officer (deck)
John Allen – Seaman
Peter Smyth – Seaman
Colin Atkinson – Seaman
Marshall Mackinnon – Seaman
Sean Angus – Engine Room Petty Officer
Darren Caines – Head Chef
Jacqui Waterhouse – Chef
Tina Carrilho Mantinha – Steward
Kevin Mason – Assistant Steward

6 Itinerary

Day	Time	Activity
Saturday 31st August	10:00 (local)	Depart Mindelo in Cape Verde
Monday 9th September	20:00	Arrived first work area in international waters
Thursday 12th September	19:00	Departed first work area
Saturday 14th September	10:00	Arrive in Luanda in Angola to collect observers
Saturday 14th September	15:00	Depart Luanda
Sunday 15th September	10:00	Arrive in second work area in Angolan waters
Sunday 22nd September	10.00	Depart Angolan waters
Monday 23rd September	02.00	Arrive in international waters
Monday 23rd September	08.00	Depart international waters
Tuesday 24th September	15.00	Arrive Luanda
Wednesday 25th September	09.20	Arrive Angolan waters
Thursday 26th September	07.20	Arrive International waters
Wednesday 2nd October	24:00	End Science activities
Monday 7th October	11:00	Arrive at Walvis Bay in Namibia

7 Overview of Events (Cruise Narrative)

This section provides a brief overview of what happened during cruise JC-187, followed by a detailed list of events in Appendix B. An electronic copy of the original master log sheets, which contain a full record of activities at all stations during the cruise, is provided by Appendix A.

Times are in UTC/GMT (i.e. ship's time) not local time.

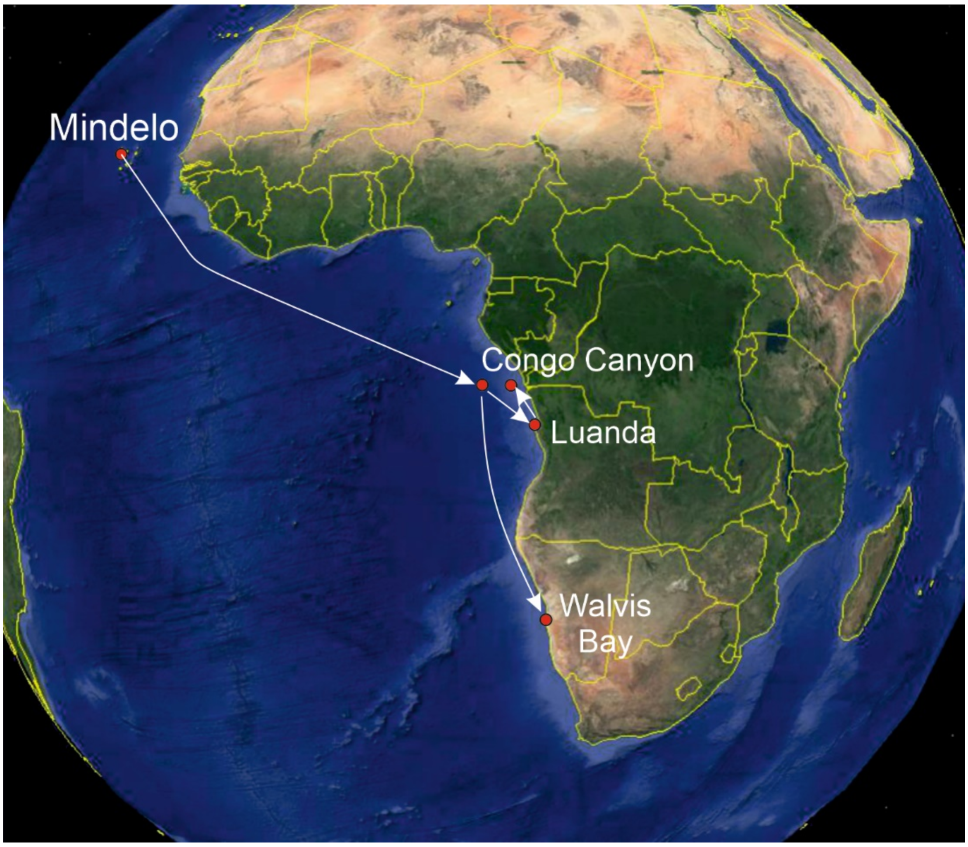


Figure 7.1. *Research cruise JC187 started at Mindelo in Cape Verde, and completed work on the Congo Canyon. There were 2 sets of boat transfers at Luanda in Angola, and it finished in Walvis Bay, Namibia.*

Cruise JC187 started from Mindelo in Cape Verde on 31st August 2019. The science team arrived in Mindelo on 28th/29th of August, whilst the vessel arrived there from Southampton a few days earlier.

The vessel departed Mindelo at 09.00 UTC (10.00 local) on August 31st 2019.

1st to 9th September: The vessel transited from Cape Verde to the first work area on the Congo Submarine Fan, located within International Waters.

3rd September (Tuesday): Transit interrupted by test of OBIC, NMFD and German OBS releases.

At Site T-1, we deployed and test 12 x acoustic releases for OBIC OBS at 1 km depth. We then deployed and tested NMFD acoustic releases and German OBS releases on CTD cast (4 km depth).

5th September (Thursday): Ceremony for crossing Equator: meeting with King Neptune and his Wife.

9th September: Arrived work area at 20.30 in International waters near NERC Mooring 8.

A **SVP/CTD cast was followed by Multibeam Survey (MBS_42) near Site 42.** By narrowing the total beam width, and making multiple passes of the same area, the ship-mounted multibeam can image the 5 m deep, and 4 km wide shallow channel seen on IFREMER's AUV survey. So, the ship mounted MBES data may have 2-5m vertical resolution, and gridded at 5m horizontally.

A series of sediments cores were taken close to Site 42. Mega-core MC-01 buried the frame in at least 1m of very weak mud on the seabed, and failed to recover sediment. So wooden planks were added to the mega-corer frame to reduce immersion in this layer, for Megacore-2. **Mega-core MC-02** eventually successfully recovered full tubes. **Piston Core PC-01 was ~9.6m long.** It has a soft muddy top, organic rich, but some fine sand lower down.

NERC Mooring 8 (300 kHz ADCP) was deployed smoothly, and it took about 23 mins to sink ~5 km to seabed. The vessel then circled the mooring, so that we can triangulate its position. The mooring was located on the seabed 56 m north of its release point. (Note that we subsequently recovered this mooring and moved it to a new site further up the channel).

10th – 11th September: Work near Mooring 7 in International Waters.

We then transited from Mooring 8 (Site 42) to Mooring 7 (Site 40 – later moved slightly to Site 76). A **Multibeam Survey (MBS_40) around Site 76** successfully resolved bars and where the channel narrows or widens, thus helping us to find the best sites for moorings and cores. **Megacore MC-03 and Piston Core PC-02 were taken at Site 58**, on a terrace near to Site 42. Gas was present in the piston core, causing end cap to pop off.

We then took **Megacore MC-04 and Piston Core PC-03** at Site 77 on the nearby channel floor, which are located about ~300 m upstream of **NERC Mooring 7 deployed at Site 76**. Our aim is to re-core these sites on later cruises, to see if there are new deposits.

12th September: Survey and deployment of German OBS-1 between Moorings 7 and 8. We completed a small **Multibeam Survey (MBS_39) and then deployed German OBS-1** outside the channel at a site located **about half-way from Mooring 7 to Mooring 6.**

12 September: Initial work around Mooring Site 6. We transited to complete a **Multibeam Survey (MBS_37)** near Mooring 6, but only had time to deploy 4 OBIC prototype OBS, before leaving for a boat transfer of observers in Luanda. The prototype OBS were later recollected. Our aim was to test if these prototype OBS worked successfully at full ocean depth before they are used elsewhere.

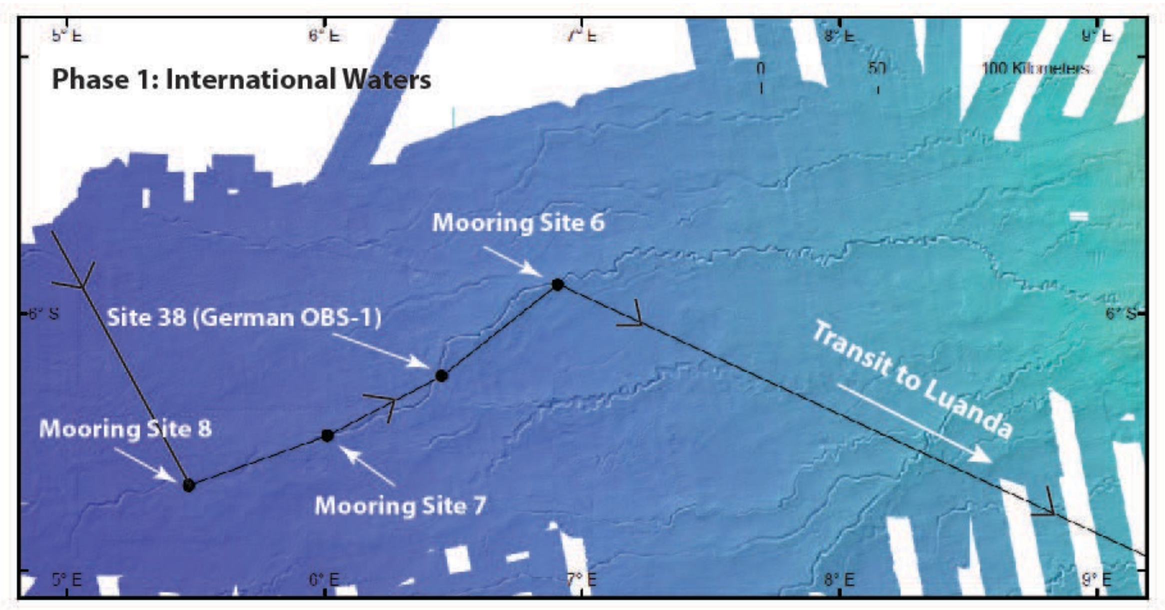


Figure 7.2. *Map of events during the first phase of work from 9th to 12th September.*

12th to 13th September: 36 hour transit to Luanda for boat transfers, which went very smoothly. We picked up four Angolan Observers in Luanda, and Guy Dale-Smith from NERC also visited the vessel.

13 to 14th September: Transit back to the work area in upper Congo Canyon (in Angolan waters).

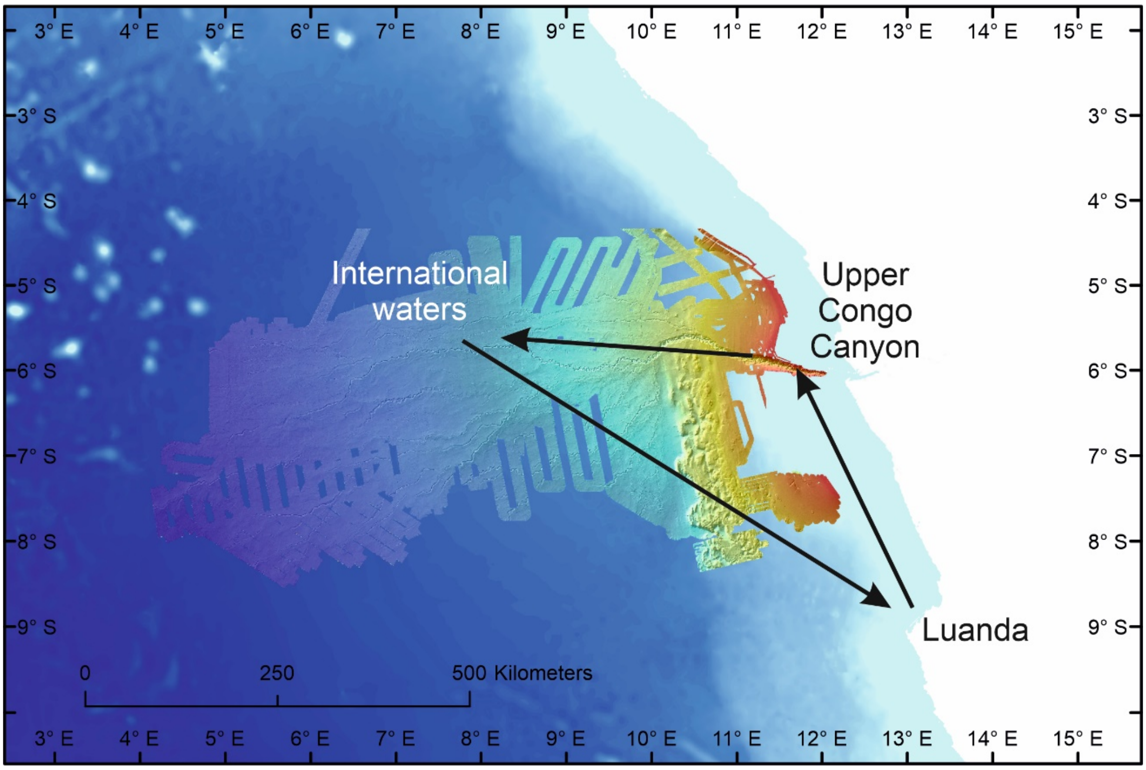


Figure 7.3. *After initial work within International waters, JC-187 transited to Luanda to pick up Angolan observers, and then resumed work in the upper Congo Canyon within Angolan waters.*

15th to 16th September: Arrived at work area (Site 83) in upper canyon at 10:00. CTD/SVP cast in canyon axis, including to test OBIC acoustic releases. This was followed by a **Multibeam Survey (MBS_83) of the upper canyon**, ending at the boundary of Angolan-only waters and those also claimed by DRC. The aim of this multibeam survey was to identify the best locations for moorings.

16th to 17th September: A second multibeam survey of the upper canyon (MBS_83) ended at the boundary of waters claimed by Congo, and provided information for the remaining mooring sites. A **prototype mooring with a vertical array of hydrophones** was tested via deployment on the seabed. It was later collected, and after this successful test, then deployed elsewhere in the upper canyon.

17th to 19th September: A **transect of three pairs of mega-cores and piston cores** were then collected near to what would later become **Mooring 2E (NERC Moorings 2 and 9)**. The first pair of cores was on the canyon floor **(MC-05 and PC-04 @ Site 49)**, and the other two sets of cores **(MC-06 and PC-07 @ Site 90; MC07 and PC-08 at Site 51)** were located on progressively higher terraces.

Four pairs of mega-cores and piston cores were then taken near Mooring 2C (Aniitra-2 and NERC Mooring-1). The first two pairs of cores **(MC-08 and PC-07 @ Site 66; MC-09 and PC-08 @ Site 93)** were located on the canyon floor, about 300m apart. A pair of cores (**MC-10 and PC-09 @ Site 96)** were then located on a very low (+20 m) elevation terrace above the thalweg. A final pair of cores **(MC-11 and PC-10 @Site 87)** were then located on a higher terrace to the south of the channel.

A pair of cores **(MC-12 and PC-11 @ Site 48)** were then taken between Moorings 2B and 2C, **on the extensive high terrace (+200m) to the north of the main channel.** A final mega-core **(MC-13)** was taken **in the thalweg of an inset channel**, just above where the canyon is blocked by a landslide.

19th September: The Aniitra-2 Mooring and NERC Mooring 1 (300 kHz) were deployed at Site 2C, at Sites 66 and 93. **OBIC OBS-1** was then placed on a large terrace (+200 m; Site 87) near the moorings.

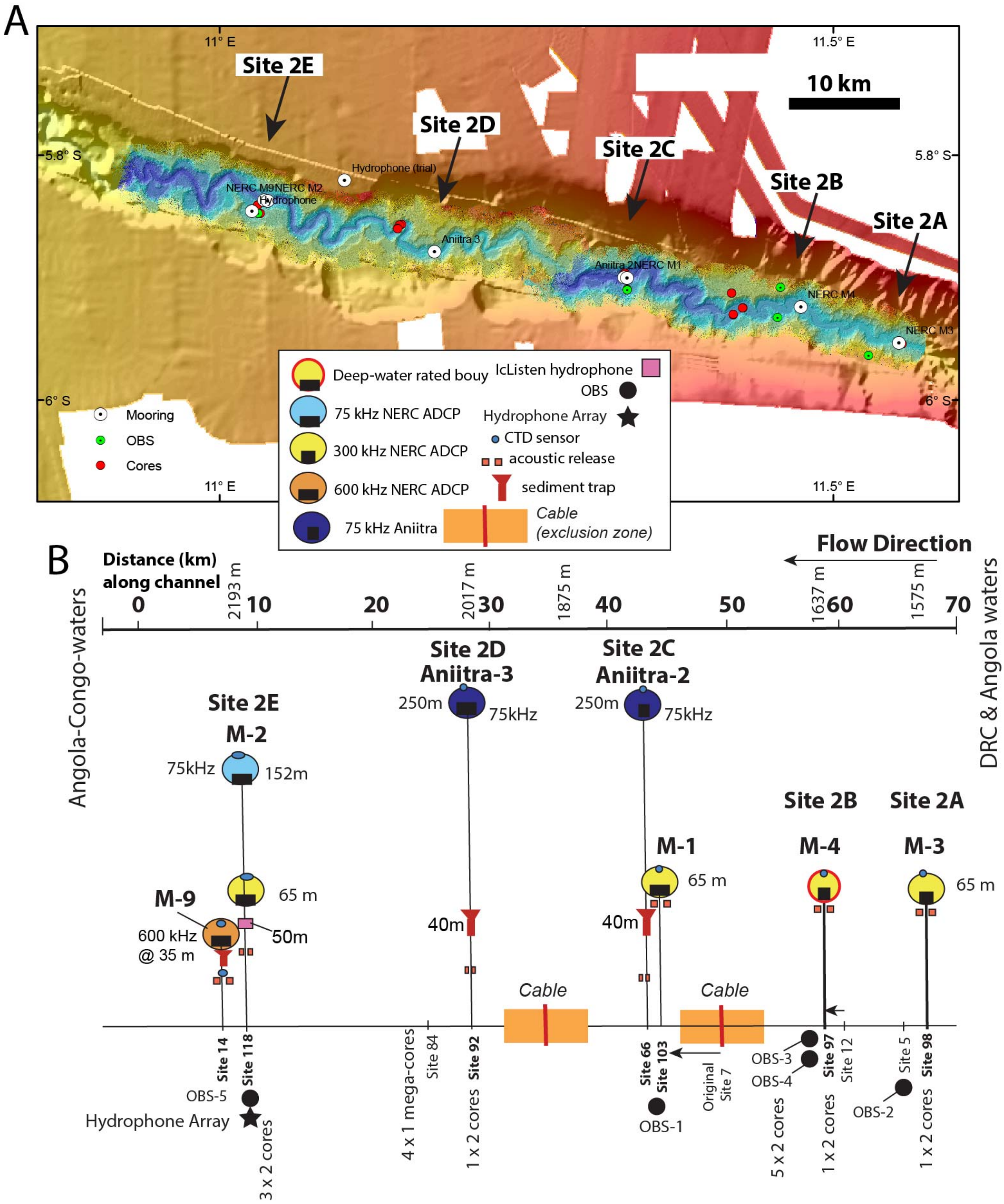


Figure 7.4. *(A) Map of the upper Congo Canyon in the territorial waters of Angola alone. It shows Mooring Sites 2A-to-2E, OBS and core sites, plus the extent of multibeam surveys between sites. (B) Schematic diagram showing array of moorings deployed in Angolan water in the upper canyon, shown as an along canyon transect from shallow water to deep water. Also shown are positions of seabed cables on nautical charts, which we that we had to avoid, together with OBS, vertical hydrophone array, and core positions. The sensors on each mooring are summarised, as set out in the key above*

19th to 20th September: We then **returned to Site 99**, **just up-canyon of the landslide-blockage**, to obtain a further pair of mega-core and piston core in the channel axis **(MC-14 and PC-12)**. A pair of cores were also then obtained at a **nearby low (+40 m) terrace (MC-15 and PC-13 @ Site 45).**

20th September: We then moved to **Mooring Site 2B,** where we first collected a **pair of cores (MC-16 and PC-14 @ Site 97) in the channel axis,** before deploying **NERC Mooring-4 (300 kHz)** at this site.

We moved to the furthest up-canyon Mooring 2A. We first collected a **pair of cores (MC-17 and PC-15 @ Site 98) in the channel axis,** before deploying **NERC Mooring-4 (300 kHz)** at this same site. Unfortunately, **PC15 @ Site 98 came back bent,** suggesting hard sand. We then deployed **OBIC OBS-2 at Site 5** on a terrace southwest of Mooring 2A.

A pair of OBS **(OBIC-3 @ 104 and OBIC-4 @ 105)** were then deployed on a **lower and higher terrace respectively, located southwest of Mooring Site 2B.**

A single piston core was taken close to Site 98 with a 6m barrel, where we had previously bent a 12m core barrel. This is near Mooring 2A.

21st September: We then moved to **Mooring Site 2D,** where we first collected a **pair of cores (MC-18 and PC-17 @ Site 92) in the channel axis,** before deploying **Aniitra Mooring 3** at this site.

We transited to **recover the prototype hydrophone array from Site 86**, located outside the canyon adjacent to **Mooring 2E. We then deployed NERC Mooring-9 (600 kHz) at Site 14**, **but did not deploy NERC Mooring-2 at a nearby site** as we were unsure whether its IcListen hydrophone's battery was working (this was later resolved, and Mooring-2 was deployed nearby at Site 118). We tried a **CTD cast (with water samples)** to try to sample an active turbidity current in the channel near Site 14, but the channel seemed to be inactive.

22nd September: We were short on piston core liner, so **4 mega-cores were collected on a single channel bend**, located upstream of Mooring 2D (Aniitra-3). Two pairs of cores targeted the channel axis (**MC-19 and MC-21 @ Sites 107 and 109),** and two pairs of cores were located on (point?) bars on the inner part of the channel bend **(MC-20 and MC-22 @ Sites 108 and 110)**.

We then transited to a **terrace above Mooring Site 2E, where we deployed OBIC OBS-5, and the Vertical Hydrophone Array** in a location with good lines of sight down into the main channel.

22nd to 23rd September: We then transited to International Waters, where we started a **multibeam survey (MBS_113) from Mooring Site 5,** including an **initial CTD/SVP cast.**

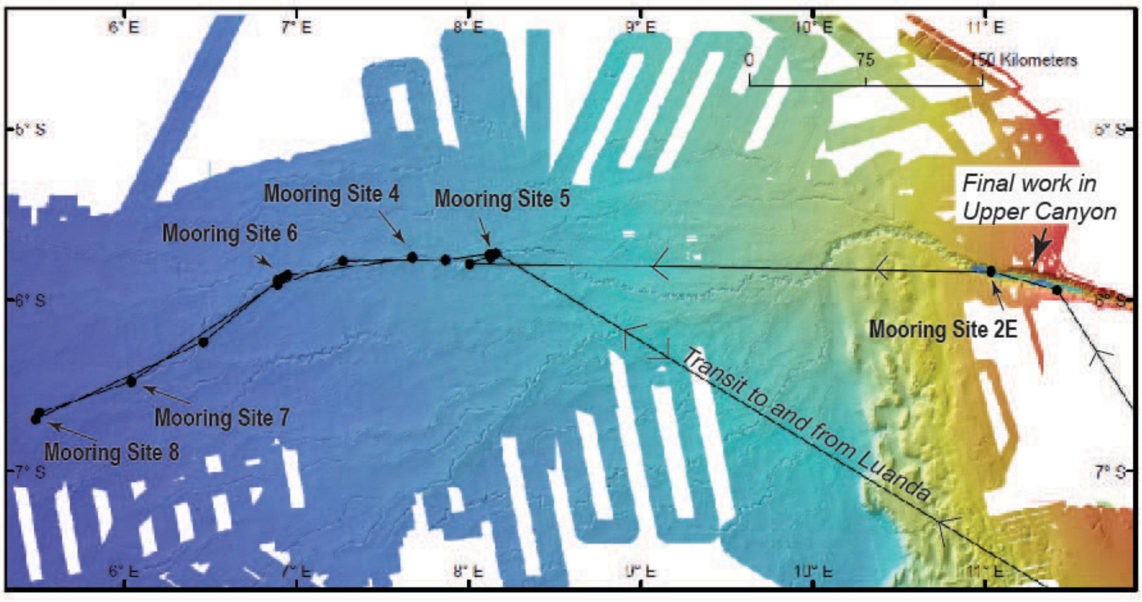


Figure 7.5. *Map of events during the third and final phase of work from 22nd September to 2nd October.*

23rd to 24th September: However, due to a sad parental bereavement for a crew member, we then **transited back to Luanda, where the crew member and Angolan observers had a boat transfer ashore.** We were grateful to the Angolan observers, as this avoided a third transit back to Luanda later in the cruise.

24th to 25th September: We transited back from Luanda to **conclude work in the upper canyon**. We finishing a small **Multibeam Survey (MB_115),** to better image the landslide that appears to block the canyon thalweg. We concluded work in the upper canyon by deploying **NERC Mooring-2** (75 kHz, 300kHz and IcListen hydrophone) **at Site 118 (300m up-canyon from Mooring-9) at Mooring Site 2E.**

25th to 28th September: We then transited from the upper canyon back to International Waters, arriving morning of the 25th. We finished off the **multibeam survey (MBS_113) from Mooring Site 5 to Mooring Site 4,** previously truncated due to the medical emergency. There was a CTD/SVP cast half way through the multibeam survey. **Two pairs of cores were collected on the channel floor (MC-23 and PC-18), and then on a terrace (MC-24 and PC-19) near Mooring Site 5**. We deployed **OBIC OBS-6** near Mooring Site 5, and finally **deployed NERC Mooring 5 (300 kHz ADCP)** and triangulated its position. Two further cores were taken outside the channel on the **open slope (MC-25 and PC-20).**

28th to 29th September: We transited from Mooring Site 5, past Mooring Site 4, to mooring Site 6 in deeper-waters. We deployed **OBIC OBS-7 between Mooring Sites 5 and 4, and OBIC OBS-8 between Mooring Sites 4 and 6.**

On reaching Mooring Site 6, we **recovered the Prototype OBS**; which were being tested for seaworthiness. We **deployed OBS-9 near Mooring Site 6, before finally deploying NERC Mooring 6 (300 KHz ADCP**) and triangulating.

29th September to 1st October: We then completed a long **multibeam survey (MBS_119) from Mooring Site 6 to Sites 38/39** (Half-way to Mooring Site 7) and back to Mooring Site 6. There was a **CTD/SVP cast** before this survey.

We then went back to Site 38/39, and completed a second long **multibeam survey (MBS_121) that provided a single swath line from Site 38/39, past Mooring Site 7, and finishing at Mooring Site 8**. There was a **CTD/SVP-12 cast at Mooring Site 8**.

1st to 2nd October: We then **recovered NERC Mooring 8 from Mooring Site 8**, onto the vessel. We then completed **multibeam survey (MBS_122) from mooring 8 back to Mooring 7**. **Together with multibeam survey MBS_121, this provides a map of the terminal lobe and final part of the channel.**

We deployed **German OBS-2 at Mooring Site 7,** and did an **extra triangulation point to better constrain the seafloor location of Mooring 7** (our original triangulation had a large error).

We then transited to near Mooring Site 6, and completed a **single swath multibeam survey (MBS_125) from Mooring Site 6 to Mooring Site 4**. We then **redeployed NERC Mooring-8 at Mooring Site 4**, and **OBIC OBS-10 near Mooring Site 4**. We concluded with a multibeam survey (MBS_126) from Mooring 4 back towards Mooring 6, which zig-zags back across MBS_125.

2nd- 7th October: Science operations finished at midnight on 2nd, and we transited to Walvis Bay. **We arrived in Walvis Bay on 7th Oct., where science party disembarked, and technicians demobilised.**

8 Methods: Tools and Techniques

8.1 Moorings

In the following sections we first describe the design and set up of NERC Moorings (Section 8.1.1), and this is followed by similar information on the ANIITRA moorings provided by IFREMER. We first set out two different methods for deploying moorings anchor-first or anchor-last, and their pros and cons.

8.1.1 Methods for Deploying Moorings

Moorings can be deployed in two different ways. First, the upper float and instruments can be streamed off the back deck, and the anchor is then deployed last. This anchor-last method is much safer and quicker; as the moorings wire is under very little tension on the back deck. However, currents within the entire water column profile can potentially cause the mooring to drift away from target. We therefore measured surface currents using the ship-mounted ADCP, and tried to factor in the amount they would deflect moorings, based on time taken to reach the seabed, current speed, and offsets seen during earlier mooring deployments. But we had no information on deep currents, including potentially active turbidity currents on the seabed. It was hoped that mooring was short, and had a very heavy anchor, and would thus have limited lateral drift. We also ensured that the ship ran-in towards the target site along the axis of the canyon-floor channel, which meant that if we missed the target in the direction of travel, the mooring would still fall onto the axis of the channel.

Alternatively, the mooring can be deployed anchor-first, with the mooring lowered to a few tens of meter above the seafloor before being released. An USBL placed on the wireline just above the release point provides information on position. The vessel will need to manoeuvre, such that the USBL at the end of the wireline is then positioned accurately over the target, and this may be tricky if the ship lacks DP. Our vessel has DP and was able to locate the USBL on the Aniitra moorings within a few meters. The anchor-first method has the advantage of dropping the mooring from much closer to the seabed, and this may increase precision, although note there is an uncertainty of ~10 m at 4 km on the USBL ranging, plus uncertainty in positions of the USBL from the ship. However, during the anchor-first method, links comprising the mooring are progressively added on the back deck, using two winches and wires, to alternatively take the weight. This procedure has major safety implications, as there are taught wires under a heavy load on the back deck, and if any link breaks it is particularly dangerous.

We deployed Aniitra moorings anchor-first without problems, as they had a much lighter anchor weights of ~500 kg (in air). But it was decided to deploy all NERC Moorings anchor-last, primarily for safety reasons, as they has far heavier anchors (1,350 kg in air) that place a much greater strain on wires on the back deck. As summarised in the later section on triangulation of positions, we found that both methods achieved satisfactory results. For the anchor-last method, moorings were located within 10-80 m of targets at 4-5 km depth in International waters, and within 11-32 m in ~2 km depth in the upper-canyon in Angolan waters. Thus we did not attempt to deploy NERC moorings anchor-first during JC-187. If NERC moorings are to be deployed anchor last, their anchor weight is critical.

8.1.2 NERC moorings

(From technical report by Paul Provost, Steve Whittle, Dave Childs, Tim Powell)

Operations summary

The deck setup for the mooring deployments used the NMF 5T direct pull deck winch mounted on forward of the deck hatch. The mooring cable (wire) was fed aft directly from the 5T deck winch with long lead to a sheave suspended from the port aft pedestal crane. A chain stopper with boss hook was attached to the deck in the ‘red zone’ for stoppering off the mooring. The moorings were deployed ‘top first - anchor last’.

The anchors for all the moorings were deployed using another NMF 5T direct pull deck winch mounted on the starboard side forward of the red zone in line with the starboard 5T block on the luffing stern gantry and released using a SeaCatch TR8 release.

Once the moorings were release they were monitored to their seabed rest position using an IXSEA TT801 deck unit connected through the single element transducer on the starboard drop keel by a patch cable.

The taut moorings were triangulated after each deployment by ranging the release from three or four equidistant positions approximately the distance of one water depth away from the release position to accurately determine the anchor rest position. The positions given for each mooring are the triangulated (or quadangulated) position of the acoustic release above the resting position of the anchor on the seabed.

Instrument positions

The planned positions of the instruments as distance, in metres, above the seabed are shown below.

Table 8.1: Instrument heights above the seabed

Mooring Instrument	M1	M2	M3	M4	M5	M6	M7	M8 M8-R	M9
CTD		153							
75kHz ADCP		152							
CTD	65	65	65	65	79	79	79	79	44
300kHz ADCP	65	65	65	65	79	79	79	79	
600kHz ADCP									44
CTD							30		34
Sediment trap							23		32
Hydrophone		50							
Release	61	32	61	61	75	75	20	75	30

Instrument set-ups

All instruments were set to UTC

SeaBird SBE37SMP Microcat CTDs

All SBE37SMP Microcat instruments were setup with the same configuration with a sampling interval every 450 seconds (8 samples per hour).

Mooring	Serial No.	Start time & date
M1	7305	18/09/2019, 06:00
M2	7306 7307	18/09/2019, 12:00 18/09/2019, 12:00
M3	7308	18/09/2019, 12:00
M4	7309	18/09/2019, 12:00
M5	7310	10/09/2019, 00:00
M6	7311	10/09/2019, 00:00
M7	7312 7313	10/09/2019, 00:00 10/09/2019, 00:00
M8	7314	10/09/2019, 00:00
M9	7303 7304	18/09/2019, 12:00 18/09/2019, 12:00

M8-R	7314	01/10/2019, 12:00

TRDI Workhorse Long Ranger 75kHz ADCP

The Long Ranger 75kHzADCP was setup as below:

Mooring	Serial No.	Start time & date
M2	22792	24/09/2019, 18:00

Pings per Ensemble: 3
Depth Cell Size (cm): 400
Ensemble period: 9 seconds
Number of bins: 42

TRDI Workhorse Sentinel 300kHz ADCP

The Sentinel 300kHz ADCPs were setup as below:

Mooring	Serial No.	Start time & date
M1	10689	17/09/2019, 18:00
M2	24505	24/09/2019, 18:00
M3	21028	18/09/2019, 18:00
M4	21029	18/09/2019, 18:00

Pings per Ensemble: 1
Depth Cell Size (cm): 150
Ensemble period: 11 seconds
Number of bins: 50

Mooring	Serial No.	Start time & date
M5	23119	10/09/2019, 00:00
M6	24495	10/09/2019, 00:00
M7	24496	10/09/2019, 00:00
M8	24504	10/09/2019, 00:00

Pings per Ensemble: 1
Depth Cell Size (cm): 150
Ensemble period: 12 seconds
Number of bins: 57

M8-R	24504	02/10/2019, 08:10

Pings per Ensemble: 1
Depth Cell Size (cm): 150
Ensemble period: 12 seconds
Number of bins: 60

TRDI Workhorse Sentinel 600kHz ADCP

The Sentinel 600kHz ADCP was setup as below:

Mooring	Serial No.	Start time & date

M9	3725	21/09/2019, 12:00

Pings per Ensemble: 1
Depth Cell Size (cm): 75
Ensemble period: 11 seconds
Number of bins: 53

The complete setup parameters for each ADCP type and deployment are shown below:

Mooring number	1,2,3,4	5,6,7,8	9	8-R	2
ADCP Frequency	(300kHz)	(300kHz)	(600kHz)	(300kHz)	(75kHz)
Factory Settings	>CR1	>CR1	>CR1	>CR1	>CR1
Power Setting (low)					>CQ0
Flow Control	>CF11111	>CF11101	>CF11111	>CF11101	>CF11101
Heading Alignment	>EA0	>EA0	>EA0	>EA0	>EA0
Heading Bias	>EB0	>EB0	>EB0	>EB0	>EB0
Transducer Depth	>ED30000	>ED50000	>ED30000	>ED50000	>ED30000
Salinity	>ES35	>ES35	>ES35	>ES35	>ES35
Coordinate Transformation	>EX11111	>EX11111	>EX11111	>EX11111	>EX11111
Sensor Source	>EZ1111101	>EZ1111101	>EZ1111101	>EZ1111101	>EZ1111101
False Target Threshold Maximum	>WA50	>WA50	>WA50	>WA50	>WA50
Wide Band On	>WB0	>WB0	>WB0	>WB0	>WB0
Output Data Selection	>WD111100000	>WD111100000	>WD111100000	>WD111100000	>WD111100000
Blanking Distance	>WF176	>WF176	>WF88	>WF176	>WF704
Number of Depth Cells	>WN50	>WN57	>WN53	>WN60	>WN42
Pings per Ensemble	>WP1	>WP1	>WP1	>WP1	>WP3
Depth Cell Size	>WS150	>WS150	>WS75	>WS150	>WS400
Ambiguity Velocity	>WV300	>WV300	>WV300	>WV300	>WV300
Time Per Ensemble	>TE00:00:11.00	>TE00:00:12.00	>TE00:00:11.00	>TE00:00:12.00	>TE00:00:09.00
Time Between Pings	>TP00:11.00	>TP00:12.00	>TP00:11.00	>TP00:12.00	>TP00:03.00
Time of First Ping	>TFyy/mm/dd hh:mm:ss	> TFyy/mm/dd hh:mm:ss	> TFyy/mm/dd hh:mm:ss	> TFyy/mm/dd hh:mm:ss	TFyy/mm/dd hh:mm:ss
(Set) Keep Parameters	>CK	>CK	>CK	>CK	>CK

Acoustic Release IXBlue AR861 units

Prior to the mooring deployments all the acoustic releases were function tested to a depth equal to or greater than the deployment depth. For deployment, the releases were doubled up in parallel.

Sediment trap units

The sediment traps setup procedure is:

Connect USB timer cable to PC
Open software
Set delay time
Set sampling time
With carousel removed from housing, install batteries in carousel, and within 1 minute:

- plug in usb timer cable
- click open in software
- press 'Cycle Interval' Setting and then Display to confirm
- press 'Delay Time' Setting and then Display to confirm
- click green button (in Chinese) to close connection
- unplug USB timer cable and install in housing

Invert housing to watch counter plate rotate approx 180 degrees.
Close software - the software should be opened for each individual trap programming

The sediment trap was setup with 20 discs as below:

Moorings:	M7 & M9
Setup up at:	14:00 10/09/19.
Delay time:	6419 minutes (106.98 hours (4 days 11 hours))
Sampling interval:	504 hours (21 days)
1st sampling interval start:	01:00 15/09/2019
1st disc drop time:	01:00 06/10/2019 (end of first interval)
2nd sampling interval start:	01:00 06/10/2019

There after discs drop at 01:00 on the following dates:

27/10/19
17/11/19
08/12/19
29/12/19
19/01/20
09/02/20
01/03/20
22/03/20
12/04/20
03/05/20
24/05/20
14/06/20
05/07/20
26/07/20
16/08/20
06/09/20
27/09/20
18/10/20
08/11/20

Mooring deployment details

M8 mooring

Deployment date: 10/09/19
Triangulated position on seabed:
Lat: 06°41.7523'S
Long: 05°28.9595'E
Depth: 4957m

Target Position:
Lat: 06°41.7815'S
Long: 05°28.967'E

Initial ship set-up: 700m East of Deployment Position
Estimated fall-back: 10m
Deployment start: 16:16
Ready to deploy (anchor on deck): 16:30
Anchor released: 16:49
Release Position:
Lat: 06°41.7'S
Long: 05°28.8'E
Fall Speed: 217 m/min
Anchor landed: 17:14
Release range depth: 4851m

Triangulation:

1	2	3
Range: 6175m/6178m Lat: 06°41.73468'S Long: 05°26.86864'E	Range: 6072m/6076m Lat: 06°40.08048'S Long: 05°30.0500'E	Range: 6129m/6131m Lat: 06°43.43808'S Long: 05°30.11802'E

Final Anchor position 56m N from target position.

Surface current of 0.2knts NW (370m/hr). Freefall time of 25mins. Surface current movement (370 x (25/60)) = 154 m. Mooring drifted 0.35 of surface current during freefall period.

Mooring 8 was recovered on 01/10/2019.
Released using AR861 serial no. 2302 at 07:29. Surfaced at 08:01, with an approximate ascent speed of 152m/min.
The instruments were downloaded and restarted.

Instrument	Serial no.	Start	Stop	
SBE37SMP CTD	7314	10/09/2019, 00:00	01/10/2019, 08:35:46	
WHS300kHz ADCP	24504	10/09/2019, 00:00	01/10/2019, 08:49:48	153850 ensembles

The mooring was replaced as mooring 8-R (it was recovered and later redeployed at Site 4).

M7 mooring

Deployment date: 11/09/19
Triangulated position on seabed:
Lat: 06°27.853'S
Long: 06°02.787'E
Depth: 4736m

Target Position:
Lat: 06°27.8623'S
Long: 06°02.8346'E

Initial ship set-up: 700m East of Deployment Position
Estimated fall-back: 0m
Deployment start: 19:36
Ready to deploy (anchor on deck): 20:00
Anchor released: 20:27
Release Position:
Lat: 06°27.85'S
Long: 06°02.74'E
Fall Speed: 207 m/min
Anchor landed: 20:51
Release range depth: 4720m

Triangulation:

1	2	3
Range: 5920m Lat: 06°27.86910'S Long: 06°00.86226'E	Range: 5818m Lat: 06°26.10150'S Long: 06°03.33834'E	Range: 6026m Lat: 06°28.03590'S Long: 06°04.81104'E

Final Anchor position 78m WNW from target position.

Surface current of 0.5knts@ 99° T (926m/hr). Freefall time of 24mins. Surface current movement (926 x (25/60)) = 370 m. Mooring drifted 0.35 of surface current during freefall period for M8, predicted 370m x 0.35 = 122m drift.

OBIC Hydrophone mooring (deployment 1)

Deployment date: 17/09/19
Triangulated position on seabed:
Lat: 05°49.2315'S
Long: 11°06.0869'E
Depth: 1279m

Target Position:
Lat: 05°49.227'S
Long: 11°06.105'E

Initial ship set-up: 1200m North West of Deployment Position, heading SW.
Estimated fall-back: 100m
Deployment start: 09:14
Ready to deploy (anchor on deck): 09:41
Anchor released: 09:56
Release Position:
Lat: 05°49.25'S
Long: 11°06.15'E
Fall Speed: 160 m/min
Anchor landed: 10:04
Release range depth: 1270m

Triangulation:

1	2	3
Range: 2189/2194m Lat: 05°49.7267'S Long: 11°06.9091'E	Range: 2099/2098m Lat: 05°48.41'S Long: 11°05.73'E	Range: 2225m Lat: 05°49.67'S Long: 11°05.20'E

Final Anchor position 34m WSW from target position.

Surface current of 0.2knts@ 315° T.

OBIC Hydrophone mooring (deployment 1) was recovered on 21/09/19

M1 mooring

Deployment date: 19/09/19
Triangulated position on seabed:
Lat: 05°54.0186'S
Long: 11°19.9042'E
Depth: 1875m

Target Position:
Lat: 05°54.012'S
Long: 11°19.911'E

Initial ship set-up: 850m West of Deployment Position
Estimated fall-back: 0m
Deployment start: 13:30
Ready to deploy (anchor on deck): 13:48
Anchor released: 13:51
Release Position:
Lat: 05°54.008'S
Long: 11°19.942'E
Fall Speed: 208 m/min
Anchor landed: 14:00
Release range depth: 1811m

Triangulation:

1	2	3	4
Range: 2344m Lat: 05°53.456'S Long: 11°20.482'E	Range: 2324m Lat: 05°54.569'S Long: 11°20.465'E	Range: 2420m Lat: 05°54.619'S Long: 11°19.277'E	Range: 2334m Lat: 05°53.485'S Long: 11°19.311'E

Final Anchor position 17m SW from target position.

Surface current of 0.2knts, 246°T.

M4 mooring

Deployment date: 20/09/19
Triangulated position on seabed:
Lat: 05°55.4548'S
Long: 11°28.4072'E
Depth: 1629m

Target Position:
Lat: 05°55.455'S
Long: 11°28.413'E

Initial ship set-up: 500m WNW of Deployment Position, drop position 10m past target position
Estimated fall-back: 10m
Deployment start: 07:42
Ready to deploy (anchor on deck): 07:52
Anchor released: 08:09
Release Position:
Lat: 05°55.4436'S
Long: 11°28.4434'E
Fall Speed: 203 m/min
Anchor landed: 08:17
Release range depth: 1577m

Triangulation:

1	2	3	4
Range: 2351m Lat: 05°54.7855'S Long: 11°29.0700'E	Range: 2269m Lat: 05°55.9198'S Long: 11°29.1564'E	Range: 2285m Lat: 05°56.0638'S Long: 11°27.7530'E	Range: 2457m Lat: 05°54.6375'S Long: 11°27.8020'E

Final Anchor position 10m W from target position.

Surface current of 0.1knts, 248°T.

M3 mooring

Deployment date: 20/09/19
Triangulated position on seabed:
Lat: 05°57.2118'S
Long: 11°33.2041'E
Depth: 1565m

Target Position:
Lat: 05°57.208'S
Long: 11°33.198'E

Initial ship set-up: 500m West of Deployment Position
Estimated fall-back: 0m
Deployment start: 14:55
Ready to deploy (anchor on deck): 15:05
Anchor released: 15:20
Release Position:
Lat: 05°57.2200'S
Long: 11°33.2302'E
Fall Speed: 203 m/min
Anchor landed: 15:28
Release range depth: 1517m

Triangulation:

1	2	3	4
Range: 2143m Lat: 05°56.6220'S Long: 11°33.7696'E	Range: 2127m Lat: 05°57.7604'S Long: 11°33.7919'E	Range: 2126m Lat: 05°57.7878'S Long: 11°32.6434'E	Range: 2139m Lat: 05°56.6528'S Long: 11°32.6135'E

Final Anchor position 13m ESE from target position.

Surface current of 1knts to West, subsurface flow 0.2knts to East

M9 mooring

Deployment date: 21/09/19
Triangulated position on seabed:
Lat: 05°50.2092'S
Long: 11°02.163'E
Depth: 2172m

Target Position:
Lat: 05°50.20'S
Long: 11°02.16'E

Initial ship set-up: 500m West of Deployment Position
Estimated fall-back: 0m
Deployment start: 14:23
Ready to deploy (anchor on deck): 14:29
Anchor released: 14:40
Release Position:
Lat: 05°50.1996'S
Long: 11°02.1890'E
Fall Speed: 203 m/min
Anchor landed: 14:51
Release range depth: 2150m

Triangulation:

1	2	3	4
Range: 2975m Lat: 05°49.4151'S Long: 11°02.9397'E	Range: 2941m Lat: 05°50.9744'S Long: 11°02.9318'E	Range: 2948m Lat: 05°51.0052'S Long: 11°02.4194'E	Range: 2930m Lat: 05°49.4496'S Long: 11°01.4019'E

Final Anchor position 17m SSE from target position.
M9 mooring is 323m WNW of M2 mooring.

Surface current of 0.2knts, 346°T

OBIC Hydrophone mooring (deployment 2)

Deployment date: 22/09/19
Triangulated position on seabed:
Lat: 05°50.7633'S
Long: 11°01.5595'E
Depth: 1939m

Target Position:
Lat: 05°50.771'S
Long: 11°01.548'E

Initial ship set-up: 900m West of Deployment Position
Estimated fall-back: 100m
Deployment start: 07:11
Ready to deploy (anchor on deck): 07:38
Anchor released: 07:48
Release Position:
Lat: 05°50.7713'S
Long: 11°01.6334'E
Fall Speed: 150m/min
Anchor landed: 08:02
Release range depth: 1924m

Triangulation:

1	2	3	4
Range: 2934m Lat: 05°51.3627'S Long: 11°02.5777'E	Range: 2802m Lat: 05°51.389'S Long: 11°00.674'E	Range: 2816m Lat: 05°49.988'S Long: 11°00.790'E	Range: 2849m Lat: 05°50.027'S Long: 11°02.404'E

Final Anchor position 21m NE from target position.

Surface current of 0.2knts, 287°T

M2 mooring

Deployment date: 25/09/19
Triangulated position on seabed:
Lat: 05°50.2313'S
Long: 11°02.3357'E
Depth: 2172m

Target Position:
Lat: 05°50.231'S
Long: 11°02.353'E

Initial ship set-up: 700m West of Deployment Position
Estimated fall-back: 32m
Deployment start: 13:48
Ready to deploy (anchor on deck): 14:10
Anchor released: 14:19
Release Position:
Lat: 05°50.2337'S
Long: 11°02.3819'E
Fall Speed: 181 m/min
Anchor landed: 14:31
Release range depth: 2148m

Triangulation:

1	2	3	4
Range: 2937m Lat: 05°49.4754'S Long: 11°03.1112'E	Range: 2955m Lat: 05°50.9932'S Long: 11°03.1258'E	Range: 2900m Lat: 05°50.9836'S Long: 11°01.5972'E	Range: 2910m Lat: 05°49.4821'S Long: 11°01.5833'E

Final Anchor position 32m W from target position.
M2 mooring is 323m ESE of M9 mooring.

Surface current of 0.1knts, 225°T

M5 mooring

Deployment date: 28/09/19
Triangulated position on seabed:
Lat: 05°43.8825'S
Long: 08°07.3028'E
Depth: 4036m

Target Position:
Lat: 05°43.8735'S
Long: 08°07.3156'E

Initial ship set-up: 500m West of Deployment Position
Estimated fall-back: 0m
Deployment start: 06:14
Ready to deploy (anchor on deck): 06:24
Anchor released: 06:34
Release Position:
Lat: 05°43.8790'S
Long: 08°07.3438'E
Fall Speed: 205 m/min
Anchor landed: 06:55
Release range depth: 4064m

Triangulation:

1	2	3	4
Range: 5060m Lat: 05°42.6225'S Long: 08°08.3456'E	Range: 5028m Lat: 05°45.0878'S Long: 08°08.3687'E	Range: 5044m Lat: 05°44.9912'S Long: 08°06.1045'E	Range: 5145m Lat: 05°42.5954'S Long: 08°06.1695'E

Final Anchor position 28m SW from target position.

Surface current of 0.4knts, 273°T

M6 mooring

Deployment date: 29/09/19
Triangulated position on seabed:
Lat: 05°52.1482'S
Long: 06°55.5175'E
Depth: 4495m

Target Position:
Lat: 05°52.143'S
Long: 06°55.521'E

Initial ship set-up: 500m South West of Deployment Position
Estimated fall-back: 0m
Deployment start: 09:04
Ready to deploy (anchor on deck): 09:12
Anchor released: 09:15
Release Position:
Lat: 05°52.1214'S
Long: 06°55.5395'E
Fall Speed: 205 m/min
Anchor landed: 09:36
Release range depth: 4403m

Triangulation:

1	2	3	4
Range: 5436m Lat: 05°52.1383'S Long: 06°53.7844'E	Range: 5470m Lat: 05°50.3808'S Long: 06°55.5376'E	Range: 5375m Lat: 05°52.1597'S Long: 06°57.1939'E	Range: 5392m Lat: 05°53.8442'S Long: 06°55.5160'E

Final Anchor position 11m SW from target position.

Surface current of 0.2knts, 340°T

M8-R mooring (deployment 2)

Deployment date: 02/10/19
Triangulated position on seabed:
Lat: 05°45.4004'S
Long: 07°40.4741'E
Depth: 4299m

Target Position:
Lat: 05°45.4225'S
Long: 07°40.4936'E

Initial ship set-up: 500m West of Deployment Position
Estimated fall-back: 0m
Deployment start: 09:22
Ready to deploy (anchor on deck): 09:30
Anchor released: 09:42
Release Position:
Lat: 05°45.4214'S
Long: 07°40.5158'E
Fall Speed: 205 m/min
Anchor landed: 10:02
Release range depth: 4235m

Triangulation:

1	2	3	4
Range: 5311m Lat: 05°44.2415'S Long: 07°41.7743'E	Range: 5357m Lat: 05°46.5528'S Long: 07°41.8368'E	Range: 5269m Lat: 05°46.5035'S Long: 07°39.1750'E	Range: 5184m Lat: 05°44.398'S Long: 07°39.192'E

Final Anchor position 54m WNW from target position.

Surface current of 0.1knts, 261°T

Mooring diagrams

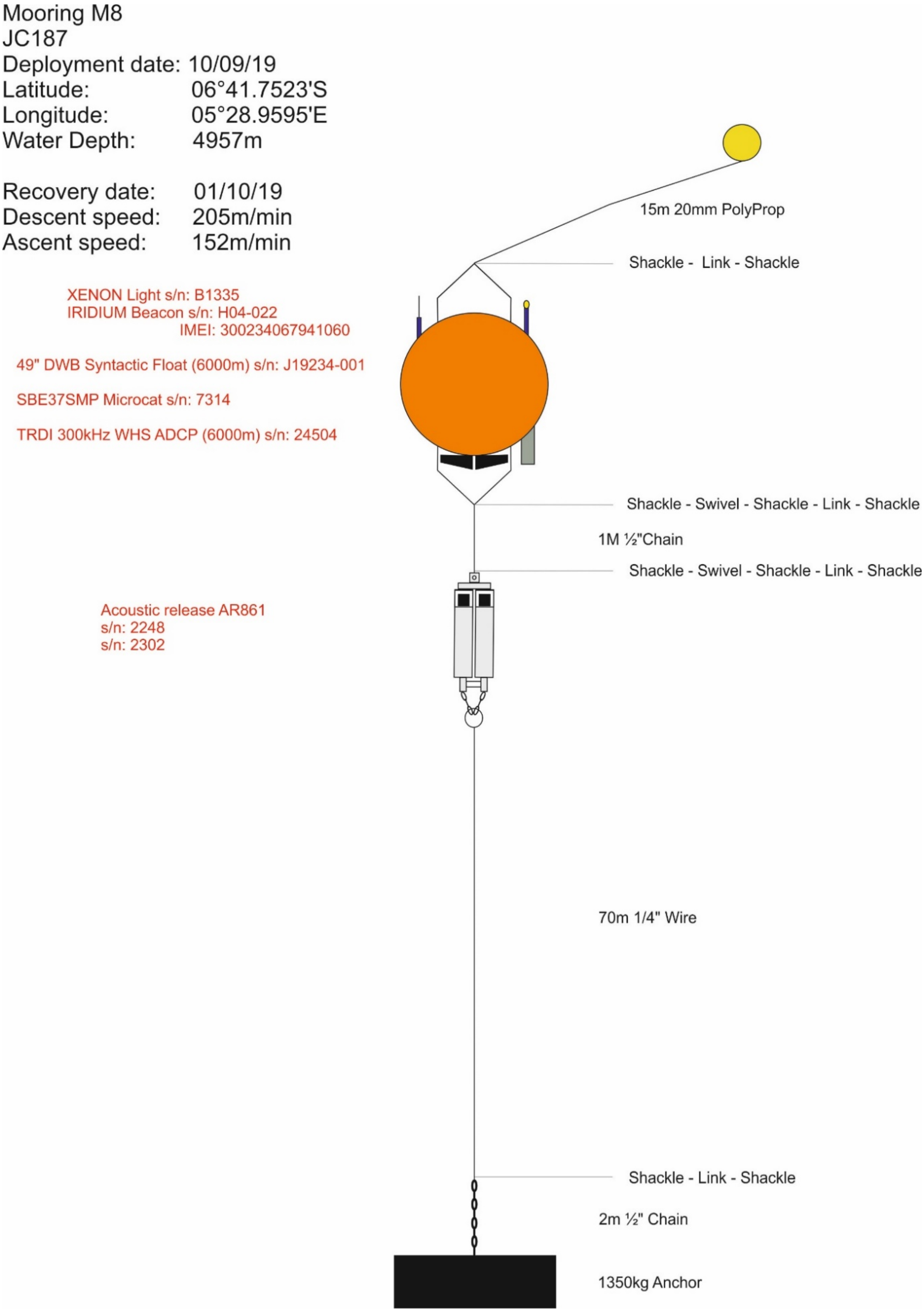


Figure 8.1. *Diagram of NERC Mooring-8*.

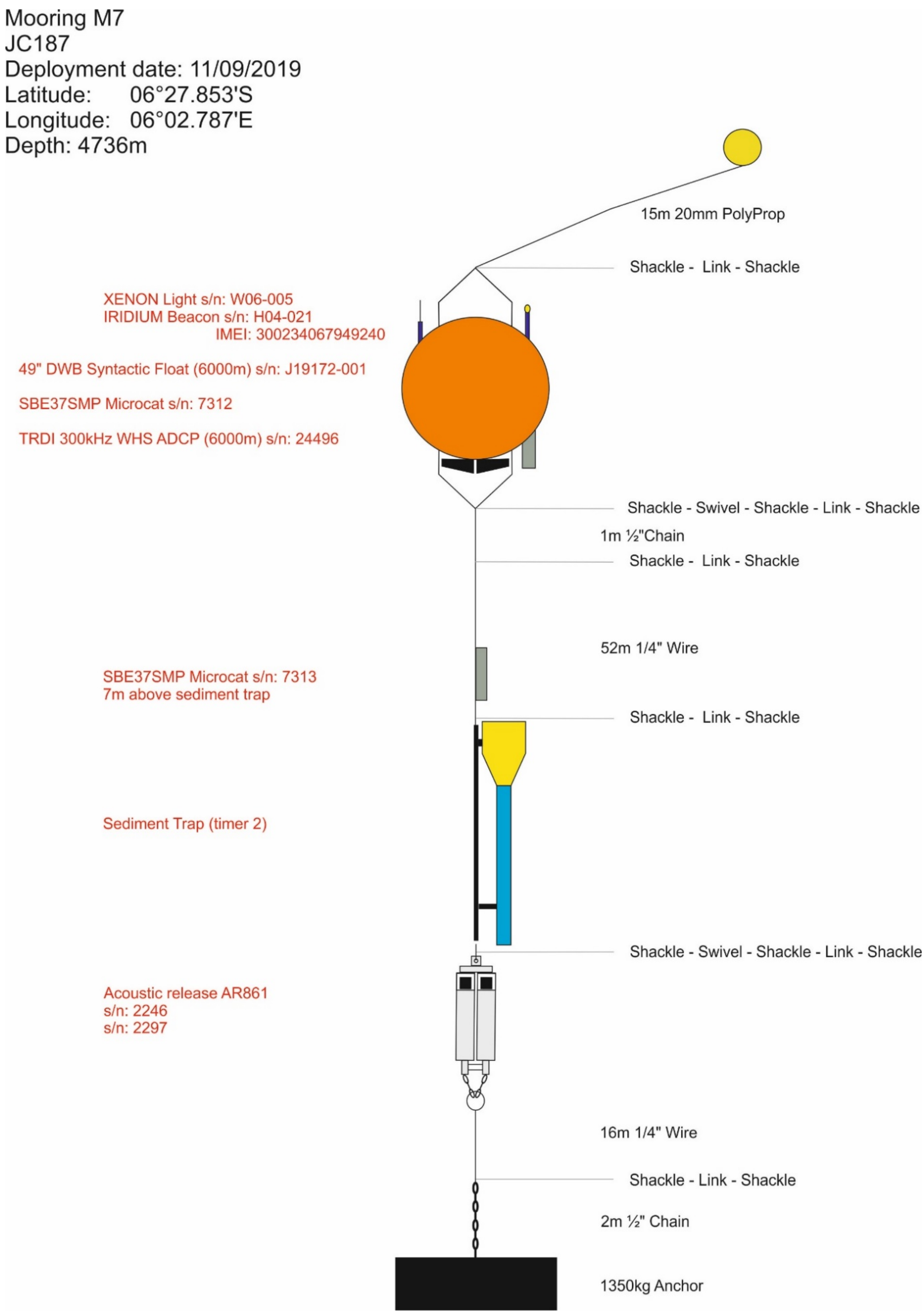


Figure 8.2. *Diagram of NERC Mooring-7.*

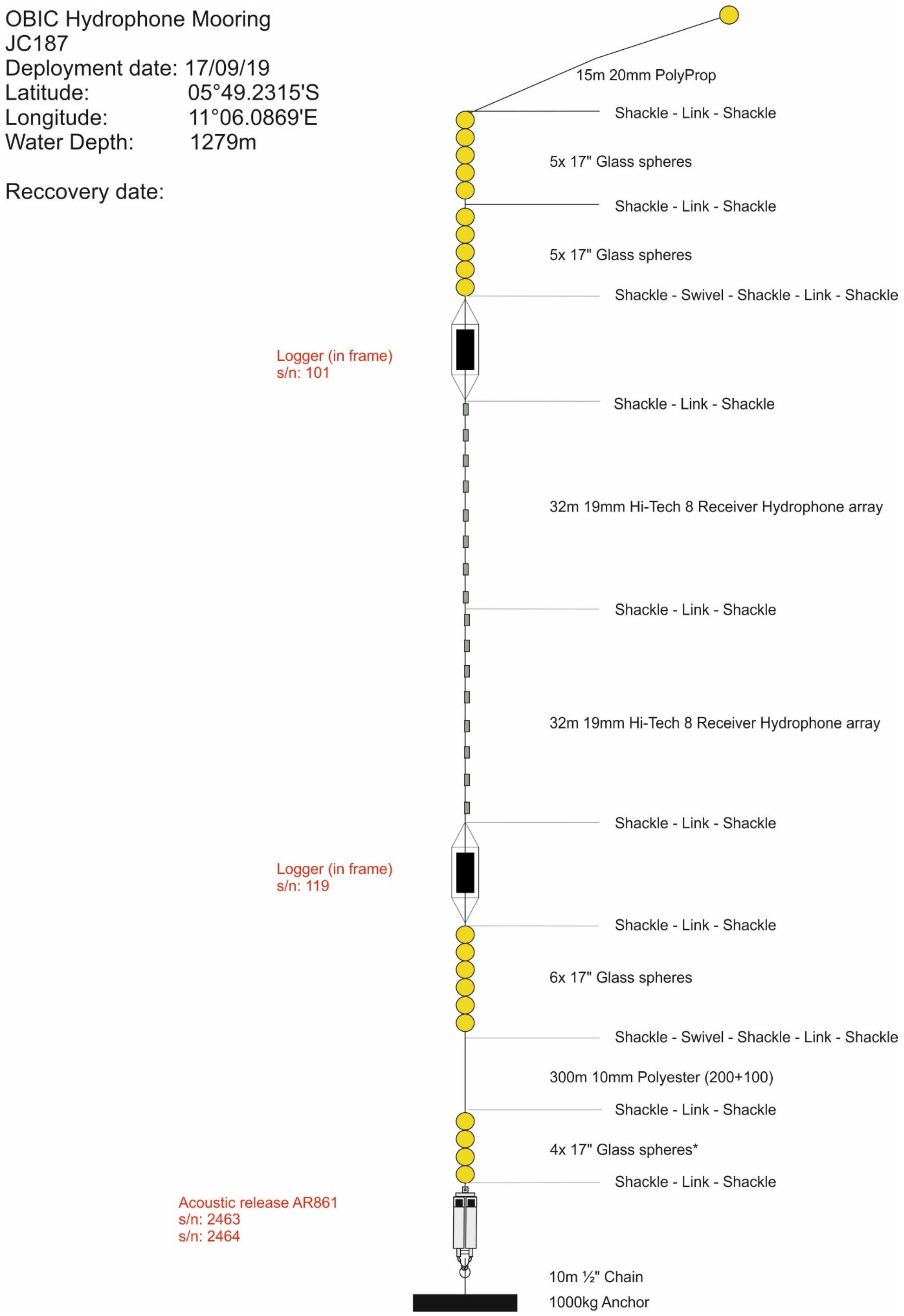


Figure 8.3. *Diagram of Vertical Hydrophone Array (for initial test deployment).*

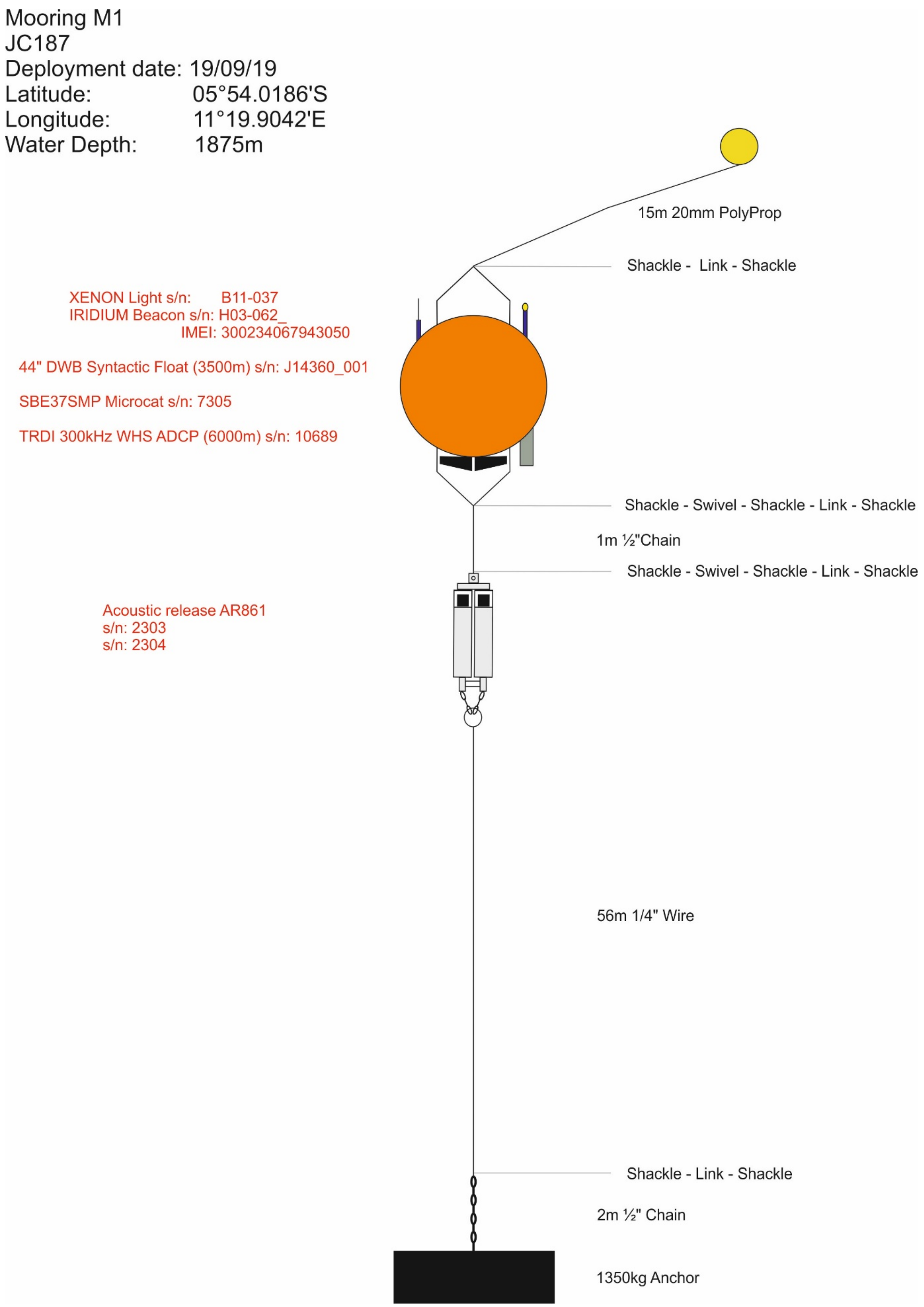


Figure 8.4. *Diagram of NERC Mooring-1.*

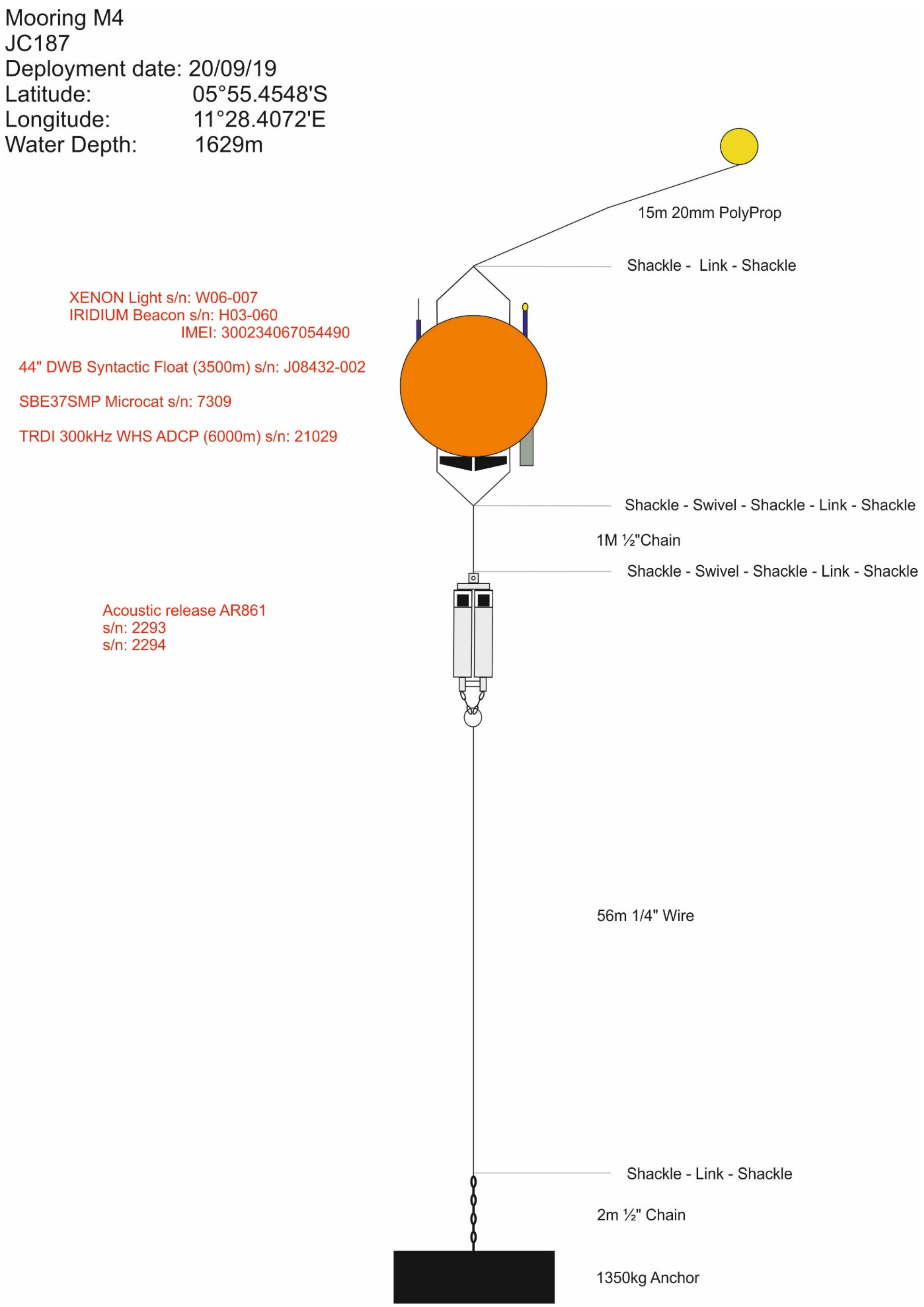


Figure 8.5. *Diagram of NERC Mooring-4.*

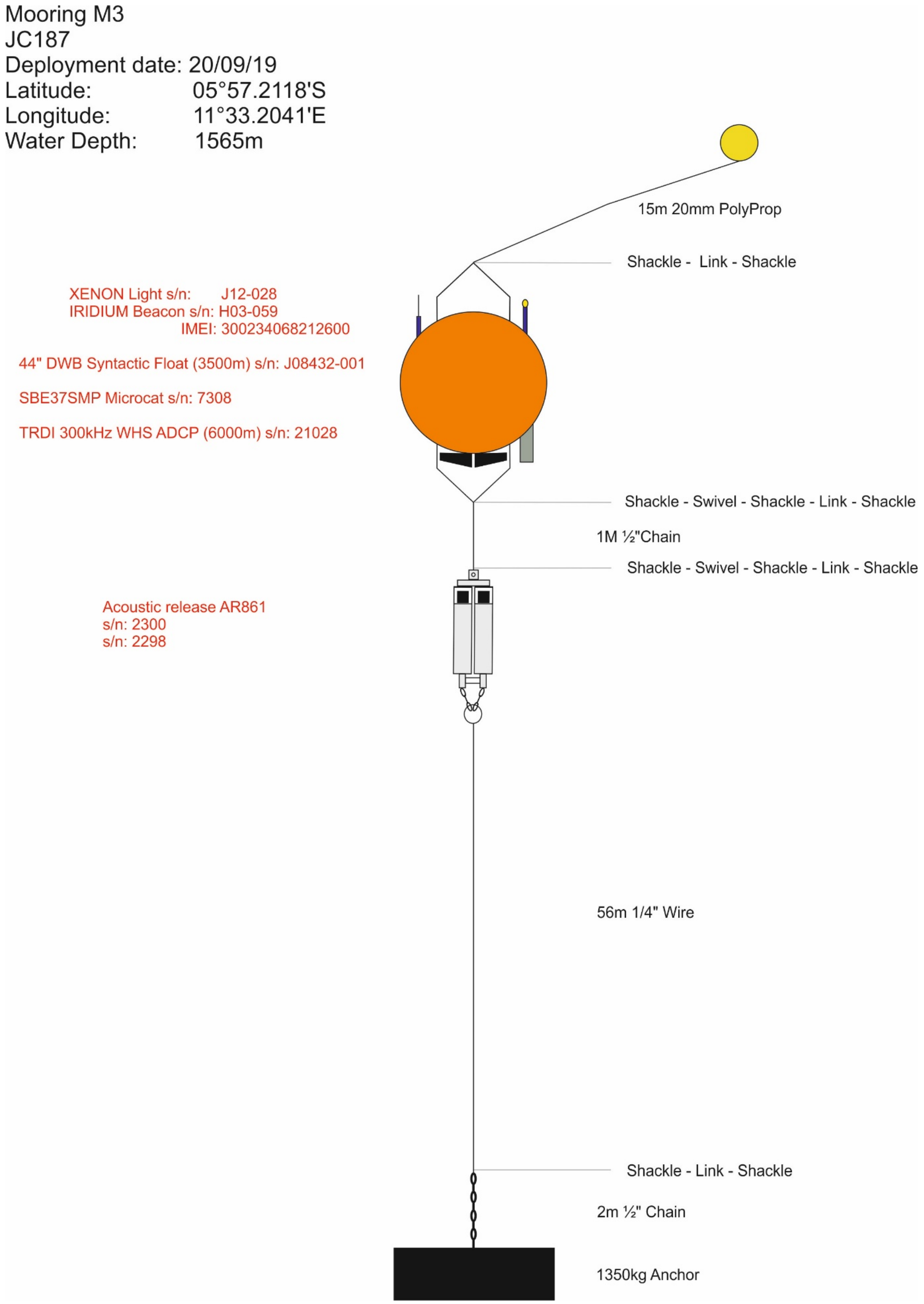


Figure 8.6. *Diagram of NERC Mooring-3*

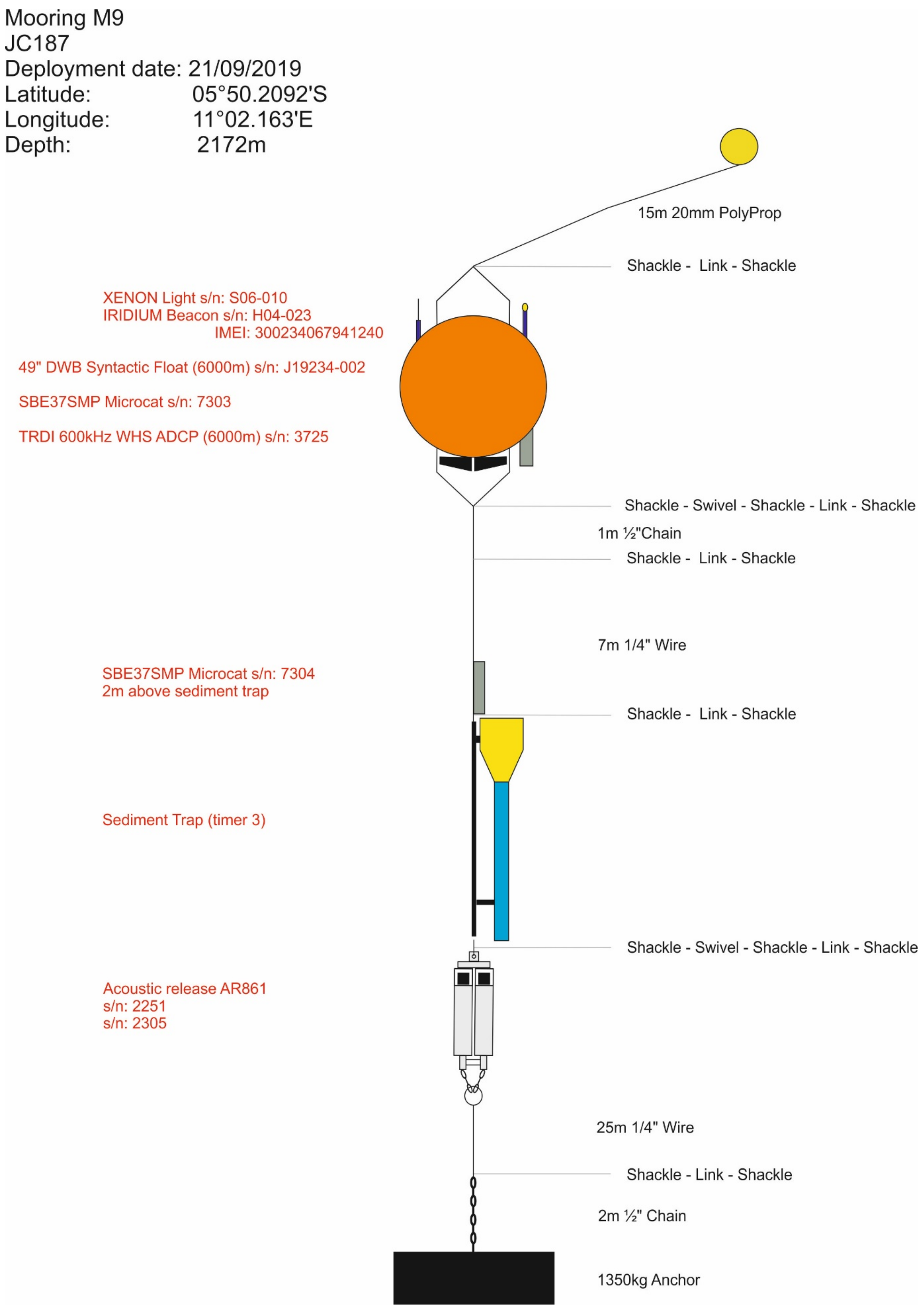


Figure 8.7. *Diagram of NERC Mooring-9.*

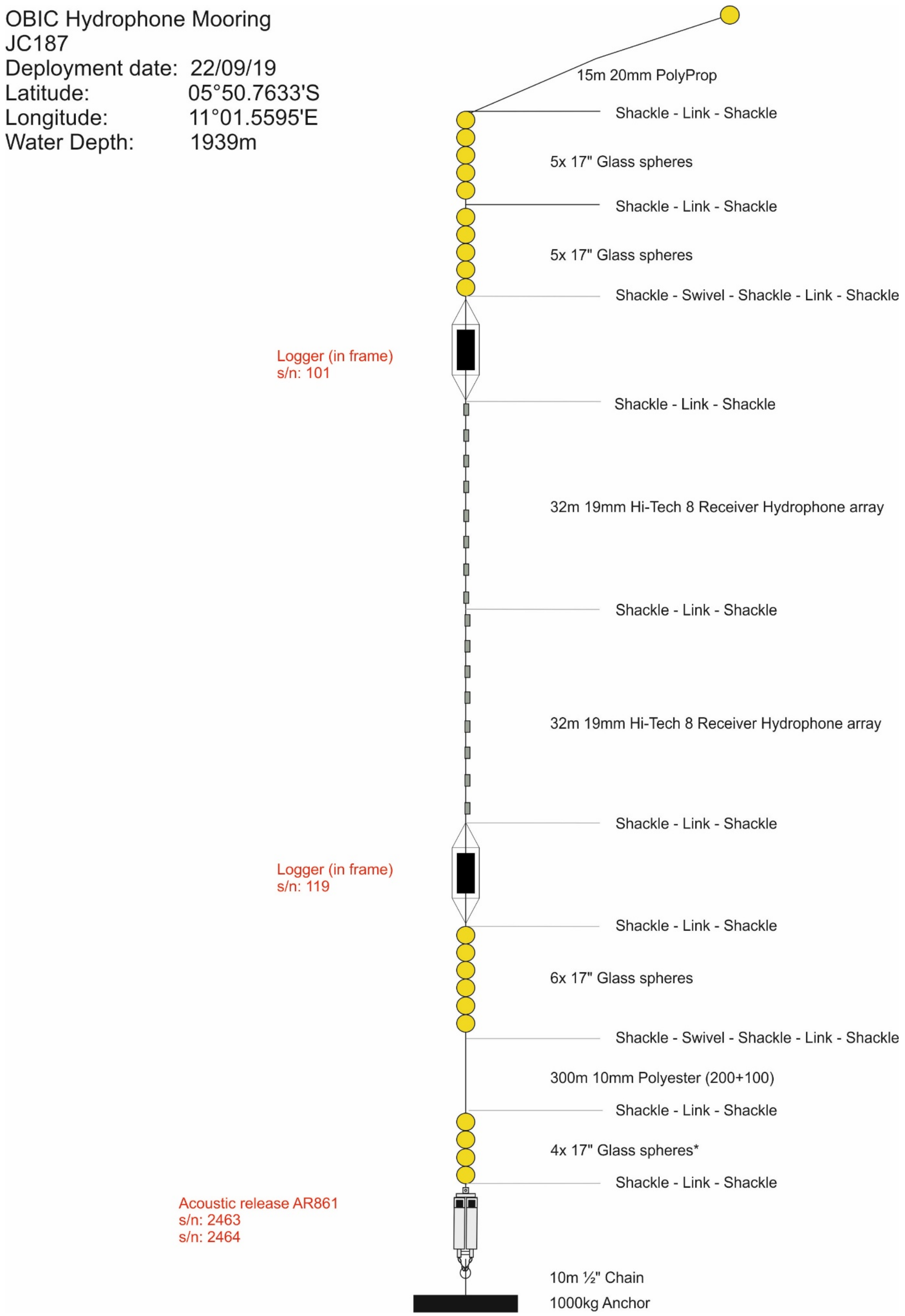


Figure 8.8. *Diagram of Vertical Hydrophone Array (final deployment).*

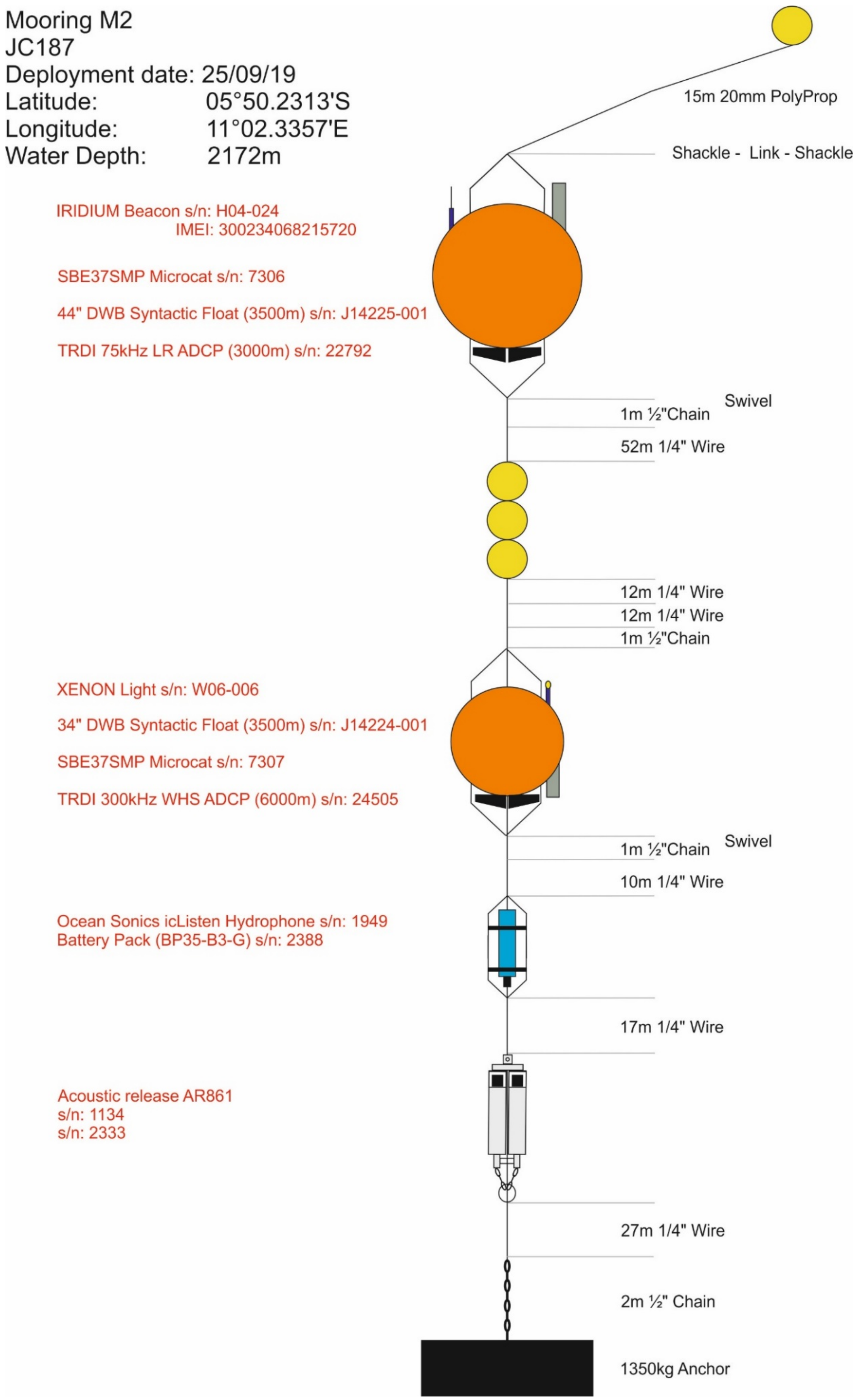


Figure 8.9. *Diagram of NERC Mooring-2.*

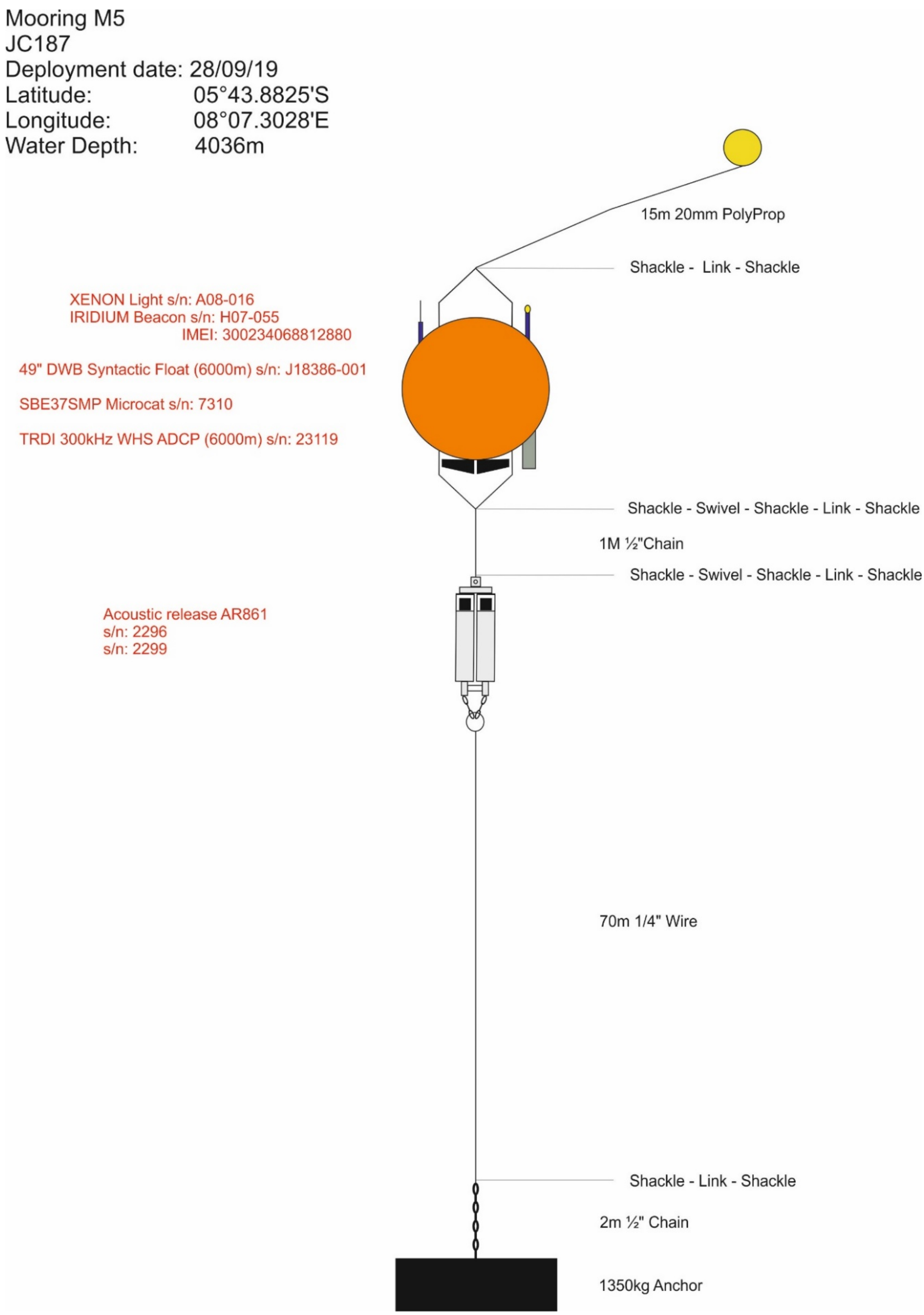


Figure 8.10. *Diagram of NERC Mooring-5.*

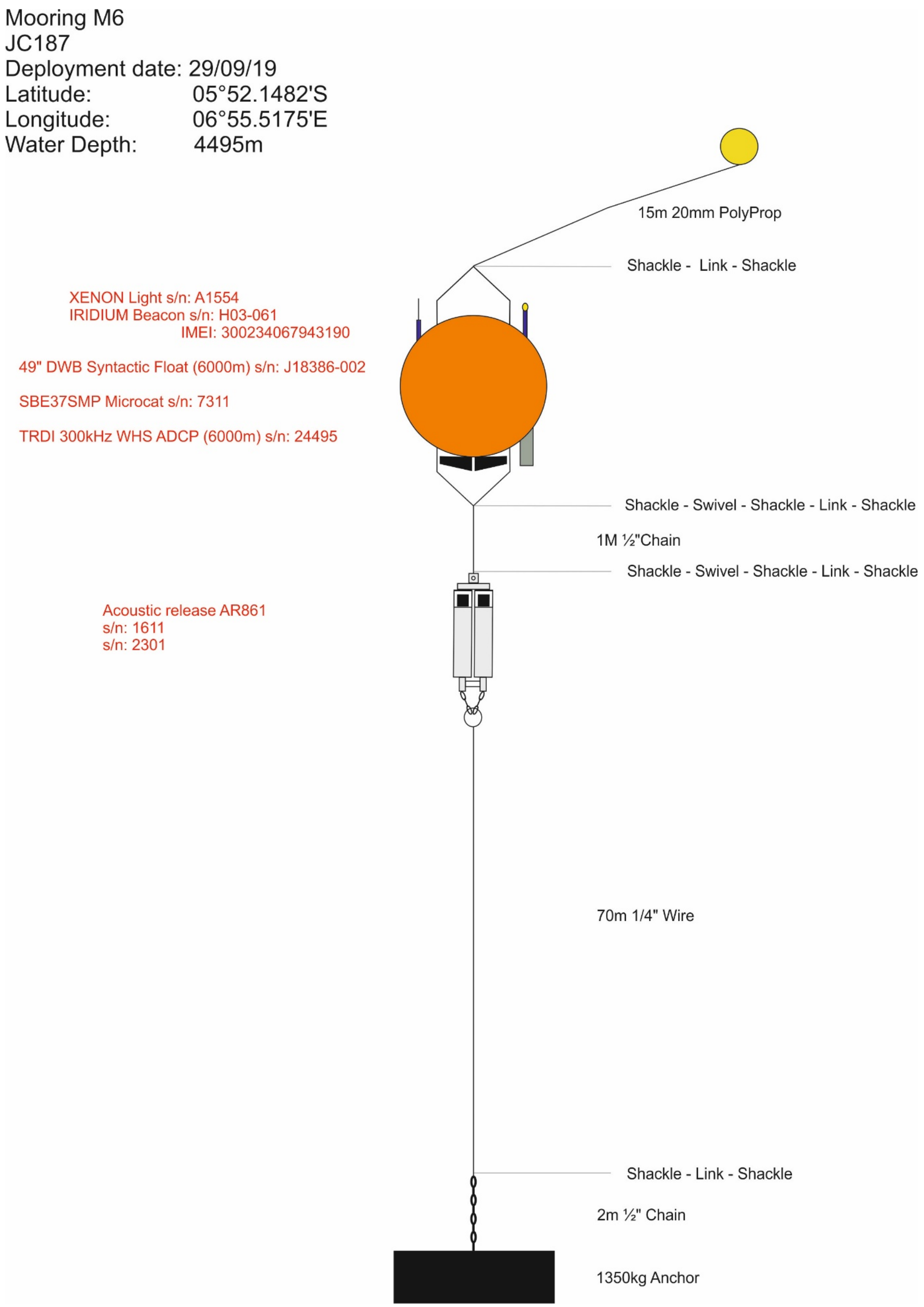


Figure 8.11. *Diagram of NERC Mooring-6.*

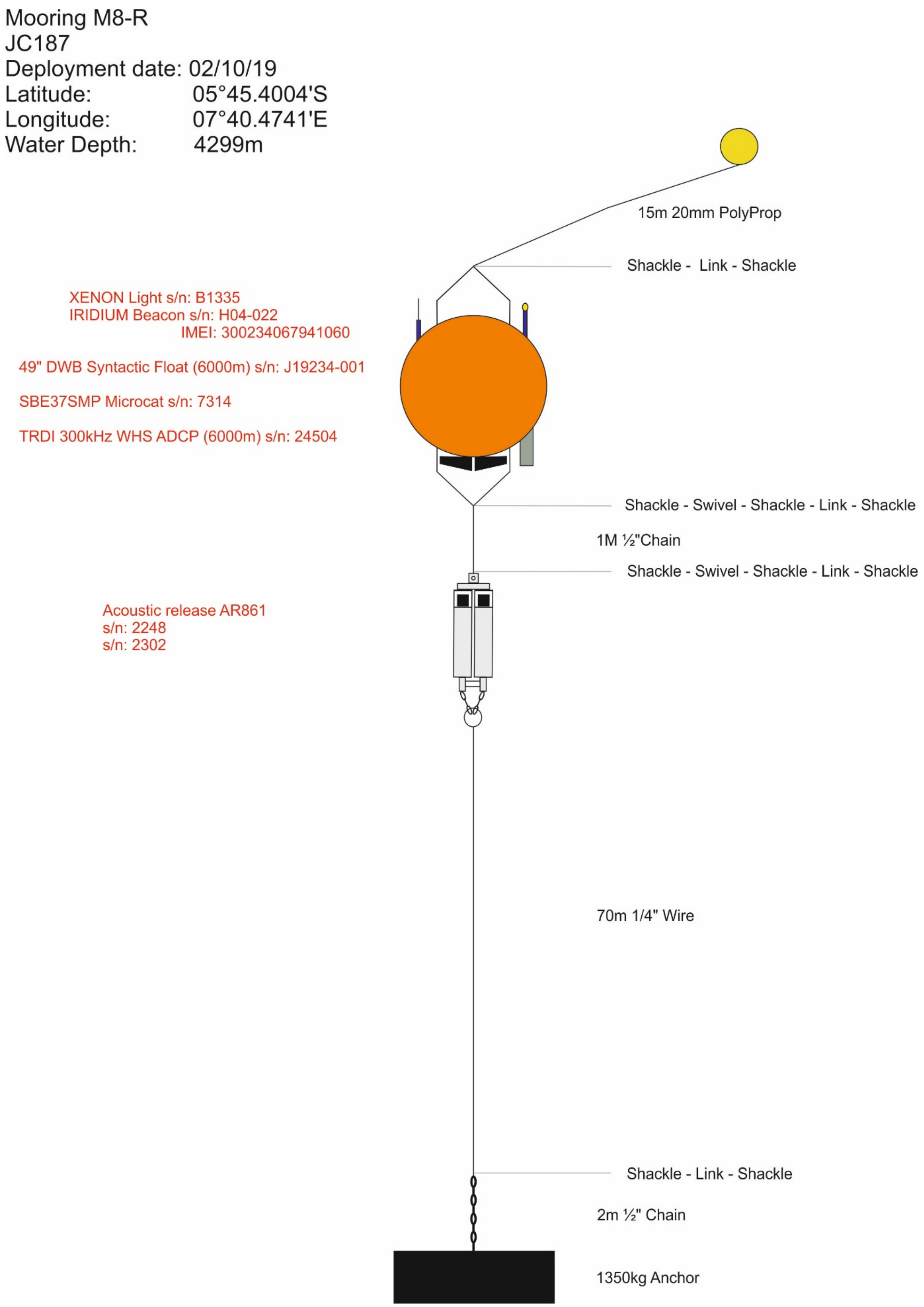


Figure 8.12. *Diagram of NERC Mooring-8, when redeployed.*

8.1.2.1 ADCP set up

Acoustic Doppler Current Meters (ADCPs) are used to measure profiles of flow velocities, and can be used to estimate sediment concentrations via acoustic backscatter.

ADCPs on three different acoustic frequencies are employed in the project. The lower frequency 75 kHz instruments provide greater penetration through the water column, and can image the full thickness of the larger flows. The higher frequency 300 kHz and 600 kHz instruments provide a means of imaging the lower layers of the flows with a higher spatial resolution. The instruments record 3D velocity vectors in range bins (heights above the seabed) through the water column, but the accuracy of the measurements is influenced by the setup parameters, which were carefully considered before deployment. The standard deviation of the measurements decreases when larger bin sizes are chosen and by increasing the number of pings per ensemble. The settings chosen for each instrument therefore reflect trade-offs between spatial resolution, temporal resolution and the quality of the velocity measurements. The backscatter magnitudes, required for sediment concentration inversion, are additionally affected by the choice of bin size, the distance of the instrument above the seafloor and the transmit power. A sufficiently powerful backscattered signal from the water column and seafloor echo is required so that the reflected sound is above the electronic noise level and below the instrument saturation level. The expected backscatter values are also largely affected by the attenuation of sound by the material in suspension. The 2010 data collected by Chevron at 300 kHz and 75 kHz (Cooper et al., 2013, 2016) are a useful guide to expected acoustic backscatter behaviour.

<u>Ambiguity velocity</u>
All ADCPs are set with an ambiguity velocity of 3 m/s which is above the recommended value of 1.75 m/s recommended by the deployment planning software, PlanADCP. This increase in the threshold is to allow recording of data where there is likely to be large differences in velocity across the instrument interrogation swath due to turbulence. The error values are recorded by the instrument and these can be used in post-processing, if deemed necessary, to screen out data with high vertical ambiguity.

<u>Pings per ensemble</u>
All NERC ADCPs are set to ping once per ensemble, with the exception of the 75 kHz ADCP. The standard deviation of the measurements can be reduced in post-processing by averaging across successive profiles. These settings are likely to produce a slightly different result to burst averaging in which the instrument records the mean profile of a number of pings triggered more closely together. However, we decided to preserve the higher temporal resolution of single ping profiles as previous deployments have demonstrated that changes in flow structure are sometimes observed between successive pings. The exception is the 75 kHz ADCP on mooring M2 which averages 3 pings per profile as there is sufficient battery power on the low power setting chosen.

<u>SD card storage and battery life</u>
Each NERC instrument is fitted with 2 x 2GB SD cards. The NERC 300 kHz and 600 kHz instruments are fitted with 1600Wh batteries and the 75 kHz with 4 x 1600 Wh batteries. ADCP settings are optimised for the cards and batteries to be used maximally but with sufficient capacity for the instruments to operate until at least early December 2020.

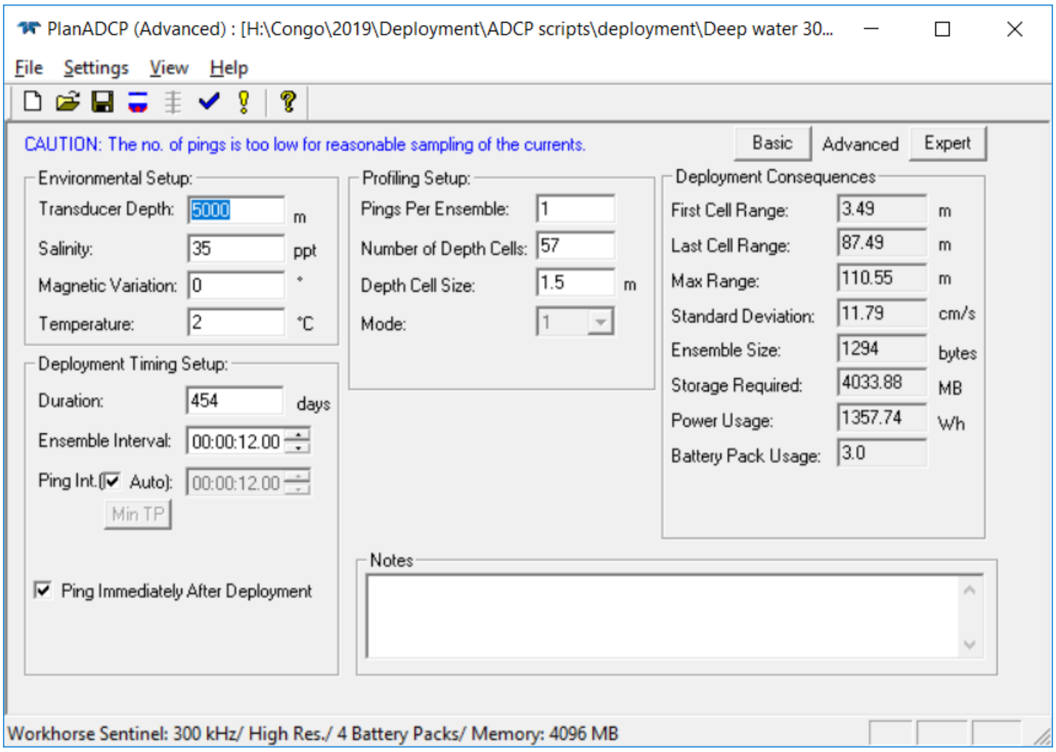
<u>Pressure sensor</u>
All NERC instruments are fitted with pressure sensors. A Seabird CTD sensor (which also measures pressure more precisely) was added to each mooring to aid in reconstructing depth, and hence precise mooring tilt or movement.

<u>Bin size</u>
A bin size of 1.5 m was chosen for the 300 kHz ADCPs. This is smaller than the 2 m bin size of the previous Chevron deployments in 2010 and 2013 (Cooper et al., 2013, 2016), but larger than the Monterey Coordinated Canyon Experiment (Paull et al., 2018) that used 1 m bins. A value of 1.5 m is

a compromise between maintaining a good signal-to-noise ratio at the same time as preserving spatial resolution. The same reasoning is applied to the 0.75 m bin size for the 600 kHz ADCP on mooring M9. The 4 m bin size for the 75 kHz instrument is the same as the 2010 Chevron setup.

Power setting
There is no option to change the transmit power on the 300 kHz and 600 kHz ADCPs instruments, but the 75 kHz can be set to lower power settings. The lowest power was chosen as this is the same as the 2010 Chevron setting and, at 150 m above the bed, the echo magnitude from the seafloor should be within the dynamic range of the instrument without causing saturation. This should enable the seafloor echo attenuation during the flows to be calculated by comparing with pre-flow echo magnitudes. This is necessary if we are to invert the data to solve for grain size and concentration using the method described in Azpiroz-Zabala et al. (2017). The low power setting also enables the instrument to be pinged at a faster rate, although the expected water column backscatter is likely to be relatively low between the flows. The low power setting was used in a previous study of the Var Canyon by IFREMER. These Var data suggests that water column backscatter at 75 kHz may be dominated by microturbulence associated with mixing in the region of the flow interface with the ambient water above.

The following figures show the set up files in PlanADCP for the ADCPs on NERC moorings.



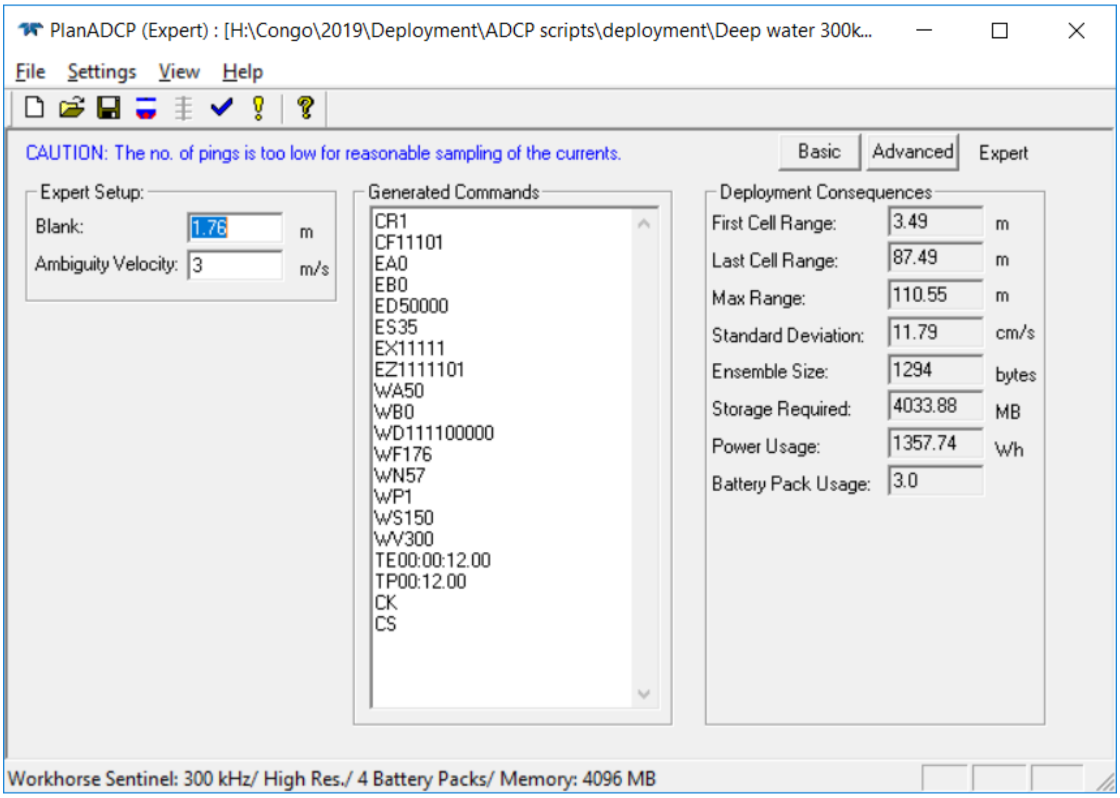
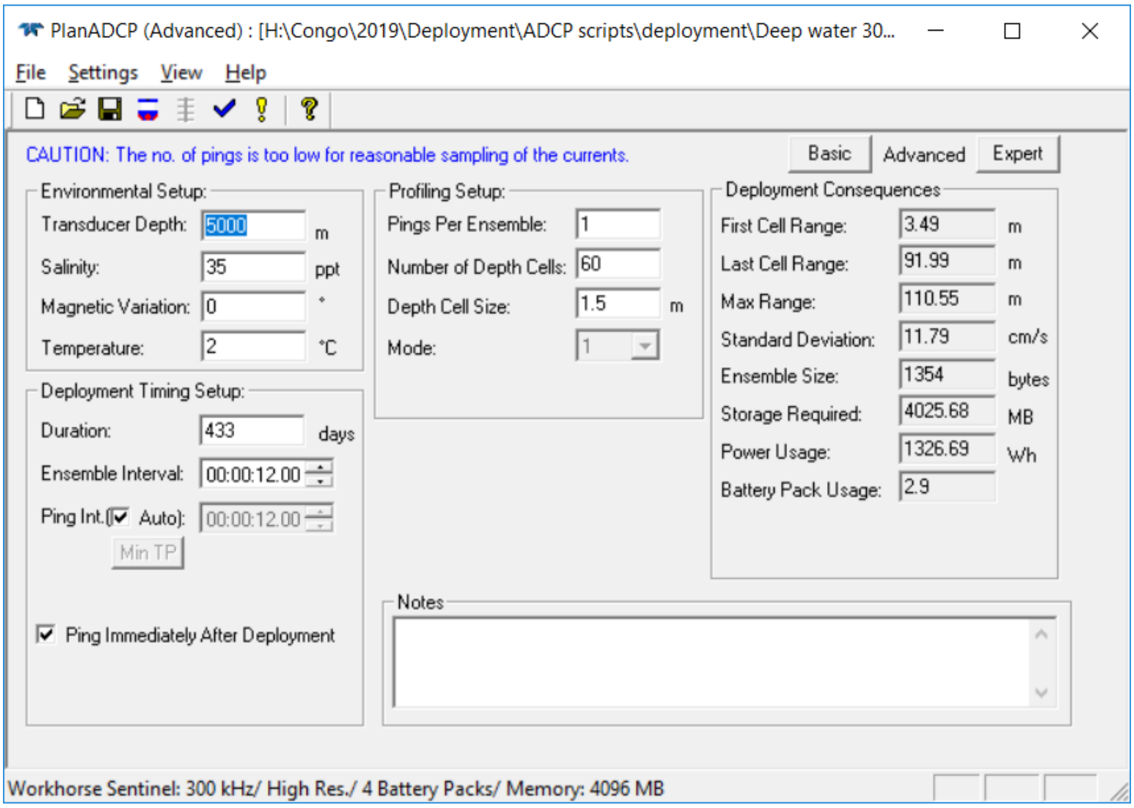


Figure 8.13*: Settings for 300 kHz ADCPs on NERC Moorings M5, M6, M7, and M8 (first deployment), located 80 m above seafloor.*



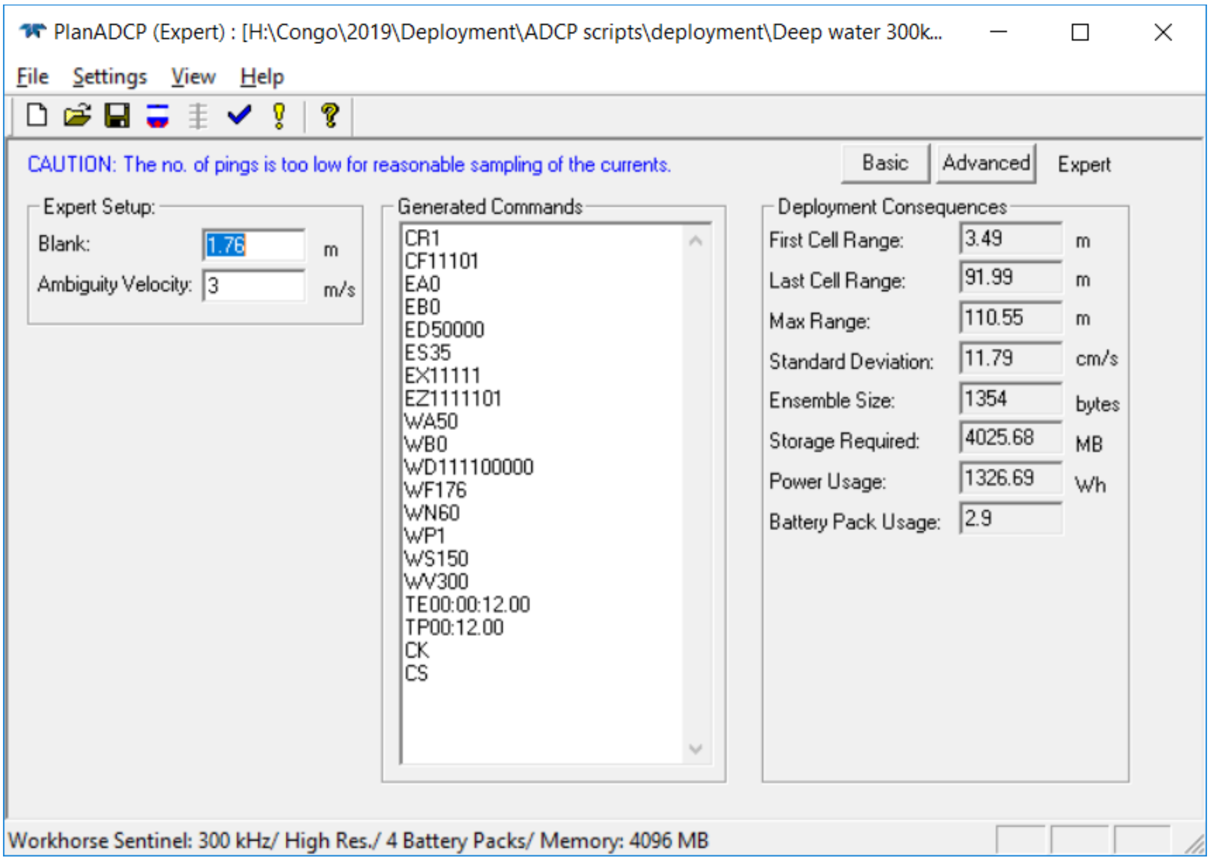
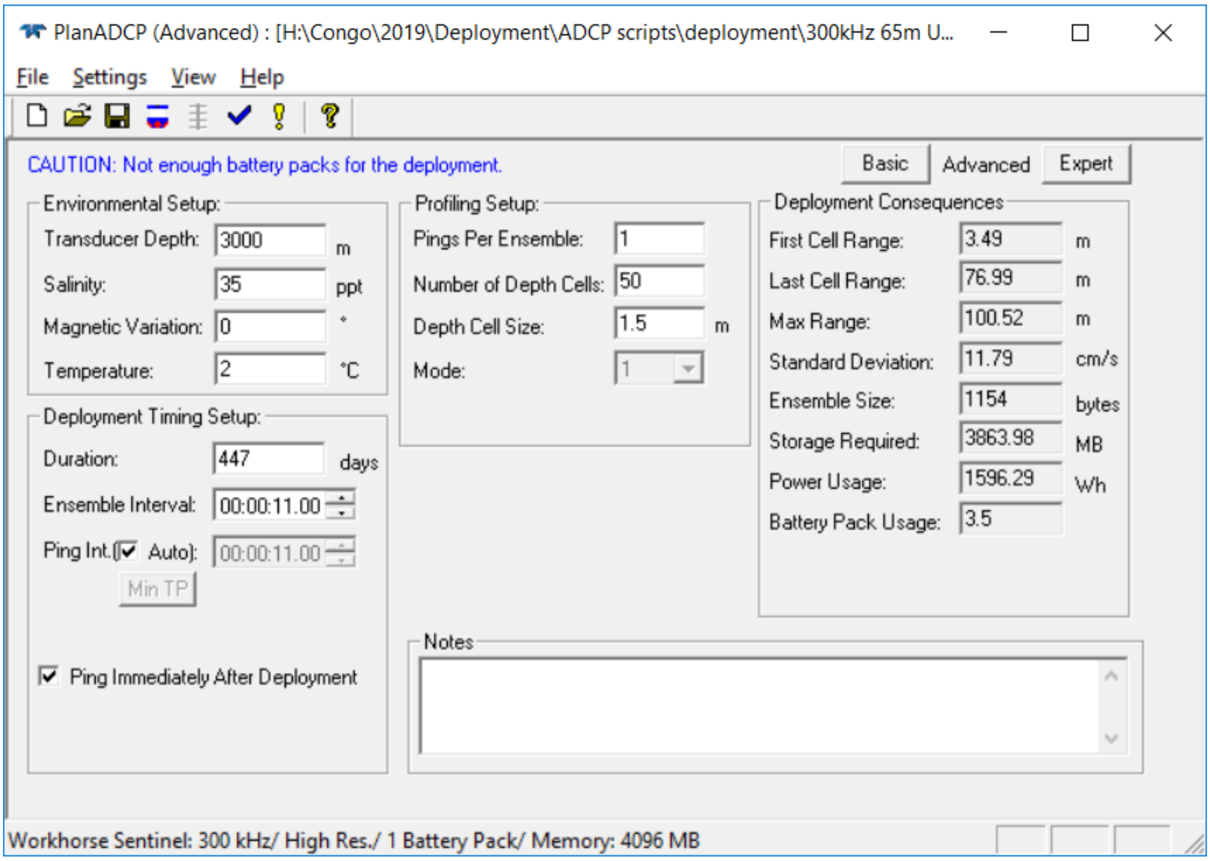


Figure 8.14: *Settings for 300 kHz ADCPs on NERC Mooring M8-R (re-deployment), 80 m above seafloor.*



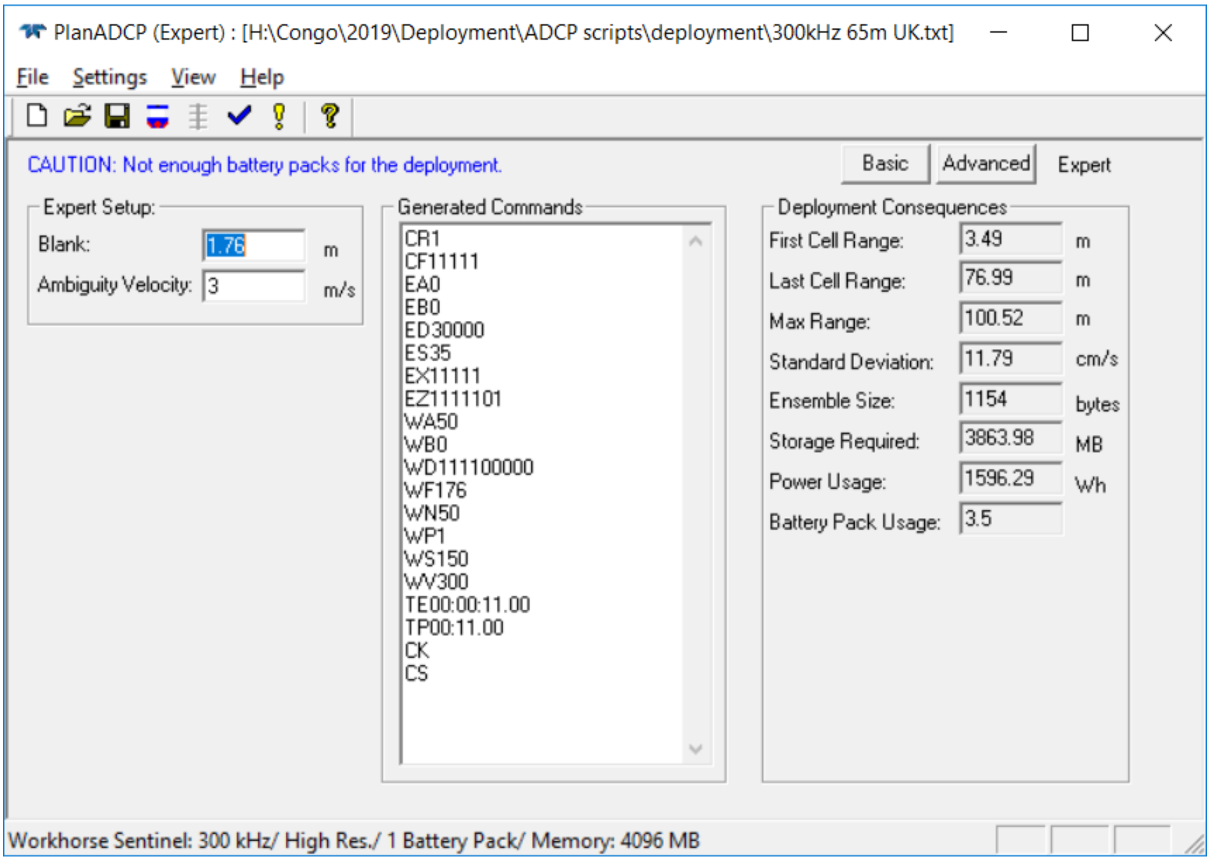


Figure 8.15: *Settings for 300 kHz ADCPS on NERC moorings M1, M2, M3 and M4, 65 m above seafloor.*

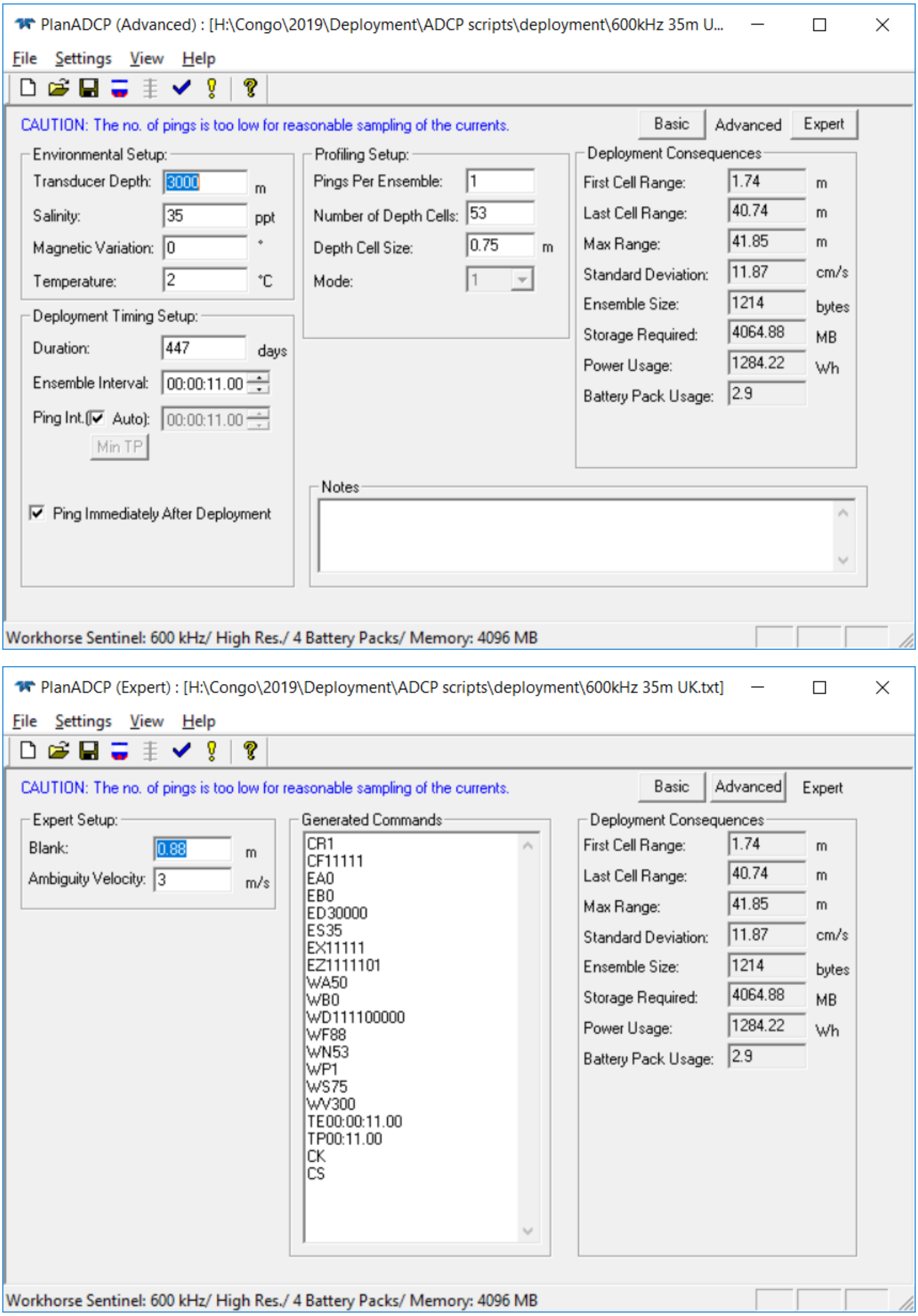
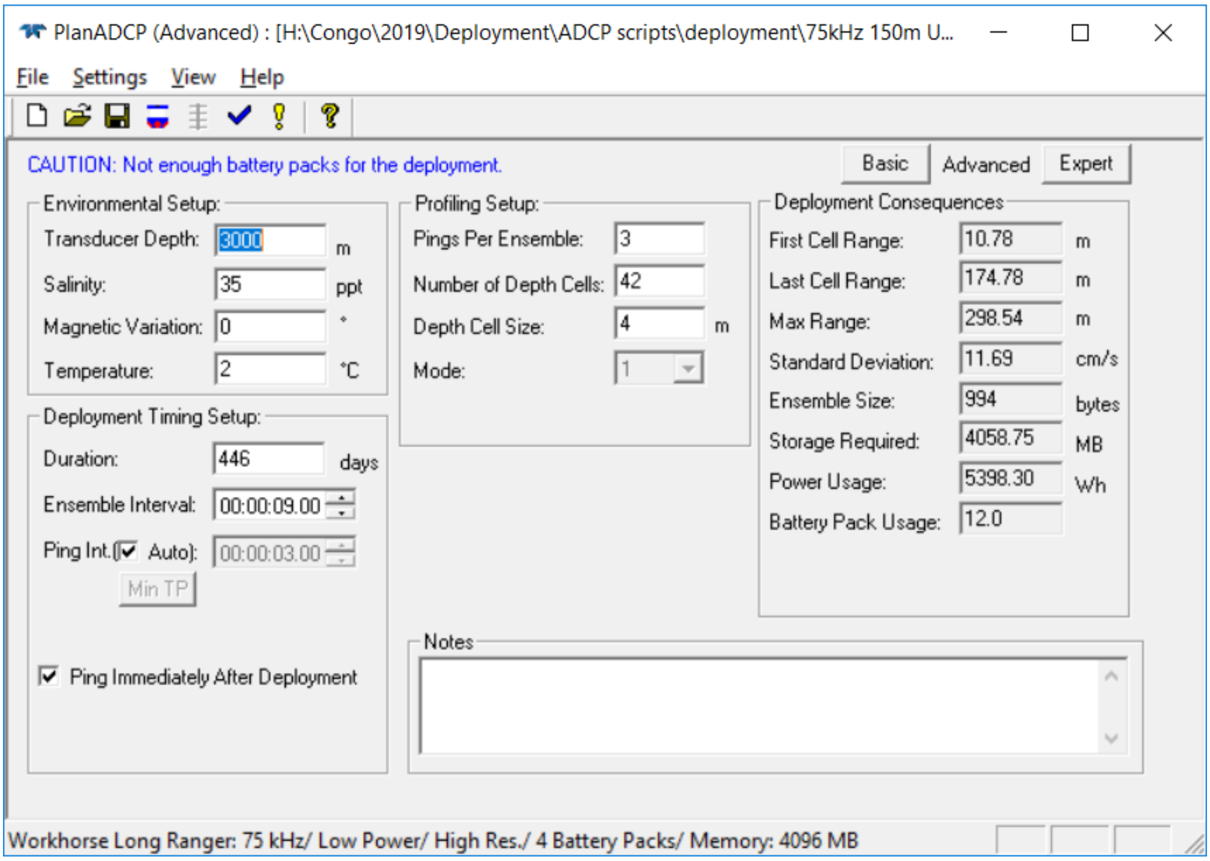


Figure 8.16: *Settings for 600 kHz ADCP on NERC mooring M9, located 65 m above seafloor*



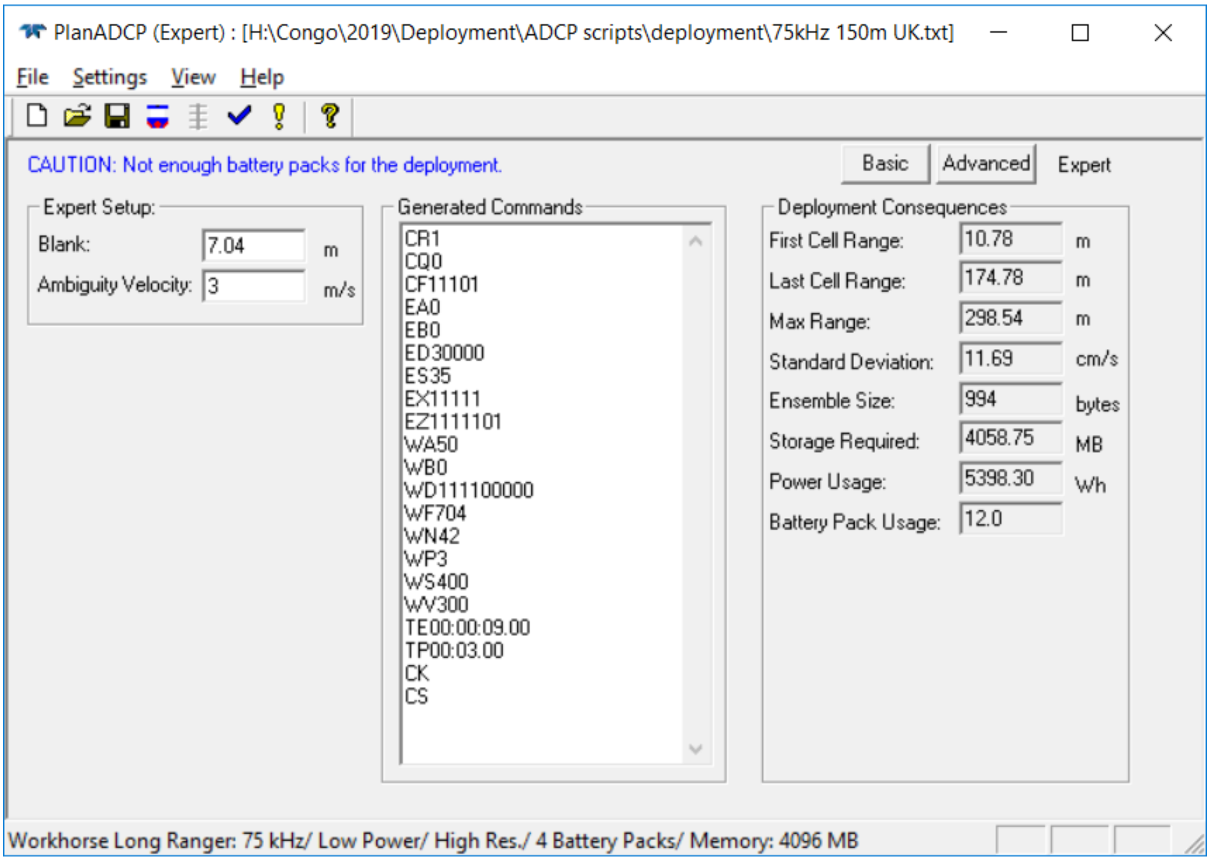


Figure 8.17: *Settings for 75 kHz ADCP on NERC mooring M2, located 150 m above seafloor*

8.1.2.2 Acoustic release

Twin acoustic releases were used on all moorings, with a second release in case the first fails. These acoustic releases were all initially tested during a dip attached to the CTD wire, during our transit. Note that we have tried to keep releases reasonable high above the seabed, as if they are engulfed in near-bed fast flow – both releases might be damaged ensuring no redundancy.

8.1.2.3 Sediment traps

Sediment traps provided by Hangzhou Sea & Stream Technology Co., Ltd. were mounted on to NERC Mooring 9 (Angolan waters, GIS site 14) and NERC mooring 7 (International waters, GIS Site 76). For NERC mooring 9, the sediment trap was mounted 32 m above the seafloor, below the ADCP. The sediment trap on NERC mooring 7 was suspended 22 m above the seafloor and below the ADCP. Recent studies in Monterey Canyon have demonstrated that sediment traps can be used to obtain samples of sediment directly from the water column during turbidity current events (*e.g.*, Maier *et al.*, 2019). The height of the sediment traps was set to be low enough to sample sediment from turbidity current events, but high enough to not be caught within the powerful part of the flows, which may result in the mooring being dragged down the canyon. The slim sediment trap design was also motivated by the presence of powerful and prolonged turbidity currents.

The sediment trap is mounted upright, along the mooring wire, with the funnel on the top end. Sediment settles into the sediment trap through an open top funnel (0.26 m diameter) covered with a mesh, and accumulates in a clear plastic liner tube (1.50 m in length, 0.063 m diameter) inside the main tube (1.57 m in length; Fig. 8.18). The total length of the sediment trap is 2.50 m (Fig. 8.18). An intervalometer is suspended near the top of the funnel and dispenses 20 disks into the liner tube at a fixed time interval (Fig. 8.18). The disks are approx. 3 cm wide, smaller than the plastic liner, to allow for settling of the disk within the tube.

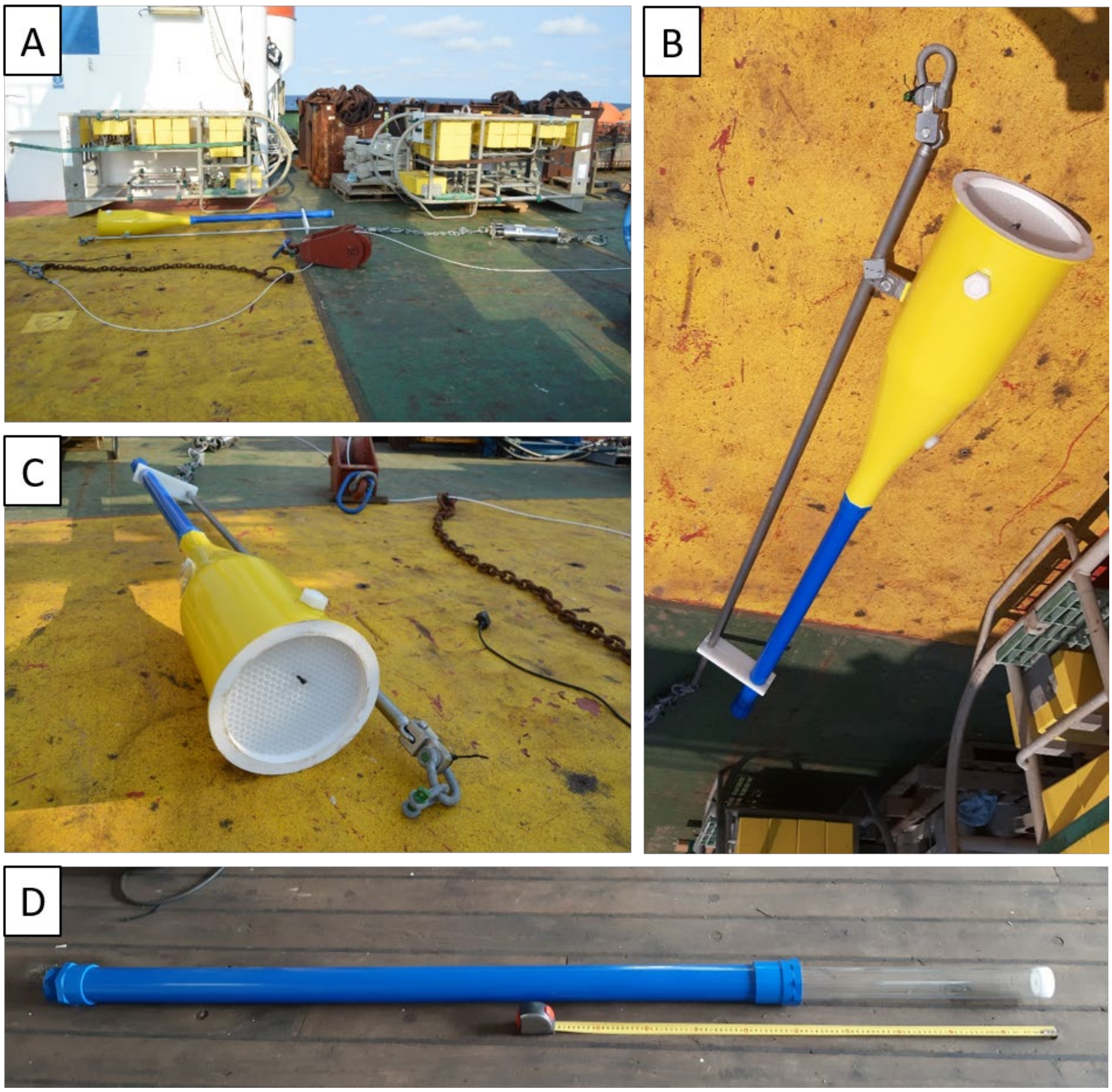


Figure 8.18: *A) sediment trap on deck showing the acoustic releases just below the trap; B) Sediment trap and metal pole attached; C) top view of sediment trap showing mesh at the top of the funnel; D) clear plastic liner tube within the main tube.*

In order to compare the deposits in the two sediment traps, the dispensing of the first disk and subsequent disks was set to occur at the same time. The dispensing of the first disk was delayed until the 6th October 2019, by which time both sediment traps had been deployed. During the deployment period of the sediment traps, the disks were programmed to dispense every 21 days (Table 8.2), covering the entire deployment period. The sediment traps will be collected next year and it is hoped the whole core can be transported back to the UK to be logged using a multi-sensor core logger and x-ray computed tomography. New liner tube and sediment disks (and possibly oil for the intervalometer) are therefore required for the next cruise to redeploy the sediment traps.

The ANIITRA sediment trap is of a different set-up (see relevant chapter).

Table 8.2 *Dates of deployment of the disks within the sediment traps.*

Disk	Date released	Disk	Date released

1	06/10/19	11	3/05/20
2	27/10/19	12	24/05/20
3	17/11/19	13	14/06/20
4	8/12/19	14	5/07/20
5	29/12/19	15	26/07/20
6	19/01/20	16	16/08/20
7	9/02/20	17	6/09/20
8	1/03/20	18	27/09/20
9	22/03/20	19	18/10/20
10	12/04/20	20	8/11/20

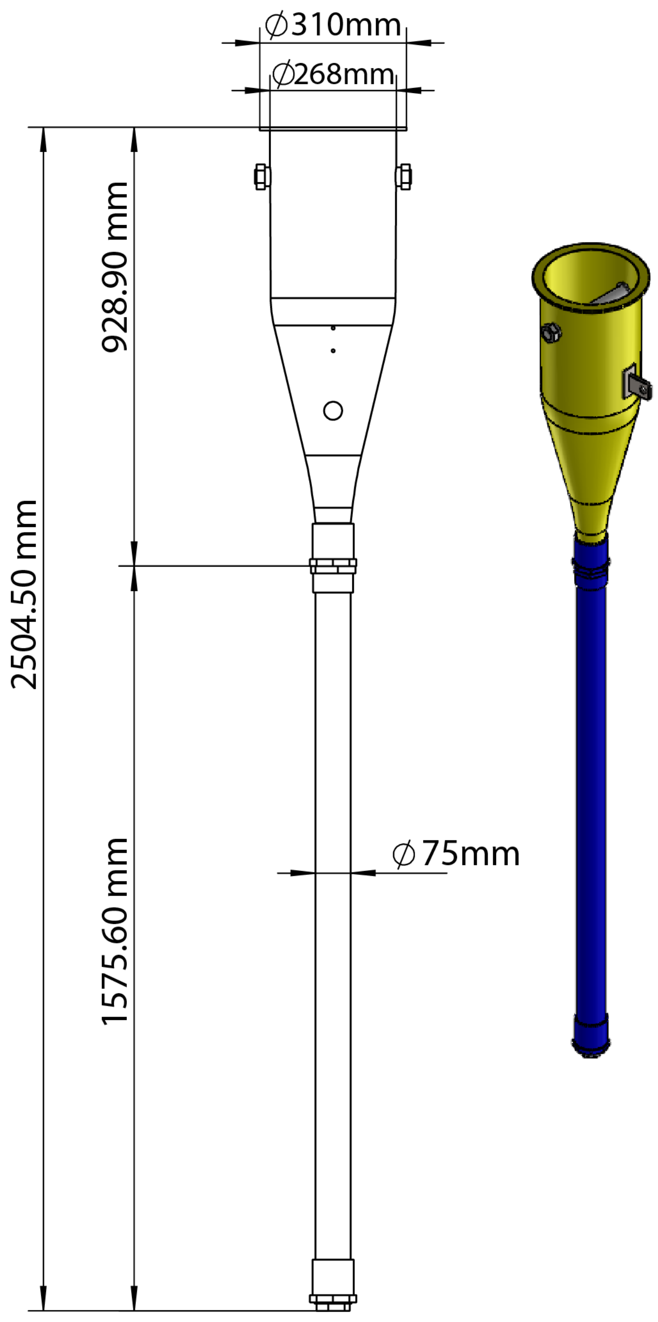


Figure 8.19: *Technical drawing of sediment trap. From Hangzhou Sea & Stream Technology Co., Ltd.*

8.1.2.4 IcListen Hydrophone (mounted onto NERC Mooring M-2)

This is an Ocean Sonics smart hydrophone unit. The smart hydrophone unit appeared to have a power issue, such that deployment of Mooring 2 was delayed. But this turned out to be misleading documentation, and it was resolved by communication with the manufacturer. A mounting bracket was fabricated by the sensors and moorings team, so that the hydrophone could be mounted directly onto the battery unit, rather than having to use the provided cable. The smart hydrophone was setup by the technicians from Ocean Bottom Instrumentation Consortium. It is set to record for 1 minute every hour, and is storing waveform data at 512 kHz, as well as spectral data.

8.1.2.5 Set-up of each mooring

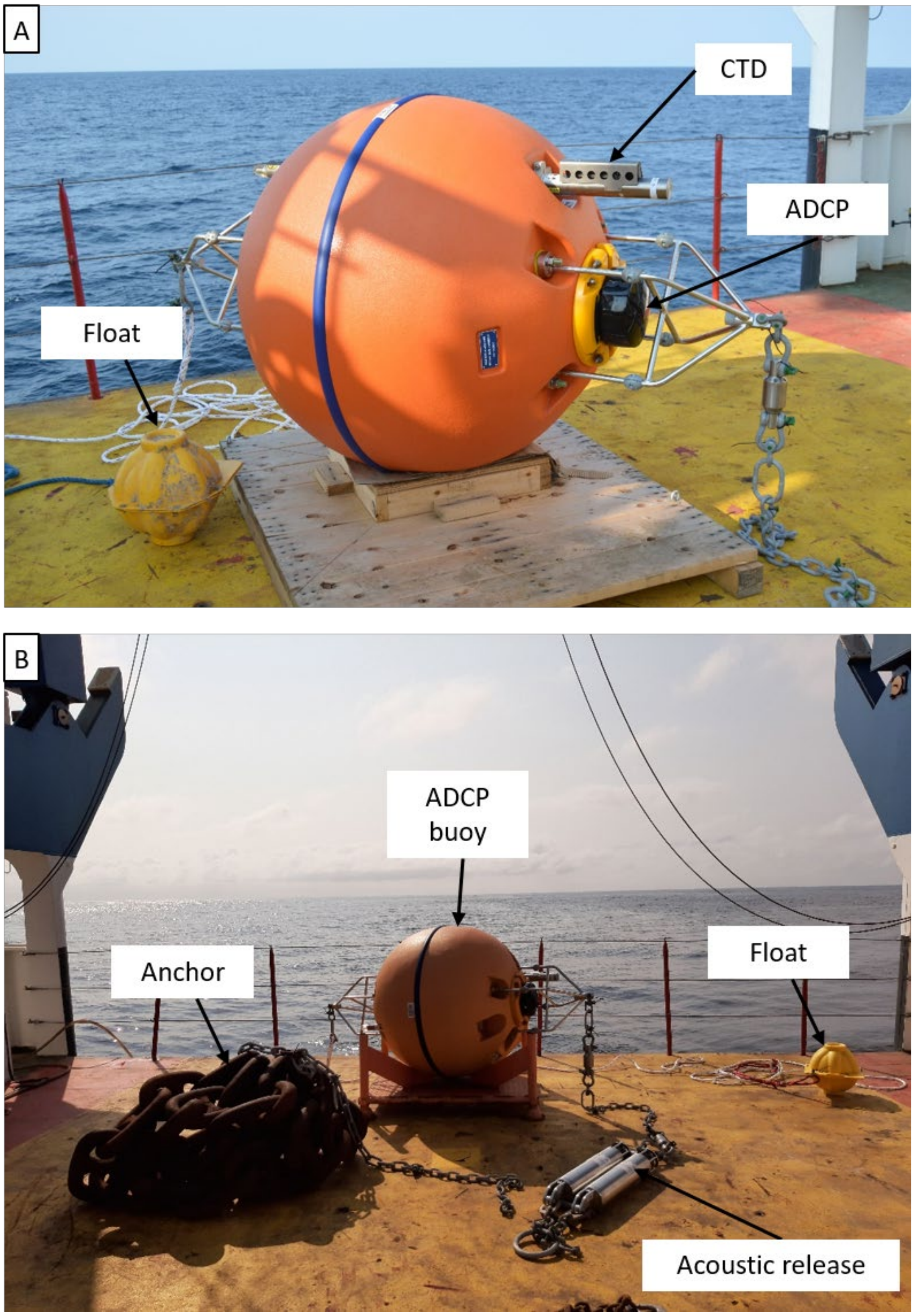


Figure 8.20: *Components within the moorings.*

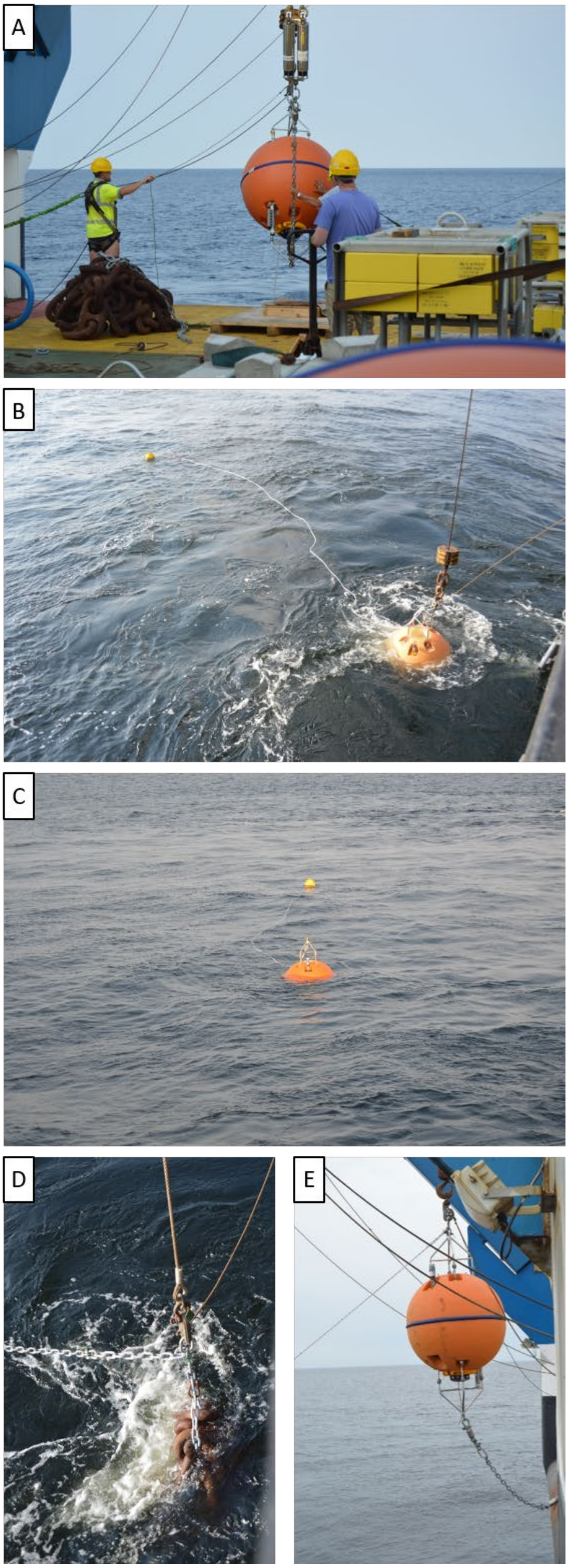

A
B
C
D
E

__Figure 8.21:__ Mooring deployment. A) and E) ADCP and acoustic releases and lifted, and B) placed in the water. C) Wire is let out, and ADCP buoy and acoustic release trail behind the boat. D) When boat is nearly on target, the anchor is deployed into the water. When the boat is on target the anchor is released. The determination of targets also takes into account cross currents.

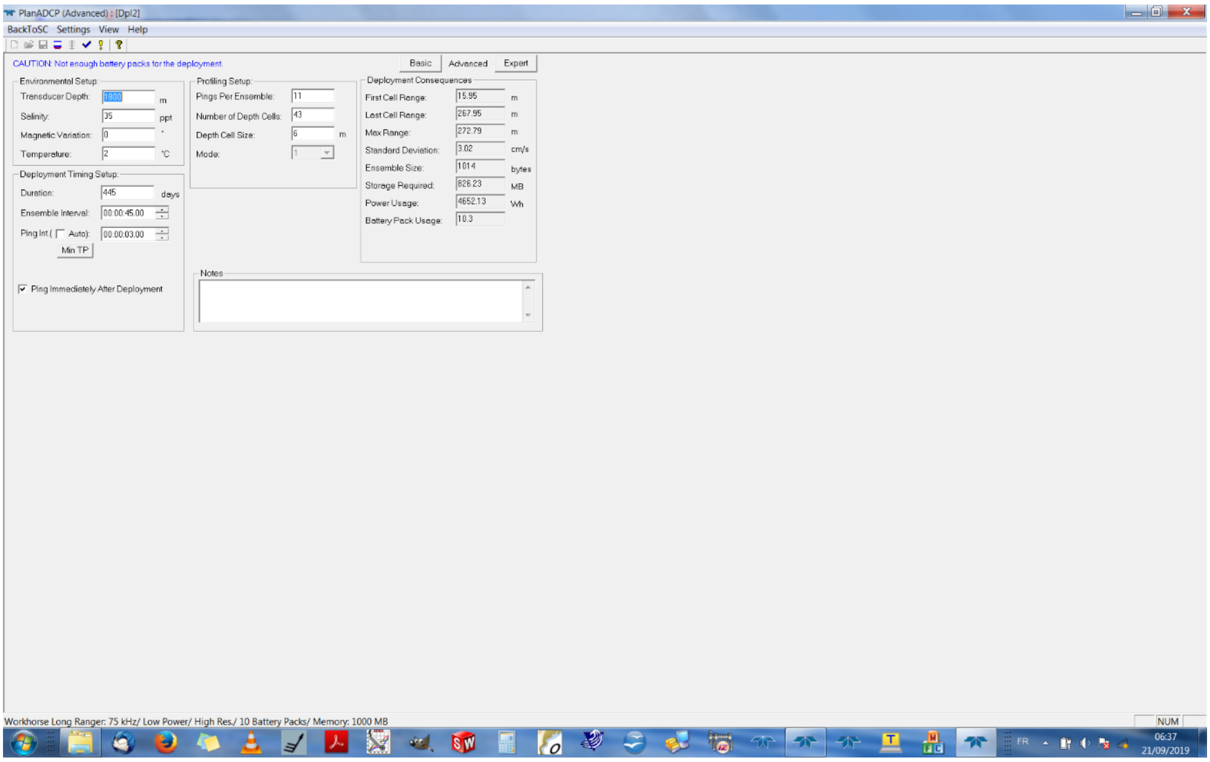
8.1.3 ANIITRA moorings

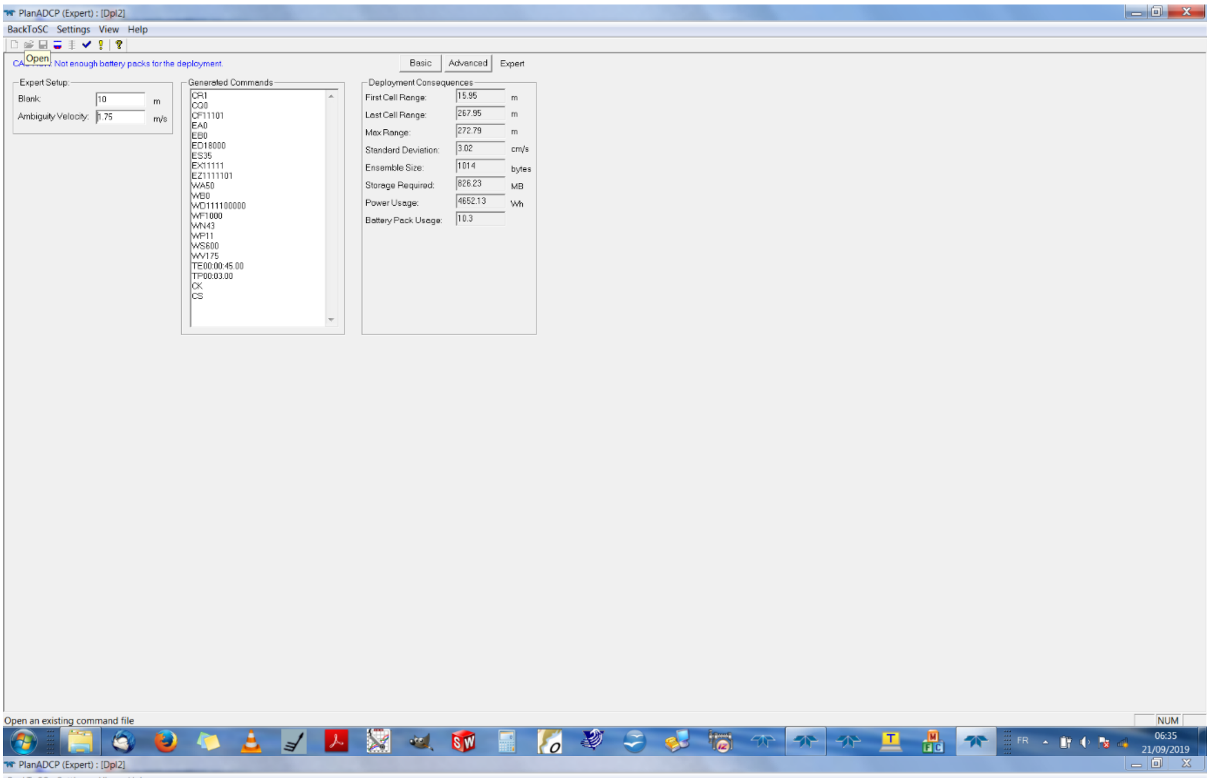
8.1.3.1 75 kHz ADCP set up

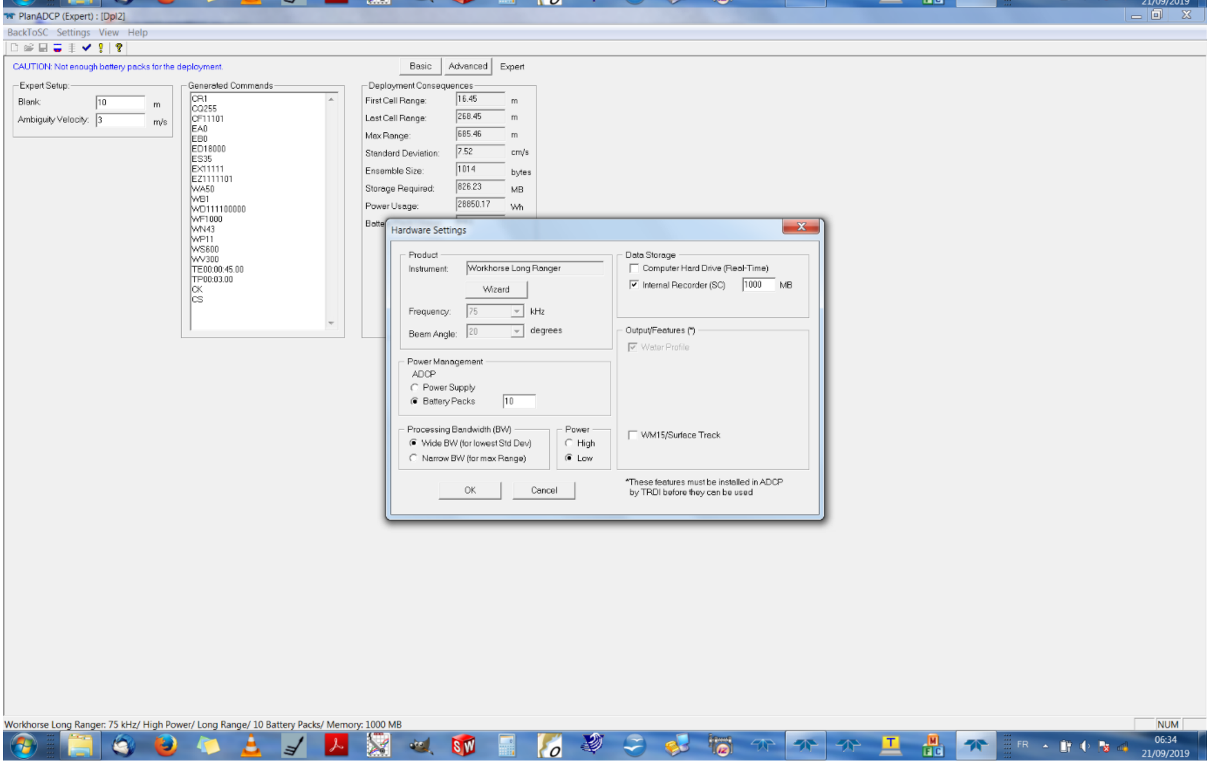
The low power setting was chosen for both Aniitra moorings to conserve battery power and enable a higher ping rate during the deployment. 6 m bins were chosen to maintain a usable signal-to-noise ratio for the full profile range to the bed, confirmed by PlanADCP and by modelling of the 75 kHz data acquired by Chevron in 2010. The signal is expected to be relatively weak near the seafloor in between the flows, but sufficient to resolve velocities. The accuracy of the velocities, i.e. low standard deviation, will be improved by the higher ping rate. Previous work in the Var canyon, and previous Congo Canyon data, suggests that this data may contain significant backscatter from microturbulence during the flows. However, the greater range of the 75 kHz instruments will provide full imaging of thicker flows, which are likely to extend above the 65 m deployment height of the 300 kHz ADCPs in the Angolan section of the canyon (Cooper et al., 2013, 2016; Azpiroz Zabala et al., 2017).

A low standard deviation of 3 cm/s is predicted by PlanADCP for the deployment choice of 11 pings averaged in ensemble profiles 45 s apart.

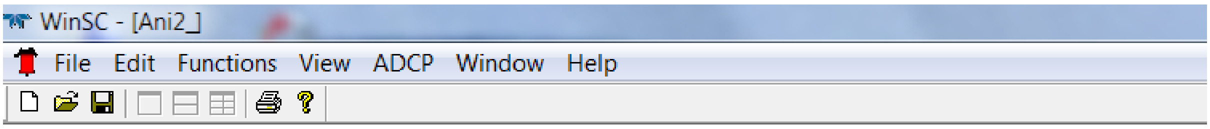
Aniitra 2 and Aniitra 3 Advanced, Expert, Hardware Settings:







Aniitra 2 setup:



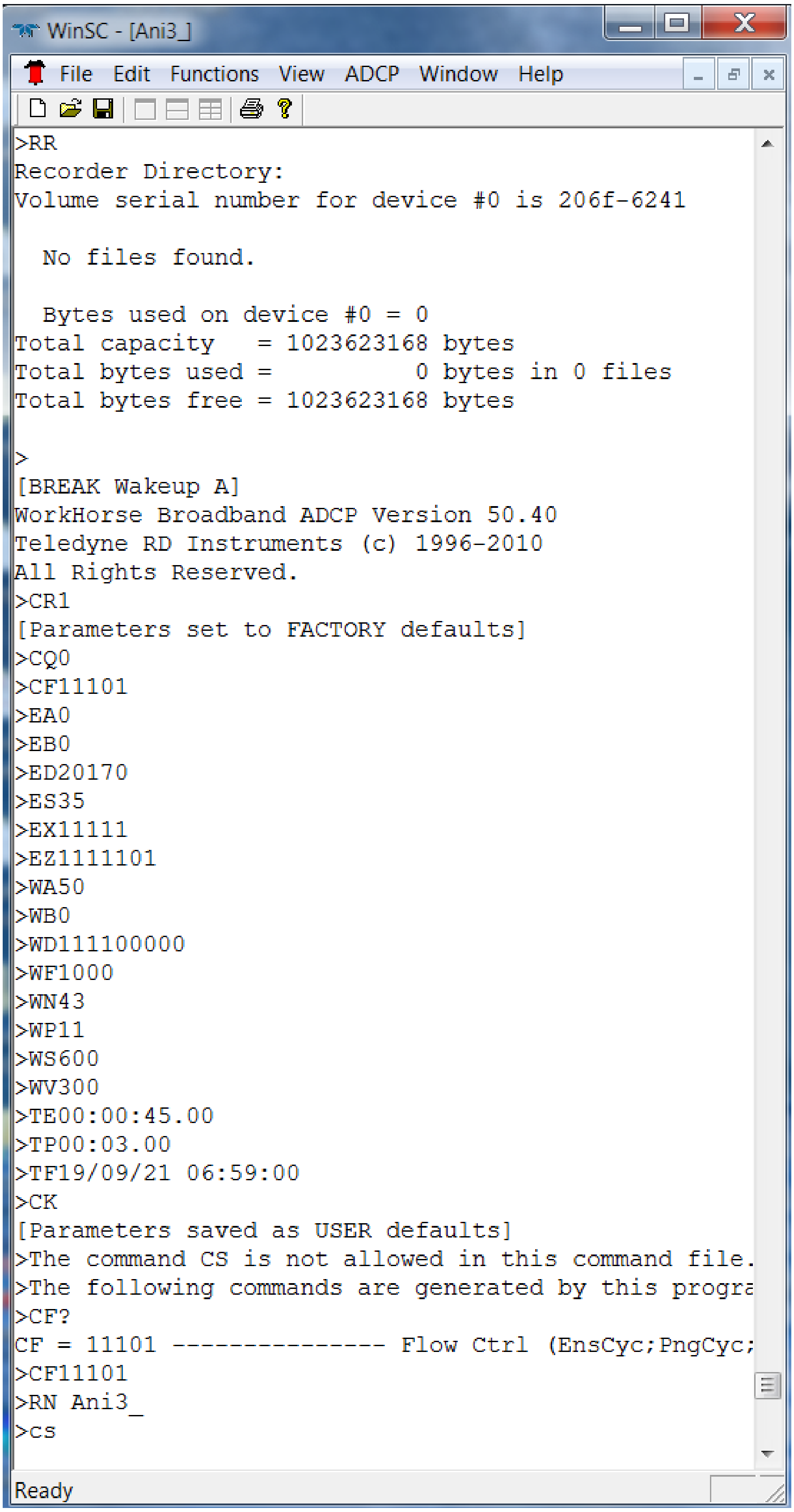

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 50.40
Teledyne RD Instruments (c) 1996-2010
All Rights Reserved.
>RR
Recorder Directory:
Volume serial number for device #0 is 206f-6241

  No files found.

  Bytes used on device #0 = 0
Total capacity   = 1023623168 bytes
Total bytes used =          0 bytes in 0 files
Total bytes free = 1023623168 bytes

>
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 50.40
Teledyne RD Instruments (c) 1996-2010
All Rights Reserved.
>CR1
[Parameters set to FACTORY defaults]
>CQ0
>CF11101
>EA0
>EB0
>ED19000
>ES35
>EX11111
>EZ1111101
>WA50
>WB0
>WD111100000
>WF1000
>WN43
>WP11
>WS600
>WV300
>TE00:00:45.00
>TP00:03.00
>TF19/09/19 05:30:00
>CK
[Parameters saved as USER defaults]
>The command CS is not allowed in this command file.  It has been ignored.
>The following commands are generated by this program:
>CF?
CF = 11101 --------------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
>CF11101
>RN Ani2_
>cs
```

Aniitra 3 setup:


WinSC - [Ani3_]
File Edit Functions View ADCP Window Help
>RR
Recorder Directory:
Volume serial number for device #0 is 206f-6241
No files found.
Bytes used on device #0 = 0
Total capacity = 1023623168 bytes
Total bytes used = 0 bytes in 0 files
Total bytes free = 1023623168 bytes
>
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 50.40
Teledyne RD Instruments (c) 1996-2010
All Rights Reserved.
>CR1
[Parameters set to FACTORY defaults]
>CQ0
>CF11101
>EA0
>EB0
>ED20170
>ES35
>EX11111
>EZ1111101
>WA50
>WB0
>WD111100000
>WF1000
>WN43
>WP11
>WS600
>WV300
>TE00:00:45.00
>TP00:03.00
>TF19/09/21 06:59:00
>CK
[Parameters saved as USER defaults]
>The command CS is not allowed in this command file.
>The following commands are generated by this progra
>CF?
CF = 11101 --------------- Flow Ctrl (EnsCyc;PngCyc;
>CF11101
>RN Ani3_
>cs
Ready

8.1.3.2 Acoustic release

The Aniitra moorings have single acoustic releases at 18 m above the bed.

8.1.3.3 Sediment traps

The Aniitra mooring has a much larger sediment trap than that used on the NERC moorings, as well as a much lighter anchor (500 kg) weight than the NERC moorings (1,350 kg). It remains to be seen if drag due to this larger trap favours down canyon movement or tilt. The sediment trap is provided by Technicap (Fig. 8.24). It contains 24 x 500 ml sample bottles. A programmable motor ensures the rotation of the 24 bottle tray. The deployment period is divided into 24 equal periods and the start date is programmed. The start date of Aniitra 2 was set for the 01/11/19 and each bottle set to collect sediment for one week. Anitra 3 was set to start 17/04/20, corresponding to the date that the Aniitra 2 sediment trap had finished collecting sediment. Each bottle in Aniitra 3 was also set to collect sediment for one week. The total sediment trap collection time equals 48 weeks.

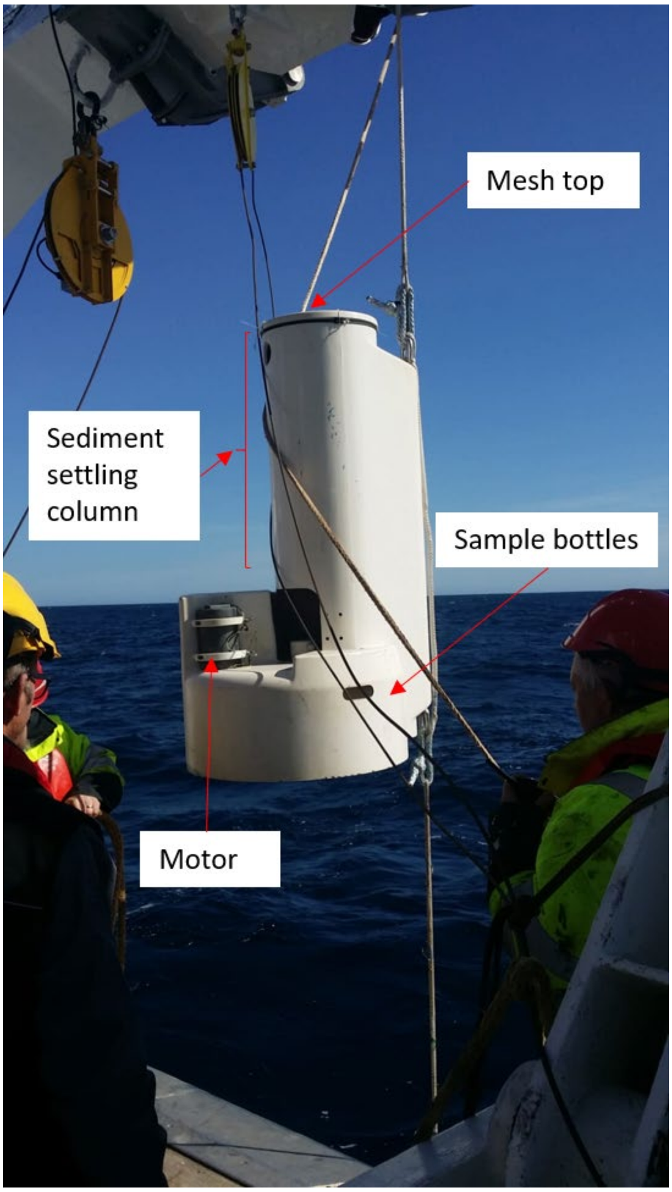


Figure 8.22. *Photograph of the sediment trap on the Aniitra mooring during deployment.*

8.1.3.4 Set-up of each mooring

The two Ifremer moorings, Aniitra 2 and Aniitra 3, consist of an anchor, a single releaser, a sediment trap at 40m above seabed, and a frame that holds a 75 kHz ADCP (Fig. 8.23). The anchor is composed of 500 kg of chain and the releaser is an Ixblue Oceano 2500 LIGHT TITANIUM AR861 CT. In addition to the ADCP, the Aniitra aluminium frame (Fig. 8.24) contains the external battery pack for the ADCP, a flashlight, a VHF radio and an ARGOS beacon. When in the water, the frame orientates itself with the current and the ADCP is mounted on a gimbal to keep it as vertical as possible. The mooring line consist of a 10 mm diameter Dyneema® (Ultra-High Molecular Weight Polyethylene) rope. This rope is reusable and can be adjusted on board; this is very useful if the mooring design changes just before deployment. The rope has a neutral weight in water and the breaking load is ~10 Ton. We now also use Dyneema® shackle that has a neutral weight, the buoyancy is therefore only required for the weight of the instruments. The position of the acoustic release is 15 m above the anchor, meaning that only a limited part of the mooring is left on the seabed.

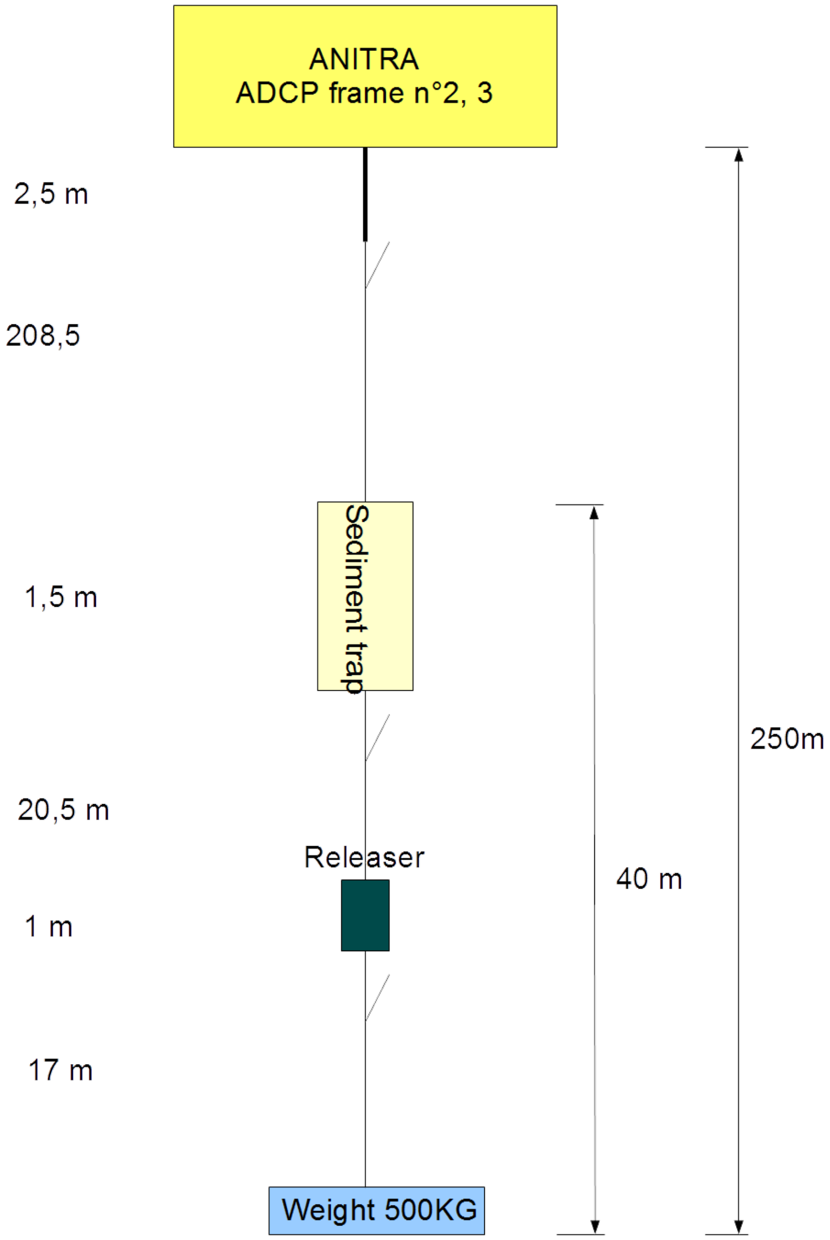


Figure 8.23. *Technical drawing of the Aniitra mooring design.*

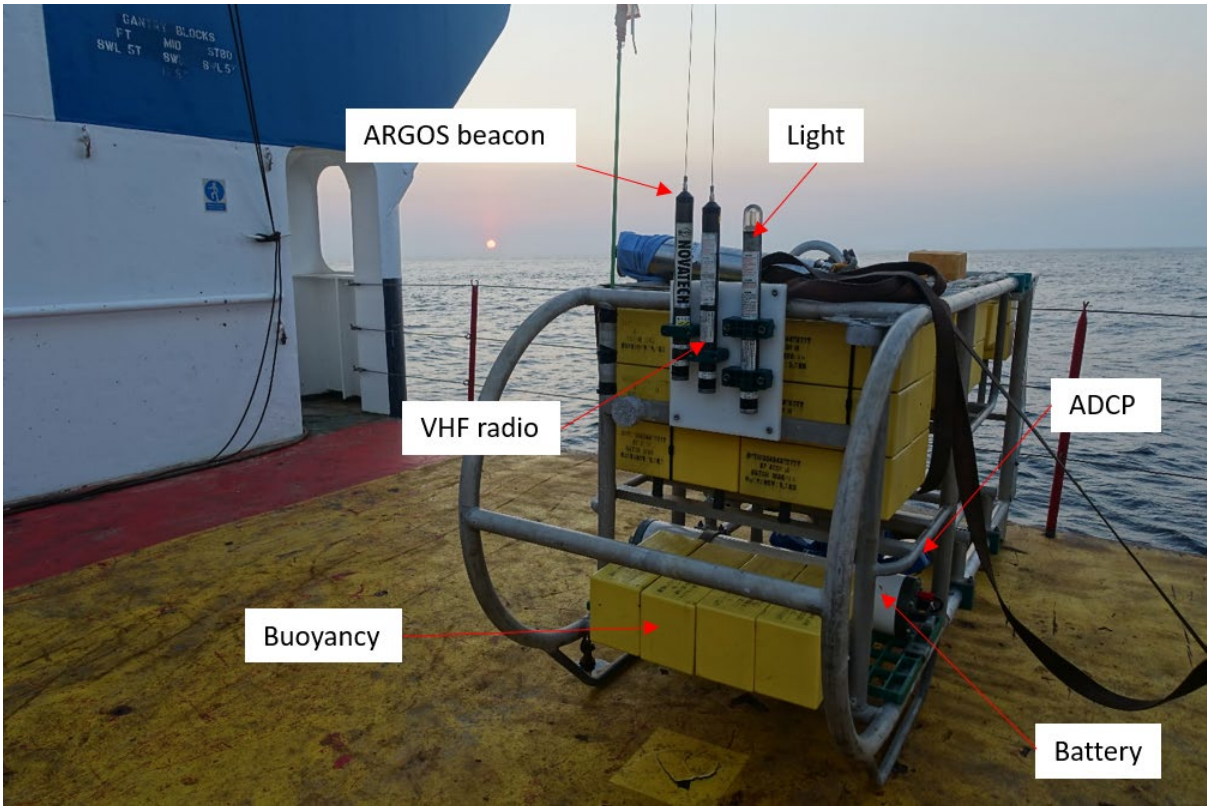


Figure 8.24. *Main upper part of the Aniitra mooring comprising ADCP, battery, buoyancy etc.*

8.1.3.5 Deployment

Due to the mounting of the ADCP and the shape of Aniitra, it is unsuitable to deploy the mooring using the anchor last method that was used for the NERC mooring deployment. Instead the anchor is lowered down on the winch and released approximately 30 meters above the seabed. For this deployment two winches are needed. See section 8.1.1. for a discussion of the advantages and disadvantages of anchor-first and anchor-last methods.

The three parts of the mooring line are connected together, and wound on the blue winch (winch 1) on the back deck. First, the anchor is deployed with the blue winch on the back deck. At the end of the first part of the mooring line, there is a special bridle that is connected to winch 2 to support the weight. When the main line is free, it can be connected under the first instrument (in this case the acoustic release). Winch 1 is now able to support the weight, and we proceed like this for the sediment trap. Once the mooring is fully constructed, it is lowered to the seafloor at a speed of 0.5 m/s. The winch is stopped when the USBL is 330 m above the seabed, and the mooring is then released.

8.1.4 Triangulation

It is important to know as accurately as possible where moorings are finally located on the canyon floor. Thus, NERC mooring positions were triangulated, by ranging from the ship to their acoustic releases. The position of the Aniitra moorings was taken as that of the USBL when released, although the Aniitra 2 mooring was also triangulated on its acoustic release from the vessel.

The usual triangulation method used on the RRS James Cook is three-point triangulation that takes three ranges to the acoustic release at equal distances from the moorings in different directions, together with a vertical depth range of the acoustic release beneath the ship. This method was initially used on the first mooring deployment, NERC M8, using the matlab graphical user interface script, triangulate_v6, supplied by Paul Provost. Although this method appeared to work well on the first mooring, the script failed to provide a solution for mooring NERC M7. This was due to the ship not taking up positions that were at equal angular spacing around the circle described by the horizontal range from the mooring to the ship. The circles failed to overlap and a second method based on the three range trigonometric solution ("triangulo") was developed that calculated a solution based on the three ranges and positions of the ship. This method was additionally applied to the first three mooring locations: NERC M8, NERC M7, and the experimental hydrophone array.

All subsequent triangulations used four ranging positions at angular separations of 90 degrees around the circle described by an equal horizontal range to the mooring. To solve for four positions a matlab script was developed and adapted for each mooring location. This script triangulates four positions and calculates the mooring position as the centroid of the overlap of the four circles. The script additionally solves the direct trigonometric solution for all four combinations of three positions and ranges. The solution is determined as the arithmetic mean of the latitude and longitude of the four solutions. The filename of the matlab scripts used for each mooring are shown below:

Matlab scripts used for triangulation of mooring positions

Mooring/method	**Paul's script**	**3 point trigonometric solution**	**4 point triangulation (circles) plus 4 x 3 point trigonometric solution**
M1			Triangulo_M1_four_ranges
M2			Triangulo_M2_four_ranges
M3			Triangulo_M3_four_ranges
M4			Triangulo_M4_four_ranges
M5			Triangulo_M5_four_ranges
M6			Triangulo_M6_four_ranges
M7		Triangulo_M7	
M8	triangulation_v6	Triangulo_M8	
M8 Redeployment			Triangulo_M8_redeployment_four_ranges
M9			Triangulo_M9_four_ranges
Hydrophone array			Triangulo_hydrophonearray_four_ranges
Hydrophone array experiment	triangulation_v6	Triangulo_hydrophonearray_experiment	
Anitra 2			Triangulo_anitra2_four_ranges

Below are descriptions of the mooring triangulations in chronological order. For each mooring there is a table describing target and release positions, together with ship positions and ranges used in the triangulation. All NERC moorings positions were triangulated in addition to both deployments of the hydrophone array. The Aniitra 2 mooring position was also triangulated to provide a comparison with the USBL position given by the USBL beacon mounted on the mooring as it was lowered to the seafloor on the winch.

NERC Mooring M8: Deployed on 10th September 2019

Mooring M8	**Latitude**	**Longitude**	**Range (m)**	**Vertical range to release (m)**
Target	-6 41.7815	5 28.967		4851
Release	-6 41.7818	5 28.9274		
Range point 1	-6 41.7347	5 26.8686	6177	
Range point 2	-6 40.0805	5 30.05	6074	
Range point 3	-6 43.4381	5 30.118	6130	
Range point 4				
Triangulated Position (triangulation_v6)	-6 41.7523	5 28.959		
Triangulated Position (3 point solution)	-6 41.752	5 28.963		
Triangulated Position (4 point circles)				
Triangulated Position (4 x 3 point solutions)				

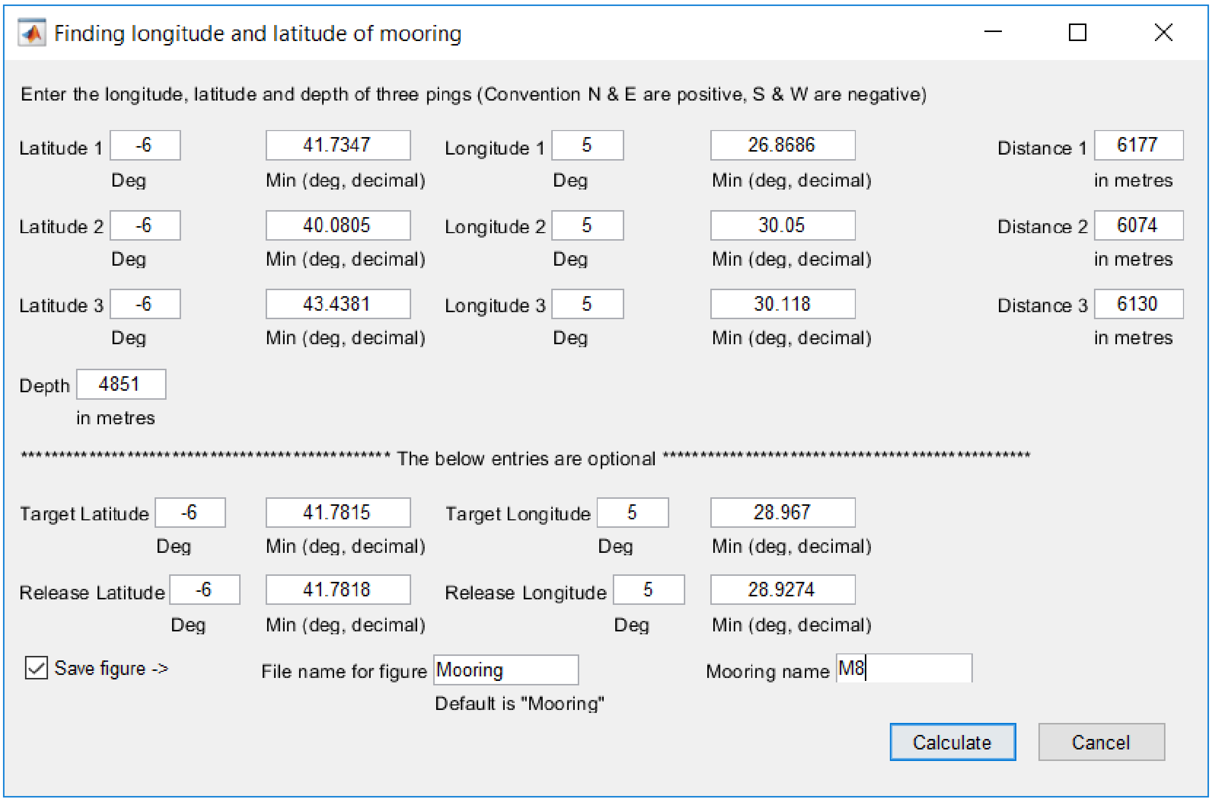


Fig 8.25. *Triangulation_v6.m graphical user interface script showing target position, release position, ranging positions, ranges and depth used in the triangulation of NERC Mooring M8.*

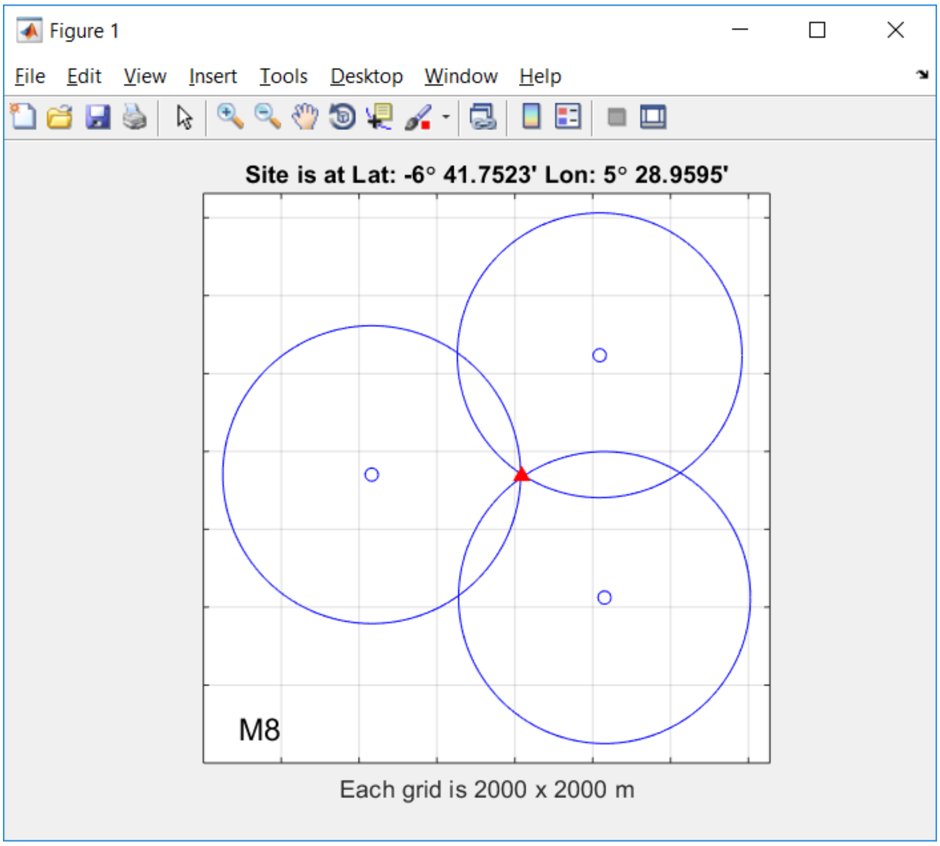


Figure 8.26. *Triangulation_v6.m output showing target position, three ranging positions (blue circles), range circles (blue lines) for the triangulation of NERC Mooring M8.*

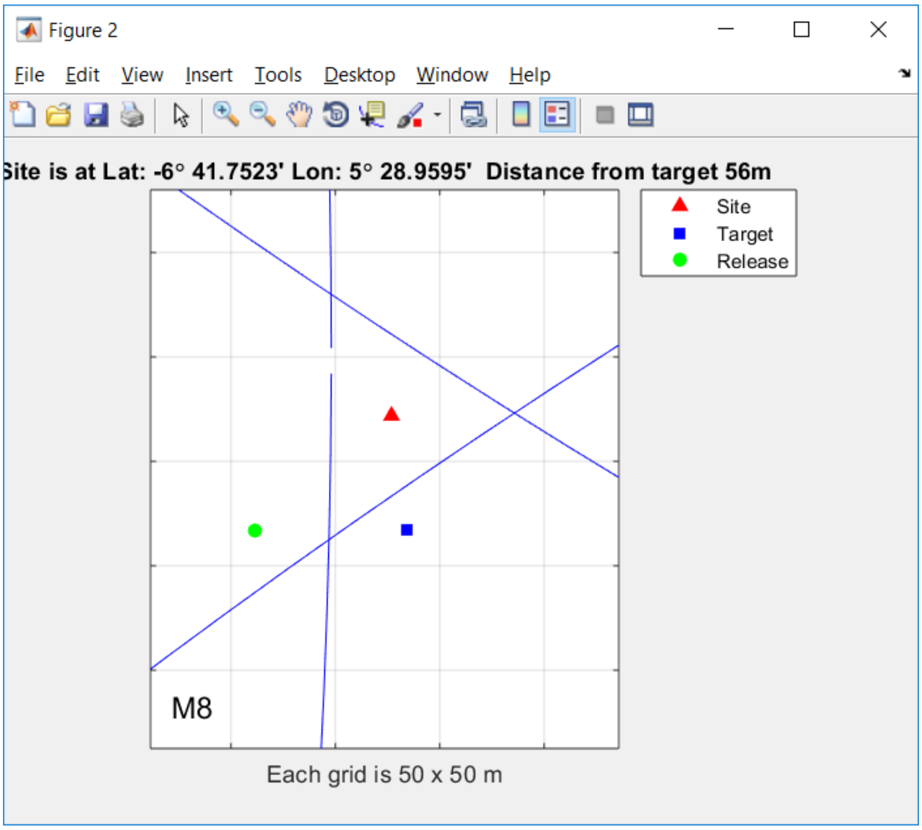


Figure 8.27. *Triangulation_v6.m output showing target position, release position and triangulated position of NERC Mooring M8.*

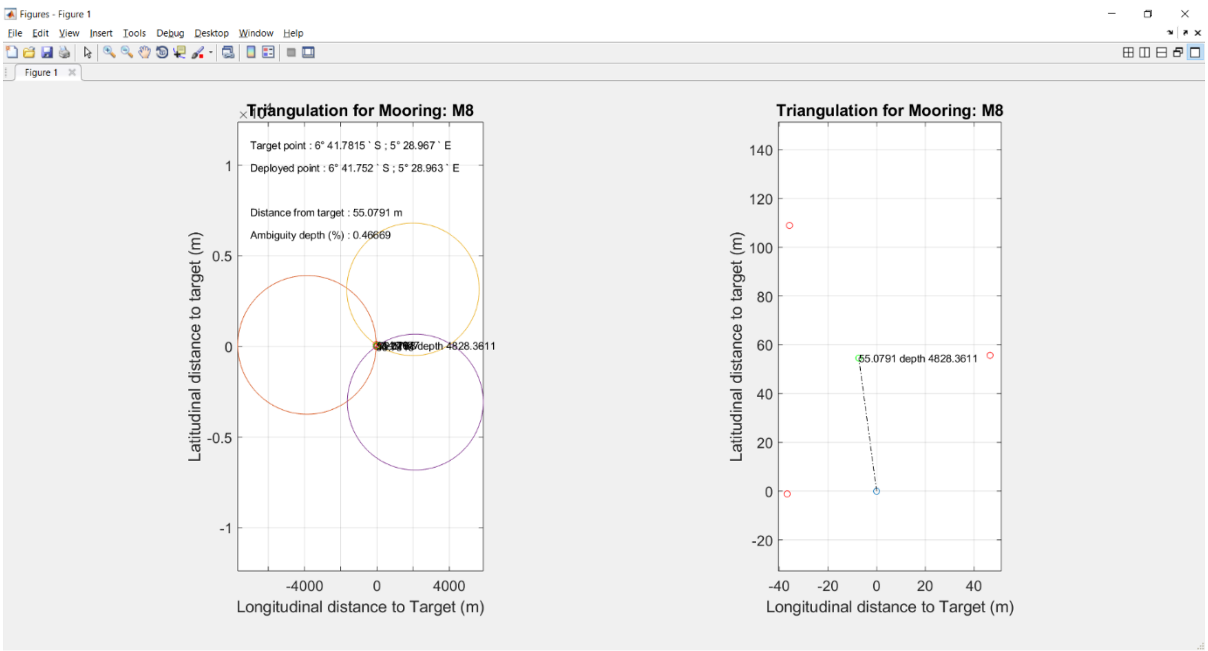


Figure 8.28. *Triangulo_M8.m output showing target position and triangulated position (left plot) and the distance from the target and the depth of the release determined by the direct trigonometric solution (right plot) for NERC Mooring M8.*

NERC Mooring M7: Deployed on 11th September

Tried these settings but it didn't work as circles didn't overlap, so used direct 3D solution method

Mooring M7	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-6 27.8623	6 2.8346		4778
Release	-6 27.852	6 2.77		
Range point 1	-6 27.8666	6 0.86226	5920	
Range point 2	-6 26.1015	6 3.3383	5818	
Range point 3	-6 28.0359	6 4.811	6026	
Range point 4				
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	**Didn't work as circles didn't overlap**			
Triangulated Position (4 x 3 point solutions)	-6 27.8458	6 2.7939		

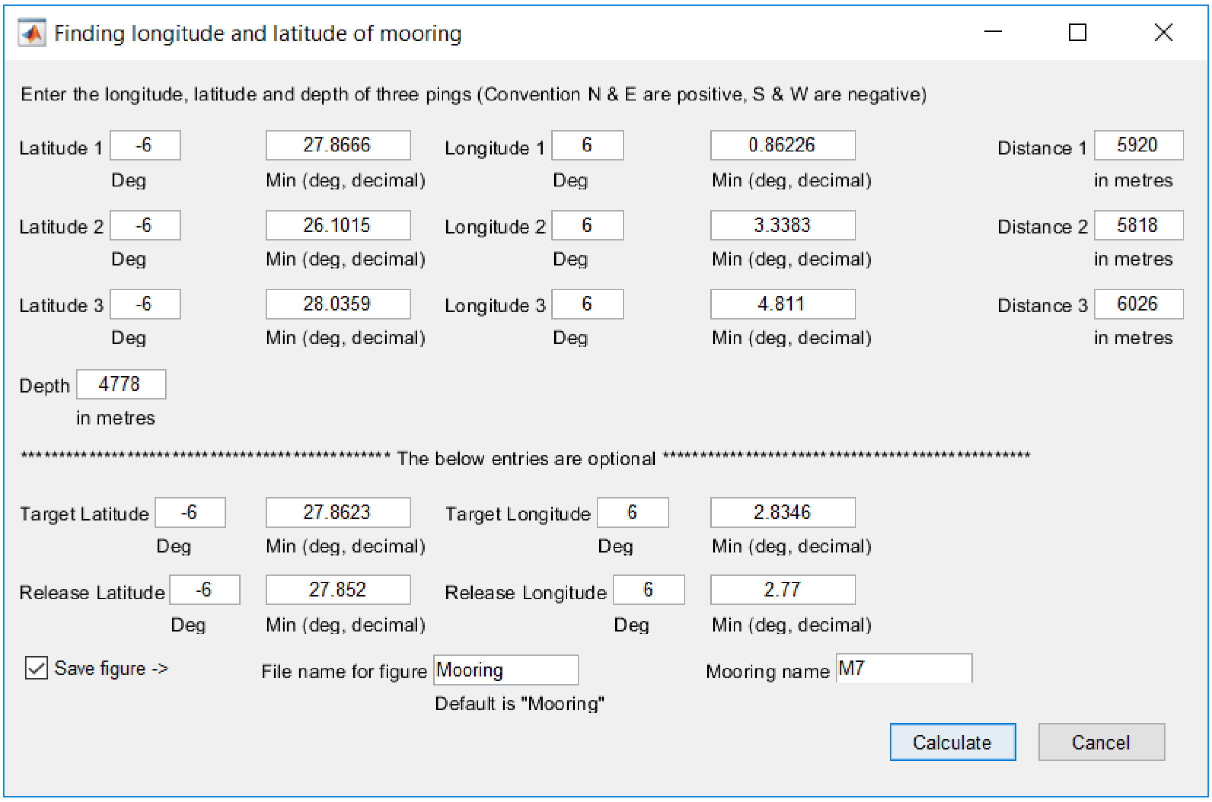


Fig 8.29. *Triangulation_v6.m graphical user interface script showing target position, release position, ranging positions, ranges and depth used in the triangulation of NERC Mooring M7.*

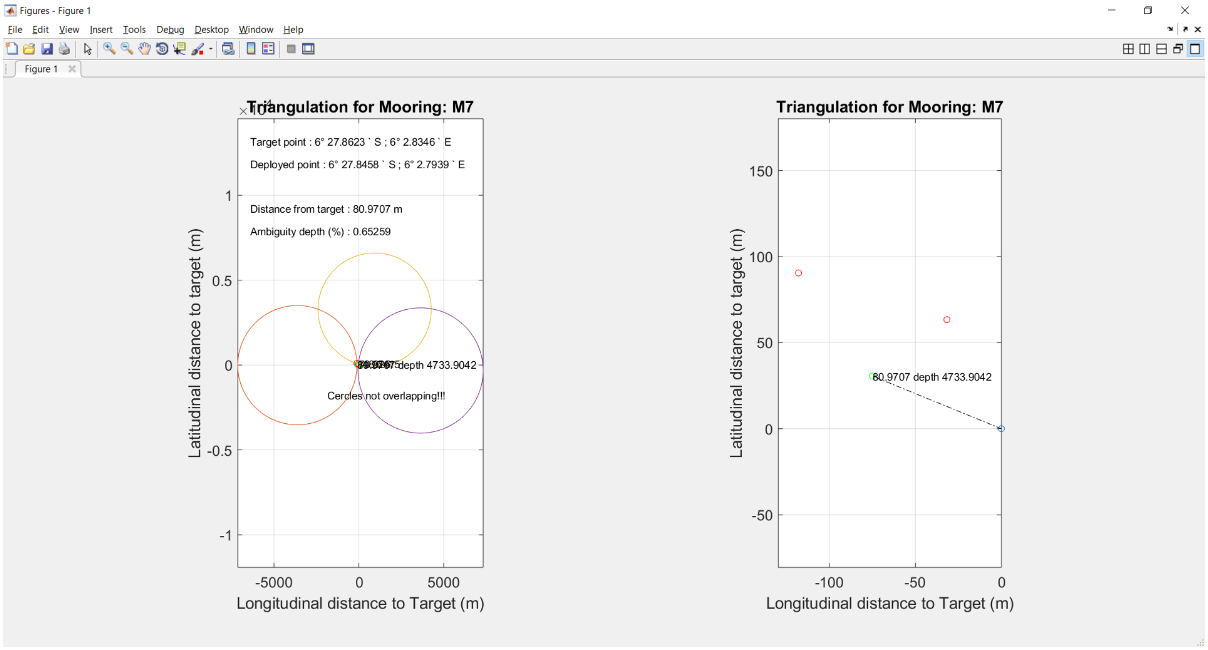


Figure 8.30. *Triangulo_M7.m output showing target position and triangulated position (left plot) and the distance from the target and the depth of the release determined by the direct trigonometric solution (right plot) for NERC Mooring M7.*

Hydrophone array experiment: Deployed 17th September:

Mooring Hydrophone array experiment	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 49.227	11 6.105		1279
Release	-5 49.2523	11 6.1595		
Range point 1	-5 49.735	11 6.91	2192	
Range point 2	-5 48.41	11 5.73	2099	
Range point 3	-5 49.67	11 5.2	2224.7	
Range point 4				
Triangulated Position (triangulation_v6)	-5 49.2315	11 6.0869		
Triangulated Position (3 point solution)	-5 49.2356	11 6.0854		
Triangulated Position (4 point circles)				
Triangulated Position (4 x 3 point solutions)				

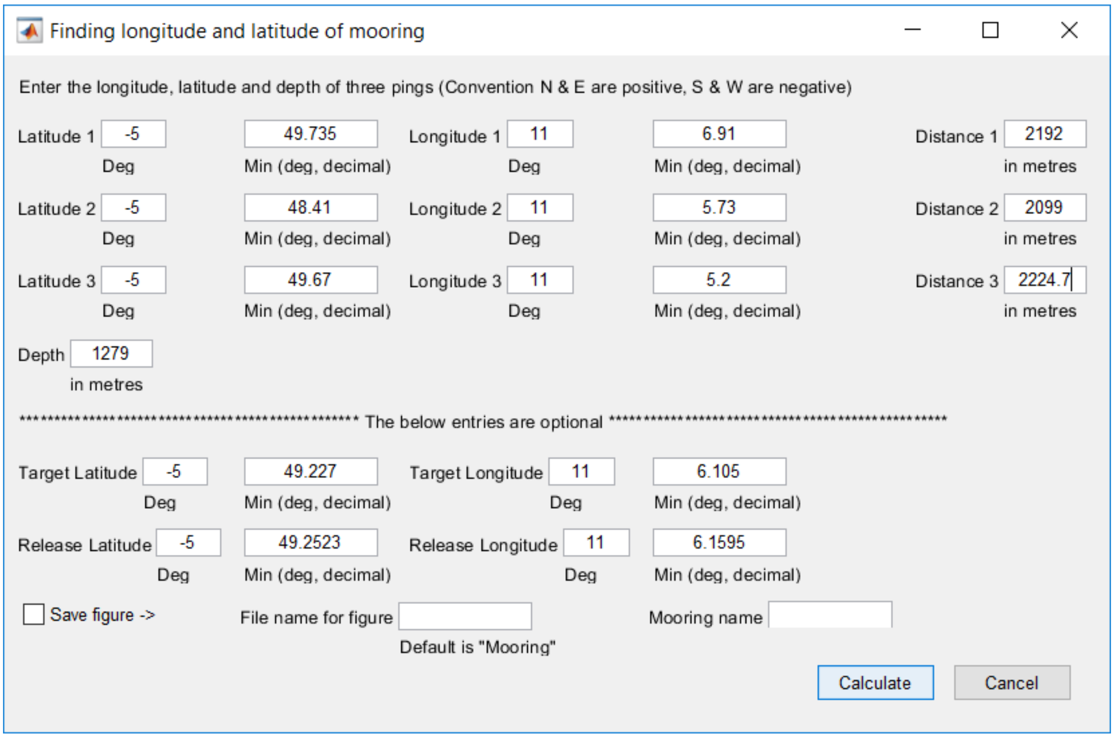


***Figure 8.31**. Triangulation_v6.m graphical user interface script showing target position, release position, ranging positions, ranges and depth used in the triangulation of the hydrophone array experiment.*

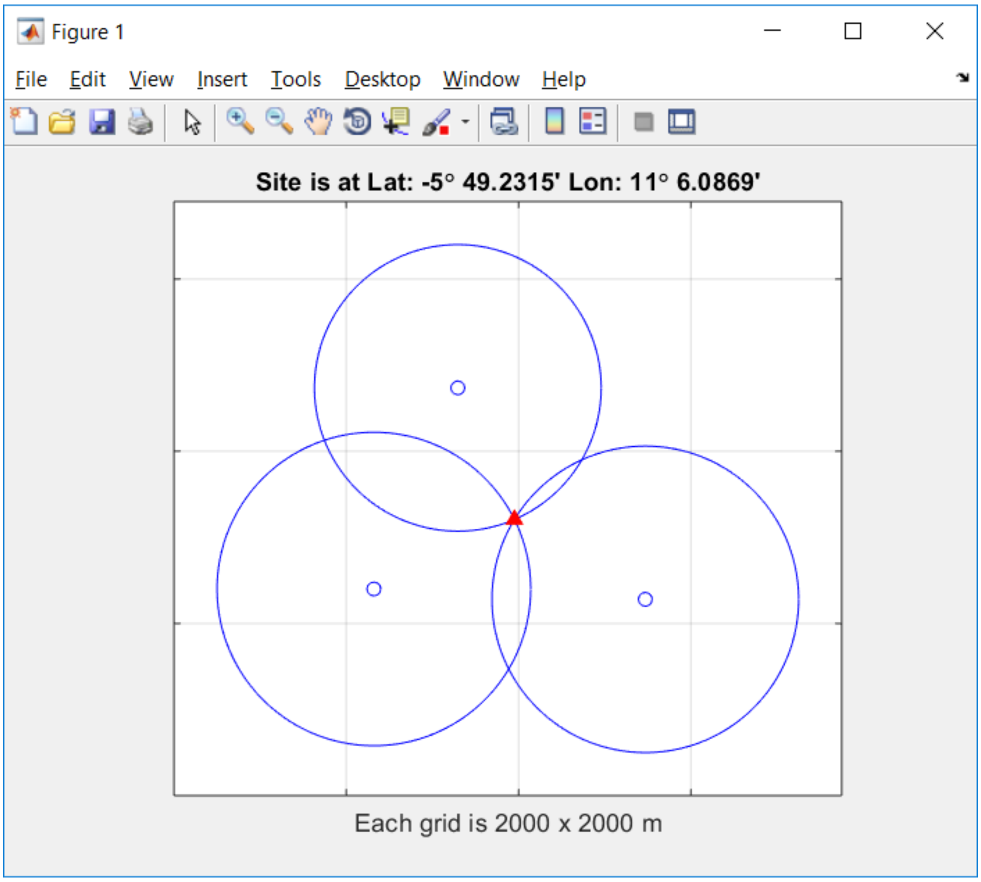


***Figure 8.32.** Triangulation_v6.m output showing target position, three ranging positions (blue circles), range circles (blue lines) for the triangulation of the hydrophone array experiment mooring.*

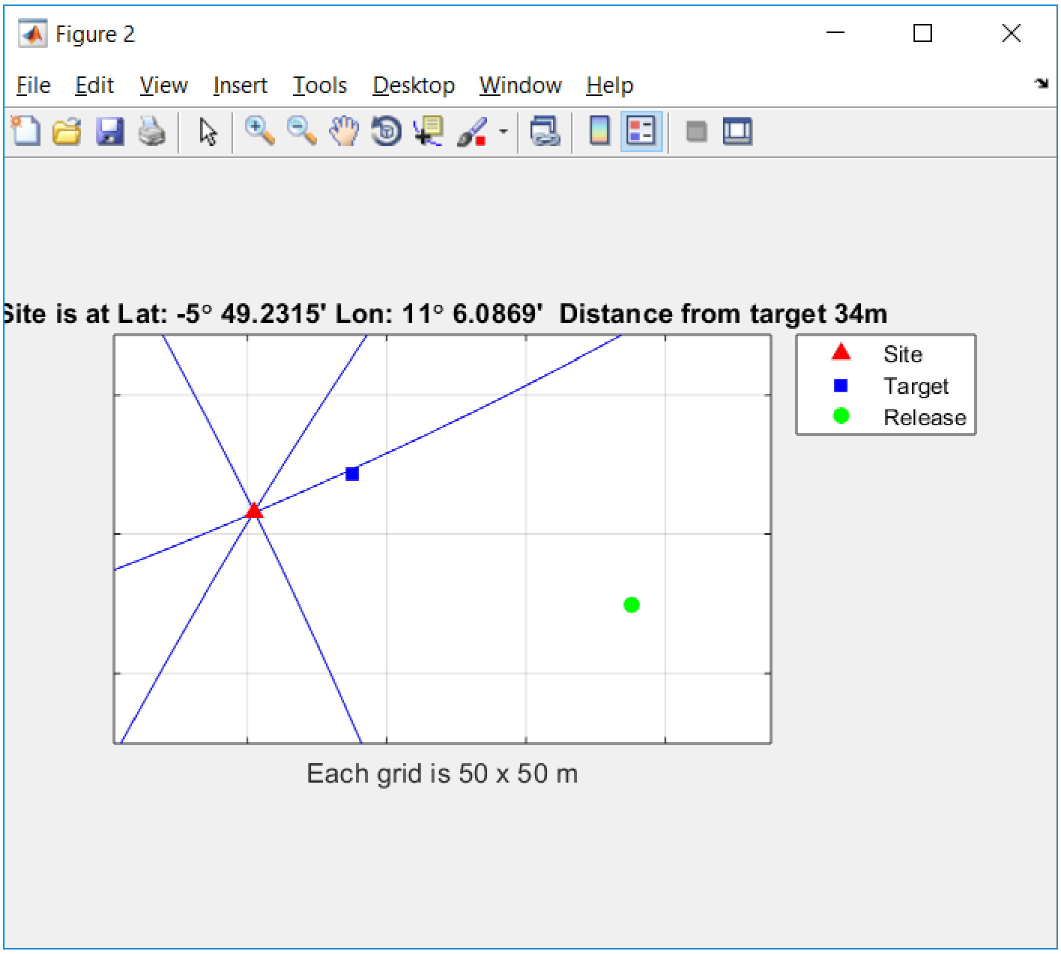


Figure 8.33. *Triangulation_v6.m output showing target position, release position and triangulated position of the hydrophone array experiment mooring.*

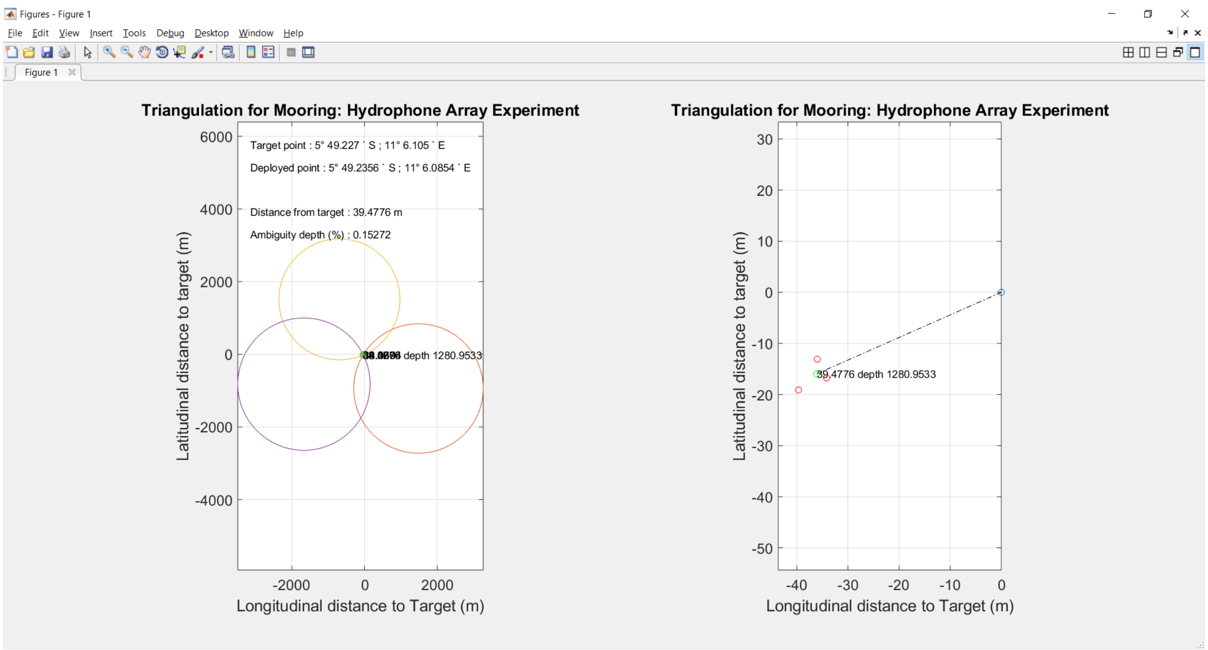


Figure 8.34. *Triangulo_M7.m output showing target position and triangulated position (left plot) and the distance from the target and the depth of the release determined by the direct trigonometric solution (right plot) for the hydrophone experiment mooring.*

IFREMER Aniitra 2: Deployed September 19th:

Mooring Aniitra 2	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 54.0029	11 19.76589		1854
Release	-5 53.9974	11 19.75744		
Range point 1	-5 53.3777	11 20.4253	2500	
Range point 2	-5 54.6635	11 20.2819	2416	
Range point 3	-5 54.5305	11 18.8634	2678	
Range point 4	-5 53.4156	11 19.1639	2415.5	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 54.0008	11 19.7661		
Triangulated Position (4 x 3 point solutions)	-5 54.0007	11 19.7661		

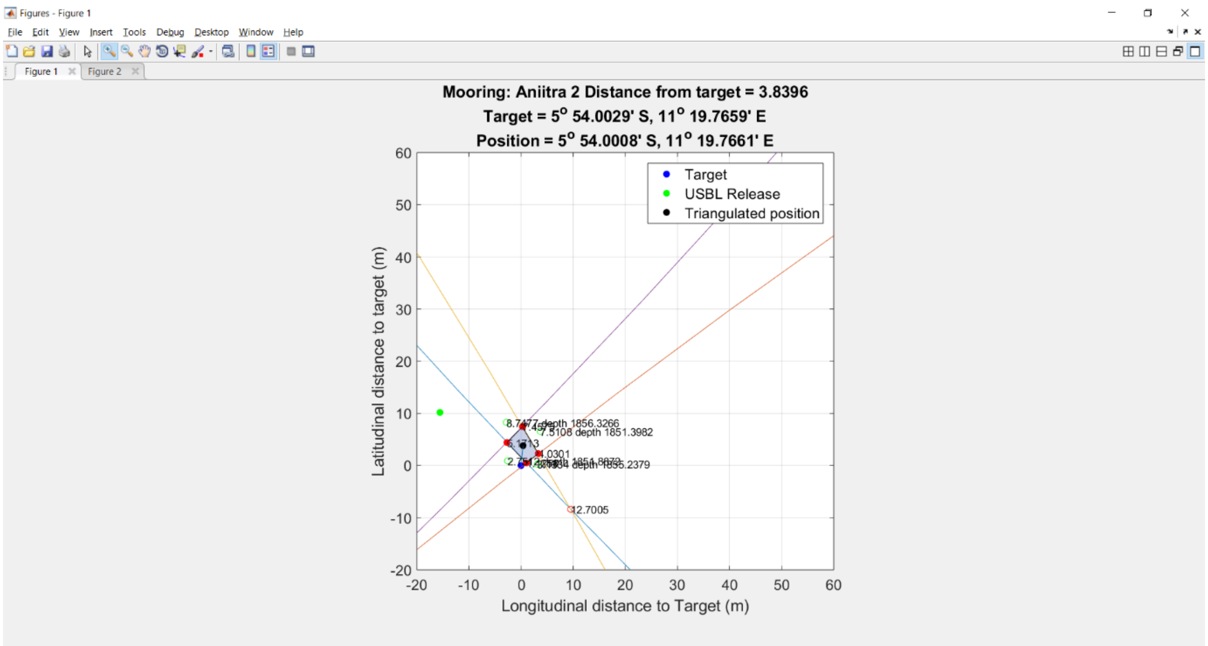


Figure 8.35. *Target, release and triangulated position of the Aniitra 2 mooring determined using the centroid of the intersection (shaded blue) of four range circles.*

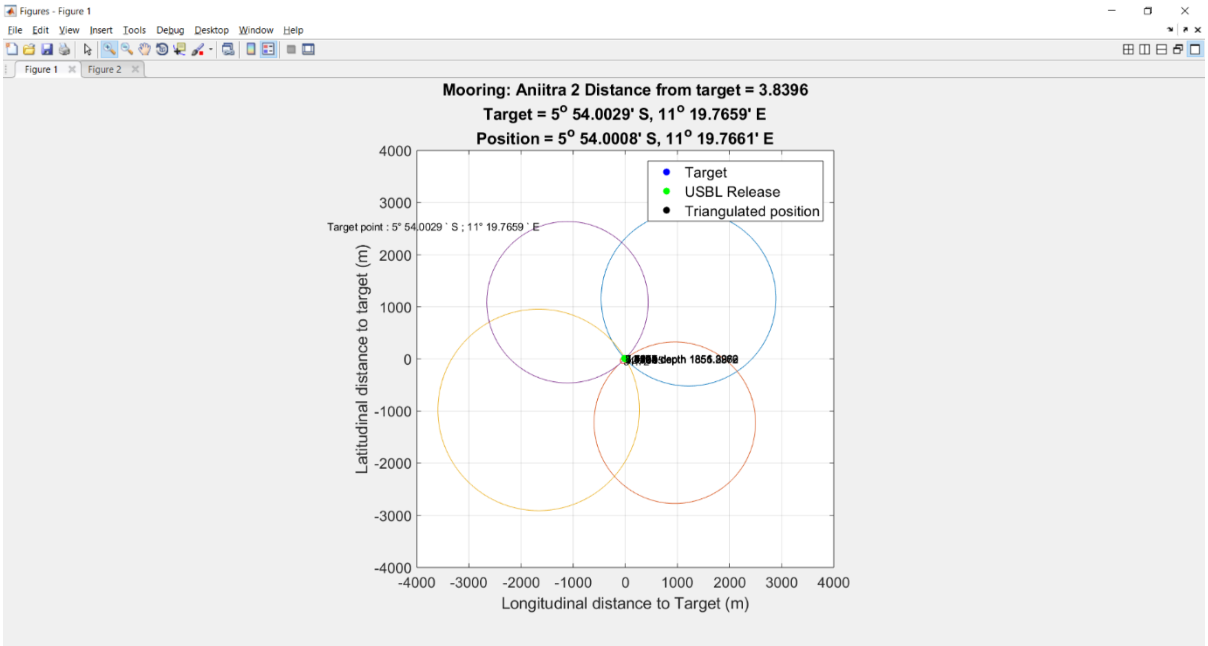


Figure 8.36. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

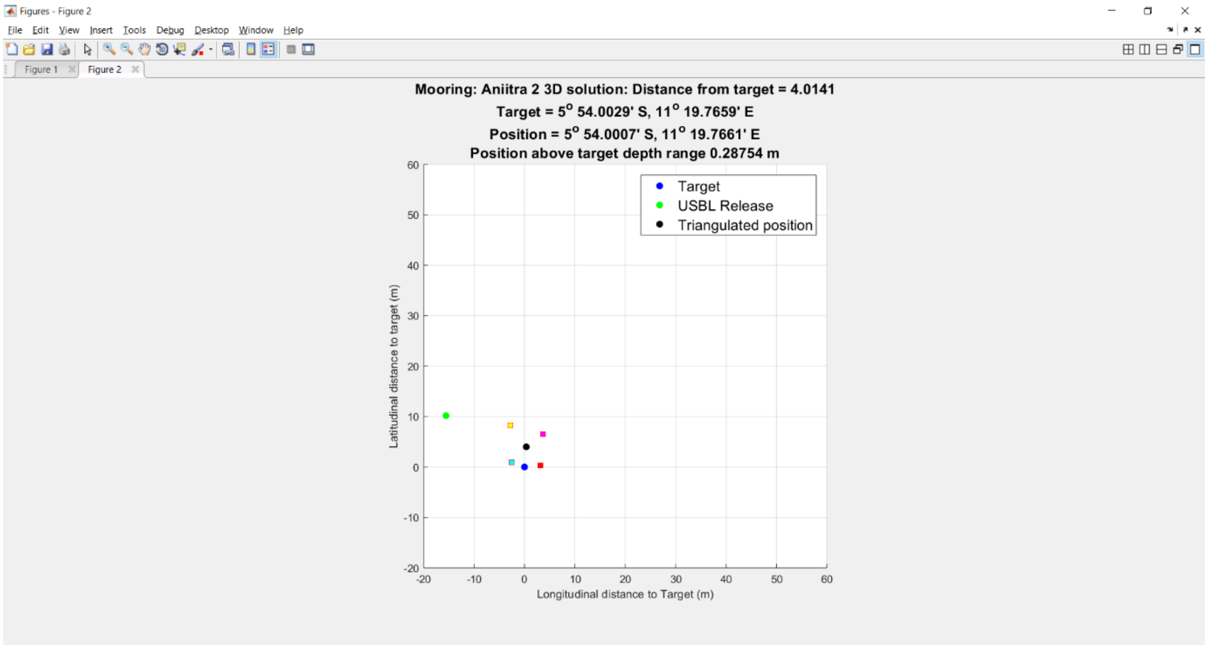


Figure 8.37. *Target, release, triangulated position and distance from target of the Aniitra 2 mooring determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M1: Deployed 19th September:

Mooring M1	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 54.012	11 19.911		1811
Release	-5 54.008	11 19.942		
Range point 1 NE	-5 53.4556	11 20.4815	2345.5	
Range point 2 SE	-5 54.5709	11 20.4674	2323.5	

Range point 3 SW	-5 54.61938	11 19.27698	2420	
Range point 4 NW	-5 -53.48472	11 19.31142	2333.5	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 54.0186	11 19.9042		
Triangulated Position (4 x 3 point solutions)	-5 54.0186	11 19.9042		

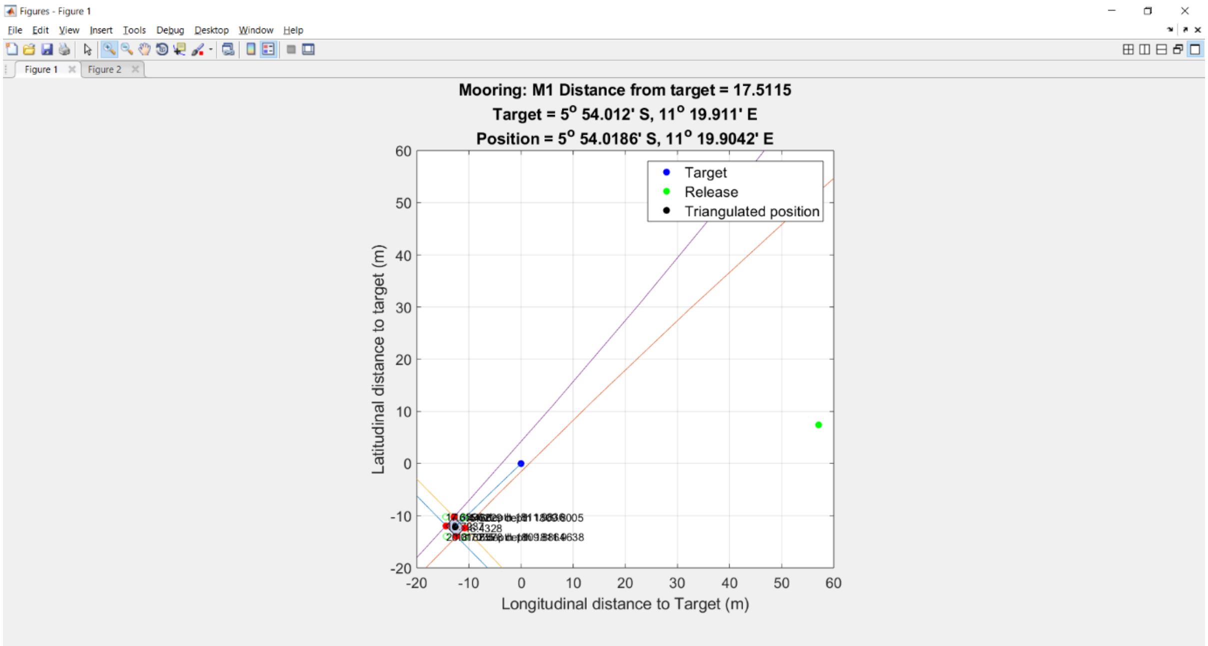


Figure 8.38. *Target, release and triangulated position of NERC Mooring M1 determined using the centroid of the intersection (shaded blue) of four range circles.*

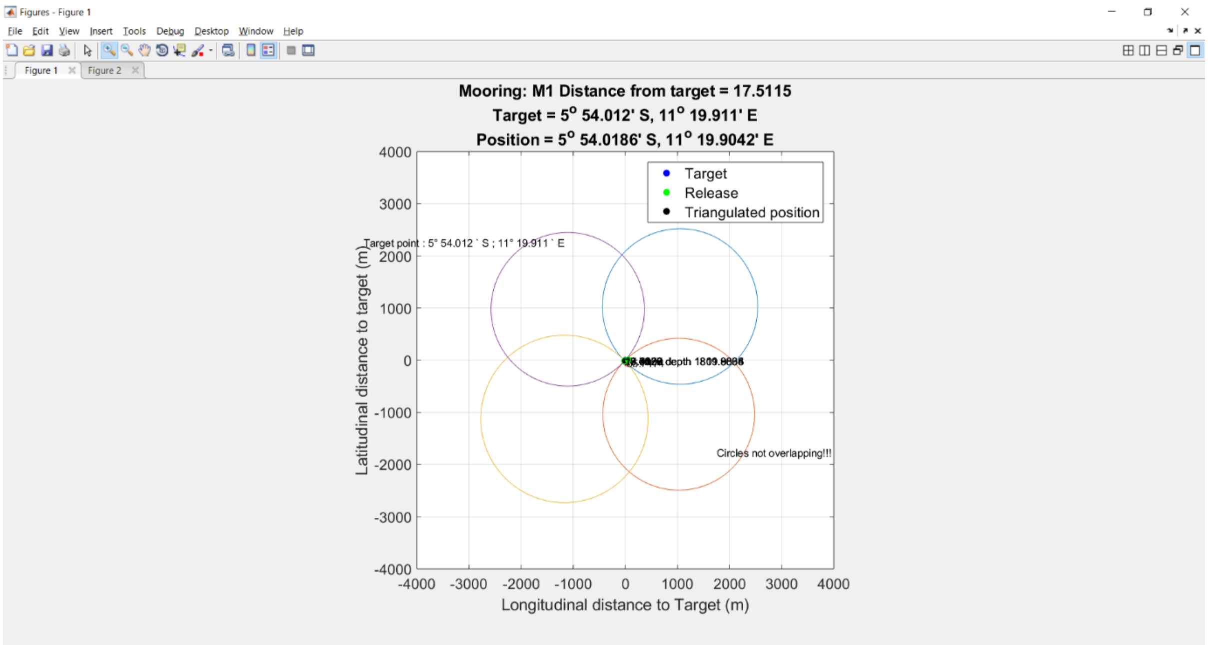


Figure 8.39. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

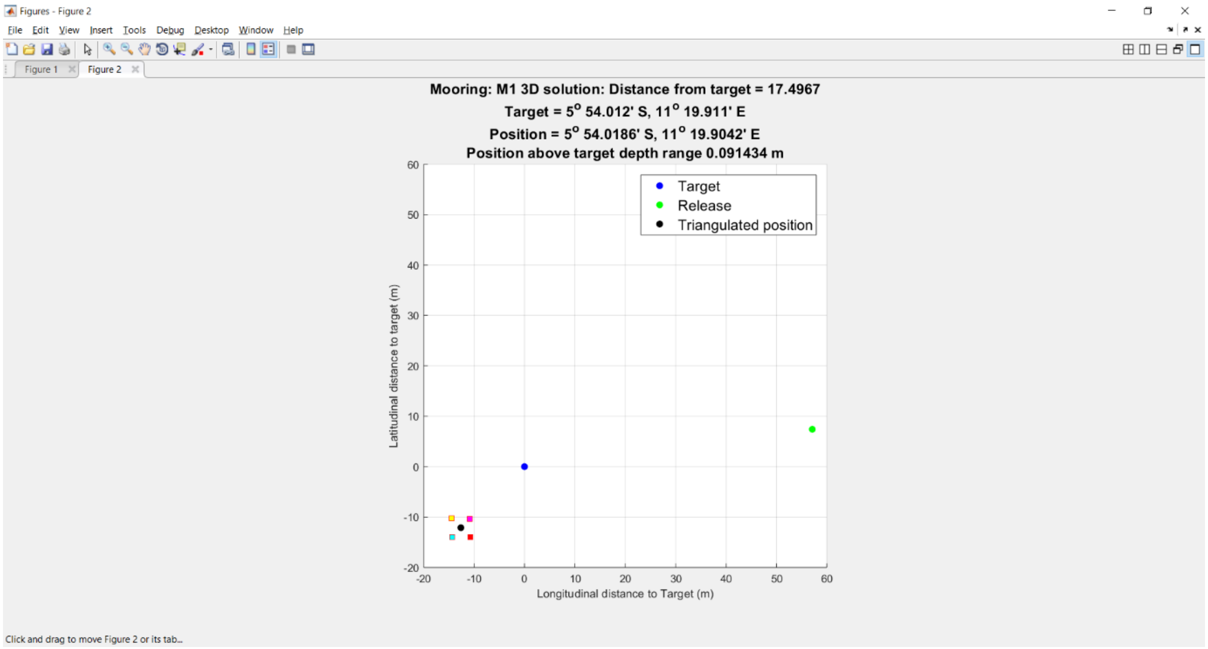


Fig. 8.40. *Target, release, triangulated position and distance from target of the NERC Mooring M1 determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M4: Deployed 20th September

Mooring M4	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 55.455	11 28.413		1577
Release	-5 55.44360	11 28.44336		
Range point 1 NE	-5 54.7855	11 29.0700	2350	
Range point 2 SE	-5 55.9198	11 29.1564	2269.5	
Range point 3 SW	-5 56.06382	11 27.75300	2284.5	
Range point 4 NW	-5 54.6375	11 27.80202	2458	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 55.4548	11 28.4072		
Triangulated Position (4 x 3 point solutions)	-5 55.4549	11 28.4074		

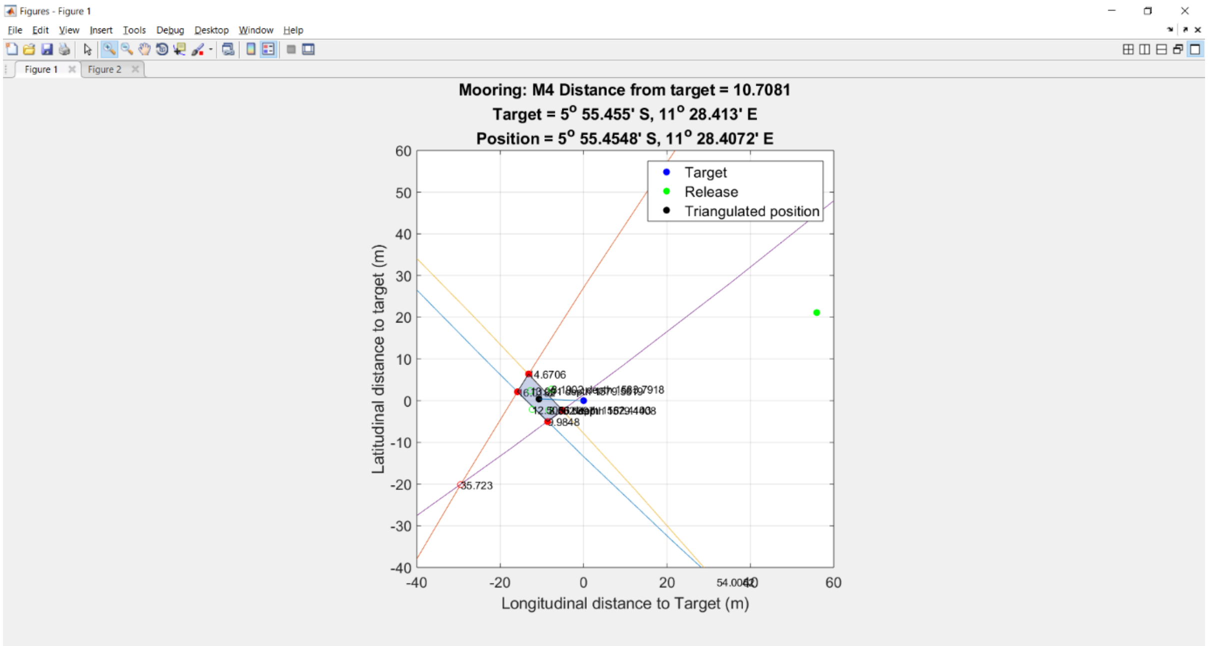


Figure 8.41. *Target, release and triangulated position of NERC Mooring M4 determined using the centroid of the intersection (shaded blue) of four range circles.*

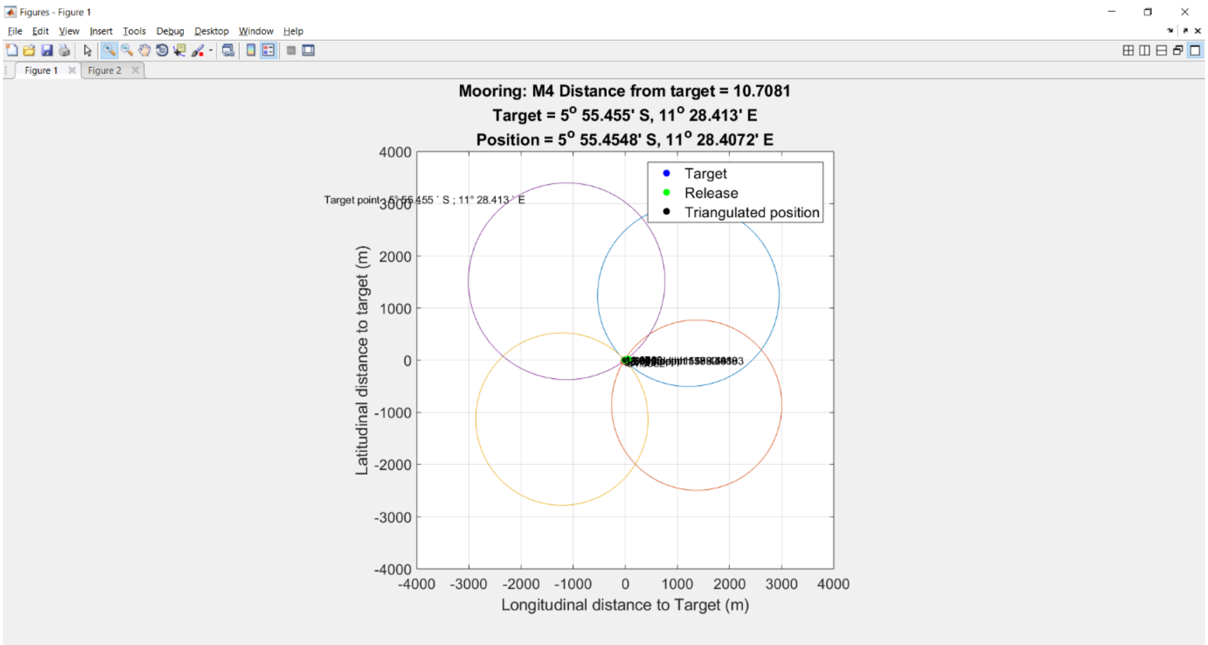


Figure 8.42. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

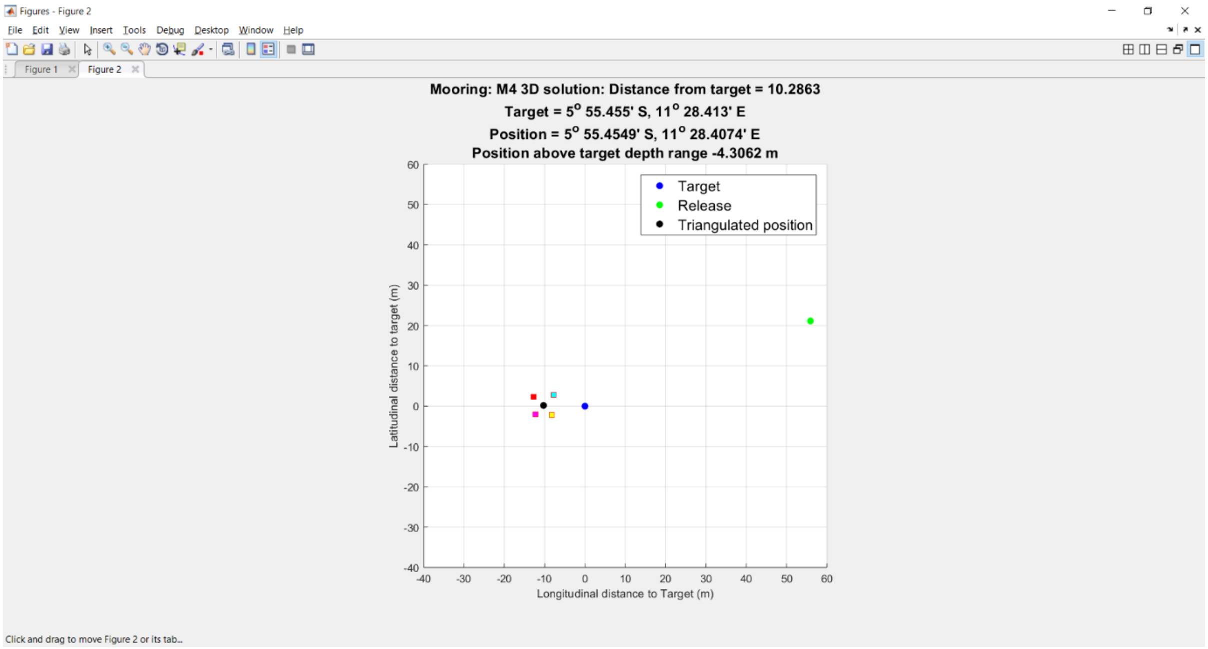


Figure 8.43. *Target, release, triangulated position and distance from target of the NERC Mooring M4 determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M3: Deployed 20th September

Mooring M3	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 57.208	11 33.198		1517
Release	-5 57.22002	11 33.23016		
Range point 1 NE	-5 56.622	11 33.76955	2143	
Range point 2 SE	-5 57.76038	11 33.79194	2127	
Range point 3 SW	-5 57.7878	11 32.64336	2126	
Range point 4 NW	-5 56.65278	11 32.61354	2139	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 57.2118	11 33.204		
Triangulated Position (4 x 3 point solutions)	-5 57.2118	11 33.2041		

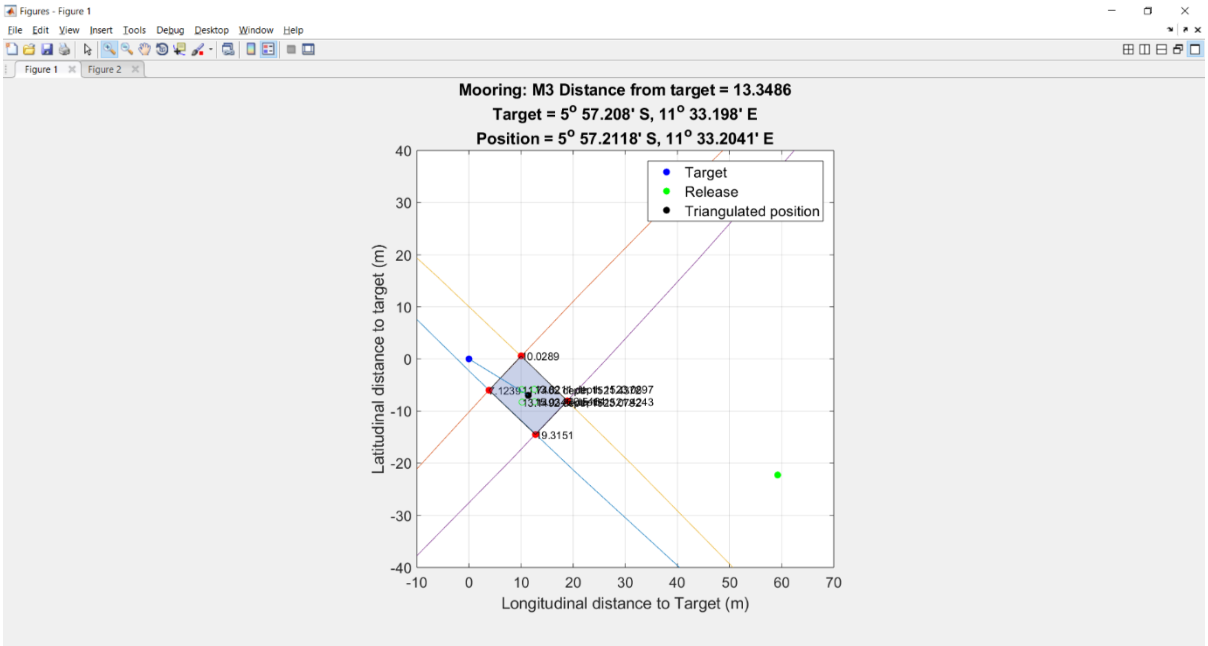


Figure 8.44. *Target, release and triangulated position of NERC Mooring M3 determined using the centroid of the intersection (shaded blue) of four range circles.*

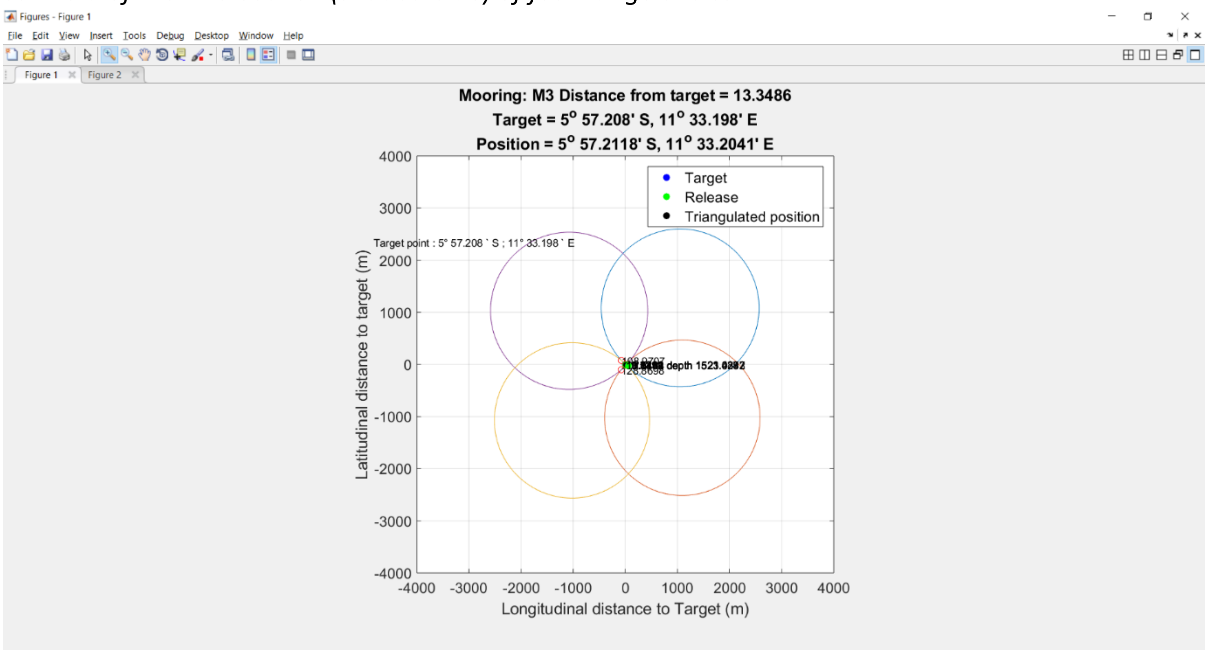


Figure 8.45. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

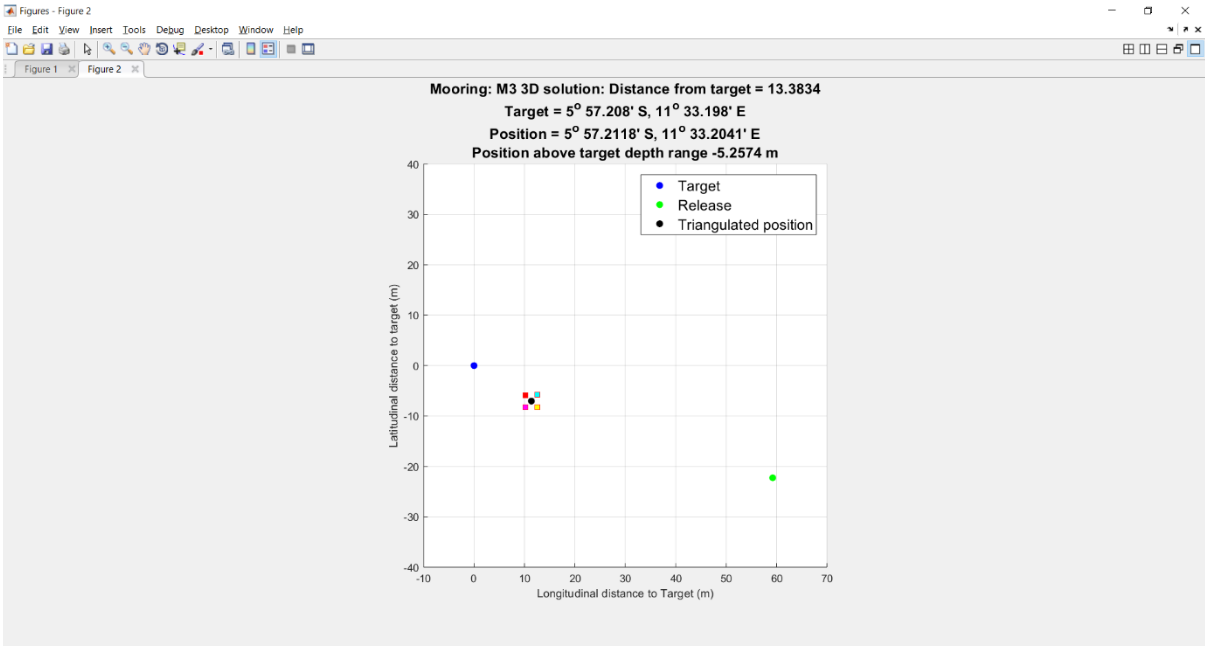


Figure 8.46. *Target, release, triangulated position and distance from target of the NERC Mooring M3 determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M9: Deployment 22nd September

Mooring M9	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 50.2	11 2.16		2150
Release	-5 50.1996	11 2.18904		
Range point 1	-5 49.4145	11 2.9396	2975	
Range point 2	-5 50.9744	11 2.9318	2941	
Range point 3	-5 51.0061	11 1.421	2947	
Range point 4	-5 49.4496	11 1.4019	2929	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 50.2092	11 2.163		
Triangulated Position (4 x 3 point solutions)	-5 50.2092	11 2.163		

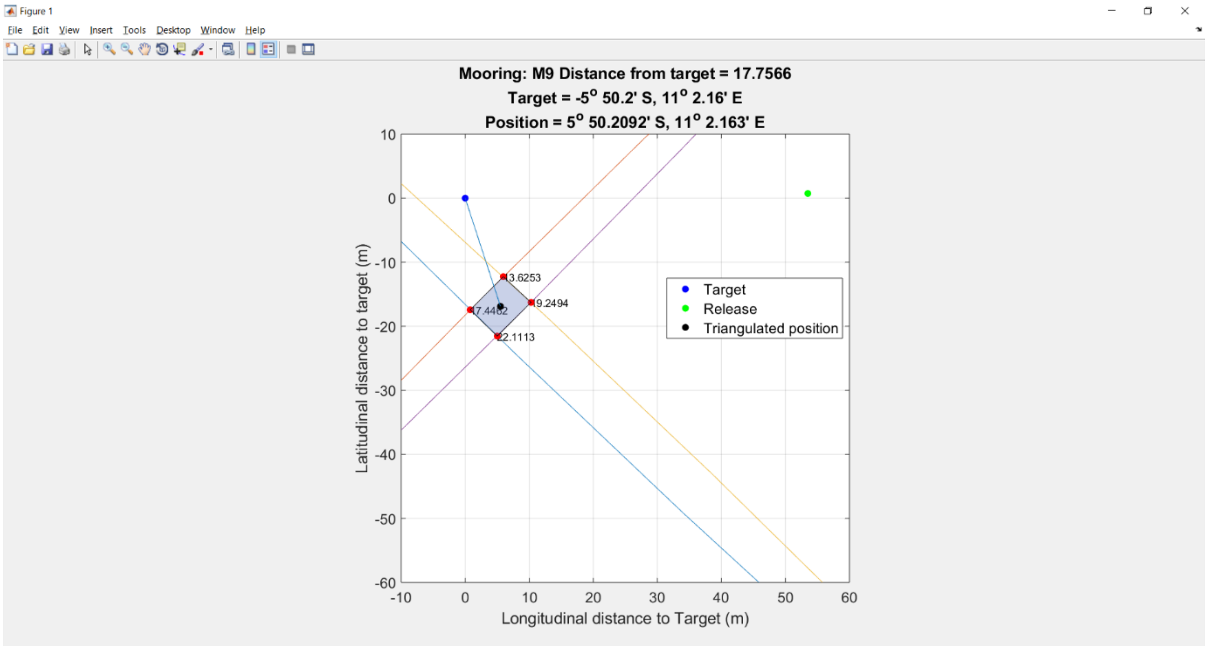


Figure 8.47. *Target, release and triangulated position of NERC Mooring M9 determined using the centroid of the intersection (shaded blue) of four range circles.*

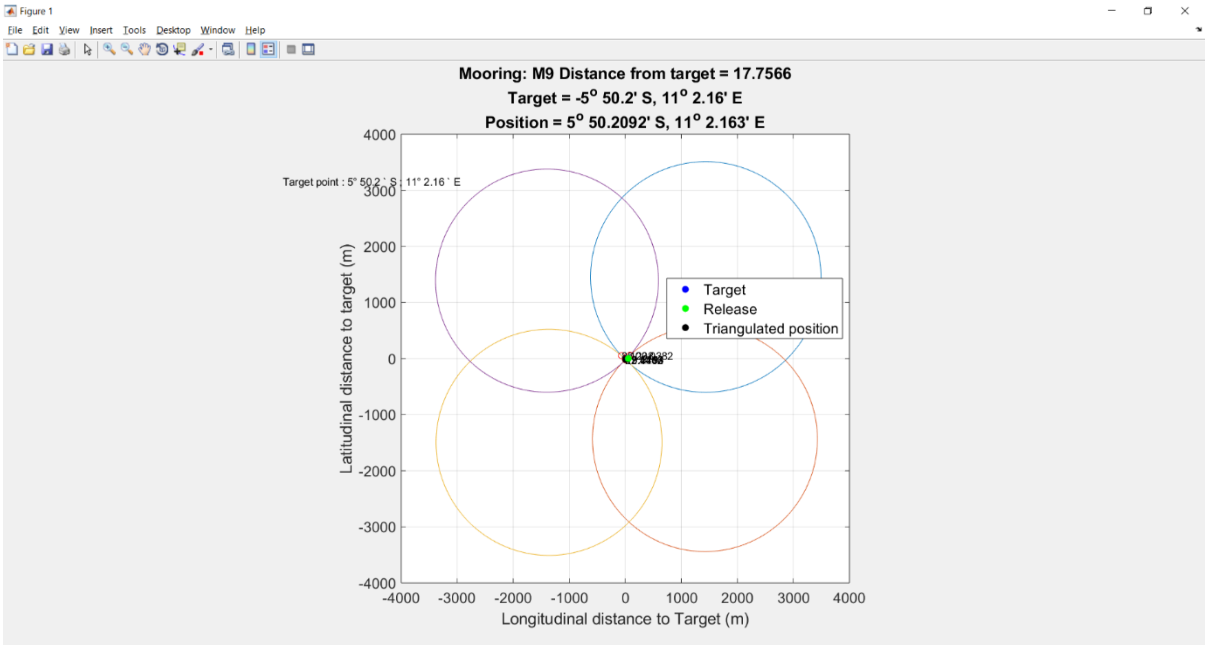


Figure 8.48. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

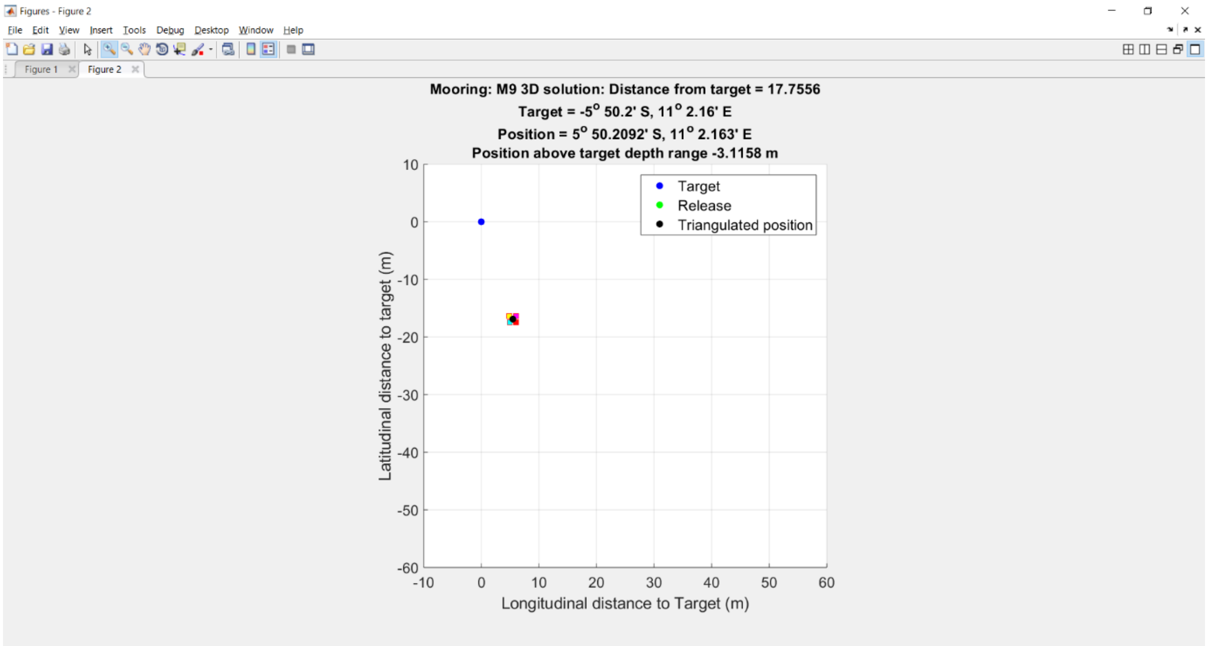


Figure 8.49. *Target, release, triangulated position and distance from target of the NERC Mooring M9 determined by averaging the four direct trigonometric solutions (squares).*

Hydrophone array: Deployed 22nd September

Mooring Hydrophone array	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 50.77	11 1.55		1929
Release	-5 50.775	11 1.63		
Range point 1	-5 51.36275	11 2.5777	2934	
Range point 2	-5 51.3895	11 0.674	2802	
Range point 3	-5 49.9885	11 0.79	2816	
Range point 4	-5 50.0275	11 2.40	2849	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 50.7633	11 1.5595		
Triangulated Position (4 x 3 point solutions)	-5 50.7644	11 1.5589		

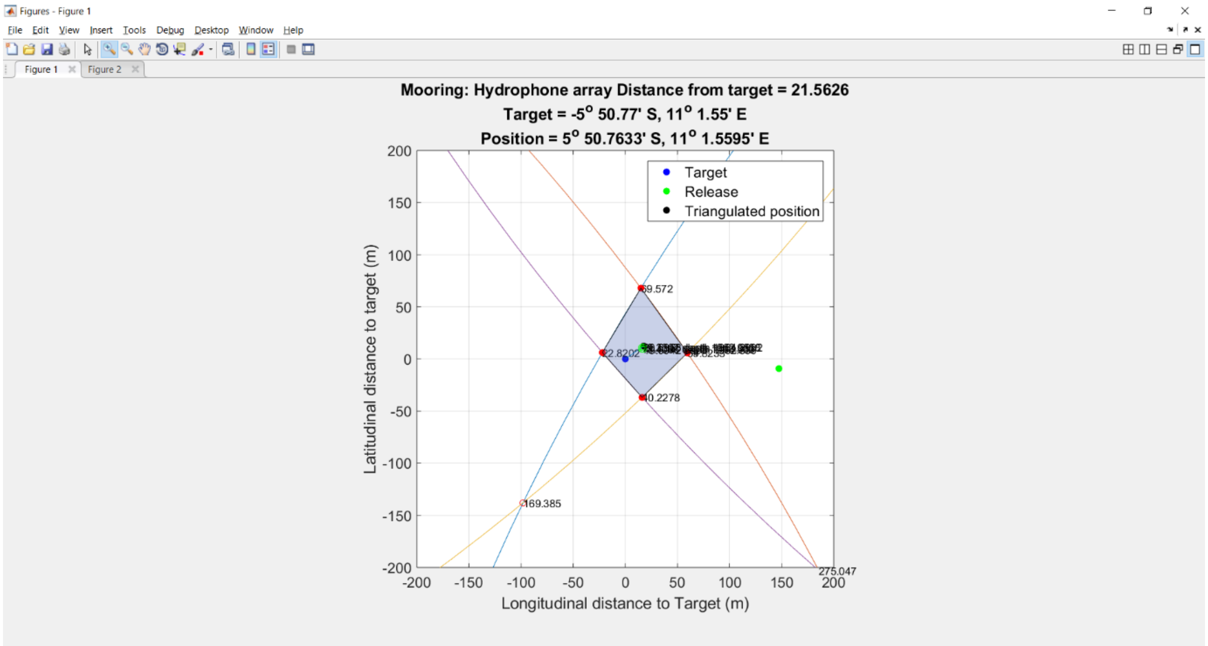


Figure 8.50. *Target, release and triangulated position of the hydrophone array mooring determined using the centroid of the intersection (shaded blue) of four range circles.*

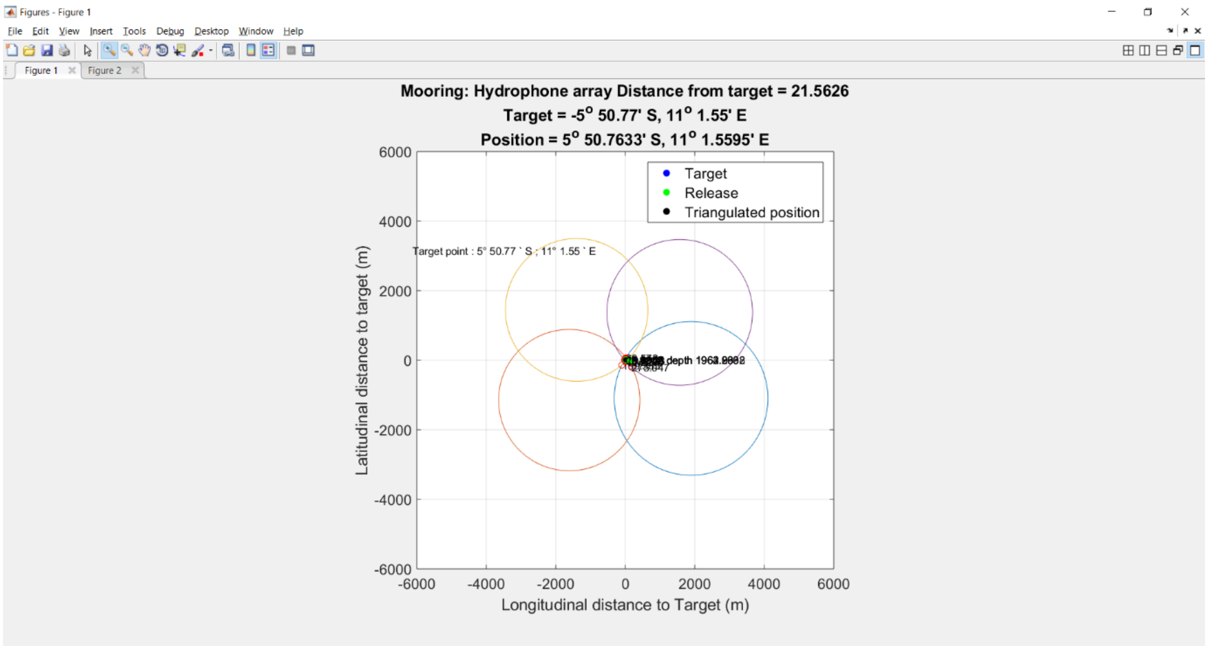


Figure 8.51. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

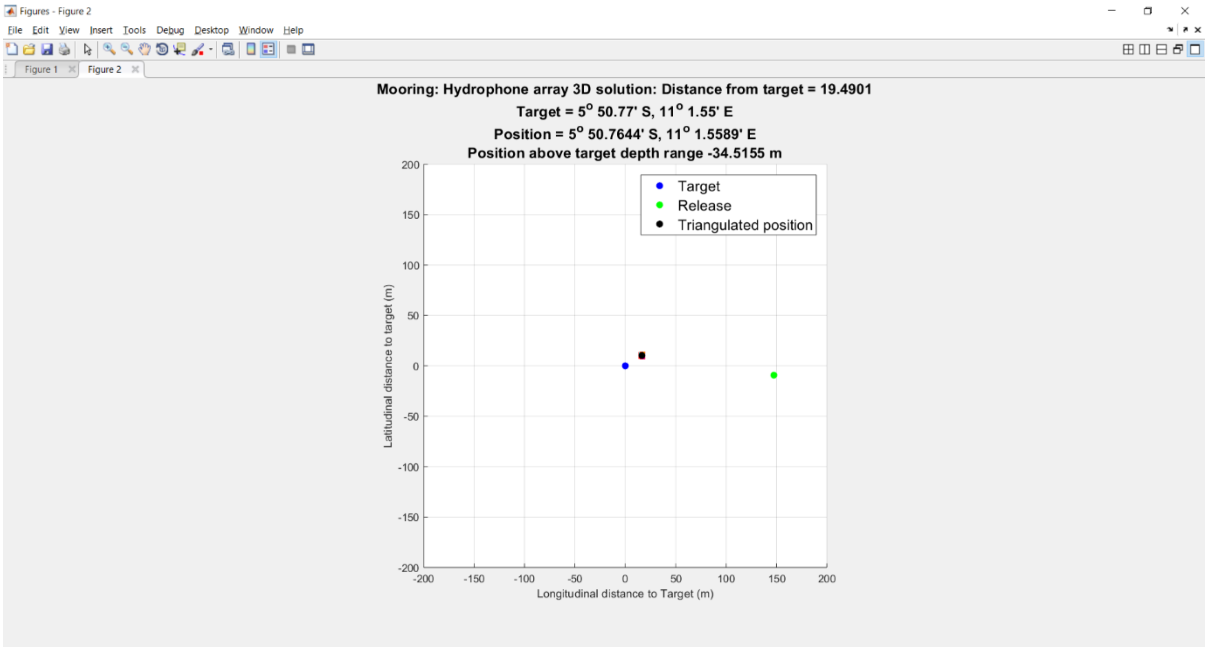


Figure 8.52. *Target, release, triangulated position and distance from target of the hydrophone array determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M2: Deployment 25th September

Mooring M2	**Latitude**	**Longitude**	**Range (m)**	**Vertical range to release (m)**
Target	-5 50.231	11 2.353		2147.5
Release	-5 50.23374	11.2.38194		
Range point 1 NE	-5 49.4754	11 3.1112	2936	
Range point 2 SE	-5 50.9332	11 3.1258	2955	
Range point 3 SW	-5 50.9836	11 1.5972	2900	
Range point 4 NW	-5 49.4821	11 1.5972	2910	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 50.2313	11 2.3357		
Triangulated Position (4 x 3 point solutions)	-5 50.2313	11 2.3357		

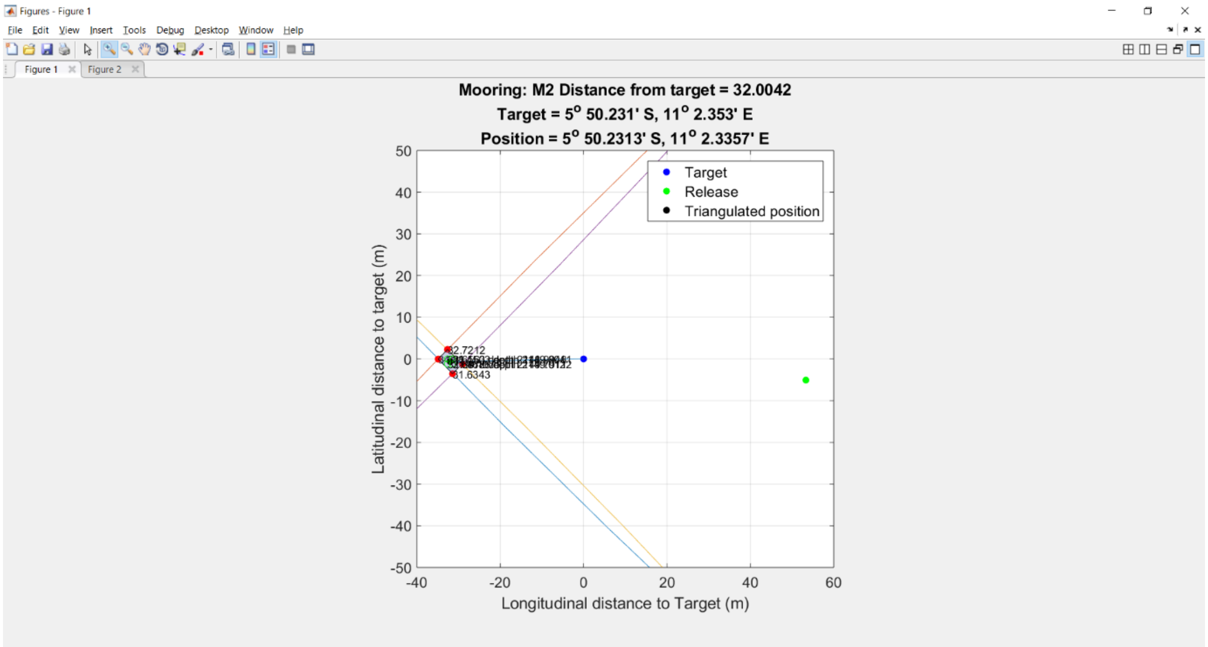


Figure 8.53. *Target, release and triangulated position of NERC Mooring M2 determined using the centroid of the intersection (shaded blue) of four range circles.*

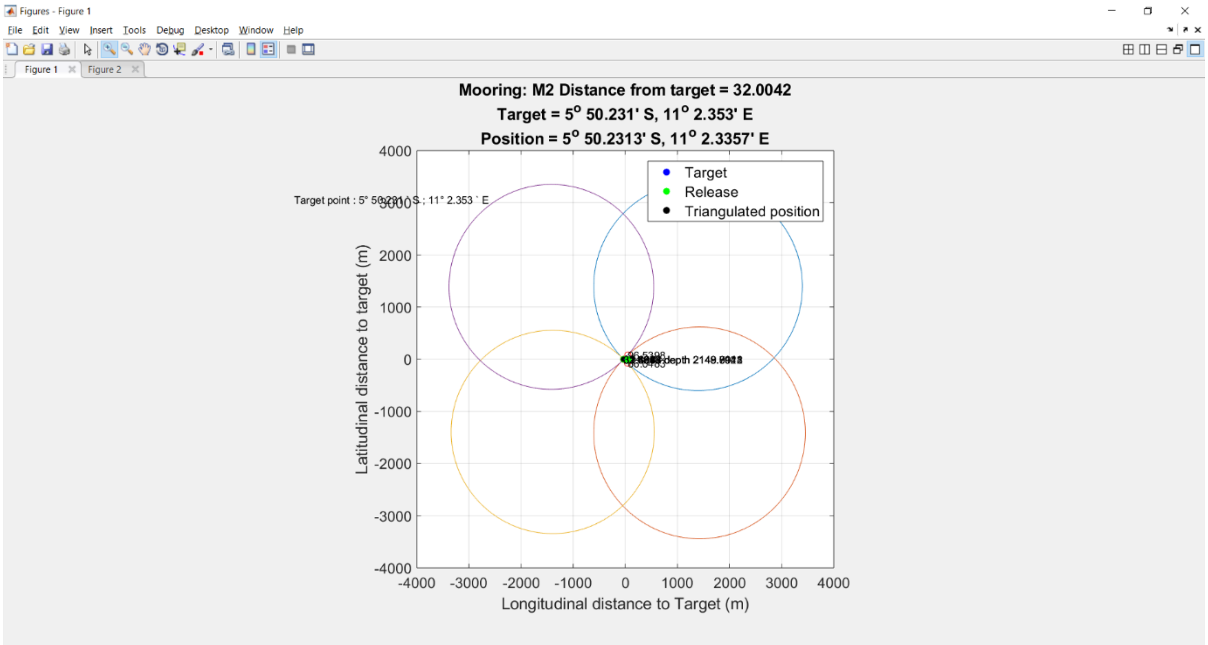


Figure 8.54. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

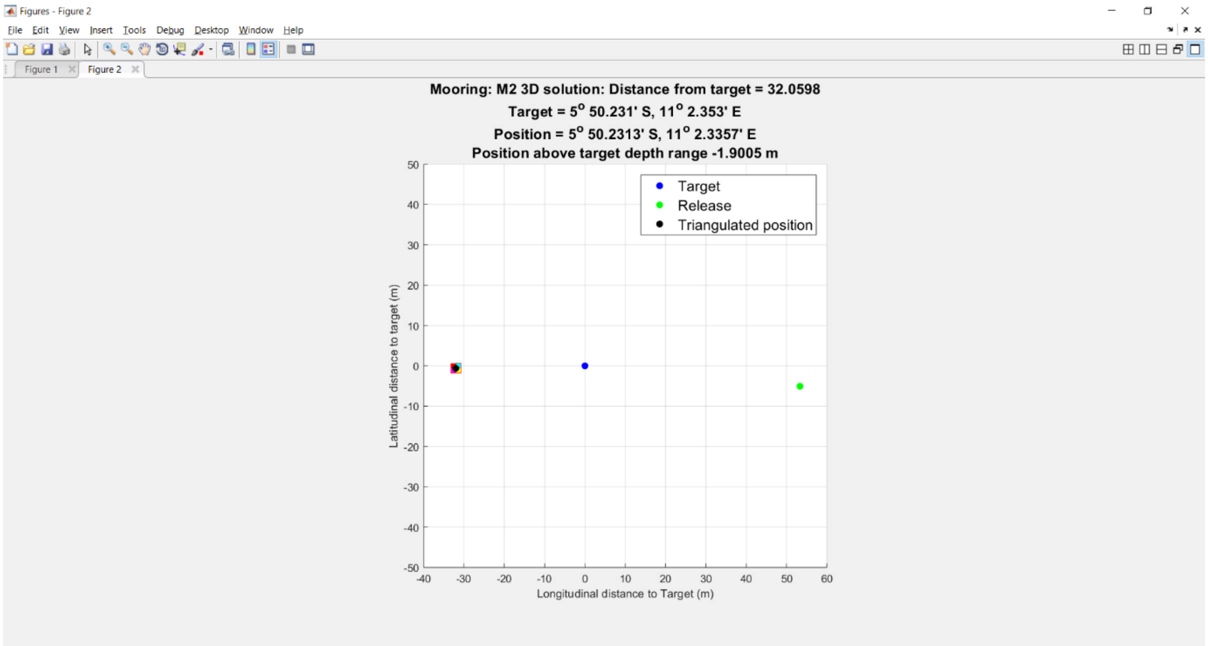


Figure 8.55. *Target, release, triangulated position and distance from target of the NERC Mooring M2*

NERC Mooring M5: Deployment 28th September

Mooring M5	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 43.87349	8 7.315559		4064
Release	-5 43.879	8 7.3438		
Range point 1 NE	-5 42.6225	8 8.34558	5059.5	
Range point 2 SE	-5 45.08784	8 8.36868	5028	
Range point 3 SW	-5 44.9912	8 6.1045	5055	
Range point 4 NW	-5 42.5954	8 6.1695	5145	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 43.8825	8 7.3028		
Triangulated Position (4 x 3 point solutions)	-5 43.8821	8 7.3024		

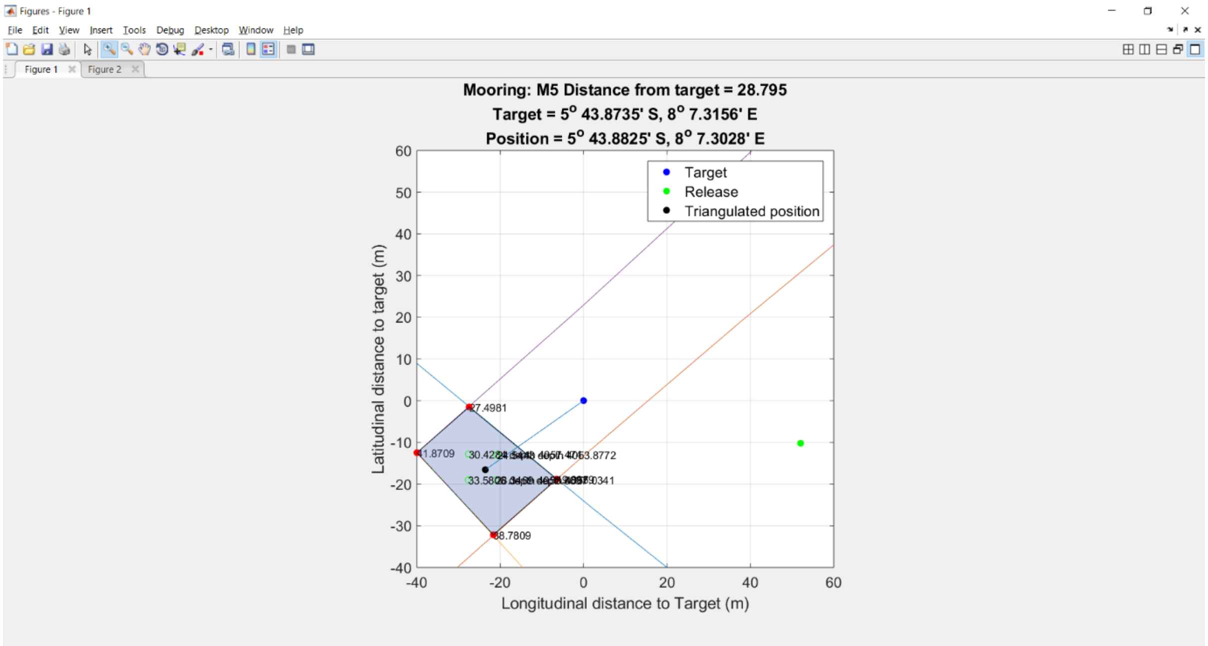


Figure 8.56. *Target, release and triangulated position of NERC Mooring M5 determined using the centroid of the intersection (shaded blue) of four range circles.*

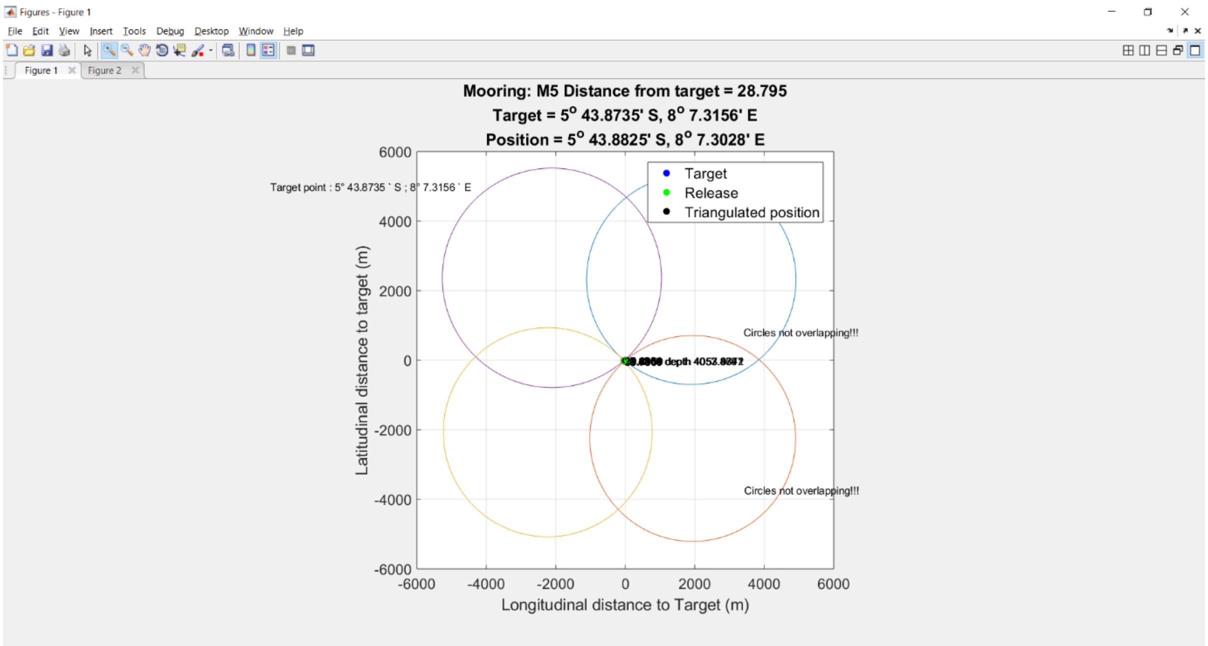


Figure 8.57. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

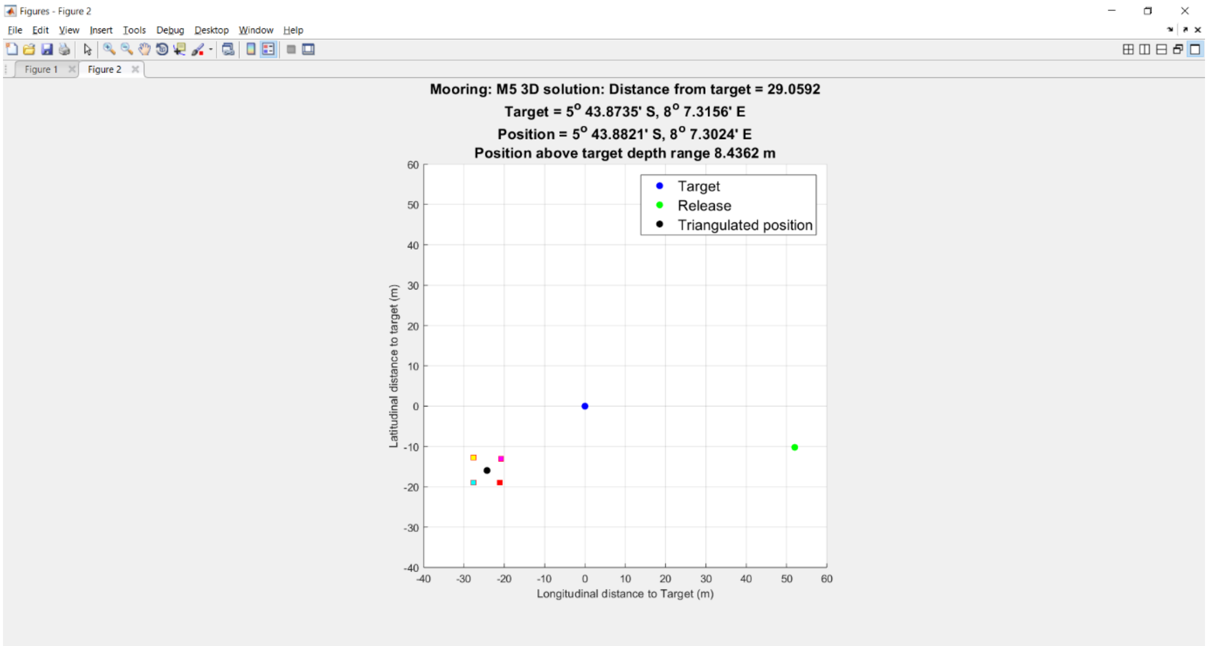


Figure 8.58. *Target, release, triangulated position and distance from target of the NERC Mooring M5 determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M6: Deployment 29th September

Mooring M6	Latitude	Longitude	Range (m)	Vertical range to release (m)
Target	-5 52.143	6 55.521		4403
Release	-5 52.12140	6 55.53954		
Range point 1 NE	-5 52.1383	6 53.7844	5436	
Range point 2 SE	-5 50.3808	6 55.5376	5470	
Range point 3 SW	-5 52.1597	6 57.1939	5375.5	
Range point 4 NW	-5 53.8442	6 55.516	5392.5	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 52.1482	6 55.5175		
Triangulated Position (4 x 3 point solutions)	-5 52.148	6 55.5173		

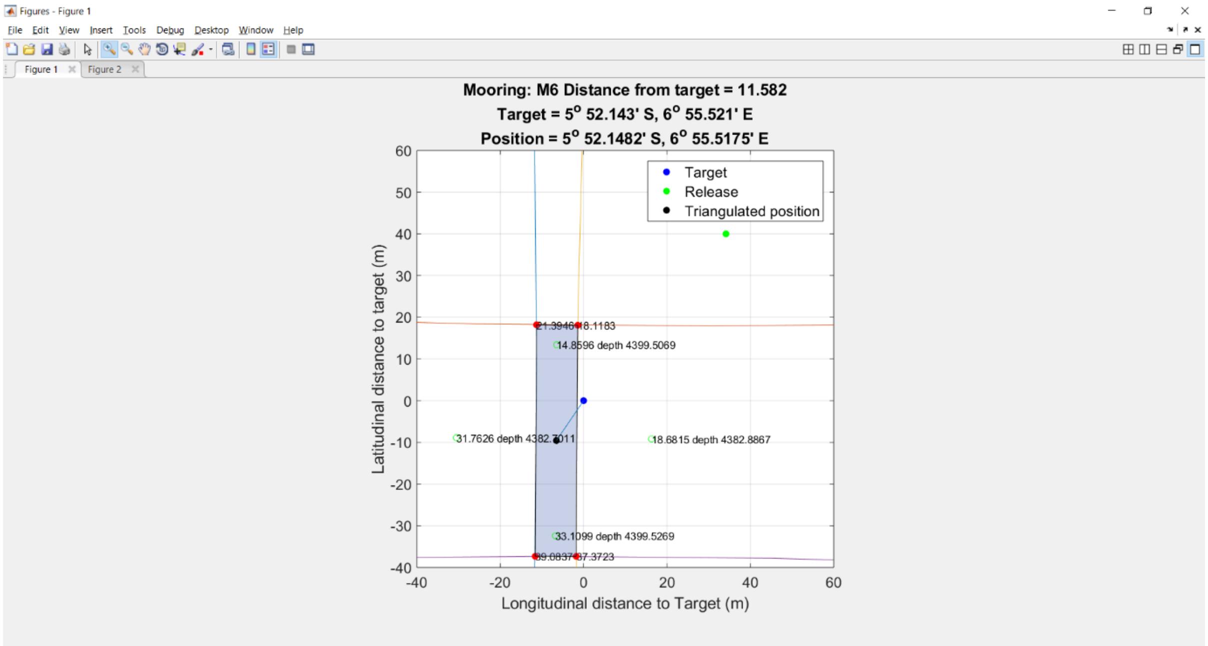


Figure 8.59. *Target, release and triangulated position of NERC Mooring M6 determined using the centroid of the intersection (shaded blue) of four range circles.*

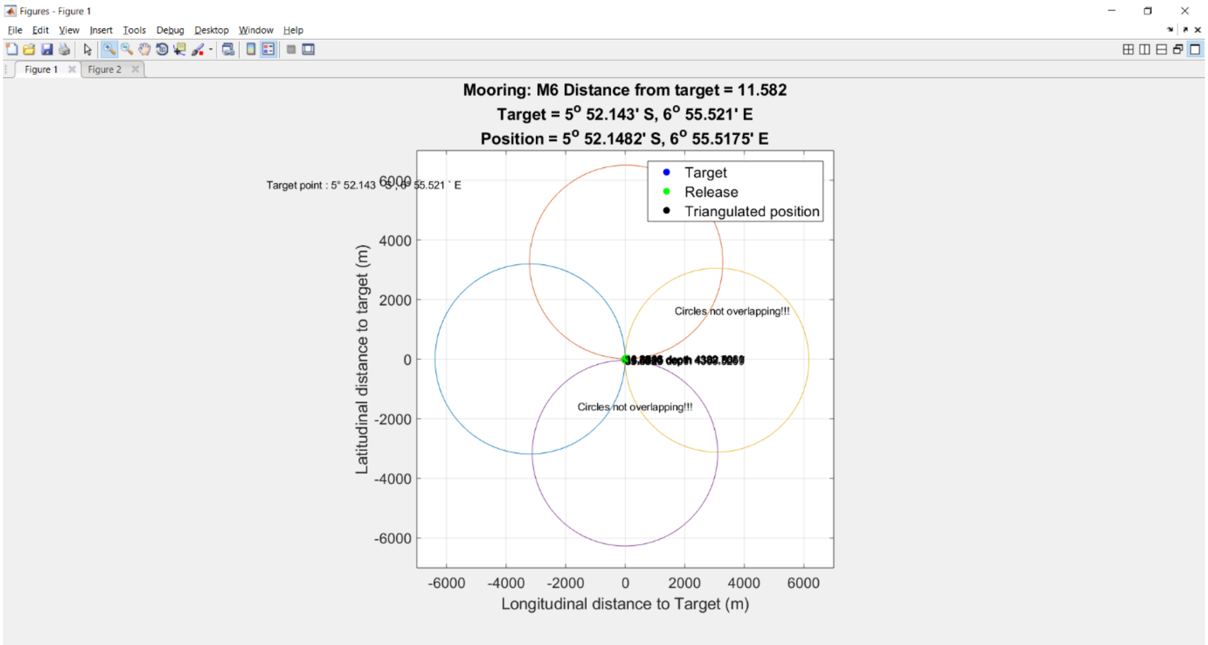


Figure 8.60. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

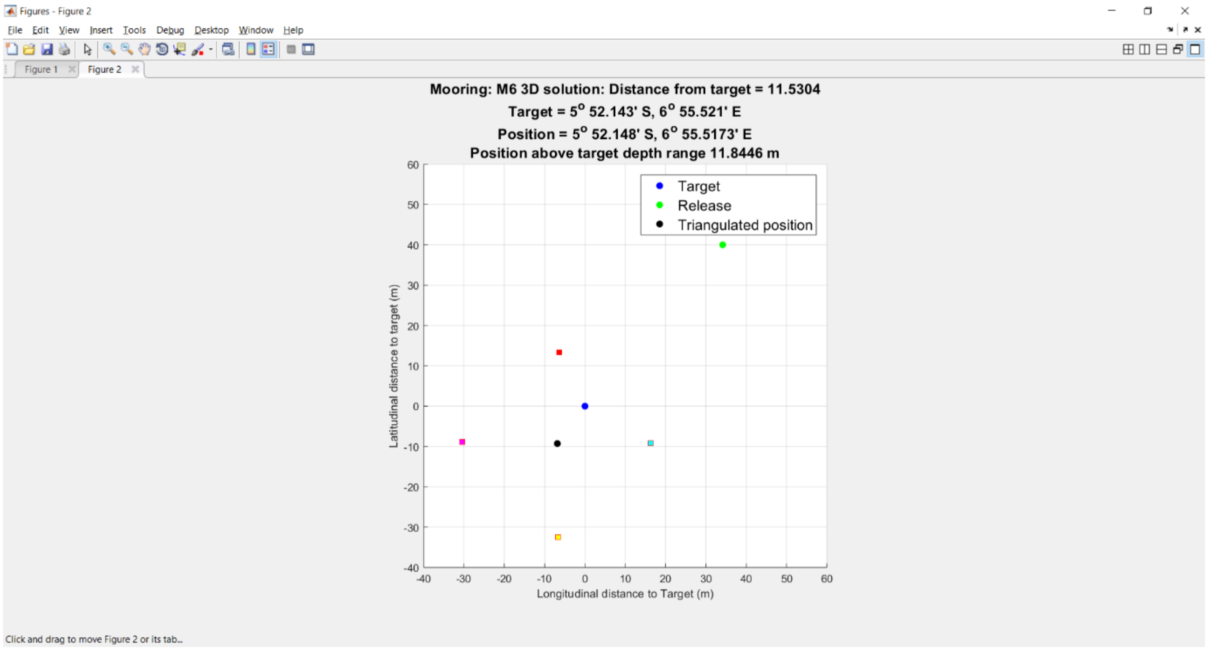


Figure 8.61. *Target, release, triangulated position and distance from target of the NERC Mooring M6 determined by averaging the four direct trigonometric solutions (squares).*

NERC Mooring M8 redeployment: Deployment 2nd October

Mooring M8 redeployment	**Latitude**	**Longitude**	**Range (m)**	**Vertical range to release (m)**
Target	-5 45.42248	7 40.49355		4235
Release	-5 45.42138	7 40.51584		
Range point 1	-5 44.2415	7 41.7743	5311	
Range point 2	-5 46.5528	7 41.8368	5357	
Range point 3	-5 46.5035	7 39.1750	5269	
Range point 4	-5 44.398	7 39.192	5184.00	
Triangulated Position (triangulation_v6)				
Triangulated Position (3 point solution)				
Triangulated Position (4 point circles)	-5 45.4004	7 40.4741		
Triangulated Position (4 x 3 point solutions)	-5 45.4006	7 40.4744		

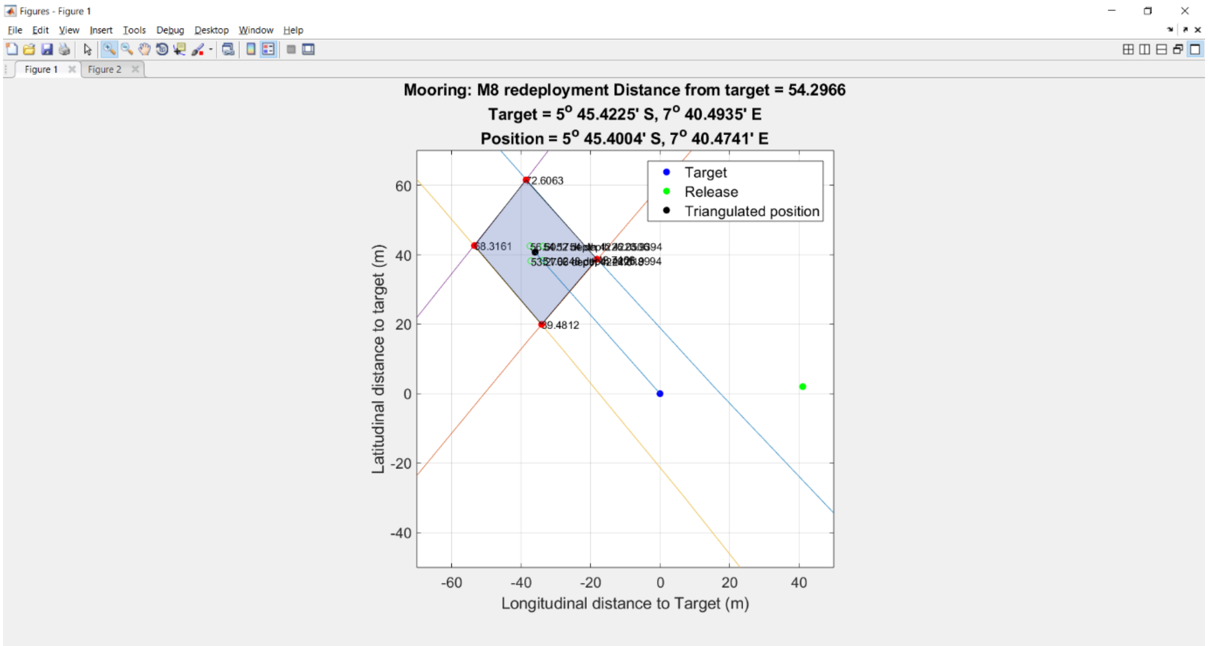


Figure 8.62. *Target, release and triangulated position of NERC Mooring M8 determined using the centroid of the intersection (shaded blue) of four range circles.*

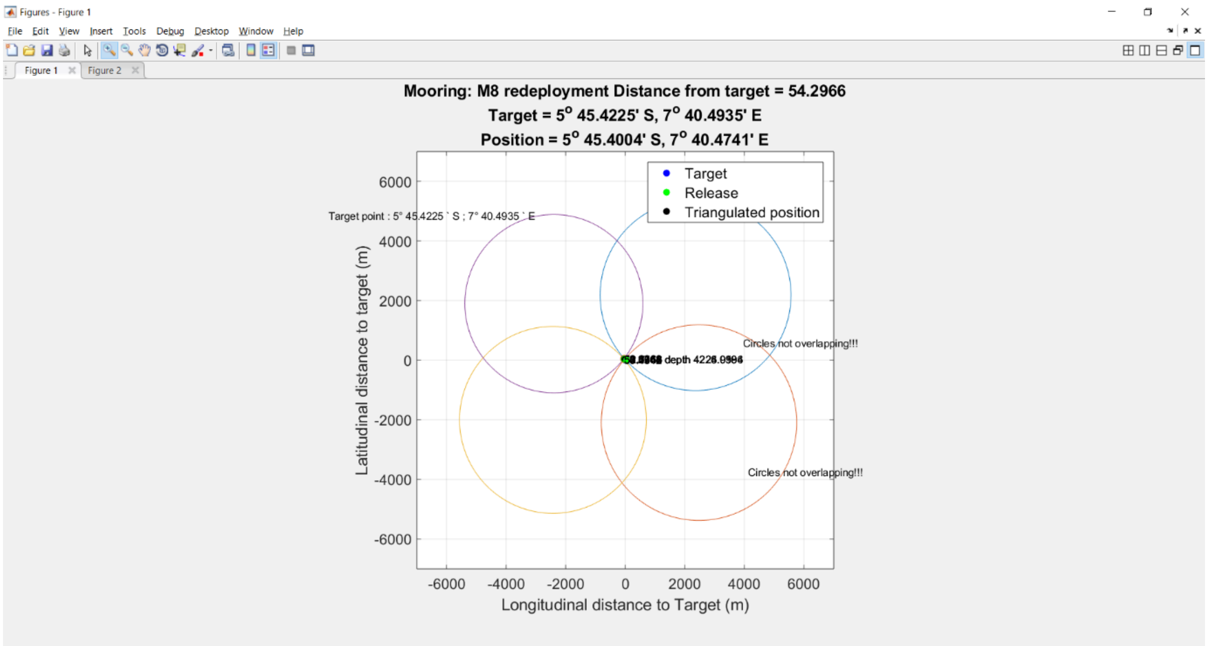


Figure 8.63. *Zoom out of previous figure showing the full extent of the range circles from the four ranging positions.*

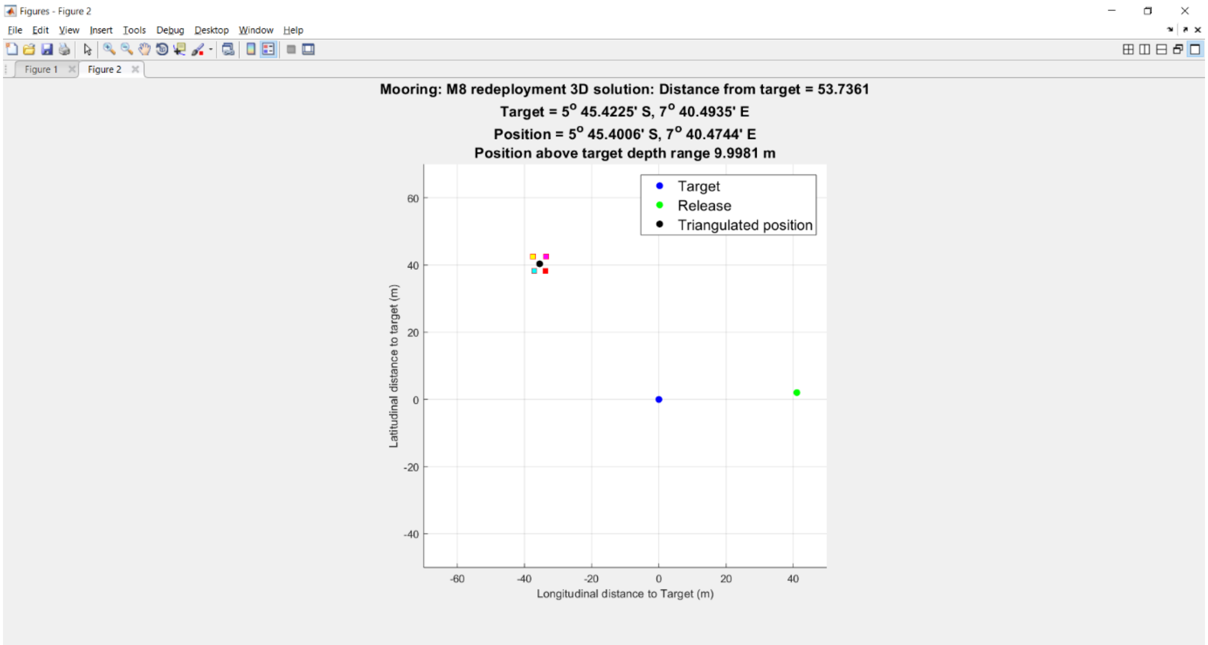


Figure 8.64. *Target, release, triangulated position and distance from target of the NERC Mooring M8 determined by averaging the four direct trigonometric solutions (squares).*

8.2 Multibeam Echo-Sounder (MBES)

8.2.1 Previous bathymetric surveys available to this cruise

Two sets of pre-existing bathymetric surveys from IFREMER were kindly made available for planning JC187. They were used as base maps to plan the cruise and select sites for higher resolution surveys. The first of these surveys is a 100 m grid size bathymetry available for the entire Congo Canyon system, obtained by IFREMER in 1998. The second dataset is a 50 m grid size bathymetry for parts of the system, mainly in the proximal part of the system, and a few smaller stretches further downstream. This was obtained by IFREMER in 1998 as well, but some areas were covered in higher resolution which was used to make this 50 m grid. The 50 m grid bathymetry covers the channel between 6.04° S 12.04° E and 5.62° S 10.33° E (proximal); 5.88° S 9.74° E and 5.87° S 9.71° E; 6.00° S 9.22° E and 5.83°S 8.59° E; 5.85° S 7.02° E and 5.90° S 6.84° E; 6.45° S 6.11° E until past channel confinement.

8.2.2 Aims of multibeam surveying

The previously available ≥50 m gridded bathymetry could not resolve small-scale features on the canyon/channel floor. Additional surveys were undertaken during JC187 to improve the precision of our bathymetry basemaps. Two surveys types were undertaken.

First, surveys covering limited areas were designed. The principal aim of these surveys was to assess whether the pre-planned mooring deployment sites were appropriate, *i.e.*, on flat areas of the canyon/channel floor or on terraces. This was essential to prevent side-lobe interference within the ADCP data and to ensure appropriate deployment (low slope angles) for the OBSs.

Second, longer along-channel surveys were performed. The aims of these surveys, in addition to instrument deployment, was to study the morphology of the channel in greater detail in order to identify features such as knickpoints, bars, mass failures and bend cut-offs. Identification of these features can subsequently be linked to observed flow characteristics from deployment instruments. They also enable future cruises to re-survey the same areas and produce difference maps.

8.2.3 Multibeam setup and processing

The surveys were performed using a Kongsberg EM122 deep water swath multibeam echosounder. Highest resolution data was generated by setting the swath to the narrowest setting: beam angle was set to 45° from the nadir, and a minimum possible beam width of 0.5°. SVPs were taken at the start of most surveys. A second SVP was performed halfway through some of the longer surveys. See section 8.3 on water column measurements for detailed locations and timings of the CTD and SVP drops. Incoming data were automatically corrected for the heave, roll and pitch of the ship. Recorded data was then processed using CARIS HIPS and SIPS software. Data were exported in geotiff format, referenced in the correct UTM zone, and then analysed in ArcGIS. This processing and exporting to GIS had to be performed very quickly in some cases, since exact deployment of instruments was based on it. Note that this procedure is not the final processing.

8.2.4 Path planning, layout, and recording

The surveys were planned using an along-channel line crossed by several transverse lines perpendicular to the along-channel line. This path lay-out ensures that all of the desired area is covered by swaths at 90° to one another and therefore prevents shadowing by the sidewalls of the channel. Line spacing of the transverse lines was dependent on water depth. The central 33% of the beam has the highest resolution. The paths are designed to overlap at least 66%, so the entire area is covered by the central 33% of the swath.

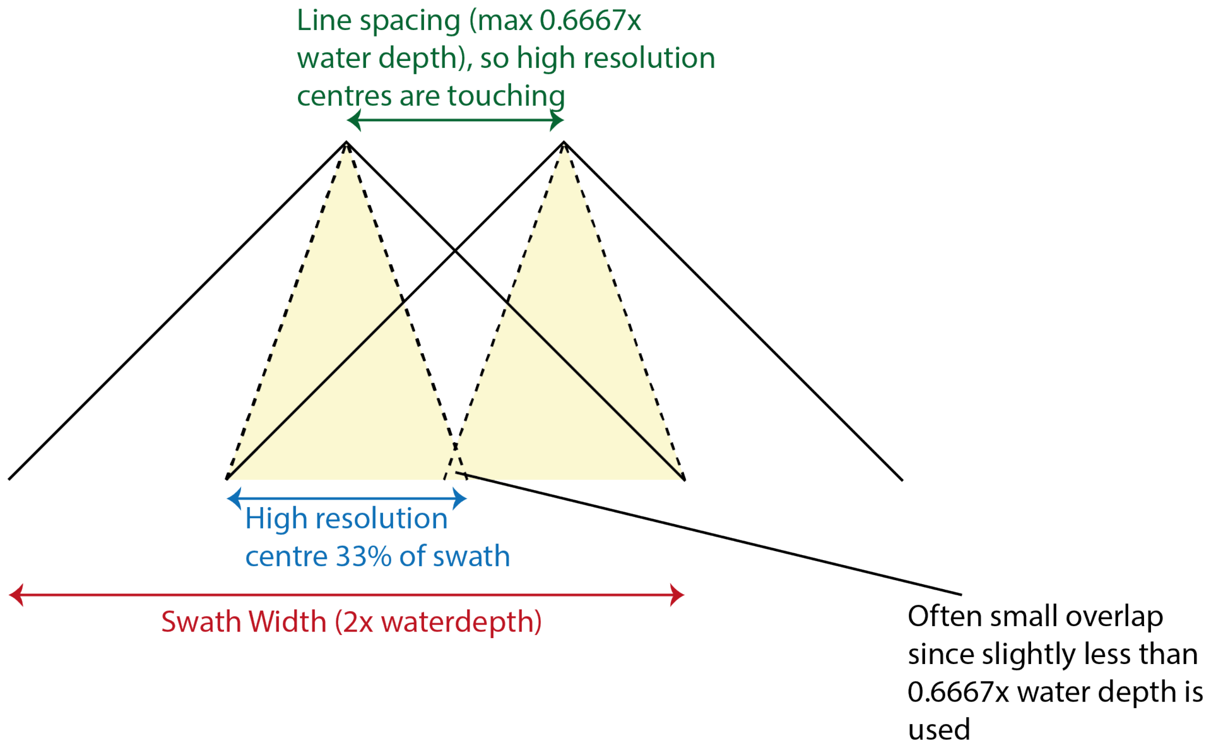


Figure 8.65. *Schematic diagram explaining how the desired overlap was determined.*

The standard length of the transverse paths is 1 km (500 m to each side of the centre along-channel line). This can be longer to cover channel meanders, or to survey overbanks where OBS deployments are planned. Start and end points of the along-channel and transverse lines are communicated to the bridge, accompanied with a definition of which points make up a line. The along-channel line can consist of more points, in case it is not a straight line. Paths between defined survey lines were navigated according to the bridge's call on how to steam between different defined lines. All turns made are outside the defined lines and the ship will be on speed and aligned with the defined line before reaching it. This led to the ship steaming ~0.5 nautical miles outside of the line before turning, adding 1 nautical mile to the length of the path per transverse line. The turn transitioning from the along-channel line to the transverse line took about 15 minutes. Surveys were performed at 6 knots. Survey time estimates can be constructed by using the path length, and the extra length for the turns and assuming an average speed of approximately 5.5 knots (speed drops in turns), for the entire path length. These estimates were than checked with the planned survey path constructed on the bridge. We also conducted a few single line surveys, with no transverse lines. These lines were designed to follow the channel thalweg.

We performed small surveys around mooring locations, solely for determining deployment sites. The along-channel lines in these surveys were 6 km long. In the deepest waters, a 6 km along-channel line is covered by 3 transverse lines with 2 km spacing in between. The more extensive surveys have variable lengths and can have a progressive decrease in line spacing as water depths become shallower.

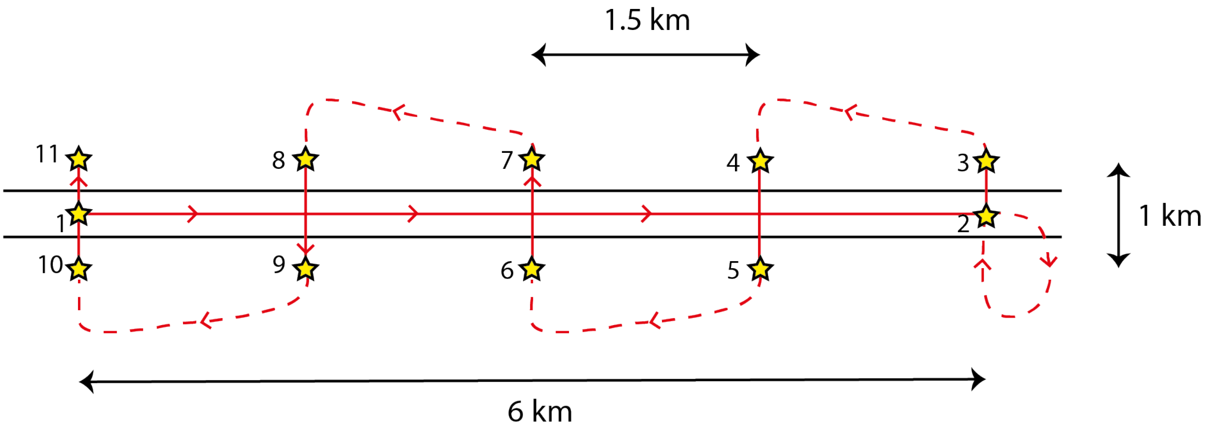


Figure 8.66: *Idealised standard multibeam path layout. Yellow stars are the coordinates and solid red lines defined paths, communicated to the bridge. The dashed red lines are the paths followed by the bridge between the lines.*

8.2.5 Locations, coverage, and performed surveys

Site	Around sites	Water depth (m)	Length (km)	Transverse lines	Time (hh:mm)	Lat min (° S)	Lat max (° S)	Long min (° E)	Long max (° E)
67	42; 59; 75; 124	4950	6	3	02:06	6.667	6.728	5.452	5.514
68	40; 57; 58; 76; 77	4780	6	3	02:14	6.443	6.491	6.001	6.072
69	38; 39; 78	4677	6	3	02:17	6.179	6.242	6.427	6.469
71	36; 37	4470	6-16	3-4	03:40	5.83	5.932	6.799	6.973
83	4; 5; 6; 7; 8; 10; 11; 12; 44; 45; 46; 48; 66; 85; 87; 88; 93; 96; 97; 98; 99; 103; 104; 105	1568-1927	35	35	19:56	5.883	5.969	11.262	11.575
84	13; 14; 86	2070-2290	25	16	10:39	5.803	5.898	10.923	11.285

89	92; 100; 107; 108; 109; 110; 111;	1914-2040	15	12	7:25				
115	-	833-1588	7	2	02:35	Survey was directly processed into 83, no separate available at the moment			
113	32; 33; 41; 43; 52; 53; 101; 112; 114	4140-4335	66	34	29:05	5.693	5.831	7.577	8.178
119	35; 55; 56; 70	4509-4675	62	31	20:54	5.874	6.199	6.435	6.912
121	-	4681-4961	114	0	10:19	6.226	6.720	6.672	6.481
122	-		56	4	9:47				
125	102	4353-4489	76	0	6:38	5.733	5.901	6.901	7.562
126	102		34	18	10:37				

Table: All performed surveys in chronological order. All the waypoints as communicated to the bridge are shown in the appendices. Colour coding in 'site' column: Red= standard survey; Blue=long survey; Yellow=single line survey; black=other.

Notes on surveys different from 'standard' survey around planned mooring site.

- **Site 69:** One of the transverse lines is extended to cover an OBS deployment location (site 38).
- **Site 71:** Some distance along the channel and a 2x2 km block formed by a cross preceded the normal part of the survey. The entire along-channel distance is about 16 km, while the site covering the planned mooring deployment is defined by the usual 6 km line along the channel.
- **Site 83:** This is a long survey covering the channel between the eastern edge of DRC waters until about 5.889° S 11.274° E. It covers several instrument sites. It will be used to study the morphology of the canyon, and possible morphological change in the future.
- **Site 84:** This is a longer survey covering the channel between 5.862907° S 11.139938° E and the western edge of Congo/Gabon waters. It will be used to study the morphology of the canyon, and possible morphological change in the future
- **Site 89:** This survey completes the gap between the surveys of site 83 and 84, between 5.889° S 11.274° E and 5.862907° S 11.139938° E. It will be used to study the morphology of the canyon, and possible morphological change in the future. (Surveys 84 and 89 were processed together).
- **Site 115:** This survey was planned after recognising a small lack of coverage of a desired location in survey 83.
- **Site 113:** This is a long survey spanning from the western edge of the Congo/Gabon international waters, to site 32. It covers two mooring locations and the part of the channel between these two mooring locations (approximately 66 km).
- **Site 119:** This is a long survey spanning between the surveys obtained at sites 69 and 71. It is 62 km long, but does not cover any mooring locations.
- **Site 121:** This is a 114 km long single-line survey spanning from the survey at site 69 to the survey at site 67. It swings around survey 68, to get a slightly better coverage over an abandoned channel here. The end is made to fit the start of survey 122.
- **Site 122:** This survey is designed to cover the area just upstream of site 67. It is designed differently from other surveys. The area is covered by four 22 km long parallel lines that are spaced 3 km apart. The last line of the survey around the head scarp transitions into a single

line back up to site 68, making this area covered by two single lines. (Surveys 121 and 122 were processed together).

- **Site 125:** This is a 76 km long single line survey between site 71 and 113. It was designed to fill the only missing gap along the channel thalweg in international water.
- **Site 126:** This is a long survey starting at the eastern side of site 113. It just consists of transverse lines over the single line performed in survey 125. It is designed to use up any time at the end of the cruise. (Surveys 125 and 126 were processed together).

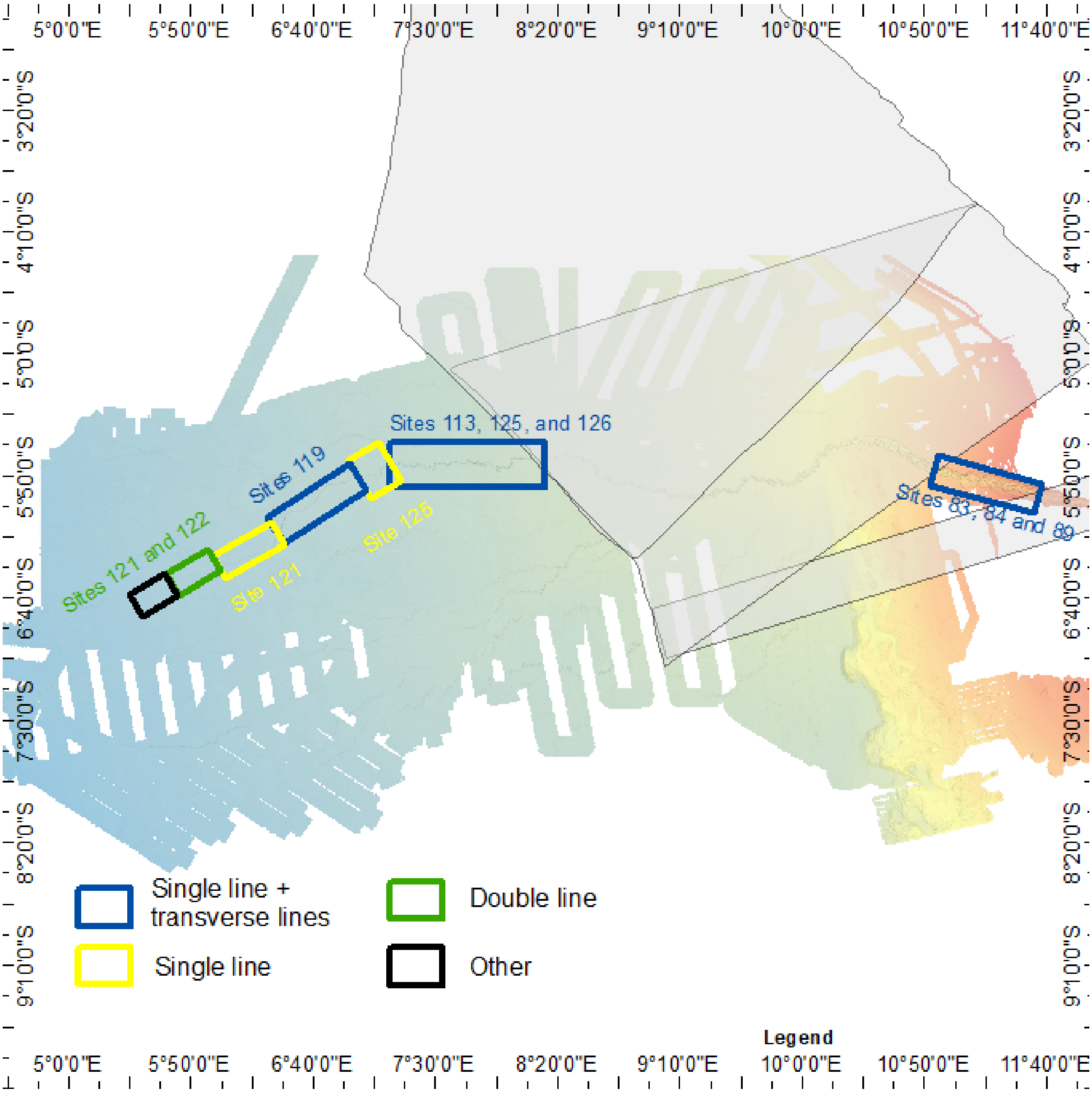


__Figure 8.67:__ Location of longer surveys and total coverage. Grey shaded areas are areas where we did not work due to permits. We only worked in Angolan or International Waters.

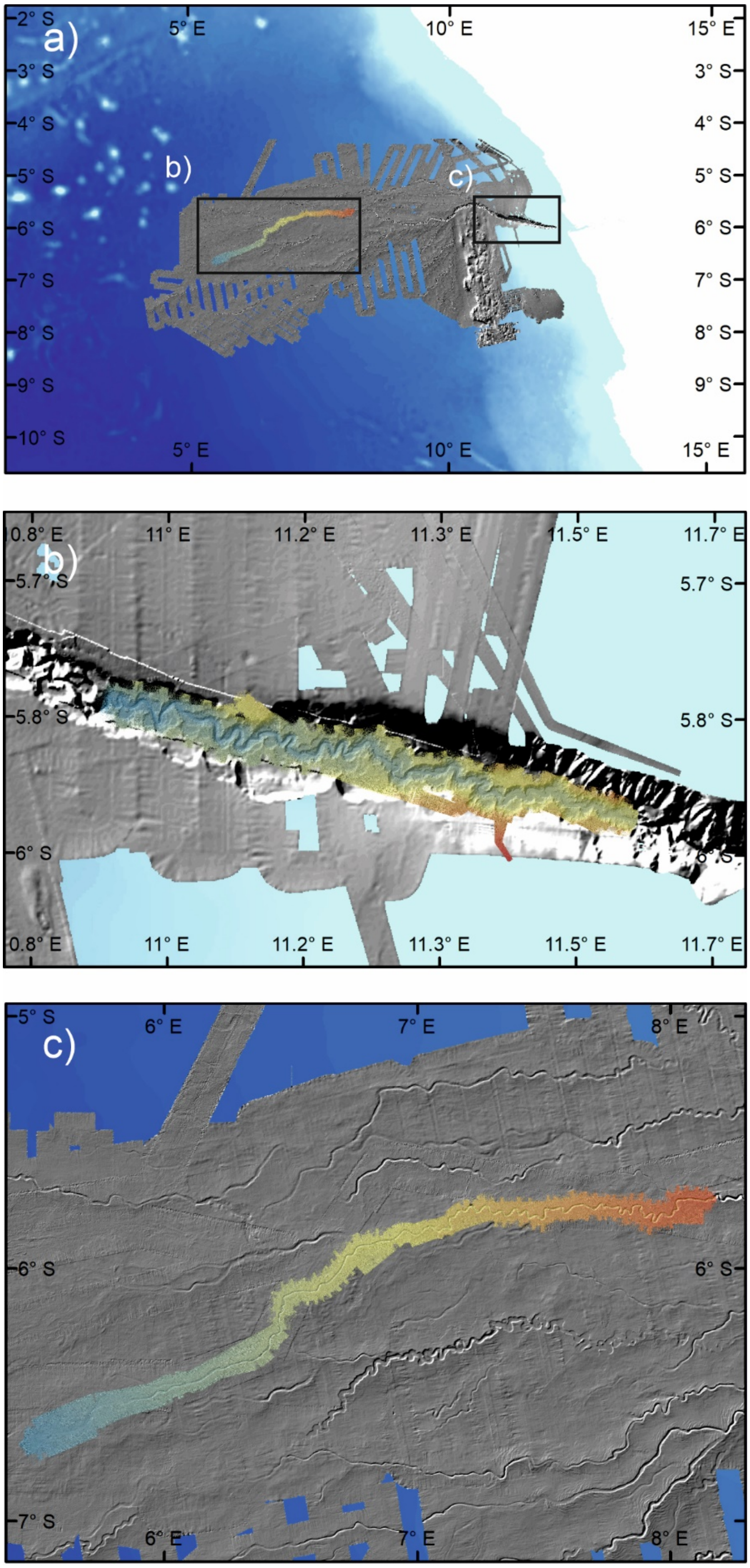


Figure 8.67 (continued). *(A) Map showing the area covered by 50m and 100m gridded IFREMER bathymetry in grey. Locations of bathymetry collected in upper canyon (b) and international waters (c) shown in colour. (B) Map showing bathymetry surveys by JC187 in the upper canyon in Angolan waters. (C) Map of bathymetric surveys collected by JC187 along the distal channel within International Waters.*

8.2.6 Survey performance

The surveys were generally very successful. We were able to construct grid with 5 m resolution from the upper-canyon surveys in shallow (<2,500 m) water. In deeper-water (up to 4500 m), we typically gridded data successfully at 15m horizontal resolution, but it was found that 5 m gridded data were possible in some areas.

The transverse lines helped reduce the noise, especially around the channel edges. Despite the traverse lines taking up the majority of the survey time and not adding a large amount of additional coverage, they were crucial for achieving the highest resolution data. This was due to the increase in point density for each grid cell, and the subsequent reduction in variability outside of the central 33%. The resulting bathymetric maps helped to decide on the exact mooring location. Several moorings were adjusted based on these newly obtained bathymetric survey results.

8.3 Water Column Measurements

8.3.1 CTD and SVP data

A CTD SBE-9 stainless steel frame from Sea-Bird was used for multiple purposes at 11 stations during the JC187 cruise.

The first purpose was to obtain vertical profiles, from close to the surface (5 m) to close to the sea floor (~5 m), of the main properties of the water masses, that are sent and monitored from the ship through the CTD cable. The classical CTD triad, conductivity (C), hence salinity, temperature (T), and pressure based depth (D), is complemented by others sensors. The complementary parameters are the oxygen, fluorescence and both acoustic-based and optical-based turbidity.

The frame is also used to obtain water samples making use of its 24 Niskin bottles of 12 litres. The bottles sample the water on the way up to the surface at different depths, based on the vertical structure of the water properties shown by the real-time monitoring on the way down. The water is sub-sampled out of the Niskin bottles once the frame back on board (see Chapter 6.5.2).

Complementary, the current velocity is measured during the casts by a LADCP (Lowered Acoustic Doppler Current Profiler) sounding and listening downwards. LADCP data can be exploited to provide an estimation of the turbidity and the sediment concentration. This would need some calibrations against sampled sediments. Due to the turbulence produced behind the frame on its way back to the surface, LADCP data is not fully exploited on both ways, but only on its way down. During stationary stations, while water samples are collected, LADCP data remains exploitable.

The vertical position relative to the surface of the CTD frame is obtained from the pressure. Its vertical position relative to the seabed is obtained by an altimeter, whose range goes up to 100 m. An USBL beacon mounted on the frame provides its 3D location and hence a way to check, close to the sea bed, the local depth.

The CTD data provide the necessary parameters to quantify the vertical profile of the water density and hence of the sound celerity in the water. CTD casts were taken before the multi-beam surveys to minimize errors. But a Sound Velocity Profiler (SVP) mounted on the frame was specifically used for this purpose. In some cases, when the CTD cast was not possible, SVP profiles were obtained alone.

8.3.2 CTD Instruments and calibration

The set of instruments used and mounted on the CTD are indicated here after together with certain specifications and, if useful and available, some information about their calibration.

8.3.2.1 Altimeter

The Teledyne's Benthos PSA-916T (titanium) altimeter measures the vertical distance between the CTD-frame and the sea bed. It pings at 1 Hz rate a 14° conical signal of 200 kHz. It may be deployed to full ocean depth, and its measurement range is from 0 to 100 m. Typical bottom detection is around 75 m.

The altimeter is a critical instrument to bring the frame as close to sea bed as possible. If the altimeter signal is stable, thanks to DP position, fair sea and weather conditions, the frame may be approached up to 5 m close to the bed.

8.3.2.2 Temperature

Temperature is obtained with two SBE-3P Premium Temperature Titanium sensor from Sea-Bird Electronics. Their serial numbers are 03P5660 and 03P5700. Their calibration from March 2018 was done with 11 points between 1 and 31 °C.

8.3.2.3 Conductivity (Salinity)

The CTD-frame is equipped with two conductivity sensors. Their serial numbers are 3698 and 3873. The SBE-4C sensors, one aluminium, the other titanium, were calibrated in March 2018 at 35 PSU. The calibration is based on 6 points. The results are recorded in both conductivity (mSiemens/cm) and equivalent salinity (PSU).

8.3.2.4 Pressure

Two instruments are used to measure pressure (dB-decibar and m-meters of salt water). A SBE-05T (serial number 053085) calibrated in March 2018, and a SBE-09Plus digiquartz (serial 134949) calibrated in March 2019.

8.3.2.5 Oxygen

The dissolved oxygen sensor is a SBE 43 (serial 0709) calibrated in July 2018. The provided and recorded oxygen values are expressed in µmol/kg.

8.3.2.6 Turbidity

The turbidity, used as a proxy of the presence of sediment in suspension is obtained from two sensors of different nature.

A WetLabs C-star transmissometer with a titanium housing samples at 8 Hz the attenuation (1/m) of the acoustic signal, or transmittance) along a pathlength of 25 cm. The WetLabs have been calibrated by Sea-Bird in March 2018.

A WetLabs ECO BBRTD Scattering meter is also used to estimate turbidity and evaluate the concentration of sediment in suspension. This instrument is based on light scattering, as in a traditional OBS (Optical Back-Scatter). The radiance attenuation is used as a proxy for the turbidity and the sediment concentration. The recorded units are $m^{-1}Sr^{-1}$ (loss per metre and steradian). The present model is based on a 660 nm wavelength signal and may be used up to 6000 m of water depth. Its calibration (Serial BBRTD-168) is from May 2017.

8.3.2.7 Fluorescence

The CTD is also equipped with a fluorometer, a Chelsea Aquatrack MK3 (serial 088195). The fluorometer is useful in surface waters where it provides evidence of chlorophyll-a. Together with turbidimeters it provides some information on the nature of the turbidity (lack of transparency, both to sound and light) levels. Sediment related turbidity shows a low level of fluorescence. The Aquatrack MK3 was calibrated in Octobre 2018. The recorded data units is µg/l.

8.3.2.8 LADCP (velocity)

The Workhorse Monitor LADCP from Teledyne-RDI (serial 24466) is a 307.2 kHz to be used up to 6,000 m of water depth. Its certificate of conformance is from March 2017. Both temperature and pressure sensors are installed directly on the LADCP.

The LADCP is installed in the lower part of the CTD frame and oriented downwards. Its beam angle is of 20°. The single ping ensembles are obtained at 1 Hz. The ambiguity velocity is ~2 m/s. The blank used is 5 m. The first has 7.17 m. The default bin size is 2 m, and there are 50 bins in total.

8.3.3 Water samples

The CTD (Conductivity, Temperature and Depth) frame on board holds 24 Niskin bottles (of 10 litres capacity each) mounted on the frame, which can be "fired" manually from a computer to trap water at specific depths. Up to 100 m above the seafloor, a 2 kHz altimeter is used to determine the height of the frame above the seafloor. However, there is a risk that the altimeter is measuring a hard rock surface underneath a fluid mud layer. The water depth measurements more than 300 m above the seafloor are determined using a pressure gauge, which is influenced by the salinity, temperature and latitude. At heights from ~ 100m to 300m above the seafloor, a combination of pressure and wire out is used to determine the height above the seafloor. It should be noted that the sample depth is not equal to the water depth, as the Niskin bottles are mounted vertically on the frame, and the instruments measuring the water depth are mounted on the bottom of the frame. The offset is ~50 cm between the instruments and the bottom of the Niskin bottles (~90cm tall).

We did not intend to take many water samples, and samples would only be taken for sediment measurements if the CTD was deployed in a (suspected) turbidity current. We therefore brought limited supplies (12x plastic bottles). Whilst at sea we also decided to collect water samples to test for the presence of microplastics. However, as this was a last-minute plan there were no adequate sampling bottles on board or a procedure in place. Beer bottles, 330 ml, London Pride or Heineken were used. The number of bottles, and water depths we sampled therefore changed between CTD casts.

We used glass (beer) bottles for the microplastic sampling. We scrubbed the labels off, and rinsed with tap water, boiling water and Milli-Q water before use. The caps for the glass bottles was layered tinfoil. The water samples were taken after 5 seconds of free flow of water from the Niskin bottles. The water samples were collected in the glass beer bottles for the microplastic sampling (1 or 3 bottles were collected depending on CTD) or 1 plastic bottle for suspended sediment sampling.

For the microplastics analysis, we also took samples for a standard. This should enable the microplastic input from our lab environment, as well as from the Niskin bottle itself, to be quantified. A Niskin bottle (#1 on frame) was unhooked & rinsed out once with milli-Q water, before filling up the Niskin bottle with milli-Q water (10 litres). Next, the Niskin bottle was left in the lab for 2 hours, to account for the time that would be taken between sampling at depth, resurfacing and subsampling during the normal microplastics water sampling protocol. Samples were taken in 3 beer bottles. (London pride and Heineken) and capped with tinfoil; following the exact same procedure as with the "normal" CTD water samples.

8.4 3.5 kHz sub-bottom profiler (CHIRP)

8.4.1 Previous sub-bottom surveys available to this cruise

Previous sub-bottom profile surveys have been conducted by IFREMER, using a CHIRP sub-bottom profiler (operating at frequencies from 1.8 to 5.3 kHz) between 1992 and 2011.

8.4.2 Aim of Sub-bottom surveying

The 3.5 kHz sub-bottom survey provide an additional dataset to try to understand the architecture of the canyon, including channel levees and terraces. Survey paths for the sub-bottom profiles were the same as the survey paths for the multibeam survey.

8.4.3 Sub-bottom setup and processing

The surveys were performed using a KONGSBERG SBP120 sub-bottom profiler operating in a 2.5-7 kHz frequency range. A narrow beam width of 3° was used to ensure a high-resolution image. Data are automatically corrected for pitch, roll and heave of the ship, and saved in a SEG-Y format.

It is not possible to view SEG-Y files whilst onboard, and therefore it is not possible to analyse the data. However, any descriptions of the data have been made from the central window seen in Figure 5.3.1 below, whilst the data is being collected (Fig. 5.3.1). It may be useful to note that throughout the cruise the 'Automatic Slope Correction' was ticked off. This is because the correction was continually providing wrong depth readings at the beginning of the cruise.

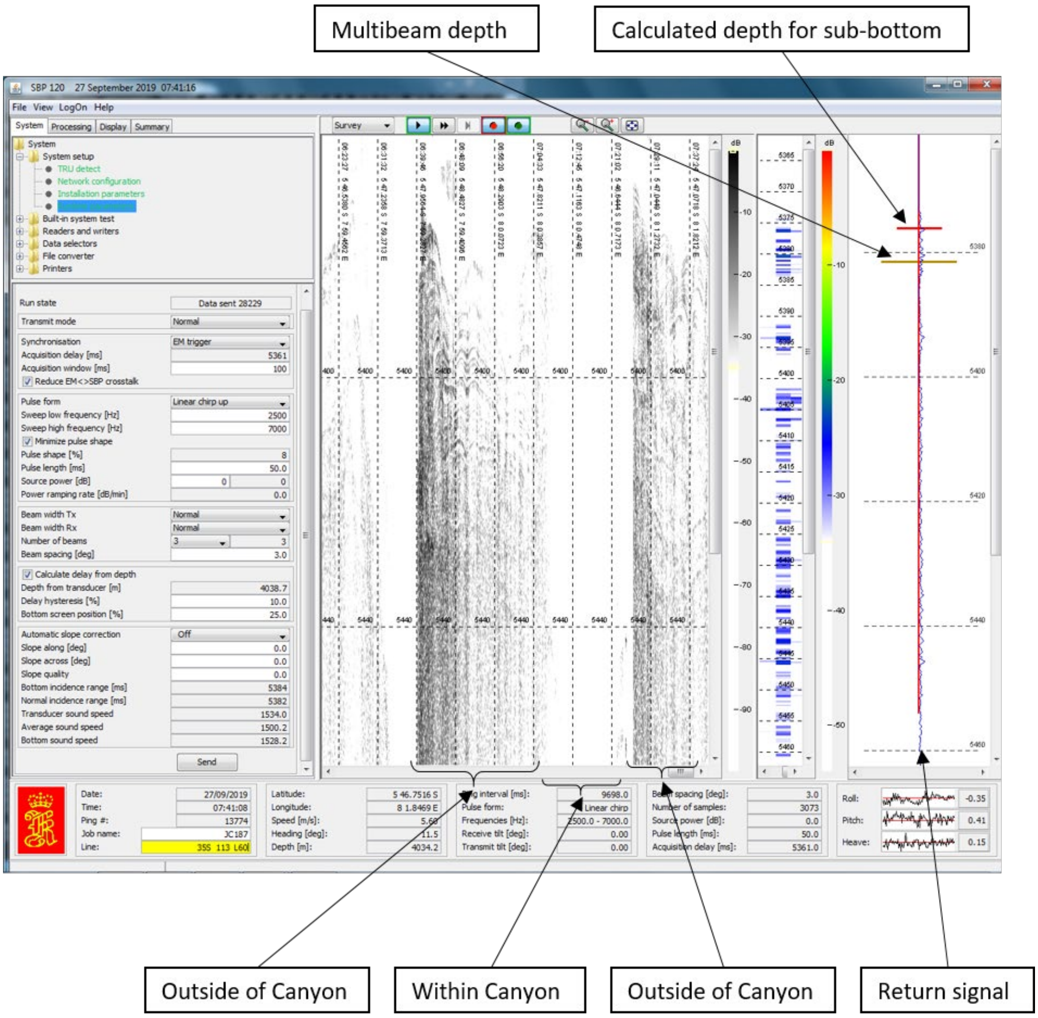


Figure 8.68. *Sub-bottom profile screenshot showing the system settings, as well as the survey data as it is collected. Note the lack of return signal shown within the canyon (white), compared to the data collected outside of the canyon.*

8.4.4 Runtime Parameters

Transit Mode: Normal

Synchronisation: EM trigger
Acquisition Delay [ms]: 1581
Acquisition window [ms]: 100
Reduce EM<>SBP crosstalk: [tick]

Pulse form: Linear Chirp up
Sweep low frequency [Hz]: 2500
Sweep high frequency [Hz]: 7000
Minimum Pulse shape: [tick]
Pulse shape [%]: 8
Source Power [dB]: 0; 0
Power ramping rate [dB/min]: 0.0

Beam Width Tx: Normal
Beam Width Rx: Normal
Number of beams: 3; 3
Beam Spacing [deg]: 3.0

Calculate Delay from depth: [tick]
Depth of transducer [m]: 1199
delay hysteresis [%]: 10
Bottom Screen Position [%]: 25.0

Automatic Slope Correction: Off
Slope along [deg]: 0
Slope Across [deg]: 0
Slope quality: 0
Bottom Incidence Range [ms]: 1607
normal Incidence Range [ms]: 1505
Transducer Sound Speed: 1527
Average Sound Speed: 1492.01
Bottom Sound Speed: 1487.7

8.5 USBL Sonardyne

USBL (Ultra-short baseline) is a range and bearing system that gives an underwater position of an acoustic transponder. The position is determined by measuring the time and phase of the received signal from the transponder by a ship-mounted transceiver, and it requires high quality vessel motion and timing data. The James Cook has two USBL transceivers mounted on retractable spars beneath the aft section of the ship's hull. A standard USBL transponder head is mounted 3.90 m to starboard, and a big head USBL transponder is mounted 1.98 m to port. USBL transponders were deployed during operations included CTD/SVP casts, multi-cores, piston cores and the anchor-first mooring deployments (Aniitra 2 and Aniitra 3).

CASIUS (Calibration of Attitude Sensors in the USBL System) calibration reports are available for both of the James Cook's USBL transceiver units. The reports were compiled from data acquired in November/December 2017 whilst the vessel moved around a transponder deployed on the seabed. Analysis of the observations provides a quantification of errors and corrections to improve the accuracy of the position of the seabed transponder. After application of the CASIUS corrections the error for the standard head transceiver is 0.53 % of depth for 98.2 % of beacon positions, and 1.47 % of depth for 98.2 % of beacon positions for the big head transceiver.

The port (big head) transceiver was initially deployed for USBL positioning during the first stage of the cruise in international waters. The starboard (standard head) transceiver was then deployed for all subsequent positioning in Angolan and International Waters.

8.6 Piston corer

The piston corer used on the James Cook is able to take sediment cores of up to 24 metres. The corer consists of a weight fitted with steel tubes (see Fig. 8.69), surrounding a PVC liner tube. Up to 4 sections of 6 m-long barrels can be fitted depending on the type of sediment being sampled. We typically used a 9 m-long barrel for coring into the canyon floor (which we suspected to be sandy) and a 12 m-long for the lobe, terraces and levees (which we suspected to be muddy). Longer barrels are chosen for softer sediment in order to protect the equipment, the winch onboard otherwise catches most of the force released when the piston is not slowed down by the underlying sediment. The corer is lowered on a wire to the seabed until a trigger weight, suspended from the corer weight, contacts the seabed. This operates a mechanism, which allows the corer to free-fall a distance pre-set by the length of trigger wire and sink into the sediment. The trigger weight captures the top part (~50 cm) of the seabed sediment and can be used as a sediment core, although it can be either disturbed or empty (Fig. 8.69).

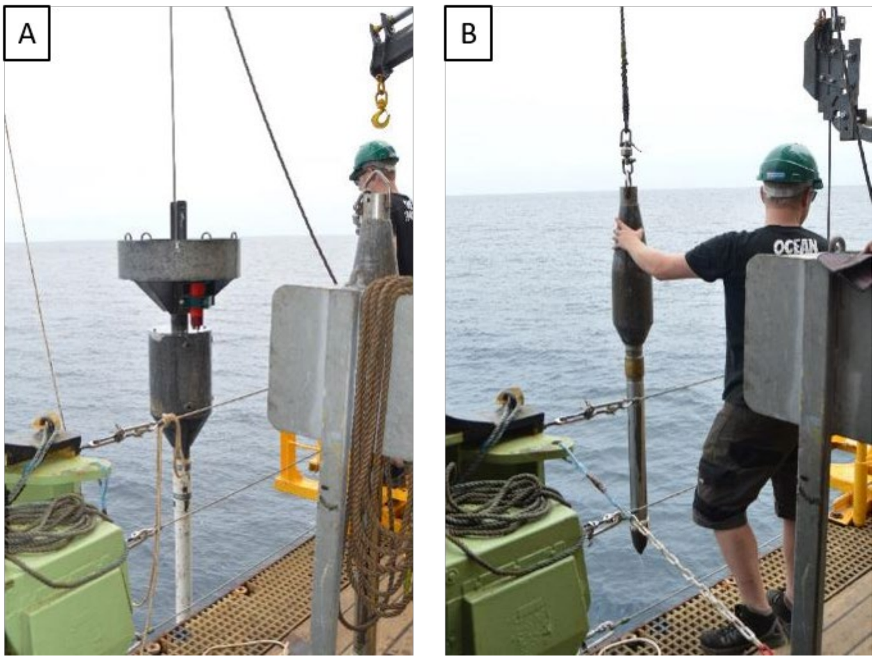


Figure 8.69. *Left: Piston corer at sea surface, Right: Trigger core*

On recovery, the piston core barrel is transferred from the outside of the boat to racks on the deck (Fig. 8.70). The heavy metal cone on the bottom end of the piston core barrel is removed, which includes the core catcher inside. We aimed to collect sediment included in the core catcher located at the bottom of the core if present (Fig. 8.71). Next, we pushed the PVC liner from the top (pulling from the bottom) exposing the PVC liner from the core barrel. (Fig. 8.72). We added a label on the long side (see below), and added a long arrow going through the new and old section, so that sections could be lined up in the lab later on. The PVC liner (containing the sediments) is then cut into 1.5 m long sections, which are typically the section lengths used in BOSCORF. Note that the PVC liner has joints, hence we sometimes had to cut <1.5m long sections in order to cut on joints, as these are a weakness in the liner. Cutting sections required a core cutter; cheese wire in order to separate muddy sections, and end caps (Fig. 8.73). Sometimes blue roll and polystyrene was added to fill gaps on the ends, caused by air or water pockets. Once sections are cut, we put caps on each section end, secured with electric tape (Fig 8.74). We also used hammer and nail, to create a hole in the end caps, ensuring the core sections can depressurise and release gasses, without expanding (i.e. popping the caps off).

Each section was labelled as follows: JC187 – PC *X* – Section *letter* to *letter* – Section depth (measured from top to bottom once all sections are cut); *X* is the piston core number; *letter* starts from A = bottom. Section depth starts from the top (=0cm), and is cumulative downward. Section A is therefore the deepest end of the piston core (see Fig. 8.75).

We did not have any core splitting equipment on board, so all preliminary findings are based on observations on the section interfaces, and success of piston core penetration into the seabed.

Figure 8.70. *Core is being put on deck*

Figure 8.71. *Collection of the core catcher sample into a plastic bag*

Figure 8.72. *Core on stand, ready to be removed from the steel tube barrel and split into sections*

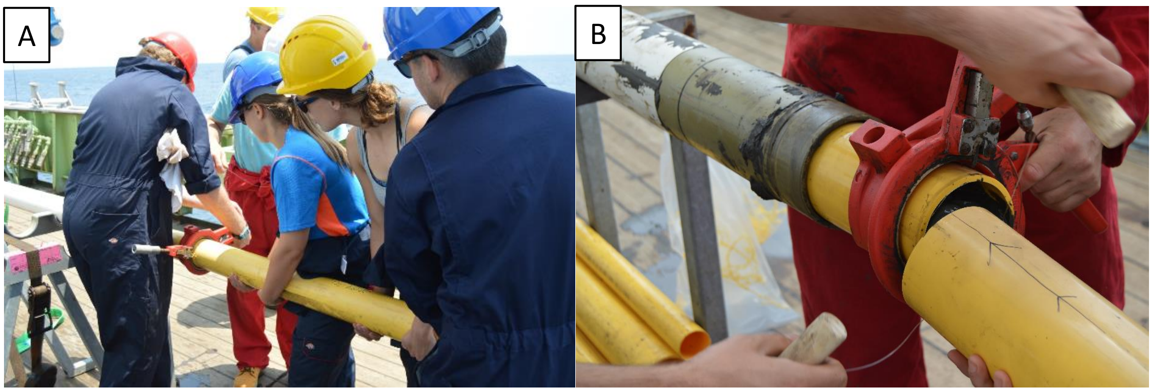


Figure 8.73. *Cutting of core into 1.5 m sections, and use of a cheese wire.*

Figure 8.74. *Caps are put at the ends of each section*

Figure 8.75. *Labelling on each section (arrow pointing towards the top).*

8.7 Mega-corer (interface corer)

8.7.1 Aim of mega-core sampling

Multi-cores are able to take high-quality, undisturbed samples of the top ~0.6 m of the seabed and preserve the seabed-water interface. Multiple transects of mega-cores were collected to compare the channel thalweg and channel terraces; cores were also taken on the lobe. The mega-cores were collected to try to answer the following questions:

1. What are the depositional, sedimentological properties of the cores in the sub-environments of the canyon and can the depositional signatures be linked to flow processes?
2. How is organic carbon transported within the Congo Canyon?
3. Are microplastic present in the surface deposits within the Congo Canyon?
4. Can these cores be dated to improve our understanding of the Congo Canyon?
5. What is the distribution of EPS and clay mineral types within the Congo Canyon?

8.7.2 Mega-core deployment

A mega-corer is an instrument to which up to 12 core tubes can be attached; eight cores were attached to the frame for this cruise. Each tube has a diameter of 110 mm and a length of 600 mm. The multi-corer is deployed by lowering the frame on a winch to the seafloor at a speed of 50 m/min (Fig. 8.76 pushes the assembled cores into the sediment whilst the frame remains on the surface (Fig. 8.77). As the cores descend into the sediment, the top of the core is sealed with a lid, creating a vacuum. The cores are then lifted out of the sediment and as soon as the core is free of the seabed, the bottom seal snaps over the base of the core. The locking mechanism of both the top lid and bottom hatch is activated by the friction of the sediment, but when the core descends into fluid mud, the friction may not be high enough for the locking mechanism to be activated, resulting in over penetration. Over penetration of the multi-corer occurred at the first site, so a square wooden frame was fixed to the base of the frame to help the frame sit on the seabed and prevent further failed recoveries. The mega-corer uses a unique hydrostatic damping system that slows the penetration rate down to approximately 10 mm/s.

When the mega-corer arrives on the deck, the cores are carefully removed from the frame and a rubber bung is placed into the base of the cores to hold the sediment in place (Fig. 8.77B, C). If seawater is present on top of the sediment within the core, this is carefully removed without disturbing the underlying sediment by siphoning with a small-diameter rubber tube. The cores are sampled by taking sub-cores or by taking syringes at specific sections within the cores. These methods are outlined below.

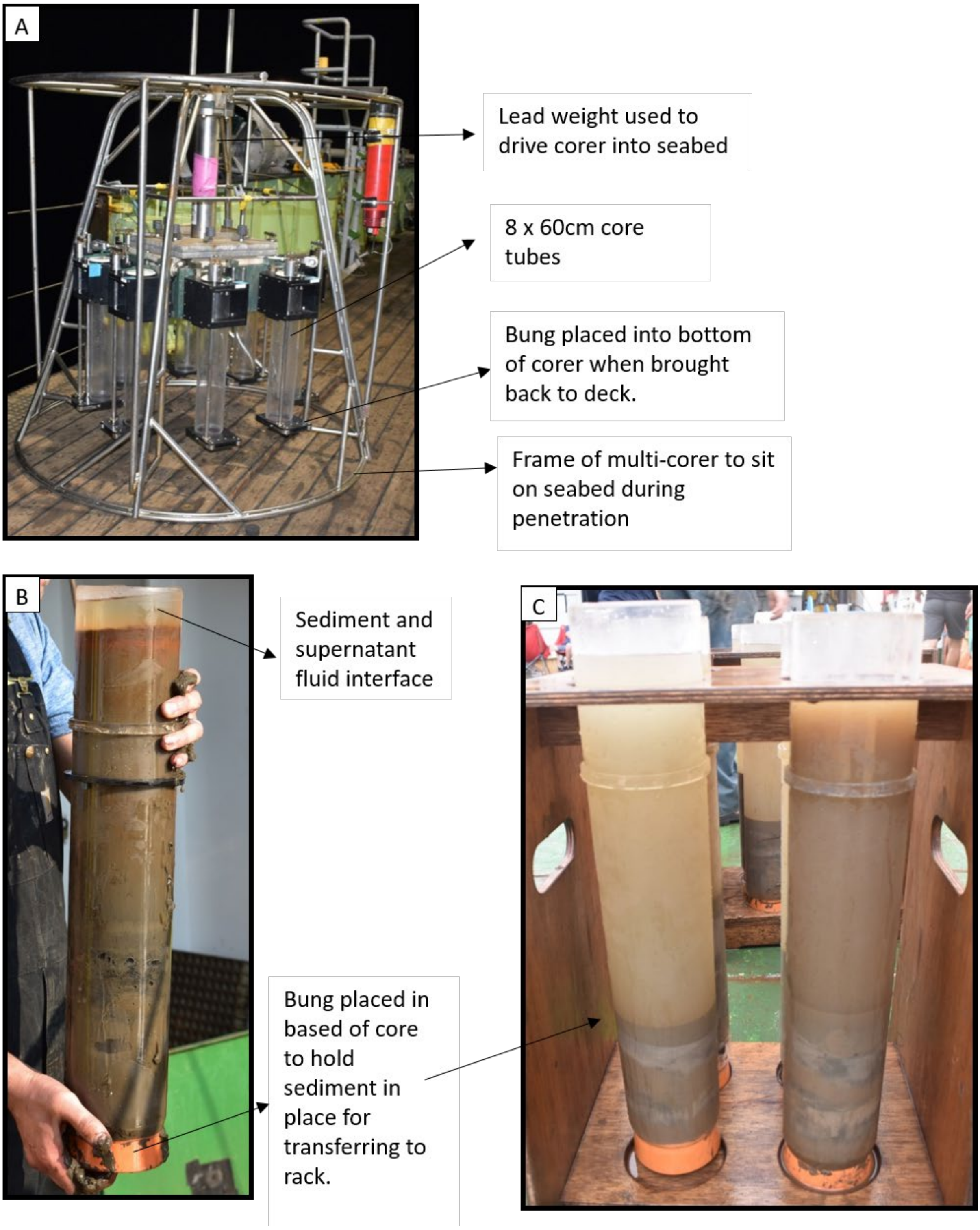


Figure 8.76: *Sequence of events to obtain multicores: A) the multi-core prepared and ready to be deployed, B) Multicore back on deck, C) sediment cores are placed into the wooden rack with the bungs in place.*

8.7.3 Subsampling using Trigger Weight Core liner

To look at the sedimentology of the cores, the organic carbon, microplastics and dating (questions 1 to 4 in section 6.8.1), sub-cores of multi-core tubes were taken using trigger weight core (TWC) liner. The TWC liner had a length of 0.6 m and a diameter of 60 mm. The liner was cleaned to remove grease and loose plastic before use. The TWC liner is slowly pushed into the centre of the multi-core through to the base of the tube (Figs 8.76, 8.78A). If there is any space between the sediment and the top of the TWC liner, the gap is filled with a polystyrene disks and blue roll. The top of the TWC liner is capped and labelled as the top (Fig. 8.78B). The TWC and multi-core tube are then carefully flipped upside down simultaneously (Fig. 8.78C). The bung at the base of the multi-core is removed and the base of the TWC liner capped. The TWC liner is then carefully removed by holding the base of the liner and lifting up the multi-core tube (Fig. 8.78D). The core is cleaned and the caps secured with tape (Fig. 8.78E, F). After labelling, the cores are stored in the refrigerated reefer. Four sub-cores were taken for MC-02 to MC-04 and MC-25. To avoid running out of trigger weight core liner, the number of sub-cores was reduced to three for MC-05 to MC-08, MC-10 to MC13, MC-16, MC-18 to MC-22, and MC-24. The following multi-cores were not successful in collecting 8 cores and the following sub-cores were taken: 2 sub-cores for MC-09, MC-15 and MC-17, 1 sub-core for MC-23, and no sub-cores for MC-01 and MC-14. MC-18

Sub-sampling trigger cores (yellow) that are carefully pushed into the multi-corer tubes.

Figure 8.77: *sub-sampling of the multicores.*


A
B
C
D
E
F

Figure 8.78: *Photos demonstrating taking sub-cores using the trigger weight core liner. A) The core liner is slowly pushed into the centre of the multi-core. B) A cap is placed on the top of the core and labelled as the top of the core. C) The multi-core and core liner have carefully been turned upside down and the bung is removed. D) The core liner is held securely upright and the multi-core is pulled up. E) The base of the cap is cleaned and labelled. D) The completed sub-cores with the caps securely taped.*

8.7.4 Subsampling for EPS and Clay Minerals

8.7.4.1 Aims and Objectives

How is detrital clay and EPS distributed in a turbidity system? What are the implications for flow behaviour, erodibility and how might that affect post-depositional fluid pathways?

When detrital clay (or early diagenetic) forms a thin coat around sand grains this inhibits blocky cement (such as quartz) formation and hence preserves the porosity to greater depths below "economic basement". Therefore, if we can predict the spatial distribution of detrital clay coats, we can also predict the distribution of porous intervals in subsurface. However, the attaching mechanism of clays on sand grains is not fully understood yet. Recently few studies showed that extracellular polymeric substance (EPS), secreted by diatoms or bacteria, is one of the key elements in the attaching process. This hypothesis will be tested by combining clean microbiological lab experiments with observations from recent systems.

The role of even small amounts of EPS has been documented to provide a strong control on erodibility (i.e. it binds the sediment and inhibits erosion) and may even regulate flow behaviour (enhance cohesion), but no studies to date have quantified the amount of EPS in turbidite systems or the deep-sea. Our new samples therefore provide a valuable opportunity to make these first measurements.

The high-resolution sampling allows us to understand how the productivity of EPS varies from the sediment-water interface and within the sediment by centimetre intervals. It is still not fully understood how EPS impacts sediment stability/erodibility so capturing these high resolution horizons allows us to study the differences in EPS by depth and the implications for associated mineral distributions. As the clay samples have been taken at exactly the same depths, the relationship between the distribution of clays, mineralogy, EPS and grain size can be investigated. This study can help up further our understanding on the cohesion of sediment and how this impacts turbidity currents.

8.7.4.2 Sub-sampling method

Sub-sampling for EPS and clays was undertaken using "mini-cores" in the form of 8.5 cm long plastic syringes. The reasoning behind these mini-cores is to take undisturbed sediment samples from each selected horizon in each core. In the laboratory, each syringe sample can be cut into centimetre sections and analysed by depth. If the cores were composed of homogenous mud, the syringes were pushed into the sediment at 0-10cm cm, 10-20 cm, 20-30 cm and 30-40 cm depth intervals to capture any potential differences in the clay composition and EPS abundance with depth. If the core contained heterogeneity, the syringes were occasionally taken at greater depths or at different points. The syringes often caught ~6 cm of the sediment, but this varied depending on the consistency of the sediment. At each depth, 2 syringes were taken for EPS analysis and 2 were taken for clay mineral analysis.

To take the sub-samples for EPS and clays, the tube was placed onto a core stand by removing the bung at the base of the tube and quickly sliding the tube onto the stand (Fig. 8.77, Fig. 8.78A). Sometimes some sediment was lost from the base of the tube during this process. The diameter of the core stand was slightly less than that of a multi-core tube, this allowed the tube to be pushed down the core stand and sediment extruded from the top of the tube. A ring 10 cm high was used to divide the tube into the 10 cm slices that the syringes were pushed into. The ring was placed exactly on the top of the multi-core (Fig. 8.78B). When the tube was pushed down the core stand, the top of the core was pushed into the 10 cm-high ring (Fig. 8.78C). When the sediment reaches the top of the ring, a core slicer was pushed between the top of the multi-core and the base of the 10 cm ring (Fig. 8.78D). This 10 cm slice could then be subsampled by pushing the syringes into the top of this slice (Fig. 8.78E). To preserve the EPS, the EPS cores were frozen at -20 C. The cores for clay mineral analysis were kept refrigerated in the reefer.

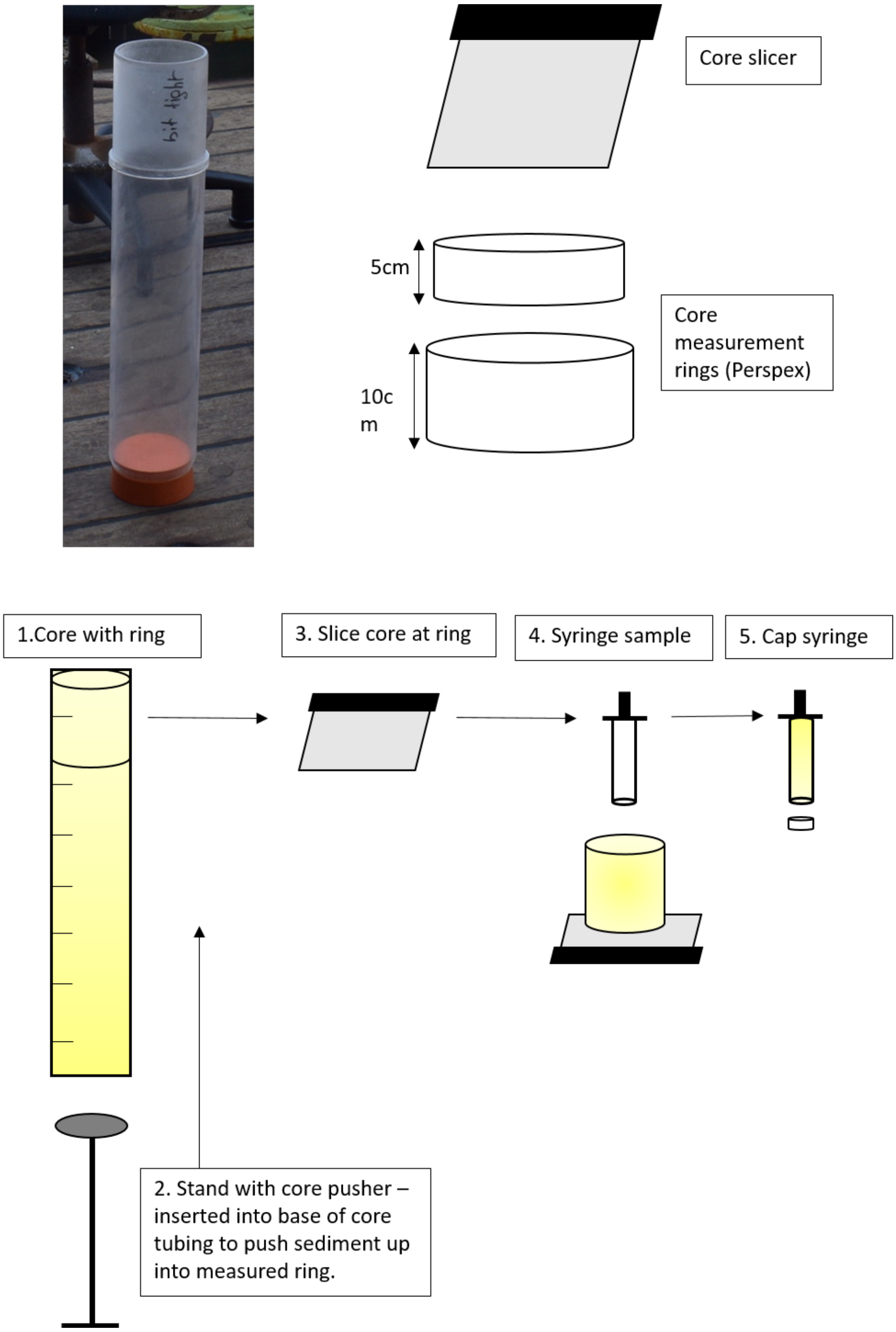


Figure 8.79: *Method to subsample cores for EPS and clay. See text for details.*

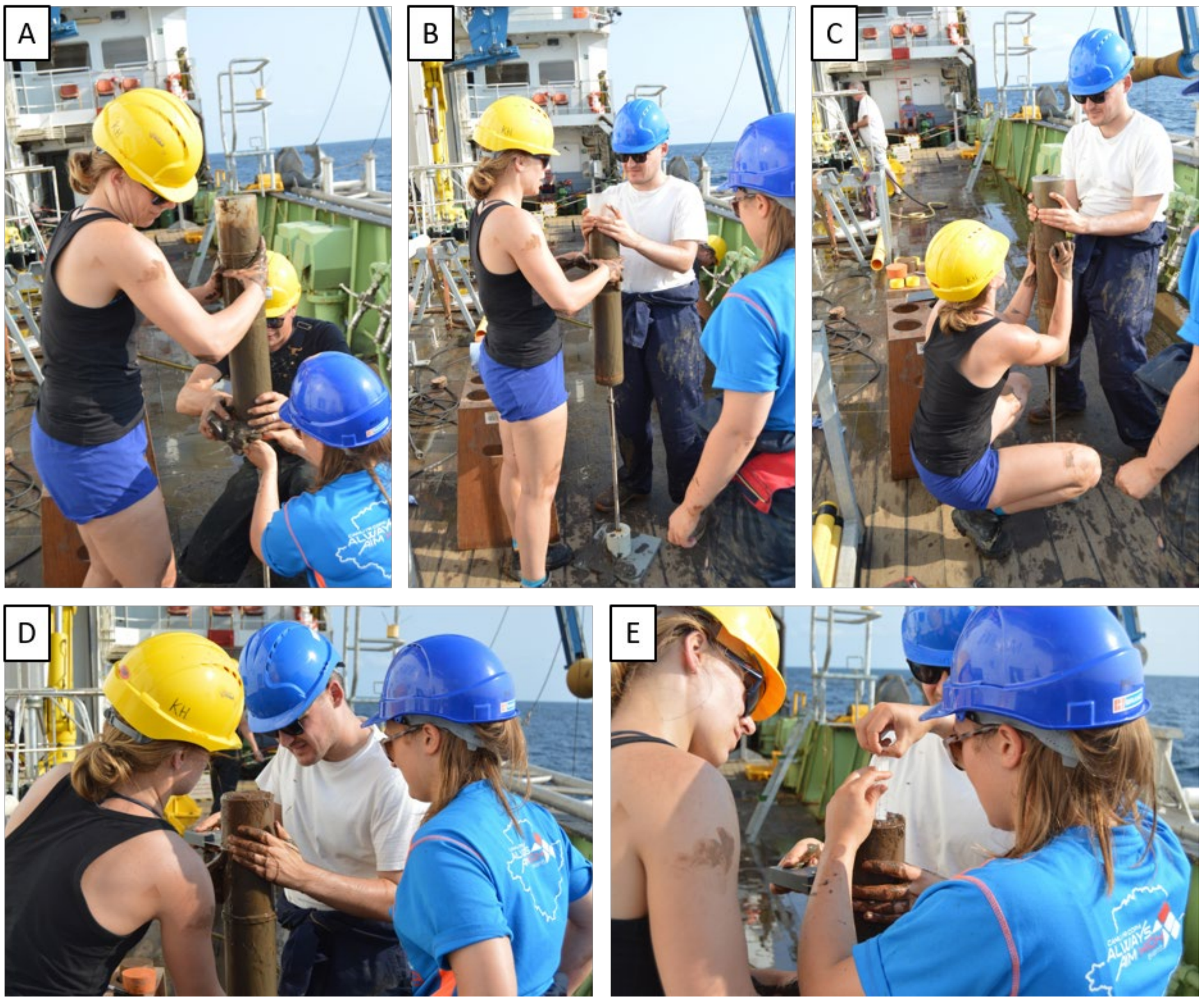


Figure 8.80: *Photos of the method for sub-sampling the multi-core for EPS and clay: A) the multi-core is quickly slid onto the core pusher; B) the 10 cm-high ring is placed on top of the multi-core; C) the multi-core is pulled down and sediment enters the ring; D) a core cutter is pushed through the gap between the top of the multi-core and the ring; E) syringe is pushed into the top of the 10 cm slice of sediment.*

8.8 Ocean Bottom Seismometers

Ocean Bottom Seismometers (OBS) contain a geophone to measure ground motion, and a hydrophone to measure acoustic noise in the water column. Typical (OBS) deployments are either active or passive seismic surveys. Passive seismicity aims is to record earthquakes below the seafloor. However, our aim is to determine whether hydrophones or geophones in the OBS can record turbidity currents moving down the canyon. This would be important because it could lead to ways of 'listening' for turbidity currents remotely, with sensors located safely outside the flow path.

The deployment sites of OBSs was thus chosen to be close to the channel, but not on the channel-floor, to safeguard the OBS equipment. Proximity to the channel is important to obtain the strongest possible signal from passing turbidity currents.

OBS deployments were conducted by OBIC (Ocean Bottom Instrumentation Consortium). A 20-foot container was shipped to Southampton for the port call, containing 15 OBS as well as the associated anchor weights, tools and equipment needed for deployments. Each standard OBS consists of a geophone pack with 3 Sercel L-28 geophones and a Hi-Tech HTI-90U Hydrophone, as well as an OBIC proprietary GPS-synchronised data recorder, and an acoustic burn-wire release unit.

The geophones have a resonant frequency of 4.5 Hz and a flat response to 1 kHz. The hydrophone has a flat frequency response between 2Hz and 20 kHz. For this deployment, the upper frequencies of both sensors were limited by the sampling rate of the data-logger. At a sampling rate of 1 kHz frequencies up to ~350 Hz should be recorded.

OBIC deployed 10 standard OBSs, recording three geophone channels and one hydrophone channel, all at 1 kHz, and outfitted with 512GB of storage. A sampling rate of 1 kHz is chosen out of battery and memory considerations. The battery life is expected to be roughly 8 months. The geophones are gimballed, so no matter the orientation of the OBS frame, the geophone itself will be level.

In addition, OBIC deployed four prototypes for a period of 18 days (12/09/2019 – 29/09/2019). These were similar to standard OBSs but with additional sensors such as Fluxgate magnetometers, and pressure gauges manufactured by Keller and Paroscientific.

Additionally, OBIC helped to prepare and deploy 2 GEOMAR OBSs. The GEOMAR OBSs were mounted with a Hi-Tech HTI-04 hydrophone and a three channel Owen (4.5Hz) Geophone, recording at 1 kHz onto 512GB of storage. The hydrophone can record lower frequencies than the hydrophone on the OBIC OBS. The geophones are not gimballed, and will remain with the same orientation as the OBS frame itself.

The following figures show the locations of OBSs deployed in Congo Canyon. This includes 2 German OBSs and 10 OBIC OBSs. Figure 8.81 shows the total array. Figure 8.82 shows all deployments in international waters, which includes most instruments: 2 German OBSs; 4x Prototype OBS and 5 standard OBIC OBSs. Figure 8.83 shows the upper canyon (OBIC OBS 1-4) only. Figure 8.84 shows OBIC OBS-5 only, and gives a clear idea of OBS deployment location relative to the canyon.

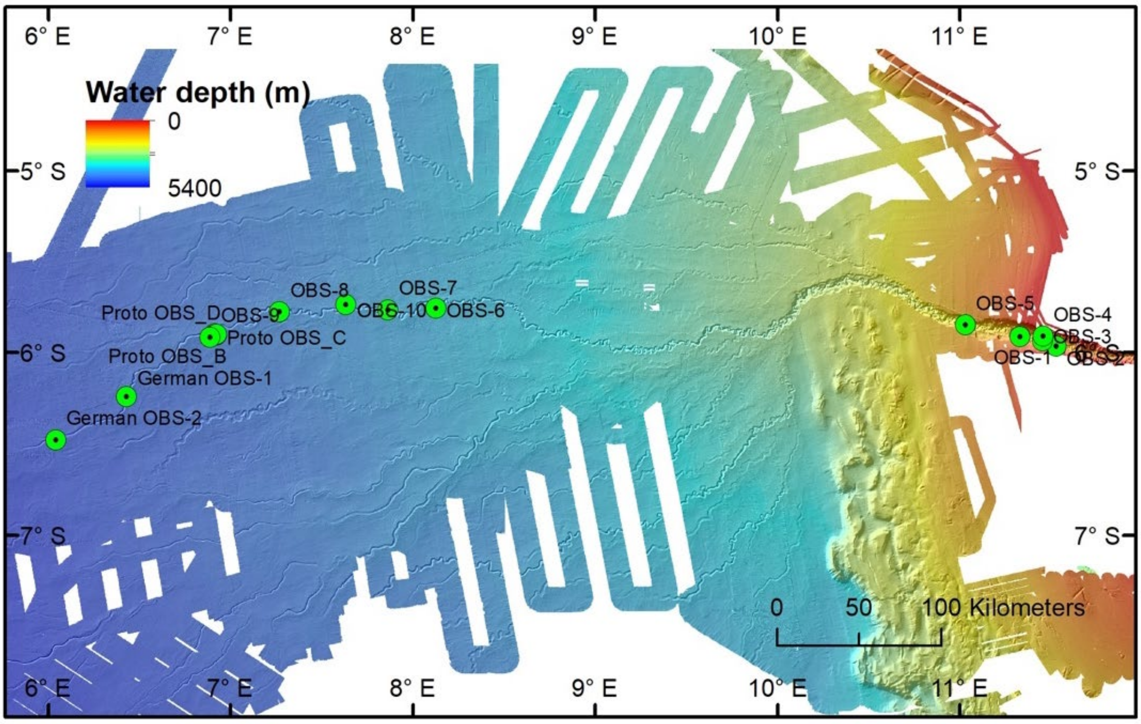


Figure 8.81. *Map of total distribution of OBS.*

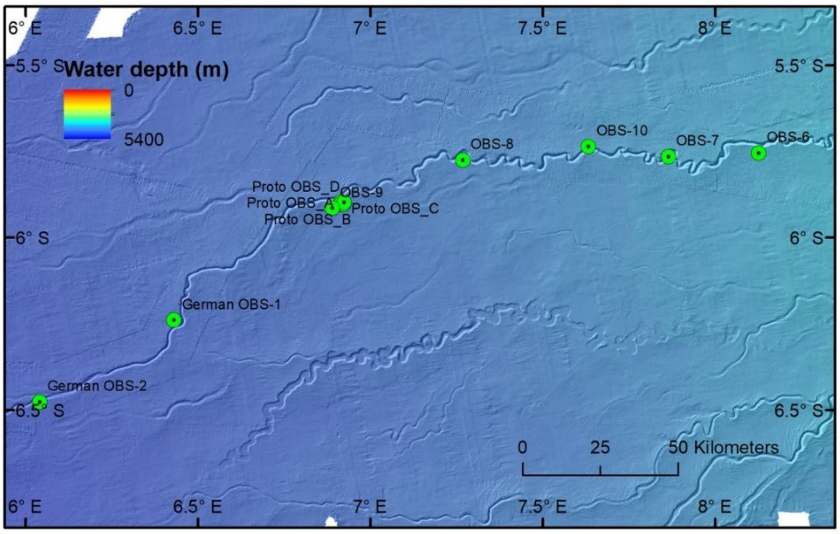


Figure 8.82. *Map of distribution of OBS within International Waters.*

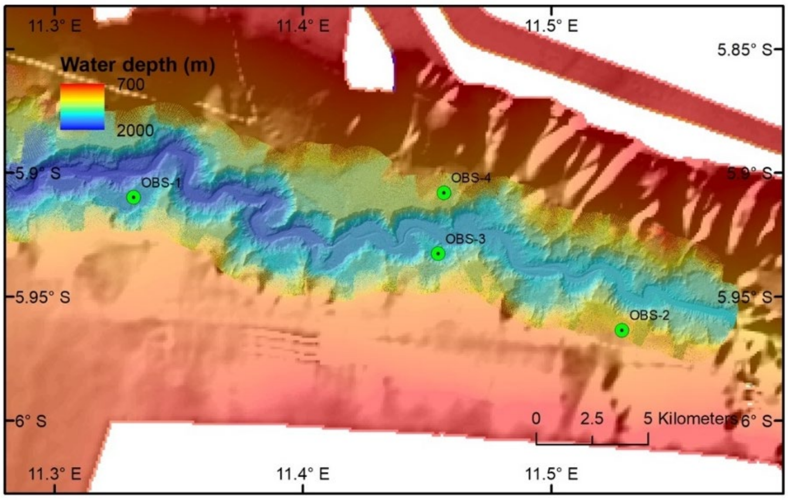


Figure 8.83. *Map of distribution of OBS in upper Upper Canyon within Angolan Waters.*

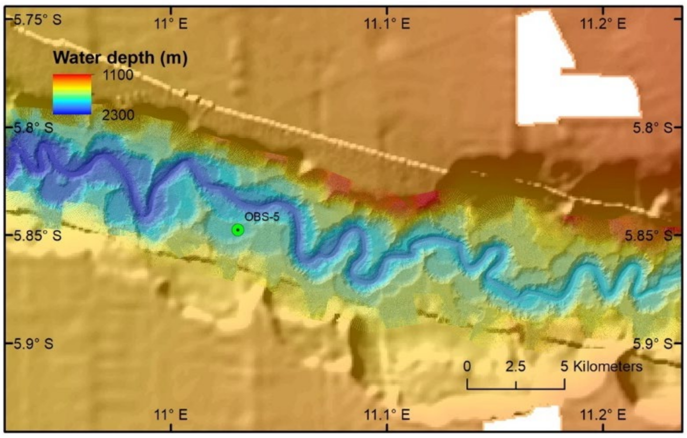


Figure 8.84. *Map of distribution of OBS in lower Upper Canyon within Angolan Waters*

8.9 Vertical Hydrophone Array

OBIC also provided a Prototype Vertical Hydrophone Array (VHA). Usually, a VHA is used during active OBS deployments, to characterise an airgun signature. In our case, we are leaving the VHA on the seafloor, and trying to increase our chances of a clear line of sight by deploying multiple stacked hydrophones, covering ~56 vertical metres.

The VHA comprises 16 of the same hydrophones used in OBS. They are Hi-tech HTI-90U hydrophones, built into a purpose-built mooring cable at a 4m spacing, and data recorders at either end, also recording at 1 kHz with 512 Gb of storage. Each hydrophone has a flat frequency response between 2 Hz and 20 kHz. For this deployment, the upper frequencies of both sensors were limited by the sampling rate of the data-logger. At a sampling rate of 1 kHz, frequencies up to ~350 Hz should be recorded.

As this was the first deployment of the VHA system, it was initially deployed for 5 days (17/09/19 to 21/09/19) to test the buoyancy, deployment and recovery methods and data quality. The data initially appears to be of good quality, with apparent signals and features. On section 2 of the VHA, 4 hydrophones were removed in order to save battery power, extending the data recording duration.

The VHA was then redeployed on 22/09/2019. The VHA contains 12 hydrophones, each recording at a different channel. The data is collected by a 4 channel logger (with an expected battery life of ~8 months) and an 8 channel logger (with an expected battery life of around 5 months). Within the VHA every fourth channel has double gain in case the signal of turbidity current flow is very quiet.

9 Preliminary Findings

9.1 Moorings

In most cases, there are no preliminary findings from moorings because they were only deployed onto the seabed. The moorings will be recovered by a subsequent cruise in Oct-Dec 2020, when their data can be downloaded. However, during JC187, we did briefly recover NERC Mooring 8 at Mooring Site 8, before moving it to Mooring Site 4. We can therefore discuss the initial three weeks of data collected by Mooring 8, but no turbidity currents occurred at this most distal location at ~5 km water depth.

9.1.1 Mooring site 8

The water column backscatter was exceptionally low, and velocity measurements only passed the threshold criteria in the upper ~20 m of the imaged water column. There is no discernible movement in the water column during the deployment period, and extremely low levels of backscatter due to what must be very low levels of suspended sediment.

9.2 Sediment Cores

The following sections provide a preliminary description of each core and its location; including photos, locations, GIS maps and cross-section profiles. Table 9.1 and 9.2 respectively provide an overview of all the multi-cores and piston cores taken during JC187. The sediment cores are subdivided in two sections, within Angolan waters and international waters.

Table 9.1: *Multi-core information. For further details please refer to master excel spreadsheet.*

CORE NAME	SITE	ENVIRONMENT	NO. OF CORES
MC-01	42	Lobe	0
MC-02	42	Terrace	4
MC-03	58	Southern Terrace	4
MC-04	77	Thalweg	4
MC-05	49	Thalweg	3
MC-06	90	Terrace	3
MC-07	51	Terrace	3
MC-08	66	Thalweg	3 at 30cm recovery
MC-09	93	Thalweg	0
MC-10	96	Low Terrace (20m above Thalweg)	3
MC-11	87	Terrace	3
MC-12	48	Terrace	3 at 40cm recovery
MC-13	99	Thalweg	1 at 20 cm recovery
MC-14	99	Thalweg	5 sediment bags
MC-15	45	S. Terrace +50m above thalweg	2
MC-16	97	Thalweg	3
MC-17	98	Thalweg	3
MC-18	92	Thalweg	3
MC-19	107	Meander bend thalweg	3 at 20cm recovery
MC-20	108	Meander bend thalweg	3 at 20cm recovery
MC-21	109	Meander bend thalweg	3 at 50cm recovery
MC-22	110	Thalweg of meander	3 at 30cm recovery
MC-23	32	Thalweg	1
MC-24	53	Terrace	3 at 40 cm recovery
MC-25	54	10km away from channel	4 at 40 cm recovery

Table 9.2: *Piston core information. For further details please refer to master excel spreadsheet.*

CORE NAME	SITE	ENVIRONMENT	NO. OF SECTION	LENGTH (M)
PC-01	42	Lobe	7	9.5
PC-02	58	Terrace	8	9.9
PC-03	77	Thalweg	2	1.9
PC-04	49	Thalweg	6	7.7
PC-05	90	Terrace	8	10
PC-06	51	Terrace	8	10.5
PC-07	66	Thalweg	5	6.5
PC-08	93	Thalweg	6	8
PC-09	96	Low terrace	8	9.6
PC-10	87	Terrace	11	15
PC-11	48	Terrace	11	14.8
PC-12	99	Thalweg	3	4
PC-13	45	Terrace	8	10.6
PC-14	97	Thalweg	2	2.8
PC-15	98	Thalweg	2	1.4
PC-16	106	Thalweg	1	1.5
PC-17	92	Thalweg	7	9.5
PC-18	32	Thalweg	6	7
PC-19	53	Terrace		
PC-20	54	10km away from channel	11	14.4

9.2.1 Upper Canyon (Angolan waters)

In total, 18 multi-cores and 14 piston cores were collected in the Angolan waters (Fig. 9.1).

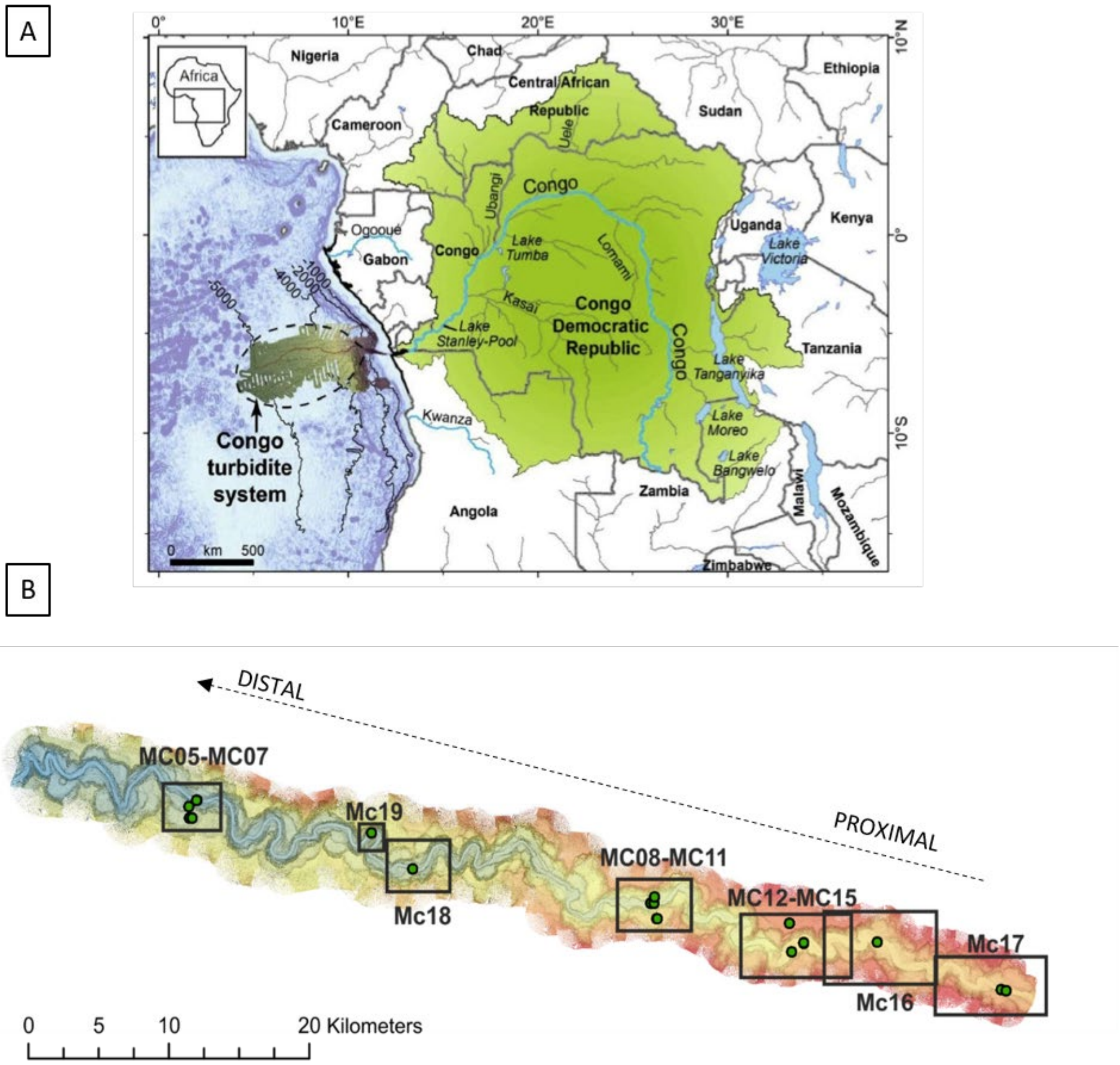


Figure 9.1: *A) Location of the Congo Canyon, offshore Congo and Angola, and the Congo Turbidite Study area. B) The proximal 2019 bathymetry study of the Angolan territorial waters, showing the proximal to distal coring locations (MC-17-05) and their associated depositional environments.*

9.2.1.1 MC17 & PC15, PC16 at Site 98

This site is the most proximal in the upper-canyon, and was taken in the centre of the straight part of the thalweg. MC17 is around 20 cm of greyish muds at the base overlain with 40 cm of homogenous brown muds. The barrel of PC15 was bent on recovery, suggesting a sandy seafloor. A 1.36 m long section was saved, which included sand, mud and organics. PC16 was a repeat from PC15. Only one 1.5 section was sand was recovered.

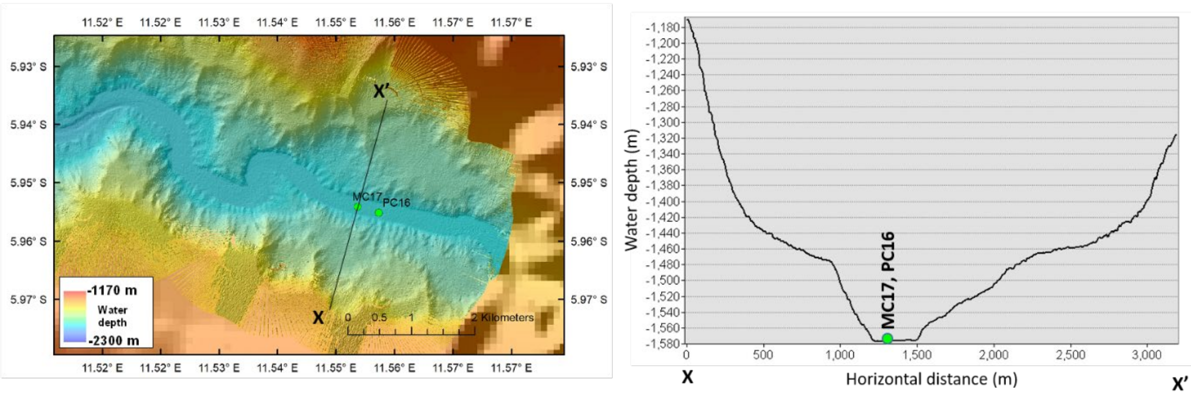


Figure 9.2: *Left: Zoom-in showing location of MC17 and PC15-16. Right: Cross canyon profile at the location of MC17 and PC15-16.*

MC – 17 – SITE – 98 – thalweg – core consists of greyish muds at the base with a sharp contact between upper homogeneous fluid muds**.**

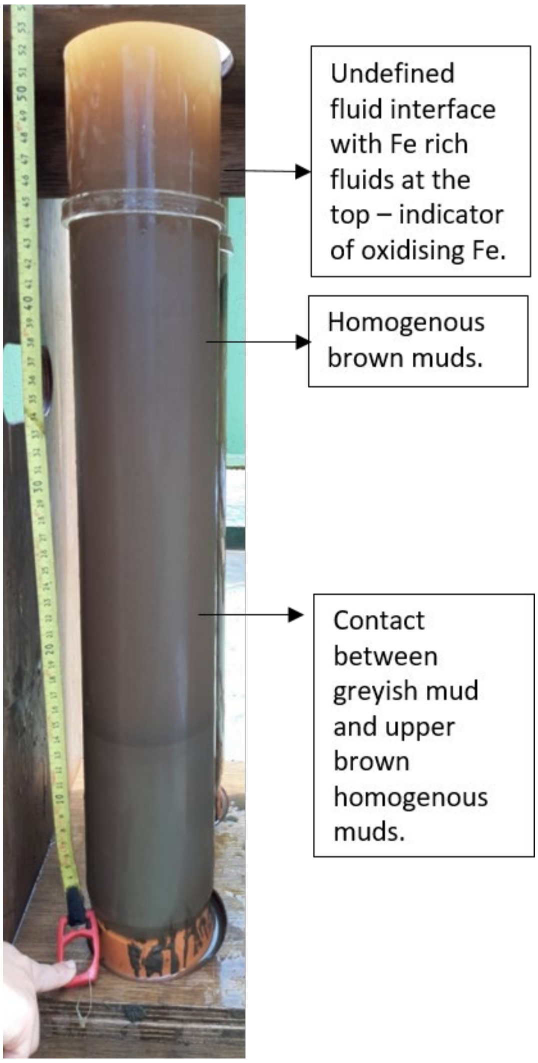


Figure 9.3: *Picture of MC17.*

9.2.1.2 MC16 & PC14 at Site 97

This coring site is located 7-8 km downstream of MC17. The lower 10cm of the MC16 has rip up mud clasts of organic rich mud and overlain with brown homogenous muds. The interface appears erosional and the mud clasts imply erosion taking place. PC14 is 2.8 m long, and is not yet split open.

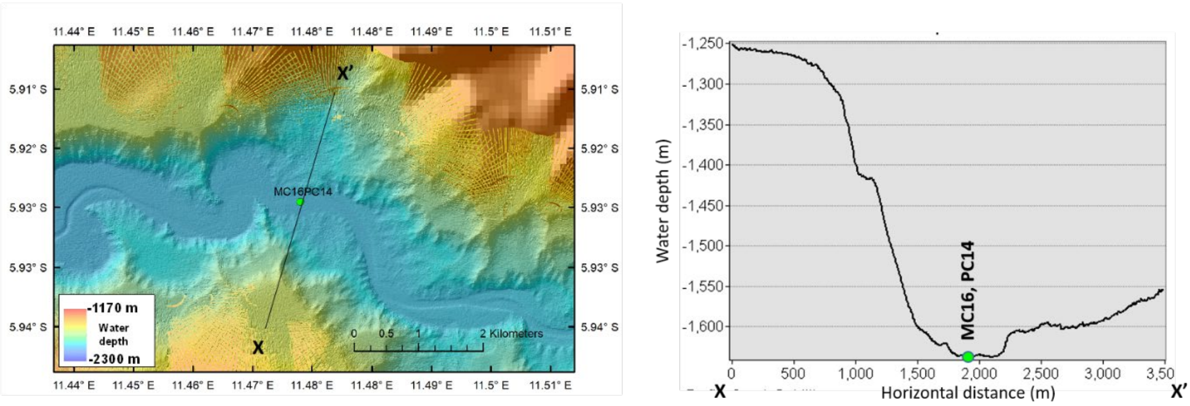


Figure 9.4: *Left: Zoom-in showing location of MC16 and PC14. Right: Cross canyon profile at the location of MC16 and PC14.*

MC – 16 – SITE – 97 – Thalweg – Brown mud grading down into terrestrial rich organic horizon with extremely dark mud rip up clasts which were very well consolidated

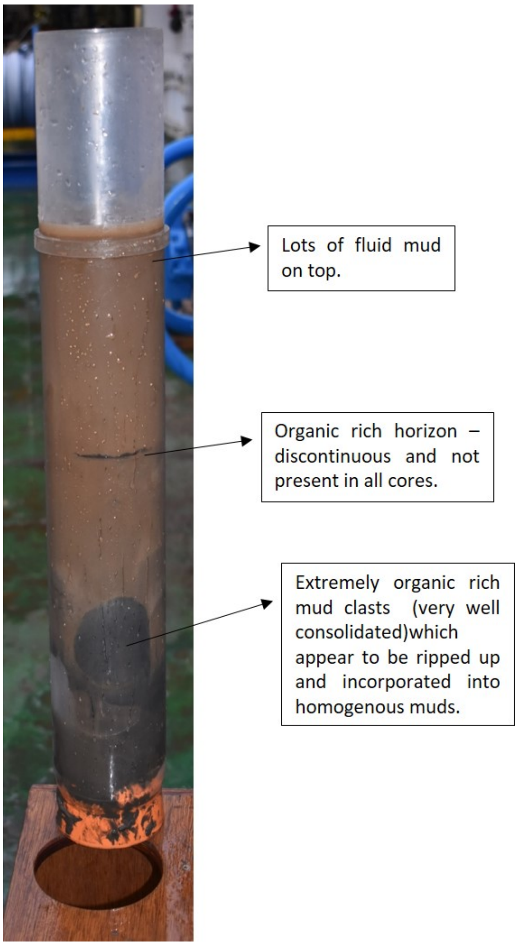


Figure 9.5: *Picture of MC16.*

9.2.1.3 MC12 to 15 & PC11 to 13

These cores are located around 5 km downstream from multi-corer 16, between mooring sites CD and 2C, near where a landslide has recently blocked the canyon. The cores form a channel transect within the thalweg, and also including the terrace. The 4 multi-cores show similarities in that they are organic rich based with abundant terrestrial material and some sandy horizons overlain by fluid rich mud and oxidised at the fluid interface. PC11 is ~15 m long and include very compacted muddy core sections. All sections expanded by around 2-3 cm from their ends. PC12, located on the channel thalweg, is 4 m long. It is probably made of loose sand (lots of water was present in all sections, and core catcher was sandy). PC13 is 10.6 m long and is made of muddy sections.

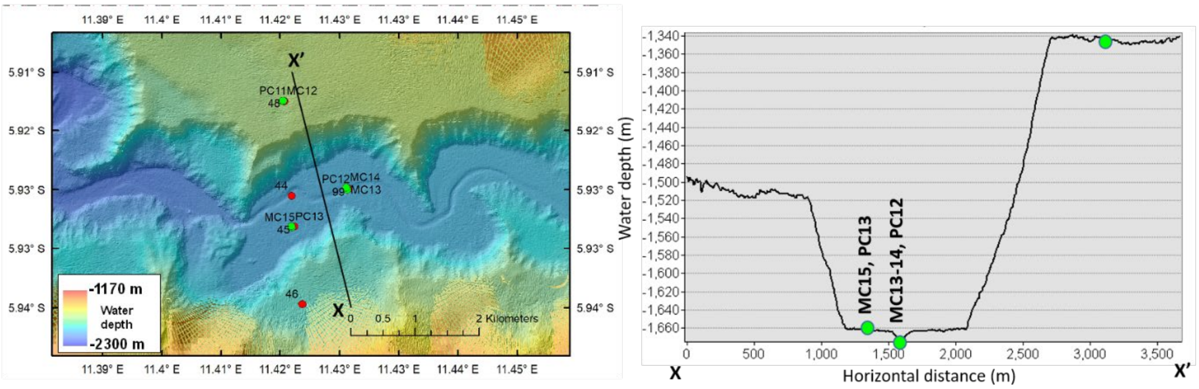


Figure 9.6: *Left: Zoom-in showing location of MC12 to 15 and PC11 to 13. Right: Cross canyon profile at the location of MC12 to 15 and PC11 to 13.*

MC – 13 – SITE – 99– thalweg core TRANSECT – Homogenous brown mud with some terrestrial organics and a sandy horizon close to base of core

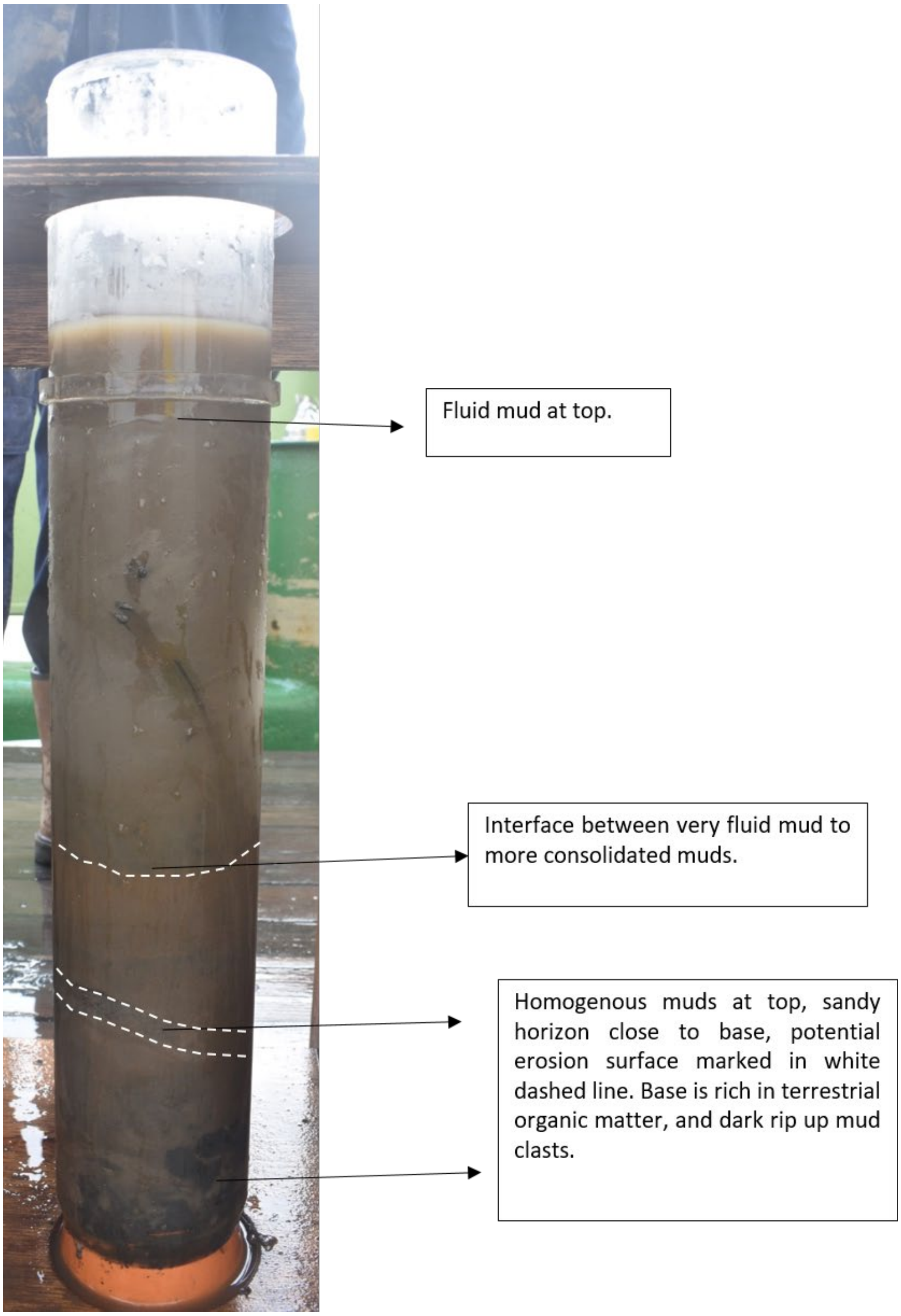


Figure 9.7: *Multicore 13 at Site 99.*

MC – 14 – SITE – 99– Thalweg core TRANSECT - Repeat of MC-13 – Extremely dark/black organic rich mudstone with black rip up mud clasts and some sands.

Figure 9.8: *Multicore 14 at Site 99.*

MC – 12 – SITE – 48– Terrace TRANSECT – Homogenous muds with 10cm Fe staining at the top. Some feint muddy clasts inside core liner.

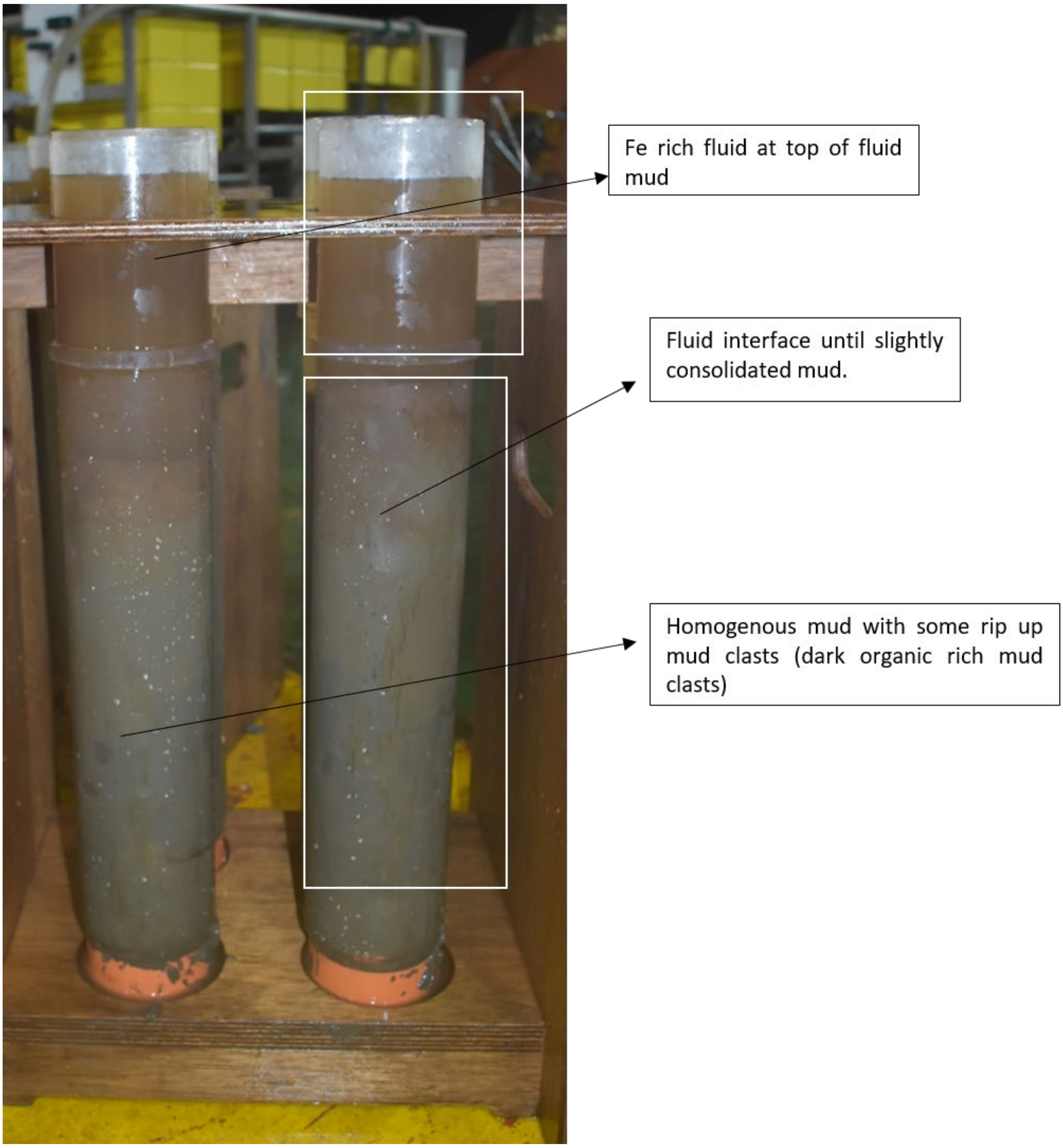


Figure 9.9: *Multicore 12 at Site 48.*

9.2.1.4 MC08 to 11 and PC07 to 10 at Site 66, 93, 96 & 87.

These cores are located near Mooring Site 2C. The thalweg multi-cores have a sandy base, rich in terrestrial organic material. MC-8 had around 25cm of sandy interbeds with mud and the others were dominated by compact organic rich muds. MC-11 in the terrace is dominated by fluid mud and didn't appear to have much sand. PC07 is 6.5 m long. The base section (AB) seems to be sandy and woody. No note on the rest of the sections. PC08 is 8 m long, and mud was covering the piston corer and trigger corer. PC09 and PC010 are 9.6 m and 15 m long respectively. Both cores seem to include only muddy sections.

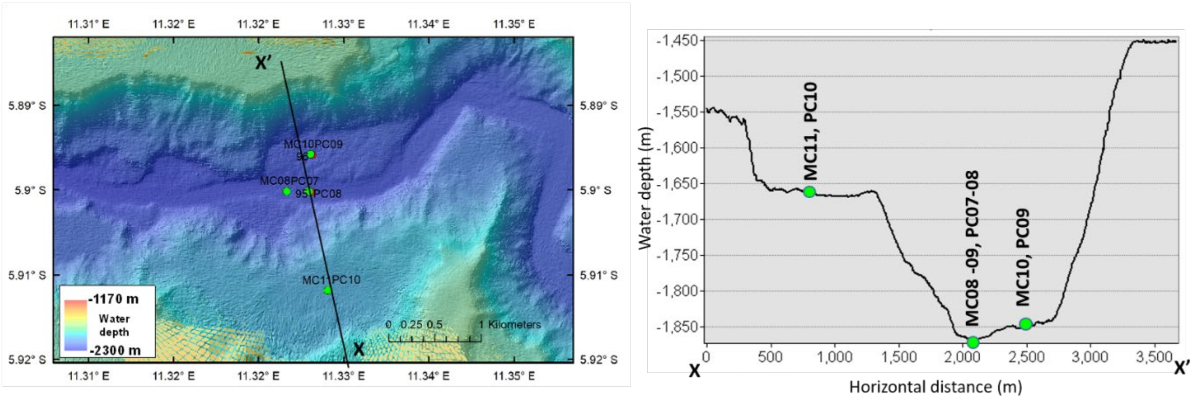


Figure 9.10: *Left: Zoom-in showing location of MC08 to 11 and PC07 to 10. Right: Cross canyon profile at the location of MC08 to 11 and PC07 to 10.*

MC – 08 – SITE – 66 – Thalweg - TRANSECT - 3 Cores at 30cm recovery – fluid mud at top of recovered core. Mud has a sharp transition with top sandy horizon and erosional on the sand below.

25cm of interbedded muds and fine sand. Some dark mud clasts (shown in picture below).

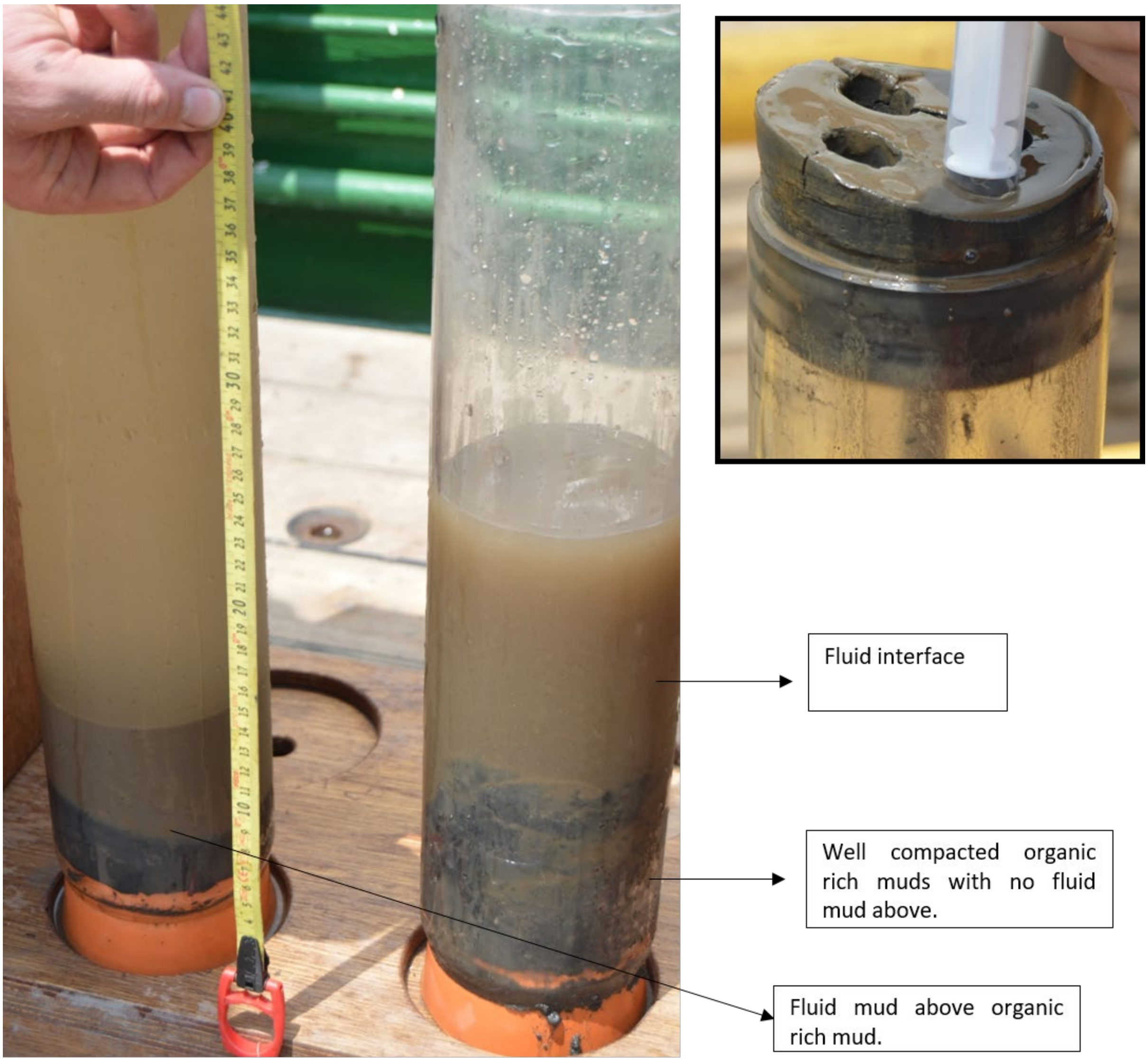
Fine sandy horizons (around 3cm) interbedded with mud horizons. Erosional based sand with sharp transition top. Lower sand unit erosional top and base with muds.

Laminated horizon of mud interbedded with fine sands.

Base of core, small rip up organic/mud clasts (black in colour) mixed in with fine sand.

Figure 9.11: *Multicore 8 at Site 66.*

MC – 09– SITE – 66 – Thalweg TRANSECT – 20cm recovery on core. Base of core is extremely organic rich mudstones, well consolidated with a muddy fluid interface above.



Note: Localised heterogeneity occurs

Figure 9.12: *Multicore 9 at Site 66.*

MC – 11 – SITE – 87– Terrace – Homogenous dark brown muds with very little variability throughout the core. Some feint zones of oxidising fe.

Figure 9.13: *Multicore 11 at Site 87.*

9.2.1.5 *MC18 and PC 17 at Site 92 – Thalweg*

MC18 include fluidised mud with terrestrial organics grading down to sandy horizons with abundant terrestrial organic material. PC17 is 9.5 m long. Base section (AB) includes sand with abundant organics. Middle sections are made of silty mud with lots of organics. Top section is made of fluid mud.

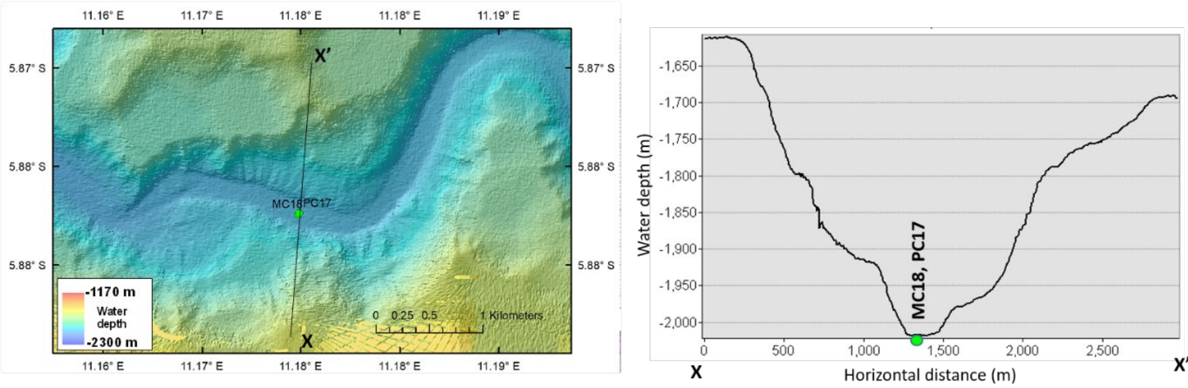


Figure 9.14: *Left: Zoom-in showing location of MC18 and PC17. Right: Cross canyon profile at the location of MC18 and PC17.*

MC – 18 – SITE – 92 – Thalweg – fluidised mud with terrestrial organics grading down to sandy horizons with terrestrial organic material**.**

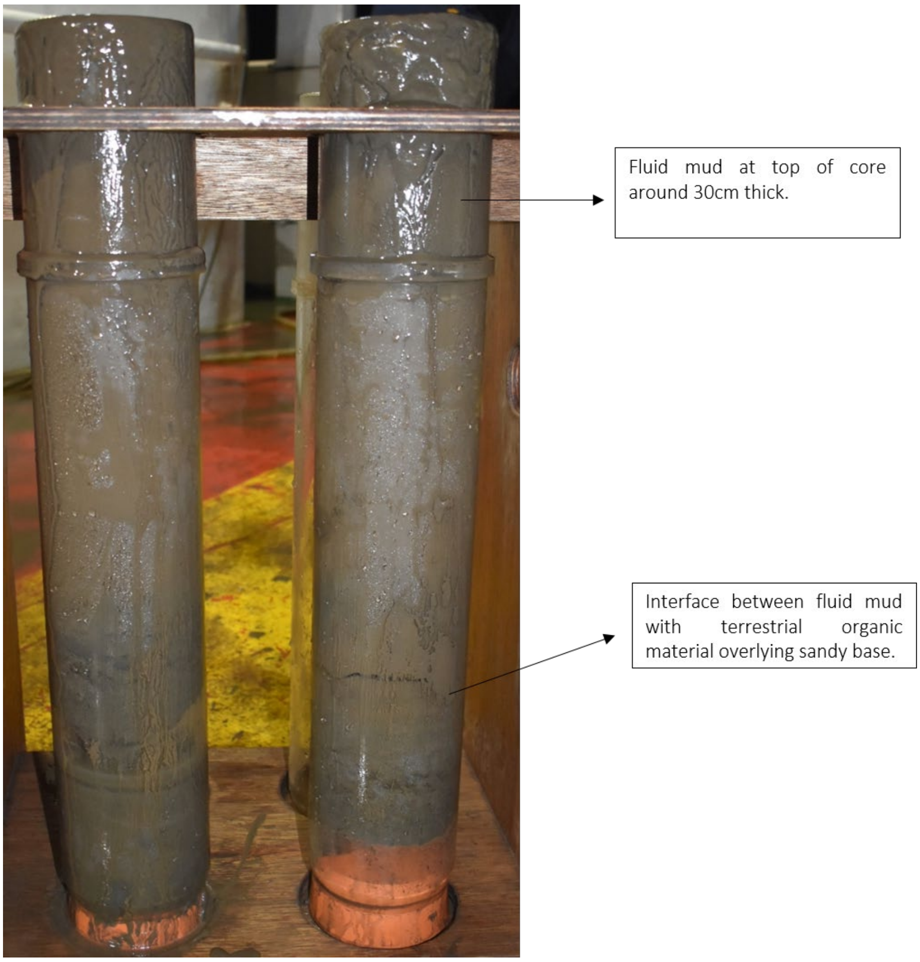


Figure 9.15: *Multicore 18 at Site 92.*

9.2.1.6 MC19 to 22 at sites 107 to 110

These four multi-cores are on meander bend but inside channel thalweg, up-canyon from Mooring Site 2D. The multi-cores from this location are defined by mostly consolidated muds with an extremely rich organic base and sharp transition between both sediments. MC-21 and MC-22 (thalweg transect) had an extremely organic rich base with gas hydrates and an oily residue within. MC 19 was sandy at the base with homogenous brown mud on top.

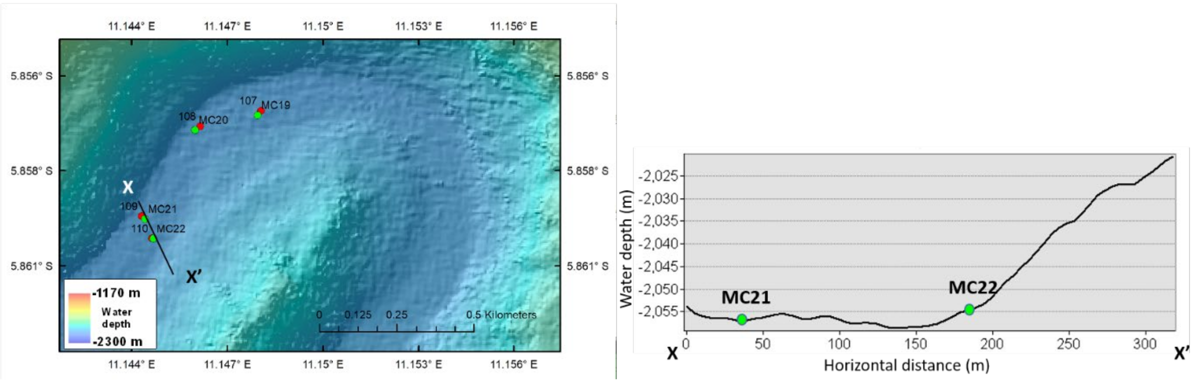


Figure 9.16: *Left: Zoom-in showing location of MC19 to 22. Right: Cross canyon profile at the location of MC19 to 22.*

MC – 19 – SITE – 107 – Thalweg – on meander bend but inside channel thalweg.

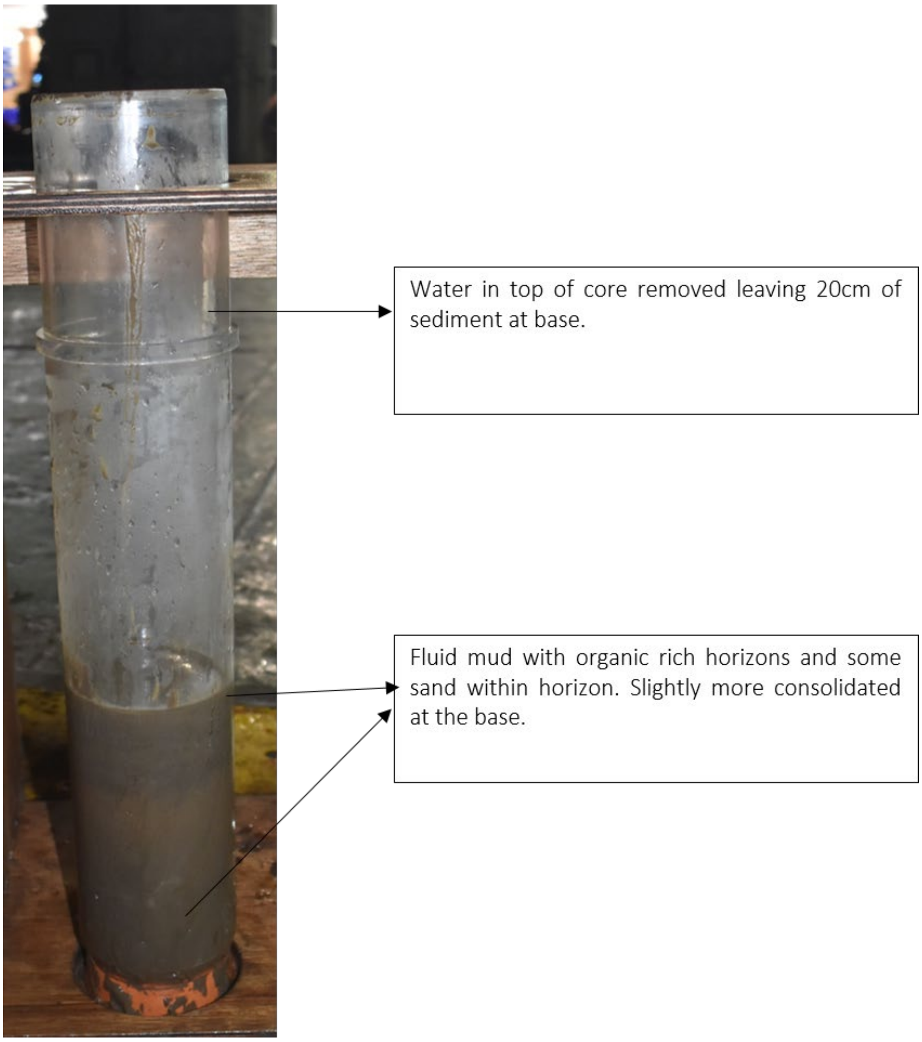


Figure 9.17: *Multicore 18 at Site 92.*

MC – 20 – SITE – 108 – Thalweg – on meander bend but inside channel thalweg.

No core image

MC – 21 – SITE – 109 – Thalweg – on meander bend but inside channel thalweg.

No core image

MC – 22 – SITE – 110 – Thalweg – on meander bend point-bar deposit.

No core image

9.2.1.7 MC05 to 07 and PC04 to 06

Channel transect through terraces and thalweg around 10km downstream from previous sites. The thalweg (MC-5) is characterised by a stiff grey clay rich/potentially calcareous mud (marl) around 25cm thick at the base with an erosional contact between the upper brown more fluid mud (35cm thick) capped by the water interface. MC-6 on the lower terrace which is 165m above the thalweg consists of slightly consolidated mud at the base grading up into fluid mud at the top of the core, similar to MC-7. PC04 is 7.7m long and over-penetrated the seabed. Core appear to be composed of fluid mud, lots of water came out of the core section ends. PC05 and is 10 m long and is muddy in all section ends (dark brown homogeneous mud). PC06 is 10.5 m long and is made of dark brown homogeneous mud in all section ends. Core catcher includes mud and organics.

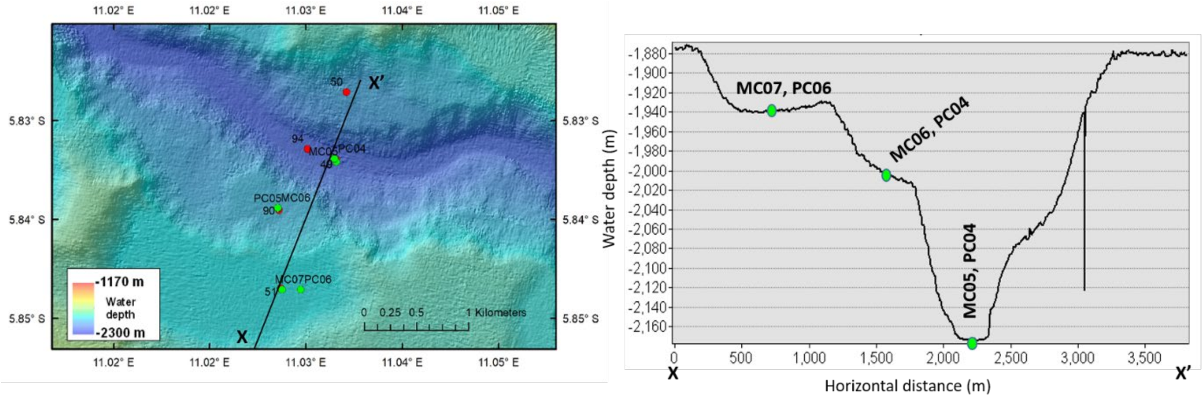


Figure 9.18: *Left: Zoom-in showing location of MC05 to 07. Right: Cross canyon profile at the location of MC05 to 07.*

MC-05- SITE – 49 – Thalweg – base of core is characterised by a stiff grey clay rich/potentially calcarous mud (marl) around 25cm thick with an erosional contact between the upper brown more fluid mud (35cm thick) capped by the water interface.

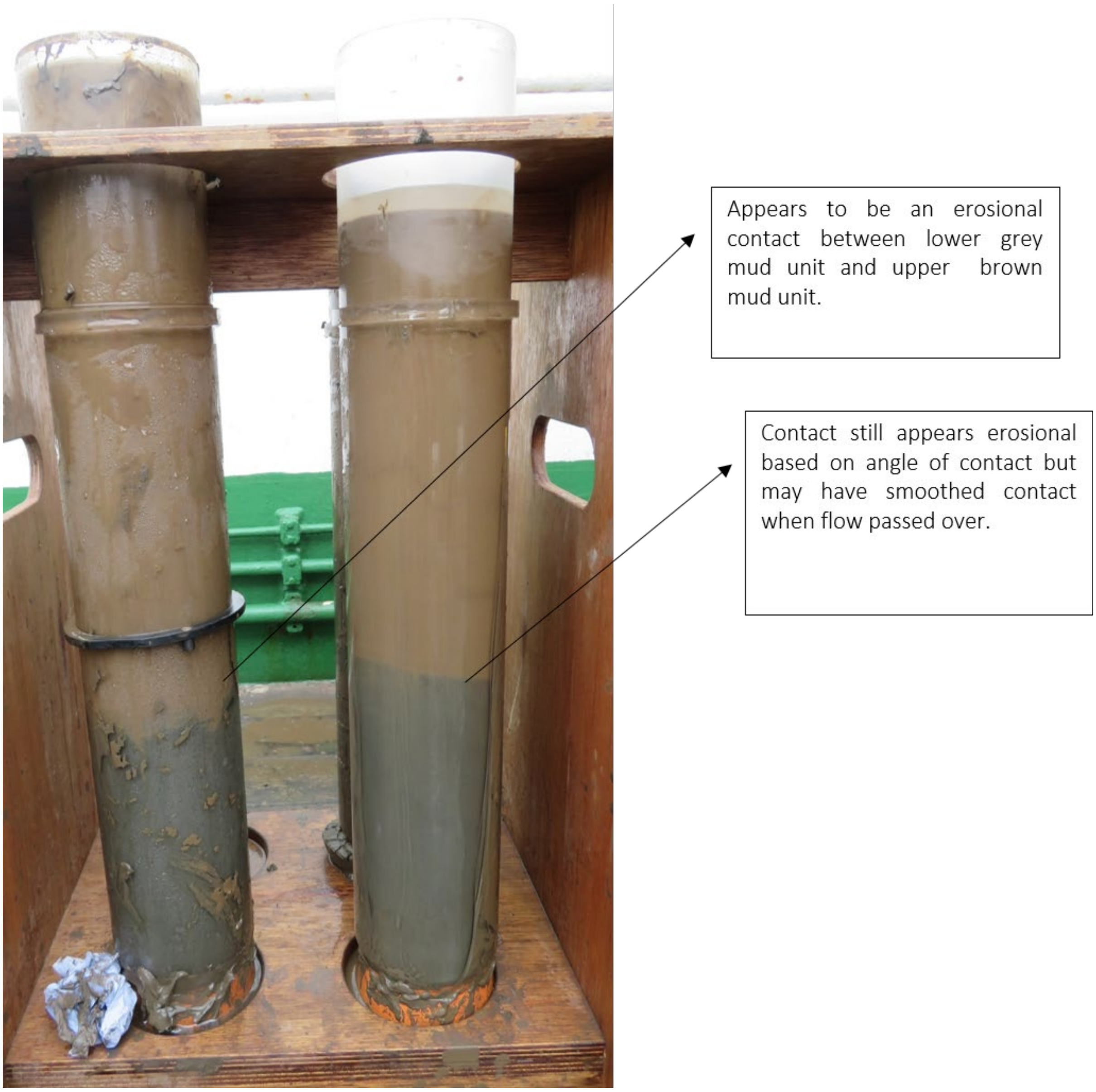


Figure 9.19: *Multicore 5 at site 49.*

MC-06- SITE 90 – Terrace TRANSECT – homogenous muds varying from extremely fluid at the top to more consolidated at the base but still fluidised.

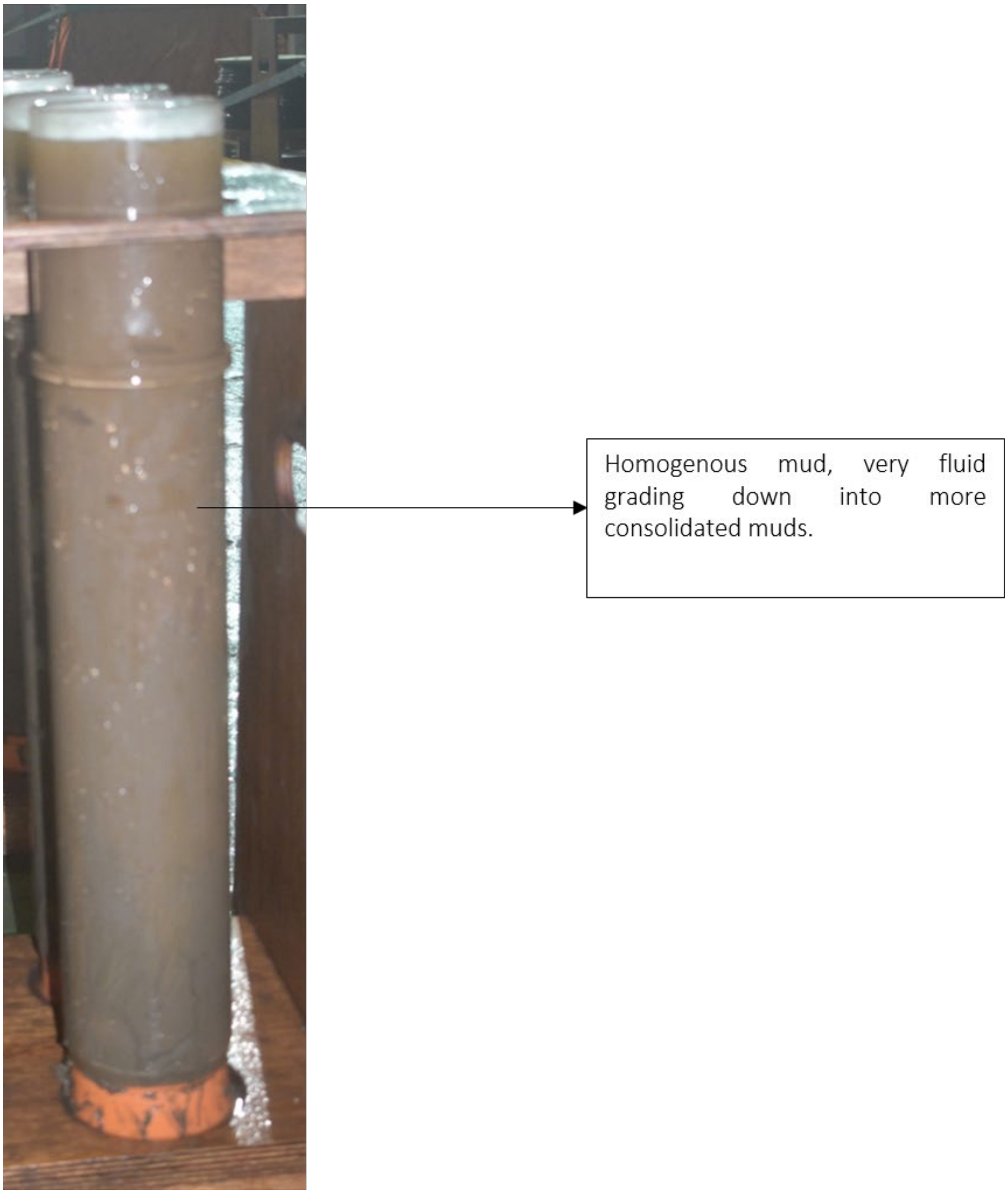


Figure 9.20: *Multicore 6 at site 90.*

9.2.2 International waters

We collected 7 multi-cores and 6 piston cores in the international water, see Fig. 9.21 below for overview of the core locations. The sections below provide details for each of these cores from the most proximal site (channel) in international water down to the lobe.

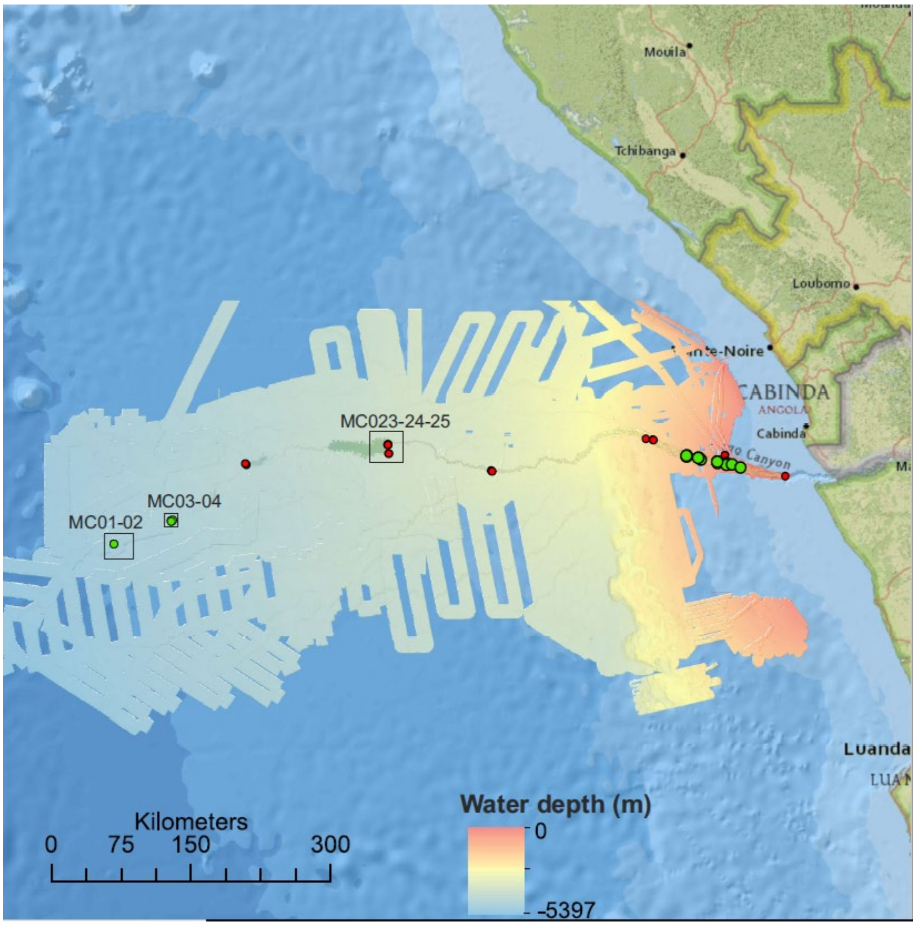


Figure 9.21: *Overview of the cores collected in International waters.*

9.2.2.1 MC23-25 & PC18-20

This site is located in the submarine channel, ~ 400 km downstream of the last set of cores collected in the Angolan water. MC23 and PC18 are located in the channel thalweg. MC24 and PC19 are located on a northern terrace, 50 m above the thalweg. MC25 and PC20 are located ~9 km to the South of the thalweg. These last 2 cores were collected to characterize the background sediment outside of the turbidity current system.

Only 1 core was recovered for MC23. It is made of homogeneous dark mud. PC18 is 7 m long. The bottom 3 sections are made of sand (based on the core ends). The top sections contain mud and silty/mud.

MC24 is made of homogeneous mud. PC19 is 13.8 m long and it shows dark consolidated mud in bottom half, overlain by more fluidised mud towards the top.

MC25 is made of consolidated mud for 35 cm, overlain by brown water with some flocs. PC20 is 14.3 m long and contains very consolidated dark mud.

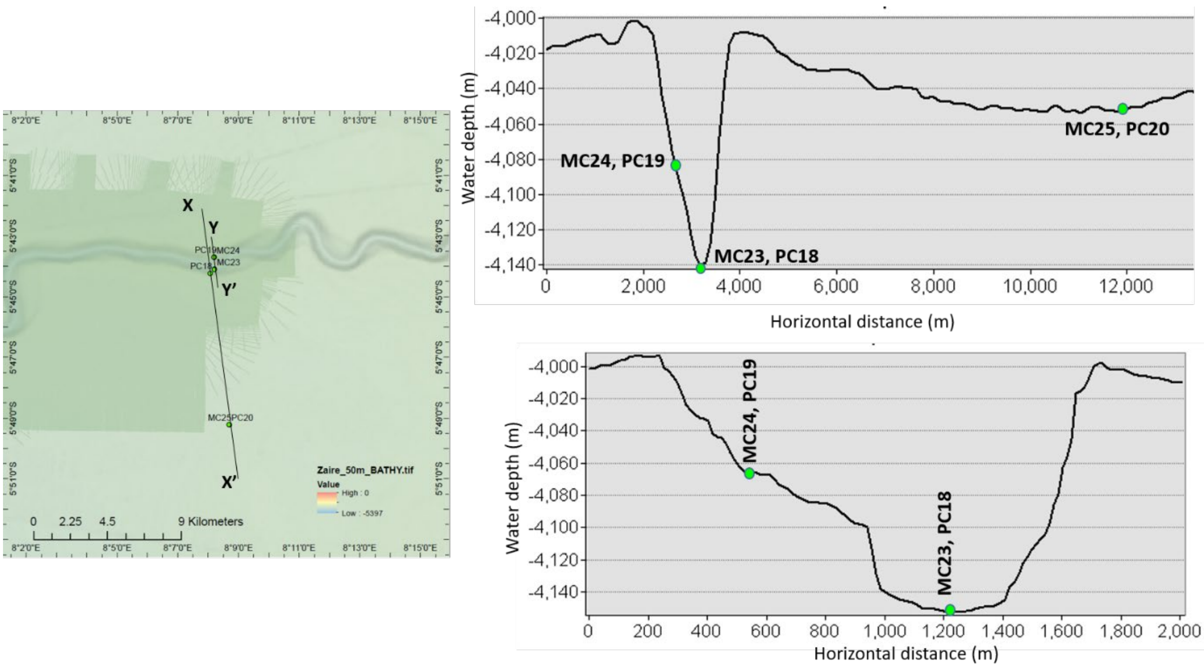


Figure 9.22: *Zoom-in and cross sections showing the locations of MC23 to 25 and PC 18 t0 20.*

MC-23- SITE 32– thalweg - only 1 complete core recovered from site. Likely over-penetration and locking mechanism failed where over-penetration occurred (a reflection of sandy substrate or undulating seafloor topography).

Figure 9.23: *Multicore 23 at site 32.*

MC-24- SITE 53– Terrace– 7 out of 8 cores recovered. Base of core is organic rich mudstones overlain by brownish red muds, potentially Fe rich. Contact is undulating and potentially erosive. Some woody/plant material at the top (bagged separately and refrigerated).

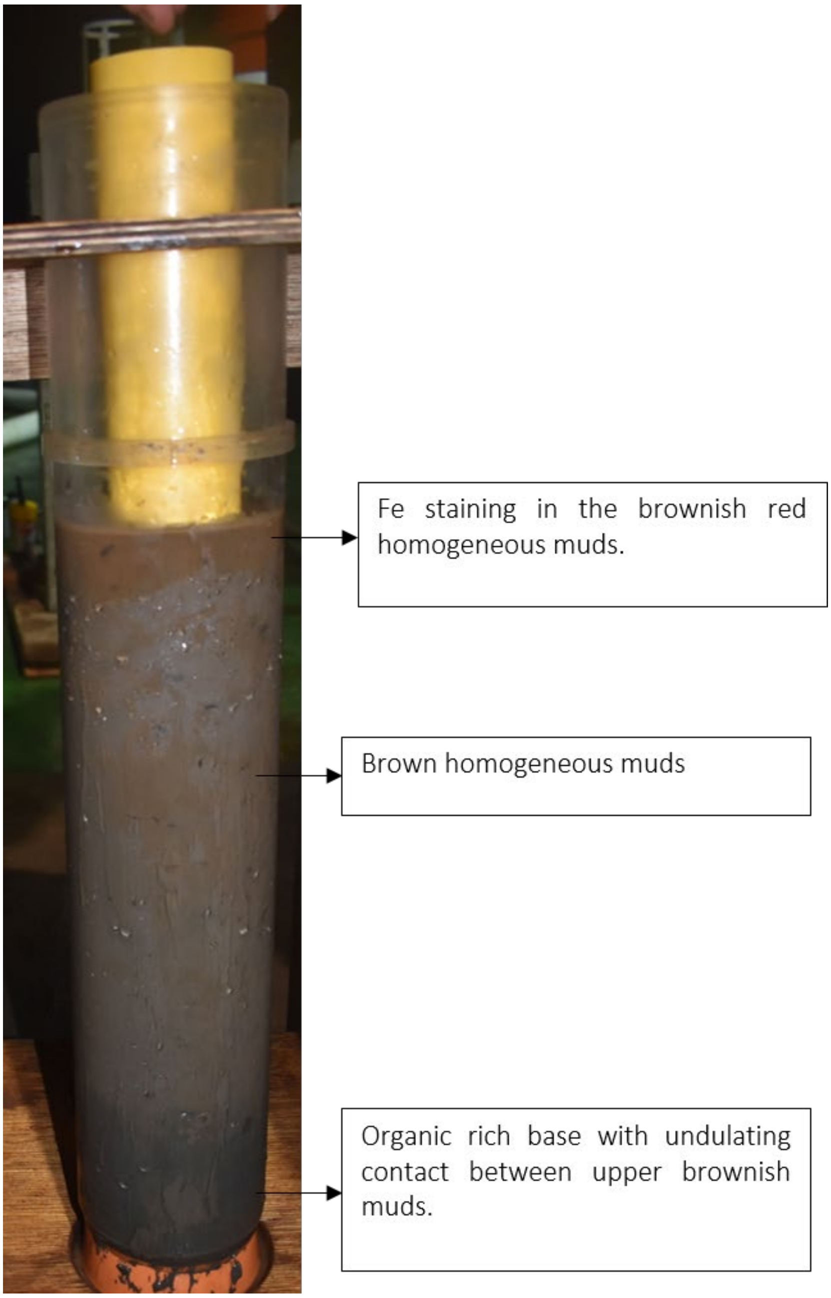


Figure 9.24: *Multicore 5 at site 49.*

MC-25- SITE 54– Outside turbidity current system

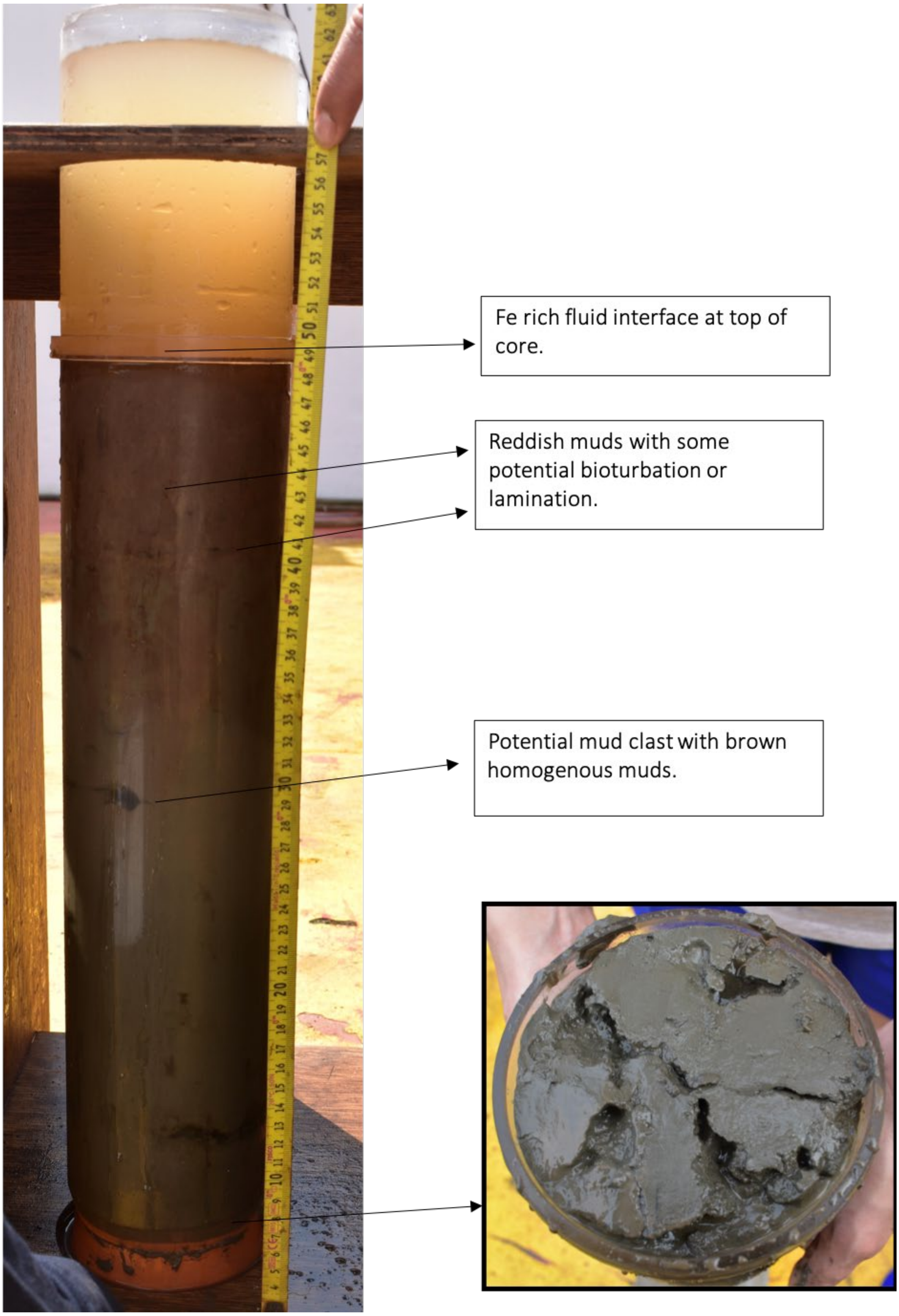


Figure 9.25: *Multicore 25 at site 54.*

9.2.2.2 MC03, MC04 & PC02, PC03 at Site 58

This site is the most distal site in the submarine channel. It is >300 km far from cores MC023-25. MC04 and PC03 are located in the channel thalweg, incised of about 40 m. MC03 and PC02 are situated 35 m above the channel thalweg, to the South-West of MC04, PC03.

MC04 is made of mud. PC03 is ~2 m long and includes sand at the base, overlain by mud.

MC03 is made of homogeneous mud, with Fe at the top. PC02 is ~10 m long. No note on composition.

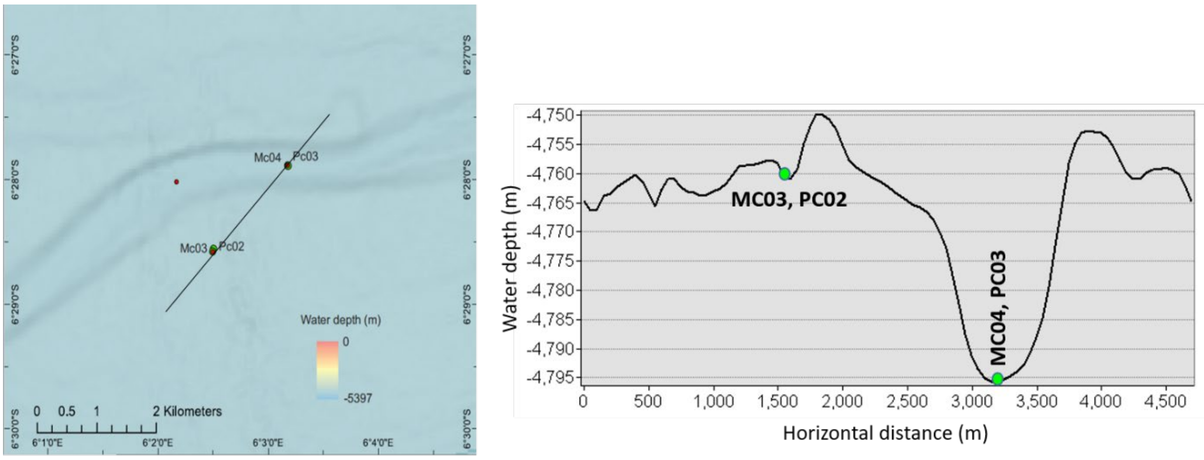


Figure 9.26: *Left: Zoom-in showing positions of MC03-04, and PC02-03; Right: Cross section showing positions of MC03-04, and PC02-03*

MC-03- SITE 58 – terrace around 1.2km away from thalweg

Homogenous muds with very little heterogeneity. Fe at top of core around 4cm thick.

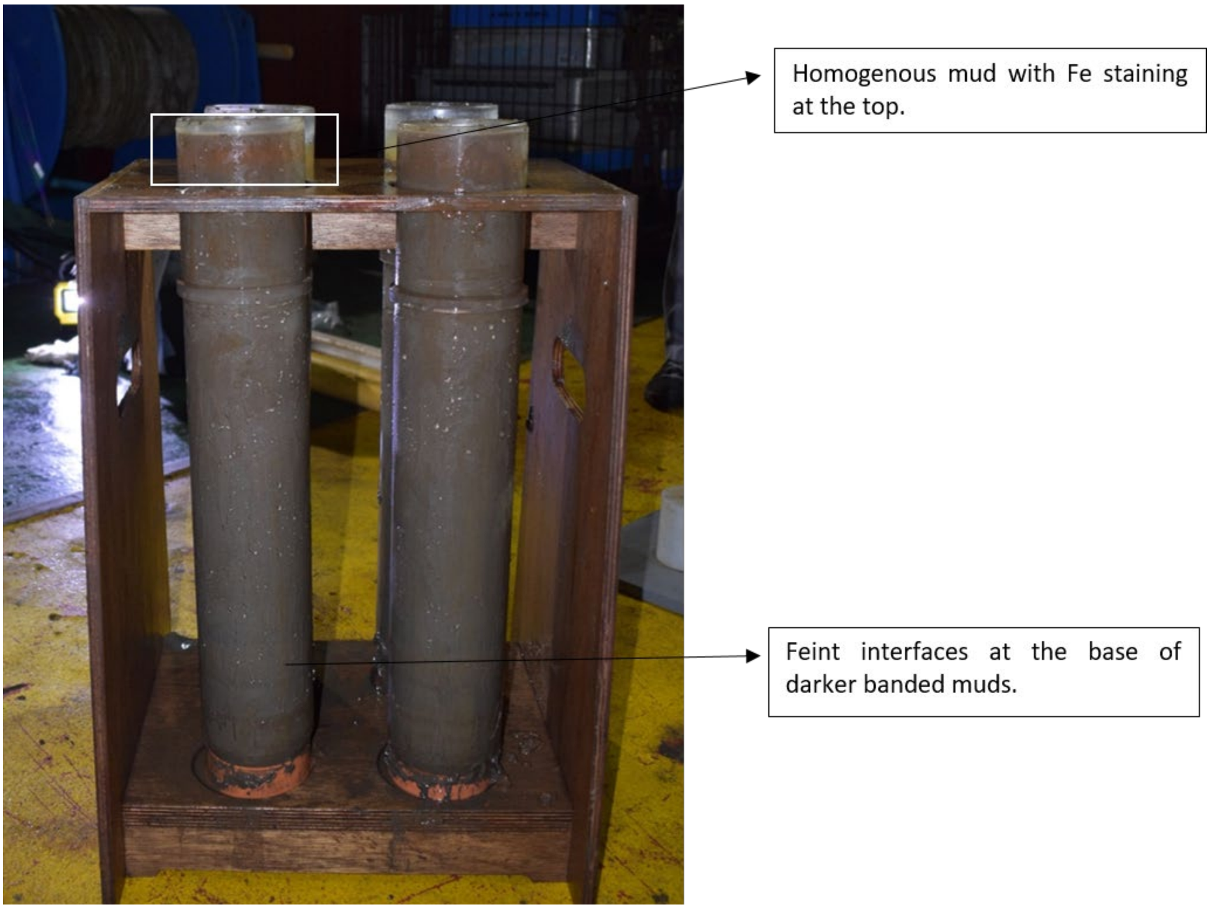


Figure 9.27: *Multicore 3 at site 58.*

MC-04- SITE – 77 – Thalweg – Homogenous mud with some Fe staining at the fluid interface.

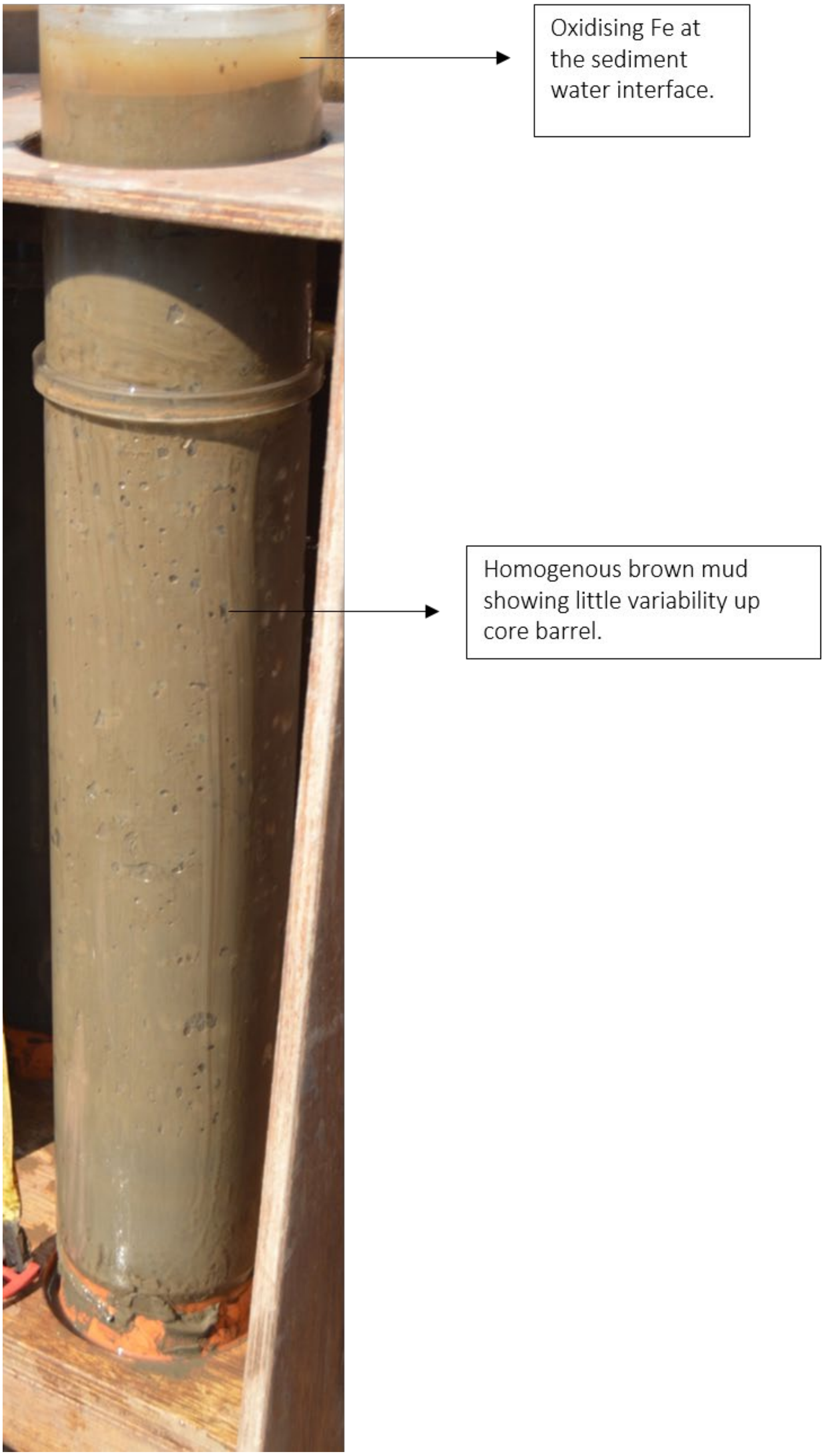


Figure 9.28: *Multicore 4 at site 77.*

9.2.2.3 MC01, MC02 & PC01 – Site 42

This site is located on lobe. MC01 failed. MC02 was collected at the same location as MC01.

MC02 was fully recovered and is composed of brown, homogeneous mud with a ~10cm thick organic rich, dark horizon.

PC01 is 9.5 m long. Core ends are muddy, and include lots of water.

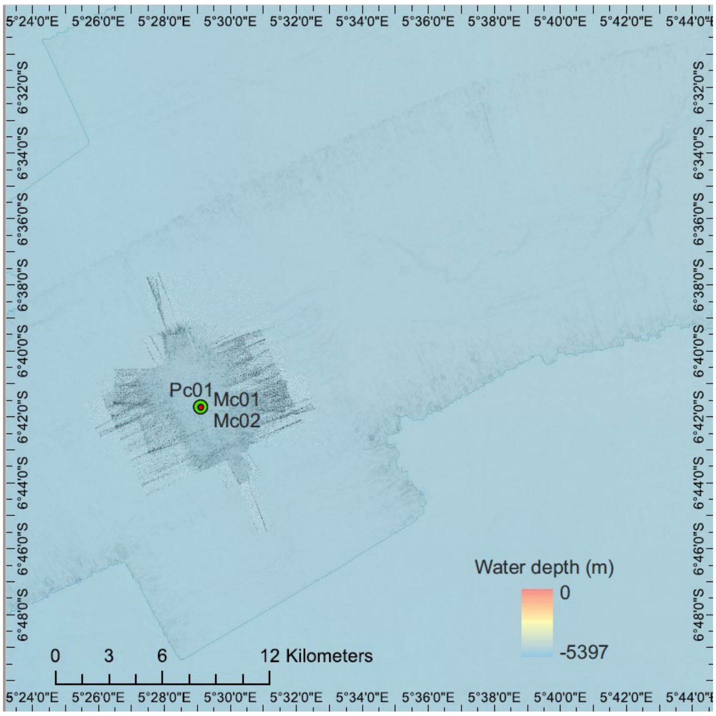


Figure 9.29: *Zoom-in showing positions of MC01 (failed), MC02 and PC01.*

MC02 - SITE 42 – Lobe

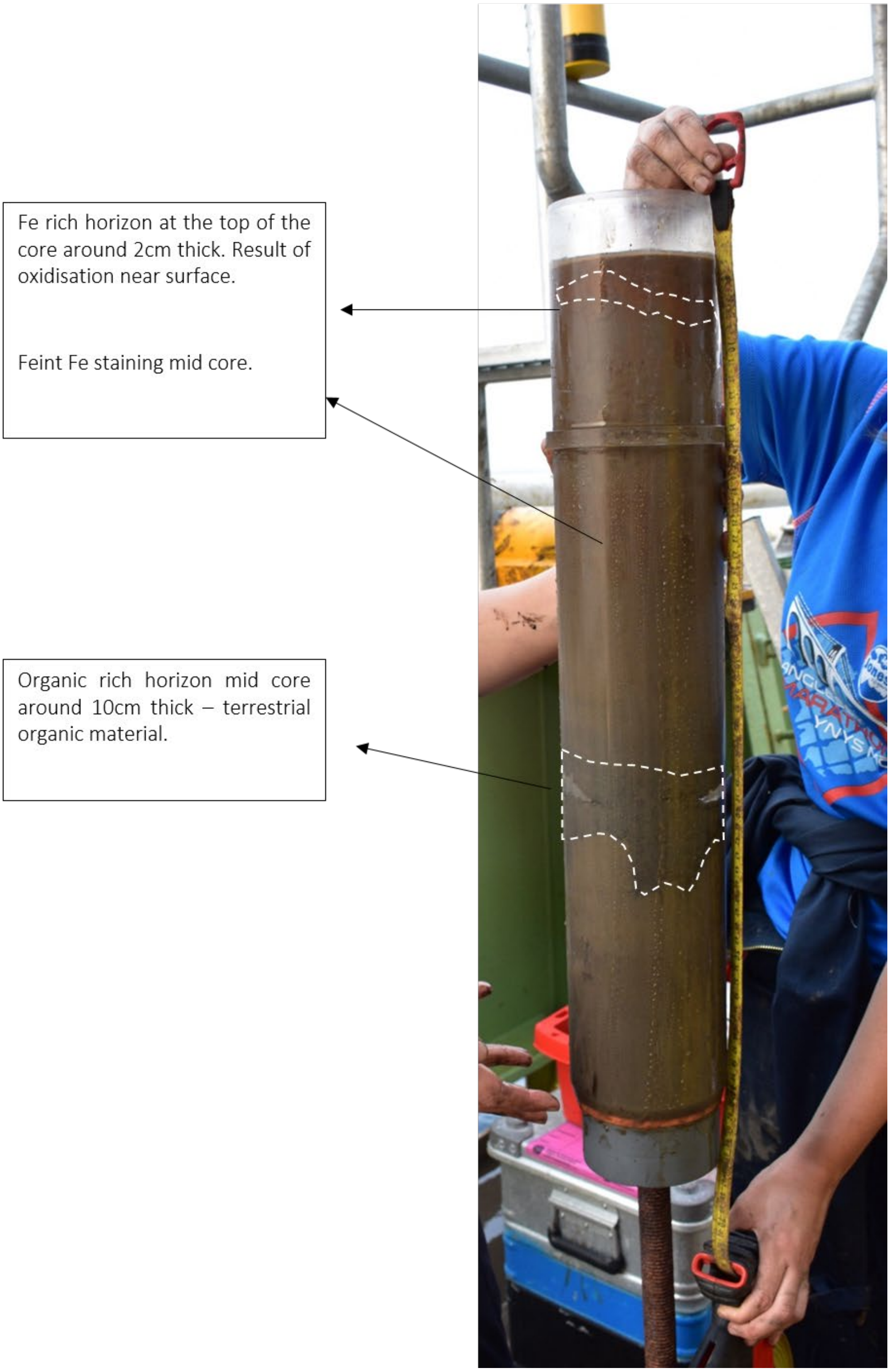


Figure 9.30: *Multicore 2 at site 42.*

9.3 3.5 kHz sub-bottom profiler (CHIRP)

Some stratigraphy is visible outside of the canyon, however the images do not appear to be good enough to discern any features beyond the existence of the stratigraphy. We do not have the means to open SEGY data until we leave the ship, however the formatted SEGY data may provide more meaningful data of the subsurface.

Sub-bottom imaging within the canyon proved to be difficult due to a very low return signal. Two possible reasons for the lack of signal received by the ship may be due to the steep side walls of the canyon and/or the fluid mud layer within the canyon.

The steep side-walls and slopes within the canyon may result in the 3.5 kHz signal being reflected away from the vessel, resulting in the incomplete and false readings that the sub bottom profiler is then trying to interpret. Furthermore, fluid mud layers and homogenous muds within the canyon may result in very weak reflections due to a lower acoustic impedance contrast.

9.4 CTD and water samples

9.4.1 CTD data

The 12 CTD location (11 casts done) are indicated on Figure 9.31. All of them are above the canyon or the channel and the thalweg but CTD-01, mainly done to test acoustic releasers.

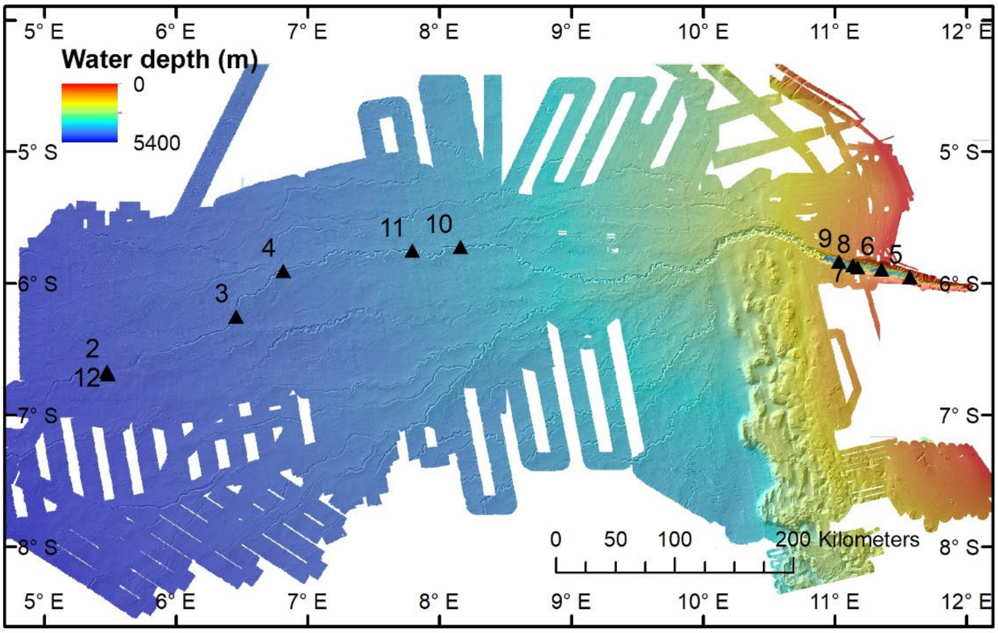


Figure 9.31: *General map with the locations of the CTD casts. Cast CTD-1 was done during the transit and it is out of the map. Cast CTD-11 was cancelled due to cable problems: it is indicated because a log-sheet for this cast exists.*

Table 9.3: *Location and major station parameters for all casts. Btls = bottles. Blue text indicates USBL data and red text indicates data with problems or ambiguity.*

Cast Nb.	Latitude	Longitude	Depth	GIS Site	Date	Bottles	Other
1	6°39.334 N	17°12.692 E	4907	1	03/09/19	1 (test)	Test releasers
2	6°40.207 S	5°28.471 E	4944	67	09/09/19	1 (test)	Test releasers
3	6°15.226 S	6°27.215 E	4660	78	12/09/19	-	Test releasers (*site 69 at CTD sheet)
4	5°54.394 S	6°48.722 E	4527	71	12/09/19	-	-
5	5°57.348 S	11°34.195 E	1568	83	15/09/19	-	Test releasers
6	5°53.672 S 5°53.662 S	11°21.358 E 11°21.354 E	1828	88	15/09/19	12 bottles (3 leak)	Site 85 on CTD Sheet
7	5°51.818 S 5°53.662 S	11°8.363 E 11°21.354 E	2020	84	16/09/19	24 bottles (leak test)	Site 83 on CTD Sheet
8	5°52.738 S	11°10.499 E	1970	92	21/09/19	5 bottles	-
9	5°50.112 S 5°50.127 S	11°1.896 E 11°1.108 E	2165 2174	14	21/09/19	9 bottles	All btls fired for frame balance
10	5°43.543 S 5°43.546 S	8°9.488 E 8°9.482 E	4133 4133	112	23/09/19	11 bottles	All btls fired for frame balance 1st botl leaked
11	5°45.320 S	7°47.600 E	4195	114	26/09/19	SVP done	Cable problem cast cancelled
12	6°41.455 S 6°41.439 S	5°29.022 E 5°29.007 E	4929 4950	124	01/10/19	12 bottles	All btls fired for frame balance

Table 9.4: *Information on SVP drops, including file name.*

Date	Time	Profile file name	Location
30/08/2019	14:51	168N25W.asvp (WOA13)	16.83° N 025.00° W
01/09/2019	19:36	1209N2165W.asvp (WOA13)	12.09° N 021.65° W
02/09/2019	20:17	0863N01888W.asvp (WOA13)	08.57° N 018.76° W
03/09/2019	14:49	0665N01721W.asvp (SVP)	06.65° N 017.21° W
05/09/2019	08:48	0087N1262W.asvp (WOA13)	00.89° N 012.52° W
06/09/2019	10:02	0090S00827W.asvp (WOA13)	00.90° S 008.27° W
07/09/2019	08:48	0250S00448W.asvp (WOA13)	02.50° S 004.48° W
08/09/2019	05:41	0414S00060W.asvp (WOA13)	04.14° S 000.60° W
09/09/2019	23:42	0666S00547E.asvp (SVP)	06.66° S 005.47° E
12/09/2019	04:27	0625S00645E.asvp (SVP)	06.25° S 006.45° E
12/09/2019	13:51	0681S00681E.asvp (SVP)	06.81° S 006.81° E
15/09/2019	11:50	0596S01157E.asvp (SVP)	05.96° S 011.57° E
15/09/2019	22:31	0589S01135E.asvp (SVP)	05.89° S 011.35° E
16/09/2019	14:01	0587S01114E.asvp (SVP)	05.87° S 011.14° E
21/09/2019	19:19	0583S01101E.asvp (SVP)	05.83° S 011.01° E
23/09/2019	05:20	0572S008016E.asvp (SVP)	05.72° S 008.02° E

25/09/2019	08:11	0596S01157E.asvp (SVP)	05.96° S 011.57° E
25/09/2019	16:59	0572S008016E.asvp (SVP)	05.72° S 008.02° E
26/09/2019	21:57	0576S00779E.asvp (SVP)	05.76° S 007.79° E
29/09/2019	16:10	0589S00689E.asvp (SVP)	05.89° S 006.89° E
01/10/2019	07:21	0669S00548E.asvp (SVP)	06.69° S 005.48° E

The raw data from the CTD casts is presented here after. A proximal location map indicates where the cast is located relatively to the main channel.

The data is plotted on six graphs. From left to right, these plots are: temperature, salinity, oxygen, turbidity (both Optical Back Scatter [OBS] and acoustic attenuation [Acoustic] are plotted), current velocity and current direction.

For simplicity and a better visualisation, current velocity and direction are smoothed by a moving average (500 values) along the vertical dimension (depth). A thin brick-colour line at each plot represents the cross section in the cast area. Cross sections are along the profiles shown on local maps.

LADCP data presented here is produced by the same routine for all plots. There is no data treatment and validation cast by cast, which will be necessary. That will be done in a post-processing phase and implies a better clock synchronisation, a pressure adjustment (between CTD and LADCP), and velocity correction close to the sea bed. Plotted data is a first glance.

Turbidity is not presented with units. There is no calibration of the sensors against reference NTU (normalized turbidity units) neither sediment concentrations. Raw OBS data is multiplied by 100 in order to provide on the same plot visual comparison to acoustic attenuation. A NTU calibration would be very interesting for future casts.

There is no bathymetry (neither local map or profile) to the first cast. So these are not shown.

9.4.1.1 CTD cast 1

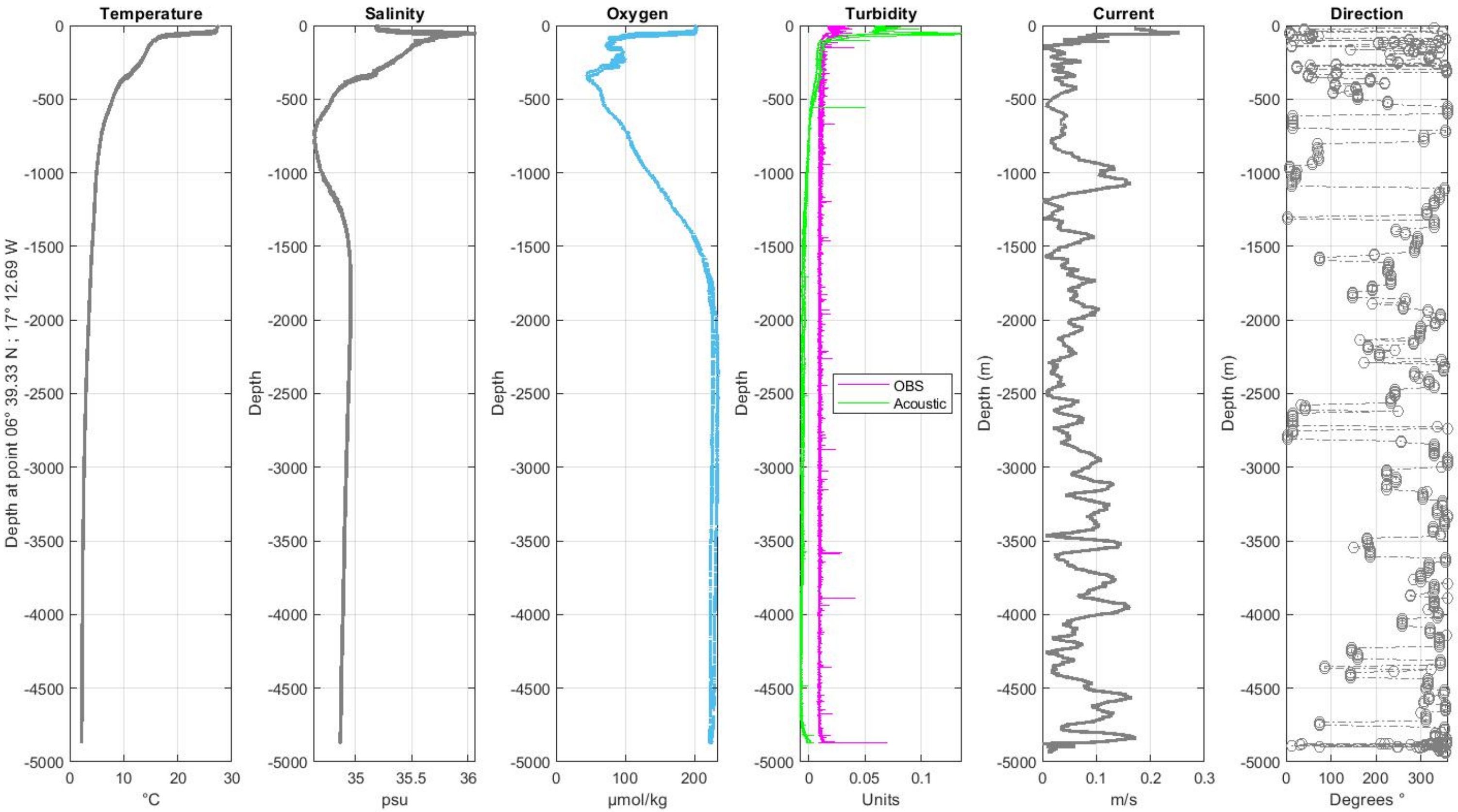


Figure 9.32: *Results from CTD-1.*

9.4.1.2 CTD cast 2

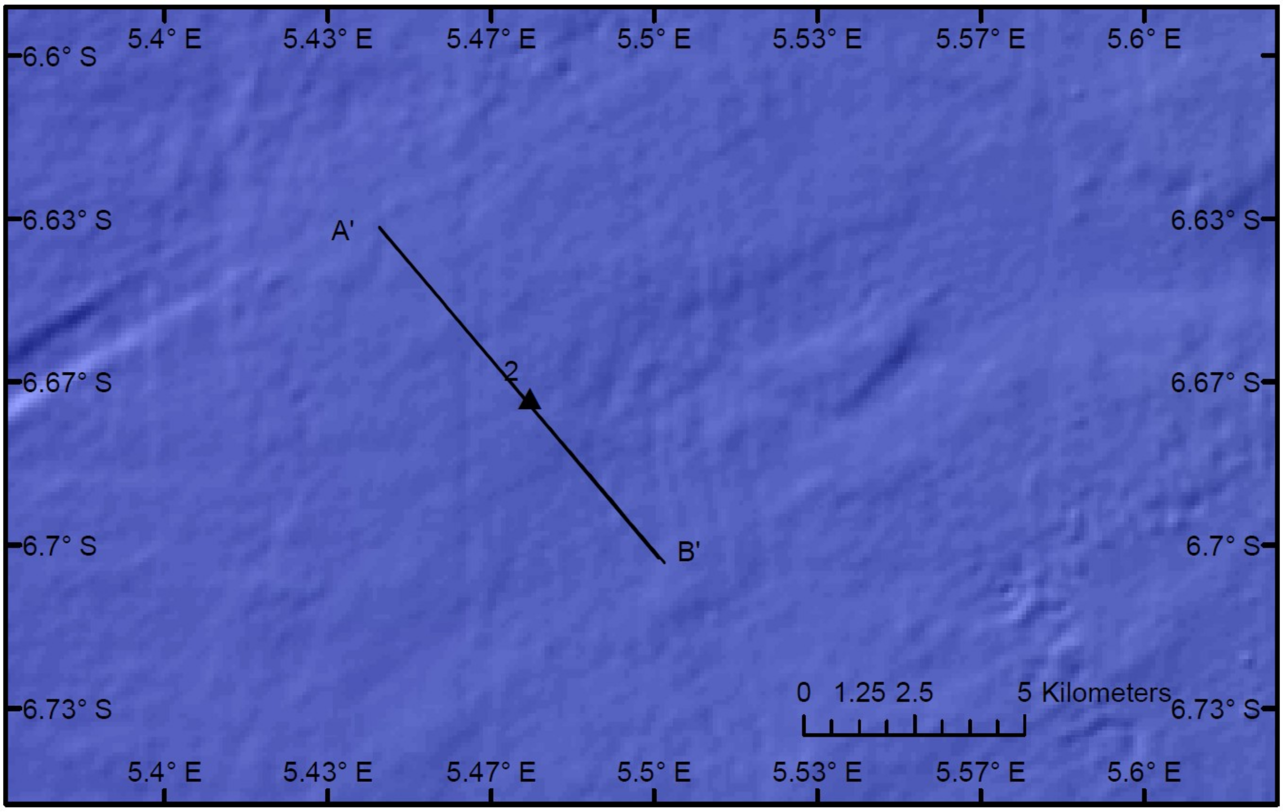


Figure 9.33: *Location of CTD-2***.**

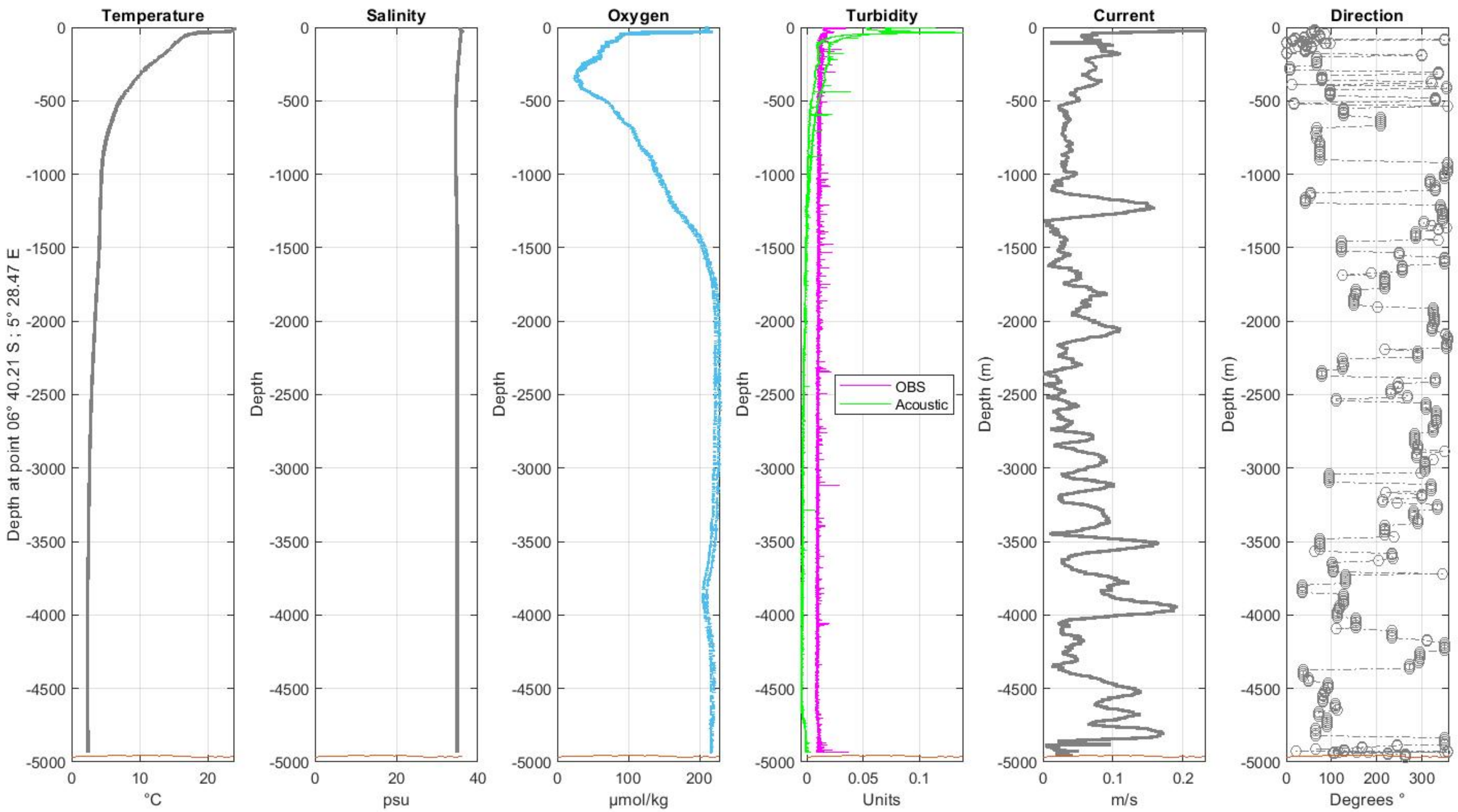


Figure 9.34: *Results from CTD-2.*

9.4.1.3 CTD cast 3

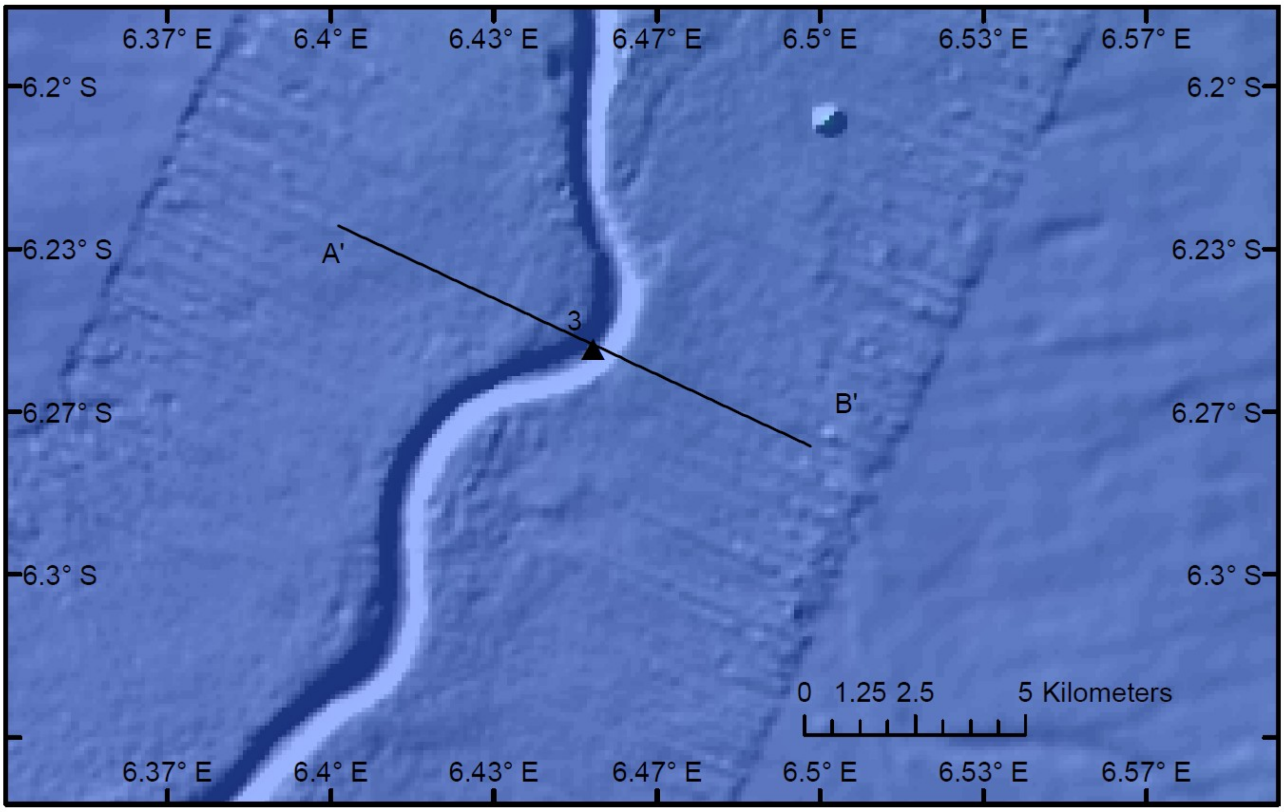


Figure 9.35: *Location of CTD-3.*

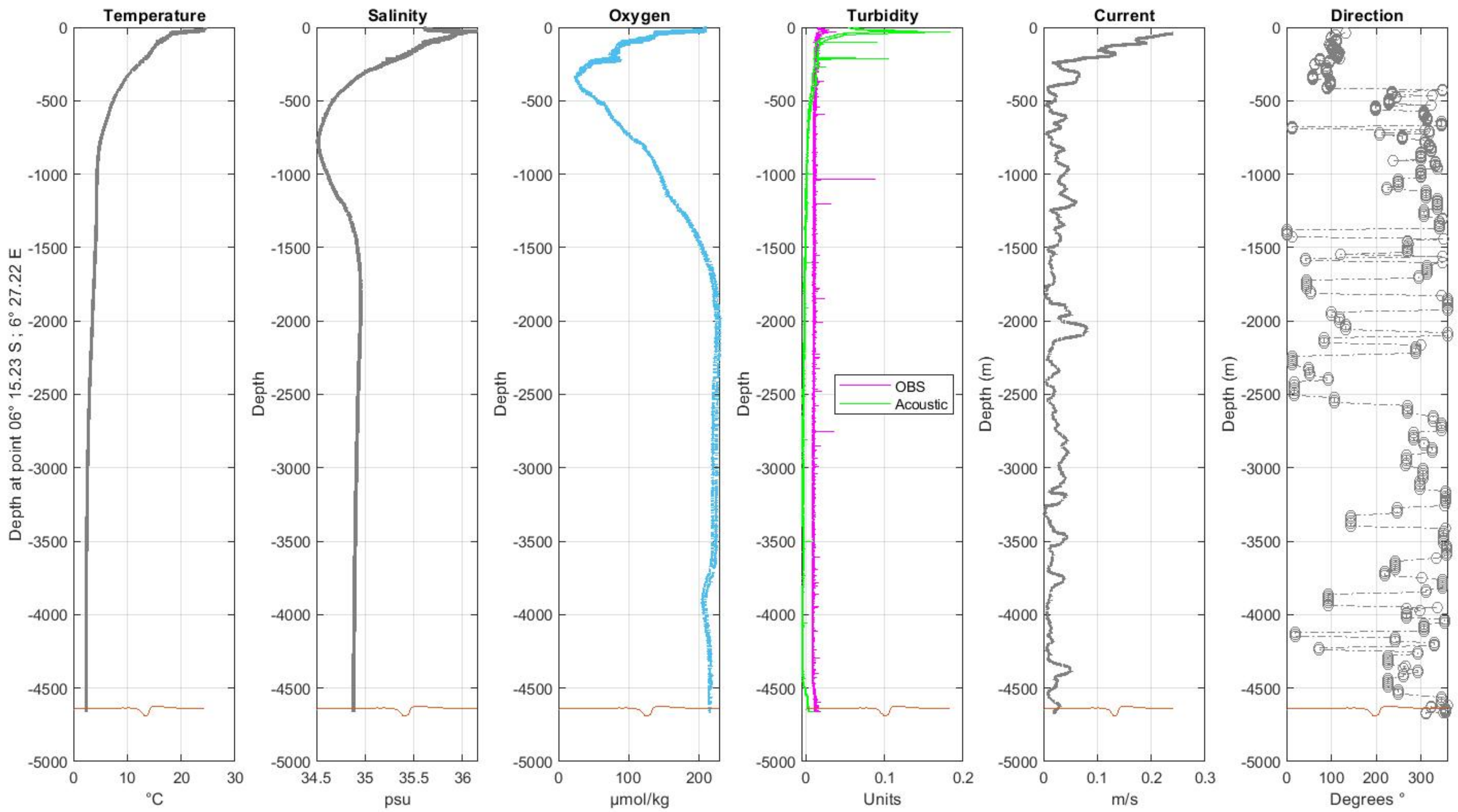


Figure 9.36*: Results of CTD-3*.

9.4.1.4 CTD cast 4

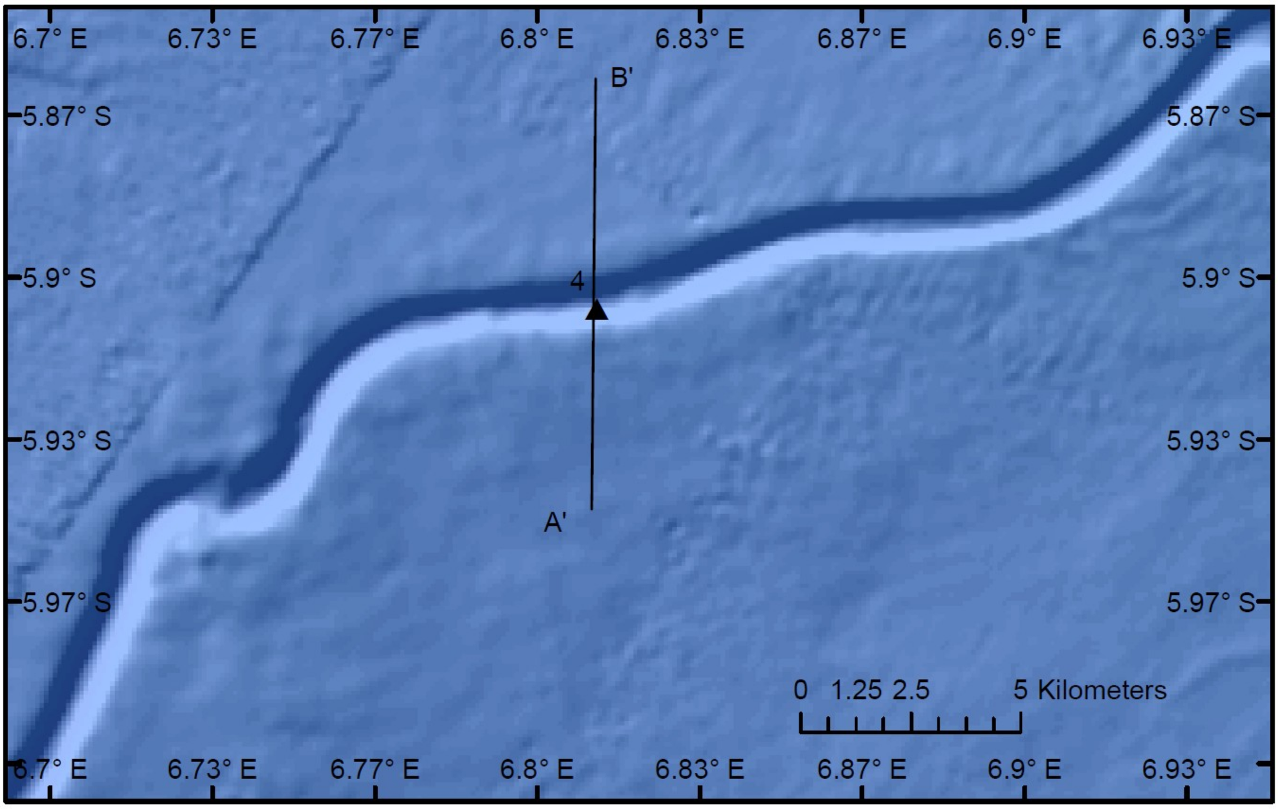


Figure 9.37: *Location of CTD-4.*

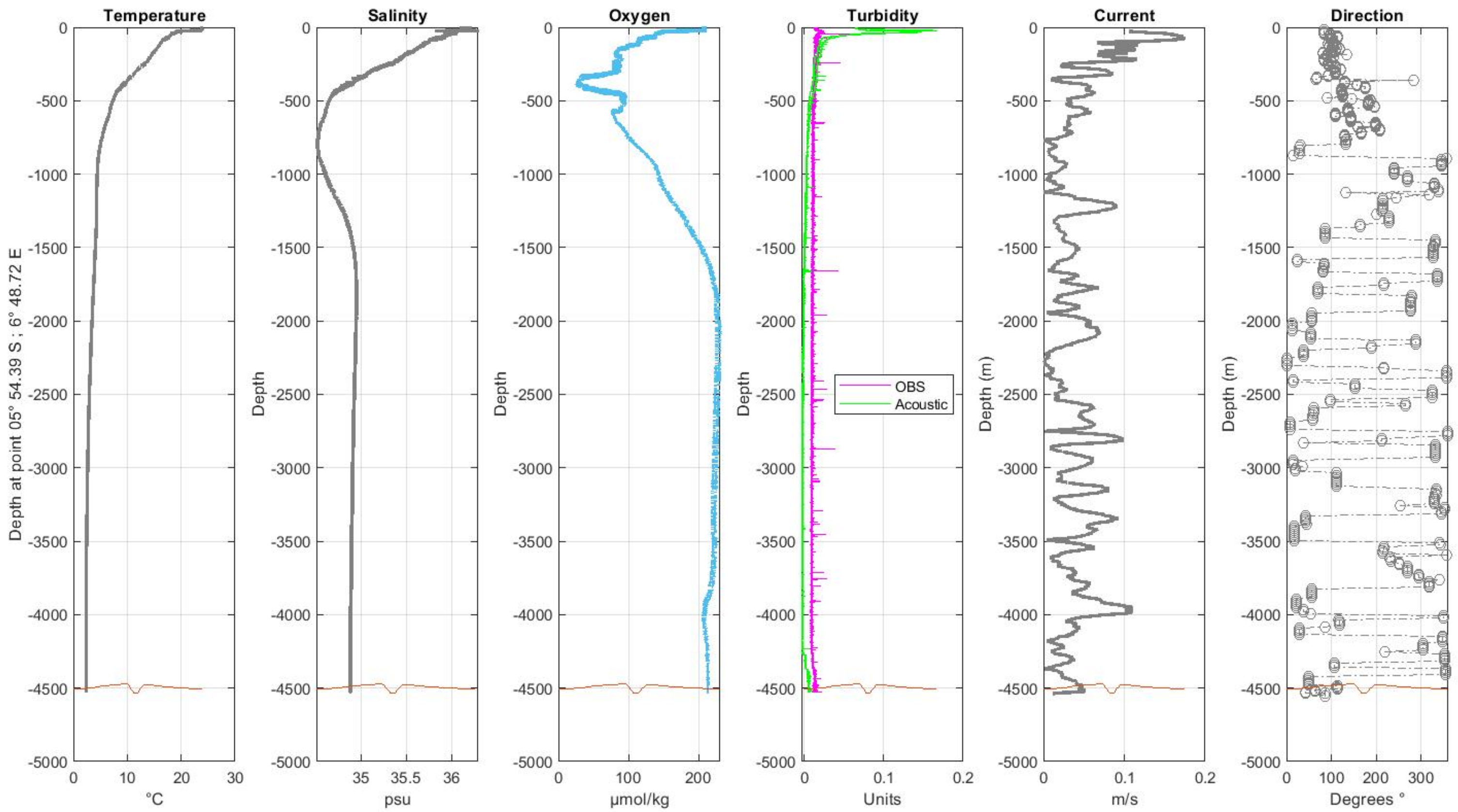


Figure 9.38: *Results of CTD-4*.

9.4.1.5 CTD cast 5

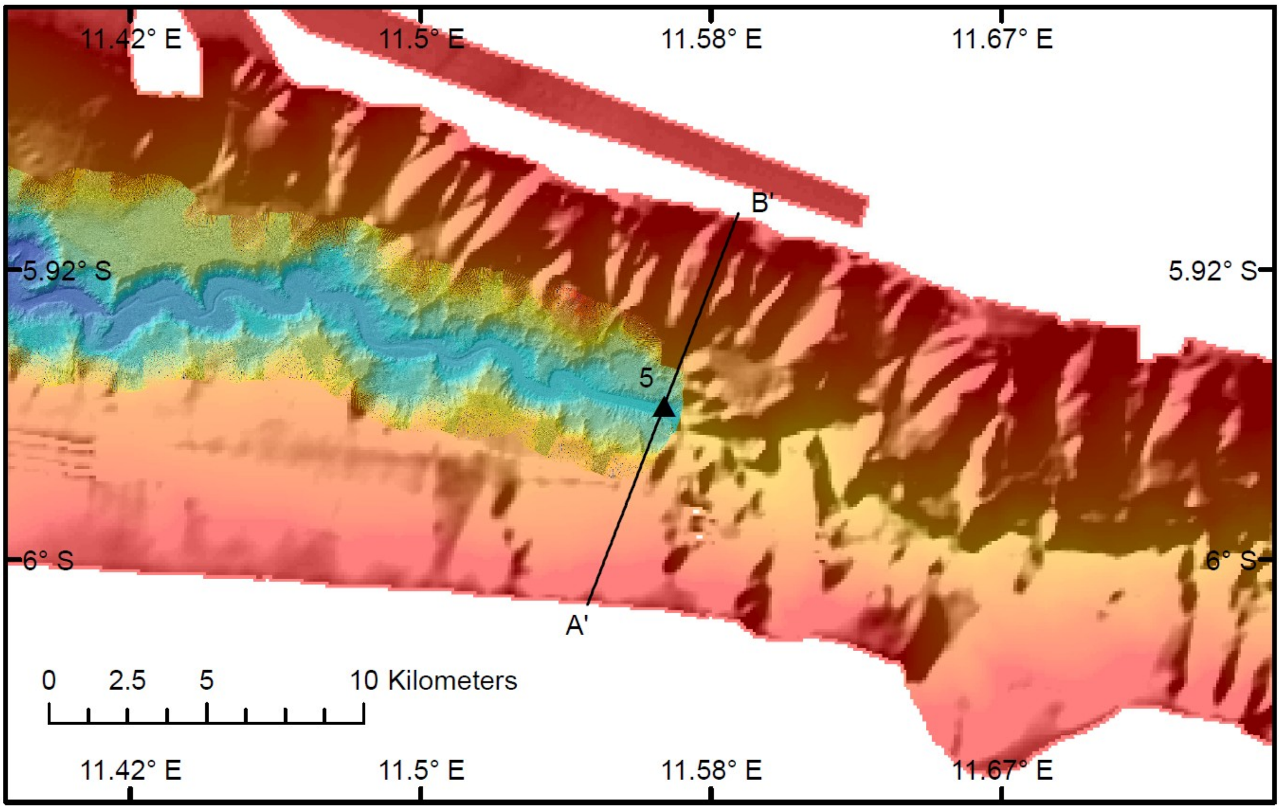


Figure 9.39: *Location of CTD-5.*

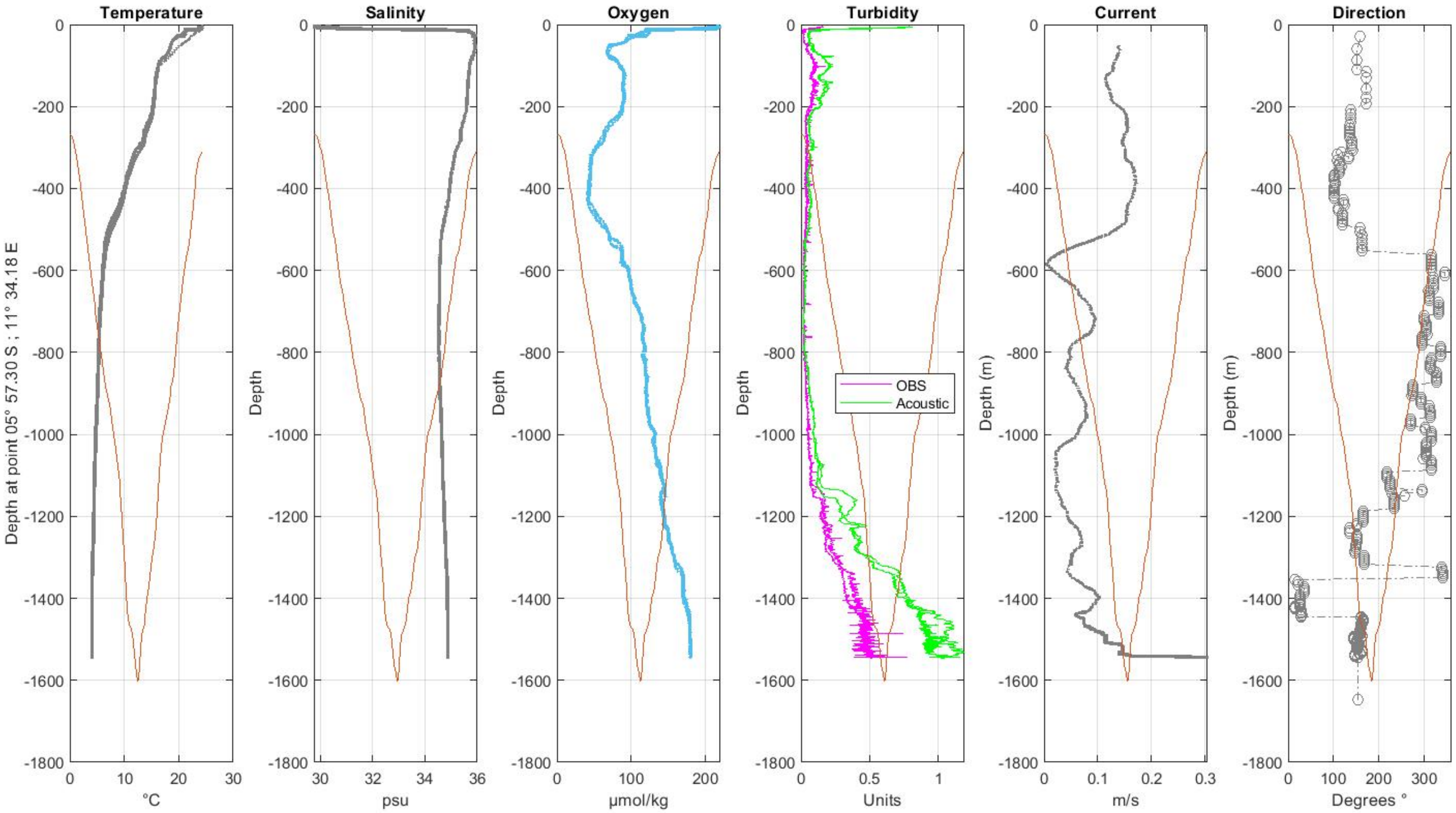


Figure 9.40: *Results of CTD-5.*

9.4.1.6 CTD cast 6

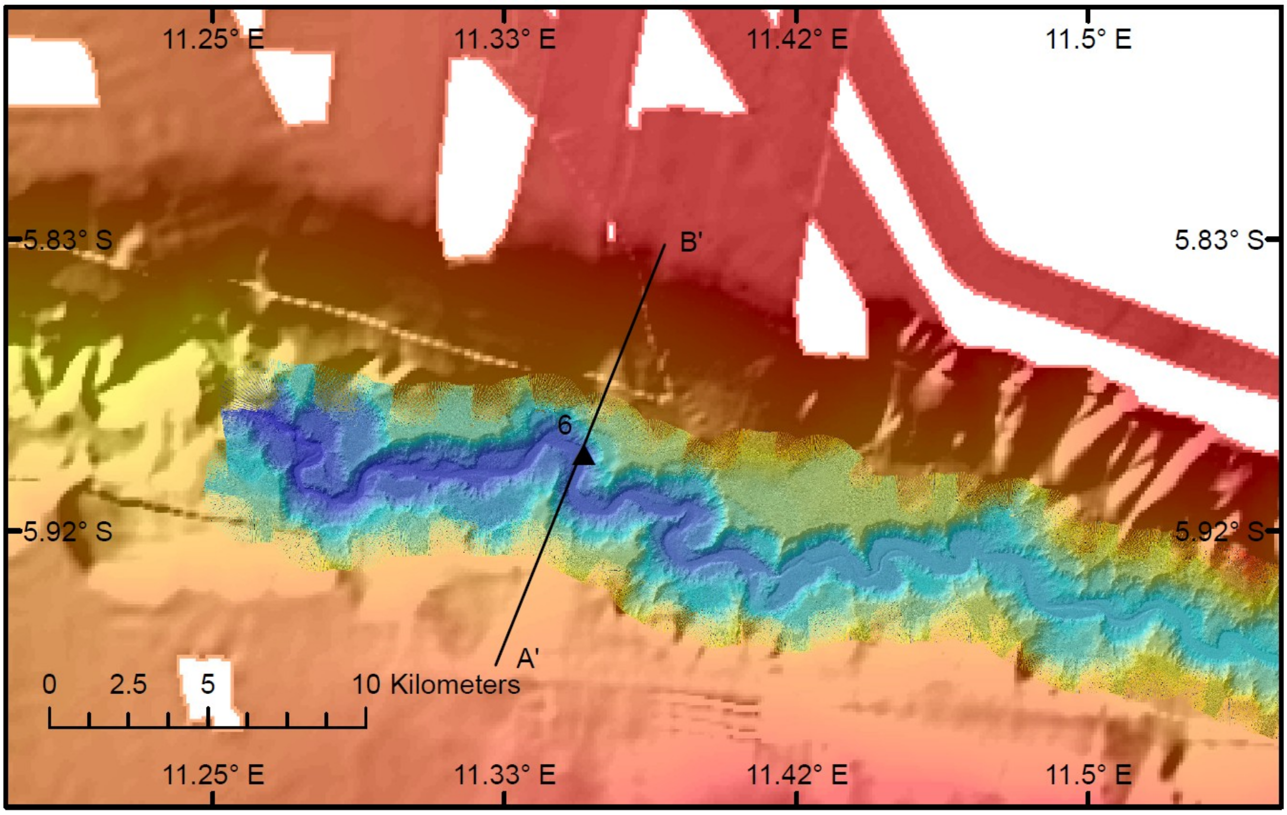


Figure 9.41: *Location of CTD-6.*

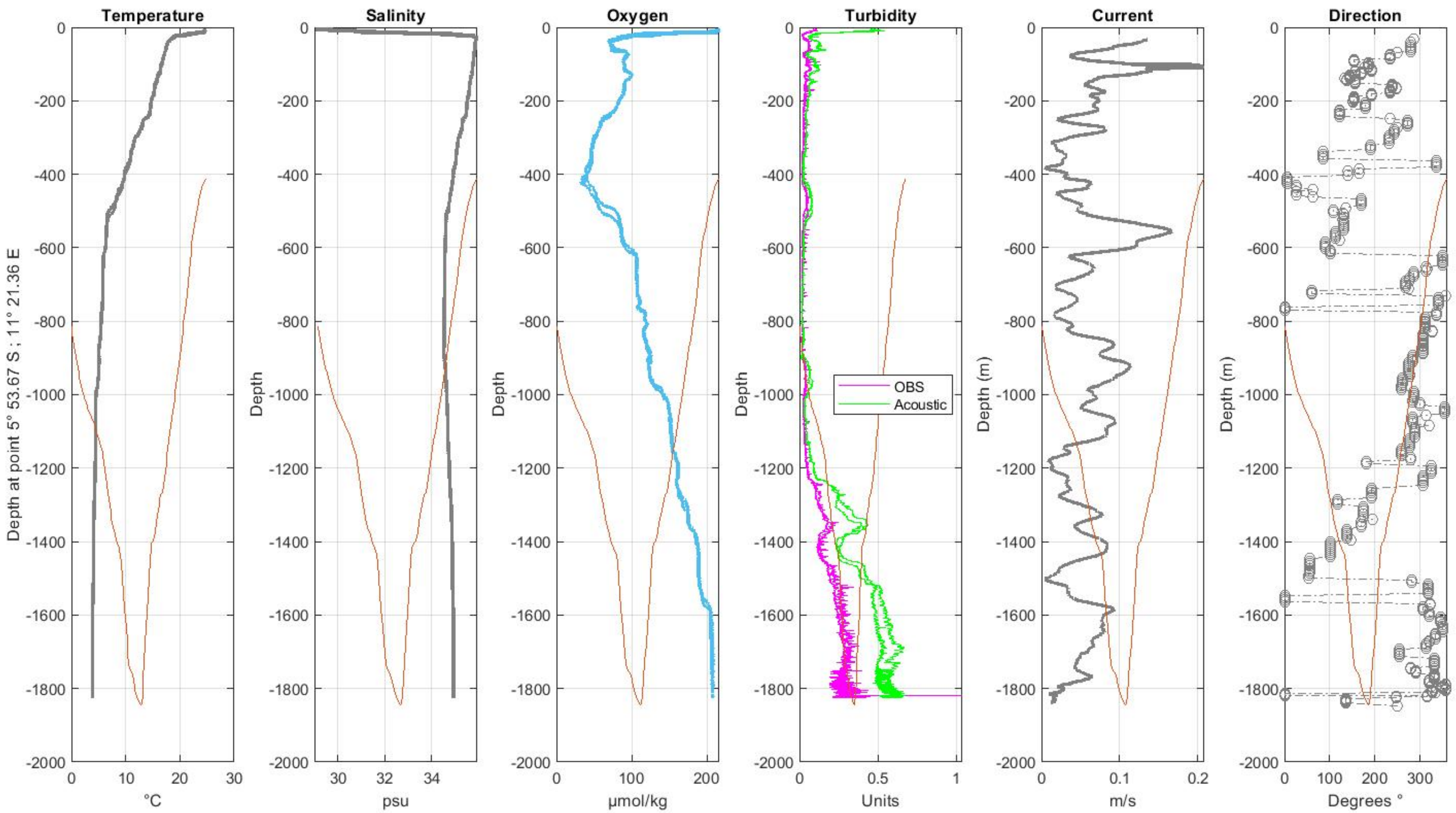


Figure 9.42: *Results of CTD-6.*

9.4.1.7 CTD cast 7

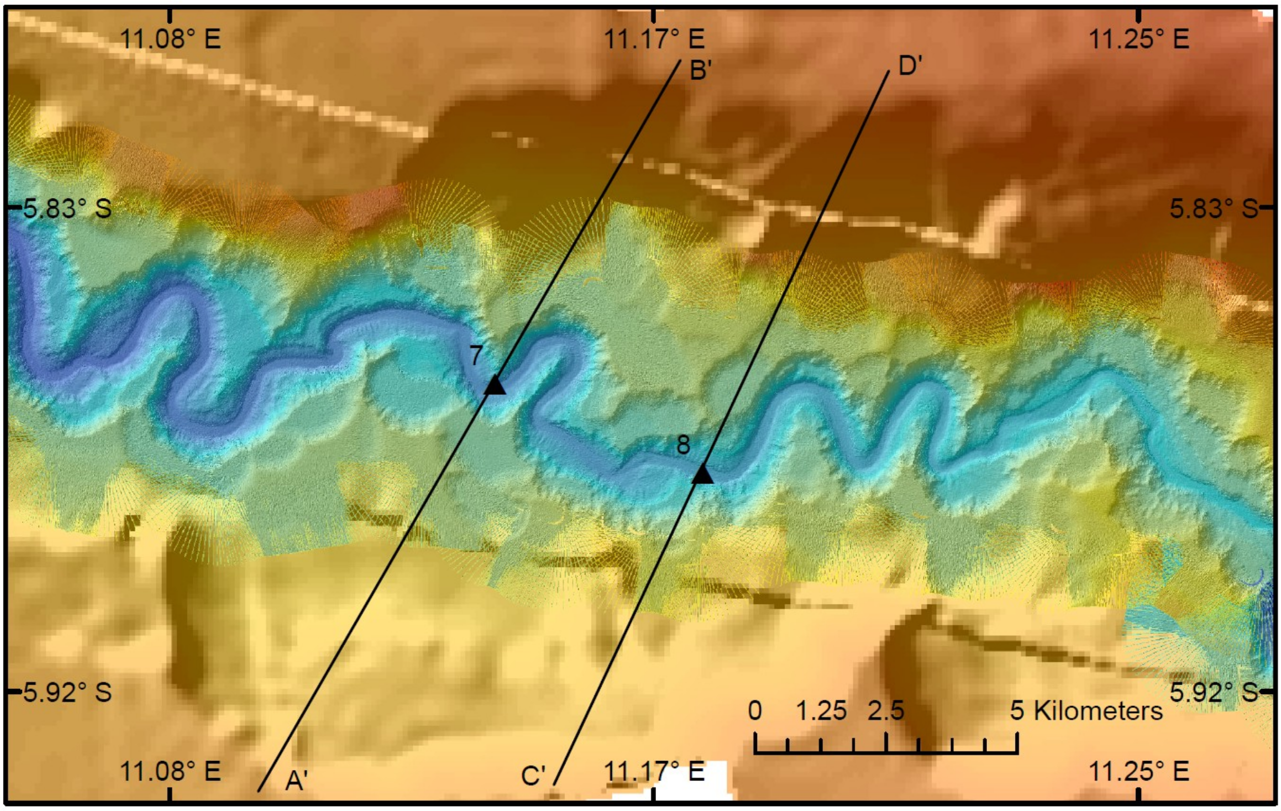


Figure. 9.43: *Location of CTD-7.*

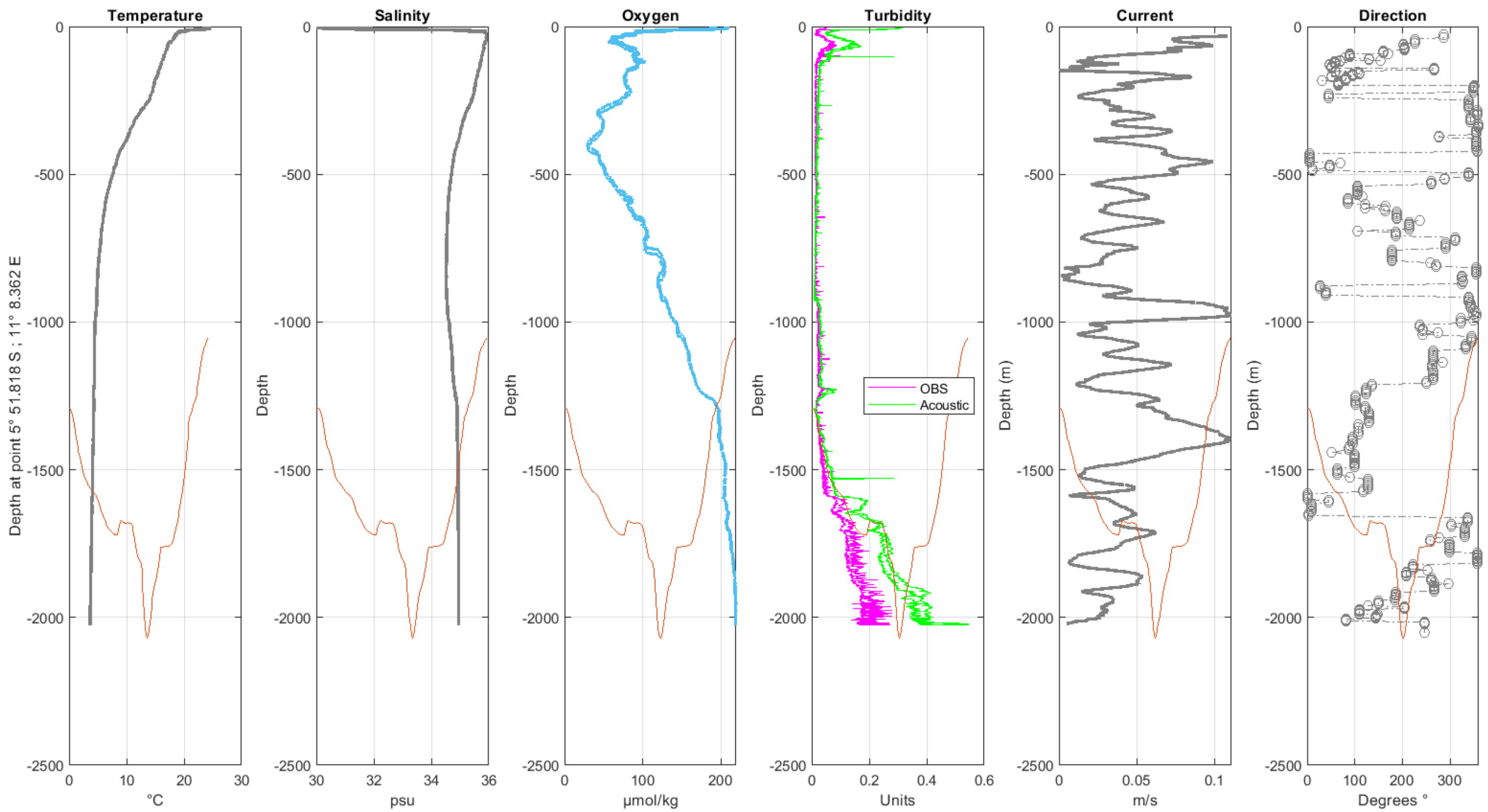


Figure 9.44: *Results of CTD-7.*

9.4.1.8 CTD cast 8

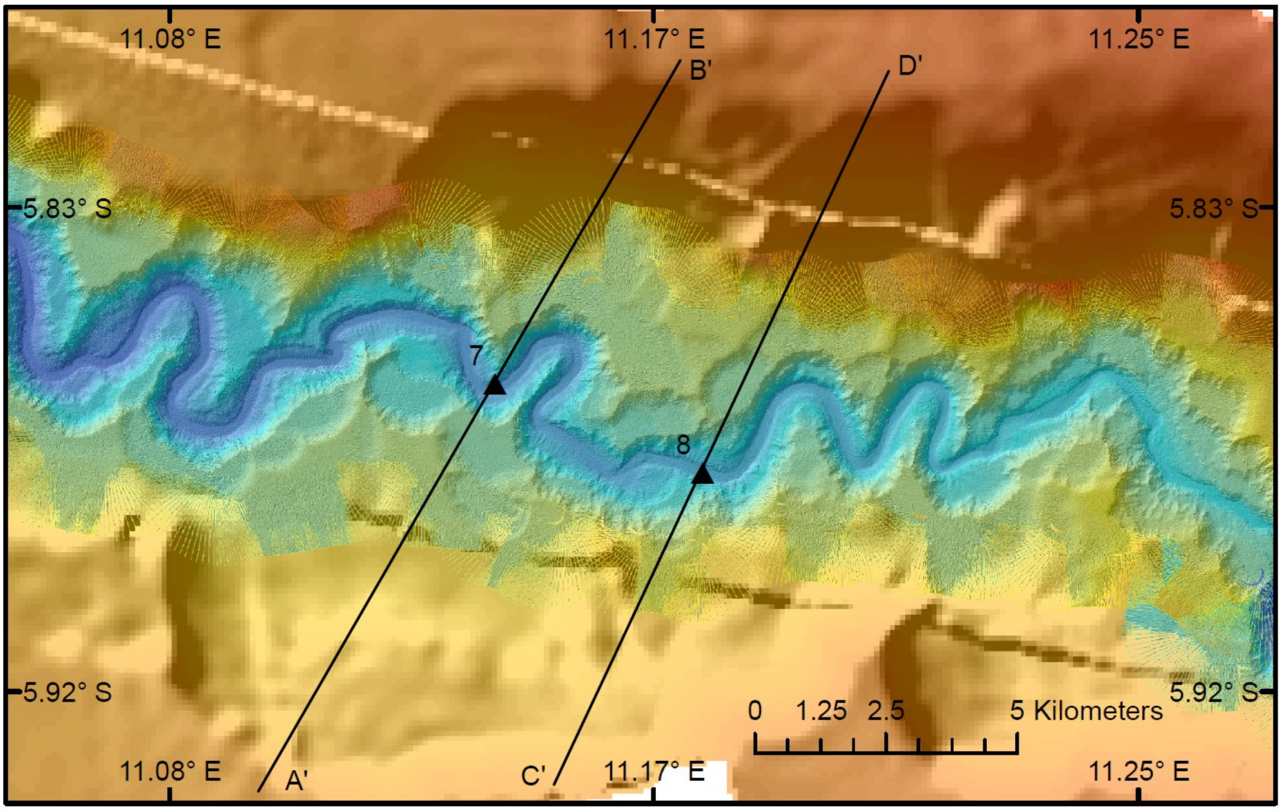


Figure 9.45: *Location of CTD-8.*

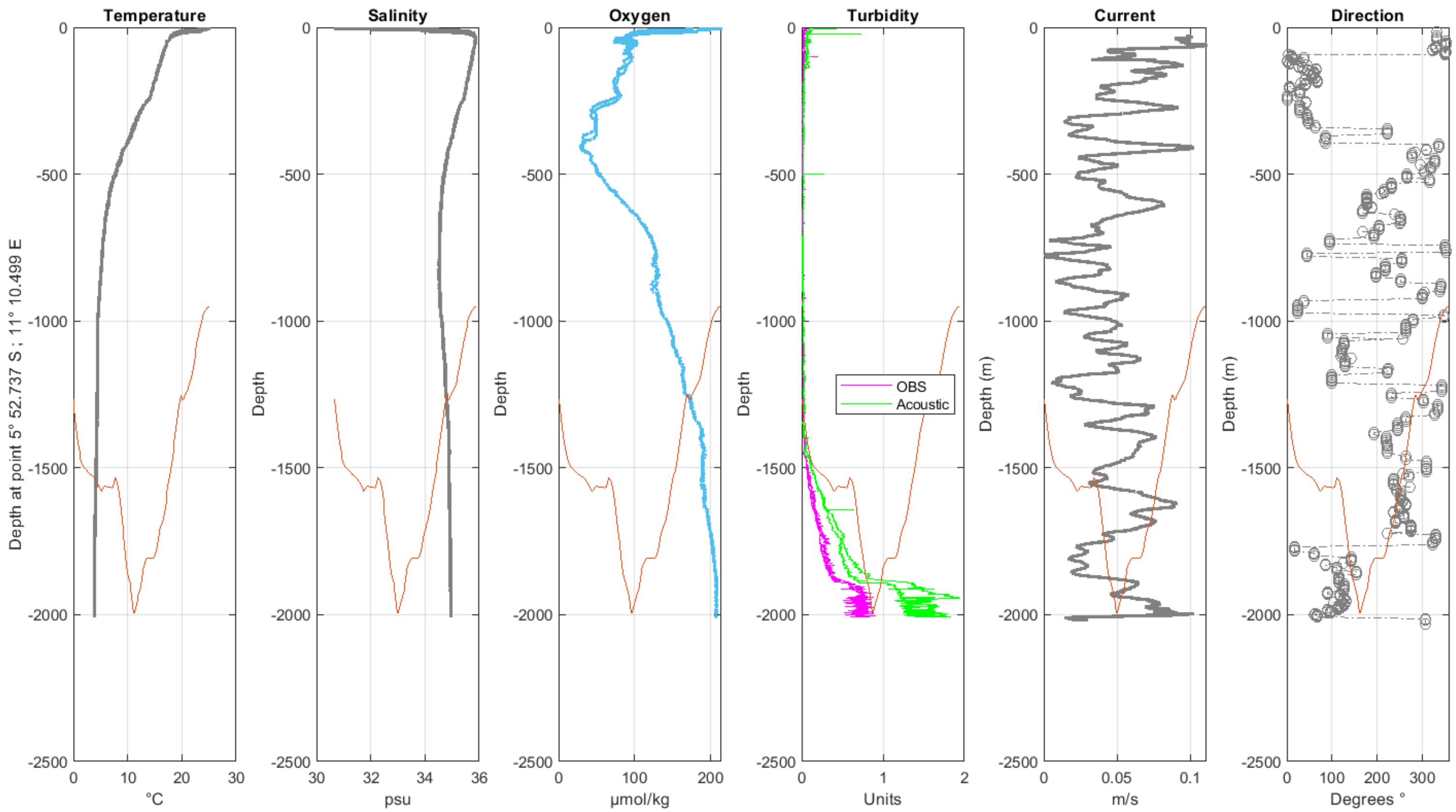


Figure 9.46: *Results of CTD-8.*

9.4.1.9 CTD cast 9

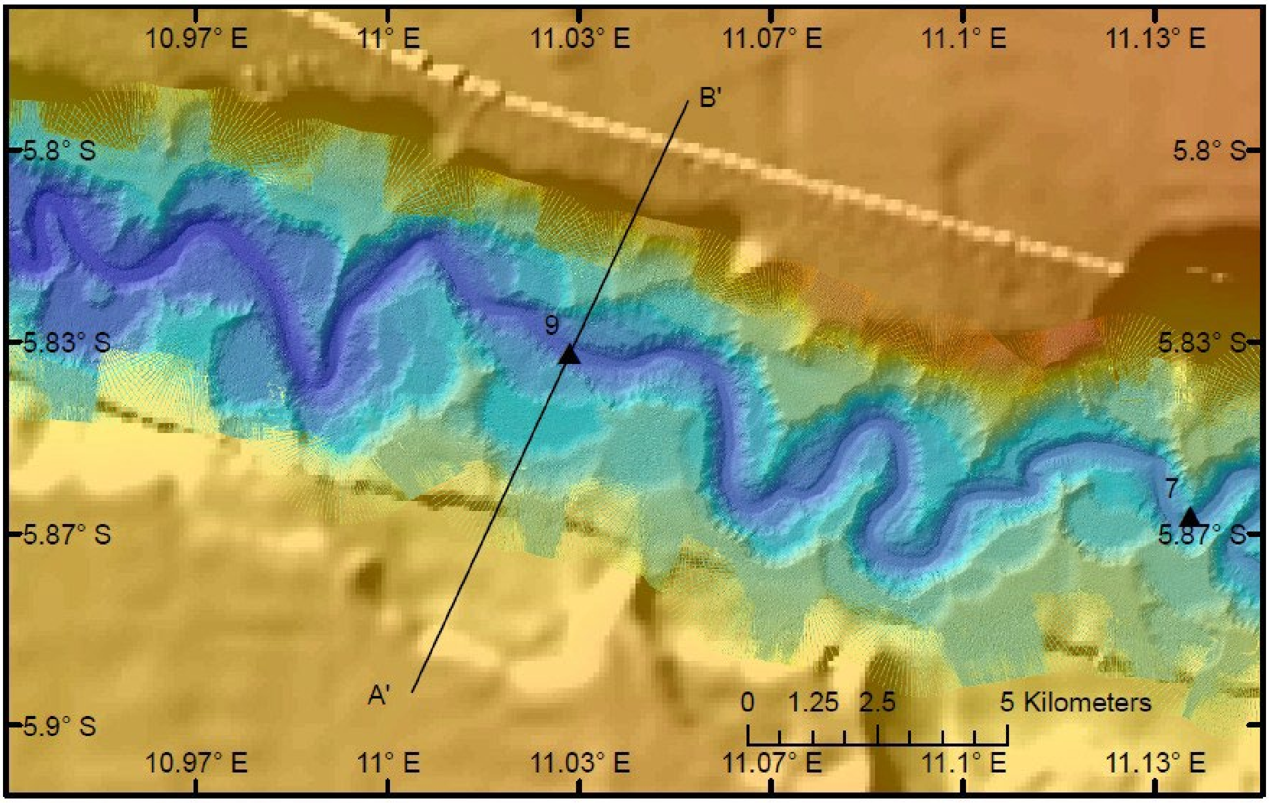


Figure 9.47: *Location of CTD-9.*

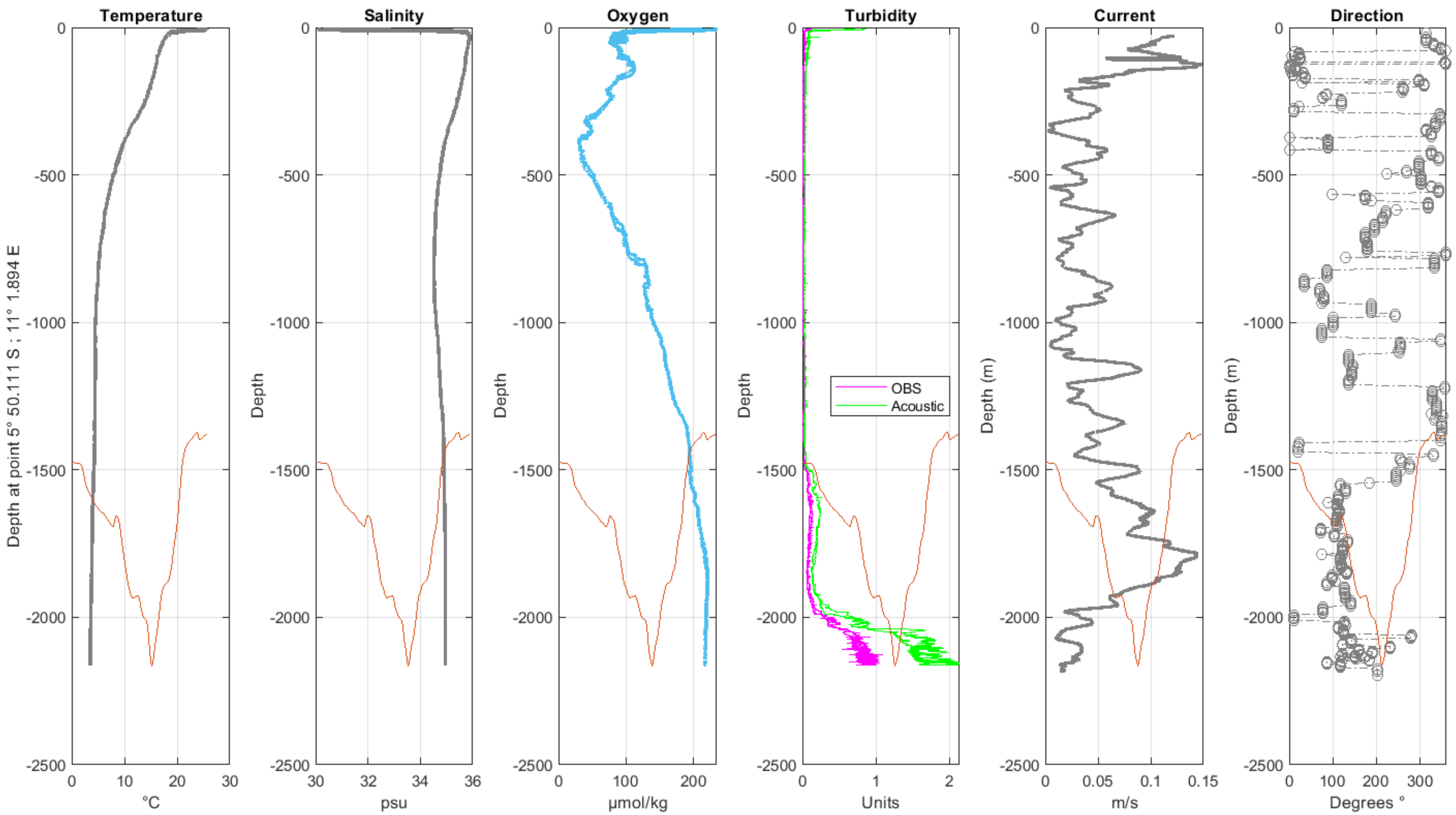


Figure 9.48: *Results of CTD-9.*

9.4.1.10 CTD cast 10

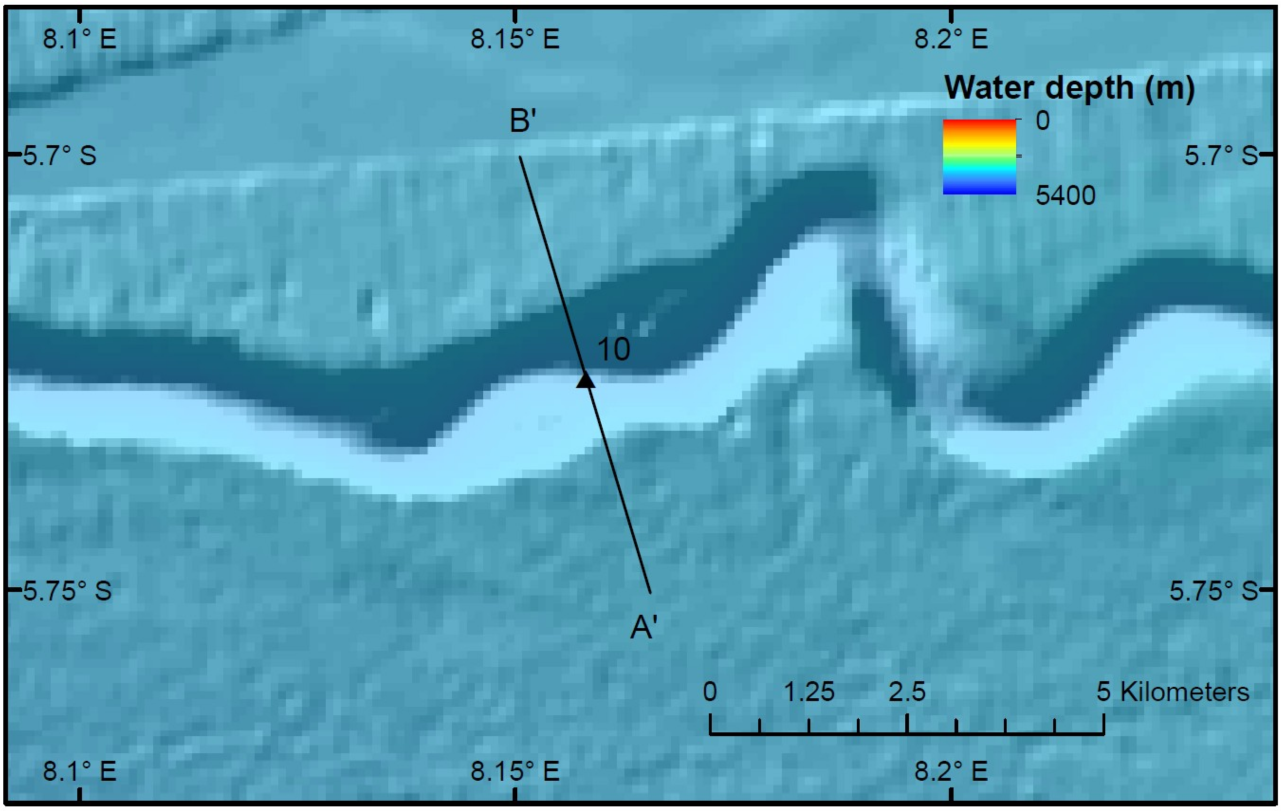


Figure 9.49: *Location of CTD-10.*

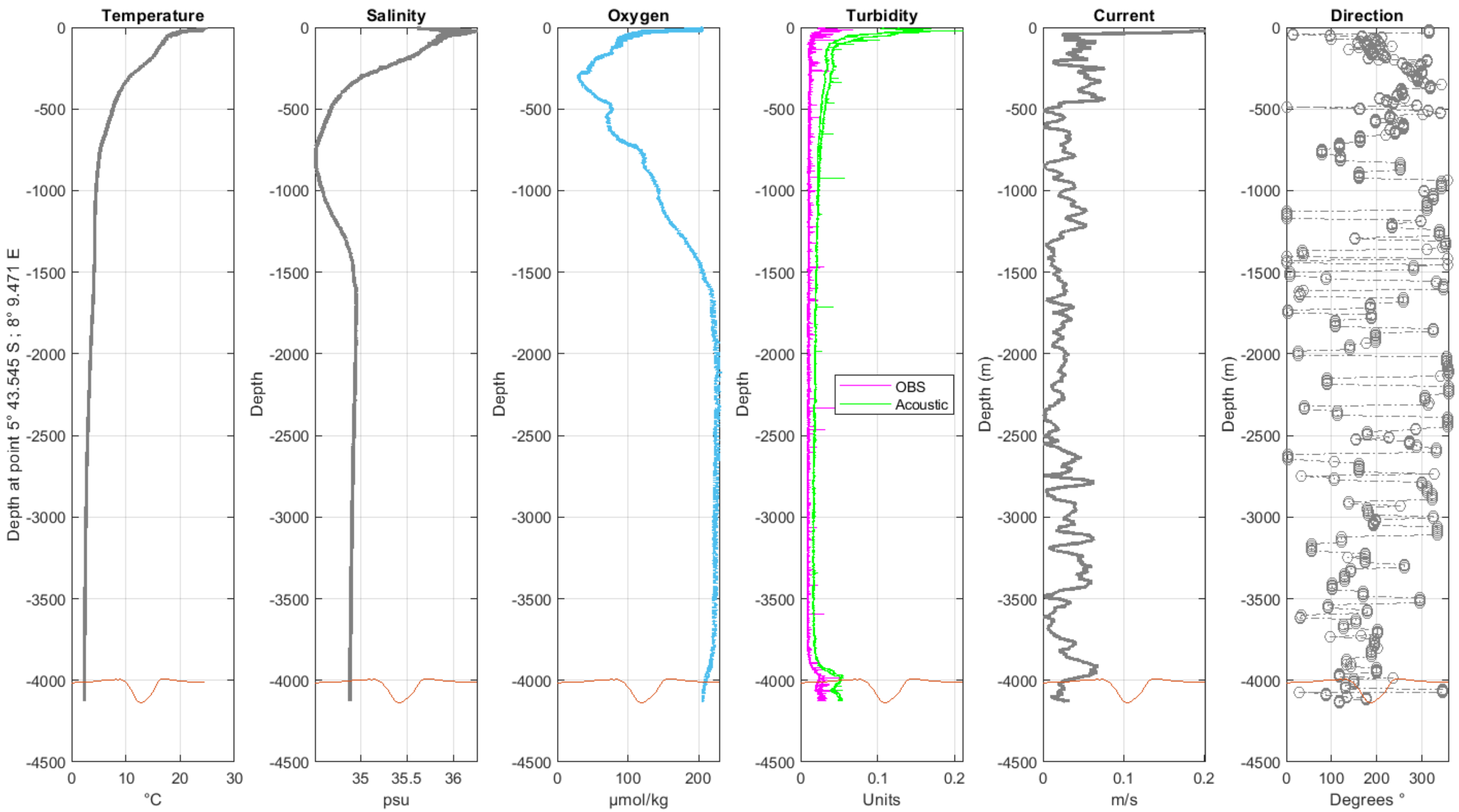


Figure 9.50: *Results of CTD-10.*

9.4.1.11 CTD cast 12

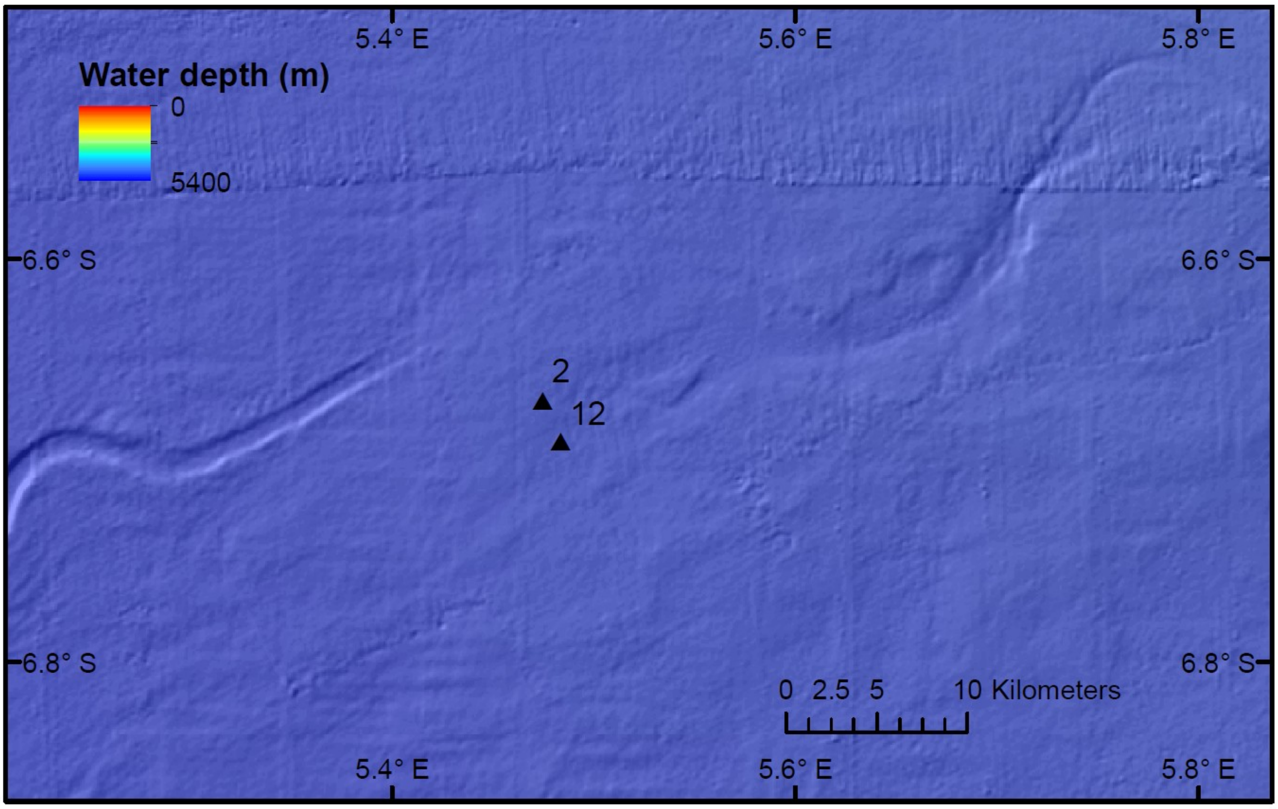


Figure 9.51: *Location of CTD-12.*

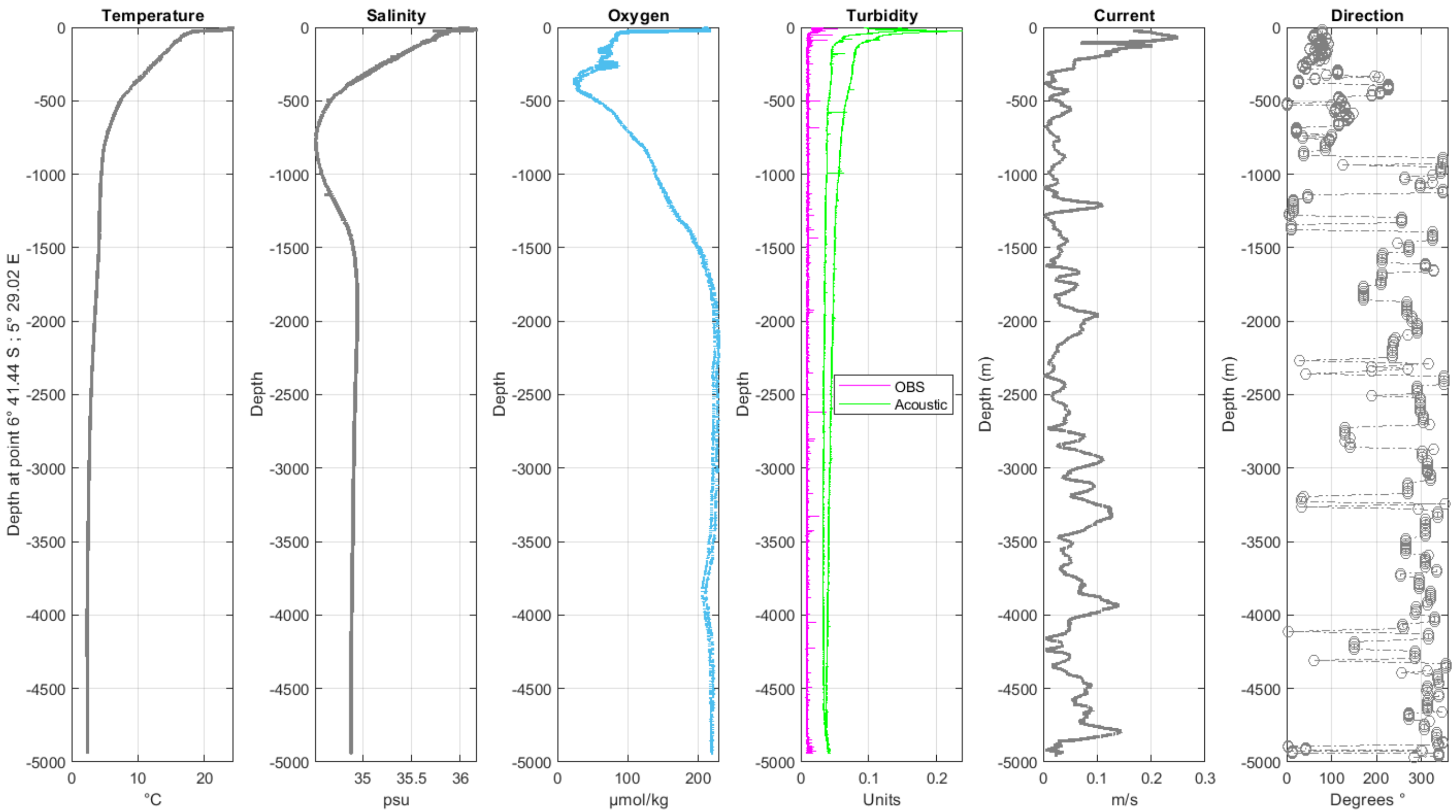


Figure 9.52: *Results of CTD-12.*

9.4.2 Water samples

Table 9.5 provides an overview of CTDs and the number of depths at which water samples have been taken. For more detailed data on the water samples, look into the master XLS sheet on coring data. The rationale for each CTD water sampling plan is outlined below. All water samples appeared to be clear when sampling, no matter the level of turbidity indicated by the CTD.

Table 9.5: *Overview of CTD water samples.*

CTD-06	**CTD-08**	**CTD-09**	**CTD-10**	**CTD-12**
10m ASB	6m ASB	6m ASB	70m ASB	20m ASB
20m ASB	20m ASB	20m ASB	100m ASB	40m ABS
30m ASB	40m ASB	40m ASB	200m ASB	60m ABS
40m ASB	60m ASB	60m ASB	WD 3000	100m ABS
100m ASB	100m ASB	100m ASB	WD 2500	300m ABS
	WD 1601m	300m ASB	WD 1600m	WD 3000m
	WD 500m	WD 1601m	WD 500m	WD 1600m
	WD 50m	WD 500m	WD 200m	WD 500m
		WD 50m	WD 50m	WD 200m
			WD 25m	WD 50m
			WD 10m	WD 25m
				WD 10m

<u>CTD-06</u>
15/09/2019 at 20:30 GIS Site: 88 Water depth: 1829 m USBL (1825 ship)
We suspected the presence of a turbidity current due to an increase in the turbidity measurements and decrease in the transmissometer readings, and therefore focused on sampling close to the seabed. [*Total 5 depths sampled*; *1 glass bottle (330 ml) and 1 plastic bottle (~200 ml) per depth]*

<u>CTD-08.</u>
On 21/09/2019 at 6:45 GIS Site: 92 Water depth: 2012 m pressure sensor (1983m ship)
We strongly suspected the presence of a turbidity current due to a very sharp turbidity increase from the seabed to 100 m above (see Fig. 9.46 in CTD section). We therefore adjusted sampling depths to cover the near-bed layer and the assumed thickness of the flow. It appeared on recovery of the bottles that no flow occurred as bottles were filled with clear water. [*Total 8 depths sampled*; *3 glass bottles (330 ml) & 1 plastic bottle (~200ml) per depth]*

<u>CTD-09</u>
On 21/09/2019 at 19:00 GIS Site: 14 (not exactly on point) Water depth: ~2170 m
Trying to get the lateral variation of microplastics within the canyon and to get some samples with the epipelagic zone as well. We didn't record any major turbidity change, so the focus was on microplastics (not sediments). [*Total 9 depths sampled; 3 glass bottles (330ml) per depth for Microplastics only].*

An alternative plan was in place in case there was an increase of turbidity recorded with the CTD, which would require 4 bottles per depth: 3 for Microplastics, 1 for sediment.

6m ASB; 20m ASB; 40m ASB; 60m ASB; 100m ASB; WD 1601m; WD 500m; WD 50m

<u>CTD-10</u>
On 23/09/2019 at 05:00 GIS Site: 11 Water depth: ~4140 m
Turbidity data looked constant all the down during the CTD dip (see Fig. 9.50 in CTD section). We therefore focused our sampling depths towards the surface. There was also a miscommunication that

water sampling was required during this CTD, leading to firing the first Niskin bottle too late (too high above seafloor). *[Total 11 depths sampled; 3 glass bottles (330 ml)]*

Original plan for constant turbidity: 6m ASB; 40m ASB; 100m ASB; WD 3000; WD 2500; WD 1601m; WD 500m; WD 200m; WD 50m; WD 10m

An alternative plan was in place in case there was an increase of turbidity recorded with the CTD, which would require 4 bottles per depth: 3 for Microplastics, 1 for sediment.

6m ASB; 20m ASB; 40m ASB; 60m ASB; 100m ASB; WD 3000; WD 2500; WD 1601m; WD 500m; WD 300m; WD 50m

<u>CTD-12</u>
On 01/10/2019 at 07:00 GIS site: 124 Water depth: ~4950m
No turbidity observed. The sampling plan focused on getting lateral variation in the lower water column and the upper water column.

10 References Cited

Azpiroz-Zabala, M., Cartigny, M.J.B., Talling, P.J., Parsons, D.R., Sumner, E.J., Clare, M.A., Simmons, S., Cooper, C., and Pope E.L., 2017. Newly recognised turbidity current structure can explain prolonged flushing of submarine canyons. Science Advances, 3, e1700200.

Cooper, C., Wood, J., and Andrieux, 0., 2013, Turbidity current measurements in the Congo Canyon. OTC 23992. Offshore Technology Conference, 6-9 May, Houston, Texas.

Cooper, C., Wood, J. Imran, J., Islam, A., Wright, P., Faria, R., Tati, A., Casey, Z., 2016. Designing for turbidity currents in the Congo Canyon. OTC 26919, Offshore Technology Conference, 2-5 May, Houston, Texas.

Paull, C.K., Talling, P.J., Maier, K., Parsons, D., Xu, J., Caress, D., Gwiazda, R., Lundsten, E., Anderson, K., Barry, J., Chaffey, M., O'Reilly, T., Rosenberger, K., Simmons, S., McCann, M., McGann, M., Kieft, B., Gales, J., Sumner, E.J., Clare, M.A., and Cartigny, M.J.B., 2018. Powerful turbidity currents driven by dense basal layers. Nature Communications, NCOMMS-18-09895A.

11 Appendix A: Summary of Events

SUMMARY TABLE OF EVENTS: CRUISE JC187

Coordinates from Master Log sh

Date	Start Time	End time	Duration (hrs)	Site	Event and equipment	Latitude	Longitude	Water Depth	Master Log Station Numbers	Zone (MS = Mooring Site)	Latitude	Longitude
Friday 31 Aug	10:00				Departed Mindelo in Cape Verde							
					TRANSIT FROM CAPE VERDE							
Mon 1 Sept	10:00	15:50	06:00	T-1	Tested various acoustic releases on SVP/CTD (Cast-1)	6 39.334 N	17 12.692 W	4883	1-7		6° 39.334 N	17° 12.692 W
					TRANSIT FROM CAPE VERDE							
					WORK AREA IN INTERNATIONAL WATERS							
Mon 9 Sept	20:00			67	Arrive Site 67 (1.6 NM from Site 42)	6 40.207 S	5 28.441 E	4957	8		6° 40.206905 S	5°28.47108 E
9 to 10 Sept	20:00	23:30	03:30	67	SVP/CTD Cast -2 (for Multibeam Survey MB_42)	6 40.207 S	5 28.441 E	4957	9-12	MS-8	6° 40.206 S	5° 28.472 E
Tues 10 Sept	23:30	02:15	02:00	67	Multibeam Survey at Site 42 (MBS_42)	6 40.207 S	5 28.441 E	4957	13-21	MS-8	6° 40.160 S	5° 28.420 E
Tues 10 Sept	02:15	02:30	02:00	67 to 42	Transit from end multibeam survey to Site 42							
Tues 10 Sept	02:30	15:40	13:10	42	2 x Mega-cores and 1 x Piston Core near Site 42 MC-01 (no recovery); PC-01 (9 m); MC-02 (full)	6 41.71 S	5 29.11 E	4952	22-31	MS-8		
Tues 10 Sept	04:48	18:50	02:30	75	Deployed NERC Mooring-8	6 41.71 S	5 29.11 E	4952	32-37	MS-8	6° 41.7523 S	5° 28.959 E
Tues 10 Sept	18:50	22:00	03:10	75 to 68	Transit (35 NM)							
Tues 10 Sept	22:05			68	Arrive Site 68	6 28.589 S	6 0.660 E	4768				
10 to 11 Sept	22:05	00:24	02:30	68	Multibeam Survey at Site 40 (MBS_40) (SVP cast from Site 67)	6 28.589 S	6 0.660 E	4768	38-46	MS-7	6°28.734 S	6°0.306 E
Wed 11 Sept	00:24	00:53	00:30	68 to 58	Transit from end multibeam survey to Site 58 (0.5 NM)							
Wed 11 Sept	00:53	09:00	08:10	58	1 x Mega-core and 1 x Piston Core (terrace near Mooring 7): MC-03 (full); PC-02 (~9 m)	6 28.58 S	6 2.5 E	4764	47-52	MS-7		
Wed 11 Sept	09:00	10:20	01:20	58 to 77	Transit Site 58 to 77 (0.6 NM)							
Wed 11 Sept	10:20	19:00	08:40	77	1 x Mega-core and 1 x Piston Core (thalweg near Mooring 7): MC-04 (full); PC-03 (~9 m)	6 28.02 S	6 2.17 E	4780	53-58	MS-7		
Wed 11 Sept	19:30	22:00	03:00	76	Deploy NERC Mooring-7	6 28.02 S	6 2.17 E	4780	59-64	MS-7	6° 27.8458 S	6° 2.7939 E
11 to 12 Sept	22:00	01:00	03:00	40 to 78	Transit (30 NM)							
Thur 12 Sept	01:00	04:00	03:00	78	SVP/CTD cast 3	6 14.671 S	6 27.289 E	4659	65-67	Between MS7 & MS6	6°15.22554 S	6°27.21534 E
Thur 12 Sept	04:00	07:00	03:00	78 to 38	Multibeam Survey at site 39 (MBS_39)	6 14.671 S	6 27.289 E	4659	68-76	Between MS7 & MS6	6°14.8758 S	6°27.279 E
Thur 12 Sept	07:30	07:50	00:20	38	Deploy German OBS-1	6 14.36 S	6 25.85 E	4636	77	Between MS7 & MS6	6°14.36178 S	6°25.85002 E
Thur 12 Sept	07:50	10:45	02:55	38 to 71	Transit (35 NM)							
Thur 12 Sept	10:45			71	Arrive Site 71 (near site 36)	5 53.171 S	6 54.371 E	4506				
Thur 12 Sept	10:45	13:30	02:45	71	SVP/CTD cast 4	5 53.171 S	6 54.371 E	4506	78-80	MS-6	5°54.39672 S	6°48.7292 E
Thur 12 Sept	14:00	17:40	03:40	71	Multibeam Survey (MBS_37) at site 37 (Mooring 6)	5 53.171 S	6 54.371 E	4506	81-93	MS-6	5°54.3594 S	6°48.27618 E
Thur 12 Sept	17:40	18:10	00:30	79,80,81, 82	Deploy 4 x Prototype OBIC Moorings @ Sites 79,80,81 and 82	5 44.12 S	7 37.97 E	4213	94-97	MS-6		
			TRANSIT TO LUANDA TO FOR BOAT TRANSFERS (ANGOLAN OBSERVERS) AND CLEAR CUSTOMS									
				TRANSIT BACK TO WORK AREA IN UPPER CANYON (IN ANGOLAN WATERS)								
Sun 15 Sept	10:00				Arrive on site 83	5 57.3534 S	11 34.189 E	1595				
Sun 15 Sept	10:00	11:30	01:30:00	83	SVP/CTD Cast 5 in channel axis	5 57.3534 S	11 34.189 E	1595	98-100		5°57.34800 S	11°34.19466 E
Sun 15 Sept	11:30	13:00	01:30:00	83	CTD cast to test OBIC acoustic release (to 1 km depth)	5 57.3534 S	11 34.189 E	1595	101-103		5°57.34818 S	11°34.1949 E
Sun 15 Sept				88	CTD/SVP Cast 6 during MBS-83; inc. 6 water samples	5 53.672 S	11 21.357 E	1832	132-139	Upper-part of upper canyon	5°53.67210 S	11°21.35664 E
15 to 16 Sept	13:00	09:30	20:30:00	83 >> 83	Multibeam survey (MBS_83) upper-canyon upper-part	5 57.3534 S	11 34.189 E	1595	104-189	Upper-part of upper canyon	5°57.24288 S	11°33.81288 E
Mon 16 Sept	09:30	12:10	02:50	85 to 84	Transit (22NM)							
Mon 16 Sept	12:10	12:10		84	Arrive Site 84	5 51.7959 S	11 8.3618 E	2064	190			
Mon 16 Sept	12:10	13:50	01:30	84	SVP/CTD Cast 7 in channel axis	5 51.7959 S	11 8.3618 E	2064	191-193		5°51.81900 S	11°8.36238 E
16 to17 Sept	13:50	08:20	18:30	84 to 89	Multibeam survey (MBS_84 & MBS_89) upper-canyon lower-part	5 51.7959 S	11 8.3618 E	2064	194-258	Lower-part of upper canyon	5°51.80322 S	11°8.42776 E
Tues 17 Sept	08:20	08:50	00:30	89 to 86	Transit (4NM)							

Tues 17 Sept	09:10	11:00	01:50	86	**Deploy: Test of the Vertical Hydrophone Array - (outside canyon near Site 14)**	5 49.227 S	11 6.105 E	1262	259-268	MS2E	5°48.86970 S	11°5.58888 E
Tues 17 Sept	11:00	11:50	00:50	86 to 14	Transit (4NM)							
Tues 17 Sept	11:50			14/49	Arrive Site 49 (same as Site 14)	5 50.2 S	11 2.16 E	2159	269			
Tues 17 Sept	11:50	16:20	04:30	49	**Mega-core (MC-05) and Piston Core (PC-04) (Thalweg)**	5 50.2 S	11 2.16 E	2159	269-274	MS2E		
Tues 17 Sept	16:20	16:50	00:30	49 to 90	Transit (0.4 NM)							
Tues 17 Sept	16:50			90	Arrive site 9(	5 49.86 S	11 2.21 E	2058	275			
Tues 17 Sept	17:10	21:00	04:30	90	**Mega-core (MC-06) and Piston Core (PC-05) (Terrac**	5 49.86 S	11 2.21 E	2058	274-280	MS2E		
Tues 17 Sept	21:00	22:00	01:00	90 to 51	Transit (1 NM)							
17 to 18 Sept	22:00	02:00	04:00	51	**Mega-core (MC-07) and Piston Core (PC-06) (Terrace)**	5 50.85 S	11 1.87 E	1931	281-286	MS2E		
Wed 18 Sept	02:00	04:00	02:00	51 to 66	Transit (17 NM)							
Wed 18 Sept	05:00	09:30	04:30	66	**Mega-core (MC-08) and Piston Core (PC-07) (thalweg)**	5 54.01 S	11 19.68 E	1875	287-292	2C upstream		
Wed 18 Sept	09:30	10:00	00:30	66 to 93	Transit (0.5 NM)							
Wed 18 Sept	10:00	14:10	04:10	93	**Mega-core (MC-09) and Piston Core (PC-08) (thalweg)**	5 54.013S	1 19.811 E	1875	293-298	2C upstream		
Wed 18 Sept	14:10	14:40	00:30	93 to 96	Transit (0.5 NM)							
Wed 18 Sept	14:50	18:20	03:30	96	**Mega-core (MC-10) and Piston Core (PC-09) (+20m terrace)**	5 53.794 S	1 19.816 E	1849	299-304			
Wed 18 Sept	18:20	19:50	01:30	96 to 87	Transit (17 NM)							
Wed 18 Sept	19:20	22:50	03:30	87	**Mega-core (MC-11) and Piston Core (PC-10) (south terrace)**	5 54.594 S	1 19.912 E	1679	305-310			
Wed 18 Sept	22:50	23:50	01:00	87 to 48	Transit (7 NM)							
Thurs 19 sept	00:00	03:20	03:20	48	**Mega-core (MC-12) and Piston Core (PC-11) (+200m north t**	5 54.75 S	11 25.03 E	1348	311-316	2C upstream		
Thurs 19 sept	03:20	03:50	00:30	48 to 99	Transit (6 NM)							
Thurs 19 sept	04:10	05:50	01:40	99	**Mega-core (MC-13) (thalweg - just up-canyon of blockage)**	5 55.492 S	1 25.577 E	1670	317-319	2C upstream		
Thurs 19 sept	05:50	06:20	00:30	99 to 66	Transit (6 NM)							
Thurs 19 Sept	06:50	12:30	05:40	66	**Deploy Aniitra-2 mooring (anchor first +USBL), triangulate**	5 54.01 S	11 19.68E	1875	320-335	2C	5° 54.00029 S	11° 19.76589 E
Thurs 19 sept	12:30	13:00	00:30	66 to 103	Transit (250m...up canyon) to Site 93							
Thur 19 Sept	13:10	15:30	02:20	103	**Deploy NERC Mooring-1 (300 kHz), triangulate**	5 54.013S	1 19.811 E	1875	336-343	2C	5° 54.0186 S	11° 19.9042 E
Thur 19 Sept	15:30	15:50	00:20	103 to 87	Transit (0.6 NM)							
Thur 19 Sept	15:50	16:20	00:30	87	**Deploy OBIC OBS-1**	5 54.594 S	1 19.912 E	1679	344	2C	5°54.59574 S	11°19.91160 E
Thur 19 Sept	16:20	16:50	00:30	87 - 99	Transit (5.6 NM)							
Thur 19 Sept	18:00	21:20	03:20	99	**Mega-core (MC-14) and Piston Core (PC-12) (thalweg)**	5 55.492 S	1 25.577 E	1670	345-350	2C upstream		
Thur 19 Sept	21:20	21:50	00:30	99 to 45	Transit (0.6 NM)							
19 to 20 sept	21:50	01:10	03:20	45	**Mega-core (MC-15) and Piston Core (PC-13) (terrace)**	5 55.82 S	11 25.11 E	1709	351-356	2C upstream		
Fri 20 Sept	01:10	01:40	00:30	45 to 97	Transit (0.3 NM)							
Fri 20 Sept	03:00	07:00	04:00	97	**Mega-core (MC-16) and Piston Core (PC-14) (thalweg)**	5 55.455 S	1 28.413 E	1637	357-362	2B		
Fri 20 Sept	07:40	09:40	02:00	97	**Deploy NERC Mooring-4 (300 kHz), triangulate**	5 55.455 S	1 28.413 E	1637	363-370	2B	5° 55.4548 S	11° 28.4072 E
Fri 20 Sept	09:40	10:40	01:00	97 to 98	Transit (5 NM)							
Fri 20 Sept	10:50	14:10	03:20	98	**Mega-core (MC-17) and Piston Core (PC-15) (thalweg)**	5 57.208 S	1 33.198 E	1575	371-376			
Fri 20 Sept	15:00	17:00	02:00	98	**Deploy NERC Mooring-3 (300 kHz), triangulate**	5 57.208 S	1 33.198 E	1575	377-384	2A	5°57.2118 S	11°33.204 E
Fri 20 Sept	17:00	17:30	00:30	98 to 5	Transit (2 NM)							
Fri 20 Sept	17:30	17:45	00:15	5	**Deploy OBIC OBS-2 near site 98**	5 57.81S	11 31.71 E	1134	385	2A	5°57.80958 S	11°31.70058 E
Fri 20 Sept	17:45	18:00	00:15	5 to 104	Transit (3.5 NM)							
Fri 20 Sept	18:00	18:15	00:15	104	**Deploy OBIC OBS-3 near site 97 (lower elevation site)**	5 55.958 S	1 27.269 E	1564	386	2B	5°55.971 S	11°27.280 E
Fri 20 Sept	18:15	18:30	00:15	104 > 105	Transit (1.5 NM)							
Fri 20 Sept	18:30	18:45	00:15	105	**Deploy OBIC OBS-4 near site 97 (high site)**	5 54.483 S	1 27.406 E	1260	387	2B	5°54.485 S	11°27.397 E
Fri 20 Sept	18:45	20:00	01:15	105 to 106	Transit (9 NM)							
Fri 20 Sept	20:00	21:00	01:00	106	**1 piston core (PC-16; 6m barrel) at Site 98**	5 57.208 S	1 33.198 E	1575	388-390	2A		
20 to 21 Sept	21:00	00:00	03:00	106 to 92	Transit (22 NM)							
Sat 21 Sept	00:00	04:50	04:50	92	**Mega-core (MC-18) and Piston Core (PC-17) (thalweg)**	5 52.737 S	1 10.499 E	2017	391-396	2D		
Sat 21 Sept	04:50	07:30	02:40	92	**CTD cast 8 and water column sampling with 8 bottles**	5 52.737 S	1 10.499 E	2017	397-406	2D	5°52.738 S	11°10.499 E
Sat 21 Sept	08:00	11:00	03:00	92	**Deploy Aniitra-3 Mooring (anchor first)**	5 52.737 S	1 10.499 E	2017	407-415	2D	5°52.7352 S	11°10.4954 E
Sat 21 Sept	11:00	11:30	00:30	92 to 86	Transit (9 NM)							

Sat 21 Sept	11:30	13:00	01:30	86	Recover vertical hydrophone array after test period	5 49.227 S	11 6.105 E	1262	416-421	2E	5°49.1887 S	11°05.93766 E
Sat 21 Sept	13:00	13:30	00:30	86 to 14	Transit (4 NM)							
Sat 21 Sept	14:20	16:30	02:10	14	Deploy NERC Mooring-9 (600 kHz ADCP), triangulate	5 50.2 S	11 2.16 E	2171	422-430	2E	5°50.2092 S	11°2.163 E
Sat 21 Sept	17:00	19:00	02:00	near 14	CTD cast 9 with 9 water column samples (**near 14)	5 50.2	11 2.16	2171	431-441	2E	5° 50.11150 S	11° 1.89473 E
Sat 21 Sept	18:30	19:00	00:30	14 to 107	Transit [7 NM]							
Sat 21 Sept	20:00	22:00	02:00	107	Megacore (MC-19) at Site 107 (thalweg on bend)	5 51.395 S	11 8.892 E	2054	442-444	near 2D		
Sat 21 Sept	22:00	22:30	00:30	107 - 108	Transit [200 m]							
Sat 21 Sept	22:10	00:00	02:00	108	Megacore (MC-20) at Site 108 (terrace on bend)	5 51.422 S	11 8.786 E	2057	445-447	near 2D		
Sun 22 Sept	00:00	00:30	00:30	108-109	Transit [300 m]							
Sun 22 Sept	00:30	02:30	02:00	109	Megacore (MC-21) at Site 109 (thalweg on bend)	5 51.580 S	11 8.684 E	2057	448-450	near 2D		
Sun 22 Sept	02:30	02:50	00:20	109-110	Transit (100 m)							
Sun 22 Sept	02:50	04:50	02:00	110	Megacore (MC-22) at Site 110 (terrace on bend)	5 51.619 S	11 8.702 E	2057	451-453	near 2D		
Sun 22 Sept	04:50	05:20	00:30	110-51	Transit (7 NM)							
Sun 22 Sept	05:30	05:50	00:20	51	Deploy OBIC OBS-5	5 50.85 S	11 1.87 E	1931	454	2E	5° 50.84958 S	11° 1.87302 E
Sun 22 Sept	05:50	06:20	00:30	51 to 13	Transit (0.5 NM)							
Sun 22 Sept	07:10	09:30	02:20	13	Deploy vertical hydrophone array, triangula	5 50.77 S	11 1.55 E	1933	455-464	2E	5°50.71194 S	11°1.11204 E
Sun 22 Sept	09:30	09:30			**TRANSIT BACK TO INTERNATIONAL WATERS**							
22 to 23 Sept	09:30	02:00	16:30	13-112	Transit [175 NM]							
Mon 23 Sept	02:00			112	Arrive Site 112 (just before old site 32)	5 43.543 S	8 9.487 E	4138				
Mon 23 Sept	02:00	05:00	03:00	112	SVP/CTD cast 10 with 11 water samples (close to site 32)	5 43.543 S	8 9.487 E	4138	466-479	MS5	5° 43.54302 S	8° 9.48768 E
Mon 23 Sept	05:30	08:10	02:30	113/114	3 hr Multibeam Survey (MBS_113)	5 43.841 S	8 8.782 E	4116	480-485	MS5	5°43.94850 S	8°9.66600 E
23-24 sept					**SURVEY TRUNCATED - TRANSIT TO LUANDA**							
24-25 Sept					**TRANSIT FROM LUANDA BACK TO SITE 115**							
Wed 25 Sept				115	**ARRIVE SITE 15 (Angola waters)**	5 56.47 S	11 25.18 E	1508	486		5°58.7452 S	11° 24.28812 E
Wed 25 Sept	09:20	11:45	02:25	115	Short Multibeam Survey (MBS_115) at landslide (Site 115 in very close to Site 46)	5 56.47 S	11 25.18 E	1508	486-502	MS2C	5°58.7452 S	11° 24.28812 E
Wed 25 Sept	11:45	13:50	02:05	115-118	Transit (24 NM)							
Wed 25 Sept	13:50	16:10	02:20	118	Deploy NERC Mooring-2 (75 + 300 kHz), triangulate * differs slightly from Site 14 to avoid Mooring 9	5 50.2 S	11 2.16 E	2171	503-513	MS2E	5°50.2313 S	11° 2.3357 E
25/26 Sept	**16:10**	**07:20**	15:10	**118 -116**	**Transit (174 NM) to International Waters**							
Thur 26 Sept	07:20	18:30	11:10	116-114	Multibeam Survey (MBS_113) Continued from where it was truncated on 23 Sept.	5 47.301	8 0.3517	4167	514-543	MS5	5°47.24004 S	8° 0.24222 E
Thur 26 Sept	18:30	19:00	00:30	114	CTD Cast - xx	5 45.182 S	7 47.623 E	4278	544-547	MS5	5° 45.32022 S	7° 47.60160 E
26 to 27 Sept	19:00	14:00	19:00	116-116	Multibeam Survey (MBS_113) Continued from location of CTD cast	5 47.301	8 0.3517	4167	548-594	MS5		
Fri 27 Sept	14:00	14:15	00:15	116 - 32	Transit [1.3 NM]							
Fri 27 Sept	14:15	21:00	06:45	32	Mega-core (MC-23) and piston core (PC-18)	5 44.1 S	8 8.23 E	4150	595-600	MS5	5° 44.10068 S	8° 8.23146 E
Fri 27 Sept	21:00	21:45	00:45	32 to 53	Transit [0.5 NM]							
27 to 28th	21:45	04:40	06:55	53	Mega-core (MC-24) and piston core (PC-19)	5 43.71 S	8 8.21 E	4071	601-606	MS5	5° 43.7199 S	8° 8.21070 E
Sat 28 Sept	04:40	05:20	00:40	53 to 33	Transit [1.3 NM]							
Sat 28 Sept	05:20	05:40	00:20	33	Deploy OBIC OBS-6	5 45.26 S	8 7.63 E	4027	607	MS5	5° 45.2514 S	8° 7.63398 E
Sat 28 Sept	05:40	05:55	00:15	53 to 120	Transit [1.3 NM]							
Sat 28 Sept	06:20	09:00	02:40	120	Deploy NERC Mooring 5, and triangulate	5 43.87349 S	8 7.315559 E	4150	608-616	MS5	5° 43.8825 S	8° 7.3028 E
Sat 28 Sept	09:00	09:30	00:30	120-54	Transit [4 NM]							
Sat 28 Sept	09:50	16:50	07:00	54	Mega-core (MC-25) and piston core (PC-20)	5 49.23 S	8 8.7 E	4044	617-622	MS5	5° 49.22946 S	8° 8.70966 E
Sat 28 Sept	16:50	18:50	02:00	54 - 101	Transit (17 NM)							
Sat 28 Sept	18:50	19:10	00:20	101	Deploy OBIC OBS-7 between Mooring Sites 5 and 4	5 45.87 S	7 51.904 E	4101	623	Between MS4 and 5	5° 45.86940 S	7° 51.91638 E
Sat 28 Sept	19:10	22:20	03:10	101-102	Transit (35 NM)							
Sat 28 Sept	22:20	22:40	00:20	102	OBIC OBS-8 (between Mooring Sites 4 and 6)	5 46.482 S	7 16.147 E	4325	624	Between MS4 and MS6	5° 46.49400 S	7° 16.13196 E
28 to 29 Sept	22:40	00:15	02:35	102-79	Transit (25 NM)							

Sun 29 Sept	00:15	07:50	07:35	Sites 79, 80, 81, 82	Recovered OBIC Prototype Moorings	5 53.7946 S	6 54.9477 E	4416	625-636	MS6	5° 53.667 S	6° 55.09146 E
Sun 29 Sept	07:50	08:10	00:20	82-37	Transit (1.6 NM)							
Sun 29 Sept	08:10	08:20	00:10	Site 37	Deploy OBIC OBS-9 (near Mooring Site 6)	5 54.87 S	6 53.41E	4470	637	MS6	5° 54.86810 S	6° 53.91830 E
Sun 29 Sept	08:20	09:00	00:40	37-117	Transit (3.4 NM)							
Sun 29 Sept	09:00	11:50	02:50	Site 117	Deploy NERC Mooring 6, and triangulate (Site 117 very close to Site 36)	5 52.143 S	6 55.521 E	4476	638-647	MS6	5° 52.1482 S	6° 55.5175 E
Sun 29 Sept	11:50	12:40	00:50	117-119	Transit [2 NM]							
Sun 29 Sept	12:40	16:00	03:20	119	SVP cast xxx (near Mooring Site 6)	5 53.372 S	53.3138 E	4516	648-650	MS6	5° 53.36958 S	6° 53.39646 E
29 to 30 Sept	16:00	13:20	21:20	119-119	Multibeam Survey (MBS_119) from Mooring Site 6 to S 38/39 and back to Mooring Site 6	5 53.372 S	53.3138 E	4516	651-731	MS6 > 38/39 > MS6	5° 53.40582 S	6° 53.38650 E
Mon 30 Sept	13:20	16:30	03:10	119 -121	Transit [30 NM]							
30 to 1 Oct	16:30	02:50	10:20	121 - 124	Multibeam Survey (MBS_121) Single Swath Line from Site 38/39 to Mooring Site 8	6 14.6837 S	6 27.4863 E	4594	732-744	38/39 > MS7 > MS8	6° 14.33472 S	6° 27.94530 E
Tues 1 Oct	02:50	07:00	04:10	124	CTD-12 for Multibeam Survey MBS_122 and MBS_121 (500m from Mooring Site 8)	6 41.456 S	5 29.021 E	4957	745-759	MS8	6° 41.45406 S	5° 29.02146 E
Tues 1 Oct	07:00	08:20	01:20	75	Recovered NERC Mooring 8	6 41.71 S	5 29.11 E	4952	760-765	MS8	6° 41.51544 S	5° 29.00646 E
	08:20	09:00	00:40	75 - 122	Transit [2.7 NM]							
Tues 1 Oct	09:00	18:50	09:50	122 - 40	Multibeam Survey (MBS_122) from Mooring Site 8 to 7	6 39.5277 S	5 30.4924 E	4958	766-775	MS8	6° 39.24432 S	5° 31.23677 E
Tues 1 Oct	18:50	19:10	00:20	40 to 58	Transit [2NM]							
Tues 1 Oct	19:10	19:20	00:10	58	German OBS-2 near Site 7	6 28.58 S	6 2.500 E	4742	776	MS7	6° 28.57302 S	6° 2.49018 E
Tues 1 Oct	19:20	19:30	00:10	58	Extra (fourth) triangulation point on Mooring 7	6 28.573 S	6 2.490 E	4642	777	MS7	6° 28.57302 S	6° 2.49018 E
Oct 1 to 2	19:30	01:40	06:10	58 to 125	Transit [65 NM]							
Wed 2 Oct	01:40	09:20	07:40	125-123	Multibeam Survey MBS_125 (single swath line along channel) from Mooring Site 6 to Mooring Site 4	51.4240 S	57.0363 E	4433	778-800	MS6 to MS4	5° 51.40464 S	6° 56.85228 E
Wed 2 Oct	09:20	12:00	03:40	123	(Re)Deployed Mooring 8-R at Mooring Site 4	5 45.413 S	7 40.491 E	4327	801-808	MS4	5° 45.4004 S	7° 40.4741 E
Wed 2 Oct	12:00	12:30	00:30	123 to 43	Transit [1 NM]							
Wed 2 Oct	12:30	12:40	00:10	43	Deploy OBIC OBS-10 near Mooring Site 4	5 44.12 S	7 37.97 E	4213	809	MS4	5° 44.11220 S	7° 37.96914 E
Wed 2 Oct	12:40	13:30	00:50	43 to 126	Transit {1 NM]							
Wed 2 Oct	13:30	00:00	10:30	126-	Multibeam Survey - West from Mooring 4 (MBS_126)	5 46.0293 S	7 33.5961 E	4221	810 - 846	West from MS4	5° 46.35972 S	7° 33.52650 E
					SCIENCE FINISHES 24:00 WEDS 2ND OCT							
					Transit to Walvis Bay (~5 days) ARRIVE WALVIS BAY 7th Oct							

KEY	(blue)		MOORING DEPLOYMENT OR RECOVERY
	(green)		MULTIBEAM SURVEY OR SVP/CTD CAST
	(yellow)		OBS OR HYDROPHONE ARRAY DEPLOYMENT

The following continuation of the same tables also give the USBL coordinates.

SUMMARY TABLE OF EVENTS: CI Coordinates from Master Log sheets

Event and equipment	Latitude	Longitude	Comments
Departed Mindelo in Cape Verde			Coordinates selected from master log sheets: Moorings = when anchor is dropped, CTD = at seabed or USBL, Cores = USBL given in comments, OBS = when dropped, multibeam =
TRANSIT FROM CAPE VERDE			start of surveys
Tested various acoustic releases on SVP/CTD (Cast-1)	6° 39.334 N	17° 12.692 W	
TRANSIT FROM CAPE VERDE			
WORK AREA IN INTERNATIONAL WATERS			
Arrive Site 67 (1.6 NM from Site 42)	6° 40.206905 S	5°28.47108 E	
SVP/CTD Cast -2 (for Multibeam Survey MB_42)	6° 40.206 S	5° 28.472 E	
Multibeam Survey at Site 42 (MBS_42)	6° 40.160 S	5° 28.420 E	
Transit from end multibeam survey to Site 42			
2 x Mega-cores and 1 x Piston Core near Site 42 01 (no recovery); PC-01 (9 m); MC-02 (full)	MC-		MC01 USBL: Depth = 4956.2m; 6° 41.70255 S; 5° 29.10085 E; PC01 Depth = 4955.9 m, 6°41.70447 S; 5° 29.10622 E; MC02 Depth = 4956 m; 6° 41.70071 S; 5° 29.10581 E
Deployed NERC Mooring-8	6° 41.7523 S	5° 28.959 E	Final triangulated Position of Mooring 8
Transit (35 NM)			
Arrive Site 68			
Multibeam Survey at Site 40 (MBS_40) (SVP from Site 67)	cast 6°28.734 S	6°0.306 E	
Transit from end multibeam survey to Site 58 (0.5 NM)			
1 x Mega-core and 1 x Piston Core (terrace near Mooring 7): MC-03 (full); PC-02 (~9 m)			MC03 USBL 4760 m; 6° 28.55832 S; 6° 2.50591 E; PC02 USBL: Depth = 4761.1 m; 6° 28.56373 S; 5° 2.48820 E
Transit Site 58 to 77 (0.6 NM)			
1 x Mega-core and 1 x Piston Core (thalweg near Mooring 7): MC-04 (full); PC-03 (~9 m)			MC04 USBL: Depth = 4795.1 m; 6° 27.88847 S; 6° 3.17800 E; PC03 USBL: Depth = 4789.5 m; 6° 27.89049 S; 6° 3.18138 E
Deploy NERC Mooring-7	6° 27.8458 S	6° 2.7939 E	Changed from Site 40 to avoid channel bar
Transit (30 NM)			
SVP/CTD cast 3	6°15.22554 S	6°27.21534 E	
Multibeam Survey at site 39 (MBS_39)	6°14.8758 S	6°27.279 E	
Deploy German OBS-1	6°14.36178 S	6°25.85002 E	
Transit (35 NM)			
Arrive Site 71 (near site 36)			
SVP/CTD cast 4	5°54.39672 S	6°48.7292 E	
Multibeam Survey (MBS_37) at site 37 (Mooring 6)	5°54.3594 S	6°48.27618 E	
Deploy 4 x Prototype OBIC Moorings @ Sites 79,80,81 and 82			OBS-A 5°53.78424 S 6°54.94698 E; OBS-B 5°54.13656 S 6°54.94224 E; OBS-C 5°54.15300 S 6°55.37352 E; OBS-D 5°53.89464 S 6°55.43009 E
NDA TO FOR BOAT TRANSFERS (ANGOLAN OBSERVERS) AND CLEAR CUSTOMS			
IT BACK TO WORK AREA IN UPPER CANYON (IN ANGOLAN WATERS			
Arrive on site 83			
SVP/CTD Cast 5 in channel axis	5°57.34800 S	11°34.19466 E	
CTD cast to test OBIC acoustic release (to 1 km depth)	5°57.34818 S	11°34.1949 E	
CTD/SVP Cast 6 during MBS-83; inc. 6 water samples	5°53.67210 S	11°21.35664 E	
Multibeam survey (MBS_83) upper-canyon upper-part	5°57.24288 S	11°33.81288 E	CTD USBL: 5° 53.66225 S 11° 21.35426 E; Depth: 1829 m
Transit (22NM)			
Arrive Site 84			
SVP/CTD Cast 7 in channel axis	5°51.81900 S	11°8.36238 E	CTD USBL: 5°51.81078, 11°8.36094, 2028.5 m
Multibeam survey (MBS_84 & MBS_89) upper-canyon lower-part	5°51.80322 S	11°8.42776 E	
Transit (4NM)			
Deploy: Test of the Vertical Hydrophone Array - (outside canyon near Site 14)	5°48.86970 S	11°5.58888 E	

Transit (4NM)			
Arrive Site 49 (same as Site 14)			
Mega-core (MC-05) and Piston Core (PC-04) (Thalweg)			MC05 USBL: 5°50.207777, 11°2.15793, 2170.1 m; PC04 USBL: 5° 50.19211511; 11° 2.14898; 2172.9 m
Transit (0.4 NM)			
Arrive site 9(			
Mega-core (MC-06) and Piston Core (PC-05) (Terrac			MC06 USBL: 5° 50.44126 S; 11° 1.85302 E; 2006.7 m; PC05 USBL: 5° 50.44345; 11° 1.85372; 2005 m
Transit (1 NM)			
Mega-core (MC-07) and Piston Core (PC-06) (Terrace)			MC07 USBL: 5° 50.85375; 11° 1.87510; 1932 m; PC06 USBL: 5° 50.85375; 11° 1.97274; depth = 1936m
Transit (17 NM)			
Mega-core (MC-08) and Piston Core (PC-07) (thalweg)			MC08 USBL: 5°54.00673; 11° 19.66128 ; depth = 1829 m; PC07 - to check!
Transit (0.5 NM)			
Mega-core (MC-09) and Piston Core (PC-08) (thalweg)			MC09 USBL 5°54.00543; 11°19.78924 Depth 1868 m; PC08 USBL 5°54.01074; 11°19.79823
Transit (0.5 NM)			
Mega-core (MC-10) and Piston Core (PC-09) (+20m terrace)			MC10 USBL 5°53.78998; 11°19.80659 Depth 1851 m; PC09 USBL 5°53.79099; 11°19.80451; Depth 1849.6m
Transit (17 NM)			
Mega-core (MC-11) and Piston Core (PC-10) (south terrace)			MC11 USBL 5°54.59294; 11°19.90275; Depth 1664m; PC10 5°54.58923; 11°19.90627; Depth 1666.2 m
Transit (7 NM)			
Mega-core (MC-12) and Piston Core (PC-11) (+200m north terrace)			MC12 USBL 5°54.74808; 11°25.02303; Depth 1345.1m; PC11 USBL 5°54.74836; 11°25.02176; Depth 1346.9 m
Transit (6 NM)			
Mega-core (MC-13) (thalweg - just up-canyon of blockage)			MC13 USBL 5°55.49192; 11°25.56407 at 1668.8 m
Transit (6 NM)			
Deploy Aniitra-2 mooring (anchor first +USBL), triangulate	5° 54.00029 S	11° 19.76589 E	USBL: 5°54.00029; 11°19.76589 at 1525 m (not then triangulated)
Transit (250m...up canyon) to Site 93			
Deploy NERC Mooring-1 (300 kHz), triangulate	5° 54.0186 S	11° 19.9042 E	Final triangulated Mooring-1 position
Transit (0.6 NM)			
Deploy OBIC OBS-1	5°54.59574 S	11°19.91160 E	
Transit (5.6 NM)			
Mega-core (MC-14) and Piston Core (PC-12) (thalweg)			PC12 USBL: 5°55.49866 11°25.56585, 1661.9 m; MC14 USBL 5°55.48218; 11°25.55578 at 1666.7 m
Transit (0.6 NM)			
Mega-core (MC-15) and Piston Core (PC-13) (terrace)			MC15 USBL 5°55.82225; 11°25.09653 at 1660.5 m; PC13 USBL 5°55.81493; 11°25.09275; Depth 1665.5 m
Transit (0.3 NM)			
Mega-core (MC-16) and Piston Core (PC-14) (thalweg)			MC16 USBL 5°55.45089; 11°28.40406 at 1634.5 m; PC14 USBL 5°55.45178; 11°28.40134; Depth 1626.8m
Deploy NERC Mooring-4 (300 kHz), triangulate	5° 55.4548 S	11° 28.4072 E	Final triangulated Mooring-4 position
Transit (5 NM)			
Mega-core (MC-17) and Piston Core (PC-15) (thalweg)			MC17 USBL: 5°57.2091, 11°33.18347, depth 1575 m; PC USBL: 5°57.208, 11°33.19582, depth 1570 m
Deploy NERC Mooring-3 (300 kHz), triangulate	5°57.2118 S	11°33.204 E	Final triangulated Mooring-3 position
Transit (2 NM)			
Deploy OBIC OBS-2 near site 98	5°57.80958 S	11°31.70058 E	
Transit (3.5 NM)			
Deploy OBIC OBS-3 near site 97 (lower elevation site)	5°55.971 S	11°27.280 E	
Transit (1.5 NM)			
Deploy OBIC OBS-4 near site 97 (high site)	5°54.485 S	11°27.397 E	
Transit (9 NM)			
1 piston core (PC-16; 6m barrel) at Site 98			PC16 USBL 5°57.25966; 11°33.36511; Depth 1576.8m
Transit (22 NM)			
Mega-core (MC-18) and Piston Core (PC-17) (thalweg)			MC18 USBL: 5°52.74190, 11°10.48663, depth 2016.5 m; PC17 USBL 5°52.73597; 11°10.49102; Depth 2020.1m
CTD cast 8 and water column sampling with 8 bottles	5°52.738 S	11°10.499 E	
Deploy Aniitra-3 Mooring (anchor first)	5°52.7352 S	11°10.4954 E	USBL: 5°52.735, 11°10.495 (not triangulated, just USBL on mooring)
Transit (9 NM)			
Recover vertical hydrophone array after test period	5°49.1887 S	11°05.93766 E	
Transit (4 NM)			

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Deploy NERC Mooring-9 (600 kHz ADCP), triangulate	5°50.2092 S	11°2.163 E	Final triangulated Mooring-9 position
CTD cast 9 with 9 water column samples (**near 14)	5° 50.11150 S	11° 1.89473 E	USBL 5°50.12683, 11°1.90832
Transit [7 NM]			
Megacore (MC-19) at Site 107 (thalweg on bend)			MC-19 USBL: 5°51.40276, 11°8.88621 @ 2054.2m
Transit [200 m]			
Megacore (MC-20) at Site 108 (terrace on bend)			MC20 USBL: 5°51.42858, 11°8.77749 @ 2055.9m
Transit [300 m]			
Megacore (MC-21) at Site 109 (thalweg on bend)			MC21 USBL: 5°51.58501, 11°8.68930 @ 2056.5m
Transit (100 m)			
Megacore (MC-22) at Site 110 (terrace on bend)			MC22 USBL: 5°51.61920, 11°8.70400 @ 2056.5m
Transit (7 NM)			
Deploy OBIC OBS-5	5° 50.84958 S	11° 1.87302 E	
Transit (0.5 NM)			
Deploy vertical hydrophone array, triangula	5°50.71194 S	11°1.11204 E	
TRANSIT BACK TO INTERNATIONAL WATERS			
Transit [175 NM]			
Arrive Site 112 (just before old site 32)			
SVP/CTD cast 10 with 11 water samples (close to site 32)	5° 43.54302 S	8° 9.48768 E	CTD USBL 5°43.54605, 8°9.48242, 13 m ABS
3 hr Multibeam Survey (MBS_113)	5°43.94850 S	8°9.66600 E	
SURVEY TRUNCATED - TRANSIT TO LUANDA			
TRANSIT FROM LUANDA BACK TO SITE 115			
ARRIVE SITE 15 (Angola waters)	5°58.7452 S	11° 24.28812 E	
Short Multibeam Survey (MBS_115) at landslide (Site 115 in very close to Site 46)	5°58.7452 S	11° 24.28812 E	
Transit (24 NM)			
Deploy NERC Mooring-2 (75 + 300 kHz), triangulate * differs slightly from Site 14 to avoid Mooring 9	5°50.2313 S	11° 2.3357 E	Final triangulated Mooring-2 position
Transit (174 NM) to International Waters			
Multibeam Survey (MBS_113) Continued from where it was truncated on 23 Sept.	5°47.24004 S	8° 0.24222 E	
CTD Cast - xx	5° 45.32022 S	7° 47.60160 E	
Multibeam Survey (MBS_113) Continued from location of CTD cast			
Transit [1.3 NM]			
Mega-core (MC-23) and piston core (PC-18)	5° 44.10068 S	8° 8.23146 E	MC-23 USBL 5° 44.09221, 8° 8.21884; PC-18 USBL 5° 44.23653 8° 8.06768
Transit [0.5 NM]			
Mega-core (MC-24) and piston core (PC-19)	5° 43.7199 S	8° 8.21070 E	MC-24 USBL 5° 43.71279, 8° 8.20819; PC-19 USBL 5° 43.69907 8° 8.20575
Transit [1.3 NM]			
Deploy OBIC OBS-6	5° 45.2514 S	8° 7.63398 E	
Transit [1.3 NM]			
Deploy NERC Mooring 5, and triangulate	5° 43.8825 S	8° 7.3028 E	Final triangulated Mooring-5 position
Transit [4 NM]			
Mega-core (MC-25) and piston core (PC-20)	5° 49.22946 S	8° 8.70966 E	MC-25 USBL 5° 49.22455, 8° 8.70782; PC-18 USBL 5° 49.21664 8° 8.69629
Transit (17 NM)			
Deploy OBIC OBS-7 between Mooring Sites 5 and 4	5° 45.86940 S	7° 51.91638 E	
Transit (35 NM)			
OBIC OBS-8 (between Mooring Sites 4 and 6)	5° 46.49400 S	7° 16.13196 E	
Transit (25 NM)			
Recovered OBIC Prototype Moorings	5° 53.667 S	6° 55.09146 E	
Transit (1.6 NM)			
Deploy OBIC OBS-9 (near Mooring Site 6)	5° 54.86810 S	6° 53.91830 E	

Transit (3.4 NM)			
Deploy NERC Mooring 6, and triangulate (Site 117 very close to Site 36)	5° 52.1482 S	6° 55.5175 E	Final triangulated Mooring-6 position
Transit [2 NM]			
SVP cast xxx (near Mooring Site 6)	5° 53.36958 S	6° 53.39646 E	CTD was broken - so used SVP only
Multibeam Survey (MBS_119) from Mooring Site 6 to S 38/39 and back to Mooring Site 6	5° 53.40582 S	6° 53.38650 E	
Transit [30 NM]			
Multibeam Survey (MBS_121) Single Swath Line from Site 38/39 to Mooring Site 8	6° 14.33472 S	6° 27.94530 E	
CTD-12 for Multibeam Survey MBS_122 and MBS_121 (500m from Mooring Site 8)	6° 41.45406 S	5° 29.02146 E	CTD fixed, water samples taken
Recovered NERC Mooring 8	6° 41.51544 S	5° 29.00646 E	Just recovered....moved from Site 42 to 75 for deployment
Transit [2.7 NM]			
Multibeam Survey (MBS_122) from Mooring Site 8 to 7	6° 39.24432 S	5° 31.23677 E	
Transit [2NM]			
German OBS-2 near Site 7	6° 28.57302 S	6° 2.49018 E	
Extra (fourth) triangulation point on Mooring 7	6° 28.57302 S	6° 2.49018 E	
Transit [65 NM]			
Multibeam Survey MBS_125 (single swath line along channel) from Mooring Site 6 to Mooring Site 4	5° 51.40464 S	6° 56.85228 E	
(Re)Deployed Mooring 8-R at Mooring Site 4	5° 45.4004 S	7° 40.4741 E	Final triangulated Mooring-8-R position
Transit [1 NM]			
Deploy OBIC OBS-10 near Mooring Site 4	5° 44.11220 S	7° 37.96914 E	
Transit {1 NM]			
Multibeam Survey - West from Mooring 4 (MBS_126)	5° 46.35972 S	7° 33.52650 E	
SCIENCE FINISHES 24:00 WEDS 2ND OCT			
Transit to Walvis Bay (~5 days) ARRIVE WALVIS BAY 7th Oct			

MOORING DEPLOYMENT OR RECOVERY
MULTIBEAM SURVEY OR SVP/CTD CAST
OBS OR HYDROPHONE ARRAY DEPLOYMEN'

12 Appendix B: GIS locations

Site	Latitude	Longitude	Depth	Equipment Deployed (or > if reserve site, and not used)	Description	Permissions
T-1	**6 39.334 N**	**17 12.692 W**	4883	CTD with acoustic releases	Tested acoustic releases with OBS and Mooring, via dips on the CTD.	international
5	**5 57.81 S**	**11 31.71 E**	1144	OBIC OBS-2 (near Mooring Site 2A)	OBS on terrace a few NM down-canyon from Site 2A	
7	**5 55.84 S**	**11 24.42 E**	1792	>	Original planned position of Mooring 2c, but moved as too close to a submarine cable position	Angola
8	**5 54.47 S**	**11 25.25 E**	1323	>	Original OBS site on northern terrace but not used	Angola
9	**5 50.16 S**	**11 24.42 E**	350	OBIC OBS-2	Old VA position; high on canyon shoulder; now an OBS site as VA has poor or no line of sight	Angola
12	**5 56.34 S**	**11 29.82 E**	1690	>	Original Mooring Site 2b, but JC187 survey shows canyon floor too narrow for mooring deployment	Angola
13	**5 50.77 S**	**11 1.55 E**	1933	**Vertical Hydrophone Array (near Site 2E)**	Deployment of Vertical Hydrophone Array on terrace near Mooring Site 2E	Angola
14	**5 50.2 S**	**11 2.16 E**	2171	**NERC Mooring 9 (600 kHz)**	Mooring Site 2E chosen from JC187 survey; Same as Core Site 49; (just down-canyon from Site 118 for Mooring-2)	Angola
32	**5 44.1 S**	**8 8.23 E**	4150	MC-23, PC-18	Megacore 23 and Piston Core 18 near Mooring Site 5 (now moved to Site 120 from 32)	international
33	**5 45.26 S**	**8 7.63 E**	4027	OBIC OBS-6 (near mooring Site 5)	OBIC OBS-6 located on terrace near Mooring Site 5	international
35	**5 55.06 S**	**6 45.52 E**	4525	>	Original position of Mooring 6, moved to Site 117	international
36	**5 52.13 S**	**6 55.5 E**	4495	>	Mooring 6 adjusted from Site 36 to Site 117	international
37	**5 54.87 S**	**6 53.41 E**	4470	OBIC OBS-9 (near mooring Site 6)	OBS-9 on terrace near mooring 6	international
38	**6 14.36 S**	**6 25.85 E**	4638	German OBS-2	OBS between Mooring Sites 6 and 7	international
40	**6 28.02 S**	**6 2.17 E**	4780	>	Original Mooring Site 7 (Dennilou et al. AUV survey Site A); Moved slightly to Site 75 after JC187 multibeam survey	international
41	**5 44.93 S**	**7 38.03 E**	4314	>	Original position of Mooring Site 4, but moved to Site 123	international
42	**6 41.71 S**	**5 29.11 E**	4952	3 cores: MC01, MC02, PC-01 (near Mooring 8)	**Mooring 8 moved slightly to Site 75; 2 x megacores, 1 x piston core; Dennilou et al. AUV Survey C**	international
43	**5 44.12 S**	**7 37.97 E**	4213	OBIC OBS-10 (Near Mooring 4)	OBS-10 located near Mooring Site 4	international
45	**5 55.82 S**	**11 25.11 E**	1709	MC-15, PC-13 (terrace between Sites 2C and 2B)	megacore 15 and Piston Core 13, on terrace between Sites 2C and 2B.	Angola
48	**5 54.75 S**	**11 25.03 E**	1348	MC-11, PC-10 (high terrace, between 2C and 2B)	Megacore and Piston core on high (+200m) northern terrace between Mooring Sites 2C and 2B	Angola
49	**5 50.2 S**	**11 2.16 E**	2159	MC-05, PC-04; channel thalweg near Site 2E	Megacore 05 and Piston Core 04 in channel thalweg (same place as Site 14 and NERC Mooring 9)	Angola
50	**5 49.86 S**	**11 2.21 E**	2058	>	replaced by nearby Site 90.	Angola
51	**5 50.85 S**	**11 1.87 E**	1931	IC-07, PC-06; OBS-5; terrace above Mooring Site 2E	Megacore 07 and Piston Core 06, and OBIC OBS-5 on terrace above Mooring Site 2E	Angola
53	**5 43.71 S**	**8 8.21 E**	4071	MC24, PC-19 (terrace near Mooring Site 5)	Megacore 24 and Piston Core 19 on terrace nera Mooring Site 5	international
54	**5 49.23 S**	**8 8.7 E**	4044	IC25, PC-20 (outside channel near Mooring Site 5)	Megacore and Piston Core entirely outside the channel, near Mooring Site 5	international
58	**6 28.58 S**	**6 2.5 E**	4764	IC-03, PC-02; German OBS-2 (terrace by Mooring 7)	Terrace near Mooring 7; mega-core (MC-03) and piston core (PC-02); German OBS-2	international
66	**5 54.01 S**	**11 19.68 E**	1875	**MC-08, PC-07; Aniitra-2 (75 kHz) Mooring**	Mooring Site 2C; with Aniitra-2 mooring; and megacore 08 and piston core 07; near Site 93	Angola
67	**6 40.207 S**	**5 28.441 E**	4957	CTD/SVP Cast -2; Start Multibeam survey MBS_42	SVP/CTD Cast-2: Multibeam Survey MBS_42 start	International
68	**6 28.589 S**	**6 0.660 E**	4768	Start Multibeam survey MBS_40	Multibeam Survey MBS_40 start	International
69	**6 14.671 S**	**6 27.289 E**	4659	Start Multibeam survey MBS_39 (near Site 38)	SVP/CTD Cast at Site 78, Multibeam Survey MBS_39 start	International
70	**5 56.546 S**	**6 44.847 E**	4547	>	redundant point for start of MBS_37 (small survey near mooring Site 6), now moved to Site 71?	International
71	**5 53.171 S**	**6 54.371 E**	4506	CTD/SVP Cast-4; Start Multibeam survey MBS_37	SVP/CTD Cast-4: Multibeam Survey MBS_37 start	International
72	**5 45.223 S**	**7 36.434 E**	4234	>	Dedundent point for start of MBS_113 Multibeam Survey - not in logs? 41 is near Mooring Site 4	International
73	**5 43.586 S**	**8 4.457 E**	4108	>	Dedundent point for start of MBS_113 Multibeam Survey - not in logs? 32 is near Mooring Site 5	International
75	**6 41.7815 S**	**5 28.967 E**	4966	**NERC Mooring-8 (300 kHz)**	NERC Mooring 8; adjusted from Site 42 by 300m	international
76	**6 27.8623 S**	**6 2.8346 E**	4794	**NERC Mooring-7 (300 kHz)**	NERC Mooring 7 - adjusted slightly from Site 40	International
77	**6 27.8899 S**	**6 3.1773 E**	4793	MC-04 and PC-03 (thalweg near Mooring 7)	Cores in thalweg near Mooring 7 (replace site 57)	International
78	**6 15.2162 S**	**6 27.2735 E**	4691	CTD/SVP Cast -3	CTD/SVP cast-3 before survey near German OBS-1 at Site 38 & Site 69; within channel thalweg	international
79	**5 53.7946 S**	**6 54.9477 E**	4448	Proto_OBS_A	Deployed and recovered OBIC Prototype OBS-A	international
80	**5 54.1732 S**	**6 54.9466 E**	4454	Proto_OBS_B	Deployed and recovered OBIC Prototype OBS-B	international
81	**5 54.1731 S**	**6 55.366 E**	4454	Proto_OBS_C	Deployed and recovered OBIC Prototype OBS-C	international
82	**5 53.7961 S**	**6 55.366 E**	4449	Proto_OBS_D	Deployed and recovered OBIC Prototype OBS-D	international
83	**5 57.3534 S**	**11 34.1890 E**	1595	Start Multibeam Survey (MBS-83) in Upper Canyon	SVP/CTD Cast-5 in channel axis; Multibeam Survey MBS-83 start, Survey to boundary with DRC waters;	Angola
84	**5 51.7959 S**	**11 8.3618 E**	2064	Start Multibeam Survey (MBS-84) in Upper Canyon	SVP/CTD Cast-7 in channel axis; Multibeam Survey MBS-84 and MBS-89 start, to boundary with Congo waters;	Angola
85	**5 55.5676 S**	**11 25.0887 E**	1752	>	Not used - CTD and SVP mid survey of MBS-84 and MBS_89 in Upper Canyon	International
86	**5 49.227 S**	**11 6.105 E**	1262	Vertical Hydrophone Array (Test Deployment)	Deployment and recovery of the vertical hydrophone array to test it works	Angola
87	**5 54.594 S**	**11 19.912 E**	1679	MC-11, PC-10; OBIC OBS-1	Megacore 11 and Piston Core 10 and OBIC OBS-1 on southern terrace, between Mooring Site 2C and 2B	Angola
88	**5 53.67198 S**	**11 21.35676 E**	1840	CTD and SVP	CTD and SVP mid survey (adjusted position of site 85)	Angola
89	**5 51.790048 S**	**11 8.483529**	2060	Start Multibeam survey between 83 and 84	This survey was evertually combined within MBS_84	Angola

90	**5 50.452624 S**	**11 1.858662 E**	2008	MC-06 and PC-05 on terrace near Site 2E	Megacore 06 and Piston Core 05 on terrace (replaces Site 50, and near Mooring Site 2E)	Angola
92	**5 52.737 S**	**11 10.499 E**	2017	**Aniitra-3 Mooring; MC-18, PC-17 (also Site 111)**	Mooring Site 2D, with Aniitra-3 mooring (adjusted slightly to Site 111), and megacore 18 and piston core 17.	Angola
93	**5 54.013S**	**11 19.811 E**	1875	MC-09, PC-08 (channel thalweg near Site 2C)	300 m up-canyon from Site 66 (with Aniitra-2 mooring).	Angola
94	**5 50.143 S**	**11 2.009 E**	1875	>	unused core site in thalweg just down canyon of site 14 mooring	Angola
95	**5 54.013 S**	**11 19.811 E**	1869	>	unused core site near Site 66	Angola
96	**5 53.794 S**	**11 19.816 E**	1849	MC-10, PC-09 (+20m terrace near Site 2C)	on low northern terrace, 20m above thalweg; near Mooring Site 2C	Angola
97	**5 55.455 S**	**11 28.413 E**	1637	**NERC Mooring-4 (300 kHz); MC-16, PC-14**	Mooring Site 2B, with Megacore 16 and Piston Core 14.	Angola
98	**5 57.208 S**	**11 33.198 E**	1575	**NERC Mooring-3 (300 kHz); MC-17, PC-15**	Mooring Site 2B, with Megacore 16 and Piston Core 14 (which bent). Closest to boundary with DRC waters.	Angola
99	**5 55.492 S**	**11 25.577 E**	1670	MC13, MC14, and PC-12	Thalweg of small inset channel just upstream of landslide blockage, between Sites 2C and 2B	Angola
100	**5 51.868 S**	**11 10.773 E**	1850	>	OBS near Mooring Site 4, now moved to Site 43	Angola
101	**5 45.87 S**	**7 51.904 E**	4101	OBIC OBS-7 (between Mooring Sites 5 and 4)	OBIC OBS-7 (between Mooring Sites 5 and 4)	International
102	**5 46.482 S**	**7 16.147 E**	4325	OBIC OBS-8 (between Mooring Sites 4 and 6)	OBIC OBS-8 (between Mooring Sites 4 and 6)	International
103	**5 54.012 S**	**11 19.911 E**	1875	**NERC Mooring-1 (300 kHz)**	loacted 250 m up-canyon from Aniitra-2 mooring at Site 66	Angola
104	**5 55.958 S**	**11 27.269 E**	1564	OBIC OBS-3 (near Mooring Site 2B, lower tarrace)	Lower of two OBIC OBS sites on either side of mooring NERC-4 at Site 93 (+120m above thalweg)	Angola
105	**5 54.483 S**	**11 27.406 E**	1260	OBIC-OBS-4 (near Mooring Site 2B, higher Terrace)	Higher of two OBIC OBS sites on either side of mooring NERC-4 at Site 93 (+420m above thalweg)	Angola
106	**5 57.257 S**	**11 33.381 E**	1575	PC-16 in channel thalweg	replaces previously bent piston core, at site 98 of NERC Mooring-3	Angola
107	**5 51.395 S**	**11 8.892 E**	2054	MC-19 (set of 4 MCs on bend) - thalweg	detailed sudy of bar/thalweg	Angola
108	**5 51.422 S**	**11 8.786 E**	2057	MC-20 (set of 4 MCs on bend)- bar	detailed sudy of bar/thalweg	Angola
109	**5 51.580 S**	**11 8.684 E**	2057	MC-21 (set of 4 MCs on bend)	detailed sudy of bar/thalweg	Angola
110	**5 51.619 S**	**11 8.702 E**	2057	MC-22 (set of 4 MCs on bend)	detailed sudy of bar/thalweg	Angola
111	**5 52.734 S**	**11 10.5 E**	2017	**djusted position of Aniitra-3 mooring (near site 92)**	Slightly adjusted position of final Aniitra-3 mooring drop	Angola
112	**5 43.507967 S**	**8 9.489147 E**	4138	CTD/SVP Cast 10, near Multibeam Survey MBS_113	CTD/SVP Cats -10 before MB survey MBS_113 from Mooring Site 5 to Mooring Site 4	International
113	**5 43.841021 S**	**8 8.781887 E**	4116	Start Multibeam Survey MBS-113	Multibeam Survey MBS_113 from Mooring Site 5 to Mooring Site 4.	International
114	**5 45.182367 S**	**7 47.623199 E**	4278	CTD/SVP Cast During MBS-113	CTD/SVP cast during Multibeam Survey 113 (from Mooring Site 5 to 4) During survey line 13 @ Site 114	International
115	**5 57.789099 S**	**11 24.393967 E**	841	Start Multibeam Survey MBS_115	Short extra multibeam survey of landslide blockage in upper canyon	Angola
116	**5 47.301 S**	**8 0.351 E**	4167	Position that MB_113 survey broken off/restarted	Position that MB_113 survey broken off/restarted	International
117	**5 52.143 S**	**6 55.521 E**	4499	**NERC Mooring-6 (300 kHz)**	Adjusted slightly from original position at Site 36, which itself was moved from Site 35	International
118	**5 50.2313 S**	**11 2.3357 E**	2170	**NERC Mooring-2 (adjusted position)**	Slightly adjusted position of NERC Mooring-2 (to avoid previously deployed NERC Mooring-9)	Angola
119	**5 53.3723 S**	**6 53.31376 E**	4516	CTD/SVP Cast; start of Multibeam Survey MBS_119	CTD/SVP Cast; start of Multibeam Survey MBS_119 from Mooring 6 towards Site 38	International
120	**5 43.873493 S**	**8 7.315559 E**	4153	**NERC Mooring-5 (300 kHz)**	NERC Mooring 5 position adjusted slightly from Site 32	International
121	**6 14.6837 S**	**6 27.4863 E**	4688	Start of Mulbeam Survey MBS_121	Start of Multibeam Survey MBS_121, single swath line from Site 38 to Mooring Site 8	International
122	**6 39.5277 S**	**5 30.4924 E**	4958	Start of Multibeam Survey MBS_122	Start of Multibeam Survey MBS_122, set of parallel swaths from mooring Site 8 to Mooring Site 7	International
123	**5 45.413 S**	**7 40.491 E**	4327	**(Re)deploy Mooring 8 at Mooring Site 4**	Adjusted Mooring Site 4 - slightly east.	International
124	**6 41.456 S**	**5 29.021 E**	4957	CTD/SVP near Site 42 (Mooring 8)	Needed to move 500m to avoid hitting mooring 8	International
125	**5 51.4240 S**	**6 57.0363 E**	4433	tart of Multibeam Survey MBS_125 (NE from Site 4	Start of single swath Multibeam Survey MBS_125 from Mooring Site 6 to Mooring Site 4	International
126	**5 46.0293 S**	**7 33.5961 E**	4221	Start of final multibeam survey to W from Site 4	Multibeam Survey (zig-zagging) from Mooring Site 4 towards Mooring Site 6	International

13 Appendix C: Master Log Sheets

Cruise JC187		**Date: 03/09/19 and 09/09/10 (from Station 8)**		**Sheet No. 1**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 1	T-1	10.00	6° 39.33390 N	17° 12.69234 W	4882	CTD-01 deployment with test of NMFD (national marine facilities Deployment) acoustic releases and German OBS acoustic releases
Station 2	T-1	11.34	6° 39.334 N	17° 12.692 W	4883	CTD-01 at seabed, acoustic release started for NMFD releases
Station 3	T-1	12.01	6° 39.3336 N	17° 12.6924 W	4883	CTD-01 at seabed, acoustic release started for German OBS releases
Station 4	T-1	13.50	6° 39.3338 N	17° 12.69240 W	4883	CTD-01 back on deck, all acoustic releases successful
Station 5	T-1	14.32	6° 39.33402 N	17° 12.69210 W	4882	Deployment with test of OBIC prototype (to check leaking) and OBS acoustic releases
Station 6	T-1	14.52	6° 39.33432 N	17° 12.69174 W	4883	OBS acoustic release test started. All test successful and Completed by 15.28. Comment from OBS guys "some difficult conditions"
Station 7	T-1	15.49	6° 39.33120 N	17° 12.68802 W	4883	OBS back on deck
Station 8	67	20.02	6° 40.206905 S	5°28.47108 E	4930	Arrival at Site 67 – Start of working area (40.207 28.441)

Station 9	67	20.12	6° 40.207 S	5° 28.4725	4921	CTD-02 @ surface to go down
Station 10	67	21.44	6° 40.206	5° 28.472	4923	CTD-02 on the way testing releases
Cruise JC187		**Date: 09/09/19 & 10/09/2019 (from STA 13)**		**Sheet No. 2**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 11	67	21.58	6° 40.206	5° 28.472	4923	Water sample at 4930 m, then coming up (4944m corrected depth) CTD-02
Station 12	67	23.28	6° 40.206	5° 28.471	4925	CTD-02 @ surface
Station 13	67	00.08	6° 40.160	5° 28.420	4924	Start of line: MBS_42_L01 → 0193 35S_42_L01 → 20190910000809
Station 14	67	00.44	6° 43.248	5° 29.815	4923	End of previous Line (ST13), start of line: MBS_42_L02 → 0194; 35S_42_L02 → 20190910004536
Station 15	67	00.59	6° 43.188	5° 29.790	4924	End of previous Line (ST14), start of line: MBS_42_L03 → 0195; 35S_42_L03 → 20190910005938
Station 16	67	01.03	6° 43.980	5° 30.216	4926	End of previous Line (ST15), start of line: MBS_42_L04 → 0196; 35S_42_L04 → 20190910010346
Station 17	67	01.18	6° 41.462	5° 29.606	4928	End of previous Line (ST16), start of line: MBS_42_L05 → 0197; 35S_42_L05 → 20190910011838
Station 18	67	01.29	6° 41.902	5° 28.660	4930	End of previous Line (ST17), start of line: MBS_42_L06 → 0198; 35S_42_L06 → 20190910012918

Station 19	67	01.44	6° 40.404	5° 27.998	4924	End of previous Line (ST18), start of line: MBS_42_L07 → 0199; 35S_42_L07 → 20190910014411
Station 20	67	01.53	6° 40.050	5° 28.826	4925	End of previous Line (ST19), start of line: MBS_42_L08 → 0200; 35S_42_L08 → 20190910015316
Station 21	67	02.14	6° 41.617	5° 29.064	4928	End of previous Line (ST20), end of MultiBeam and 3.5 Survey for Site 42

Cruise JC187		**Date: 10/09/2019**	**Sheet No. 3**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 22	42	02.30	6° 41.70564 S	5° 29.10570 E	4928	Multi-corer at sea surface Core name : JC187-MC01
Station 23	42	04.31	6° 41.70924 S	5° 29.11074 E	4928	Multi-corer at sea bottom JC187-MC01 USBL: Depth = 4956.2m; 6° 41.70255 S; 5° 29.10085 E Difference USBL SHIP: USBL 23m NW of ship
Station 24	42	06.25	6°41.70912 S	5° 29.11044 E	4928	Multi-corer back on deck JC187-MC01 Tubes empty, corer covered in clay/fluid mud to the top
Station 25	42	07.30	6°41.70966 S	5°29.11002 E	4928	Piston-corer at sea surface Core name : JC187-PC01
Station 26	42	09.04	6°41.708825 S	5°29.10966 E	4978.3	Piston-corer stopped 100m above seafloor JC187-PC01 USBL: Depth = 4840.4 m; 6° 41.7077 S; 5° 29.11809 E
Station 27	42	09.09	6°41.70948 S	5°29.10984 E	4928.4	Piston-corer at sea bottom, peak tension 6.3 Te JC187-PC01USBL: Depth = 4955.9 m; 6° 41.70447 S; 5° 29.10622 E. Difference USBL SHIP: USBL 12m NW of ship

Station 28	42	10.57	6°41.71008 S	5°29.11056 E	4928.9	Piston-corer back on deck JC187-PC01
Station 29 (EP)	42	11.45	6°41.70948 S	5°29.10966 E	4929	Multi-corer at sea surface JC187-MC02
Station 30 (MB)	42	13.46	6°41.70896 S	5°29.11013 E	4956	Multi-corer at sea bottom, Wire out = 4987.4 m, Peak tension ~5 USBL: Depth = 4956 m; 6° 41.70071 S; 5° 29.10581 E Difference USBL SHIP: USBL 18m NW of ship
Station 31 (SR)	42	15.41	6°41.70924 S	5°29.10966 E	4928.9	Multi-corer on deck 8 cores, all full!
Station 32 (SR)	N/A start position/run up	16.19	6°41.78058	5°29.32824	4928	Mooring buoy in water at surface JC187 NERC Mooring 8
Cruise JC187		**Date: 10/09/2019**	**Sheet No. 4**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 33 (SR)	75	16.50	6°41.78184	5°28.92738	4971	Chain/anchor dropped JC187 NERC Mooring 8
Station 34 (SR)	75	17.24	6°41.77398	5°28.62676	4929.7	By this time anchor on sea floor (not sure exact timing, took ~15 mins) Lat and long of boat not mooring JC187 NERC Mooring 8
Station 35 (EP)	75	17.44	6°41.73365	5°26.86542	4929.7	Stopped at triangulation point 1 JC187 NERC Mooring 8
Station 36 (SS)	75	18.16	6°40.08048	5°30.04308	4929.7 (?)	Stopped at triangulation point 2 JC187 NERC Mooring 8
Station 37	75	18.48	6°43.43700	5°30.11826	“ ”	Stopped at triangulation point 3

						JC187 NERC Mooring 8
Station 38	68	22.05	6°28.734	6°0.306	4747	Start of line: MBS_40_L01 → 0219 35S_40_L01 → 20190910220502
Station 39	68	22.44	6°27.355	6°3.920	4743	End of previous Line (ST38), start of line: MBS_40_L02 → 0220; 35S_40_L02 → 20190910224454
Station 40	68	23.00	6°27.119	6°3.570	4745	End of previous Line (ST39), start of line: MBS_40_L03 → 0221; 35S_40_L03 → 20190910230008
Station 41	68	23.09	6°28.040	6°3.911	4730	End of previous Line (ST40), start of line: MBS_40_L04 → 0222; 35S_40_L04 → 20190910230657
Station 42	68	23.30	6°28.486	6°2.350	4738	End of previous Line (ST41), start of line: MBS_40_L05 → 0223; 35S_40_L05 → 20190910233013
Station 43	68	23.40	6°27.410	6°1.918	4749	End of previous Line (ST42), start of line: MBS_40_L06 → 0224; 35S_40_L06 → 20190910234100
Cruise JC187		**Date: 10/09/2019** **11/09/2019 (from STA 45)**		**Sheet No. 5**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 44	68	23.59	6°28.108	6°0.470	4745	End of previous Line (ST43), start of line: MBS_40_L07 → 0225; 35S_40_L07 → 20190910235921
Station 45	68	00.09	6°29.105	6°0.884	4743	End of previous Line (ST44), start of line: MBS_40_L08 → 0226; 35S_40_L08 → 20190911000925
Station 46	68	00.24	6°28.530	6°2.413	4737	End of previous Line (ST45), end of MultiBeam and 3.5 Survey for Site 40
Station 47	58	00.53	6°28.58040	6°2.49948	4737	Megacorer at sea surface

						JC187-MC03
Station 48	58	02.44	6°28.58062 S	6°2.49007 E	4737	Megacorer at sea bottom JC187-MC03 USBL: Depth = 4759 m; 6° 28.55770 S; 5° 2.49279 E ➔ written at time USBL Checked: 4760 m; 6° 28.55832 S; 6° 2.50591 E ➔ checked later Difference USBL SHIP: USBL 44m NW of ship
Station 49	58	04.34	6°28.58080 S	6°2.49916 E	4737	Megacorer back on deck JC187-MC03
Station 50	58	05.32	6°28.58040 S	6°2.49972 E	4737	Piston corer at sea surface JC187-PC02
Station 51	58	07.18	6°28.58034 S	6°2.49984 E	4736.5	Piston-corer at sea bottom JC187-PC02 Pull out = 6.7 Te USBL: Depth = 4761.1 m; 6° 28.56373 S; 5° 2.48820 E ➔ written at time USBL Checked: 4746.4 m; 6° 28.57833 S; 5° 2.49718 E ➔ checked later
Station 52	58	09.05	6°28.58094 S	6°2.50014 E	4736.6	Piston core back on deck JC187-PC02
Station 53	77	10.19	6°27.890045 S	6°3.17964 E	4740	Multi core at sea surface JC187-MC04
Station 54	77	12.19	6°27.89034 S	6°3.17964 E	4750.7	Multi core at sea bottom JC187-MC04 Cable out 4832.1 USBL: Depth = 4795.1 m; 6° 27.88847 S; 6° 3.17800 E

Cruise JC187		**Date: 11/09/19**	**Sheet No. 6**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 55	77	14.24	6°27.89016 S	6°3.17922 E	4751	Multicore back on deck JC187-MC04 8 tubes full

Station 56	77	15.08	6°27.889004 S	6°3.18000 E	4743.7	Piston core at sea surface JC187-PC03
Station 57	77	16.41	6°27.8905 S	6°3.17982 E	4757	Piston core at seabed JC187-PC03 Cable out – 4794; cable tension 5.6 USBL: Depth = 4789.5 m; 6° 27.89049 S; 6° 3.18138 E
Station 58	77	19.04	6°27.8902 S	6°3.1800 E	4744	Piston core at sea surface JC187-PC03 Fish vire(?) caught on cable on way up
Station 59	n/a run-up, start position	19.36	6°27.85164 S	6°3.15210 E	4731	Mooring buoy in water at surface JC – NERC Mooring 7
Station 60	76	20.27	6° 27.85170 S	6° 2.73930 E	4765	Chain/anchor dropped JC – NERC Mooring 7
Station 61	76	20.53	6° 27.85014 S	6° 2.46228 E	4765	Mooring anchor at seafloor / waiting for triangulation JC – NERC Mooring 7
Station 62	76	21.10	6° 27.86910 S	6° 0.86226 E	Not pinging	Triangulation stop 1 / range 5920 m JC – NERC Mooring 7
Station 63	76	21.35	6° 26.10318 S	6° 3.33884 E	Not pinging	Triangulation stop 2 / range 5818 m JC – NERC Mooring 7
Station 64	76	22.01	6° 28.03800 S	6° 4.80954 E	Not pinging	Triangulation stop 3 / range 6026 m JC – NERC Mooring 7
Station 65	78	00.57	6° 15.225185 S	6° 27.21498 E	4645	CTD-03 deployment – at sea surface
Cruise JC187		**Date: 12/09/2019**	**Sheet No. 7**			

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
Station 66	78	02.26	6°15.22554 S	6°27.21534 E	4629 Cor. 4683	CTD-03 at 4640 m (cable out) water depth (deepest point designed For CTD) plus release test
Station 67	78	04.00	6°15.22548 S	6°27.21546 E	surface	CTD-03 on deck
Station 68	69	04.47	6°14.8758 S	6°27.279 E	4671	Start of line MBS_39_L01 ➔ 0256 35S_39_L01 ➔20190912044954
Station 69	69	05.27	6°10.77414 S	6°27.45386 E	4671	End of previous line, start of line MBS_39_L02 ➔ 0257 35S_39_L02 ➔20190912052739
Station 70	69	05.45	6°11.407056 S	6°27.63070 E	4593	End of previous line, start of line MBS_39_L03 ➔ 0258 35S_39_L03 ➔20190912054544
Station 71	69	05.53	6°11.4041 S	6°26.868 E	4587	End of previous line, start of line MBS_39_L04 ➔ 0259 35S_39_L04 ➔20190912055340
Station 72	69	06.13	6°13.03784 S	6°26.83464 E	4603	End of previous line, start of line MBS_39_L05 ➔ 0260 35S_39_L05 ➔20190912061328
Station 73	69	06.24	6°13.04688 S	6°27.86826 E	4595	End of previous line, start of line MBS_39_L06 ➔ 0261 35S_39_L06 ➔20190912062400
Station 74	69	06.42	6°14.66774 S	6°27.83424 E	4588	End of previous line, start of line MBS_39_L07 ➔ 0262 35S_39_L07 ➔20190912064231
Station 75	69	06.52	6°14.61132 S	6°26.80854 E	4602	End of previous line, start of line MBS_39_L08 ➔ 0263

						35S_39_L08 ➔20190912065252
Station 76	69	07.04	6°14.36862 S	6°25.67562 E	4609	End of line MS and 35S

Cruise JC187		**Date: 12/09/2019**	**Sheet No. 8**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 77	38	07.31	6°14.36178 S	6°25.85002 E	4606.8	German OBS-1 deployment dropped off deck side
Station 78	71	10.45	5°54.3942 S	6°48.72150 E	4514	CTD-04 deployment at sea surface
Station 79	71	12.13	5°54.39672 S	6°48.7292 E	4499.5	CTD-04 at deepest point. Cable out: 4510
Station 80	71	13.33	5°54.39660 S	6°48.72156 E	4480.9	CTD-04 on deck
Station 81	37	14.05	5°54.3594 S	6°48.27618 E	4526.4	Start of line MBS_37_L01 ➔ 0272 35S_37_L01 ➔201909140120 Questionable sub-bottom data, did not look good on screen
Station 82	37	15.02	5°54.92466 S	6°54.03684 E	4439.7	Start of line MBS_37_L02 ➔ 0273 35S_37_L02 ➔201909150306
Station 83	37	15.22	5°55.63338 S	6°53.34852 E	4452	Start of line MBS_37_L03 ➔ 0274 35S_37_L03 ➔201909152236
Station 84	37	15.36	5°54.29718 S	6°53.45406 E	4439.9	Start of line MBS_37_L04 ➔ 0275 35S_37_L04 ➔201909153637

Station 85	37	15.47	5°53.23062 S	6°54.30222 E	4429.1	Start of line MBS_37_L05 → 0276 35S_37_L05 →201909154750
Station 86	37	16.20	5°50.99316 S	6°56.83800 E	4467.3	Start of line MBS_37_L06 → 0277 35S_37_L06 →201909162051
Station 87	37	16.32	5°50.97648 S	6°56.78400 E	4475	Start of line MBS_37_L07 → 0278 35S_37_L07 →201909163239

Cruise JC187		**Date: 12/09/19** **19255**	**Sheet No. 9**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 88	37	16.36	5°51.24858 S	6°56.83800 E	4467	Start of line MBS_37_L08 → 0279 35S_37_L08 →201909163613
Station 89	37	16.57	5°52.33434 S	6°55.79814 E	4415	Start of line MBS_37_L09 → 0280 35S_37_L09 →201909165748
Station 90	37	17.03	5°51.87168 S	6°55.38378 E	4413.4	Start of line MBS_37_L10 → 0281 35S_37_L10 →201909170339
Station 91	37	17.25	5°52.86708 S	6°54.10866 E	4428.9	Start of line MBS_37_L11 → 0282 35S_37_L11 →201909172519
Station 92	37	17.32	5°53.34736 S	6°54.58122 E	4415.9	Start of line MBS_37_L12 → 0283 35S_37_L12 →201909173213

						End of survey (this line not in survey)
Station 93	37	17.45	5°54.07720 S	6°54.94846 E	4436	End of line MBS_37_L12 End of multibeam and 3.5 survey (confusion that line 12 was not in survey, so ended this line to be sure)
Station 94	79	17.40	5°53.78424 S	6°54.94698 E	4429	Prototype OBS-A deployed
Station 95	80	17.48	5°54.13656 S	6°54.94224 E	4478 (?)	Prototype OBS-B deployed
Station 96	81	17.58	5°54.15300 S	6°55.37352 E	4345 (?)	Prototype OBS-C deployed
Station 97	82	18.11	5°53.89464 S	6°55.43009 E	4429	Prototype OBS-D deployed
Cruise JC187		**Date: 15/09/19** **19258**	**Sheet No. 10**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
Station 98	83	10.06	5°57.24562	11°34.18212	1507	CTD-05 deployment at sea surface. CTD deployed on edge of channel Boat had to move into centre of channel
Station 99	83	10.46	5°57.34800	11°34.19466	1568	CTD-05 at bottom, cable out = 1539 m, testing acoustic releases Increase in turbidity in bottom ~300 m – nepheloid layer?
Station 100	83	11.35	5°57.34890	11°34.19388	1571	CTD-05 back on deck

Station 101	83	11.52	5°57.34800	11°34.19454	1573	Acoustic release test at sea surface (delay in deployment ~5-10 mins finding correct equipment)
Station 102	83	12.17	5°57.34818	11°34.1949	1572	Acoustic releases at 1000 m water depth and tested (multibeam And single beam turned off) test ends 12.27
Station 103	83	12.49	5°57.34848	11°34.19388	1566	Acoustic releases back on deck
Station 104	83	13.31	5°57.24288	11°33.81288	1501	Start of line MBS_83_L01 → 0303 35S_83_L01 →20190915125357 *Potential turbidity current observed in multibeam backscatter image*
Station 105	83	13.35	5°57.15990	11°33.56989	1499	No new filename was saved for 3.5S L01 (name had already been saved during parameter change) New name for this line: 35S_83_L01B →20190915133509
Station 106	83	13.45	5°56.60702	11°32.08700	1509	Changed parameters for 3.5S so 3 new filenames assigned 35S_83_L02 →20190915134444/20190915134456/ 20190915134549 This is all still part of L01

Cruise JC187		**Date: 15/09/2019** **19528**		**Sheet No. 11**		
Station Number (JC187/Station x)	**Site Number** **(as on GIS)**	**Time** **In GMT**	**Latitude** **(degree, DM)**	**Longitude** **(degree, DM)**	**Depth** **(m)**	**Equipment Deployed (Events) & Comments** **(Include any exact USBL positions here)**
Station 107	83	13.59	5°56.47890	11°31.43676	1589	Start of line: MBS_83_L02 → 0304 35S_83_L02b →20190915135908

Station 108	83	14.17	5°56.28750	11°29.51802	1603	Start of line: MBS_83_L03 → 0305 35S_83_L03 →20190915141737
Station 109	83	14.32	5°55.42464	11°28.44960	1637	Start of line: MBS_83_L04 → 0306 35S_83_L04 →20190915143220
Station 110	83	14.49	5°55.49406	11°26.82792	1610	Start of line: MBS_83_L05 → 0307 35S_83_L05 →20190915145001
Station 111	83	15.21	5°55.2414	11°23.59254	1708	Start of line: MBS_83_L06 → 0308 35S_83_L06 →20190915152148
Station 112	83	15.53	5°53.95896	11°20.81130	1667	Start of line: MBS_83_L07 → 0309 35S_83_L07 →20190915155338
Station 113	83	16.43	5°54.0021	11°15.937	1533	Start of line: MBS_83_L08 → 0310 35S_83_L08 →20190915164245
Station 114	83	16.59	5°54.09882	11°16.06320	1533	Start of line: MBS_83_L09 → 0311 35S_83_L09 →20190915165953
Station 115	83	17.03	5°53.70432	11°16.06683	1792	Start of line: MBS_83_L10 → 0312 35S_83_L10 →20190915170337
Station 116	83	17.10	5°52.97100	11°16.0777	1834	Start of line: MBS_83_L11→ 0313 35S_83_L11 →20190915171043
Station 117	83	17.20	5°53.0220	11°16.76814	1820	Start of line: MBS_83_L12 → 0314 35S_83_L12 →20190915172011
Cruise JC187		**Date: 15/09/2019**	**Sheet No. 12**			

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
Station 118	83	17:40	5° 55.005	11° 16.78338	1415	EOL/SOL: MBS – 83 - L25 → 0315 3.5S – 83 – L25 → 20190915174051
Station 119	83	17:51	5° 54.75120	11° 17.48766	1548	EOL/SOL: MBS – 83 - L25 → 0316 3.5S – 83 – L25 → 20190915175143
Station 120	83	18:05	5° 53.28600	11° 17.42778	1742	EOL/SOL: MBS – 83 - L25 → 0317 3.5S – 83 – L25 → 20190915180540
Station 121	83	18:14	5° 53.36520	11° 18.15432	1504	EOL/SOL: MBS – 83 - L25 → 0318 3.5S – 83 – L25 → 20190915181454
Station 122	83	18:28	5° 54.66672	11° 18.17364	1511	EOL/SOL: MBS – 83 - L25 → 0319 3.5S – 83 – L25 → 20190915182801
Station 123	83	18:37	5° 54.49404	11° 18.84810	1571	EOL/SOL: MBS – 83 - L25 → 0320 3.5S – 83 – L25 → 20190915183712
Station 124	83	18:48	5° 53.29224	11° 18.83706	1464	EOL/SOL: MBS – 83 - L25 → 0321 3.5S – 83 – L25 → 20190915184846
Station 125	83	19:00	5° 53.41194	11° 19.53558	1538	EOL/SOL: MBS – 83 - L25 → 0322 3.5S – 83 – L25 → 20190915190007
Station 126	83	19:12	5° 54.65926	11° 19.46282	1662	EOL/SOL: MBS – 83 - L25 → 0323 3.5S – 83 – L25 → 20190915191202
Station 127	83	19:22	5° 54.422385	11° 20.22576	1647	EOL/SOL: MBS – 83 - L25 → 0324 3.5S – 83 – L25 → 20190915192213

Station 128	83	19:34	5° 53.15032	11° 20.22660	1534	EOL/SOL: MBS – 83 - L25 → 0325 3.5S – 83 – L25 → 20190915193455
Cruise JC187		**Date: 15/09/2019**	**Sheet No. 13**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN129	83	19:45	5° 53.19366	11° 20.68662	1707	EOL/SOL: MBS – 83 - L24 → 0326 3.5S – 83 – L24 → 20190915194457
STN130	83	19:56	5° 20.35136	11° 20.61624	1562	EOL/SOL: MBS – 83 - L25 → 0327 3.5S – 83 – L25 → 20190915195634
STN131	83	20:06	5° 54.2520	11° 20.67965	1460	EOL/SOL: MBS – 83 – L26 → 0328 3.5 – 83 – L26 → 20190915200559
STN132	88	20:38	5° 53.67210	11° 21.35664	1832	CTD-06 at sea surface (boat is in a fixed position and we keep recording Line 26 on the MB and 3.5 surveys)
STN133	88	21:28	5° 53.67216	11° 21.35705	1825	CTD-06 at sea bottom USBL: 5° 53.66225 S 11° 21.35426 E Depth: 1829 m; 1st water sample at 6 m above seafloor
STN134	88	21:32	5° 53.67199	11° 21.35722	1825	CTD-06 at 1819 m; 2nd water sample, at 10 m above seafloor
STN135	88	21:34	5° 53.67181	11° 21.35688	1825	CTD-06 at 1809 m; 3rd water sample at 20 m above seafloor
STN136	88	21:36	5° 53.67222	11° 21.35686	1825	CTD-06 at 1799 m; 4th water samples at 30 m above seafloor
STN137	88	21:38	5° 53. 67212	11° 21.35603	1825	CTD-06 at 1789 m; 5th water sample at 40 m above seafloor

STN138	88	21:41	5° 53.67235	11° 21.35670	1825	CTD-06 at 1729 m; 6th water sample at 100 m above seafloor
STN139	88	22:15	5° 53.67210	11° 21.35676	1825	CTD-06 back at sea surface

Cruise JC187	**Date: 15/09/2019** **16/09/2019 (from STN147)**	**Sheet No. 14**

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
STN140	83	22:30	5° 53.67168	11° 21.35760	1842	Resume line: MBS_83_L26 → now 0330 35S_83_L26 → now 20190915223514
STN141	83	22:41	5° 53.37720	11° 21.61626	1491	EOL/SOL: MBS – 83 – L27 → 0331 3.5 – 83 – L27 → 20190915223514
STN142	83	22:53	5° 53.81844	11° 21.84090	1493	EOL/SOL: MBS – 83 – L28 → 0332 3.5 – 83 – L28 → 20190915225311
STN143	83	23:10	5° 55.04898	11° 21.14304	1381	EOL/SOL: MBS – 83 – L29 → 0333 3.5 – 83 – L29 → 20190915231002
STN144	83	23:21	5° 55.20162	11° 21.82980	1426	EOL/SOL: MBS – 83 – L30 → 0334 3.5 – 83 – L30 → 20190915232058
STN145	83	23:36	5° 53.77080	11° 22.52844	1363	EOL/SOL: MBS – 83 – L31 → 0335 3.5 – 83 – L31 → 20190915233616
STN146	83	23.44	5° 54.07872	11° 22.97730	1508	EOL/SOL: MBS – 83 – L32 → 0336 3.5 – 83 – L32 → 20190915234433

STN147	83	00:04	5° 55.73712	11° 22.23750	1344	EOL/SOL: MBS – 83 – L33 → 0337 3.5 – 83 – L33 → 20190916000417
STN148	83	00:14	5° 56.04312	11° 22.87014	1486	EOL/SOL: MBS – 83 – L34 → 0338 3.5 – 83 – L34 → 20190916001153
STN149	83	00:33	5° 54.25068	11° 23.47110	1474	EOL/SOL: MBS – 83 – L35 → 0339 3.5 – 83 – L35 → 20190916003308
STN150	83	00:46	5° 54.95526	11° 23.55018	1574	EOL/SOL: MBS – 83 – L36 → 0340 3.5 – 83 – L36 → 20190916004618
Cruise JC187		**Date: 16/09/2019**	**Sheet No. 15**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN151	83	01:01	5° 56.22844	11° 23.65620	1414	EOL/SOL: MBS_83_L37 → 0341 3.5_83_L37 → 20190916010137
STN152	83	01:09	5° 56.29056	11° 24.17784	1513	EOL/SOL: MBS_83_L38 → 0342 3.5_83_L38 → 20190916010952
STN153	83	01:33	5° 54.00000	11° 24.04230	1270	EOL/SOL: MBS_83_L39 → 0343 3.5_83_L39 → 20190916013322
STN154	83	01:44	5° 54.01704	11° 24.73000	1258	EOL/SOL: MBS_83_L40 → 0344 3.5_83_L40 → 20190916014450
STN155	83	02:11	5° 56.38440	11° 24.72000	1675	EOL/SOL: MBS_83_L41 → 0345 3.5_83_L41 → 20190916021105

STN156	83	02:19	5° 56.26572	11° 25.22256	1514	EOL/SOL: MBS_83_L42 → 0346 3.5_83_L42 → 20190916021917
STN157	83	02:41	5° 54.02136	11° 25.25568	1313	EOL/SOL: MBS_83_L43 → 0347 3.5_83_L43 → 20190916024151
STN158	83	02:51	5° 54.38490	11° 25.71624	1304	EOL/SOL: MBS_83_L44 → 0348 3.5_83_L44 → 20190916025143
STN159	83	03:12	5° 56.24844	11° 25.78740	1454	EOL/SOL: MBS_83_L45 → 0349 3.5_83_L45 → 20190916031207
STN160	83	03:20	5° 56.18082	11° 26.33046	1432	EOL/SOL: MBS_83_L46 → 0350 3.5_83_L46 → 20190916032044
STN161	83	03:35	5° 54.81808	11° 26.27004	1300	EOL/SOL: MBS_83_L47 → 0351 3.5_83_L47 → 20190916033504

Cruise JC187		**Date: 16/09/2019**	**Sheet No. 16**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN162	83	03:43	5° 54.86999	11° 26.80668	1396	EOL/SOL: MBS_83_L48 → 0352 3.5_83_L48 → 20190916034347
STN163	83	03:59	5° 56.24994	11° 26.89590	1403	EOL/SOL: MBS_83_L49 → 0353 3.5_83_L49 → 20190916045918
STN164	83	04:08	5° 56.14500	11° 27.41448	1495	EOL/SOL: MBS_83_L50 → 0354 3.5_83_L50 → 20190916030804

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
STN165	83	04:22	5° 54.75336	11° 27.34440	1255	EOL/SOL: MBS_83_L51 → 0355 3.5_83_L51 → 20190916042233
STN166	83	04:30	5° 54.83706	11° 27.88710	1500	EOL/SOL: MBS_83_L52 → 0356 3.5_83_L52 → 20190916043056
STN167	83	04:45	5° 56.26710	11° 27.97374	1266	EOL/SOL: MBS_83_L53 → 0357 3.5_83_L53 → 20190916044522
STN168	83	04:51	5° 56.11440	11° 28.41190	1340	EOL/SOL: MBS_83_L54 → 0358 3.5_83_L54 → 20190916045136
STN169	83	05:05	5° 54.74646	11° 28.71810	1434	EOL/SOL: MBS_83_L55 → 0359 3.5_83_L55 → 20190916050612
STN170	83	05:14	5° 55.054165	11° 29.24706	1291	EOL/SOL: MBS_83_L56 → 0360 3.5_83_L56 → 20190916051441
STN171	83	05:31	5° 56.59998	11° 28.70798	1240	EOL/SOL: MBS_83_L57 → 0361 3.5_83_L57 → 20190916053050
STN172	83	05:50	5° 55.38180	11° 29.48724	1345	EOL/SOL: MBS_83_L58 → 0362 3.5_83_L58 → 20190916055011
Cruise JC187		**Date: 16/09/2019**		**Sheet No. 17**		
STN173	83	06:09	5° 57.13686	11° 29.55294	1491	EOL/SOL: MBS_83_L59 → 0363 3.5_83_L59 → 2019091606060911

STN174	83	06:31	5° 55.62932	11° 30.10872	1267	EOL/SOL: MBS_83_L60 → 0364 3.5_83_L60 → 20190916063047
STN175	83	06:38	5° 55.63682	11° 30.58368	1264	EOL/SOL: MBS_83_L61 → 0365 3.5_83_L61 → 20190916063756
STN176	83	06:53	5° 55.571462	11° 30.46290	1390	EOL/SOL: MBS_83_L62 → 0366 3.5_83_L62 → 20190916065305
STN177	83	06.59	5°57.19770	11°30.91986	1178	EOL/SOL: MBS_83_L63 → 0367 3.5_83_L63 → 20190916065901
STN178	83	17.14	5°55.66350	11°31.03308	1249	EOL/SOL: MBS_83_L64 → 0368 3.5_83_L64 → 20190916071410
STN179	83	17.20	5°55.7236	11°31.50780	1171	EOL/SOL: MBS_83_L65 → 0369 3.5_83_L65 → 20190916072033
STN180	83	07.31	5°56.74356	11°31.41366	1478	EOL/SOL: MBS_83_L66 → 0370 3.5_83_L66 → 20190916073104
STN181	83	08.04	5°56.18196	11°32.53278	1096	Line 68 to 69 missed as not programmed into autopilot. Decided not to go back and complete this line as this is an OBS site and the original base map is good
STN182	83	08.05	5°56.18196	11°32.53278	1168	EOL/SOL: MBS_83_L67 → 0371 3.5_83_L67 → 20190916080612 (line 70 – 71)
STN183	83	08.19	5°57.45882	11°32.13192	1245.4	EOL/SOL: MBS_83_L68 → 0372 3.5_83_L68 → 20190916081950 (line 71 – 72)
Cruise JC187		**Date: 16/09/19** **19259**	**Sheet No. 18**			

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
STN184	83	08.27	5°57.6204	11°32.59476	1378.5	EOL/SOL: MBS_83_L69 → 0373 3.5_83_L69 → 20190916082808
STN185	83	08.41	5°56.17668	11°33.05076	1130.2	EOL/SOL: MBS_83_L70 → 0374 3.5_83_L70 → 20190916084228
STN186	83	08.51	5°56.43606	11°33.47508	1347.1	EOL/SOL: MBS_83_L71 → 0375 3.5_83_L71 → 20190916085107
STN187	83	09.03	5°57.71988	11°33.06096	13.69	EOL/SOL: MBS_83_L72 → 0376 3.5_83_L72 → 20190916090359
STN188	83	09.13	5°57.87504	11°33.51114	1318	EOL/SOL: MBS_83_L73 → 0377 3.5_83_L73 → 20190916091400
STN189	83	09.27	5°56.65320	11°33.90348	1353.4	END OF SURVEY EOL/SOL: MBS_83_L74 → 0378 3.5_83_L74 → 20190916092712
STN190	84	12.07	5°51.815	11°8.36094	2060	Arrive at site 84
STN191	84	12.23	5°51.81900	11°8.36202	2054	CTD-07 at surface
STN192	84	13.08	5°51.81900	11°8.36238	2030	CTD-07 at seabed USBL: 5°51.81078, 11°8.36094, 2028.5 m
STN193	84	13.46	5°51.81870	11°8.36238	2034	CTD-07 back on deck

STN194	84	14.14	5°51.80322	11°8.42776	2034	SOL: MBS_84_L75 → 0383 35S_83_L75 → 20191916141442 *saved as line 83 until L78

Cruise JC187		**Date: 16/09/2019**	**Sheet No. 19**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN195	84	14.39	5°51.661	11°5.8995	2085	EOL/SOL: MBS_84_L76→0384 35S_83_L76→20190916143954
STN196	84	15.04	5°50.6330	11°3.7200	2009	EOL/SOL: MBS_84_L77→0385 35S_83_L77→20190916150436
STN197	84	15:37	5°49.75002	11°0.59998	1962	EOL/SOL: MBS_84_L78→0386 35S_84_L78→20190916153727
STN198	84	16:28	5°48.63706	10°55.74342	2249	EOL/SOL: MBS_84_L79→0387 35S_84_L79→20190916162910
STN199	84	16:42	5°48.410	10°56.46288	2253	EOL/SOL: MBS_84_L80→0388 35S_84_L80→20190916164221
STN200	84	16:56	5°49.76196	10°56.15346	1908	EOL/SOL: MBS_84_L81→0389 35S_84_L81→20190916165615
STN201	84	17.07	5°49.80324	10°57.02340	2155	EOL/SOL: MBS_84_L82→0390 35S_84_L82→20190916170807
STN202	84	17.24	5°48.201065	10°57.42522	1952	EOL/SOL: MBS_84_L83→0391 35S_84_L83→20190916172452

STN203	84	17.36	5°48.38670	10°58.24638	2055	EOL/SOL: MBS_84_L84→0392 35S_84_L84→20190916173610
STN204	84	17.51	5°49.95822	10°57.91218	1941	EOL/SOL: MBS_84_L85→0393 35S_84_L85→20190916175149
STN205	84	18.04	5°59.88382	10°58.79100	2250	EOL/SOL: MBS_84_L86→0394 35S_84_L86→20190916180456
Cruise JC187		**Date: 16/09/2019**		**Sheet No. 20**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN206	84	18:18	5° 48.61122	10° 59.07786	1911	EOL/SOL: MBS_84_L87→0395 35S_84_L87→20190916181817
STN207	84	18:29	5° 48.82060	10° 59.92770	1858	EOL/SOL: MBS_84_L88→0396 35S_84_L88→20190916182958
STN208	84	18:52	5° 50.91684	10° 59.46288	1973	EOL/SOL: MBS_84_L89→0397 35S_84_L89→20190916185241
STN209	84	18:58	5° 50.88012	10° 59.83134	1901	EOL/SOL: MBS_84_L90→0398 35S_84_L90→20190916185839
STN210	84	19:07	5° 50.40366	11° 0.42342	1973	EOL/SOL: MBS_84_L91→0399 35S_84_L91→20190916190722
STN211	84	19:24	5° 48.97710	11° 0.85644	2047	EOL/SOL: MBS_84_L92→0400 35S_84_L92→20190916192424

STN212	84	19:34	5° 49.30428	11° 1.50090	1991	EOL/SOL: MBS_84_L93→0401 35S_84_L93→20190916193414
STN213	84	19:54	5° 51.26466	11° 1.27560	1792	EOL/SOL: MBS_84_L94→0402 35S_84_L94→20190916195441
STN214	84	20:05	5° 51.30000	11° 1.95828	1811	EOL/SOL: MBS_84_L95→0403 35S_84_L95→20190916200506
STN215	84	20:29	5° 49.44456	11° 2.33700	1817	EOL/SOL: MBS_84_L96→0404 35S_84_L96→20190916202934
STN216	84	20:42	5° 49.71930	11° 3.14070	1900	EOL/SOL: MBS_84_L97→0405 35S_84_L97→20190916204205
Cruise JC187		**Date: 16/09/2019**	**Sheet No. 21**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN217	84	21:00	5° 51.51999	11° 2.69574	1800	EOL/SOL: MBS_84_L98→0406 35S_84_L98→20190916210038
STN218	84	21:09	5° 51.70014	11° 3.28890	1811	EOL/SOL: MBS_84_L99→0407 35S_84_L99→20190916210920
STN219	84	21:29	5° 49.85588	11° 4.03320	1641	EOL/SOL: MBS_84_L100→0408 35S_84_L100→20190916212932
STN220	84	21:39	5° 50.25816	11° 4.85160	1633	EOL/SOL: MBS_84_L101→0409 35S_84_L101→20190916213908

STN221	84	22:01	5° 52.33152	11° 3.68460	1772	EOL/SOL: MBS_84_L102→0410 35S_84_L102→20190916220034
STN222	84	22:10	5° 52.58083	11° 4.45362	1752	EOL/SOL: MBS_84_L103→0411 35S_84_L103→20190916221001
STN223	84	22:36	5° 50.43222	11° 5.70342	1528	EOL/SOL: MBS_84_L104→0412 35S_84_L104→20190916223521
STN224	84	22:45	5° 50.89614	11° 6.30090	1684	EOL/SOL: MBS_84_L105→0413 35S_84_L105→20190916224522
STN225	84	23:03	5° 52.6888	11° 5.42592	1824	EOL/SOL: MBS_84_L106→0414 35S_84_L106→20190916230335
STN226	84	23:18	5° 57.5360	11° 6.67614	1784	EOL/SOL: MBS_84_L107→0415 35S_84_L107→20190916231821
STN227	84	23:38	5° 50.63210	11° 6.79926	1616	EOL/SOL: MBS_84_L108→0416 35S_84_L108→20190916233816

Cruise JC187	**Date: 16/09/2019 & 17/09/2019 (from STA 229)**	**Sheet No. 22**

Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN228	84	23:48	5° 50.41764	11° 7.58412	1614	EOL/SOL: MBS_84_L109→0417 35S_84_L109→20190916234743
STN229	84	00:09	5° 52.52160	11° 7.51099	1707	EOL/SOL: MBS_84_L110→0418

						35S_84_L110→20190917000942
STN230	84	00:22	5° 52.66026	11° 8.26194	1819	EOL/SOL: MBS_84_L111→0419 35S_84_L111→20190917002159
STN231	84	00:41	5° 51.13854	11° 8.38422	1713	EOL/SOL: MBS_84_L112→0420 35S_84_L112→20190917004115
STN232	84	00:55	5° 51.65292	11° 7.73724	1930	EOL/SOL: MBS_84_L113→0421 = turn for next survey 35S_84_L113→2019091700 =turn for next survey
STN233	89	00:56	5° 51.72829	11° 7.86018	2112	EOL/SOL: MBS_89_L01→0422 = start of survey 89 35S_89_L01→20190917005647 = start of survey 89
STN234	89	02:31	5°52.76400	11°17.23124	1447	EOL/SOL: MBS_89_L02→0424 !line missing (but still ok for survey); 35S_89_L02→20190917023130
STN235	89	02:47	5°52.19952	11° 16.41906	1529	EOL/SOL: MBS_89_L03→0425 35S_89_L03→20190917024714
STN236	89	03:03	5°53.83501	11° 16.24068	1709	EOL/SOL: MBS_89_L04→0426 35S_89_L04→20190917030345
STN237	89	03:12	5° 53.35869	11° 15.57192	1688	EOL/SOL: MBS_89_L05→0427 35S_89_L05→20190917031321
STN238	89	03:35	5° 53.25772	11° 15.79314	1442	EOL/SOL: MBS_89_L06→0428 35S_89_L06→20190917033542
Cruise JC187		**Date: 17/09/2019**	**Sheet No. 23**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

STN239	89	03:43	5° 51.26478	11° 15.05940	1533	EOL/SOL: MBS_89_L07→0429 35S_89_L07→20190917034432
STN240	89	04:05	5° 53.27934	11° 14.85300	1574	EOL/SOL: MBS_89_L08→0430 35S_89_L08→20190917040449
STN241	89	04:12	5° 53.28034	11° 14.13028	1635	EOL/SOL: MBS_89_L09→0431 35S_89_L09→20190917041234
STN242	89	04:31	5° 51.48038	11° 14.32524	1678	EOL/SOL: MBS_89_L10→0432 35S_89_L10→20190917043149
STN243	89	04:40	5° 51.52020	11° 13.58820	1579	EOL/SOL: MBS_89_L11→0433 35S_89_L11→20190917044014
STN244	89	04:58	5° 53.15976	11° 13.41126	1729	EOL/SOL: MBS_89_L12→0434 35S_89_L12→20190917045752
STN245	89	05:06	5° 53.11230	11° 12.68700	1725	EOL/SOL: MBS_89_L13→0435 35S_89_L13→20190917050605
STN246	89	05:25	5° 51.32240	11° 12.90132	1484	EOL/SOL: MBS_89_L14→0436 35S_89_L14→20190917052533
STN247	89	05:34	5° 51.35694	11° 12.15306	1656	EOL/SOL: MBS_89_L15→0437 35S_89_L15→20190917053450
STN248	89	05:52	5° 52.98678	11° 11.98740	1696	EOL/SOL: MBS_89_L16→0438 35S_89_L16→20190917055241

STN249	89	06:00	5° 53.03814	11° 11.29008	1644	EOL/SOL: MBS_89_L17→0439 35S_89_L17→20190917060013

Cruise JC187	**Date: 17/09/2019** **19260**	**Sheet No. 24**

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
STN250	89	06:19	5° 51.27504	11° 11.44812	1769	EOL/SOL: MBS_89_L18→0440 35S_89_L18→20190917061938
STN251	89	06:28	5° 51.21594	11° 11.70370	1650	EOL/SOL: MBS_89_L19→0441 35S_89_L19→20190917062824
STN252	89	06:50	5° 53.33724	11° 10.50042	1616	EOL/SOL: MBS_89_L20→0442 35S_89_L20→20190917065014
STN253	89	06.58	5°53.27592	11°9.76086	1630	EOL/SOL: MBS_89_L21→0443 35S_89_L21→20190917065845
STN254	89	07.23	5°50.90004	11°10.03183	1720	EOL/SOL: MBS_89_L22→0444 35S_89_L22→20190917072309
STN255	89	07.31	5°50.8080	11°9.2938	1763	EOL/SOL: MBS_89_L23→0445 35S_89_L23→20190917073127
STN256	89	07.55	5°53.15544	11°9.06738	1667	EOL/SOL: MBS_89_L24→0446 35S_89_L24→20190917075548

STN257	89	08.11	5°52.25574	11°8.43234	1814	EOL/SOL: MBS_89_L25→0447 35S_89_L25→20190917081115
STN258	89	08.21	5°51.21282	11°8.54832	1836.5	EOL/SOL: MBS_89_L26→0448 35S_89_L26→20190917082137 END OF SURVEY
STN259	86	09.14	5°48.86970	11°5.58888	1306	Start of Hydrophone Array. 1st buoy to touch surface of water.
STN260	86	09.21	5°48.89940	11°5.63364	1341	1st data recorder in water + deployment of hydrophone array
Cruise JC187		**Date: 17/09/2019** **19260**		**Sheet No. 25**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN 261	86	09.25	5°48.92076	11°5.67756	1306	2nd data recorder at surface of water
STN 262	86	09.37	5°49.03638	11°5.84430	1304	3rd set of buoys in water at surface
STN 263	86	09.41	5°49.06920	11°5.89176	1302	All equipment at water surface apart from anchor
STN 264	86	09.56	5°49.25228	11°6.15954	1264	Anchor for hydrophone array deployed
STN 265	86	10.06	5°49.26078	11°6.17202	1300	Anchor on seabed
STN 266	86	10.22	5°49.72794	11°6.90888	1300	Triangulation stop 1 Range (distance between anchor and boat): 2189 m – 2184 m

STN 267	86	10.43	5°48.41610	11°5.72544	1300	Triangulation stop 2 Range: 2098 – 2099 m
STN 268	86	10.58	5°49.67142	11°5.19342	1300	Triangulation stop 3 Range: 2221 – 2229 m, missed target by 34 m
STN 269	49	11.49	5°50.1996	11°2.15952	2115	Multicore at sea surface JC187-MC05 2 knots current at surface
STN 270	49	12.51	5°50.19942	11°2.1604	2147	Multicore at seabed, cable out = 2183.8 m JC187-MC05 USBL: 5°50.207777, 11°2.15793, 2170.1 m peak tension: 2.5 Te
STN 271	49	13.48	5°50.1989	11°2.15934	2135	Multicore back on deck JC187-MC05 8 full tubes
Cruise JC187		**Date: 17/09/2019** **19260**		**Sheet No. 26**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN 272	49	14:36	5° 50.19948	11° 2.16006	2127	Piston corer at sea surface (12 m barrel) JC187 – PC04
STN 273	49	15:25	5° 50.19972	11° 2.15988	2159	JC187 – PC04 at sea bottom. Pull-out – 3.87 Te USBL: 5° 50.19211511; 11° 2.14898; 2172.9 m
STN 274	49	16:18	5° 50.19978	11° 2.15994	2151	Piston corer at sea surface JC187 – PC04
STN 275	90	17:10	5° 50.44950	11° 1.85892	2014	Multi-corer at sea surface JC187 – MC06

STN 276	90	18:06	5° 50.4500	11° 1.85900	2010	Multi-corer at sea bottom JC187 – MC06 USBL: 5° 50.44126 S; 11° 1.85302 E; 2006.7 m
STN 277	90	19:00	5° 50.45004	11° 1.85958	2003	Multi-corer back on deck JC187 – MC06
STN 278	90	19:31	5° 50.44932	11° 1.85754	2015	Piston corer at sea surface JC187 – PC05
STN 279	90	20:22	5° 50.45009	11° 1.85971	2013	Piston corer at seabed JC187 – PC05 USBL: 5° 50.44345; 11° 1.85372; 2005 m
STN 280	90	21:00	5° 50.45064	11° 1.85982	2009	Piston corer back on deck JC187 – PC05
STN 281	51	21:57	5° 50.86218	11° 1.99142	1940	Multi-corer at sea surface JC187-MC07
STN 282	51	22:50	5° 50.86285	11° 1.88387	1943	Multi corer at bottom JC187-MC07 USBL: 5° 50.85375; 11° 1.87510; 1932 m
Cruise JC187	**Date: 17/09/2019; 18/09/2019; 19260 &19261**			**Sheet No. 27**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN 283	51	23:47	5° 50.86152	11° 1.88262	1943	Multicorer back on deck JC187-MC07
STN 284	51	00:28	5° 50.86200	11° 1.88220	1943	Piston corer at sea surface JC187-PC06

STN 285	51	01:19	5° 50.86254	11° 1.88232	1943	Piston corer at sea bottom JC187-PC06 USBL: 5° 50.85375; 11° 1.97274; depth = 1936m
STN 286	51	02:03	5° 50.86212	11° 1.88232	1943	Piston corer at sea surface JC187-PC06
STN 287	66	04:56	5° 54.01236	11° 19.67988	1845	Multicore at sea surface JC187-MC08
STN 288	66	05:51	5° 54.01308	11° 19.67904	1856	Multicore at sea bottom JC187-MC08 USBL: 5°54.00673; 11° 19.66128 ; depth = 1829 m
STN 289	66	06.48	5°54.01272	11° 19.67946	1852	Multicore back on deck JC187-MC08
STN 290	66	07.39	5°54.01296	11°19.67922	1853	Piston Core at surface JC187-PC07
STN 291	66	08.37	5°54.0128	11°19.679	1850	Piston Core at bottom. JC187-PC07 USBL 5°50.19211; 11°2.14898. Pull out: 4.15 Cable out: 1850 → written at time; USBL Checked: 5° 54.00890 S; 11° 19.6413 E; 1877 m → checked later
STN 292	66	09:27	5°54.0129	11°19.67999	1857	Piston core @ Surface JC187-PC07
STN 293	93	10.08	5°54.01038	11°19.81086	1872	Multicore at sea surface JC187-MC09
Cruise JC187		**Date: 18/09/2019** **19261**		**Sheet No. 28**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

STN 294	93	11.05	5° 54.01032	11° 19.81116	1834	Multicore at seabed JC187-MC09 USBL 5°54.00543; 11°19.78924 Depth 1868 m
STN 295	93	11.57	5° 54.01074	11° 19.81113	1853	Multicore on deck JC187-MC09 6 empty, 2 containing consolidated mud
STN 296	93	12.42	5° 54.01008	11° 19.81074	1865	Piston Core at surface JC187-PC-08, Deployment
STN 297	93	13.22	5° 54.0104	11° 19.8108	1868	Piston Core at bottom. JC187-PC-08. USBL 5°54.01074; 11°19.79823. Pull out: 4.33 Cable out: 1845m
STN 298	93	14.10	5° 54.01044	11° 19.81116	1856	Piston core @ Surface JC187-PC-08
STN 299	96	14.49	5° 53.7947	11° 19.81554	1850	Multicore at sea surface JC187-MC10
STN 300	96	15.37	5° 53.79438	11° 19.8162	1848	Multicore at seabed JC187-MC10 USBL 5°53.78998; 11°19.80659 Depth 1851 m
STN 301	96	16:26	5° 53.79384	11° 19.81656	1843	Multicore on deck JC187-MC10 Success
STN 302	96	17:00	5° 53.79402	11° 19.81584	1851	Piston Core at surface JC187-PC-09, Deployment
STN 303	96	17:35	5° 53.79334	11° 19.81652	1848	Piston Core at bottom. JC187-PC-09. Cable out: 1824m USBL 5°53.79099; 11°19.80451; Depth 1849.6m; Pull out: 4.02
STN 304	96	18:16	5° 53.794	11° 19.816	1851	Piston core @ Surface JC187-PC-09

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
STN 305	87	19:18	5° 54.59222	11° 19.91190	1673	Multicore at sea surface JC187-MC11, Deployment
STN 306	87	20:06	5° 54.59394	11° 19.91166	1673	Multicore at seabed JC187-MC11; Cable out: 1679.4m USBL 5°54.59294; 11°19.90275; Depth 1664m; Pull out: 2.30
STN 307	87	20:55	5° 54.59304	11° 19.91274	1672	Multicore on deck JC187-MC11 5 empty, 3 containing mud
STN 308	87	21:25	5° 54.59280	11° 19.91340	1672	Piston Core at surface JC187-PC-10, Deployment
STN 309	87	22:04	5° 54.59304	11° 19.91160	1673	Piston Core at bottom. JC187-PC-10. Cable out: 1640 m USBL 5°54.58923; 11°19.90627; Depth 1666.2 m; Pull out: 3.8
STN 310	87	22:44	5° 54.59370	11° 19.91160	1672	Piston core @ Surface JC187-PC-10
STN 311	48	00:05	5° 54.73890	11° 25.02858	1344	Multicore at sea surface JC187-MC12, Deployment
STN 312	48	00:47	5° 54.74988	11° 25.02929	1345	Multicore at seabed JC187-MC12; Cable out: 1352m USBL 5°54.74808; 11°25.02303; Depth 1345.1m; Pull out: 2.0
STN 313	48	01:28	5° 54.74970	11° 25.02960	1345	Multicore on deck JC187-MC12 8 successful, containing mud
STN 314	48	02:04	5° 54.75000	11° 25.02948	1345	Piston Core at surface JC187-PC-11, Deployment

STN 315	48	02:39	5° 54.75000	11° 25.02948	1343	Piston Core at bottom. JC187-PC-11. Cable out: 1325.2 m USBL 5°54.74836; 11°25.02176; Depth 1346.9 m; Pull out: 4.6
Cruise JC187		**Date: 19/09/2019** **19262**		**Sheet No. 30**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN 316	48	03:18	5° 54.74940	11° 25.02990	1342	Piston core @ Surface JC187-PC-11
STN 317	99	04:11	5° 55.49172	11° 25.57614	1670	Multicore at sea surface JC187-MC13, Deployment
STN 318	99	04:57	5° 55.49182	11° 25.57681	1662	Multicore at seabed JC187-MC13; Cable out: 1683 m USBL 5°55.49192; 11°25.56407 at 1668.8 m; Δ=23.53m 269.8°
STN 319	99	05:46	5° 55.49184	11° 25.57662	1668	Multicore on deck JC187-MC13 Back on deck, 3 successful cores, containing mud
STN 320	66	06:54	5° 53.99	11° 19.80	1870	Aniitra 2 - Starting to put anchor in water
STN 321	66	07:04	5° 53.99978	11° 19.80321	1864.5	Aniitra 2 – Sediment trap in water
STN 322	66	07:21	5° 53.99992	11° 19.80208	1866.1	Aniitra 2 – ADCP suspended
STN 323	66	07:23	5° 53.99940	11° 19.80204	1820.6	Aniitra 2 – ADCP in water
STN 324	66	07.28	5° 52.99939	11° 19.80194	1865.5	Aniitra 2 – USBL in water

STN 325	66	08:03	5° 54.00150	11° 19.80234	1837	Aniitra 2 – Winch tracking mechanism broke – deployment paused at 686m.
STN 326	66	09:20	5° 54.00150	11° 19.80234	1837	Aniitra 2 – Winch tracking mechanism fixed. Deployment resumed
Cruise JC187		**Date: 19/09/2019** **19262**		**Sheet No. 31**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
STN 327	66	09.57	5°54.00120	11°19.80198	1844	Aniitra 2 – Stopped to moves ship to correct USBL position USBL: 5°53.9974; 11°19.75744 at 1495.7 m cable out: 1533.9 m
STN 328	66	10.20	5° 54.00130	11° 19.81842	1862.7	Aniitra 2 – released on seafloor USBL: 5°54.00029; 11°19.76589 at 1525 m cable out: 1564.9
STN 329	66	10.25	5° 54.00130	11° 19.81842	1869	Aniitra 2 – Checking position, depth of acoustic releases (16 m Above the anchor) = 1854 m. Depth = 1870 m
STN 330	66	10:58	5° 5400162	11° 19.81830	1863.8	USBL detached from wire
STN 331	66	11:00	5° 54.00108	11° 19.81848	1858.6	Cable back on deck
STN 332	66	11:31	5° 53.37570	11° 20.42754	1606.4	Aniitra 2 – Triangulation 1, NE Range = 2500 m, 2490 m
STN 333	66	11:47	5° 54.6635	11° 20.2819	1606	Aniitra 2 – Triangulation 2, SE Range = 2416 m, 2416 m

STN 334	66	12:05	1) 5° 54.528665° 2) 5°54.5359	1)11° 18.87138 2)11° 18.8432	1606	Aniitra 2 – Triangulation 3, SW Range: 1) 2678 m; 2) 2702 m
STN 335	66	12:30	1) 5°53.41854 2) 5°53.41650	1) 11°19.16730 2) 11°19.16424	N/A	Aniitra 2 – Triangulation 4, NW Range: 1) 2415 m; 2) 2416 m
STN 336	103	13.13	5° 54.10008	11° 19.48038	1863	NERC mooring 1 Buoy in water
STN 337	103	13.48	5°54.01578	11°19.89500	1868	NERC mooring 1 Anchor in water

Cruise JC187		**Date: 19/09/19** **19262**		**Sheet No. 32**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
338	103	13.51	5°54.00738	11°19.93764	1858	NERC mooring 1 Anchor dropped
339	103	14.01	5°54.00678	11°19.94154	1862	NERC mooring 1 Anchor on seafloor, depth 1811 m
340	103	14.23	5°53.45394	11°20.48328	1862	Triangulation stop 1, NE Range: 234 – 2344 m
341	103	14.43	5°54.57234	11°20.46744	1862	Triangulation stop 2 Range: 2323 – 2324 m

342	103	15.09	5°54.2010	11°19.27470	1863	Triangulation stop 3 Range: 2420 m
343	103	15.30	5°53.48412	11°19.31292	1863	Triangulation stop 4 Range: 2333 – 2334 m
344	87	16.07	5°54.59574	11°19.91160	1670	OBS-1 dropped
345	99	18.07	5°55.49208	11°25.57620	1667.1	Piston core at surface PC-012
346	99	18.45	5°55.49166	11°25.57656	1669.1	Piston core at seabed PC-012 max cable: 1645 m USBL: 5°55.49866 11°25.56585, 1661.9 m, max tension = 4.5 Te
347	99	19.29	5°55.49172	11°25.57647	1667	Piston core back on deck JC187-PC-12
348	99	19.53	5°55.49172	11°25.57647	1667	Multicore at sea surface JC187-MC14, Deployment

Cruise JC187		**Date: 19/09/2019-20/09/2019; 19262-19263**		**Sheet No. 33**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
349	99	20.41	5°55.49274	11°25.57686	1666	Multicore at seabed JC187-MC14; Cable out: 1686.1 m USBL 5°55.48218; 11°25.55578 at 1666.7 m; Δ=43.07m 296.5°
350	99	21.26	5°55.49166	11°25.57578	1668	Multicore on deck JC187-MC14 All 8 partly filled with mud/sand

351	45	21.51	5°55.81806	11°25.11438	1667	Multicore at sea surface JC187-MC15, Deployment
352	45	22.36	5°55.81855	11°25.11463	1666.8	Multicore at seabed JC187-MC15 USBL 5°55.82225; 11°25.09653 at 1660.5 m; Δ=34.11m 258.7°
353	45	23.24	5°55.81740	11°25.11564	1667	Multicore on deck JC187-MC15 2 successful cores, containing mud
354	45	23.56	5°55.81776	11°25.11516	1667	Piston Core at surface JC187-PC-13, Deployment
355	45	00.37	5°55.81908	11°25.11204	1667	Piston Core at bottom. JC187-PC-13. Δ=36.35m 282.5° USBL 5°55.81493; 11°25.09275; Depth 1665.5 m; Pull out: 4.12t
356	45	01.14	5°55.81896	11°25.11168	1667	Piston core @ Surface JC187-PC-13 10.5m of Sediment
357	97	03.07	5°55.45500	11°28.41300	1633	Multicore at sea surface JC187-MC16, Deployment
358	97	03.59	5°55.45560	11°28.41246	1635	Multicore at seabed JC187-MC16; Cable out: 1653.1 m USBL 5°55.45089; 11°28.40406 at 1634.5 m; Δ=18.77m 295.5°
359	97	04.53	5°55.45560	11°28.41204	1633	Multicore on deck JC187-MC16 All 8 partly filled with mud

Cruise JC187		**Date: 20/09/2019** **19263**		**Sheet No. 34**		
Station Number (JC187/Station x)	**Site Number**	**Time** **In GMT**	**Latitude** **(degree, DM)**	**Longitude** **(degree, DM)**	**Depth** **(m)**	**Equipment Deployed (Events) & Comments** **(Include any exact USBL positions here)**

	(as on GIS)					
360	97	05.25	5°55.455	11°28.411	1634	Piston Core at surface JC187-PC-14, Deployment
361	97	06.05	5°55.45500	11°28.41162	1645	Piston Core at bottom. JC187-PC-14. Δ=21.51m 292.8° USBL 5°55.45178; 11°28.40134; Depth 1626.8m; Pull out: 4.1te
362	97	06.59	5°55.45512	11°28.41240	1636	Piston core @ Surface JC187-PC-14
363	97	07.45	5°55.5530	11°28.1444	1632	NERC mooring 4 Buoy in water
364	97	08.07.30	5°55.4493	11°28.41486	1632	NERC mooring 4 Anchor chain in water
365	97	08.09	5°55.44360	11°28.44336	1628.9	NERC mooring 4 Anchor dropped
366	97	08.20	5°55.438	11°28.4529	1637	NERC mooring 4 On bed
367	97	08.43	5°54.7882	11°29.0759	1403	Triangulation stop 1, NE NERC mooring 4
368	97	09.04	5°55.9190	11°29.1577	1403	Triangulation stop 2, SE NERC mooring 4
369	97	09.24	5°56.0614	11°27.7640	1358.3	Triangulation stop 3, SW NERC mooring 4
370	97	09.40	5°54.6601	11°27.8332	1243.5	Triangulation stop 4, NW NERC mooring 4

Cruise JC187		Date: 20/09/2019 19263		Sheet No.35		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
371	98	10.52	5°57.205	11°33.195	1569	Multi core at surface MC-17
372	98	11.39	5°57.205	11°33.194	1567	MC-17 at seabed. Cable out: 1585, pull out: 2.27 USBL: 5°57.2091, 11°33.18347, depth 1575 m
373	98	12.26	5°57.206	11°33.194	1582	Multi core back on deck MC-17
374	98	13.00	5°57.209	11°33.197	1561	Piston core @ Surface JC187-PC-15
375	98	13.35	5°57.207	11°33.198	1564	Piston core at seabed JC187-PC-15. Cable out: 1550, pullout: 3.81 USBL: 5°57.208, 11°33.19582, depth 1570 m
376	98	14.09	5°57.208	11°33.198	1570	Piston core @ Surface JC187-PC-15
377	98	14.58	5°57.11892	11°32.95422	1578	NERC mooring 3 Buoy in water
378	98	15.18	5°57.20604	11°33.19266	1569	NERC mooring 3 Anchor chain in water
379	98	15.20	5°57.22002	11°33.23016	1565	NERC mooring 3 Anchor dropped

380	98	15.28	5°57.22194	11°33.2334	1572	NERC mooring 3 On bed
381	98	15.49	5°56.62146 5°56.62182	11°33.76866 11°33.76956	1572	Triangulation stop 1, NE NERC mooring 3 Range: 2142 m, 2142 m, 2143 m

Cruise JC187		**Date: 20/09/2019 – 21/09/2019; 19263 - 19264**	**Sheet No. 36**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
382	98	16:08	5°57.76026 5°57.76026	11°33.79152 11°33.79176	1572	Triangulation on SE Range: 2127, 2128, 2127 m
383	98	16:32	5°57.78924 5°57.78858	11°32.63778 11°32.64216	1573	Triangulation Stop 3. SW Range: 2132, 2126, 2126m
384	98	16:54	5°56.65320 5°56.65230	11°32.61456 11°32.61348	1573	Triangulation Stop 4. NW Range: 2139, 2139, 2139m
385	5	17:31	5°57.80958	11°31.70058	1130.8	OBIC OBS-2 Deployed
386	104	18:17	5°55.971	11°27.280	1567	OBIC OBS-3 Deployed
387	105	18:40	5°54.485	11°27.397	1260	OBIC OBS-4 Deployed
388	106	19:55	5°57.25164	11°33.36948	1580	Piston Core at surface JC187-PC-16, Deployment
389	106	20:28	5°57.25140	11°33.36924	1583	Piston Core at bottom. JC187-PC-16. Δ=15.30m 207.6^{0} USBL 5°57.25966; 11°33.36511; Depth 1576.8m; Pull out: 3.1t

390	106	21.11	5°57.25044	11°33.36954	1578	Piston Core back on deck. JC187-PC-16.
391	92	23.59	5°52.74012	11°10.49388	1982	Multi core at surface MC-18
392	92	00.58	5°52.74072	11°10.49370	1991	MC-18 at seabed. Cable out: 2037.1, Δ=26.1m 262.1° USBL: 5°52.74190, 11°10.48663, depth 2016.5 m, Pull out: 2.7

Cruise JC187		**Date: 21.09.2019 19264**	**Sheet No.37**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
393	92	01:55	5°52.74030	11°10.49382	1985	Multi core back on deck MC-18
394	92	02:55	5°52.73676	11°10.50006	1983	Piston Core at surface JC187-PC-17, Deployment
395	92	03:50	5°52.73814	11°10.49850	1989	Piston Core at bottom. JC187-PC-17 Δ=15.37m 273.9°. Cable Out: 2004.4m USBL 5°52.73597; 11°10.49102; Depth 2020.1m; Pull out: 4.8t
396	92	04:50	5°53.73718	11°10.49940	1983	Piston Core back on deck. JC187-PC-17.
397	92	05:53	5°52.737	11°10.499	1977	CDT-08 at surface
398	92	06.37	5°52.738	11°10.499	1983	CTD-08 @ bottom, 5m above bed. CTD pressure depth – 2012m, 1st water sample bottle 1.
399	92	06.39	5°52.738	11°10.499	1983	CTD-08, 20m above sea bed. 2nd water sample - bottle 2.

400	92	06.42	5°52.738	11°10.499	1983	CTD-08, 40m above sea bed. 3rd water sample - bottle 3.
401	92	06.44	5°52.738	11°10.499	1983	CTD-08, 60m above sea bed. 4th water sample - bottle 4.
402	92	06.46	5°52.737	11°10.499	1983	CTD-08, 100m above sea bed. 5th water sample - bottle 5.
403	92	06.54	5°52.737	11°10.499	1983	CTD-08, 1600m water depth. 6th water sample - bottle 6.

Cruise JC187		**Date: 21/09/2019** **19264**		**Sheet No.38**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
404	92	07.14	5°52.73737	11°10.49895	1982	CTD-08 500m water depth 7th water sample - bottle 7.
405	92	07.26	5°52.73756	11°10.49877	1985	CTD-08 50m water depth 8th water sample - bottle 8.
406	92	07.30	5°52.73742	11°10.49886	1986	CTD-08 back on deck
407	92	08.13	5°52.7248	11°10.52460	1976	Aniitra 3 sediment trap in water
408	92	08.31	5°52.74001	11°10.52640	1985	Aniitra 3 ADCP lifted from deck
409	92	08.35	5°52.73418	11°10.52652	1978	Aniitra 3 ADCP in water

410	92	08.42	5°52.73340	11°10.52676	1979	Aniitra 3 USBL in water
411	92	10.00	5°52.74288	11°10.52532	1990	Aniitra 3 Cable stopped at 1680m (Cable out)
412	92	10.04	5°52.74168	11°10.52442	1991	Aniitra 3 Started moving 20m ESE
413	92	10:09:50	5°52.74756	11°10.53504	1991	Aniitra 3 – Mooring released. USBL: 5°52.735, 11°10.495. Cable out 1680m
414	92	10.22	5°52.74756	11°10.53504	1991	Aniitra 3 Range to acoustic release: 2003m

Cruise JC187		**Date: 21/09/2019** **19264**	**Sheet No. 39**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
415	92	10.54	5°52.749	11°10.5341	1986	Aniitra Cable onboard
416	86	11.32	5°49.1887	11°05.93766	1306	Arrive on site for hydrophone recovery
417	86	11.39	5°49.05726	11°06.10416	1292.6	Hydrophone Acoustic release 1353m range before release
418	86	11.52	5°49.07664	11°06.15588	1290.5	Hydrophone release command sent
419	86	12.01	5°49.08	11°06.16	1290	Hydrophone visible at sea surface

420	86	12.20	5°49.18	11°05.97	1290	Hydrophone first buoy on deck.
421	86	12.53	5°49.44561	11°06.05958	1290	Hydrophone array completely on deck
422	14	14.23	5°50.19816	11°01.92546	2047 (?) 74	NERC Mooring 9.Orange buoy dropped. Depth reading off due to bubbles
423	14	14.24	5°50.19786	11°01.92774	2071	NERC Mooring 9. Acoustic release in water
424	14	14.37	5°50.19996	11°2.15028	2172	NERC Mooring 9. Anchor in water
425	14	14.40	5°50.19960	11°2.18904	2151	NERC Mooring 9 Anchor released
Cruise JC187		**Date: 21/09/2019** **19264**		**Sheet No. 40**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
426	14	14.52	5° 50.19978	11° 2.19960	2126	NERC mooring 9 Anchor on seafloor, acoustic release @ 2150m
427	14	15.18	5° 49.4148	11° 2.9397	2126.8	Triangulation stop 1, NE NERC mooring 9 Range: 2975m, 2975m
428	14	15.44	5° 50.97150 5° 50.97246	11° 2.93208 11° 2.93118	2126.8	Triangulation stop 2, SE NERC mooring 9 Range: 2941m, 2941m

429	14	16.10	5° 51.00450 5° 51.00600	11° 1.41978 11° 1.42104	2126.8	Triangulation stop 3, SW NERC mooring 9 Range: 2948m, 2947.7m
430	14	16.35	5° 49.44950 5° 49.44948	11° 1.40268 11° 1.40184	2126.8	Triangulation stop 4, NW NERC mooring 9 Range: 2928.4-2930.4m, 2928.5-2930.4m
431	14 (not exactly on pt)	17.08	5° 50.11152	11° 1.89486	2167	CDT-09 at surface
432	14 (not exactly on pt)	17.56	5° 50.11150	11° 1.89473	6171	CTD-09 @ bottom, 6m ABS, Altimeter 5.8m, CTD depth – 2168m USBL 5°50.12683, 11°1.90832, 1st water sample bottle 1.
433	14 (not exactly on pt)	17.58	5° 50.11149	11° 1.8949	2181	CTD-09, 20m above sea bed, Altimeter 20.2m 2nd water sample - bottle 2.
434	14 (not exactly on pt)	18.01	5° 50.11152	11° 1.8958	2170	CTD-09, 40m above sea bed, Altimeter 39.8m 3rd water sample - bottle 3.
435	14 (not exactly on pt)	18.03	5° 50.11128	11° 1.89528	2181	CTD-09, 60m above sea bed, Altimeter 59.6m 4th water sample - bottle 4.
436	14 (not exactly on pt)	18.07	5° 50.11128	11° 1.89564	2119	CTD-09, 100m above sea bed, Altimeter 98.6m, cable out: 2063m 5th water sample - bottle 5.

Cruise JC187		**Date: 21/09/2019-22/09/2019, 19264-19265**		**Sheet No. 41**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
437	14 (not exactly on pt)	18.14	5° 50.11092	11° 1.89586	2159	CTD-09, 300m above sea bed, cable out: 1763m 6th water sample - bottle 7.

438	14 (not exactly on pt)	18.18	5° 50.11158	11° 1.89510	2149	CTD-09, 1601m water depth, cable out: 1601m 7th water sample - bottle 6.
439	14 (not exactly on pt)	18.37	5° 50.11194	11° 1.89552	2119	CTD-09, 500m water depth 8th water sample - bottle 8.
440	14 (not exactly on pt)	18.44	5° 50.11158	11° 1.89600	2115	CTD-09, 50m water depth 9th water sample - bottle 9.
441	14 (not exactly on pt)	18.55	5° 50.11164	11° 1.89600	2158	CTD-09 back on deck
442	107	20.03	5° 51.39636	11° 8.89206	2054	MC-19 at surface
443	107	20.58	5° 51.39510	11° 8.89242	2053	MC-19 at seabed. Cable out: 2076.1, Pull out: 2.4 Te USBL: 5°51.40276, 11°8.88621 @ 2054.2m, Δ=21.33m 219.0°
444	107	21.54	5° 51.39594	11° 8.89188	2054	MC-19 back on deck 5 cores partly filled with mud
445	108	22.13	5° 51.42288	11° 8.78610	2052	MC-20 at surface
446	108	23.08	5° 51.42210	11° 8.78622	2044	MC-20 at seabed. Cable out: 2077.1m, Pull out: 2.6 Te USBL: 5°51.42858, 11°8.77749 @ 2055.9m, Δ=23.24m 229.9°
447	108	00.07	5° 51.42156	11° 8.78574	2050	MC-20 back on deck 5 cores partly filled with mud

Cruise JC187		**Date: 22/09/2019** **19265**		**Sheet No. 42**		
Station Number (JC187/Station x)	**Site Number**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

	(as on GIS)					
448	109	00.28	5° 51.57996	11° 8.68440	1921	MC-21 at surface
449	109	01.27	5° 51.57972	11° 8.68470	1931	MC-21 at seabed. Cable out: 2077.1m, Pull out: 2.4 Te USBL: 5°51.58501, 11°8.68930 @ 2056.5m, Δ=12.41m 156.3^{o}
450	109	02.26	5° 51.57888	11° 8.68482	2028	MC-21 back on deck
451	110	02.48	5° 51.61950	11° 8.70258	2067	MC-22 at surface
452	110	03.45	5° 51.61872	11° 8.70294	2041	MC-22 at seabed. Cable out: 2077.1m, Pull out: 2.65 Te USBL: 5°51.61920, 11°8.70400 @ 2056.5m, Δ=5.70m 182.7^{o}
453	110	04.42	5° 51.61974	11° 8.70228	2046	MC-22 back on deck All 8 partly filled
454	51	05.53	5° 50.84958	11° 1.87302	1945	OBIC OBS-05 Deployed
455	13	07.11	5°50.71194	11°1.11204	1945	Hydrophone deployment Top yellow head float in the water
456	13	07.19	5° 50.71938	11°1.1958	1943	Hydrophone deployment First array of floats and data logger in The water
457	13	07.21	5°50.72382	11°1.20846	1945	Hydrophone deployment second array of floats in the water
458	13	07.38	5°50.75280	11°1.46550	1945	Hydrophone deployment third array of floats plus acoustic releases

Cruise JC187		Date: 22/09/2019-23/09/2019, 19265-19266		Sheet No. 43		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
459	13	07.48	5° 50.77134	11° 1.63344	1939	Hydrophone deployment – Anchor deployment/drop
XXX	XX	XX	XX	XX	XX	XXX
460	13	08.02	5° 50.77398	11° 1.65744	1939.8	Hydrophone deployment array on seafloor 1953m, stabilised
461	13	08.20	5° 51.36222	11° 2.57760	1939	Triangulation stop 1, SE Hydrophone array Range: 2934m
462	13	08.43	5° 51.39072	11° 0.67644	Not ping	Triangulation stop 2, SW Hydrophone array Range: 2802
463	13	09.03	5° 49.98858	11° 0.79002	Not ping	Triangulation stop 3, NW Hydrophone array Range: 2816m
464	13	09.24	5° 50.02728	11° 2.40480	Not ping	Triangulation stop 4, NE Hydrophone array Range: 2849m
465	13	09.59	5° 50.06842	11° 2.17614	2081	Beginning transit to International Water
466	112	02.14	5° 43.54332	8° 9.48828	4081	CDT-10 at surface
467	112	03.31	5° 43.54302	8° 9.48768	4082	CTD-10 @ bottom,13m ABS, Altimeter 13m, CTD depth – 4133m USBL 5°43.54605, 8°9.48242

468	112	03.35	5° 43.54318	8° 9.48766	4082	CTD-10, 70m above sea bed, 1st water sample - bottle 1.

Cruise JC187		**Date: 23/09/2019, 19266**	**Sheet No. 44**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
469	112	03.37	5° 43.54337	8° 9.48274	4080	CTD-10, 100m above sea bed, Altimeter 98.6m 2nd water sample - bottle 2.
470	112	03.40	5° 43.54293	8° 9.48822	4078	CTD-10, 200m above sea bed, depth CTD 3932m 3rd water sample - bottle 3.
471	112	03.57	5° 43.54285	8° 9.48813	4078	CTD-10, 3000m water depth, depth CTD 3007m 4th water sample - bottle 4.
472	112	04.07	5° 43.54267	8° 9.48848	4079	CTD-10, 2500m water depth, depth CTD 2510m 5th water sample - bottle 5.
473	112	04.23	5° 43.54000	8° 9.48231	4081	CTD-10, 1600m water depth, depth CTD 1601.4m 6th water sample - bottle 7.
474	112	04.43	5° 43.54335	8° 9.48787	4081	CTD-10, 500m water depth, depth CTD 499m 7th water sample - bottle 6.
475	112	04.50	5° 43.54255	8° 9.47911	4081	CTD-10, 200m water depth, depth CTD 200m 8th water sample - bottle 8.
476	112	04.57	5° 43.54216	8° 9.47935	4081	CTD-10, 50m water depth, depth CTD 50m 9th water sample - bottle 9.

477	112	04.59	5° 43.54195	8° 9.47968	4081	CTD-10, 25m water depth, depth CTD 24.7m 10th water sample - bottle 9.
478	112	05.01	5° 43.54194	8° 9.47917	4081	CTD-10, 10m water depth, depth CTD 10.8m 11th water sample - bottle 9.
479	112	05.04	5° 43.54314	8° 9.48780	4081	CTD-10, back on deck

Cruise JC187		**Date:23/09/19** **19266**	**Sheet No. 45**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
480	113	05.38	5°43.94850	8°9.66600	3973	EOL/SOL: MBS – 113 – L01 → 0566 3.5S – 113 – L01 → 20190923053735
481	113	06.48	5°43.58891	8°2.26008	4135	EOL/SOL: MBS – 113 – L02 → 0567 3.5S – 113 – L02 → 20190923064842
482	113	06.58	5°44.16300	8°1.41324	4150	EOL/SOL: MBS – 113 – L03 → 0568 3.5S – 113 – L03 → 20190923065932
483	113	07.32	5°47.27816	8°0.44501	4174	EOL/SOL: MBS – 113 – L04 → 0569 3.5S – 113 – L04 → 20190923073253
484	113	07.34	5°47.30064	8°0.35166	4167	EOL/SOL: MBS – 113 – L05 → 0570 3.5S – 113 – L05 → 20190923073434
485	113	08.09	5°47.03982	7°56.81172	4158	EOL/SOL: MBS – 113 – L06 → 0572 SURVEY SUSPENDED 3.5S – 113 – L06 → 20190923080938

486	115	09.18	5°58.7452	11°24.28812	587	Arrive on site for Multibeam for landslide
487	115	09.20	5°58.574	11°24.30486	637	EOL/SOL: MBS – 115 – L01 → 0578 3.5S – 115 – L01 → 20190925093015
488	115	09.43	5°56.18172	11°24.58098	1665	EOL/SOL: MBS – 115 – L02 → 0579 3.5S – 115 – L02 → 20190925094317
489	115	09.58	5°56.41900	11°25.79458	1368	EOL/SOL: MBS – 115 – L03 → 0580 3.5S – 115 – L03 → 20190925095849
490	115	10.01	5°56.5946	11°25.834	/	EOL/SOL: MBS – 115 – L04 → 0581 3.5S – 115 – L04 → 20190925100124

Cruise JC187		**Date: 25/09/2019** **19268**	**Sheet No. 46**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
491	115	10.07	5°57.16098	11°25.62732	1055	EOL/SOL: MBS – 115 – L05 → 0582 3.5S – 115 – L05 → 20190925100751
492	115	10.10	5°57.22344	11°25.36834	1014	EOL/SOL: MBS – 115 – L06 → 0583 3.5S – 115 – L06 → 20190925101044
493	115	10.23	5°57.01521	11°24.05411	1045	EOL/SOL: MBS – 115 – L07 → 0584 3.5S – 115 – L07 → 20190925102307

494	115	10.35	5°56.67450	11°22.80170	1204	EOL/SOL: MBS – 115 – L08 → 0585 3.5S – 115 – L08 → 20190925103533
495	115	10.51	5°55.83024	11°21.50628	1170	EOL/SOL: MBS – 115 – L09 → 0586 3.5S – 115 – L09 → 20190925105113
496	115	10.55	5°55.56888	11°21.10566	1262	EOL/SOL: MBS – 115 – L10 → 0587 3.5S – 115 – L10 → 20190925105544
497	115	10.58	5°55.31522	11°21.11130	1311	EOL/SOL: MBS – 115 – L11 → 0588 3.5S – 115 – L11 → 20190925105843
498	115	11.12	5°54.23100	11°22.62406	1631	EOL/SOL: MBS – 115 – L12 → 0589 3.5S – 115 – L12 → 20190925111248
499	115	11.14	5°54.298800	11°22.70274	1747	EOL/SOL: MBS – 115 – L13 → 0590 3.5S – 115 – L13 → 20190925111428
500	115	11.26	5°55.22680	11°23.17506	1708	EOL/SOL: MBS – 115 – L14 → 0591 3.5S – 115 – L14 → 20190925112615
501	115	11.28	5°55.44066	11°23.10900	1765	EOL/SOL: MBS – 115 – L15 → 0592 3.5S – 115 – L15 → 2019092512811

Cruise JC187		**Date: 25/09/2019** **19268**		**Sheet No. 47**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

502	115	11.45	5°56.509	11°21.509	1000	End of Survey
503	118	13.48	5°50.2026	11°1.95894	2153	Float (little yellow buoy) in water at surface JC187 NERC Mooring 2
504	118	13.53	5°50.2078	11°2.01744	2122	First ADCP mooring buoy in water at surface JC187 NERC Mooring 2
505	118	13.57	5°50.21226	11°2.09274	2152	Second ADCP mooring buoy in water at surface JC187 NERC Mooring 2
506	118	14.05	5°50.21928	11°2.18880	2118	Acoustic release in water JC187 NERC Mooring 2
507	118	14.18	5°50.23116	11°2.34786	2102	Anchor in water JC187 NERC Mooring 2
508	118	14.19	5°50.23374	11°2.38194	2103	Anchor dropped JC187 NERC Mooring 2
509	118	14.31	5°50.23458	11°2.38980	2125	Anchor on seafloor JC187 NERC Mooring 2
510	118	14.57	5°49.4754	11°3.11124	2125	Triangulation point 1 JC187 NERC Mooring 2
511	118	15.21	5°50.993	11°3.126	1917	Triangulation point 2 JC187 NERC Mooring 2
512	118	15.43	5°50.984	11°1.597	1941	Triangulation point 3 JC187 NERC Mooring 2

Cruise JC187		**Date: 25/09/2019** **26/09/19; 19268/9**		**Sheet No. 48** (NB. The MB and 3.5 survey file numbers saved are not subsequential for long Lines (i.e. L07), the computer automatically sub-saves files after certain time/file size)		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
513	118	16.07	5°49.482	11°01.583	1979	Triangulation point 4 JC187 NERC Mooring 2
514	N/A	07.19 (26/09)	5°47.294	8°3.456	4044	Just before arriving back at MB survey_113
515	113	07.36	5°47.24004	8°0.24222	4048	Return to MBS and 3.5 survey suspended 23/09
516	113	07.43	5°47.17386	7°59.4424	4069	EOL/SOL: MBS_113_L07 → 0598 3.5S_113_L07 → 20190926074351
517	113	10.11	5°45.31432	7°44.32458	4270	EOL/SOL: MBS_113_L08 → 0601 3.5S_113_L08 → 20190926101141
518	113	11.02	5°44.77482	7°38.98272	4253	EOL/SOL: MBS_113_L09 → 0602 3.5S_113_L09 → 20190926110247
519	113	11.39	5°45.87348	7°35.38578	4203	EOL/SOL: MBS_113_L10 → 0603 3.5S_113_L10 → 20190926113959
520	113	11.55	5°45.2877	7°35.7156	4199	EOL/SOL: MBS_113_L11 → 0604 3.5S_113_L11 → 20190926115508
521	113	12.12	5°46.83672	7°36.18096	4211	EOL/SOL: MBS_113_L12 → 0605 3.5S_113_L12 → 20190926121303

522	113	12.27	5°46.03680	7°37.07016	4203	EOL/SOL: MBS_113_L13 → 0606 3.5S_113_L13→ 20190926122704
523	113	12.48	5°43.9272	7°36.41016	4233	EOL/SOL: MBS_113_L14 → 0607 3.5S_113_L14 → 20190926124819

Cruise JC187		**Date: 26/09/2019** **19269**	**Sheet No. 49**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
524	113	13.05	5°43.76082	7°37.48698	4206	EOL/SOL: MBS_113_L15 → 0608 3.5S_113_L15 → 20190926130438
525	113	13.28	5°45.88920	7°38.17218	4195	EOL/SOL: MBS_113_L16 → 0609 3.5S_113_L16 → 20190926132803
526	113	13.42	5°45.34181	7°39.11292	4188	EOL/SOL: MBS_113_L17 → 0610 3.5S_113_L17 → 20190926134200
527	113	13.54	5°44.06598	7°38.73186	4194	EOL/SOL: MBS_113_L18 → 0611 3.5S_113_L18 → 20190926135359
528	113	14.10	5°44.11686	7°40.10820	4188	EOL/SOL: MBS_113_L19 → 0612 3.5S_113_L19 → 20190926141124
529	113	14.35	5°46.40112	7°39.87234	4197	EOL/SOL: MBS_113_L20 → 0613 3.5S_113_L20 → 20190926143441

530	113	14.47	5°46.48770	7°40.95870	4180	EOL/SOL: MBS_113_L21 → 0614 3.5S_113_L21 → 20190926144733
531	113	15.11	5°44.08606	7°41.20440	4182	EOL/SOL: MBS_113_L22 → 0615 3.5S_113_L22 → 20190926151139
532	113	15.23	5°44.32182	7°42.26454	4168	EOL/SOL: MBS_113_L23 → 0616 3.5S_113_L23 → 20190926152449
533	113	15.48	5°46.59600	7°42.03774	4199	EOL/SOL: MBS_113_L24 → 0617 3.5S_113_L24 → 20190926154800
534	113	16.02	5°46.20510	7°43.1514	4150	EOL/SOL: MBS_113_L21 → 0618 3.5S_113_L21 → 20190926160201

Cruise JC187		**Date: 26/09/2019** **19269**		**Sheet No. 50**		
Station Number (JC187/Station x)	**Site Number** **(as on GIS)**	**Time** **In GMT**	**Latitude** **(degree, DM)**	**Longitude** **(degree, DM)**	**Depth** **(m)**	**Equipment Deployed (Events) & Comments** **(Include any exact USBL positions here)**
535	113	16.24	5°53.87362	7°43.39558	4159	EOL/SOL: MBS_113_L26 → 0619 3.5S_113_L26 → 20190926162411
536	113	16.41	5°44.6427	7°44.39292	4127	EOL/SOL: MBS_113_L27 → 0620 3.5S_113_L27 → 20190926164103
537	113	16.56	5°46.11186	7°44.25282	4148	EOL/SOL: MBS_113_L28 → 0621 3.5S_113_L28 → 20190926165630

538	113	17.10	5°46.1774	7°45.31890	4136	EOL/SOL: MBS_113_L29 → 0622 3.5S_113_L29 → 20190926171028
539	113	17.25	5°44.55180	7°45.51972	4121	EOL/SOL: MBS_113_L30 → 0623 3.5S_113_L30 → 20190926172548
540	113	17.38	5°44.77526	7°46.57866	4131	EOL/SOL: MBS_113_L31 → 0624 3.5S_113_L31 → 20190926173812
541	113	17.54	5°46.36638	7°46.38906	4133	EOL/SOL: MBS_113_L32 → 0625 3.5S_113_L32 → 20190926175404
542	113	18.04	5°46.50084	7°47.46594	4114	EOL/SOL: MBS_113_L33 → 0626 3.5S_113_L33 → 20190926180445
543	113	18.25	5°45.32010	7°47.60028	4243	EOL/SOL: MBS_113_L34 → 0627 3.5S_113_L34 → 20190926182508
544	114	18.29	5°45.32112	7°47.60040	4188	At site CTD → CTD-11 cancelled as problem with wire. SVP run For multibeam
545	114	18.57	5°45.32076	7°47.60016	4305	SVP @ surface (to be deployed)

Cruise JC187		**Date: 26/09/2019-27/09/2019, 19269-19270**		**Sheet No. 51**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

546	114	20.25	5°45.32022	7°47.60160	4190	SVP @ bottom, cable out: 4100m
547	114	21.44	5°45.32040	7°47.60094	4192	SVP @ back on deck
548	113	21.59	5°45.26130	7°47.59296	4204	Resume line: MBS_113_L34 → 0630 3.5S_113_L34 → 20190926182508
549	113	22.10	5°44.37186	7°47.75040	4131	EOL/SOL: MBS_113_L35 → 0631 3.5S_113_L35 → 20190926221008
550	113	22.25	5°45.02550	7°48.74472	4117	EOL/SOL: MBS_113_L36 → 0632 3.5S_113_L36 → 20190926222532
551	113	22.52	5°47.58768	7°48.47640	4119	EOL/SOL: MBS_113_L37 → 0633 3.5S_113_L37 → 20190926225248
552	113	23.12	5°47.24220	7°49.54860	4107	EOL/SOL: MBS_113_L38 → 0634 3.5S_113_L38 → 20190926231233
553	113	23.40	5°44.33700	7°49.91580	4117	EOL/SOL: MBS_113_L39 → 0635 3.5S_113_L39 → 20190926234026
554	113	23.52	5°44.37936	7°50.9673	4108	EOL/SOL: MBS_113_L40 → 0636 3.5S_113_L40 → 20190926235209
555	113	00.26	5°47.66490	7°50.61030	4107	EOL/SOL: MBS_113_L41 → 0637 3.5S_113_L41 → 20190927002655
556	113	00.42	5°47.12244	7°51.74048	4101	EOL/SOL: MBS_113_L42 → 0638 3.5S_113_L42 → 20190927004208

Cruise JC187		**Date: 27/09/2019** **19270**		**Sheet No. 52**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
557	113	01.11	5°44.31288	7°52.08162	4102	EOL/SOL: MBS_113_L43 → 0639 3.5S_113_L43 → 20190927011113
558	113	01.27	5°44.13174	7°53.17446	4102	EOL/SOL: MBS_113_L44 → 0640 3.5S_113_L44 → 20190927012707
559	113	02.14	5°48.71847	7°52.64244	4095	EOL/SOL: MBS_113_L45 → 0641 3.5S_113_L45 → 20190927021406
560	113	02.27	5°48.79182	7°53.73234	4081	EOL/SOL: MBS_113_L46 → 0642 3.5S_113_L46 → 20190927022711
561	113	02.59	5°45.48282	7°54.14814	4088	EOL/SOL: MBS_113_L47 → 0643 3.5S_113_L47 → 20190927025949
562	113	03.13	5°45.84872	7°55.19232	4074	EOL/SOL: MBS_113_L48 → 0644 3.5S_113_L48 → 20190927031327
563	113	03.52	5°49.83048	7°54.71478	4082	EOL/SOL: MBS_113_L49 → 0645 3.5S_113_L49 → 20190927035221
564	113	04.05	5°49.73106	7°55.77384	4065	EOL/SOL: MBS_113_L50 → 0646 3.5S_113_L50 → 20190927040533
565	113	04.44	5°45.70806	7°56.30802	4068	EOL/SOL: MBS_113_L51 → 0647

						3.5S_113_L51 → 20190927044407
566	113	04.57	5°46.08987	7°57.33900	4056	EOL/SOL: MBS_113_L52 → 0648 3.5S_113_L52 → 20190927045726
567	113	05.26	5°48.67782	7°57.04158	4064	EOL/SOL: MBS_113_L53 → 0649 3.5S_113_L53 → 20190927052654

Cruise JC187		**Date: 27/09/2019** **19270**	**Sheet No. 53**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
568	113	05.44	5°47.83110	7°58.21200	4040	EOL/SOL: MBS_113_L54 → 0650 3.5S_113_L54 → 20190927054425
569	113	06.04	5°45.98148	7°58.45416	4051	EOL/SOL: MBS_113_L55 → 0651 3.5S_113_L55 → 20190927060516
570	113	06.18	5°46.2308	7°59.46984	4043	EOL/SOL: MBS_113_L56 → 0652 3.5S_113_L56 → 20190927061859
571	113	06.48	5°48.40752	7°59.23304	4044	EOL/SOL: MBS_113_L57 → 0653 3.5S_113_L57 → 20190927064446
572	113	06.59	5°48.19041	8°0.36198	4047	EOL/SOL: MBS_113_L58 → 0654 3.5S_113_L58 → 20190927065957

573	113	07.17	5°46.68036	8°0.5331	4154	EOL/SOL: MBS_113_L59 → 0655 3.5S_113_L59 → 20190927071751
574	113	07.41 - ish	?	?	?	EOL/SOL: *Accidently started new line at some point in sub-bottom* 3.5S_113_L60 → 20190927074118
575	113	07.46	5°46.50972	8°1.60002	4028	EOL/SOL: MBS_113_L61 → 0656 3.5S_113_L61 → 20190927074623
576	113	08.07	5°45.97152	7°59.81400	4040	EOL/SOL: MBS_113_L62 → 0657 3.5S_113_L62 → 20190927080703
577	113	08.22	5°44.96544	8°0.23508	4033	EOL/SOL: MBS_113_L63 → 0658 3.5S_113_L63 → 20190927082200
578	113	08.52	5°45.77472	8°2.96112	4026	EOL/SOL: MBS_113_L64 → 0659 3.5S_113_L64 → 20190927085235

Cruise JC187		**Date:27/09/2019** **19270**		**Sheet No. 54**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
579	113	09.06	5°44.59914	8°2.85960	4014	EOL/SOL: MBS_113_L65 → 0660 3.5S_113_L65 → 20190927090631
580	113	09.31	5°43.89738	8°0.46944	4030	EOL/SOL: MBS_113_L66 → 0661 3.5S_113_L66 → 20190927093114

581	113	10.00	5°42.57900	8°2.30178	4017	EOL/SOL: MBS_113_L67 → 0662 3.5S_113_L67 → 20190927100046
582	113	10.18	5°44.32750	8°2.30880	4011	EOL/SOL: MBS_113_L68 → 0663 3.5S_113_L68 → 20190927101835
583	113	10.32	5°44.43192	8°3.37974	4014	EOL/SOL: MBS_113_L69 → 0664 3.5S_113_L69 → 20190927103200
584	113	10.50	5°42.52832	8°3.37740	4020	EOL/SOL: MBS_113_L70 → 0665 3.5S_113_L70 → 20190927105014
585	113	11.03	5°42.57318	8°4.46844	4014	EOL/SOL: MBS_113_L71 → 0666 3.5S_113_L71 → 20190927110349
586	113	11.25	5°44.60964	8°4.45920	4004	EOL/SOL: MBS_113_L72 → 0667 3.5S_113_L72 → 20190927112528
587	113	11.38	5°44.453	8°5.55816	4013	EOL/SOL: MBS_113_L73 → 0668 3.5S_113_L73 → 20190927113851
588	113	11.56	5°42.68388	8°5.52660	4015	EOL/SOL: MBS_113_L74 → 0669 3.5S_113_L74 → 20190927115622
589	113	12.10	5°42.76440	8°6.63100	4009	EOL/SOL: MBS_113_L75 → 0670 3.5S_113_L75 → 20190927121054

Cruise JC187		**Date: 27/09/19** **19270**	**Sheet No. 55**

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
590	113	12.41	5°45.61488	8°6.50772	4027	EOL/SOL: MBS_113_L76 → 0671 3.5S_113_L76 → 20190927124100
591	113	12.56	5°45.94410	8°7.58208	4024	EOL/SOL: MBS_113_L77 → 0672 3.5S_113_L77 → 20190927125617
592	113	13.22	5°43.21956	8°7.82814	3997	EOL/SOL: MBS_113_L78 → 0673 3.5S_113_L78 → 20190927132237
593	113	13.39	5°42.7698	8°8.79462	3996	EOL/SOL: MBS_113_L79 → 0674 3.5S_113_L79 → 20190927133943
594	113	13.55	5°44.270	8°8.784	3986	EOL/SOL: MBS_113_80 → 0675 END OF SURVEY 3.5S_113_L80 → 20190927135604
595	32	14.15	5°44.08512	8°8.24130	4096	Multicore on deck to be deployed JC187-MC-23
596	32	15.59	5°44.10068	8°8.23146	4116	Multicore @ seabed JC187-MC23 cable out: 4185 m pull out: 4.32 USBL: 5°44.09221 S, 8°8.21884 E, depth 4175 m
597	32	17.43	5°44.10066	8°8.23134	4098	JC187-MC23 back on deck 7 bottles empty. Over penetration bases could not close
						Odd pull out, may have juddered along the seafloor 1 full tube, homogenous mud
598	32	18.28	5°44.10048	8°8.23086	4132	JC187-PC18 at surface, 12 m barrel

599	32	19.43	5°44.10090	8°8.23128	4098	JC187-PC18 @ bottom cable out: 4185 m pull out: 5.4 USBL: 5°44.23653S, 8°8.06768E, depth 4107.5m

Cruise JC187		**Date: 27/09/2019-28/09/2019; 19270-19271**	**Sheet No. 56**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
600	32	21.02	5°44.10012	8°8.23038	4097	JC187-PC18 back on deck, slightly band barrel 7m core, sandy
601	53	21.47	5°43.71996	8°8.21088	4207	MC-24 at surface
602	53	23.27	5°43.7199	8°8.21070	4196	MC-24 at seabed. Cable out: 4093m USBL: 5°43.71279, 8°8.20819 @ 4061.2m, Δ=13.89m 340.5^{o}
603	53	01.07	5°43.7203	8°8.21070	4157	MC-24 back on deck 8 cores with interface and layered mudrich sediment
604	53	01.31	5°43.71078	8°8.21058	4361	JC187-PC19 at surface, 18 m barrel
605	53	03.08	5°43.71078	8°8.21040	4210	JC187-PC19 @ bottom cable out: 4059.5m pull out: 6.3Te USBL: 5°43.69907, 8°8.20575, depth 4060m
606	53	04.39	5°43.71000	8°8.21010	4214	JC187-PC19 back on deck
607	33	05.39	5°45.25146	8°7.63398	4014	OBS-06 released

608	120	06.17	5°43.80126	8°7.06044	4142	NERC Mooring 5. Sphere on the water
609	120	06.31	5°43.86276	8°7.28220	4124.5	NERC Mooring 5. In the water ready to release
610	120	06.34	5°43.88013	8°7.34379	4141	NERC Mooring 5 Anchor released

Cruise JC187		**Date: 28/09/2019** **19271**	**Sheet No. 57**			
Station Number (JC187/Station x)	**Site Number** **(as on GIS)**	**Time** **In GMT**	**Latitude** **(degree, DM)**	**Longitude** **(degree, DM)**	**Depth** **(m)**	**Equipment Deployed (Events) & Comments** **(Include any exact USBL positions here)**
611	120	6.41	5°43.88238	8°7.35612	4139.5	NERC Mooring 5 Anchor going down
612	120	7.00	5°43.88310	8°7.35654	4073	NERC Mooring 5 Anchor on the ground. 4046 m water depth
613	120	7.22	1) 5°42.62148 2) 5°42.62388	8°8.34618 8°8.34456	N/A	NERC Mooring 5 Triangulation point 1, NE 1) 5062; 2) 5061, 5058
614	120	7.56	1) 5°45.08934 2) 5°45.08784	8°8.36844 8°8.36868	N/A	NERC Mooring 5 Triangulation point 2, SE 1) 5031; 2) 5028
615	120	8.26	1) 5°44.99820 2) 5°44.99124	8°6.10422 8°6.10422	N/A	NERC Mooring 5 Triangulation point 3, SW 1) 5055; 2) 5054
616	120	8.54	1) 5°42.59526	8°6.16992	N/A	NERC Mooring 5 Triangulation point 4, NW

			2) 5°42.59496	8°6.16920		1) 5145; 2) 5145
617	54	9.53	5°49.22934	8°8.70882	4034	JC187-MC25 At sea surface
618	54	11.35	5°49.22946	8°8.70966	4034	JC187-MC25 Cable out: 4069 m, pull out: 4.19 USBL: 5°49.22455, 8°8.70782, depth: 4041 m
619	54	13.17	5°49.22964	8°8.70918	4034	JC187-MC25 Core at surface, 8 full tubes
620	54	14.06	5°49.22958	8°8.70048	4044	JC187-PC20 Core at surface
621	54	15.25	5°49.23036	8°8.70060	4035	JC187-PC20 at seabed. Cable out: 4035.5 m, Max Te 6.1 Te USBL: 5°49.21664, 8°8.69629, depth: 4021.2 m

Cruise JC187		**Date: 28/09/2019-29/09/2019; 19271-19272**		**Sheet No. 58**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
622	54	16.49	5°49.23012	8°8.70036	4039	JC187-PC20 Back on deck
623	101	19.03	5°45.86940	7°51.91638	4084	OBS-07 released
624	102	22.35	5°46.49400	7°16.13196	4305	OBS-08 released
625	79	00.46	5°53.667	6°55.09146	4416	Recover OBIC prototype moorings OBS

						One mooring released already (45m/min)
626	79	02.05	5°53.670	6°55.01982	4441	OBS mooring on surface, flash visible
627	79	02.18	5°53.73834	6°54.98454	Not pinging	OBS Prototype back on deck, 1/4
628	79	02.25	5°53.77098	6°54.99192	Not pinging	Releasing second OBS
629	80	04.05	5°54.0579	6°55.0998	Not pinging	OBS @ surface
630	80	04.30	5°54.0307	6°54.9175	Not pinging	OBS Prototype back on deck, 2/4
631	81	04.39	5°54.030	6°54.9199	Not pinging	OBS released and coming up
632	81	06.00	5°54.104	6°55.42326	Not pinging	OBS @ surface

Cruise JC187		**Date: 29/09/2019** **19272**		**Sheet No. 59**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**

633	81	06.??	5°54.131	6°55.351	Not pinging	OBS Prototype back on deck, 3/4
634	82	06.06	5°53.6280	6°55.432	Not pinging	OBS prototype released
635	82	07.36	5°53.66004	6°55.43844	Not pinging	OBS prototype on sea surface
636	82	07.51	5°53.46256	6°55.46268	Not pinging	OBS Prototype back on deck, 4/4
637	37	08.18	5°54.86820	6°53.41830	4442	OBS-9 deployed (near NERC mooring 6)
638	117	09.04	5°52.27008	6°55.38432	4482	NERC Mooring 6 Float in water
639	117	09.05	5°52.24422	6°55.41450	4457	NERC Mooring 6 ADCP float in water
640	117	09.12	5°52.15446	6°55.50822	4470	NERC Mooring 6 Anchor in water
641	117	09.15	5°52.12140	6°55.53954	4476	NERC Mooring 6 Anchor dropped
642	117	09.38	5°52.11114	6°55.55004	4430	NERC Mooring 6 Anchor on seafloor, range: 4403 m, 4402 m
643	117	10.04	5°52.14198	6°53.78484	/	NERC Mooring 6 Triangulation point 1, west, 5436 m

Cruise JC187		**Date: 29/09/2019** **19272**		**Sheet No. 60** ***During this line the Multibeam stopped logging for 20 mins, but luckily we Already have this data!*		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
644	117	10.37	5°50.38686 5°50.38074	6°55.53768 6°55.53762	/	NERC Mooring 6 North Triangulation point 2, 1) 5461 m, 5463 m, 2) 5469 m, 5471 m
645	117	11.14	5°52.15422 5°52.15536	6°57.18360 6°57.18596	/	NERC Mooring 6 East *boat still moving so values discarded* Triangulation point 3, 1) 5359 m, 2) 5563 m
646	117	11.14	5°52.15962 5°52.15962	6°57.19416 6°57.19440	/	NERC Mooring 6 East Triangulation point 3, 1) 5375 m, 5479 m, 2) 5375 m
647	117	11.49 (?)	5°53.84496 5°53.84412	6°55.51590 6°55.51614	/	NERC Mooring 6 South Triangulation point 3, 1) 5393 m, 2) 5392 m, 5393 m
648	100 m E of 119	12.41	5°53.36958	6°53.39646	4483	Deployment of SVP @ sea surface
649	100 m E of 119	14.17	5°53.37216	6°53.39694	4479	SVP @ seabed (cable out 4400 m)
650	100 m E of 119	15.58	5°53.37270	6°53.39718	4482	SVP back on deck
651	119	16.31	5°53.40582	6°53.38650	4493	EOL/SOL: MBS_119_L01 → 0714 ** 35S_119_L01 → 20190929163145
652	119	17.37	5°54.47874	6°47.01702	4533	EOL/SOL: MBS_119_L02 → 0717

						35S_119_L02 → 20190929173712
653	119	17.52	5°55.06662	6°45.52698	4551	EOL/SOL: MBS_119_L03 → 0718 35S_119_L03 → 20190929175213
654	119	18.07	5°56.54670	6°44.8362	4549	EOL/SOL: MBS_119_L04 → 0719 35S_119_L04 → 20190929180738

Cruise JC187		**Date: 29/09/2019** **19272**	**Sheet No. 61** **Station 656-665 skipped because of a typo**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
655	119	19.29	6°3.23358	6°39.15186	4558	EOL/SOL: MBS_119_L05 → 0721 35S_119_L05 → 20190929192858
666	119	20.08	6°5.40024	6°35.42001	4526	EOL/SOL: MBS_119_L06 → 0722 35S_119_L06 → 20190929200829
667	119	20.47	6°5.52990	6°31.10682	4595	EOL/SOL: MBS_119_L07 → 0723 35S_119_L07 → 20190929204737
668	119	21.08	6°6.27816	6°29.061305	4613	EOL/SOL: MBS_119_L08 → 0724 35S_119_L08 → 20190929210748
669	119	21.54	6°10.90800	6°27.50592	4563	EOL/SOL: MBS_119_L09 → 0725 35S_119_L09 → 20190929214416

670	119	22.06	6°10.19202	6°27.15312	4560	EOL/SOL: MBS_119_L10 → 0726 35S_119_L10 → 20190929220726
671	119	22.23	6°10.61167	6°28.79820	4566	EOL/SOL: MBS_119_L11 → 0727 35S_119_L11 → 20190929222351
672	119	22.34	6°9.56543	6°28.82163	4556	EOL/SOL: MBS_119_L12 → 0728 35S_119_L12 → 20190929223449
673	119	22.53	6°8.98398	6°26.93032	4560	EOL/SOL: MBS_119_L13 → 0729 35S_119_L13 → 20190929225350
674	119	23.04	6°8.04354	6°27.62214	4547	EOL/SOL: MBS_119_L14 → 0730 35S_119_L14 → 20190929230505
675	119	23.32	6°8.62230	6°29.43984	4561	EOL/SOL: MBS_119_L15 → 0731 35S_119_L15 → 20190929232337

Cruise JC187		**Date: 29/09/2019-30/09/2019, 19272-19273**		**Sheet No. 62**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
676	119	23.32	6°7.52524	6°29.51943	4556	EOL/SOL: MBS_119_L16 → 0732 35S_119_L16 → 20190929233259
677	119	23.52	6°6.87000	6°27.49248	4554	EOL/SOL: MBS_119_L17 → 0733 35S_119_L17 → 20190929235249

678	119	00.11	6°5.58576	6°28.53864	4557	EOL/SOL: MBS_119_L18 → 0734 35S_119_L18 → 20190930001220
679	119	00.31	6°7.08324	6°29.73300	4543	EOL/SOL: MBS_119_L19 → 0735 35S_119_L19 → 20190930003212
680	119	00.42	6°6.43109	6°30.25284	4543	EOL/SOL: MBS_119_L20 → 0736 35S_119_L20 → 20190930004235
681	119	00.55	6°5.01043	6°29.77788	4550	EOL/SOL: MBS_119_L21 → 0737 35S_119_L21 → 20190930005623
682	119	01.07	6°4.273432	6°30.83176	4541	EOL/SOL: MBS_119_L22 → 0738 35S_119_L22 → 20190930010757
683	119	01.25	6°6.32190	6°31.41570	4540	EOL/SOL: MBS_119_L23 → 0739 35S_119_L23 → 20190930012551
684	119	01.35	6°6.25806	6°32.21532	4532	EOL/SOL: MBS_119_L24 → 0740 35S_119_L24 → 20190930013514
685	119	01.50	6°6.46656	6°32.17758	4535	EOL/SOL: MBS_119_L25 → 0741 35S_119_L25 → 20190930015011
686	119	02.02	6°4.73220	6°33.24840	4523	EOL/SOL: MBS_119_L26 → 0742 35S_119_L26 → 20190930020216

Cruise JC187		**Date: 30/09/2019** **19273**	**Sheet No. 63**

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
687	119	02.19	6°6.34818	6°33.32610	4527	EOL/SOL: MBS_119_L27 → 0743 35S_119_L27 → 20190930021909
688	119	02.30	6°6.21480	6°34.38138	4515	EOL/SOL: MBS_119_L28 → 0744 35S_119_L28 → 20190930023052
689	119	02.46	6°4.54200	6°34.35480	4520	EOL/SOL: MBS_119_L29 → 0745 35S_119_L29 → 20190930024640
690	119	02.59	6°4.65060	6°35.40618	4510	EOL/SOL: MBS_119_L30 → 0746 35S_119_L30 → 20190930025938
691	119	03.18	6°6.12750	6°35.86530	4501	EOL/SOL: MBS_119_L31 → 0747 35S_119_L31 → 20190930031821
692	119	03.32	6°5.47782	6°36.71166	4504	EOL/SOL: MBS_119_L32 → 0748 35S_119_L32 → 20190930023212
693	119	03.52	6°3.57138	6°35.67036	4510	EOL/SOL: MBS_119_L33 → 0749 35S_119_L33 → 20190930035216
694	119	04.04	6°3.20940	6°36.65952	4504	EOL/SOL: MBS_119_L34 → 0750 35S_119_L34 → 20190930040443
695	119	04.25	6°5.04576	6°37.74750	4511	EOL/SOL: MBS_119_L35 → 0751 35S_119_L35 → 20190930042547
696	119	04.38	6°4.42212	6°38.62380	4507	EOL/SOL: MBS_119_L36 → 0752 35S_119_L36 → 20190930043825

697	119	04.56	6°2.64912	6°37.59234	4505	EOL/SOL: MBS_119_L37 → 0753 35S_119_L37 → 20190930045639

Cruise JC187		**Date: 30/09/2019** **19273**	**Sheet No. 64**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
698	119	05.09	6°2.35632	6°38.68104	4501	EOL/SOL: MBS_119_L38 → 0754 35S_119_L38 → 20190930050939
699	119	05.27	6°3.98388	6°39.62898	4504	EOL/SOL: MBS_119_L39 → 0755 35S_119_L39 → 20190930052753
700	119	05.45	6°2.85744	6°40.55844	4497	EOL/SOL: MBS_119_L40 → 0756 35S_119_L40 → 20190930054517
701	119	06.02	6°1.70004	6°39.21222	4498	EOL/SOL: MBS_119_L41 → 0757 35S_119_L41 → 20190930060223
702	119	06.13	6°0.97308	6°40.05444	4497	EOL/SOL: MBS_119_L42 → 0758 35S_119_L42 → 20190930061344
703	119	06.32	6°2.24112	6°41.53002	4498	EOL/SOL: MBS_119_L43 → 0759 35S_119_L43 → 20190930063240
704	119	06.44	6°1.36446	6°42.14003	4496	EOL/SOL: MBS_119_L44 → 0760 35S_119_L44 → 20190930064422

705	119	07.03	6°0.04182	6°40.66114	4491	EOL/SOL: MBS_119_L45 → 0761 35S_119_L45 → 20190930070327
706	119	07.14	5°59.32062	6°41.45130	4481	EOL/SOL: MBS_119_L46 → 0762 35S_119_L46 → 20190930071447
707	119	07.32	6°0.44406	6°42.76878	4487	EOL/SOL: MBS_119_L47 → 0763 35S_119_L47 → 20190930073213
708	119	07.44	5°59.53308	6°43.36066	4477	EOL/SOL: MBS_119_L48 → 0764 35S_119_L48 → 20190930074402

Cruise JC187		**Date: 30/09/19** **19273**		**Sheet No. 65**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
709	119	08.07	5°57.95928	6°41.49054	4477	EOL/SOL: MBS_119_L49 → 0765 35S_119_L49 → 20190930080725
710	119	08.18	5°57.13794	6°42.23178	4463	EOL/SOL: MBS_119_L50 → 0766 35S_119_L50 → 20190930081811
711	119	08.40	5°58.65270	6°43.98128	4468	EOL/SOL: MBS_119_L51 → 0767 35S_119_L51 → 20190930084005
712	119	08.52	5°57.81900	6°44.70660	4459	EOL/SOL: MBS_119_L52 → 0768 35S_119_L52 → 20190930085234

713	119	09.13	5°56.37012	6°42.98730	4463	EOL/SOL: MBS_119_L53 → 0769 35S_119_L53 → 20190930091354
714	119	09.29	5°56.27484	6°44.24502	4456	EOL/SOL: MBS_119_L54 → 0770 35S_119_L54 → 20190930092939
715	119	09.43	5°56.83632	6°45.5400	4455	EOL/SOL: MBS_119_L55 → 0771 35S_119_L55 → 20190930094335
716	119	09.59	5°55.46064	6°46.01922	4455	EOL/SOL: MBS_119_L56 → 0772 35S_119_L56 → 20190930095918
717	119	10.12	5°54.55986	6°44.84346	4459	EOL/SOL: MBS_119_L57 → 0773 35S_119_L57 → 20190930101254
718	119	10.36	5°53.86158	6°46.89558	4453	EOL/SOL: MBS_119_L58 → 0774 35S_119_L58 → 20190930103618
719	119	10.50	5°55.27806	6°47.15922	4455	EOL/SOL: MBS_119_L59 → 0775 35S_119_L29 → 20190930105055

Cruise JC187		**Date: 30/09/19** **19273**		**Sheet No. 66**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
720	119	11.03	5°54.80101	6°48.13998	4445	EOL/SOL: MBS_119_L60 → 0776 35S_119_L60 → 20190930110315

721	119	11.13	5°53.72034	6°47.96160	4457	EOL/SOL: MBS_119_L61 → 0777 35S_119_L61 → 20190930
722	119	11.26	5°53.46606	6°48.99036	4450	EOL/SOL: MBS_119_L62 → 0778 35S_119_L62 → 20190930112633
723	119	11.40	5°54.94596	6°49.26924	4453	EOL/SOL: MBS_119_L63 → 0779 35S_119_L63 → 20190930114038
724	119	11.50	5°54.63504	6°50.30232	4444	EOL/SOL: MBS_119_L64 → 0780 35S_119_L64 → 20190930115025
725	119	12.05	5°52.95300	6°49.99518	4451	EOL/SOL: MBS_119_L65 → 0781 35S_119_L65 → 20190930120538
726	119	12.17	5°52.76544	6°51.04686	4443	EOL/SOL: MBS_119_L66 → 0782 35S_119_L66 → 20190930121735
727	119	12.35	5°54.50922	6°51.35394	4443	EOL/SOL: MBS_119_L67 → 0783 35S_119_L67 → 20190930123545
728	119	12.47	5°54.23418	6°52.39116	4435	EOL/SOL: MBS_119_L68 → 0784 35S_119_L68 → 20190930124740
729	119	13.01	5°52.68636	6°52.11504	4442	EOL/SOL: MBS_119_L69 → 0785 35S_119_L69 → 20190930130145
730	119	13.14	5°52.68042	6°53.20422	4434	EOL/SOL: MBS_119_L70 → 0786 35S_119_L70 → 20190930131452

Cruise JC187		Date: 30/09/19 19273		Sheet No. 67		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
731	119	13.25	5°53.70642	6°53.36688	4428	End of Survey 119, Transit
732	121	16.30	6°14.33472	6°27.94530	4591	SOL: MBS_121_L01 → 0791 35S_121_L01 → 20190930163050
733	121	17.05	6°16.48422	6°24.98250	4665	EOL/SOL: MBS_121_L02 → 0792 35S_121_L02 → 20190930170554
734	121	17.32	6°19.05672	6°24.73146	4694	EOL/SOL: MBS_121_L03 → 0793 35S_121_L03 → 20190930173210
735	121	18.12	6°21.69372	6°21.40902	4681	EOL/SOL: MBS_121_L04 → 0794/0795 35S_121_L04 → 20190930181209
736	121	19.38	6°23.86530	6°12.48546	4732	EOL/SOL: MBS_121_L05 → 0796 35S_121_L05 → 20190930193832
737	121	20.34	6°26.91456	6°7.26000	4757	EOL/SOL: MBS_121_L06 → 0797 35S_121_L06 → 20190930203430
738	121	21.15	6°27.06618	6°2.67810	4740	EOL/SOL: MBS_121_L07 → 0798 35S_121_L07 → 20190930211543
739	121	21.49	6°28.56354	5°59.34930	4745	EOL/SOL: MBS_121_L08 → 0799 35S_121_L08 → 20190930214932

740	121	22.19	6°29.79666	5°56.51340	4759	EOL/SOL: MBS_121_L09 → 0800 35S_121_L09 → 20190930221938
741	121	23.18	6°31.02336	5°50.67840	4798	EOL/SOL: MBS_121_L10 → 0801/0802 35S_121_L10 → 20190930231834

Cruise JC187		**Date: 01/10/2019** **19274**	**Sheet No. 68**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
742	121	00.23	6°32.05344	5°43.90036	4825	EOL/SOL: MBS_121_L11 → 0803 35S_121_L11 → 20191001002320
743	121	00.53	6°33.11898	5°40.98072	4828	EOL/SOL: MBS_121_L12 → 0804/0805 35S_121_L12 → 20191001005321
744	121	02.49	6°38.10418	5°29.67414	4913	End of Survey 121
745	124	03.32	6°41.45406	5°29.02146	4929	CTD-12 at surface (CTD 11 is the one cancelled but still Numbered as such by CTD team)
746	124	05.07	6°41.45581	5°29.02103	4928	CTD-12 @ bottom, 6.5m ABS USBL 6°41.43945, 5°29.00677 @ 4949.8m
747	124	05.10	6°41.4555	5°29.02110	4928	CTD-12 @ 20m above sea bed, water sample - bottle 1-2 USBL 6°41.44304, 5°29.00822 @ 4937.5m
748	124	05.14	6°41.45598	5°29.02110	4929	CTD-12 @ 40m above sea bed, water sample - bottle 3-4

						USBL 6°41.44593, 5°29.00926 @ 4917.4m
749	124	05.16	6°41.45604	5°29.02116	4929	CTD-12 @ 60m above sea bed, water sample - bottle 5-6 USBL 6°41.44467, 5°29.00569 @ 4897m
750	124	05.19	6°41.45616	5°29.02086	4928	CTD-12 @ 100m above sea bed, water sample - bottle 7-8 USBL 6°41.44243, 5°29.01327 @ 4856.7m
751	124	05.25	6°41.45622	5°29.02104	4929	CTD-12 @ 300m above sea bed, water sample - bottle 9-10 USBL 6°41.44319, 5°29.01091 @ 4654.3m
752	124	05.54	6°41.45586	5°29.02110	Not pinging	CTD-12 @ 3000m water depth, water sample - bottle 11-12 USBL 6°41.44469, 5°29.00747 @ 3093.5m

Cruise JC187		**Date: 01/10/2019** **19274**		**Sheet No. 69**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
753	124	06.20	6°41.45574	5°29.02104	Not pinging	CTD-12 @ 1600m water depth, water sample - bottle 13-14 USBL 6°41.44930, 5°29.01289 @ 1606.2 m
754	124	06.41	6°41.45592	5°29.02134	Not pinging	CTD-12 @ 500m water depth, water sample - bottle 15-16 USBL 6°41.45131, 5°29.0154 @ 502 m
755	124	06.47	6°41.45592	5°29.02116	Not pinging	CTD-12 @ 200m water depth, water sample - bottle 17-18 USBL 6°41.44953, 5°29.01580 @ 201.4 m

756	124	06.54	6°41.45583	5°29.02130	Not pinging	CTD-12 @ 50m water depth, water sample - bottle 19-20 USBL 6°41.44951, 5°29.01530 @ 51 m
757	124	06.56	6°41.45586	5°29.02110	Not pinging	CTD-12 @ 25m water depth, water sample - bottle 21-22 USBL 6°41.45054, 5°29.01493 @ 25.7 m
758	124	06.58	6°41.45562	5°29.02110	Not pinging	CTD-12 @ 10m water depth, water sample - bottle 23-24 USBL 6°41.45035, 5°29.01488 @ 10.7 m
759	124	07.03	6°41.45574	5°29.02094	Not pinging	CTD-12 @ back on deck
760	42	07.15	6°41.45604	5°29.02044	Not pinging	JC187 NERC Mooring 8 Range test-1 for release (4823)
761	42	07.22	6°41.51616	5°29.00610	Not pinging	JC187 NERC Mooring 8 Range test-2 for release (4871)
762	42	07.29	6°41.51544	5°29.00646	Not pinging	JC187 NERC Mooring 8 Acoustic release triggered 155 m/min rise rate
763	42	08.01	6°41.5490	5°28.99116	Not pinging	JC187 NERC Mooring 8 Seen at sea surface

Cruise JC187		**Date: 01/10/2019** **19274**		**Sheet No. 70**		
Station Number (JC187/Station x)	**Site Number** **(as on GIS)**	**Time** **In GMT**	**Latitude** **(degree, DM)**	**Longitude** **(degree, DM)**	**Depth** **(m)**	**Equipment Deployed (Events) & Comments** **(Include any exact USBL positions here)**

764	42	08.20	6°41.60052	5°28.88484	4928	JC187 NERC Mooring 8 Grappling line caught
765	42	08.22	6°41.52	5°28.91	4926	JC187 NERC Mooring 8 Mooring back on deck
766	122	09.00	6°39.24432	5°31.23674	4922	Start of survey MBS_122_L01 → 0810 35S_122_L01 → 20191001090043
767	122	10.56	6°34.30548	5°42.28776	4846	EOL/SOL: MBS_122_L02 → 0812 35S_122_L02 → 20191001105644
768	122	11.13	6°35.87346	5°42.78966	4835	EOL/SOL: MBS_122_L03 → 0813 35S_122_L03 → 2019100111306
769	122	13.17	6°41.29854	5°30.50694	4925	EOL/SOL: MBS_122_L04 → 0816 35S_122_L04 → 20191001131754
770	122	13.36	6°42.65916	5°31.49172	4919	EOL/SOL: MBS_122_L05 → 0817 35S_122_L05 → 20191001133642
771	122	15.38	6°37.43454	5°43.20768	4840	EOL/SOL: MBS_122_L06 → 0820 35S_122_L06 → 20191001153838
772	122	16.26	6°32.7556	5°45.43092	4818	EOL/SOL: MBS_122_L07 → 0821 35S_122_L07 → 20191001162658
773	122	17.17	6°32.60652	5°50.77002	4780	EOL/SOL: MBS_122_L08 → 0822 35S_122_L08 → 20191001171730
774	122	18.26	6°30.73758	5°57.79014	4781	EOL/SOL: MBS_122_L09 → 0824 35S_122_L09 → 201910011182659

Cruise JC187		Date: 01/10/2019-02/10/2019, 19274-19275		Sheet No. 71		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
775	122	18.47	6°30.05442	6°59.82030	4766	End of Survey 122: MBS_122_L10 → 0825 35S_122_L10 → 20191001184704 → TRANSIT
776	58	19.22	6°28.57302	6°2.49018	4742	German OBS released
777	58	19.24	6°28.57302	6°2.49018	4742	Triangulation for mooring 7
778	125	01.41	5°51.40464	6°56.85228	4412	SOL: MBS_125_L01 → 0834 35S_125_L01 → 20191002014119
779	125	02.08	5°51.64452	6°59.64222	4405	EOL/SOL: MBS_125_L02 → 0835 35S_125_L02 → 20191002020810
780	125	02.41	5°50.49180	7°2.99622	4384	EOL/SOL: MBS_125_L03 → 0836 35S_125_L03 → 20191002024135
781	125	03.00	5°50.59218	7°5.00532	4370	EOL/SOL: MBS_125_L04 → 0837 35S_125_L04 → 20191002030059
782	125	03.12	5°50.74428	7°6.37840	4360	EOL/SOL: MBS_125_L05 → 0838 35S_125_L05 → 20191002031257
783	125	03.30	5°49.52000	7°7.57128	4351	EOL/SOL: MBS_125_L06 → 0839 35S_125_L06 → 20191002032959
784	125	03.41	5°48.33060	7°8.04204	4342	EOL/SOL: MBS_125_L07 → 0840

						35S_125_L07 → 20191002034157

Cruise JC187		Date: 02/10/2019 19275		Sheet No. 72		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
785	125	04.05	5°46.73944	7°9.94098	4337	EOL/SOL: MBS_125_L08 → 0841 35S_125_L08 → 20191002040515
786	125	04.18	5°45.94984	7°11.22408	4327	EOL/SOL: MBS_125_L09 → 0842 35S_125_L09 → 20191002041935
787	125	04.43	5°45.67638	7°12.74118	4328	EOL/SOL: MBS_125_L10 → 0843 35S_125_L10 → 20191002043421
788	125	04.49	5°46.23750	7°14.28756	4328	EOL/SOL: MBS_125_L11 → 0844 35S_125_L11 → 20191002045019
789	125	05.09	5°45.53383	7°16.22544	4328	EOL/SOL: MBS_125_L12 → 0845 35S_125_L12 → 20191002051034
790	125	05.30	5°46.49274	7°18.06570	4296	EOL/SOL: MBS_125_L13 → 0846 35S_125_L13 → 20191002053136
791	125	05.47	5°46.74012	7°19.76958	4291	EOL/SOL: MBS_125_L14 → 0847 35S_125_L14 → 20191002054831

792	125	06.02	5°46.96896	7°21.27990	4287	EOL/SOL: MBS_125_L15 → 0848 35S_125_L15 → 20191002060311
793	125	06.23	5°46.05354	7°23.16884	4375	EOL/SOL: MBS_125_L16 → 0849 35S_125_L16 → 20191002062340
794	125	06.36	5°46.72771	7°24.43542	4288	EOL/SOL: MBS_125_L17 → 0850 35S_125_L17 → 20191002063721
795	125	06.48	5°46.69272	7°25.67100	4260	EOL/SOL: MBS_125_L18 → 0851 35S_125_L18 → 20191002064919

Cruise JC187		**Date: 02/10/2019** **19275**		**Sheet No. 73** *******Thought end of survey but actually continued straight along the channel for A bit, so made new end of survey when the boat turned.*		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
796	125	07.03	5°47.46600	7°26.90442	4259	EOL/SOL: MBS_125_L19 → 0852 35S_125_L19 → 20191002070307
797	125	07.28	5°47.58642	7°29.55348	4235	EOL/SOL: MBS_125_L20 → 0853 35S_125_L20 → 20191002072814
798	125	07.45	5°46.27716	7°30.73770	4232	EOL/SOL: MBS_125_L21 → 0854 35S_125_L21 → 20191002074516
799	125	08.14	5°45.50430	7°33.64230	4281	EOL/SOL: MBS_transit → 0855 ** 35S_transit → 20191002081429

800	125	08.19	5°45.36060	7°34.14660	4300	EOL/SOL: MBS_transit_transit → 0856 *End of survey* 35S_transit_transit → 20191002081946
801	123	09.24	5°45.30564	7°40.25784	4311	JC187 NERC Mooring 8-R ADCP and acoustic release in water
802	123	09.40	5°45.40458	7°40.48188	4288	JC187 NERC Mooring 8-R Anchor in water
803	123	09.42	5°45.42138	7°40.51584	4299	JC187 NERC Mooring 8-R Anchor released
804	123	10.02	5°45.42960	7°40.53060	4218	JC187 NERC Mooring 8-R Anchor on seafloor (4236 m)
805	123	10.34	5°45.42142	7°41.77434	4218	JC187 NERC Mooring 8-R Triangulation 1, NE
806	123	11.07	5°46.55316	7°41.83650	4220	JC187 NERC Mooring 8-R Triangulation 2, SE
Cruise JC187		**Date: 02/10/2019** **19275**		**Sheet No. 74**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
807	123	11.36	5°46.5035	7°39.1750	4204	JC187 NERC Mooring 8-R Triangulation 3, SW
808	123	12.00	5°44.39814	7°39.19170	N/A	JC187 NERC Mooring 8-R

						Triangulation 4, NW
809	43	12.36	5°44.11220	7°37.96914	4196	OBS-10 deployed
810	126	13:23	5°46.35972	7°33.52650	4208	Start of Survey MBS_126_L01 → 0860 SOL 35S_126_L01→ 20191002132354
811	126	13:37	5°45.09312	7°33.64464	4216	EOL/SOL MBS_126_L02 → 0861 35S_126_L02 → 20191002133749
812	126	13:53	5°45.04693	7°32.54484	4228	EOL/SOL MBS_126_L03 → 0862 35S_126_L03 → 20191002135350
813	126	14:10	5°46.75152	7°32.47982	4216	EOL/SOL MBS_126_L04 → 0863 35S_126_L04 → 20191002141044
814	126	14:23	5°46.77750	7°31.37380	4222	EOL/SOL MBS_126_L05 → 0864 35S_126_L05 → 20191002142304
815	126	14:39	5°45.01944	7°31.46520	4234	EOL/SOL MBS_126_L06 → 0865 35S_126_L06 → 20191002143954
816	126	14:50	5°44.91504	7°30.37728	4238	EOL/SOL MBS_126_L07 → 0866 35S_126_L07 → 20191002145200
817	126	15:33	5°49.12338	7°30.18354	4248	EOL/SOL MBS_126_L08 → 0867 35S_126_L08 → 20191002153307

Station Number (JC187/Station x)	Site Number (as on GIS)	Time In GMT	Latitude (degree, DM)	Longitude (degree, DM)	Depth (m)	Equipment Deployed (Events) & Comments (Include any exact USBL positions here)
818	126	15.48	5°48.82386	7°29.12388	4237	EOL/SOL MBS_126_L09 → 0868 35S_126_L09 → 20191002154759
819	126	16.10	5°46.42140	7°29.23848	4238	EOL/SOL MBS_126_L10 → 0869 35S_126_L10 → 20191002161049
820	126	16.23	5°46.42410	7°28.14372	4251	EOL/SOL MBS_126_L11 → 0870 35S_126_L11 → 20191002162332
821	126	16.47	5°48.54012	7°28.03452	4245	EOL/SOL MBS_126_L12 → 0871 35S_126_L12 → 20191002164718
822	126	16.59	5°48.4952	7°28.94858	4240	EOL/SOL MBS_126_L13 → 0872 35S_126_L13 → 20191002165932
823	126	17.23	5°46.02654	7°27.09690	4259	EOL/SOL MBS_126_L14 → 0873 35S_126_L14 → 20191002172336
824	126	17.40	5°45.74580	7°26.02818	4258	EOL/SOL MBS_126_L15 → 0874 35S_126_L15 → 20191002174048
825	126	18.05	5°48.24328	7°25.88874	4249	EOL/SOL MBS_126_L16 → 0875 35S_126_L16 → 20191002180511
826	126	18.19	5°47.64390	7°24.84162	4228	EOL/SOL MBS_126_L17 → 0876 35S_126_L17 → 20191002181922
827	126	18.41	5°45.26040	7°24.95622	4275	EOL/SOL MBS_126_L18 → 0877 35S_126_L18 → 20191002184142

828	126	18.55	5°45.33408	7°23.85870	4269	EOL/SOL MBS_126_L19 → 0878 35S_126_L19 → 20191002185500

Cruise JC187		**Date: 02/10/2019** **19275**	**Sheet No. 76**			
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
829	126	19.16	5°47.522390	7°23.75514	4263	EOL/SOL MBS_126_L20 → 0879 35S_126_L20 → 20191002191642
830	126	19.29	5°47.11494	7°22.67814	4276	EOL/SOL MBS_126_L21 → 0880 35S_126_L21 → 20191002192912
831	126	19.47	5°45.29856	7°22.77900	4276	EOL/SOL MBS_126_L22 → 0881 35S_126_L22 → 20191002194706
832	126	20.05	5°46.48476	7°21.64602	4284	EOL/SOL MBS_126_L23 → 0882 35S_126_L23 → 20191002200548
833	126	20.21	5°48.11586	7°21.55626	4297	EOL/SOL MBS_126_L24 → 0883 35S_126_L24 → 20191002202134
834	126	20.33	5°47.89074	7°20.48268	4318	EOL/SOL MBS_126_L25 → 0884 35S_126_L25 → 20191002203323
835	126	20.51	5°45.95580	7°20.58246	4294	EOL/SOL MBS_126_L26 → 0885 35S_126_L26 → 20191002205121

836	126	21.07	5°45.50826	7°19.50204	4291	EOL/SOL MBS_126_L27 → 0886 35S_126_L27 → 20191002210722
837	126	21.30	5°47.84680	7°19.39554	4307	EOL/SOL MBS_126_L28 → 0887 35S_126_L28 → 20191002213022
838	126	21.42	5°47.78832	7°18.31080	4312	EOL/SOL MBS_126_L29 → 0888 35S_126_L29 → 20191002214141
839	126	22.04	5°45.41178	7°18.40746	4233	EOL/SOL MBS_126_L30 → 0889 35S_126_L30 → 20191002220452

Cruise JC187		**Date: 02/10/2019** **19275**		**Sheet No. 77**		
Station Number (JC187/Station x)	**Site Number (as on GIS)**	**Time In GMT**	**Latitude (degree, DM)**	**Longitude (degree, DM)**	**Depth (m)**	**Equipment Deployed (Events) & Comments (Include any exact USBL positions here)**
840	126	22.16	5°45.47855	7°17.33628	4303	EOL/SOL MBS_126_L31 → 0890 35S_126_L31 → 20191002221653
841	126	22.33	5°47.15010	7°17.26272	4311	EOL/SOL MBS_126_L32 → 0891 35S_126_L32 → 20191002223357
842	126	22.51	5°45.77920	7°16.25868	4307	EOL/SOL MBS_126_L33 → 0892 35S_126_L33 → 20191002225156
843	126	23.06	5°44.31528	7°16.30404	4313	EOL/SOL MBS_126_L34 → 0893 35S_126_L34 → 201910022230178

844	126	23.29	5°44.94822	7°16.19578	4390	EOL/SOL MBS_126_L35 → 0894 35S_126_L35 → 20191002233000
845	126	23.46	5°46.54794	7°15.13728	4305	EOL/SOL MBS_126_L36 → 0895 35S_126_L36 → 20191002234703
846	126	24.00	5°47.50008	7°14.78130	4328	End of Survey 126 **End of Science**

14 Appendix D. Distances from cores to target, ship's position and ship's corer's position

This section provides information on how close cores from their targets, and to the ship's position.

Figure D-1 shows a plot of distance to target (given in GIS to bridge) from the USBL on corer (at time it was dropped), against water depth. The cores are all located within < 45 m of their target, and typically < 25 m from that target.

Figure D-2 shows the distance from the ship's position (at the time the core was dropped) to that of the USBL on the corer, against water depth. Again, the cores are located < 45 m from the ship's position, and often < 25 m from that position. The ship was typically ~2-6 m of its target coordinates.

Figure D-3 shows the distance from the mega-corer and piston corer on the ship's starboard deck, and the USBL. Note that the ship's position is defined as a point in the Gravimeter room with the GRU. This point is 13 m from position on the starboard side of the ship, where we actually deploy the piston corer or mega-corer. Thus, there is a 13m offset at 120° between ship's position (gravimeter room) and were we drop cores on the starboard side of the vessel. Thus, the ships heading was recovered from the ship's gyro (sgyr file recorded by ship's TECHSAS system). Within the GIS, an adjustment of 13 m at 120° from that heading of the ship. So, if the ships heading was 200°, then 13m at 320 degrees was added to the ship's position., to find the position of the corer on the starboard deck. The distance from the corer to the USBL position was then plotted on Fig. D-3. This resulted in significantly shorter distances between USBL, targets and position of corer.

The corer was typically less than 15m from the USBL (Fig. D-3), for both upper canyon and deep-water sites, although in a few cases to ranges up to 40m.

Note that the USBL system for locating objects itself has an uncertainty of about 0.5% water depth, which is 10m at 2,000m, and 20m at 4,000m. Thus the offset between location of corer and USBL site is almost within those errors of the USBL system itself. This suggests that the dominant term in the offset may be the uncertainties in the USBL system, and cores are rather close to the target (+/- 5-15 m).

There does not appear to be a strong correlation between water depth and distance from ship to target or USBL. This is perhaps because the strongest currents (that cause the corer to drift from the vessel) are near the sea surface, and there is little drift in the deep-ocean, or because other factors dominate the error from core to target positions.

There was also no strong difference between mega-corer and piston corer, which is surprising, as the mega-corer is lighter than the piston corer (~1T head weight), and might be expected to drift more. But it is possible that both types of corer land close to targets, and the offset then results mainly from the USBL system (which would affect piston and mega corer equally).

In future years, it may be possible to adjust the ship's position to bring the core (and USBL) even closer to the seabed target, as is done for an anchor-first mooring. Thus, we may be able to reduce these uncertainties substantially, and place cores even closer to their seabed targets.

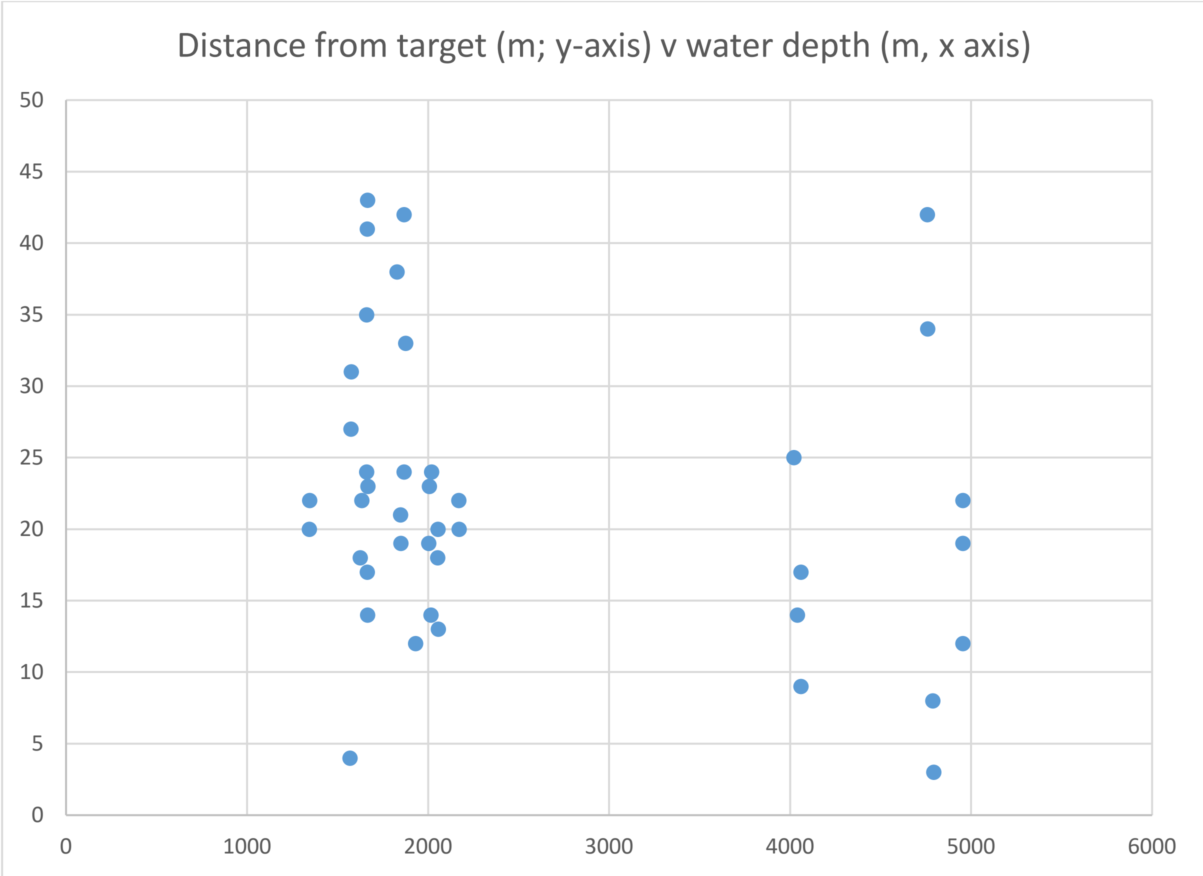

Fig. D-1. Distance from USBL on corer from original coordinates of target given to the bridge.

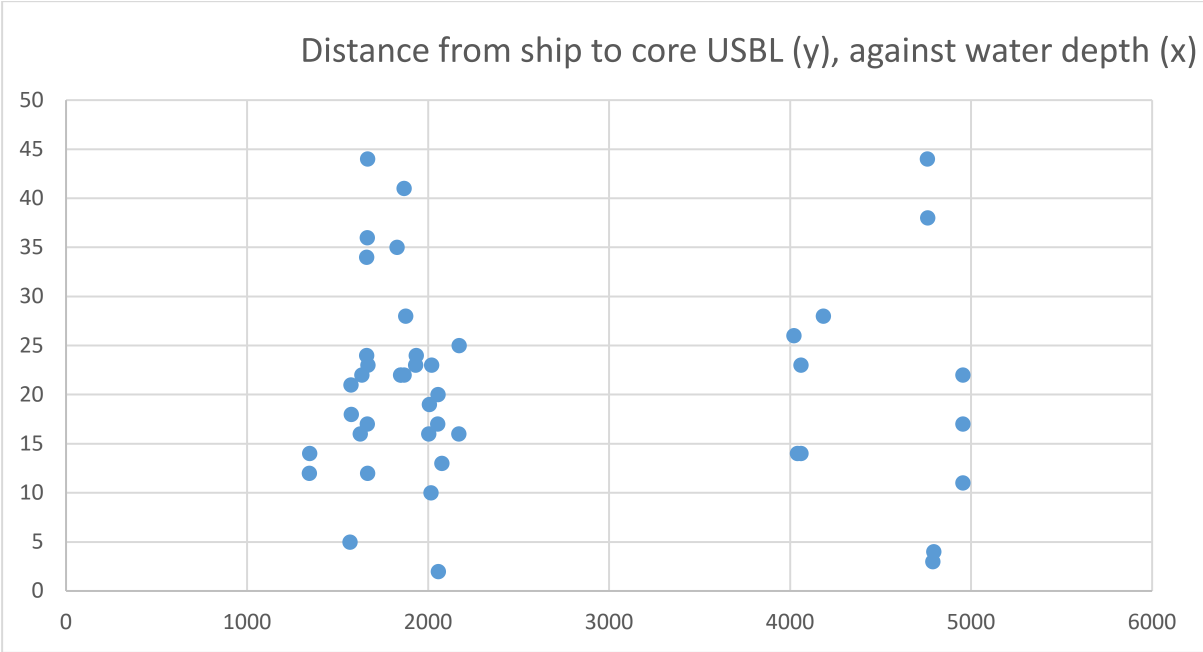

Fig. D-2. Distance of USBL on corer from the position of the ship (measured at the GRU in the Gravimeter Room – which is ~13m from where cores dropped) at time of release, against water depth.

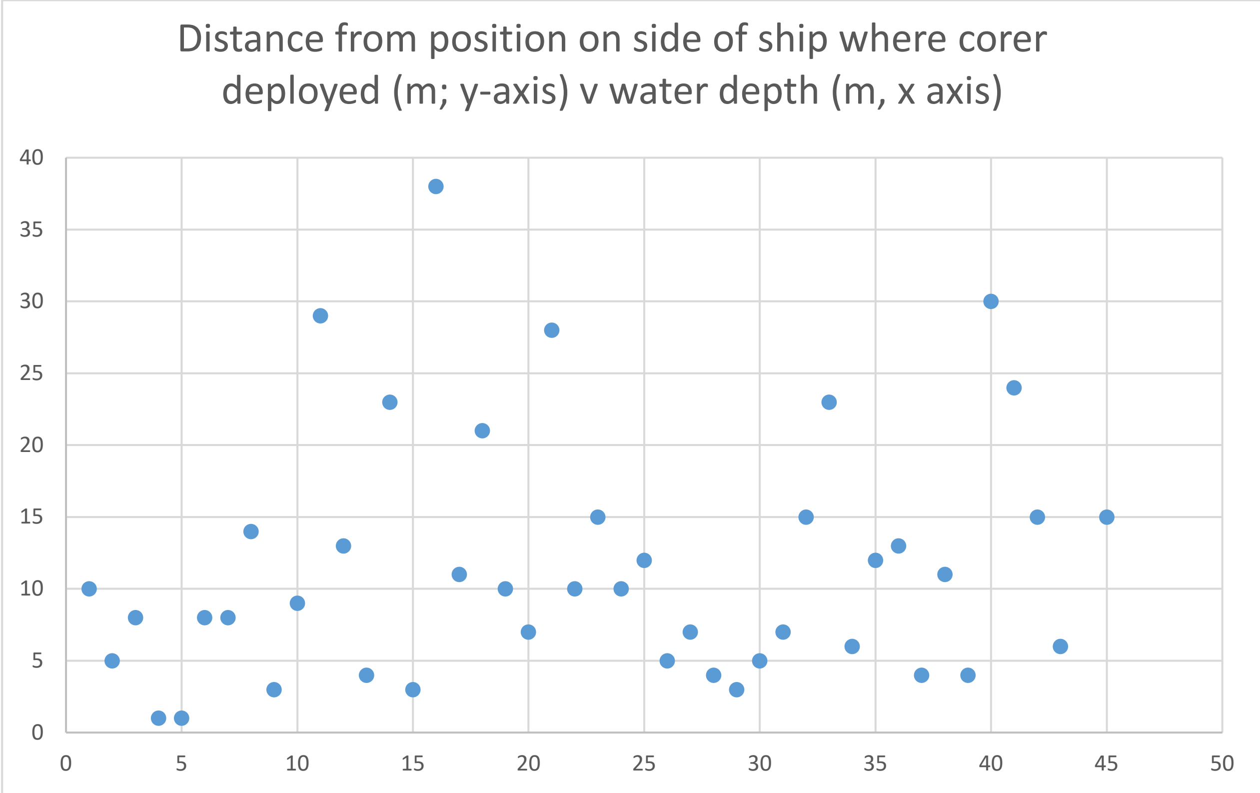

Figure D-3. Distance from the location of the corer on the ship's starboard side to the USBL on the core (i.e. where core dropped). This includes adjustment of 13m at 120° from ship's heading, from GPS position of ship (gravimeter room) to where the corer is located on the side of ship.

Target Site	Station	Core	USBL lat	USBL long	USBL Depth (m)	Distance(m) target to USBL	Direction from target	Ship to USBL distance (m)	ships position lat	ship long	distance ship to target	ships heading	Distance USBL to ship's corer (m)
42	23	MC01	-6.6950425	5.485014167	4956	22	NW	22	-6 41.709345	5 29.11074	2	187	10
42	27	PC01	-6.6950745	5.485103667	4956	12	NW	11	-6 41.70948	5 29.10984	2	188	5
42	30	MC02	-6.6950118	5.485096833	4956	19	NW	17	-6 41.70896	5 29.11013	1	200	8
48	312	MC12	-5.912468	11.417051	1345	20	NW	12	-5 54.749885	11 25.02929	8	164	1
48	315	PC11	-5.912473	11.417029	1347	22	NW	14	-5 54.75000	11 25.02948	8	164	1
98	375	PC15	-5.9534667	11.55326367	1570	4	W	5	-5 57.207	11 33.198	2	125	8
98	372	MC17	-5.953485	11.553058	1575	27	W	21	-5 57.205	11 33.194	9	125	8
106	389	PC16	-5.954361	11.556093	1577	31	W	18	-5 57.25140	11 33.36924	23	130	14
97	361	PC14	-5.924196	11.473356	1627	18	NW	16	-5 55.45500	11 28.41162	3	170	3
97	358	MC16	-5.924182	11.473401	1635	22	NW	22	-5 55.45560	11 28.41246	1	172	9
45	352	MC15	-5.930371	11.418276	1661	35	W	34	-5 55.81855	11 25.11463	3	066	29
99	346	PC12	-5.924978	11.426097	1662	24	W	24	-5 55.49166	11 25.57656	1	094	13
87	306	MC11	-5.909882	11.331713	1664	17	NW	17	-5 54.59394	11 19.91166	2	172	4
45	355	PC13	-5.930249	11.418212	1666	41	W	36	-5 55.81908	11 25.11204	6	174	23
87	309	PC10	-5.909821	11.331771	1666	14	NW	12	-5 54.59304	11 19.91160	2	171	3
99	349	MC14	-5.924703	11.42593	1667	43	NW	44	-5 55.49274	11 25.57686	1	235	38
99	318	MC13	-5.924865	11.426068	1669	23	W	23	-5 55.49182	11 25.57681	1	148	11
66	288	MC08	-5.900112	11.327688	1829	38	W	35	-5 54.01308	11 19.67904	12	186	21
96	303	PC09	-5.896516	11.330075	1850	21	NW	22	-5 53.79334	11 19.81652	2	160	10
96	300	MC10	-5.8965	11.33011	1851	19	NW	22	-5 53.79438	11 19.8162	1	160	7
93	294	MC09	-5.900091	11.329821	1868	42	W-NW	41	-5 54.01032	11 19.81116	5	181	28
93	297	PC08	-5.900179	11.329971	1868	24	W-NW	22	-5 54.0104	11 19.8108	5	156	10
66	291	PC07	-5.900148	11.327735	1877	33	W	28	-5 54.0128	11 19.679	12	181	15
51	282	MC07	-5 50.86285	11 1.88387	1932	12	SE	23	-5 50.85375	11 1.8751	35	199	10
51	285	PC06	-5 50.85375	11 1.87274	1936	9	SE	24	-5 50.86254	11 1.88232	33	199	12
90	279	PC05	-5.840724	11.030895	2005	19	NW	16	-5 50.45009	11 1.85971	5	195	5
90	276	MC06	-5.840688	11.030884	2007	23	NW	19	-5 50.4500	11 1.85900	5	200	7
92	392	MC18	-5 52.7419	11 10.48663	2017	14	W	10	-5 52.74072	11 10.49370	12	160	4
92	395	PC17	-5 52.73597	11 10.49102	2020	24	SW	23	-5 52.73814	11 10.4985	2	160	3
107	443	MC19	-5.856713	11.148103	2054	18	SW	17	-5 51.3951	11 8.89242	1	100	5
108	446	MC20	-5.857143	11.146292	2056	20	SW	20	-5 51.4221	11 8.78622	0	110	7
110	452	MC22	-5.86032	11.145073	2057	4	SE	2	-5 51.61872	11 8.70294	2	140	15
109	449	MC21	-5 51.58501	11 8.68930	2077	13	SE	13	-5 51.57972	11 8.68470	1	140	23
49	270	MC05	-5.836796	11.035966	2170	22	S	16	-5 50.19942	11 2.1604	6	056	6
49	273	PC04	-5.836535	11.035816	2173	20	W	25	-5 50.19972	11 2.15988	6	200	12
54	621	PC20	-5 49.21664	8 8.69629	4021	25	NW	26	-5 49.23036	8 8.7006	4	220	13
54	618	MC25	-5.8204092	8.145130333	4041	14	NE	14	-5 49.22946	8 8.70966	10	220	4
53	605	PC19	-5.7283178	8.1367625	4060	17	N	23	-5 43.71078	8 8.21040	5	215	11
53	602	MC24	-5.7285465	8.136803167	4061	9	S	14	-5 43.7199	8 8.2107	22	210	4
58	48	MC03	-6 28.55770	6 2.49279	4759	42	N-NW	44	-6 28.58062	6 2.500007	5	205	30
58	51	PC02	-6.4760622	6.04147	4761	34	N-NW	38	-6 28.58034	6 2.49984	5	195	24
77	57	PC03	-6.4648415	6.053023	4790	8	N	3	-6 27.8905	6 3.17982	5	200	15
77	54	MC04	-6.464745	6.052966667	4795	3	N	4	-6 27.89034	6 3.17964	4	180	6
32	599	PC18	-5 44.23653	8 8.06768	4108	394	Typo on USBL position?	398	-5 44.10090	8 8.23128	2		
32	596	MC23	-5 44.09221	8 8.21884	4185	25		28	-5 44.10068	8 8.23146	2	175	15

Table D-1. Distances from target to USBL on corer (drop site), ship's position to USBL on corer, and location on corer on ship's starboard deck to USBL on corer.