JC142 Tropic Seamount,

23°55'N; 20°45'W

JC142 Cruise Report

October 29-December 8, 2016, Tenerife to Tenerife

PI: Dr Bramley J Murton

MarineE-Tech Project

To Map the cobalt-rich Ferromanganese crusts of Tropic Seamount, NE Atlantic Ocean

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1. NARRATIVE

1.1 AIMS AND OBJECTIVES

Cruise JC142 departed Santa Cruz, Tenerife of the 29th of October 2016 on the RRS James Cook. The aims and objectives of Cruise JC142 were to undertake a holistic study of a simple seamount in the NE Atlantic with the focus on those processes that control the formation, composition and distribution of ferromanganese crusts. These crusts are rich in scares elements including cobalt and tellurium that are considered critical to emerging technologies and especially those that needed for low-carbon energy production. Cruise JC142 was in support of the NERC research programme 'SoS Minerals', of which MarineE-tech formed one of four large consortium projects.

1.1.1 BACKGROUND

Ferromanganese crusts are thought to form by precipitation of iron and manganese oxides from oxygen depleted mid-water known as the oxygen minimum zone. Oxidation and precipitation starts at the interface of the OMZ with deeper more oxygen-rich water, typically at depths of about 1000m. The OMZ is maintained by organic productivity in the surface waters and its subsequent microbial consumption of that material at depth. Iron and manganese remain dissolved in the OMZ and only precipitate on oxidation. The source of and exact process by which trace metals and other elements are co-precipitated with the ferromanganese crusts is unclear. Growth of the ferromanganese crusts occurs at a rate of a few tens of millimeters per million years and is thought to depend on the presence of sediment-free substrates at a depth just below the base of the OMZ. While there is a general knowledge of the broad ocean-basin wide distribution of ferromanganese crusts and their compositions, the controls on growth, composition and formation are unknown at a the scale of a typical seamount.

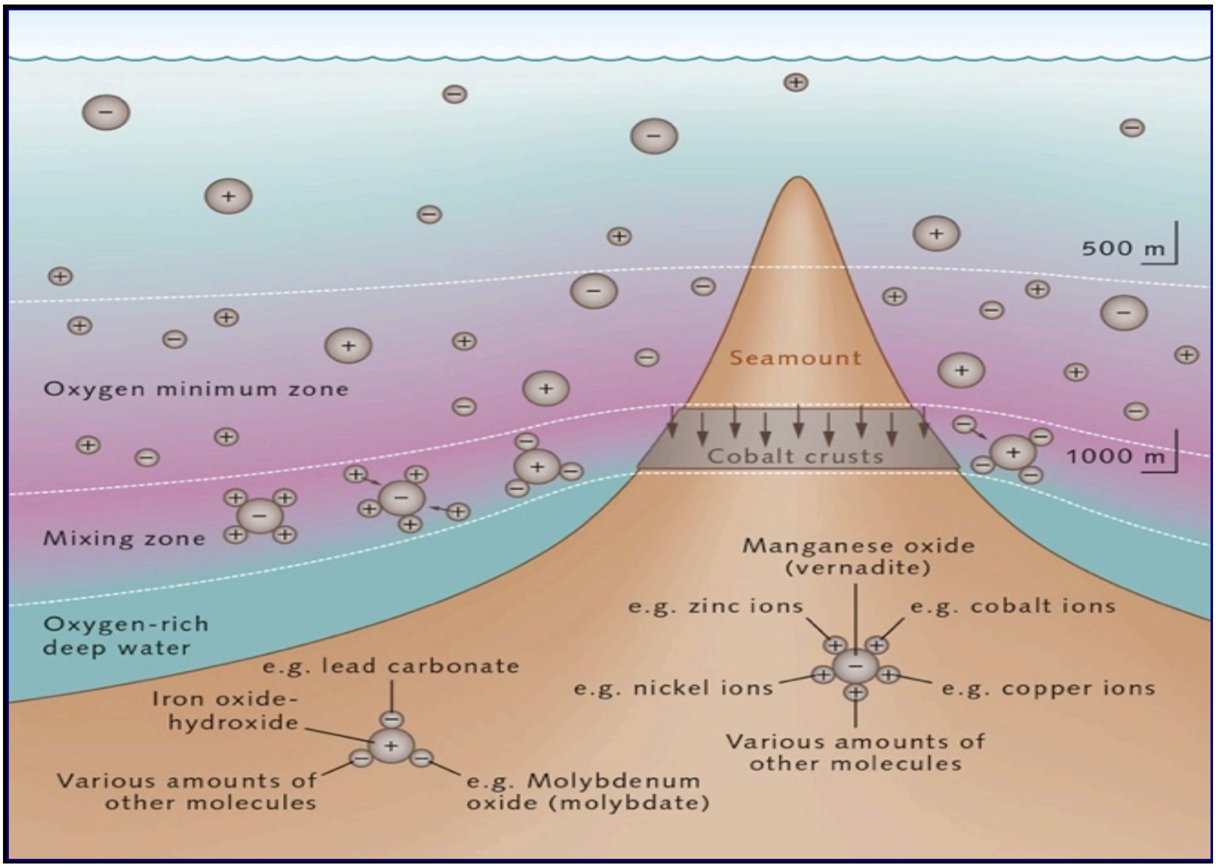


Figure 1: Schematic showing hypothesized process of formation of ferromanganese crusts on seamounts at base of oxygen minimum zone.

Our study was hypothecated on testing the controls exerted on ferromanganese crusts growth by the energy and orientation of currents from the surface to the seafloor, their effect on surface productivity and sediment distribution, the affects of seafloor morphology and its evolution, the eustatic and isostatic subsidence history of the seamount, the lithology of the substrate, and the mobility and thickness of sediment cover. Additional research was conducted on the environmental sensitivity of the ecology of the seamount with attention to the potential disturbance arising from extraction of the ferromanganese crusts. By addressing these variables, we designed a holistic study that spans the sea surface to the shallow sub-seafloor.

1.1.2 METHODOLOGY

Water column properties and dynamics were studied using three fixed moorings deployed for thirty days and ship-deployed ADCP and CTD casts. These, and the meteorological data were used to update numerical models of the current patterns and their variability around the seamount by HR Wallingford staff in Oxford. The results were sent back to us on a regular basis and were used to guided our subsequent observations and experiments. Over 400 samples of ferromanganese crusts were collected by ROV (Isis 6500), including dozens of cores drilled using a new core-drill designed especially for this cruise. High-definition video and stills were acquired from multiple ROV dives at all depths across the seamount including numerous transects of 500m or more to assess the diversity and density of mega fauna. An AUV (Autosub6000) collected high-resolution (EM2040) multibeam bathymetry, 200 kHz and 300 kHz sidescan (Edgetech chirp) sonar and sub-bottom profiler data, and tens of thousands of still photographs. Voucher specimens of some mega fauna were collected including soft corals and sponges. Dead solitary corals were collected for palaeooceanographic studies as well as those with ferromanganese crusts for dating precipitation rates. Material for microbiological studies were collected including matched push cores and ferromanganese nodules and crusts, water samples and a new *in situ* microbial incubator was deployed. A modified niskin bottle was used for collecting hard substrate material, with the ROV, without contamination from surface waters. A series of novel experiments were conducted by generating sediment plumes with the ROV at a range of distances up-current from a specially designed lander comprising sediment traps, optical backscatter sensors and an upward looking ADCP. In concert, the AUV was deployed to occupy a section at a down-stream range of 1km from the ROV, acquiring water-column data including EM2040 mid-water acoustic backscatter, to assess the distal dispersal of the sediment plumes. The location of the plume generation sites, the lander and the AUV mission were informed by the model outputs sent to us from HR Wallingford.

The location chosen for our study is an isolated seamount, approximately 300 nautical miles SSW of the Canary Islands (Figure 2). Part of the Canary Islands Seamount Province (CISP), Tropic Seamount was an active volcano between 120 Ma and 85Ma (Bogaard, 2013). The 50km-wide seamount is surrounded by a flat abyssal plain, at a depth of 4100m, and rises steeply over a distance of 10km to a depth of 1000m where it is characterized by a relatively flat top. Mass wasting of the seamount has resulted in a four-pointed star-shaped plan-form with the points of the star oriented N-S-E-W. Between the points, steep scarps plunge at over 30° from 1000m to 2000m and form the seamount flanks. Bifurcating channels of mass wasted debris feed wider channels that terminate at the seamount's base where they are covered by pelagic sediment. This relatively simple, isolated seamount provides a symmetrical structure ideally suited to study the interaction of those processes we hypothesise to affect the growth and composition of ferromanganese crusts. Dating using K-Ar and Ar-Ar of volcanic rocks from the base (basaltic) to the plateau (trachytic) reveal an eruption history for Tropic Seamount from 119 Ma to 114 Ma with possible late stage eruptions until ~60 Ma on the northern flank (Bogaard, 2013) making this one of the oldest seamounts in the North Atlantic.

Van den Bogaard, P, 2013, The origin of the Canary Island Seamount Province - New ages of old seamounts, Nature Scientific Reports, doi.org/10.1038/srep02107

Figure 2: Location of study site, Tropic Seamount, relative to the location of the Western Sahara and Saharan Seamounts that are part of the Western Saharan Seamount Province.

1.2 SUMMARY OF RESULTS

Cruise JC142 departed from Santa Cruz, Tenerife of the 29th of October 2016 and returned to Santa Cruz on the 8th of December. During the cruise, we mapped the entire seamount with EM120 multibeam, set to a 90° swath angle, with equidistant beam spacing, and surveyed at 5 kts. We also deployed three moorings, occupied 36 CTD stations, 3 in situ microbial incubator stations, 18 AUV missions (of which 2 were aborted), 28 ROV dives (of which 2 were aborted), 5 gravity cores, 4 lander deployments and 3 plume generation and dispersal experiments (Figure 3). These operations are described in more detail in the following chapters. A total of 70 core-drill sites were occupied with 58 cores recovered. Over 344 individual rock samples were collected by ROV from locations across the seamount at depths ranging from 4000m to 998m. The AUV mapped in high resolution the bathymetry of the entire summit area of Tropic Seamount and two flanks, gathered high-resolution sidescan sonar imagery and collected 361,644 photographs.

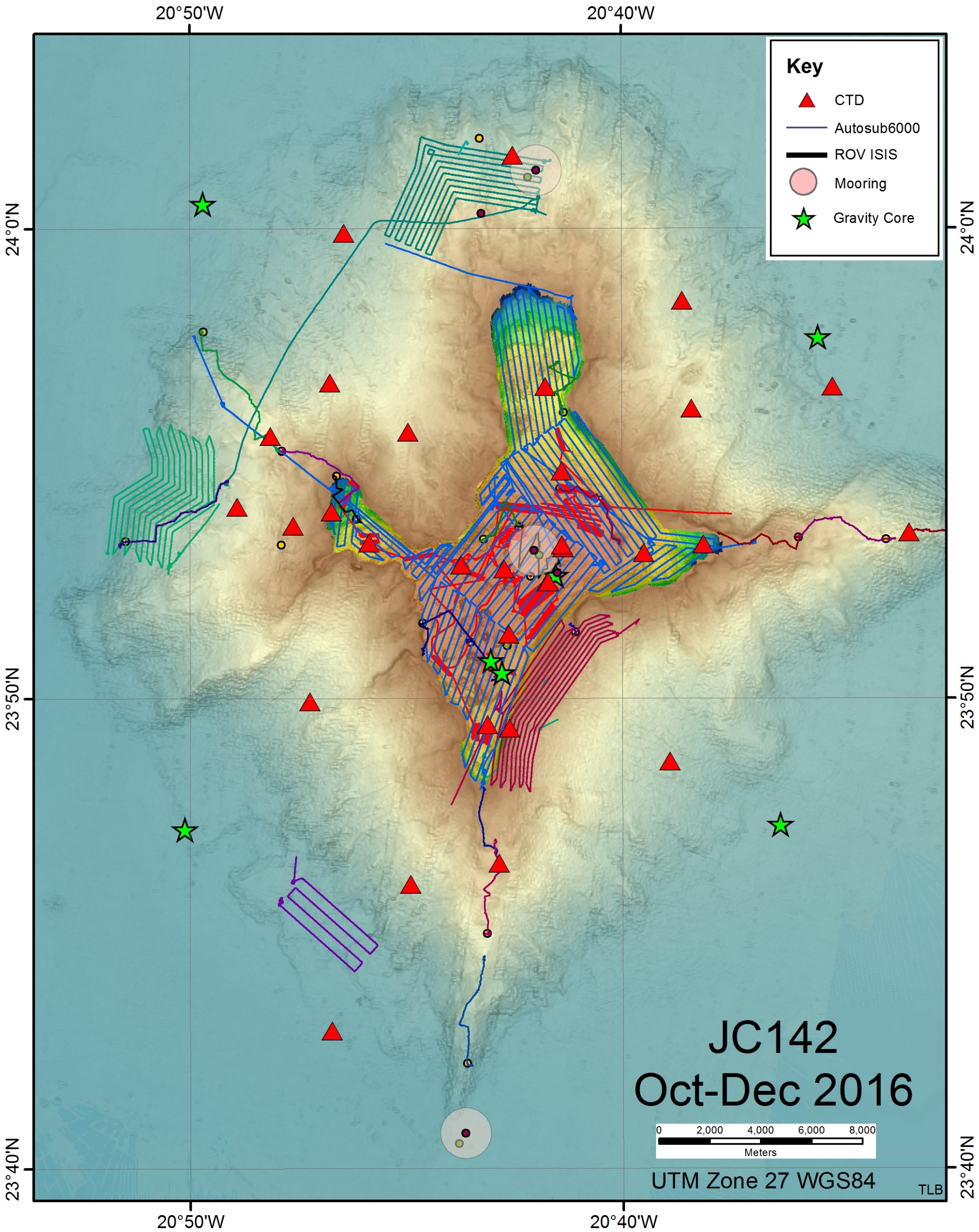
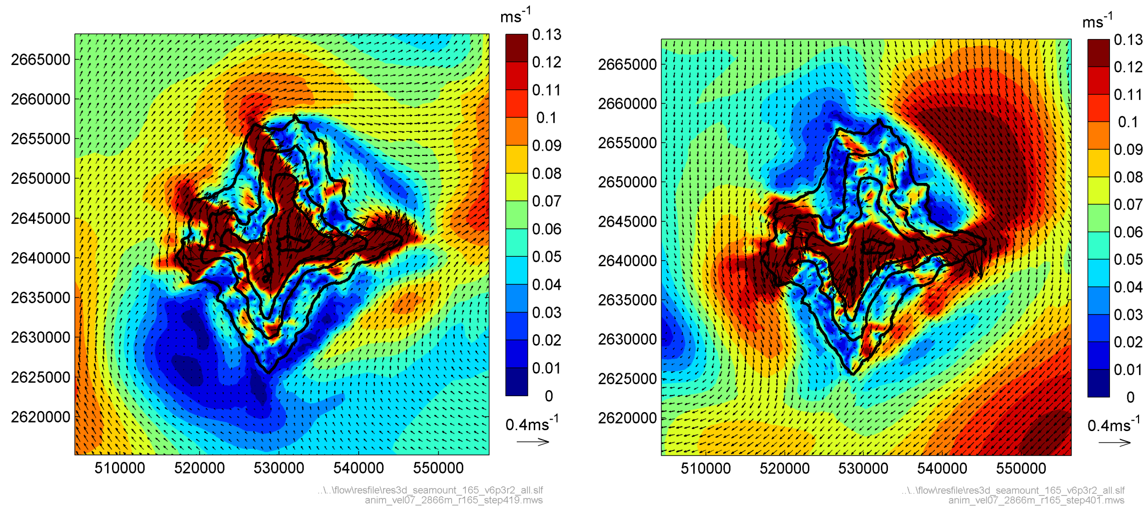


Figure 3: Map showing JC142 data collection over Tropic Seamount. Background

1.2.1 HYDROGRAPHY

Modelling by HR Wallingford staff back in Oxford used data sent back by our team on board to update the models in real time. The latest iterations showed the strong influence of tides on both the surface and bottom currents. In general, a NE-SW current rotates anticlockwise over the diurnal tidal cycle. The orientation of the spurs forming the points of the star-shaped bathymetry of the seamount cause high current variability and energy dissipated at the east and western side with lower energy dissipated on the northern and southern spurs (Figures 4 and 5). This distribution of energy coincides with the distribution of sediment covered and sediment poor areas on the seamount, as determined by both the EM120 backscatter and observations from the ROV (Figure 6). This in turn correlates with the distribution of crusts and sessile biota (corals and sponges) with the thickest and highest densities in high-energy areas. Sediment cover on the relatively flat plateau of the seamount was found to be both variable and thin (<1m). Here, ripples and longitudinal dunes indicate a predominant transport direction from the NE to the SW. This in turn indicates a relatively short residence time for sediments on the summit area with currents transporting sediment from the northeast to the southwest where it is swept off the summit and onto the lower southwest and southern flanks.



Figures 4 & 5: Currents responding to the tidal excursion diamond during the Spring Tide period. Note the highest energy is dissipated over the eastern and western spurs of the seamount. The lowest current areas are over the NE,SW,NW and SW flanks.

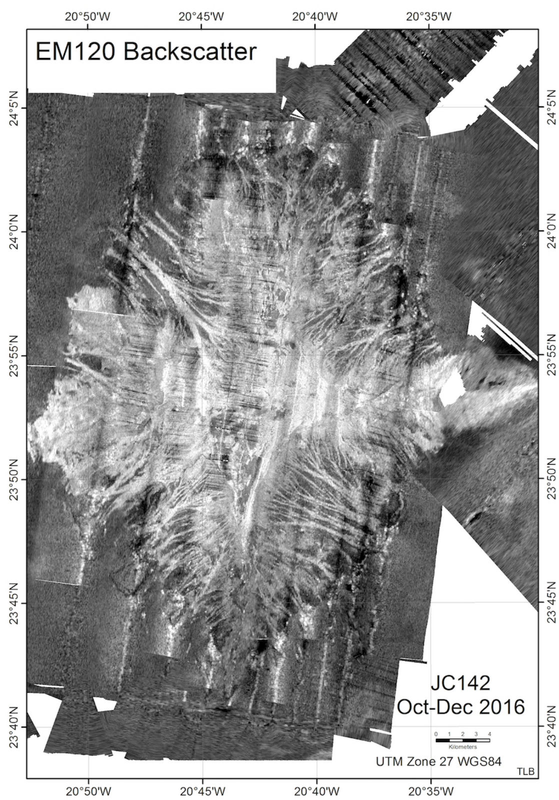


Figure 6: EM120 backscatter acquired over Tropic Seamount show areas of poor sediment cover (bright backscatter areas) compared with areas of thicker sediment cover (dull backscatter). The data are corrected for beam incidence by the acquisition system and acquired at 5kts in N-S lines with a swath angle of 90° and equidistant beams. The areas of high backscatter on the east and west spurs indicate poor sediment cover and correspond to those areas predicted by the hydrographic modeling as dispersing high current energy.

1.2.2 CRUST DISTRIBUTION

Crusts were found at all depths of the seamount with the thickest crusts, in general, located at the greatest depths on its eastern and western spurs. The thinnest crusts are found on the plateau but with thicker crusts found at its northwestern edge. The centre and southern sides of the summit plateau have the thickest sediment cover. The presence of thick crusts at the base of the seamount contradicts accepted understanding of crust deposition to a depth horizon just below the oxygen minimum zone (OMZ). At Tropic Seamount, this would predict thickest crusts at 1000m. Instead we found the thickest crusts at 3000-4000m. In areas on the eastern and western spurs, between 2500m and 1000m, where the current energy is greatest, the sessile fauna are most abundant. Dense coral debris at these locations appears to inhibit crust formation and coral and sponge 'gardens' are frequent on near vertical cliffs.

Crusts of up to 11cm thick were encountered as both nodules and pavements. On the summit area, pavements were observed covering many different terrace levels. These were often undercut by erosion exposing a calcareous substrate. Elsewhere, cobbles and pebbles formed the nucleolus for crust growth in the form of nodules up to 20cm in diameter. Crusts have grown on top and underneath these nodules and pavements, often where the substrate has clearly been semi-submerged in sediment. This observation is enigmatic since present understanding requires hard substrates to be exposed to seawater for crusts to grow, and any burial would inhibit such growth. Similarly, many substrates are found to comprise semi-consolidated sediment. In places, this sediment has since been eroded away leaving large broken slabs of crust pavement strewn across the seafloor. This is especially apparent on the spurs of the seamount where pavement has formed on steep slopes of up to 30°.

Lithological associations between crust and substrate also reveal patterns. Carbonate, consolidated and semi-consolidated sediment, and massive basalt frequently, form substrates to thick (centimetric) crust. However, volcaniclastic substrates, and especially those comprising pumice fragments or aggregates of millimetric clasts and altered volcanic ash often host only the thinnest of crusts (millimetric or less). The reason for this is unclear, but may relate to oxidation of the finer grained volcaniclatic material and the greater surface areas presented to sewater. This could generates a locally reduced substrate surface that inhibits the formation of crust growth by effectively re-dissolving the iron and manganese oxides as it comes into contact with the volcanoclastic substrate. The volcaniclastic substrate often has a penetrative red coloured exterior indicative of ongoing oxidation, supporting this hypothesis.

Where the substrate is carbonate, as is common on the plateau, drill cores reveal a lithified limestone commonly containing vugs and fossilized remains of reef-building coral and shelly fauna. Phosphorite is often present as a replacement of the carbonate underlying the ferromanganese crusts. The contact with the crusts is also often irregular and appears to be erosional. Elsewhere, phosphorite replacement is apparent in the cores of nodular material.

Lithostratigraphy is evident in many of the crusts samples, where a fine (tens of microns thick) lamination is easily seen in cut sections. Occasionally, laminations of white material are seen near the base of crusts overlying carbonate. These are often seen repeated in neighbouring samples possibly representing marker horizons. Crust closest to the substrate is also often characterized by a fine clastic particulate content, possibly representing the inclusion of fine sediment during the early period of crust growth.

1.2.3 EVOLUTION OF THE SEAMOUNT

The summit plateau has a number of discrete terraces, often bound by scarps of 2 to 6m high and that follow common depth contours. These are interpreted as a series of relict wave-cut platforms, generated as the seamount subsided to sea level and below. In this sense, the morphology of the plateau area represents a fossilised landscape, preserved from between 30 and 40 million years ago as the seamount subsided. From the distribution of wave-cut terraces, it is evident that the seamount was initially a single island, with an upland area located in the south of the plateau area. A channel in the northern indicates a possible river drainage feature (figure 7). During the period of subsidence, the island was slowly inundated and wave action leveled most of the summit area.

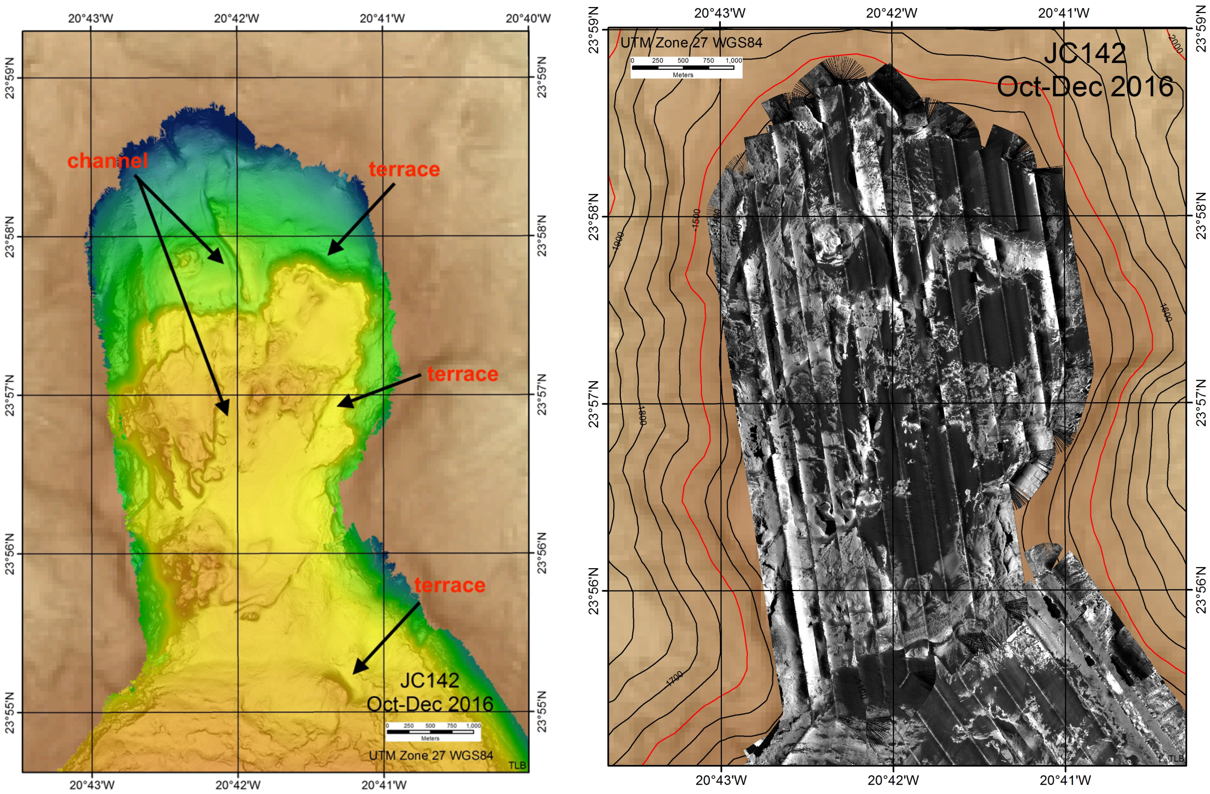


Figure 7: left: 200kHz, 5m gridded bathymetry and right: 100kHz sidescan sonar, derived from the AUV, for the northern extension of the summit area showing a series of terraces and a palaeo-channel. The terraces are probably the result of wave erosion and the channel can be traced back towards the south and an are of once high ground. Since

Continued subsidence separated the western area from the main edifice resulting in the formation of a small archipelago. Wave action continued to level the remainder of the plateau with only a small island remaining in the south. The recovery of cores of coralliferous limestone indicates Tropic Seamount became an atoll before finally subsiding below sea level. Based on a summit depth of 1000m and an age of the seamount of ~100Ma, Tropic Seamount must have subsided below sea level about 30Ma (Figure 8). Hence the morphology of the summit area of Tropic Seamount we observe today is, in effect, a fossilized landscape some 30 million years old.

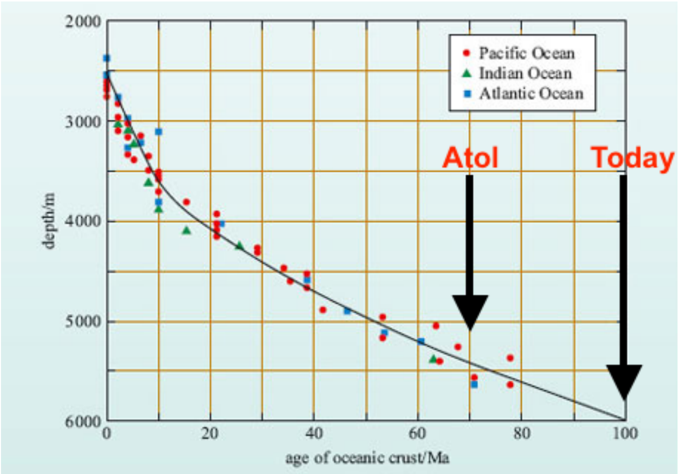


Figure 8: Depth age curves for average oceanic crust. Based on an average age for Tropic Seamount of ~100Ma, and a subsidence of ~1000m for the summit area, the seamount would have taken about 30 million years to subside from sea level to the present day. With an OMZ at 700m, this leaves only 10Ma for crust growth on the plateau.

1.2.4 PLUME EXPERIMENTS

One of our objectives was to test hypotheses for the dispersal of sediment plumes that may arise during any future extraction of the crusts for industrial purposes. The impact of these plumes on sessile fauna are of special concern to the protection of ecosystems on the seamount and the prospect of ecologically sustainable deep-sea mining. Until now, plume dispersal studies have used hydrological models and assumed plume materials act as conservative tracers in the water column. Hence dispersal is by dilution only, and they have the potential of infinite residence time in the water column. Our study aimed to generate plumes using a powerful pump attached to the ROV and inject sediment into the water immediately above the vehicles thrusters while generating the maximum upthrust to enable greater mixing and vertical advection. A lander was deployed using an optical backscatter and an upward looking ADCP to measure the density of particles in the water column. Plumes were generated at a range of distance up-stream from the lander (25, 50 and 100m) and positioned according to the predicted current and tidal diamond. On two of the three experiments the AUV was use to monitor the water column at a range of 1km down-stream of the lander and at a range of altitudes of 5m, 20m, and 25m. The AUV survey occupied a 2D plane that extended 50% longer than the range of possible plume advection directions, and hence would have sampled the plume water that passed the lander. Initial results from the lander show both backscatter and ADCP signals in the water column whereas the AUV optical backscatter data showed no detectable particles at a range of 1000m and only a small cloud of scatterers after 6 hours (Figure 9).

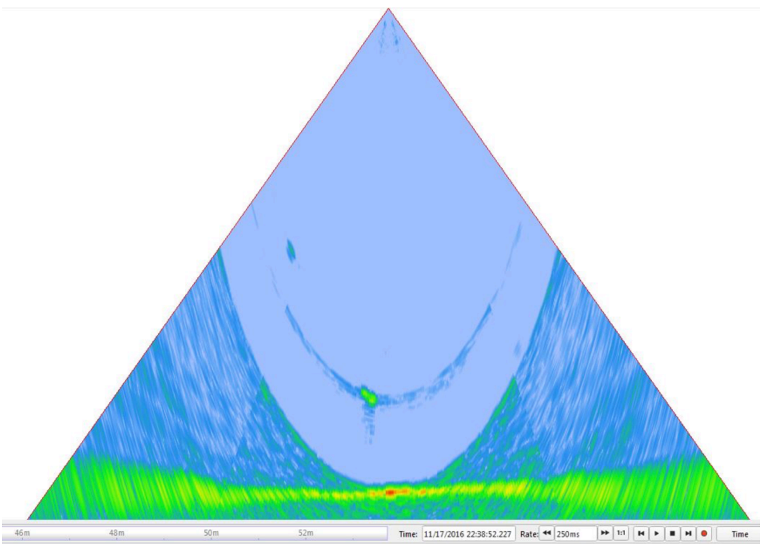


Figure 9: Example of Autosub6000 EM2040 multibeam echo sounder water column data indicating the possible presence of a cloud of scatterers in the water column some 6 hours after the final plume generation for the first experiment.

1.3 THE SCIENCE PARTY, TECHNICAL TEAM, OFFICERS AND CREW OF JC142

Onboard Cruise JC142 were scientists the National Oceanography Centre and British Geological Survey, UK; HR Wallingford, UK, the University of Sao Paulo, Brazil and the Geological Survey of Spain. With us were seven ROV technicians, three AUV technicians, two CTD and moorings technicians, and two mechanical technicians, all from NOC.

The members of the ship's company for JC142 are listed below:

1.3.1 THE SCIENTIFIC PARTY COMPRISED

name	position	affiliation	role	watch
Bramley J. Murton	chief scientists	NOC	PSO	06:00 - 18:00
Paul A. J. Lusty	co-chief scientist	BGS	shift leader	12:00 - 00:00
Pirrre Josso	scientist (Geochemist)	BGS	sampling work flow	12:00 - 00:00
Mariana Benites	PhD student	USP	geo	12:00 - 00:00
Natascha Bergo	PhD student	USP	chem/CTD	12:00 - 00:00
Christian Millo	scientist (Geochemist)	USP	chem/CTD	12:00 - 00:00
Jonathan Taylor	scientist (Hydrograpthy)	HR Wallinford	leader/lander	12:00 - 00:00
Isobel Yeo	co-chief scientist	NOC	ROV/AUV	00:00 - 12:00
Berit Lehrmann	scientist	NOC	sampling work flow	00:00 - 12:00
Sarah Howarth	PhD student	NOC	geo	00:00 - 12:00
Mascimiliano Maly	PhD student	USP	chem/CTD	00:00 - 12:00
Francisco Javier González Sanz	scientist (geology)	GSP	geo	00:00 - 12:00
Lissette Victorero	PhD student (Biology)	NOC	ROV/CTD/bio	00:00 - 12:00
Neil Crossouard	scientist (Hydrography)	HR Wallinford	CTD/moorings	00:00 - 12:00
Mike Zubkov	Scientist (Microbial)	NOC	leader/microbio	as requied
Greta Giljan	PhD student	Bramen	microbio	as requied
Tim LeBas	data manager	NOC	data /GIS	06:00 -18:00
NOC = National Oceanography Centre, European Way, Southampton, UK				
USP = University of Sao Paulo	BGS = British Geological Survey		GSP = Geological Survey of Spain	

1.3.2 THE TECHNICAL PARTY COMPRISED

name	position	affiliation	role
James Burris	Technical Liason Officer	NOC	Autosub
Rachel Marlow	AUV Mission Planner	NOC	Autosub
Ella Richards	AUV engineer	NOC	Autosub
Jeff Benson	technician	NOC	CTD
Nick Rundle	technician	NOC	Moorings and Sensors
Dave Turner	ROV team leader	NOC	ROV
Andy Webb	ROV technician	NOC	ROV
Josue Viera	ROV technician	NOC	ROV
Antonio Campus	ROV technician	NOC	ROV
Russell Locke	ROV technician	NOC	ROV
Dave Edge	ROV technician	NOC	ROV
Richie Phips	Base Engineering	NOC	Coring
Owain Shepherd	Base Engineering	NOC	Coring
Mark Maltby	Computing	NOC	Ship's sensors and systems

1.3.3 THE SHIPS OFFICERS AND CREW COMPRISED

name	position	affiliation	role
James Gwyinnell	Master	NOC	Captain
Stuart Makay	Chief Officer	NOC	Bridge
Malcolm Graves	2nd Officer	NOC	Bridge
Dominick Muller-Tolk	3rd Officer	NOC	Bridge
Bob Brett	Chief Engineer	NOC	Engines
Chris Utley	2nd Enginer	NOC	Engines
Scott Donaldson	3rd Engineer	NOC	Engines
Gary Slater	4th Engineer	NOC	Engines
David Hawksworth	ETO	NOC	Electrics
Neil Machin	ERPO	NOC	Engines
Anthony Stevens	Purser	NOC	Hotel and Logisitics
Mick Minnock	CPO Scientific	NOC	Scientific systems
Andy Maclean	CPO Deck	NOC	Ship systems
Steve Duncan	PO	NOC	deck
Nick Byrne	Able Seaman	NOC	deck
Jarrod Welton	Able Seaman	NOC	deck
Mark Moore	Able Seaman	NOC	deck
Steve Toner	Able Seaman	NOC	deck
John Haughton	Head Chef	NOC	Galley
Chris Keighley	Chef	NOC	Galley
Pete Robinson	Steward	NOC	Galley
Tina Mantinha	Assistant Steward	NOC	Galley

1.3.4 ACKNOWLEDGEMENTS

We would like to thank the officers and crew of the RRS James Cook, and technical team, cruise JC142, for their professionalism and dedication to securing MarineE-tech the best possible samples and data. We also commend the officers and crew of the RRS James Cook for their prompt actions in rescuing the crew of the yacht ‘Noah’ as it sank close to our work area, thereby saving the lives of five people including two children.

1.4 SUMMARY OF STATIONS

JC142 occupied 126 stations in total. Of these, we occupied 33 CTD stations, made 27 ROV dives, 16 AUV missions and 8 gravity cores. In addition, we deployed three deep-water moorings, and a bottom lander on four occasions. We recovered 607 samples including water samples, biological voucher specimens, whole rock pieces and drill cores. Details of each of the operations, a list and description of the samples, an explanation of how the geophysical and hydrological data were acquired and processed is given in this report. The purpose of this report is to describe the operations undertaken on the cruise including aims and objectives, methodologies, data and material collected and provide a guide to the location and acquisition of these data and samples and their initial processing. A full list of the stations occupied is given below.

Station number	Date	Time start	Time at bott.	Time off bott.	Time end	Operation	Location	Objective	Latitude [°]	Latitude [dec min]	Londitude [°]	Londitude [dec min]	Depth [m]
001	30/10/16	17:15	---	---	22:42	ire test (ROV)		Wire test	23	42.925	-20	46.742	3989
002	30/10/16	23:15	---	---		Wire test (CTD)		Wire test	23	42.929	-20	46.727	3989
003	31/10/16	04:40			05:20	CTD		Microbiology sampling	23	42.929	-20	46.727	3989
004	31/10/16	07:24				AUV	SW base of seamount	Mission 125: START	23	46.817	-20	47.503	3998
005	31/10/16	11:06				MB + SBP	W flank of seamount	Ship Swath Multibeam	23	45.978	-20	47.277	4010
	31/10/16				14:26				23	46.244	-20	45.024	2459
006	31/10/16				18:07	AUV		Mission 125: END	23	45.161	-20	48.448	4152
007	31/10/16	19:04				MB + SBP	Centre of seamount	Ship Swath Multibeam	23	40.95	-20	43.86	4177
	01/11/16				08:00				23	56.155	-20	39.547	2004
008	01/11/16	08:43			10:28	CTD	Summit	HRW#1 and microbiology sampling	23	53.209	-20	41.365	988
009	01/11/16	11.3				ROV	Summit (lander) to SW edge of seamount	Dive 297: Lander deployment, plume generation, reconnaissance and rock sampling	23	50.498	-20	42.84	1080
	01/11/16		12:36						23	50.402	-20	42.991	1080
	02/11/16			06:08					23	50.953	-20	44.6	1013
	02/11/16				07:12				23	50.841	-20	44.658	1082
010	02/11/16	08:42			18:58	MOORING	South	Mooring C (S site)	23	38.792	-20	45.161	4198
011	02/11/16	20:11			21:50	AUV	Summit	Mission 126: START	23	54.954	-20	42.516	998
012	02/11/16	22:26			23:08	AUV		Mission 126:END	23	54.609	-20	42.675	3867
013	03/11/16	00:42			01:43	CTD	North Summit	HRW#7 and microbiology sampling	23	56.615	-20	41.658	1097
014	03/11/16	02:23	02:57		03:28	CTD	North Summit	HRW#2	23	54.841	-20	41.406	1055
015	03/11/16	04:10	04:44		05:17	CTD	East Summit	HRW#3	23	53.099	-20	39.498	1043
016	03/11/16	06:00	06:37		07:10	CTD	East Summit	HRW#8	23	53.28	-20	38.122	1222
017	03/11/16	07:57			09:20	CTD	West Summit	HRW#5	23	52.876	-20	93.73	992
018	03/11/16	09:58	11:16		12:34	CTD	West Summit	HRW#6	23	53.314	-20	45.862	1084
019	03/11/16	19:04				MOORING	North	Mooring A (N site)	24	1.239	-20	41.977	2974
020	03/11/16	21:25				ROV	Summit	Dive 298: Rock sampling and first drill test	23	53.645	-20	42.383	999
	03/11/16		22:46						23	53.653	-20	42.297	988
	04/11/16			16:42					23	52.898	-20	41 46.5	994
	04/11/16				17:52				23	52.832	-20	41.433	989
021	04/11/16	19:00				AUV		Mission 127: START	23	55.227	-20	42.723	1174
022	04/11/16	21:55				MB + SBP	E flank of seamount		23	56.089	-20	39.578	2085
	05/11/16				11:20				23	55.86	-20	36.597	3339
023	05/11/16	11:55			15:01	AUV		Mission 127: END	23	52.554	-20	40.532	993
024	05/11/16	15:45			16:35	MOORING	Summit	Mooring B (centre)	23	53.151	-20	42.035	1006
025	05/11/16	17:35				ROV	SW ridge to summit	Dive 299: Lander recovery, push cores HRW	23	50.46	-20	42.827	1021
	05/11/16		19:08						23	50.473	-20	42.896	1019
	05/11/16			22:19					23	50.488	-20	42.823	1029
	05/11/16				23:07				23	50.495	-20	42.817	980
026	05/11/16	23:42			00:07	CTD		Aborted- incorrect depth	23	51.057	-20	44.592	1823
027	06/11/16	00:32			02:18	CTD		Aborted- bottles failed.	23	50.999	-20	45.201	1500
028	06/11/16	03:02				MB + SBP		Ship Swath Multibeam	23	51.522	-20	43.163	980
	06/11/16				14:50				23	40.759	-20	46.837	4229
029	06/11/16	14:55			15:20	AUV		Fish test	23	40.678	-20	47.366	4228
030	06/11/16	15:24				MB + SBP		Ship Swath Multibeam	23	41.085	-20	47.78	4231
	06/11/16				02:20				23	59.883	-20	41.848	2114
031	07/11/16	03:13			04:33	AUV		Mission 128, Camera test, sonar failure	23	53.719	-20	42.754	1011
033	07/11/16	05:20	06:24		07:17	CTD	Summit	POC + microbiology	23	53.088	-20	43.348	1005
034	07/11/16	07:49				MB		Swathing	23	51.088	-20	43.215	1002
	08/11/16				09:15				23	55.853	-20	36.601	3369
035	08/11/16	10:07	10:44		11:52	CTD	South summit	HRW # 4, Microbiology	23	51.376	-20	42.629	1015
036	08/11/16	13:05	13:34		14:06	CTD	South summit	HRW #9	23	49.441	-20	43.119	1055
037	08/11/16	15:15	16:14		17:44	CTD	flank area	HRW #16, POC + microbiology	23	48.669	-20	38.903	3376
038	08/11/16	19:01				AUV		Mission 129: START	23	54.696	-20	42.954	1020

Station	Date	Time	Time	Time	Time	Operation	Location	Objective	Latitude		Londitude		Depth
number		start	at bott.	off bott.	end				[°]	[dec min]	[°]	[dec min]	[m]
039	08/11/16	22:40				ROV	Eastern arm towards summit	Dive 300	23	53.384	-20	33.893	2661
	09/11/16		00:21						23	53.398	-20	33.687	2662
	09/11/16			14:09					23	53.411	-20	35.202	1940
	09/11/16				15:45				23	53.42	-20	36.89	1969
040	09/11/16	16:42			17:40	AUV		Mission 129: END	23	53	20	39.638	1034
041	09/11/16	18:38			20:51	INC		Incubator test	23	53.891	-20	44.081	1366
042	09/11/16	22:30	00:02		01:19	CTD	flank area	HRW #15	23	56.635	-20	35.124	3870
043	10/11/16	02:32	03:42		04:50	CTD	flank area	HRW #14	23	58.471	-20	38.612	3187
044	10/11/16	05:57	07:10		08:29	CTD	flank area	HRW #13	24	1.562	-20	42.528	3173
045	10/11/16	09:41			19:36	CABLE (ROV)		Streaming ROV cable	23	58.921	-20	47.563	3619
046	10/11/16	20:36			22:39	AUV		Mission 130 START	23	58.252	-20	41.207	1290
047	11/11/16	00:13				ROV	NE summit	Dive 301: Rock sampling and drilling	23	53.396	-20	43.203	1015
	11/11/16		01:11						23	53.414	-20	43.115	1006
	11/11/16			14:08					23	53.731	-20	42.436	998
	11/11/16				15:09				23	53.604	-20	42.518	1000
048	11/11/16	16:03			18:42	AUV		Mission 130:END	23	54.603	-20	46.828	1336
049	11/11/16	19:36			20:50	ADCP		ADCP test for HRW	23	54.825	-20	41.494	1004
050	1/-12/11/2	21:18			20:37	INC	SE summit	Incubator experiment	23	54.828	-20	41.397	1053
051	12/11/16	22:19			00:44	CTD	flank area	HRW #12	23	59.907	-20	46.434	3650
052	13/11/16	05:35			06:01	GC	NW flank	cancelled: winch system failure	24	0.546	-20	49.695	4079
053	13/11/16	08:11				MB		Survey line 233	24	54.977	-20	35.773	3599
	13/11/16				10:11				24	3.72	-20	34.271	3789
054	13/11/16	12:34				AUV		Mission 131: START	23	48.212	-20	43.205	1124
055	13/11/16	15:14				ROV	NE summit	Dive 302: Rock, biology and microbiology	23	44.999	-20	43.129	2600
	13/11/16		16:57						23	45.004	-20	43.106	2685
	14/11/16			06:00					23	46.991	-20	42.945	1897
	13/11/16				07:51				23	46.989	-20	42.959	1800
056	14/11/16	09:25			11:05	AUV		Mission 131: END	23	57.4	-20	49.899	3699
057	14/11/16	12:06	12:52		13:56	CTD		POC	23	53.878	-20	47.623	1953
058	14/11/16	15:37				ROV		DIVE 303: Rock and biology sampling and drilling	23	54.472	-20	41.434	1022
	14/11/16		16:19						23	54.465	-20	41.426	1012
	15/11/16			12:26					23	53.322	-20	40.054	975
	15/11/16				13:17				23	53.29	-20	40.085	1000
059	15/11/16	14:30			15:50	CTD		POC + microbiology	23	53.973	-20	46.732	1234
060	15/11/16	16:10				AUV		Mission 132: START	23	54.095	-20	46.637	1172
061	15/11/16	19:17				ROV	NW plateau	Dive 304	23	56.089	-20	41.347	1150
	15/11/16		20:08						23	56.081	-20	41.353	1012
	16/11/16			09:08					23	57.172	-20	41.472	1101
	16/11/16				10:14				23	57.126	-20	41.487	1098
062	16/11/16	11:06			12:03	AUV		Mission 132: END	23	53.57	-20	36.722	1599
063	16/11/16	13:51	13:59	15:22	16:39	GC	SE flank	Gravity coring	23	47.321	-20	36.351	3969
064	16/11/16	18:56	20:24		21:45	GC	SW flank	Gravity coring	23	47.23	-20	50.123	4197
065	17/11/16	00:28	01:43		03:06	GC	NE flank	Gravity coring	23	57.698	-20	35.463	3924
066	17/11/16	04:10				MB		Swath line 287	24	3.529	-20	34.399	4004
	17/11/16				08:11				23	42.804	-20	37.693	3921
067	17/11/16	09:57	11:25			AUV		Mission 133: START	23	52.411	-20	42.488	1000
068	17/11/16	12:24				ROV		DIVE 305: Plume experiment #1	23	52.605	-20	42.118	997
	17/11/16		13:17						23	52.605	-20	42.126	983
	17/11/16			22:14					23	52.644	-20	42.096	980
	17/11/16				23:10				23	52.602	-20	42.089	995
069	1/-18/11/2	23:41			05:51	CTD		CTD yoyo	23	52.484	-20	41.725	1005
070	18/11/16	06:57			07:03	AUV		Mission 133: END	23	53.644	-20	42.17	994
071	18/11/16	07:47	09:16		10:33	CTD		POC	23	55.671	-20	44.959	2262
072	18/11/16	12:32				ROV		DIVE 306: Plume experiment #2	23	50.468	-20	42.838	1028
	18/11/16		13:17						23	50.485	-20	42.838	1027
	18/11/16			20:42					23	50.495	-20	42.835	1028
	18/11/16				20:45				23	50.494	-20	42.841	1029
073	18/11/16	22:43	23:14		23:44	CTD			23	52.757	-20	42.743	994
074	19/11/16	00:19				AUV		Mission 134: START	23	52.852	-20	42.589	994
075	19/11/16	02:45	03:38		04:52	CTD	NE flank		23	56.172	-20	38.400	2578
076	19/11/16				07:33	AUV		Mission 134: END	23	53.467	-20	42.574	996

Station number	Date	Time start	Time at bott.	Time off bott.	Time end	Operation	Location	Objective	Latitude [°]	Latitude [dec min]	Londitude [°]	Londitude [dec min]	Depth [m]
077	19/11/16	09:53				SBP			23	58.037	-20	50.605	4086
	19/11/16				09:53				23	56.716	-20	51.05	3975
078	19/11/16	11:26				ROV	Western Spur	DIVE 307	23	57.81	-20	49.689	3970
	19/11/16		13:28						23	57.819	-20	49.711	3969
	20/11/16			10:51					23	55.272	-20	47.953	2394
	20/11/16				12:39				23	55.305	-20	47.958	2400
079	20/11/16	16:00				AUV		Mission 135: START	23°	52.783	-20	50.502	3500
080	20/11/16	20:17				ROV	Western summit	DIVE 308	23	54.741	-20	46.611	1362
	20/11/16		21:24						23	54.719	-20	46.622	1347
	21/11/16			10:11					23	53.759	-20	46.042	1119
	21/11/16				11:22				23	53.796	-20	46.095	1128
081	21/11/16					AUV		Mission 135: END	23°	53.1	-20	51.908	4150
082	21/11/16				17:58	CTD	Western flank	POC & microbiology	23	55.57	-20	48.14	2600
083	21/11/16	21:44				ROV	Western flank	DIVE 309	23	53.352	-20	51.496	3965
	22/11/16		00:14						23	53.341	-20	51.557	3932
	22/11/16			15:19					23	54.642	-20	49.117	2895
	22/11/16				17:12				23	54.584	-20	49.176	2895
084	22/11/16	19:15	21:32			AUV	Northern flank	Mission 136: START	24	0.897	-20	41.921	2849
085	22/11/16	23:15				ROV		DIVE 310 pavement drilling	23	53.816	-20	46.154	1087
	23/11/16		00:20						23	53.760	-20	46.073	1131
	23/11/16			11:08					23	53.771	-20	46.063	1130
	23/11/16				12:17				23	53.795	-20	46.032	1131
086	23/11/16				19:20	AUV		Mission 136: END	24	1.688	-20	41.64	3800
087	26/11/16	11:00			13:43	CTD		HRW #17	23	46.051	-20	44.906	3230
088	26/11/16	14:54				AUV		Mission 137: START	23	49.739	-20	42.835	1050
089	26/11/16	18:46				ROV		DIVE 311	23	54.21	-20	40.514	1025
	26/11/16		19:38						23	54.235	-20	40.505	1009
	27/11/16			09:37					23	54.268	-20	40.521	1013
	27/11/16				10:30				23	54.257	-20	40.513	1027
090	27/11/16				13:51	AUV		Mission 137: END	23°	51.327	-20	40.108	2050
091	27/11/16	15:38				ROV		DIVE 312	23	53.863	-20	30.329	3883
	27/11/16		18:10						23	53.841	-20	30.327	3877
	28/11/16			11:39					23	53.548	-20	33.414	2780
	28/11/16				13:25				23	53.527	-20	33.358	2782
092	28/11/16	13:55			16:08	CTD			23	53.528	-20	33.358	2635
093	28/11/16	17:30				AUV		Mission 138: START	23	54.509	-20	41.071	978
094	28/11/16	21:09				ROV	East spur	DIVE 313	23	53.427	-20	35.919	1950
	28/11/16		22:34						23	53.412	-20	35.896	1961
	29/11/16			13:12					23	53.516	-20	37.766	1319
	29/11/16				14:19				23	53.530	-20	37.729	1350
095	29/11/16				17:45	AUV		Mission 138: END	23	55.191	-20	41.196	1130
096	29/11/16	18:59			19:03	ROV		DIVE 314	23	53.268	-20	47.884	2355
097	11-30/11/2	23:52	01:08		02:30	GC	NW flank		24	0.404	-20	49.302	4052
098	30/11/16	04:13	05:08		06:20	CTD		HRW #11	23	56.721	-20	46.759	2960
099	30/11/16	07:16	08:12		09:42	CTD		HRW #10	23	54.080	-20	48.915	3052
100	30/11/16	11:14				ROV	SE flank scarp	DIVE 314	23	51.416	-20	41.081	1406
	30/11/16		12:10						23	51.338	-20	41.073	1397
	30/11/16			16:31					23	51.576	-20	41.208	1140
	30/11/16				17:27				23	51.591	-20	41.194	997
101	30/11/16	18:39			19:36	GC	Summit		23	50.812	-20	43.038	998
102	30/11/16	20:13				AUV		Mission 139: START	23	51.075	-20	43.167	984
103	30/11/16	22:09				ROV		DIVE 315 Plume experiment #3	23	51.129	-20	42.665	1013
	30/11/16		23:00						23	51.115	-20	42.649	1020
	01/12/16			08:50					23	51.116	-20	42.645	1019
	01/12/16				10:00				23°	52.112	-20	42.652	1100
104	01/12/16	14:00				ROV	SE plateau	DIVE 316 microbiology sampling & Ellsworth push core	23	51.202	-20	43.505	1000
	01/12/16		14:48						23	51.219	-20	43.483	1010
	01/12/16			17:03					23	51.214	-20	43.598	1012
	01/12/16				17:48				23	51.248	-20	43.595	1011
105	01/12/16				20:00	AUV		Mission 139: END	23	52.110	-20	41.191	1011

Station number	Date	Time start	Time at bott.	Time off bott.	Time end	Operation	Location	Objective	Latitude [°]	Latitude [dec min]	Londitude [°]	Londitude [dec min]	Depth [m]
106	01/12/16	21:24			22:35	ROV		DIVE 317: failed, wire problem	23	55.268	-20	47.874	2275
107	01/12/16	22:57				ROV	Western spur	DIVE 318	23	55.270	-20	47.873	2270
	02/12/16		00:31						23	55.262	-20	47.887	2352
	02/12/16			13:03					23	54.184	-20	46.527	1220
	02/12/16				14:06				23	54.211	-20	46.534	1250
108	02/12/16	16:02				AUV		Mission 140: START	23	54.583	-20	46.255	1227
109	02/12/16	20:08				ROV	South spur	DIVE 319	23	42.239	-20	43.594	3890
	02/12/16		22:27						23	42.206	-20	43.599	3888
	03/12/16			10:52					23	44.523	-20	44.523	2890
	03/12/16				13:06				23	44.440	-20	43.200	2900
110	03/12/16	14:50			16:10	CTD			23	49.370	-20	42.613	1280
111	03/12/16				18:20	AUV		Mission 140:END	23	49.279	-20	42.807	1066
112	03/12/16	19:10			21:09	CTD			23	46.498	-20	42.858	2077
113	03/12/16	21:36				ROV		DIVE 320	23	46.469	-20	42.828	2100
	03/12/16		23:00						23	46.490	-20	42.835	2077
	04/12/16			09:05					23	48.114	-20	43.219	1168
	04/12/16				10:11				23	48.089	-20	43.153	1166
114	04/12/16				15:15	MOORING	Mooring C (S site)	Mooring C recovery	23	40.728	-20	44.011	4191
115	04/12/16	18:57				AUV		Mission 141: START	23	49.103	-20	43.156	1068
116	04/12/16	21:04				ROV		DIVE 321	23	51.6	-20	44.62	1020
	04/12/16		21:54						23	51.601	-20	44.616	1016
	05/12/16			10:24					23	51.489	-20	44.506	1017
	05/12/16				11:10				23	51.532	-20	44.496	966
117	05/12/16				13:06	AUV		Mission 141: END	23	49.565	-2	41.797	1937
118	05/12/16				16:55	MOORING	Moorin A (N flank)	Mooring A recovery	24	1.376	-20	42.424	3098
119	05/12/16	18:53				ROV		Dive 322	24	1.929	-20	43.593	3338
	05/12/16		20:58						24	1.833	-20	43.576	3303
	05/12/16			23:14					24	1.612	-20	43.757	3208
	06/12/16				01:20				24	1.638	-20	43.72	
120	06/12/16	03:21	04:30		05:31	CTD		HRW #18	23	49.971	-20	47.187	3231
121	06/12/16				09:04	MOORING	Mooring B (centre)	Mooring B recovery	23	53.324	-20	41.51	998
122	06/12/16	10:10				INCUBATOR	Centre site	Test	23	53.323	-20	41.51	997
123	06/12/16	13:52	14:20			CTD		CTD (Failed termination)	23	53.374	-20	56.467	895
124	06/12/16	16:30	17:33			GC		Summit area, 10 cm recovery	23	50.556	-20	42.737	1030
125	06/12/16	18:08				GC		Summit area, no recovery	23	52.62	-20	41.55	999
126	06/12/16	22:57				SWATH		Mapping	23	57.84	-20	33.84	4010

CTD = condustivitty, temperature and depth
ROV = Isis 6500m remotely operated vehicle
AUV = Autosub6000 autonomous underwater vehicle
Mooring = moored instrument array
GC = gravbity core (3m barrel)
Incubator = Zubkov microbial in situ incubator

2 JC142 NMFSS SHIP SYSTEMS REPORT

by Mark Maltby (Science Systems Tech)

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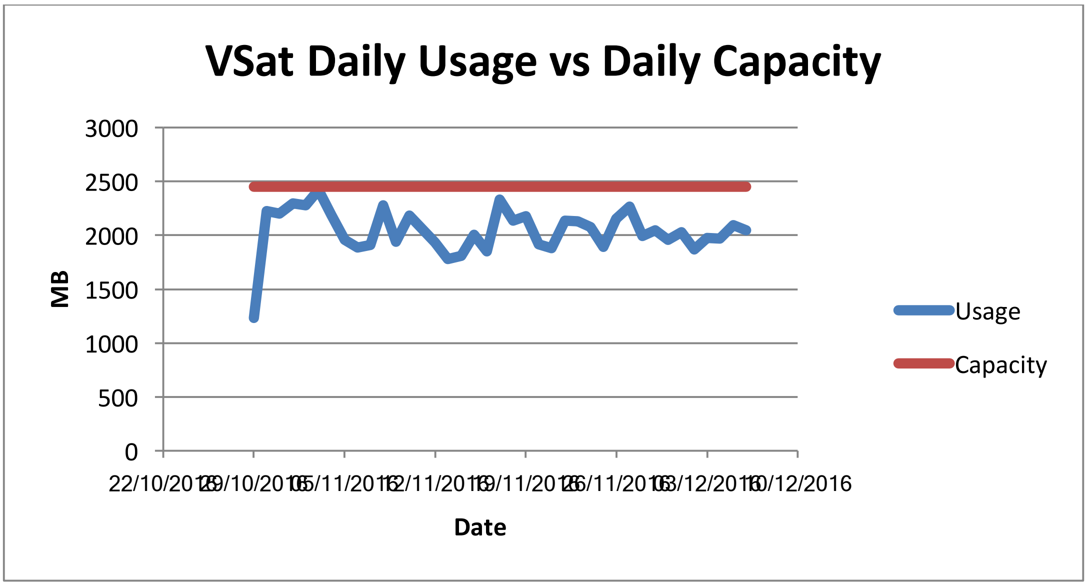
2.1 SHIP SCIENTIFIC COMPUTING SYSTEMS

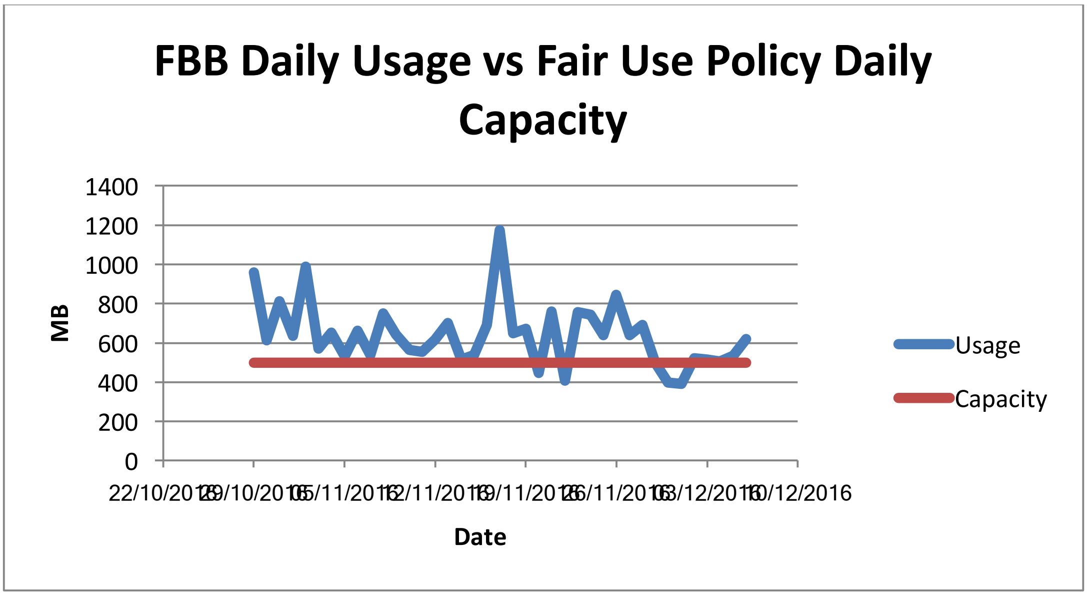
Network drives were setup on the on-board file server; firstly a read-only drive of the ships instruments data and a second scratch drive for the scientific party. Both were combined at the end of the cruise and copied to disks for the PSO and BODC.

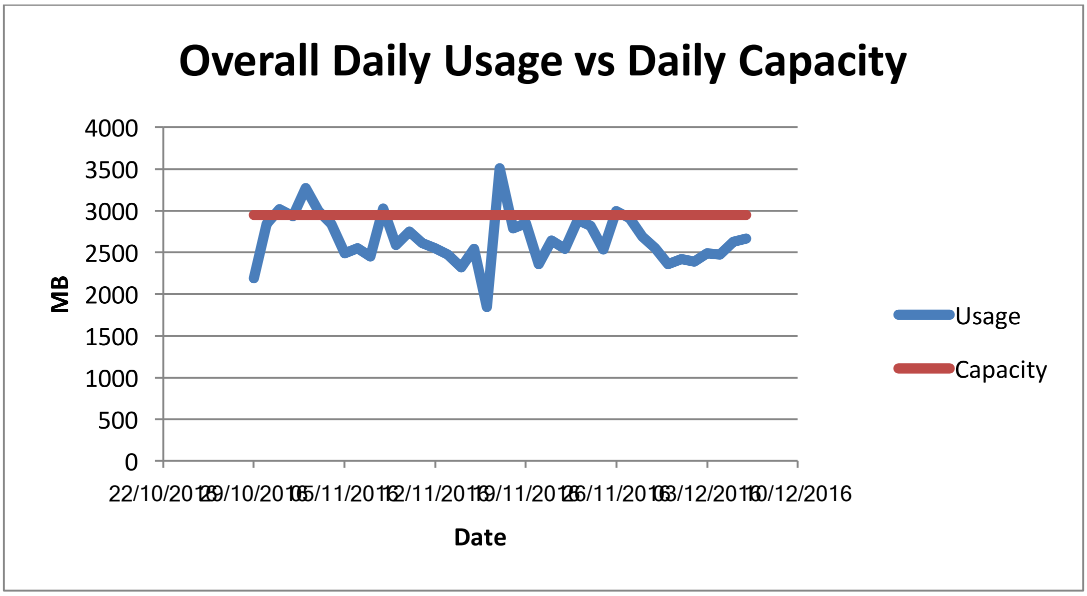
Data was logged by the Techsas data acquisition system into NetCDF files. The format of the NetCDF files is given in the file NMFSS_NetCDF_Description_Cook_v2.docx. The instruments logged are given in JC142_Ship_fitted_information_sheet.docx. Data was additionally logged into the RVS Level-C format, which is described in the same documentation.

ASCII output was generated for daily summaries of 1 second and 1 min resolution. The read_netcdf.py script was used to create these ascii files from the Techsas NetCDF. The output from this program is included on the data disk in the directory: Ship_Systems\Techsas\Ascii_from_NetCDF\. There are also ASCII dumps of all the Level-C streams included on the data disk in the directory: Ship_Systems\Level-C\prodata\ascii\

Satellite Communications were provided with both the Vsat and FBB systems. The Vsat had a guaranteed speed of 256kbps unlimited data, the FBB had a maximum un-guaranteed speed of 256kbps with a fair use policy that equates to 15 GB of data a month. The traffic for the cruise was in the region of what is now the norm; this resulted in the system being stretched to the limit.







2.2 POSITION AND ATTITUDE

All GPS and attitude measurement systems were run throughout the cruise.

The Applanix POSMV system is the vessel's primary GPS system, outputting the position of the ship's common reference point in the gravity meter room. The POSMV is the GPS sent to all systems and is repeated around the vessel. The POSMV failed and was rebooted which created a gap in the data on 15th November 2016 from 11:02:35 to 11:06:17.

The Seapath 300 system is the vessel's secondary GPS system, this was the position and attitude source that was sent to the EM120 due to it's superior real-time heave data. Applanix POSMV TRUE heave were also logged and could be used in reprocessing. These *.ath files can be found on the data disk in Ship_Systems\Acoustics\EM-120\Delayed Heave\

The CNav 3050 GPS system is the vessels correction service, which is feed to the POSMV and Seapath systems to enable <10cm position accuracy.

Course Made good and Speed Made Good computations in all GPS systems has been compromised due to the failure of the ships stability system, while at slow speeds the CMG was seen to be at 90 degrees to the ships heading.

2.3 SPEED LOGS

The single axis bridge Skipper Log and the dual axis Chernikeef science log were logged. The Cherinkeef log was calibrated in September 2016.

On arrival at the ship it was found that the Chernikeef was defective showing full-scale deflection of minus 20 knots in the fore/aff axis and minus 5 knots in the port/stbd axis. The problem was rectified but the data is in error for the following periods.

Start Date/Time	End Date/Time
29/10/16 10:46:34	04/11/16 06:10:00

08/11/16 12:54:49	08/11/16 14:20:20
14/11/16 15:07:42	15/11/16 15:02:56

2.4 METEOROLOGY AND SEA SURFACE MONITORING PACKAGE

The Surfmet system was run throughout the cruise. Please see the separate BODC information sheet JC142_Surfmet_sensor_information_sheet.docx for details of the sensors used and the calibrations that need to be applied. The calibration sheets are included in the directory Ship_Systems\Met\SURFMET\calibrations.

The non-toxic water supply was active from 09:59:25 on 30th October 2016 until 00:08:00 on 24th November 2016 and from 03:20:00 on 26th November 2016 until 06:55:00 on 7th December 2016. The break in logging was due to leaving international waters for a port call in Tenerife.

There was a period of system failure on the 1st December from 11:29:46 – 12:11:51 where data is in error showing full-scale deflection in most channels.

The Non-toxic water supply was turned off and the sensors cleaned at intervals throughout the cruise details below. Transmissometer readings were taken after cleaning with the sensor in open air and closed off to light, readings are also below.

Date	Time	Event
30/10/16	09:59:25	Underway Started - Trans open 4.6490v closed 0.0581v
08/11/16	10:13:10	Underway Shutdown for cleaning
08/11/16	10:26:00	Underway Restarted - Trans open 4.6490v closed 0.0581v
15/11/16	13:18:00	Underway Shutdown for cleaning
15/11/16	13:46:00	Underway Restarted - Trans open 4.6460v closed 0.0581v
21/11/16	09:40:00	Underway Shutdown for cleaning
21/11/16	09:50:00	Underway Restarted - Trans open 4.6461v closed 0.0581v
23/11/16	16:00:00	Underway Shutdown for Rescue
23/11/16	16:38:00	Underway Restarted
24/11/16	00:08:00	Underway Shutdown – Exit international waters
26/11/16	03:20:00	Underway Restarted –Trans open 4.6458 v closed 0.0581v
05/12/16	08:08:40	Underway Shutdown for cleaning
05/12/16	08:22:30	Underway Restarted –Trans open 4.6458 v closed 0.0581v
07/12/16	06:55:00	Underway Shutdown – Exit international waters
		After cruise cleaning – Trans open 4.6459v closed 0.0581v

TSG Samples were taken as below. Salinity reading can be found in:
\Ship_Systems\Met\tsg_salinities

Date	Time	Crate No.	Bottle No.
01/11/16	15:04:30	3	49
01/11/16	19:07:07	3	50
02/11/16	08:14:00	3	51
02/11/16	19:52:30	3	52
03/11/16	08:08:00	3	53
03/11/16	19:20:25	3	54

04/11/16	07:15:15	3	55
04/11/16	19:11:45	3	56
05/11/16	08:05:19	3	57
05/11/16	20:04:15	3	58
06/11/16	08:00:00	3	59
06/11/16	19:54:20	3	60
07/11/16	08:20:25	3	61
07/11/16	21:45:15	3	62
08/11/16	08:27:30	3	63
08/11/16	20:13:50	3	64
09/11/16	08:22:00	3	65
09/11/16	20:02:00	3	66
10/11/16	07:57:00	3	67
11/11/16	09:21:20	3	68
12/11/16	09:13:17	3	69
12/11/16	20:54:00	3	70
13/11/16	09:07:25	3	71
13/11/16	19:22:00	3	72
14/11/16	08:16:12	1	1
15/11/16	08:12:15	1	2
15/11/16	19:46:43	1	3
16/11/16	08:03:50	1	4
16/11/16	20:16:00	1	5
17/11/16	12:17:40	1	6
17/11/16	20:04:09	1	7
18/11/16	08:10:40	1	8
18/11/16	19:22:35	1	9
19/11/16	08:28:40	1	10
19/11/16	19:47:30	1	11
20/11/16	08:30:20	1	12
20/11/16	19:55:50	1	13
21/11/16	08:32:20	1	14
21/11/16	20:27:20	1	15
22/11/16	08:13:25	1	16
22/11/16	20:08:50	1	17
23/11/16	08:14:06	1	18
23/11/16	19:09:00	1	19
26/11/16	08:45:50	1	20
27/11/16	08:09:30	1	21
27/11/16	20:43:00	1	22
28/11/16	10:01:45	1	23
28/11/16	18:53:43	1	24
29/11/16	08:48:20	6	122
30/11/16	08:27:10	6	121
30/11/16	18:17:40	6	123
01/12/16	08:11:06	6	124
02/12/16	08:03:24	6	125
02/12/16	20:38:18	6	126
03/12/16	08:16:30	6	127
04/12/16	08:10:40	6	128
04/12/16	19:55:10	6	129
05/12/16	08:04:30	6	130

05/12/16	18:27:15	6	131

2.5 DROP KEELS AND ECHOSOUNDERS

During the cruise the port drop keel was lowered in an attempt to improve the quality of the ADCP's data. The table below shows the timing of the movements these affect the ADCP's and EA600 settings in these were changed to compensate apart from on the 26/11/16 where the technician wasn't informed of the request to move the drop keel. Setting were adjusted in both the ADCP's and EA600 at 08:12:00 on 27/11/16 and on the 01/12/16 when the technician wasn't informed of the move therefore all data from 01/12/16 until 07/12/16 10:30:00.

Date	Time	Transducer Depth
29/10/16	00:00:00	6 m
12/11/16	19:38:00	8.7 m
23/11/16	14:27:00	6 m
26/11/16	12:00:00	8.7 m
01/12/16	13:38:00	6 m

2.5.1 KONGSBERG EA600 12 KHZ SINGLE BEAM ECHO SOUNDER.

The EA600 single-beam echo-sounder was run throughout the cruise, while in international waters it was run in passive mode triggered with the EM120. It was used with a constant sound velocity of 1500 ms^{-1} throughout the water column to allow it to be corrected for sound velocity in post processing. As well as depths being logged to the Techsas and Level-C data loggers, files were saved as .BMP images and in raw Kongsberg format.

EA600 settings were changed to compensate for drop keel movements apart from on the 26/11/16 where the technician wasn't informed of the request to move the drop keel. Setting were adjusted in the EA600 at 08:12:00 on 27/11/16 and on the 01/12/16 when the technician wasn't informed of the move therefore all data from 01/12/16 until 07/12/16 10:30:00 is not compensated. There are breaks in the data due to the acoustic instrumentation being isolated during Autosub and moorings deployment and recovery.

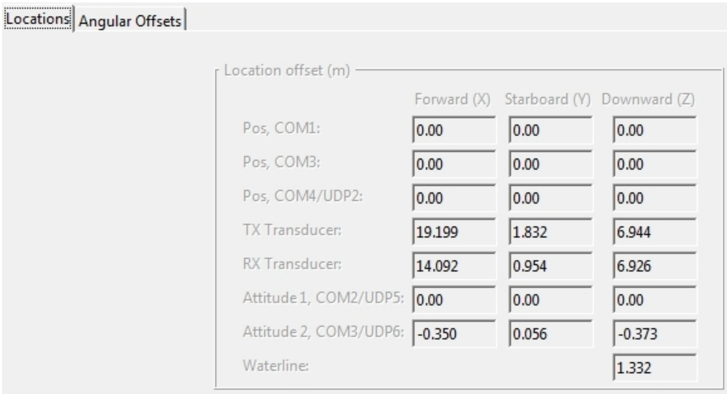
2.5.2 KONGSBERG EM120 DEEP WATER MULTI-BEAM ECHO SOUNDER

The EM120 multi-beam echo sounder was run throughout the cruise while in international waters. Data was logged in Kongsberg .all format. The centre beam depth was logged to Techsas and Level-C. There are breaks in the data due to the acoustic instrumentation being isolated during Autosub and Moorings deployment and recovery.

The EM120 was fed attitude and position data from the Seapath 300 system due to it's superior real time heave. Applanix POSMV True heave was also logged so is available for reprocessing. These *.ath files can be found on the data disk in : Ship_Systems\Acoustics\EM-120\Delayed

Heave\. The beam angle was set to 70° during transits and 45° while in the work area. At all times the spacing was equidistant.

The following figures show the system installation configuration. The values ordinate from the ships BLOM survey report, which is included on the data disk. The attitude angular corrections for use with the Seapath 300 system were derived from a post refit trial calibration on JC108 Sept 2014. The attitude angular corrections for use with the Applanix Posmv system are from calibration during JC103 May 2014.

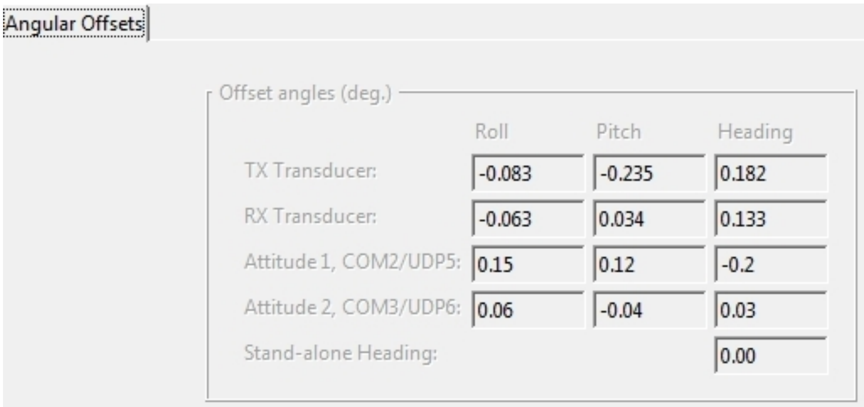


Locations | Angular Offsets

Location offset (m)

	Forward (X)	Starboard (Y)	Downward (Z)
Pos, COM1:	0.00	0.00	0.00
Pos, COM3:	0.00	0.00	0.00
Pos, COM4/UDP2:	0.00	0.00	0.00
TX Transducer:	19.199	1.832	6.944
RX Transducer:	14.092	0.954	6.926
Attitude 1, COM2/UDP5:	0.00	0.00	0.00
Attitude 2, COM3/UDP6:	-0.350	0.056	-0.373
Waterline:			1.332

Figure 1 - EM120 transducer locations



Angular Offsets

Offset angles (deg.)

	Roll	Pitch	Heading
TX Transducer:	-0.083	-0.235	0.182
RX Transducer:	-0.063	0.034	0.133
Attitude 1, COM2/UDP5:	0.15	0.12	-0.2
Attitude 2, COM3/UDP6:	0.06	-0.04	0.03
Stand-alone Heading:			0.00

Figure 2 - EM120 transducer offsets

2.5.3 KONGSBERG SBP120 SUB BOTTOM PROFILER

The SBP120 Sub Bottom Profiler was run throughout the cruise while in international waters. There are breaks in the data due to the acoustic instrumentation being isolated during Autosub and Mooring deployment and recovery. Data was recorded in Kongsberg raw format and in Seg-Y format.

The SBP120 runtime parameters initially used are shown in figure 3, the echogram display settings are show in figure 4, the legend settings for the display are shown in figure 5. The only processing options enabled were in the following order below. These were the suggested settings from the Kongsberg training notes. After the initial setup the scientific party took control of the setup. The data quality is good during transit between stations but poor on station due to the azimuth thruster wash. Hard copy of the data was printed.

The SBP120 software is included with the data for replay and reprocessing.

Gain correction: Transmission loss: 0.7 dB/km	**Attribute processing:** Inst. amplitude
Filters: Filter type: Matched, Corner frequencies: Auto Replica shaping: enabled	**Gain:** Filter coefficient 0.5

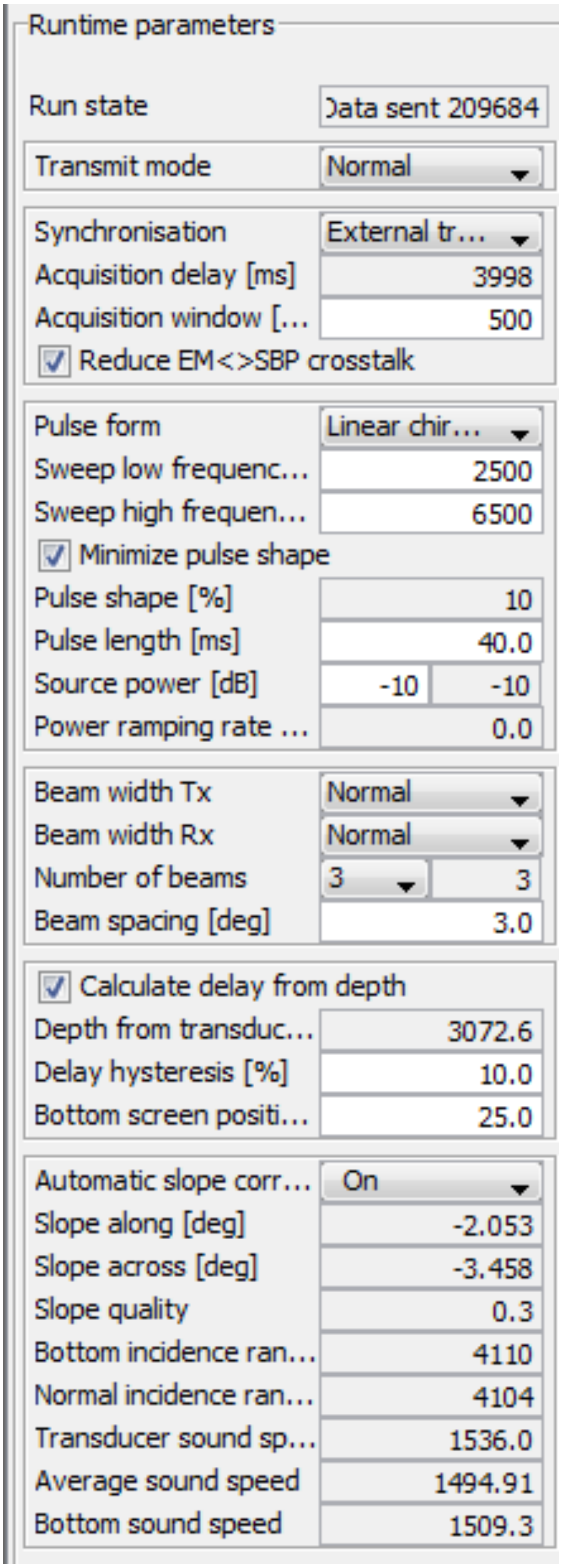


Figure 3 - Sub Bottom Profiler Runtime Parameters.

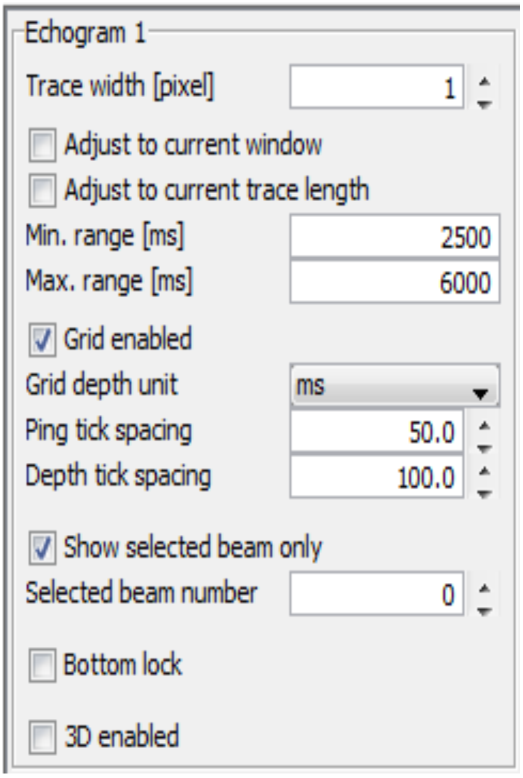


Figure 4 - Sub Bottom Profiler Echogram display settings.

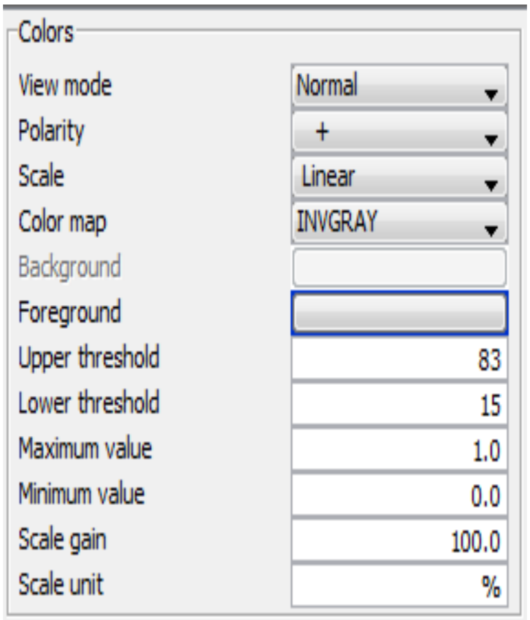


Figure 5 - Sub Bottom Profiler Legend display settings.

2.5.4 SOUND VELOCITY PROFILES

A Valeport Midas SN 22355 sound velocity profiler was attached to the CTD. The profiles are included on the data disk. The raw files downloaded from the instrument have a file extension .000. The files were then processed using the SVP Editor in the Kongsberg SIS program. A files is then produced with extension .asvp and is the sound velocities and depths of the entire cast. The profile is extended to 12000m by the SVP editor and finally then thinned by the SVP editor with a scale factor of 0.2. Below shows the thinned files that were loaded into SIS on the EM120. The same profiles were loaded into the USBL system in the *.pro format. The calibration sheets for the profiler is located in the directory: Ship_Systems\Acoustics\Sound_Velocity_Profiles\SVP_Probe\Calibrations\.

All CTD casts were also reprocessed to create sound velocity profiles.

Installation Time	Profile	Location
Start of cruise	default_salinity_03500.asvp	
31/10/2016 05:01	JC142_Station003_sorted_extended_thinned	N 23° 42.93' W 020° 46.73'
13/11/2016 01:02	JC142_Station51_sorted_extended_thinned	N 23° 59.91' W 020° 46.43'
26/11/2016 13:59	JC142_Station087_sorted_extended_thinned	N 23° 46.05' W 020° 44.91'

2.5.5 75 KHZ AND 150 KHZ HULL MOUNTED ADCP SYSTEMS

Both the 75 kHz and 150 kHz ADCP systems were run during the cruise while in international waters. The raw data files are included on the data disk. The configuration files are included on the data disk. To summarise the configuration, the 75 kHz was run in broadband mode with 48 bins of 16 m with an 8 m blank. The 150 kHz was run in narrowband mode with 96 bins of 4 m with a 4 m blank. Heading alignment in the configuration files was set to 0° for both instruments. As there was no bottom track data from this cruise to calculate instrument alignment data with bottom track enabled from JC137 passage in the English Channel was provided.
The ADCP's were set to free run as the science party didn't wish to compromise the other acoustic instruments repetition rate.

ADCP settings were changed to compensate for drop keel movements apart from on the 26/11/16 where the technician wasn't informed of the request to move the drop keel. Setting were adjusted in the EA600 at 08:12:00 on 27/11/16 and on the 01/12/16 when the technician wasn't informed of the move therefore all data from 01/12/16 until 07/12/16 10:30:00 is not compensated.

2.5.6 SONARDYNE USBL

The ships USBL system was used with the ships WMT beacons to track Autosub and Incubator deployments and recoveries.
Position information was recorded to the Techsas data acquisition system in NetCDF format and also to the level-C system.
The NetCDF data was then dumped to ASCII and can be found in
Ship_Systems\Acoustics\USBL\Ranger2\Ascii_from_NetCDF

The ROV group used the Starboard USBL head with their own topside unit. All ROV position data was logged by the ROV Group and isn't included with the Ship data.

2.6 OFOP

The ships OFOP system was used throughout the cruise for Autosub deployments and recoveries for display purposes only. This system is feed ships position and heading from the Seapath 330 and vehicle position and depth from the Sonardyne USBL system. Data files can be found on the data disk in directory /Ship_Systems/OFOP.

2.7 WAMOS WAVE RADAR

The WaMos wave radar was not requested but was run for part the cruise for display use only to add the bridge in positioning the ship after the roll stability system failed. The summary data files are included on the data disk.

3 ISIS ROV SYSTEM REPORT

NMFSS Senior Tech:	James Burris (AUV Lead)		
ROV Supervisor:	Dave Turner		
NMF ROV Team:	Andy Webb	Dave Edge	
	Russell Locke	Allan Davies	
	Josue Viera	Antonio Campos	
NMF AUV Team:	Ella Richards	Racheal Marlow	
NMF Tech Team:	Richie Phipps	Owen Shepherd	
	Jeff Benson	Nick Rundel	Mark Maltby

3.1

3.2 CRUISE OUTLINE

Objective: To carry out a 40 day cruise to conduct AUV and ROV operations in the North East Atlantic on the Tropic Seamount. The ROV has been modified to facilitate the addition of a rock drill for taking samples of the manganese crusts.

ROV Dive Stats	
No. of dives JC142	26 (Dive nos. 297 to Dive no. 322)
Total run time for (JC142) thrusters:	367.03 hrs
Total time at seabed or survey depth:	300 hrs
Isis ROV *total* run time:	4563 hrs
Max Depth and Dive Duration: (25.18 hrs in water)	3979 m and 21.0 hrs (Dive 307)
Max Dive Duration and Depth: (25.18 hrs in water)	21.0 hrs at 3979m (Dive 307)
Shallowest Depth and Duration (20.08 hrs in water)	999 m for 18.0hrs (Dive 298)
Recorded Data:	Techas (12.59 GB)
	CTD (392MB)
	DVLNAV (28.73 GB)
	Sonardyne (6.51 GB)
	OFOP Event Logger (836.8 MB)
	Video (56 TB)
	Scorpio Digital Still (57.92 GB)
	Database (10.43GB)
Master 1 & 2 Lacie Raid units SER# RVL0001B6DB7C9AD39B and SER# TBC will return to NOC onboard and be installed in the BODC media room for archiving and access for science post expedition.	
Backup 1 & 2 Lacie Raid units SER# RVL0001B6E818AE6F70 and SER# TBC will remain installed in the ROV control container 2.	

3.3 MOBILISATION

3.3.1 SOUTHAMPTON (NOC) 17TH OCT TO 20TH OCT 2016

The Isis ROV system was mobilised in Southampton. This was a straight forward installation with a 7000kg and 9000kg load test carried out carried out at the request of the cruise manager. There is still an unanswered question as to whether or not this test should be carried out during every mobilisation. It takes time and inevitably delays getting on with the ROV system installation.

The termination of the umbilical was made, but due to various ship delays the load test was unable to be carried out prior to the vessel sailing. The new fusion spice system was used for the terminating of the umbilical fibres, taking approximately 1hr to complete all three. Attenuation levels through the complete system were all recorded below 8dB.

During the testing of the winch system it was noted that the back tension on the storage drum kept dropping out. This was later tracked down to a loose connection on one of the main hydraulic lines quick release connectors to the storage drum. During this fault finding process it was also noted that the brakes on the traction head would not release unless both pump string motors were in operation. As we do not generally run the system on one motor, it is possible that this fault could have been with us for a while. This issue was later rectified, (see notes in HPU section).

3.3.2 TENERIFE (SANTA CRUZ), 8TH DEC TO 10TH DEC 2016

Due to the excessive rolling of the vessel, as result of the anti-roll tanks failure, it was not possible to move the ROV from the LARS using the ships crane. As a consequence of this the ROV handling system was not able to be made ready for lifting off the vessel on arrival. Following the berthing of the vessel and the placement of the gangplank, the crane was able to lift the ROV shore-side. The LARS and associated hydraulics were then stowed and disconnected respectively.
All containers and equipment were lifted shore side without any problems. All equipment was then transferred to the Discovery using the shore side tele-handler and flatbed truck.

Historically eight ROV engineers have been deployed onto cruises to support 24hr ROV operations. Typically this would be four engineers on each watch to cover a 12hr period. With the right combination of engineers on each watch the ROV could be deployed and recovered any time throughout the 24hrs. As the ROV group only has seven engineers, the eighth engineer has always been an ROV contractor with many years of experience in this type of specialist vehicle (namely an ex WHOI ROV pilot).

Generally the operation of the ROV can be covered by three engineers once the vehicle has been deployed. This requires one engineer to pilot the vehicle and other engineer to take the samples. The third engineer operates the cameras and monitors the system, making all the necessary checks. This process is rotated giving the required breaks from each roll as the engineer's cycle through. Providing the sampling demand is manageable this process with three pilots can be sustained for a few hrs. The addition of the fourth pilot eases the work load allowing for more frequent breaks over a 12hr period and allows enough cover during meal breaks.

In an attempt to reduce the amount of manpower to operate the ROV it was decided that the ROV group of engineers (7) would run 24hr operations without the additional cost of a contractor for the cruise. To allow this to happen and to make the watches manageable it was necessary to run two 12hr watches of three pilots (04-00 to 16-00hrs and 16-00 to 04-00hrs) and one watch of 12hrs covering both watches for an even period of 6hrs (10-00 to 22-00hrs). This watch pattern meant that the ROV could only be launched or recovered in the 12hr period of 10am to 10pm when four engineers were available, unless a technical issue came to light where the vehicle needed to be recovered, and an engineer needed to be disturbed out of hrs.

Prior to this cruise the science team were informed of the ROV operating schedule, and were happy to plan around this requirement. For the majority of this cruise this worked very well with a few hours here and there of flexibility required from both parties to meet the daily plans.

3.4 HYDRAULIC POWER UNIT (HPU)

Following further investigation into the issue of not being able to run the system on one pump string, as mentioned in the mobilisation notes, it was remembered that a similar problem had occurred on a previous cruise. This previous problem was linked to the proximity switches on the ball valves. Various tests were carried out to the proximity switches, with relay K19 being replaced, as it was thought that this one was related to the ball valve in question. Further investigation revealed that the relays were in good working order and that the mechanical part (the lever) that activates the switches appeared to not be making the required contact when the ball valve was opened or closed. This was due to the gap between the lever and the switch being too big. With some slight adjustments made to the position of the sensors, the problem was rectified, with no further problems encountered. The relay that was removed from the system was returned to the spares as a working unit and was marked as used.

During the wire stream of the umbilical it was noted that there was a loud noise coming from the traction winch when a speed >30m/min was applied to the system. Following some investigation it was determined that an oil flow issue could be causing the problem, 'starving' the motor of oil. With the introduction of new Quick Disconnects (QD's) on the last cruise to the storage drum and traction winch supply it was decided that these could potentially be causing the issue, even though this issue did not come to light during that cruise. As soon as these connectors were removed from the hoses, the problem went away and the winch performed normally for the rest of the cruise. It is now thought that some of the back tension issues encountered at various times may also be linked to these connectors, and that it may just have been fortunate that because we had a leaking QD connector on the previous cruise, which was removed, may have prevented the issue from manifesting to its full potential.

Future modification/requirements:

- Quick release connectors to be returned to Pirtek, as not fit for purpose.
- Inform Mark at Pirtek that these fitting come loose during operation, causing a host of problems.
- Inform Mark at Pirtek that the QD's supplied could not meet the flow requirements of the system.

3.5 STORAGE DRUM/TRACTION WINCH

With the removal of the QD's from their pressure and return lines no further problems were encountered. The possible issue from the previous cruise, with the drum losing back tension at times, is most likely attributed to the one QD that was on the system for that cruise.

During dive 300 it was noted that some gaps in the scrolling of the umbilical were starting to appear which got worse as the dive went on and the umbilical was recovered. Following this dive it was requested that a wire stream beyond 4000m was carried out, as it was thought at the time, that the back tension issue seen previously may have something to do with the way the umbilical had laid onto the drum during the previous wire stream.

Due to ships position not being at the required water depth, beyond 4000m, the wire could only initially be deployed to 3500m. Unfortunately this was about ½ a lay short of the problem on the storage drum. The ship started a slow steam of 0.6 knts in a NW direction towards deeper water. After approximately 2hrs enough water depth was achieved to get the required amount of umbilical out to get past the possible problem on the storage drum. With 4008m wire out, the scrolling was re-aligned and the wire began to lay on the drum correctly. A max hauling speed of 33m/min was carried out reducing to 18m/min at the ends of the drum to ensure that the wire spooled nicely onto the next lay. After a couple of lays there no longer appeared to be any problems and the wire was scrolled correctly onto the storage drum.

During Dive 307 when the umbilical passed the 4008m wire out, it was noted that at the same point on the drum cheek that the wire did not lay correctly on the first attempt as it was hauled in. Following a second slower attempt the umbilical laid correctly and continued to scroll correctly as the wire was hauled onto the drum.

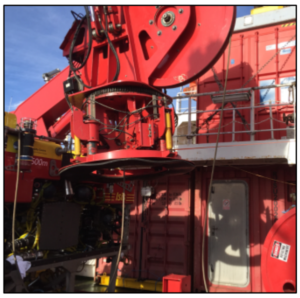
At various times early in the cruise it was noted that a distinctive squeak was emanating from the storage drum brake. This was identified as partial seizing of the floating part of the assembly due to salt water ingress. The assembly was cleaned and greased and the squeak was eliminated. It is important on future cruises to regularly lubricate this part to prevent reoccurrence.

The winch control at the engineer's station appears to be suffering from lack of range when the winch is being hauled or veered. Varying speeds have been observed with the lever in the same position.

3.5.1 FUTURE MODIFICATION/REQUIREMENTS:

- Check brake assembly.
- One tombstone on storage drum baseplate will require small amount of modification on return to Southampton as unable to fit mounting bolt.
- Small rear storage baseplate requires painting on return to Southampton.
- Remove umbilical from storage drum and re-spool from the reeler winch checking the scrolling proximity switches for their correct change over point. Some adjustment to the end stop bars may be required. An end for end of the umbilical should be considered.
- Replace/repair engineers winch control lever.
- Slip-ring to be removed and the F/O part to be switched back from the unit taken out of the TMS. The whole unit is to then be returned to manufactures for complete overhaul.

3.6 LAUNCH AND RECOVERY SYSTEM (LARS)



It was noted during the recovery of Dive 300 (Wed 9th Nov) that a 'knocking' noise could be heard when the tugger wheel was engaged. This seemed to worsen until such that the sound could be heard even when the assembly was not engaged. To prevent any unknowns the tugger assembly was disengaged for the remainder of the recovery, and the winch driven slowly to minimise the mechanical noise. As there was also a problem with the scrolling of the umbilical, which required it to be streamed again, the ROV was rotated on deck, enabling the docking head to be lowered and secured on the inboard side of the ROV. See pic.

This lowered position enabled a thorough inspection of the docking head, where it was identified that the sprocket that drives the main sheave was badly worn and no longer engaging in the drive chain. The sprocket was replaced with a spare, and aligned accordingly to the drive chain on the sheave. The drive chain was also repaired at this stage requiring a couple of weld tacks, to secure it back to the sheave plate.

During the deployment of Dive 314 the powered sheave would not engage and put tension onto the inboard side of the umbilical when the ROV reached the water. Due to this the ROV was recovered to latches and returned to deck. First thoughts on the issue led to the pressure sensor on the tugger assembly hydraulic block. With the sensor adjusted the sheave assembly was able to drive, which at this time was thought to allow the dive to proceed. Unfortunately further tests revealed the sheave would only allow the umbilical to be paid out and would not rotate when the umbilical was hauled in.

The tell-tale signs of a pressure related problem were still present as the tugger ram would only move slowly into position, and the tension on the control consul was only indicating 120kg with the tugger activated where normally it would indicate 500 to 600kg. A pressure gauge was attached to TP1 on the tugger assembly valve block to establish system pressure. This read the correct pressure of 3000psi. The pressure gauge was then attached to TP5 to read the pressure on the ram assembly. This read 300psi where it should have been reading 1800psi. To increase the pressure valve PRRV-21 was adjusted. It was anticipated that this valve would need to be changed, but fortunately the adjustment seemed to work. Following the increase in pressure the ram activated at faster speed applying a higher pressure on to the sheave, increasing the tension to approx. 800kg.

The pressure sensor that was originally thought to be problematic was re-adjusted to set the sequence of the ram engaging onto the sheave before the sheave started to rotate.
It remains a mystery as to why the pressure would have decreased without the valve failing, however no further problem were encountered with the system

3.6.1 FUTURE MODIFICATION/REQUIREMENTS:

- Inspect sheave drive sprocket/chain.
- Check tugger wheel assembly.
- Add drive chain sprocket/chain to inspection and testing procedure.
- Procure replacement spare sprocket, and re-evaluate spares for complete assembly.
- Spare pressure sensor

- Procure test gauges and tails.

3.7 UMBILICAL

The umbilical was terminated and load tested during the mobilisation. A load of 7000kg was applied and held for 5 minutes.
From issues experienced on the previous cruise it was decided that the black fibre would not be used, and would be made available as a spare. With the use of the new fusion splice kit, the fibre terminations were made efficiently and effectively achieving much lower losses through the system. Prior to this cruise new F/O leads were put through the slip-ring and new inboard ends were made to the umbilical using the fusion splice method. Additionally a new patch panel was installed into the control container, eliminating a couple of unnecessary patch leads.
Following the termination the following attenuations for each fibre were recorded from the vehicle end to the control container patch panel.

The attenuation for each fibre was recorded as:

Black	1310 – 7.47db 1550 – 6.13db
Red	1310 – 6.01db 1550 – 5.10db
Grey	1310 – 7.69db 1550 – 6.19db

Prior to connection of the umbilical to the ROV a 4000m stream was to be carried out. This depth was identified as being the max ROV deployment for this cruise. On arriving at station, Sun 30th October, the umbilical was vertically streamed to a depth of 4000m using the ROV weight assembly of 1750kg. During this process the ROV C5 and G6 (WMT) beacons were tested, attached to the deployment weight, in their bespoke mounting brackets. The wire was lowered at a max rate of 40m/min, and remained at depth for one hour before being hauled to the surface at 40m/min. Both beacons tracked well.

Unfortunately following the umbilical stream, and the requirement to remove the protective tube to enable assembly of the termination, the F/O tails were damaged, and were deemed not suitable for operations. To prevent further risk of damage whilst running the termination into the vehicle it was decided that the new ends would be put on once this had been carried out. This method proved to work well and is worth adapting for future cruises.

A new set of attenuation figures were recorded:

Red	1310 - 6.0db	1550 – 6.8db (used for vehicle telemetry)
Grey	1310 – 6.4db	1550 – 6.3db (used for CWDM)(blue cable tie)
Black	1310 – 9.2db	1550 – 8.7db (not used based on problems encountered on previous cruise)

Based on the attenuation for each fibre, red fibre was chosen to be used for the vehicle telemetry and the grey fibre for the CWDM and HD cameras. To help reduce the chance of damage whilst removing and placing the protective cover over the fibres and electrical connections, the circular ring that is part of the gimbal assembly needs to be machined such that a Dorn fitting will pass through. This will enable the protective sleeve to remain on the umbilical whilst the assembly is put together, following the wire stream.

Following Dive 300 a second vertical stream was carried out to help correct the bad scrolling that was starting to develop. Ref 4.2 Storage Drum. Again during dive 307 the umbilical did not scroll onto drum correctly at the same point identified during the previous stream (Inboard storage drum cheek at 4008m wire out). This was again corrected by running the winch slowly as the new lay started on the drum. No further problems were encountered as there was no requirement to dive to that depth again.

The management of the umbilical was carried by the addition of a Sonardyne G6 WMT beacon attached to the umbilical. This beacon was attached at approximately 50m after the last football float, generally around the 150m wire out position with the ROV stopped at 100m depth. During operations the attached umbilical beacon gave a good indication of the vertical wire position enabling the ROV to maintain a good position relative to the umbilical and the ship.

During the power up for Dive 313(16) it was noted that the science camera would only work intermittently. The camera was power cycled followed by a complete system power cycle, including the prizm unit, both of which made no difference to the situation. A check of the Fibre Optic SDI receivers (rattlers) showed that the Pilot and the Scorpio units only had one level of LED's on with science showing none. These signal levels taken through the CWDM were low compared to the start of the cruise where 3 LED's were indicated. The first LED indicates power with the 2nd and 3rd indicating signal strength. With all three lower it was clear that the fibre going to the CWDM was showing signs of failure. To rectify the situation the black fibre (spare) in the umbilical was connected to the CWDM in the vehicle junction box. This quick modification proved to reinstate the F/O SDI receivers to their normal levels, allowing all the cameras to function normally again.
Approximately half an hour was lost to this process and delay to the launch of the ROV.

Following Dive 318(22) which involved the ROV a having an encounter with a cave, the vehicle was inspected for damage, especially on top of the vehicle and the gimbal arrangement. During these checks it was noted that the umbilical had accumulated several turns under the docking bullet. See Pic.

To avoid a re-termination in the late stages of the cruise it was decided that the termination would be removed from the HV junction box and spun out to remove the turns. Although some damage to the inner of the umbilical had occurred it appeared to be superficial. The umbilical was electrically tested applying 5000v across the phases, and from all phases to the armouring of the fibres. All the fibres were tested and recorded as below:

○	Red (red fibre)	1310 – 7.0dB	1550 – 7.9dB (Vehicle)
○	Blue (grey fibre)	1310 – 12.4dB	1550 – 13.1dB (spare)
○	White (black fibre)	1310 – 9.7dB	1550 – 10.8dB

When re-assembling the HV junction and fibre connections it was noted that the blue patch lead had failed with a broken connector. This may have been why the CWDM and cameras failed previously. With all connection made a final set of tests were made before the vehicle was made ready for the next dive.

Following the next dive, Dive 319 (23), a couple of turns were seen below the umbilical again. To prevent any further problems for the remaining two dives of the cruise, the turns were taken further into the ROV and down the inner tail. The potted termination was then secured to the bullet utalising the pin arrangement that was put in place some years previous. The risk with using the pin arrangement is that the umbilical can experience 'bird-caging' if torque remains in the wire.

3.7.1 FUTURE MODIFICATION/REQUIREMENTS:

- Umbilical to be removed from drum and re-spooled. Scrolling to be monitored and set up as per Dynacon instruction. Ref 4.2 Storage Drum
- Look at replacement umbilical (possible torque related issue with black fibre. (Ref JC125 cruise report)
- Machine circular ring (part of gimbal assembly) to allow a Dorn fitting to pass through.

3.8 CCTV & LIGHTING

There was a continual judder movement experienced on all cameras. This could possibly be attributed to a power supply issue.

Future modification/requirements:

- Investigate power issue on all cameras. (Build a new voltage and frequency stabilised power supply unit). Locate unit in a more accessibly location.
- Investigate new CCTV system. HD cameras over IP

3.9 CONTAINERS

3.9.1 CONTROL CONTAINER 2

At the beginning of the expedition a problem occurred with the electrical supply circuit SW406. This fed a number of rack mounted devices namely video recording and data storage. The ground fault (GF) breaker would trip at indeterminate intervals up to approximately 24 hours. To isolate and identify the cause devices were redistributed across 3 separate circuits SW403(Heater 16A/300mA), SW404(Red Lights 16A/300mA) and SW406(32A/300mA). Eventually the system became stable and no further faults occurred – leaving the problem unidentified.

It was identified on the previous cruise that working in darkness with a high contrast from multiple large monitors may be causing eyestrain for some operators. As a measure to improve the lighting, the lights behind the monitors were left switched on for the duration of the cruise. This made a reasonable improvement.
The first stage of a comprehensive power supply monitoring system was installed during the mobilisation which provided real-time monitoring of the incoming 3 phase supply. It is planned to complete the installation of further monitoring of the single phase and 110v supplies prior to the next cruise.

Future modification/requirements:

- Check CSE plates for next cruise.
- Touch up paint defect for next cruise.
- Investigate if working in different type of van lighting during ROV operations would be more comfortable for the operators.
- Replace the catches that secure the extension piece to the front bench work tops.

- Replace worn door catch.

3.9.2 WORKSHOP CONTAINER

Future modification/requirements:

- Look at options for new bench tops
- Check CSE plates for next cruise.
- This van and spares should be linked into ships fire system.

3.9.3 SPARES CONTAINER

The heater plug was found to be damaged, most probably resulting from the plug being pulled out without switching off the power supply (interlock). This was repaired during the cruise.
The RCCD in main distribution board trips when power is applied. Until repaired no lights are available. A work light was set up to suffice until suitable repairs could be made.

It is expected that the fault will be identified during the passage back and it will be suggested that a new part is procured in Las Palmas during the Christmas recess which will allow the lighting to be restored to normal during the forthcoming trials cruise.

Future modification/requirements:

- Investigate RCCD failure.

3.9.4 LUVU CONTAINER

The LUVU has no interior lighting and the night team found difficulty in working safely within the container in the dark. It would be a simple matter to install a couple of robust bulkhead style lights which can be easily connected to the convenient socket outlet located on the ships bulwark adjacent to the container. The addition of a "Roxteth" style gland would be needed for the cable access.

Future modification/requirements:

- Investigate fitting a couple of bulkhead style lights.

3.10 SONARDYNE BEACONS

3.10.1 COMPATT 5 MIDI BEACON

The Compatt5 beacon address 110 was attached to the ROV for the duration of the cruise. This beacon was only on the vehicle for back up and was not tracked during the dives.

Future modification/requirements:

- Batteries to be disconnected and stored in LI battery store at NOC.

3.10.2 G6 WMT BEACONS

In the absence of testing the 2702 umbilical beacon on the wire stream it was decided that the 2709 beacon would be used for the umbilical and that 2702 would be used on the ROV along with the tested C5. This change required some modifications to the telegrams in DVLNAV and the change of name on the Sonardyne display. During the first dive (Dive 297) the umbilical beacon 2709 stopped tracking and was unable to re-connect for the remainder of the dive. Following the

recovery it was identified that the battery was completely flat and appeared to have not held its charge. It was thought at this time, that the life of trickle charge from the ROV, may have limited the batteries ability to retain charge. The battery was charged from its flat status to 100%.
For the next dive the beacon was put back onto the ROV, with the relevant topside changes made. However, to establish if the battery was able to retain its charge, it was not powered from the ROV. Following Dive 298 the battery status of beacon 2709 appeared ok, indicating that the trickle charge from the ROV had not caused any permanent damage to the battery.

Beacons 2709 and 2702 were used for the duration of the cruise, with no further problems encountered.

Future modifications/recommendations/maintenance

- Connect to terminal and switch off both beacons.
- Procure spare beacon as part of capital expenditure. (James Burris may have done this)

3.10.3 HOMER BEACON

The Homer Master, Ser No. 279773-001 and Beacon, Ser No. 217323-001 were used for the deployment and location of the lander experiment. These units worked well on all occasions that the lander was deployed.

Prior to the cruise new batteries were brought for all 4 beacons. During the testing of the beacons only the above unit appeared to connect to the master unit.

Future modifications/recommendations/maintenance

- Disconnect battery from beacon
- Consider returning the other beacons to Sonardyne for inspection and repair.

3.11 FOOTBALL FLOATS

8 x 6000m floats were used for the duration of the cruise.

Future modifications/recommendations/maintenance:

- Check and re-tighten float latches where necessary.
- Check quantities and order replacements if necessary.

3.12 ROV SAMPLING EQUIPMENT

3.12.1 SUCTION SAMPLER

The suction sampler was used periodically throughout the cruise. A new medium weight suction hose, and special hose clamps were used to secure to the nozzle and suction unit. These worked well.

Future modifications/recommendations/maintenance:

- Fit clear solid pipe arrangement on rear of drawerer and through vehicle, with flexible hose only use for where drawerer comes out and connection to the nozzle.

3.12.2 PLUME PUMP

For this cruise a requirement was made to produce a cloud of sediment using the suction sampler to suck up sediment, and exhaust it out of the front or over the top of the vehicle. This was to be done at set distances up current from the lander experiment.
As there were concerns that the pumping sediment for long periods of time may cause excessive wear to the suction pump, it was decided that a second pump assembly would be fitted to the vehicle when the experiment was to be carried out. For the first experiment the pump was fitted to the rear of the tool tray, with the section hose mounted on the port side for use with the Kraft manipulator arm. The exhaust was attached to another hose mounted on the starboard side of the tool sled for use with the Schilling manipulator. The exhaust hose was cut and designed to be held at a set height from the seabed/bottom of the vehicle. The hydraulic supply for operating the pump was taken from the suction sampler rotate function.
For the operation of the pump the hydraulics of the vehicle were set as:

Motor speed:	1500rpm
Pump pressure:	1500psi (2 pumps)
Manifold:	74%
Rotate (Suction valve):	83%

For the second and renaming experiments the suction motor was relocated to the starboard side, taking the space of the removed swing arm. The exhaust was relocated to a fixed position ducted next to the starboard vertical thruster. It was thought that with the ROV thrusting down, to hold position, the plume would be pushed higher into the water column. To monitor the plume from the thruster, one of the drawer tooling cameras was repositioned to the top of the vehicle, giving a clear view of when the plume was being generated. It was recorded that the plume pump discharge rate was 300l/min

3.12.3 PUSH CORES

Only a few push cores were taken during the cruise, with only one crate of six tubes used at one time on the vehicle.

Future modifications/recommendations/maintenance:
- Service units and make ready for next cruise.

3.12.4 MAGNETIC TUBES

Not used this cruise

Future modifications/recommendations/maintenance:
- Look at new lids with magnets on the top plate and not the lids.
- Look at the tubes being taller than top plates so that cross contamination of samples is less likely when putting the samples into the tubes.

3.12.5 NISKIN CAROUSEL

This system was used extensively throughout the cruise. Worked well with only a couple of occasions where bottles did not fire.

Future modifications/recommendations/maintenance:

- Look into making Niskins easier to cock/set.

3.13 ROV POWER SYSTEMS

3.13.1 THRUSTERS

After several dives it was noted that the SH unit was starting to lose oil from the compensator. It was also noted that this particular thruster was noisier when checked after each dive. Following Dive 306 (10th Dive) it was decided that the unit would be removed and replaced with a spare. Following Dive 308 it was noted that this replaced unit was also leaking. This was removed and replaced with the other, now serviced unit.

Following each dive all the thruster units had their compensation oil flushed through, and were checked for bearing noise and leaking seals. The FL unit seemed to experience the most amount of water ingress during the cruise, but never seemed to lose oil or suffer from noisy bearing. This was monitored closely throughout the cruise.

During some dives, and recoveries some fluctuation was seen on the AC Ground Fault monitoring (GF). This appeared to be associated with the hydraulic motor. The AC GF usually appeared after recovery, and will clear if the HPU driveBlok was powered off. During one of the pre-dives, it was noted that after running for a longer time the HPU, the AC GF started to appear. This fault maybe related to heat issue in the pump and leakage in the windings.

Future modification/requirements:

- Run hydraulic thruster motor through deck unit, and check Drive-Blok for errors.
- All motors to be stripped with bearings and seals replaced. This should take place following the Discovery trials in Jan/Feb.
- Consider adding Swagelok barbed tap to all thruster motors to reduce mess when flushing.

3.14 HYDRAULIC SYSTEM

For the majority of the cruise the hydraulic system worked well. It was not until approximately 10 dives had been completed before the system started to show some signs of water ingress. Following Dive 306 the Hydraulic reservoir was drained and replaced with new oil. This was again repeated following Dive 309 (12) and Dive 311 (14) to further flush the system. Dive 311 was a long drilling dive, where it is possible some water could be introducing itself into the hydraulic circuit. At this oil change the water separator was also replaced. Dive 312 (15) showed no signs of water ingress, following a 20hr dive to 3884m

During the descent of Dive 317 (21) a lack of oil pressure was noted, the dive was aborted and returned to deck where a quantity of air was bled from the system. The dive was then resumed with no further problems.

During Dive 322 (26) the hydraulic oil pressure was seen lose pressure rather early on in the dive. At the point where oil was being observed leaving the vehicle and the pressure pretty much zero, it was decided that the dive should be aborted and the ROV returned to the surface. On first inspection it was hard to identify where the potential oil was coming from, but over time it became apparent that the Kraft arm was leaking oil through its HP side into the compensation side of the circuit. This is turn was over pressurising the comp and blowing the relief valve (hence the display of oil seen at the front of the vehicle).

See notes on Kraft arm for repair details.

For the deep dives over 1000m the drawer was exercised every 1000m to compensate for pressure change which was previously thought to be where some of the water ingress could be coming from. This was pretty inconclusive on this cruise, but may have worked.

During pre-dives the hydraulic motor gets hot and requires cooling. An easier way to secure the hose over the motor would be useful.

Future modifications/recommendations/maintenance:

- Flush oil system and change all filters.
- Service all hydraulic motors and actuators.
- Check to see if the drawerer function is fitted with a pilot check valve block?
- Fabricate small cradle with hose adaptor and nozzels to allow localised cooling to the Hydraulic thruster motor.

3.14.1 MANIPULATORS

3.14.1.1 KRAFT PREDATOR

The Kraft Predator arm was used extensively for sampling on most dives and worked reliably for the majority of the cruise. During Dive 310 (13) the arm started to fail on the Shoulder Elevation (SE), whereby it would drop when the arm was hydraulically enabled and indexed to start using. It was found by switching off the Hydraulics and turning back on the arm would start to rise again, providing the index button was not enabled. This process was carried out until the arm was in a secure position for the vehicle recovery. Fortunately this malfunction developed toward the end of the dive. Following a couple of deck checks to establish whether the error was caused by the slave unit and not the master it was identified that it was likely to be failed potentiometer in the SE ram. The unit was replaced with a spare and set up using a single axis calibration.
During the calibration process it was noted that there was a stroke restriction error coming up on the mini master display. This was identified that the replacement ram, which is physically identical to the removed unit, was indeed an elbow ram. These differ by their stroke distance, with the elbow ram having a small plastic spacer inside the unit to restrict the stroke. As this does not cause a major issue to the operation of the arm it was left in place until the end of the cruise.

It has been identified that there is a leak from the Kraft HP side into the compensation side of the system. It is anticipated that this is likely to be the azimuth movement (vane rotator) which has seen a fair bit of wear during this cruise. Due to the extent of the repair, and the time remaining in the cruise, it was deemed not viable to carry out whilst at sea.

Future modifications/recommendations/maintenance:

- Service Jaws
- Flush compensation oil
- Clean and inspect for corrosion/oil leaks
- Order spare potentiometers, noted that quantities on spares list do not match items in the drawer.
- Shoulder ram to be exchanged with the repaired spare, to restore full range of operation.
    - Service removed elbow ram and return to spares. Mark as elbow ram.
- Azimuth rotator to be stripped and serviced.

3.14.1.2 SCHILLING T4

This arm was used extensively for the duration of the cruise with only the Jaw recorded as 'sticking' following Dive 309 (12). During the service of the Schilling jaw mechanism the jaws were found to be slightly damaged, requiring some attention.
The camera and light assembly proved to be very beneficial for many sampling operations.

Future modifications/improvements/maintenance:

- Perform visual inspection of Schilling T4.
- Flush compensating oil.
- Remove camera and lights in preparation for ≥4000m dives (check next cruise requirements)
- Replace worn bronze bushes and pins in the Jaw assembly. Order replacement spares.

3.15 TOOL SLED

Following Dive 302 (6) it was noted that the front RH edge of the tool sled had been damaged lifting the plastic mounting sheet away from its fixings. Further inspection revealed that this must have been pulled up, breaking the securing Stauff clamps below. As no spare clamps of that size were available some polypropylene blocks were drilled and cut to work in their place. This repair worked well and lasted the remaining duration of the cruise.
Following Dive 312(15) it was noted that the alignment of the tool sled to the vehicle was slightly out, which in turn was preventing the swing arms from closing properly. In addition to this the rear of the drawer is starting to show signs of wear whereby the floatation attached to it are no longer secured flush. This poor fit was also contributing the swing arms not closing properly. As a repair to the drawer would require a complete strip down it was decide to continue the cruise, with the proviso that the drawer would have to remain extended by an inch or so to allow the swing arms to come in

Future modifications/improvements/maintenance:

- Procure spare Stauff clamps in the required size.
- Replace back of drawer with a more substantial material.
- Remove drawer and repair accordingly.

3.16 VEHICLE COMPENSATION SYSTEM

The vehicle main compensation system worked well for the duration of the cruise. Following each dive oils samples were taken from each junction box, with no signs of water present.
A small leak was found following Dive 312 (15) on the comp line to the science pan & tilt unit. This hole was due to the line being slightly brittle form UV exposure. A short section was removed to complete the repair.

Future modifications/improvements/maintenance:

- Time permitting it may be advisable to remove the vehicle floatation and give the transformer an inspection and new lid gasket. (Fault log entry 44)
- Check all comps for cracks and general wear.
- Inspect compensator hoses for splits and UV damage and replace if necessary.

3.16.1.1 THRUSTER COMPENSATORS

The thruster compensators worked well with no faults. UV damage spotted on some of the ¼" ID Tygon hoses.

Future modifications/improvements/maintenance:

- Perform visual inspection of compensators for leaks/damage.
- Inspect compensator hoses for splits and UV damage and replace if necessary.

3.16.1.2 MANIPULATOR COMPENSATORS

The manipulator compensators worked well with no faults. Neither Schilling nor Kraft compensators lost any significant amount of oil during dives. UV damage spotted on some of the ¼" ID Tygon hoses.

Future modifications/improvements/maintenance:

- Perform visual inspection of compensators for leaks/damage.
- Inspect compensator hoses for splits and UV damage and replace if necessary.
- Consider removal of starboard Kraft compensator, which is no longer used.

3.16.1.3 PAN & TILT UNITS

During the pre-dive of Dive 308 (11) the science pan and tilt unit would not pan in the left direction. The software was checked and the end stops removed, both of which made no difference to the units behaviour. Following this the unit was removed to establish if a mechanical failure had occurred. Upon inspection of the unit it became clear that no internal repairs could be attempted, and that only the manufacturer would be able to do so. In an attempt to not lose both the pan and tilts function, the unit was rebuilt and returned to the vehicle. The unit was then set up so that the camera was facing forward, and would be able to tilt up and down only. To achieve the single axis movement the end stops for the pan motion were set to a minimum, not allowing the unit to move in that direction.
During the decent on the next dive it was found that the unit could pan left and right with the end stops switched off. This could be linked to a possible pressure related issue. During the dive the end stops were enabled and the unit was used without problems.

During the pre-dive test for Dive 309 (12) the unit again would not move in the left direction. Again in was set in the centre facing position, just in case the unit failed to pan again during the dive. With the pressure of the compensation system applied (approx 6psi) the unit was able to pan to the left. With the dive in progress the end stops were applied and the unit was used again with no problems. Further dives from this point on proved to be problematic during the pre-dive and vehicle ascent, with no explanation reached. Generally on each dive the unit did become operable, and suitable for science to use.

During the ascent of Dive 312 (15) oil could be seen coming from somewhere high on the vehicle. Upon the post dive checks it was discovered that a small hole in the science pan and tilt comp line had developed. This appeared to be due to the line becoming brittle from the effects of UV. As an easy repair a short piece of the hose was removed.

Future modification/requirements:

- Development project to produce a new camera controller that communicates with the P&T units.
- Send science Kongsberg P&T back to manufacturers for fault diagnostics and repair.
- Procure spare Kongsberg unit. Now identified as an essential to carry.
- Replace comp lines to both units

3.17 CAMERAS

3.17.1 MINI ZEUS HD (PILOT & SCIENCE)

During one dive, the Science camera started to "glitch", losing intermittently the image. After several tests, a power cycle solved the issue.

Both cameras worked well for the duration of the cruise, with no problems reported.

Future modification/requirements:

- Wash and pack for next cruise

3.17.2 SCORPIO

This camera worked well for the duration of the cruise. Some movement of the camera module within the housing was noted.
The addition of the coloured tapes on the Schilling arm enabled the camera to be compared to the colours from the other camera. At times the image appeared a slight greenish compared to the other cameras.
This may be rectified by using a larger white target when carrying out the white balance.

Future modification/requirements:

- Investigate camera movement.

3.17.3 TOOLING CAMERAS

For the rock drill and plume experiment one of the drawer tooling cameras was re-positioned for each dive configuration. For the plume experiment the camera was mounted onto the top of the light bar looking towards the starboard vertical thruster, and for the core drill operations the camera was mounted onto the left hand front corner of the tool sled angled down to look at where the drill would make contact with seabed. Unfortunately, whilst the camera was being repositioned from the light bar, it fell and dropped to the deck. This later revealed that the unit was no longer working. The unit was replaced with a monochrome tooling camera, which was the only spare camera available. For the job required this was more than adequate.

Future modification/requirements:

- Investigate camera failure
- Return to manufacturer for repair if required
- Investigate tooling camera replacements

3.18 LIGHTS

3.18.1 DSPL MULTI SEALITE (LED)

All units function well with no faults recorded.

Future modification/requirements:

- Acquire more LED spares.
- Acquire more Y-Slice leads.

3.18.2 APHOS 16 LED

During Dive 299 (3) pre-dive one of the Aphos 16 led's was found not to be working. This unit was removed from the vehicle and replaced with a spare. Some tests were carried out using the Cathx software, proving that the faulty unit would need to be returned to the manufacturers.

No further lighting issues occurred for the remainder of the cruise.
Some splits in the wiring harnesses have been noted during post dive checks.

Future modification/requirements:

- Return light unit Inv No. 250007601
- Look at serial port connection for dimming option
- Check continuity of anodes to housing.
- Inspect wiring harnesses and replace were required.

3.19 LASERS

3.19.1 NOC LASERS

The NOC lasers were mounted onto the Scorpio stills science camera. No faults occurred during the duration of the cruise.

Future modifications/improvements/maintenance:

- Perform visual inspection of lasers. Check and re-grease o-rings as required.

- Build two more NOC lasers from components already procured.

3.19.2 SIDUS LASERS

The Sidus lasers were initially mounted onto the pilot HD camera. Following Dive 299 these lasers were repositioned onto the science HD Mini Zeus. During Dive 319 (23) one of the lasers appeared less focused, without any penetration. This would possible indicate some water ingress into the lens area. The unit was removed and replaced with a spare.

Future modifications/improvements/maintenance:

- Perform visual inspection of lasers. Check and re-grease o-rings as required.
- Service unit marked with yellow tape.

3.20 CWDM F/O MULTIPLEXOR

Future modifications/improvements/maintenance:

- Check spare stock of F.O. Rattlers.
- Acquire a spare long F.O. patch lead.

3.21 SONARS AND SENSORS

3.21.1 DOPPLER

Future modification/requirements:

- Consider a training course for some of the team members.
- Possible liaise with WHOI

3.21.2 TRITECH IMAGING

This unit worked well for the duration of the cruise.

Future modification/requirements:

- Check oil levels in sonar head.
- Look at options with regards to connectors and compatibility with HyBIS 4K unit (as a spare)

3.21.3 DIGIQUARTZ PRESSURE SENSOR

Following the return of the unit form the NOC calibration department the GUI was not showing data. This required a slight change, setting the unit to sample continuously P4 mode. The unit worked well for the duration of the cruise.

3.21.4 CTD

Following the return of the unit from the NOC calibration lab it would not communicate with the Seabird software. This required the NOC calibration lab technician to reconfigure it from polling mode to running mode. The CTD worked well for the duration of the cruise.

Future modification/requirements:

- Check the last calibration date and find out if a recalibration is needed.
- Service cruise CTD unit and send to Seabird to repair pump.ROV Topside Systems

3.22 JETWAY

During the first rock drill dive, Dive 298 (2) the vehicle experienced a power failure tripping the main power breakers. This failure was due to one of the main power fuses on the incoming side having blown. All three incoming fuses were found to be extremely hot, and therefore it was decide that all three should be replaced so that power to the dead vehicle could be resumed as soon as possible. With the vehicle having been thrusting hard to remain on the seabed, the drill running and the Kraft manipulator being used to apply downward force to the core drill, the system had been overloaded, causing the fuses to increase in temperature.
With the vehicle dead in the water, and the drill still placed in the seabed the ROV remained in place whilst the repairs were carried out. The position and depth of the vehicle were still monitored by the USBL WMT beacon. With power restored the drill was retracted, and the dive continued.

Some lessons were learnt during this process, and therefore the drilling process was modified in an attempt to reduce the amount of power drawn.

In order to alleviate the overheating fuses problem it is proposed to install a small 'computer type' cooling fan in the top of the main fuse switch with ducting at the base to draw cold air from the a/c units. This will be linked to the existing cooling fans within the plastic JB above the Jetway.

Future modification/requirements:

- Inspect all A/C units.
- Procure more spare fuses.
- This again raises the issue that the Jetway may need replacing, as spares become harder to source.
- Cooling fan for fuses.

3.23 ROV TOP-SIDE SYSTEMS

3.23.1 DATABASE PC

The database and event logging (logbook tool) performed well during the cruise and is much more reliable following the latest changes. The improvement to the memory problem which was making the software to crash in the previous version has now been implemented. The DB is still quite a memory hungry as it handles and stores a huge amount of data every second during many hours, (around 20 hours per dive average), therefore is still necessary to clear the RAM memory or simply reboot the server every 2 or 3 dives.

Future modification/requirements:

- Look into different ways to improve and minimize this buffer overflowing and to make the system self-responsible of the memory management.

- Screen overlay data frozen. It is still not clear if is the overlay injector box or the main software who stops sending the data.
- Recording of the maximum depth. The software will record the maximum depth "forever"
  - Include function to reset this value to zero every time a new dive is created.
- Database or schema name are wrong when a new dive is created.
- Include an "additional weight dropped" button
- Include a "Dive aborted button"
- Include an option to change the default transparency setting of the overlay data.
- Include a "Stopped for sampling button"
- Include a bouoyancy calculator for the pre-dive information
- Include a general information table to create and evaluate the data for the whole cruise. It will allow me to provide precise information of the cruise and produce an automatic cruise report.
- In relation to the previous point. Create an end of the cruise or "close database and create report" option.
- In relation to the previous points, create an option to choose database, or cruise.
- Create an option to do a "cable streaming logging"

3.23.2 OVERLAY DATA DISPLAY

The overlay was incorrectly showing the coordinates of the USBL beacon, probably also on the previous cruise. This was rectified as soon as it was noticed

Future modification/requirements:

- Look at options with team as to how we progress.
- Possible use of buttons for selection of displays as per HyBIS system?
- One particular issue about the HDMI injector unit is that it needed to be power cycled almost every time the vehicle and cameras were power up. This needs to be investigated and reported to the manufacturer.

3.23.3 CLAM PC

This PC worked correctly with the Moxa modification from the previous cruise. The Sonardyne depth modification for calculating delta in a dead vehicle recovery was tested and appears to be working. A simple log converter was developed, since the original old code would not execute due to incompatibility with newer Labview version.

Future modification/requirements:

- Study how to move the conversions scripts from Labview to another computer.
- Investigate integration of the translation of the ROV Sonardyne coordinates from the Sonardyne system to DVLNAV inot the main topside system (Antonio notes).

3.23.4 DVLNAV PC

This PC worked correctly after the RAM upgrade, removing the problem of losing the GYRO as experienced on the previous cruise. Only during one dive the GYRO go red. This issue was found to be the overlay map being too big, causing the software to struggle.

Future modification/requirements:

- Study the option of a hardware PCIe COM card for the G5 servers.

3.23.5 WORKSHOP PC

The small "NUC" fitted on the workshop container, replacing the broken workshop server proved to be a useful tool.

Future modification/requirements:

- Install Windows 7 32 bits instead of the actual 64 bit version for software compatibility.

3.23.6 PRIZM

Work correctly. Need to acquire a modem spare board, since one of the subsea boards is showing a warning on the power supply.

Future modification/requirements:

- Needs investigation to find if the power supply or the modem board is breaking down.
- Consider buying a spare modem board.
- Investigate possibility of relocating the PRISM unit so that connections are more accessible.

3.23.7 JOYBOX

After adding the earth link to the housing, no more static electricity shocks were experienced neither it rebooted randomly as it happened on previous cruise. The spare unit was not used.

Future modification/requirements:

- Start a development project to produce a joybox that communicates with topside.
- Acquire two Z thruster joysticks.

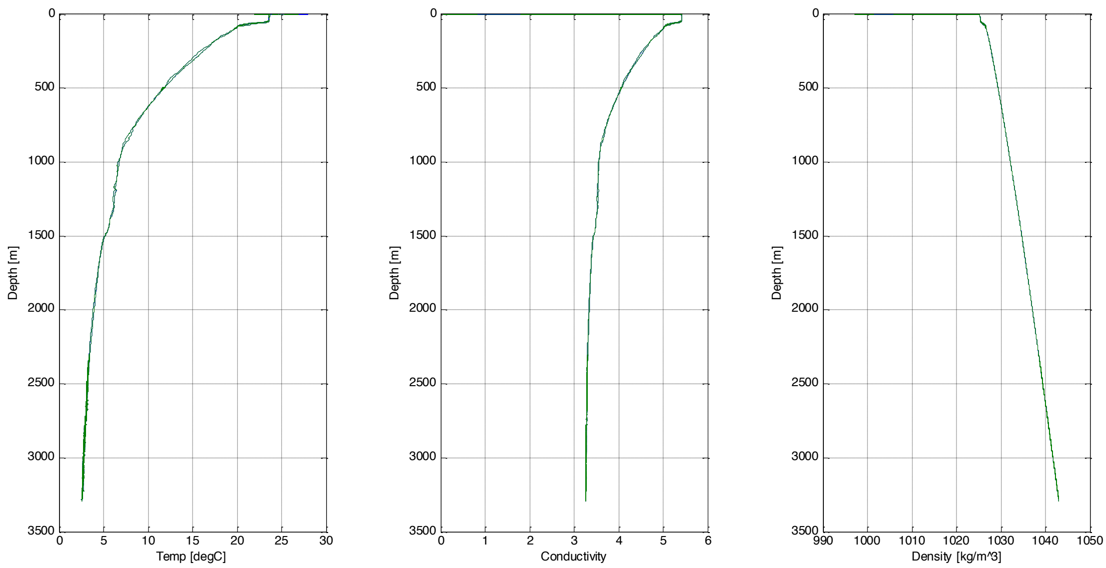
3.23.8 NETWORK TIME PROTOCOL (NTP) SERVER

This will randomly loose lock of the ship NTP server. A power cycle resolves the issue.

4 AUTOSUB 6000 SYSTEM REPORT.

4.1 INTRODUCTION

The purpose of the JC142 expedition, from an AUV point of view, was to survey the Tropic Seamount. The areas to be surveyed included the top, flanks and lower flank sides of the seamount. The survey was done using the Autosub 6000 AUV. This vehicle is equipped with a range of sensors including an EM2040 multibeam and Edgetech 2200 sidescan sonar and sub bottom profiler. Prior to the expedition, the AUV was ballasted at NOC for a target surface density of 1025 kg/ m^3. The information used for ballasting was obtained from the ISEAS data base. This was found to be a good match to data collected on this expedition. (See plots below from M136).



The primary objective of most of the AUV missions was to collect multibeam echo sounder, sidescan sonar and sub bottom profiler imagery of the sea bed bathymetry.
In addition to this, other sensors were also used to collect data at the same time. These sensors included Seabird CTD, Wetlabs Optical backscatter sensors (OBS), magnetometer, EH sensor and Teledyne RDI 300kHz ADCP.

During some later missions a downwards looking camera and flash system were used to collect images of the seabed.The AUV performed well on most missions, with relatively low technical downtime overall. Unfortunatley there were some issues with the EM2040 that resulted in missing data on some missions.

4.1.1 ENVIRONMENTAL CONDITIONS

Due to the geographic location, the sea state was normally very good. Wind speeds of F2-3 were common. The sea state was often only 1 -2m with occasional large swells (~3m) from the North. The second week of the expedition, the weather and sea state worsened to the point of F5-F6 with 3+m seas.
Unfortunately in the second week the anti-roll system on board malfunctioned due to a failed component. As no spare was carried, this resulted in the remainder of the expedition being conducted with the ship rolling considerably more than one would expect given the calm

conditions. For example roll of 6° was often seen despite the sea being flat calm. Despite this, work still carried on as normal and launch and recoveries could continue due to the good weather conditions. Had the sea state been worse this would have reduced the operational window of the AUV system.

4.2 OVERVIEW OF AUV MISSIONS

A total of 17 missions were carried out. Most missions were run using the EM2040 multibeam echo sunder and the Edgetech sidescan and sub bottom profiler. The CTD system and magnetometer were run on every mission. The AUV was launched from the stern LARS position. This worked very well, and almost all launch and recoveries went very smoothly. The PES fish (used for Linkquest acoustic comms to the AUV) was a combination of North Sea winch and port pedestal crane. This combination is not ideal, however due to crowded deck space; use of the purpose built PES davit was not viable. Unfortunately, due to technical issues, two of these missions (M126 and M128) were non-productive from a data point of view.

During M126 the AUV experienced propulsion issues and due to a lack of thrust couldn't dive to depth. This was then recovered and rectified.

M128 was planned to be a camera and collision avoidance test mission. Prior to this dive, the collision avoidance sonar had been replaced due to the original unit failing on M127. (As M127 was flown at 90m altitude, the collision avoidance sonar was not critical). Unfortunately due to issues with the firmware of the replacement collision avoidance sonar, this resulted in the system not operating correctly. Due to this, the dive was ended from the surface, when the AUV was at 500m depth. Once on deck this was resolved by rolling back the software.

The last three missions (M139, M140 and M141) suffered from a reduction in propeller RPM. This resulted in the ascent speeds being slower than normal. The reason for this reduction is suspected to be due to water ingress into the motor compensating oil. Further investigations will be carried out to resolve this issue. These missions were still completed successfully despite the issues with the motor.

4.3 EDGETECH 2200 OPERATIONS

The AUV is equipped with an EdgeTech 2200-M 120-425kHz side scan and 2-16kHz sub-bottom profiler.
For higher altitude missions the 425 kHz setting was used. For the low level operations, the 120kHz setting was used.
A range of sub bottom profiler settings were used, the file detail can be seen in section 2.2.

The Edgetech sidescan and sub bottom profiler gave consistently good results. The exception to this was M130 where the disk space on the unit ran out. Prior to the dive, there had been issues downloading the data quickly enough over the Wi-Fi link to the sub. (This was taking in the region of several hours). It was calculated that there would be enough free disk space on the Edgetech to handle the next mission, whilst the issue of downloading the data via a wired link was looked into. Unfortunately due to the very large amount of data produced on the mission, the available space was used up resulting in lost data for the later part of the mission. A new cable was made up which allowed the data to be transferred off the AUV much faster. The transfer speed 100 mbps, this resulted in approx. 40GB being transferred in 1.5 hours.

4.4 EM2040 OPERATIONS

The EM2040 produced very good results on the top if the seamount (where the bathymetry was relatively flat and benign). However during M130 and M131 the EM2040 failed to collect data for the later parts of the missions. Initially the loss of data for M130 was thought to be due to turning water colomn data on towards the end of the mission. (Later investigation showed this to not be the cause).Trouble shooting was carried out on the EM2040, as after the loss of data at the end of M131 the fault was believed to be due to the internal network connection.

When carrying out surveys on the flank sides (and consequentially steeper areas) the issues with the EM2040 worsened. M135 had three restarts of the EM2040 casing gaps of 20mins, 13mins and 14mins in the data. Trouble shooting of the system continued and Kongsberg support was contacted.

It transpired that there may have been two issues causing the problems. The first issue was possibly due to the buffer size on the internal disk not being large enough. With certain settings on the EM2040 a larger amount of data could be produced. For example is a short pulse type was used in deep water, this would result in larger amounts of data, or if water coloumn data was enabled this may also cause issues for the buffer. Kongsberg support then created a software patch to resolve this.

The second problem was possibly power related. If the AUV was working in steeper areas with a pulse type set to automatic (PTY=0), the unit could use more power. It was speculated that if the Edgetech were running at the same time (which on nearly all multibeam missions it had been) then the power demand would be too great which could then result in the system restarting. After discussion with Kongsberg support it was found that if the FME setting was set to 2 (enable FM without attitude velocity) which it had been, this would use 0.25A more than if the setting was set to CW. Due to these issues, M138 –M140 concentrated on Edgetech and camera runs on the top of the sea mount.

The last dive (M141) was used to re survey the site of M137 (the site that had only produced approx. 2 hours of Multibeam data). As M137 had produced all the required sidescan and sub bottom profiler data, it was decided to resurvey the area with only the EM2040 enabled (in addition to the normal additional sensors that had run on every mission). Prior to M141, the software patch to rectify any buffer issues was installed. The FME setting was also changed from 2 to 0. (Essentially disabling FM). It should be noted that this was one of the steepest areas the AUV operated in.
The mission was then carried out and the EM2040 worked for the entire mission. Unfortunately, for the last hour of that mission the AUV remained at a constant depth of 2050m. This was due to the settings in the mission script being set to a maximum depth of 2050m due to the available bathymetry plot at the time. This does not appear to have had a detrimental effect on the Multibeam coverage.

4.5 JOINT AUV ROV OPERATIONS

The AUV was also used on two missions in conjunction with the ROV. The purpose of these missions was to Use the ROV to generate a sediment plume. This plume would then be detected by a lander frame placed on the sea bed.

The AUV would then cover a survey area “downstream” of the plume site in order to try to identify if the plume had drifted to that distance.
For the first joint mission (M133), the AUV was set up to use the EM2040 in water column data mode in addition to the OBS sensors that were fitted on every mission. This survey worked well, with the suspended sediment being visible in the EM2040 for the first survey site.

The second joint mission (M139) used the AUV without the EM2040. (Due to concerns about its reliability at that time). For this mission the OBS and ADCP data would be used for identifying if the plume were present. This dive did not show evidence of the plume.

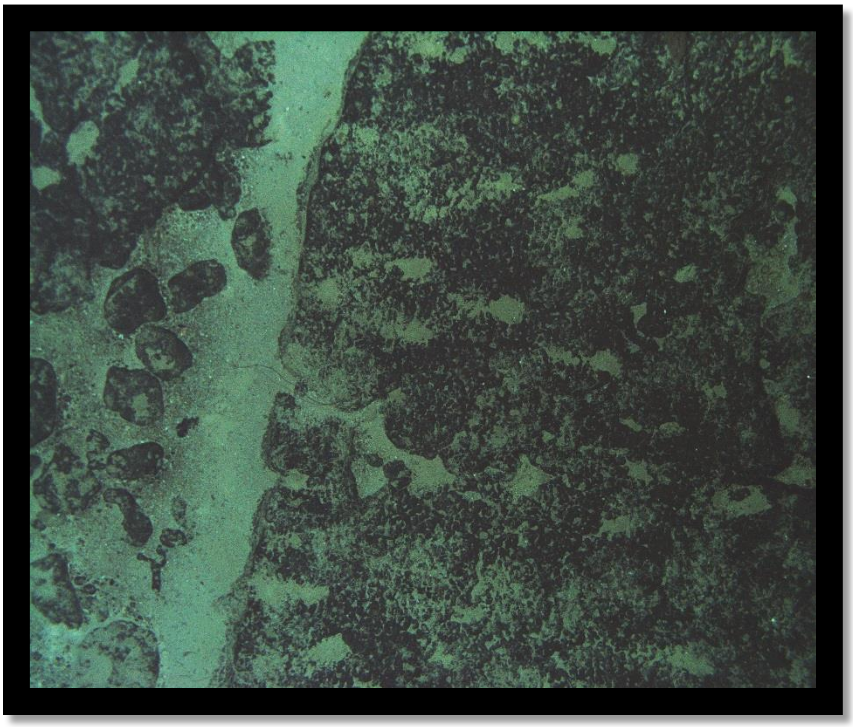
4.6 CAMERA OPERATIONS

For this expedition the AUV was fitted with one Point Grey Grasshopper 5 mega pixel colour camera. This camera was mounted in the nose of the vehicle just forward of the EM2040 head. The flash unit was mounted parrellel to the side of the camera...

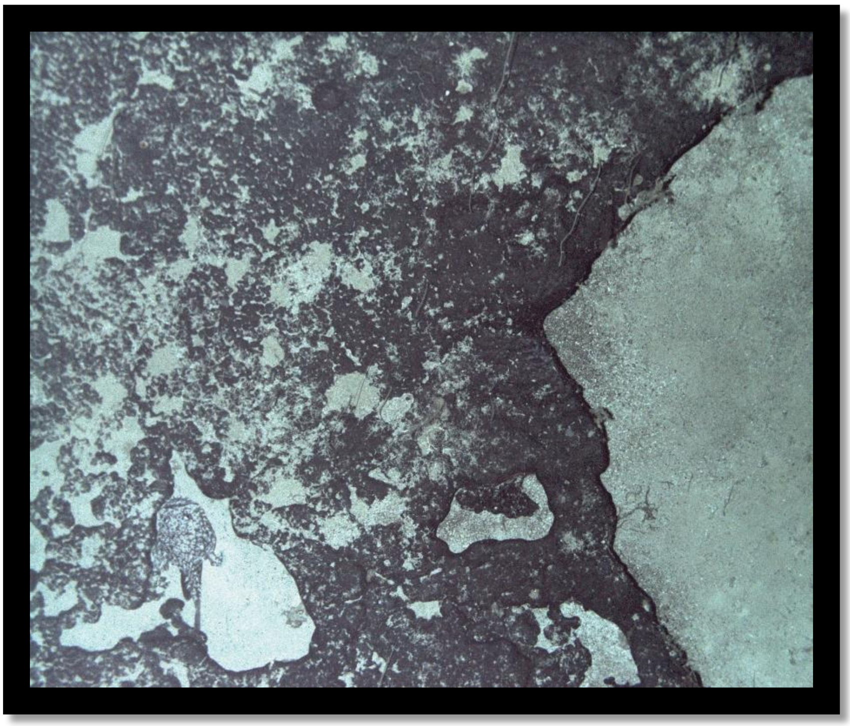
Camera model: Grasshopper2 GS2-GE-50S5C
Camera vendor: Point Grey Research
Sensor: Sony ICX625AQ (2/3" 2448x2048 CCD)
Resolution: 2448x2048
Image pixel format: PIXEL_FORMAT_RAW8
Bayer tile format: GBRG

Mission's M133, M134, M138, M139 and M140 were carried out using the downward camera system. The original proposed flying altitude was 3m; however despite best efforts to achieve this, the typical altitude achieved was approx. 5m. However, due to the very clear water, it was still possible to achieve usable images at this altitude. The reason for not being able to get close enough to the sea bed were due to the settings in the collision avoidance system. This was has a scale factor in the depth control node. This value is normally set to "1". Experiments were tried by increasing the value to "2" and then "2.33" to essentially de sensitize the system. This value was not increased further due to concerns that it would completely de activate the collision avoidance system. Examples of images taken at 5m altitude can be seen below.

Example of image from approx. 5m altitude (M138):



Example of image from approx. 5m altitude (M139)



4.7 CTD SYSTEM

The AUV was fitted with a Seabird 9 CTD system. This comprised 2 x temperature sensors, 2 x conductivity sensors, 1 dissolved Oxygen sensor, 1 EH sensor, 1 x Wetlabs BBRTD (scaled to 5 NTU)and 1 x Wetlabs NTU sensor (scaled to 1000NTU) .
The ctd system worked very well apart from M130 where the entire system was non-operational. Post dive trouble shooting revelled the cause to be a component had burnt out on the 5 NTU scale BBRTD (S/N: 168). This was replaced with a spare sensor for later missions.
During the first dive (M125) a difference of approx. 2-3 deg °C was noted between the two temperature sensors. Later trouble shooting found this was due to the cross over in the calibration coefficient set up. This was corrected and the data was then good.
M139 and M140 also had a difference in the data from the primary sensors and the secondary sensors. Post dive, the reason for this was found to be biofouling (and a small fish) stuck in the ducting system.

4.8 NAVIGATION

The AUV is fitted with a UBlox M8N GPS/GLONASS receiver. This provides GPS fixes whilst on the surface. On decent the AUV will circle with a fixed rudder offset, during this time the AUV will drift due to currents. Once the altitude is being reliably seen at the bottom, the AUV will then move to where it thinks the Start Waypoint is. The AUV relies on dead reckoning navigation whilst underwater. This is achieved by using the inertial navigation system (INS) and the downwards looking Teledyne ADCP Improved navigation is achieved by maintaining "bottom lock" with the ADCP. Bottom lock is normally maintained up to a range of 180 from the sea bed. On all dives, the AUV decent was monitored to the sea bed to ensure the systems were working; the AUV was also monitored on the ships Sonardyne USBL system. It was then possible to provide the AUV with a navigation correction. This was calculated from the difference of the observed sonadyne USBL output, and the output of where the AUV believed it was. Once the correct was applied, the AUV was then sent on its mission.

In most cases, due to the terrain type the AUV maintained good bottom lock, which resulted in low drift from the intended course. For example, on some of the missions on the seamount top, the drift by the end of line was in the region of 60m. However in some of the steeper terrain areas, bottom lock was lost which resulted in greater drift. The intention was to rendezvous with the AUV at the end of each mission, while it was completing its final track. The PES acoustic fish could then be deployed over the side of the ship to communicate with the AUV and determine where the AUV calculated it was. The ships USBL could then be used to calculate where the AUV actually was. This information could then be used to give correction data in post processing the navigation. Unfortunately due to varying BSP (which again is a product of losing bottom lock) the time the AUV reached end of line could be variable. This resulted in the vessel arriving too late to track the AUV whilst still doing the mission track. See appendix for the USBL coordinates for corrections.

4.9 TECHNICAL DOWN TIME

The following is the detail of technical downtime incurred in the AUV operations:

- M126. Propulsion issues resulted in dive being terminated. Downtime approx. 3 hours.
- M128 Tritech collision avoidance sonar firmware issue. Downtime approx. 3 hours.
- M140 Launch. Forward rope box hatch opened when AUV entered water. Resulted in the need for recovery and re packing of lines. 1.5 hours down time.
- M141. Prior to launch, the fish cable was severly damaged due to jumping the sheave of the block. (This was due to crane operator error). Fish cable had to be replaced. 1.5 hours down time.

Total down time: 9 hours.

4.10 SUMMARY OF AUTOSUB 6000 AUV SYSTEM

Sensors used	***Sub configuration***
1) PHINS INS 2) Applied Physics tri axis magnetometer. 3) Kongsberg EM2040 multi-beam. 4) Seabird 9+ CTD with 2 x SBE3plus, 2 x SBE4C, SBE DO sensor 5) EH sensor. 6) Wetlabs BBRTD sensor. (scaled to 5NTU) 7) Wetlabs NTU sensor. (scaled to 1000NTU) 8) Teledyne RDI workhorse ADCP 300kHz (downwards looking) 9) EdgeTech 2200-M 120-425kHz side scan and 2-16kHz sub-bottom profiler. 6) Tritech Seaking obstacle avoidance sonar 7) Sonardyne G6 USBL Transponder.	1) Rear winglets set at 6º pitched downwards. 2) Autosub 6k recovery line retention system with nylon springer lines 3) 13.2kg positive buoyancy at surface. 4) 6 x Lithium polymer battery packs. 5) 2 x ARGOS location beacons. 6) Novatech positioning iridium beacon. 7) Lawson Engineering Autosub6000 launch and recovery system (LARS)

4.10.1 SETTINGS USED FOR EACH MISSION

The table below details the settings for each of the missions.

Mission	Terrain type	Planned altitude (m)	Actual altitude (m)	MB Freq (kHz)	SSS Freq (kHz)	MB range (Nadir)	Camera images collected	Line spacing (m)	SBP file
M125	Flat	120	120	300	120	165	N/A	450	SB216_2_13_16MS_SS8E.spf
M126	N/A	120	N/a	300	120	N/A	N/A	N/a	SB216_2_13_32MS_SS8E.spf
M127	Flat	120	120	300	120	156	N/A	350	SB216_2_13_32MS_SS8E.spf
M128	N/A	90	90	N/A	N/A	N/A	N/A	N/a	SB216S_2_15_10WB_SB.spf
M129	Flat/ steep towards EOL	90	90	200	120	160	N/A	280	SB216_2_13_32MS_SS8E.spf
M130	Flat	90	90	200	120	166	N/A	280	SB216_2_13_32MS_SS8E.spf
M131	Flat/ Steep at End	90	90	200	120	170	N/A	250	SB216_2_13_32MS_SS8E.spf
M132	Flat	90	90	200	120	160	N/A	250	SB216_2_13_32MS_SS8E.spf
M133	Flat	3	7.5	300 + WC data	N/A	13	73186	Variable	N/A
M134	Flat	4	5	400	N/A	70	24138	Variable	SB216S_2_15_10WB_SB.spf
M135	Slopes of 20°. Contour following	90	90	200	120	120	N/A	220	SB216_2_13_32MS_SS8E.spf
M136	Slopes of 20°. Contour following	90	90	200	120	120	N/A	200	SB216_2_13_32MS_SS8E.spf

M137	Slopes of 30°. Contour following	90	90	200	120	80	N/A	120	SB216_2_13_32MS_SS8E.spf
M138	Flat	4	5	N/A	425	68	86304	15	SB216D_2_15_5MS_SB.spf
M139	Flat	4	5	N/A	425	68	84529	50	SB216D_2_15_5MS_SB.spf
M140	Flat	4	4.5-5	N/A	425	68	93487	Variable	SB216D_2_15_5MS_SB.spf
M141	Slopes of 30°. Contour following	90	90	200	N/A	N/A	N/A	120	N/A

4.10.2 EM2040 SETTINGS:

Mission	**EM2040 Allsetup.txt settings.**
M125	$PCP40,EMX=2040,APS=2,AHS=2,PRF=200,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=15300,MID=50.0,MAD=200.0,RGS=2,SFS=1,*99
M126	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=2,PTY=2,VSN=1,FME=2,SHS=1,S2H=0.00,SST=15300,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M127	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=2,PTY=2,VSN=1,FME=2,SHS=1,S2H=0.00,SST=15300,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M128	N/A
M129	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14950,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M130	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14950,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M131	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14950,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M132	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14950,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M133	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=3,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14950,MID=1.0,MAD=100.0,RGS=2,SFS=1,WCD=1*99
M134	N/A

M135	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=15230,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M136	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=15230,MID=10.0,MAD=300.0,RGS=2,SFS=1,*99
M137	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=2,SHS=1,S2H=0.00,SST=14980,MID=10.0,MAD=300.0,RGS=2,SFS=1,SOM=0,PAM=0*99
M138	N/A
M139	N/A
M140	N/A
M141	$PCP40,EMX=2040,APS=2,AHS=2,PRF=400,PMO=1,PTY=0,VSN=1,FME=0,SHS=1,S2H=0.00,SST=14980,MID=10.0,MAD=300.0,RGS=2,SFS=1,SOM=0,PAM=0*99

Explanation for the above: (valid ranges or settings in brackets):
APS: Active position system number (0-2)
AHS: Active heading sensor (0-9)
PRF: Max ping frequency in centiHz (10-5000)
PMO: Ping mode (1=200 kHz, 2=300 kHz, 3=400kHz)
PTY: Pulse type (0=auto, 1=short CW, 2=medium,CW, 3=long CW, 4=FM)
VSN: Active velocity sensor number (0-2)
FME: FM enable (0-2) 0= Disable, 1= Enable, 2= enable FM without attitude velocity
SHS: Transducer depth sound speed source (0 = probe/ 1=manual, 2=profile)
S2H: RX 1 Transducer heading in degrees
SST: Sound speed at transducer in dm/s. Valid range 14000-16000
MID: Minimum depth in m
MAD: Maximum depth in m
RGS: Range gate size (0=small, 1=medium, 2=large)
SFS: Spike filter strength (0=off, 1=weak, 2=medium, 3=strong)
SOM: Sonar mode (0=Off, 1=On)
PAM: Passive acoustic mode. 1: On 0: Off.
WCD: Send water column datagram 1 : On 0: Off.

4.11 MISSION OBJECTIVES

Mission	Mission objective	Comments
M125	Test mission to 4000m. To test all systems apart from Cameras and Flash	All systems worked well. However, line spacing too far apart. This resulted in gaps between lines for MB.
M126	MB, SSS and SBP middle top of seamount. Planned altitude 120m.	Just after completing mag circles at 500m depth, the AUV had power issues to the motor. This loss of thrust meant the AUV couldn't dive, and returned to surface.
M127	MB, SSS and SBP middle top of seamount. Planned altitude 120m.	All systems worked well. However, Line spacing still slightly too wide given the MB frequency.
M128	Run short camera test on top of sea mount	Mission aborted by sending surface command when sub at 500m depth due to tritech head not updating.
M129	MB, SSS and SBP NE section top of seamount. Planned altitude 90m.	On returning to monitor the AUV on its ascent it was found it was already on its way up, inspection of the data suggests this is because the ADCP lost contact with the bottom on its final science legs due to the steep terrain and so the speed used for dead-reckoning was increased.
M130	MB, SSS and SBP N section top of seamount. Planned altitude 90m.	During the mission the AUV was monitored on the Ships USBL as it passed within 1400m of the ROV. Inspection of the collected data shows that the EM2040 seemed to stop recording data when an attempt was made in the script to enable water column data. It also seems that the Edgetech stopped recording when the disc became too full. The CTD also appears to not have been functioning during the entire mission.
M131	MB, SSS and SBP survey western top of seamount. Then track down western ridge of seamount. Planned altitude 90m.	The AUV then navigated the science tracks successfully although the last waypoint was not reached as the mission line timed out before the AUV arrived at the waypoint. The AUV was monitored on the final part of its ascent on the Ships USBL, it was noted that it was approx. 2km north of the end waypoint. On inspection of the data it appeared that the EM2040 had stopped collecting data about two hours before the end of the mission.
M132	MB, SSS and SBP survey remaining top of seamount. Planned altitude 90m.	Inspection of the data shows the AUV navigated the science tracks successfully and collected all expected data. The AUV was monitored via the Ships USBL on its ascent from the magnetometer calibration circles.

M133	Plume experiment 1 (for AUV and rov) track three gates then move to second " crucifix" plume site. After that, survey photo and SSS and SBP track on top of seamount.	The AUV was launched successfully and dived to plan. The AUV was monitored on the Ships USBL and Linkquest and was given a navigation offset once at depth. On this occasion a start command was not sent as the AUV was required to wait for approximately 4 hours before starting its science tracks, this was to allow time for the ROV to be deployed, reach the seabed and start producing a plume of sediment that the AUV would then fly through over a kilometre away. The AUV started its tracks on time and flew multiple transects at different altitudes and distances from the plume. Following the plume transects the AUV then went on to run a camera survey. Unfortunately the Tritech sensor caused the AUV to fly at 7m rather than the 3m required for the camera survey resulting in the images being too dark to be used.
M134	Camera, SSS and SBP survey top of seamount. Planned altitude 3m.	The AUV performed the science tracks although still flew slightly higher than the requested altitude due to the Tritech sensor, despite this the camera images are good.
M135	MB, SSS and SBP survey W slope side. Planned altitude 90m.	EM2040 restarted 3 times. Resulting in 3 gaps in the data. 20min, 13min and 14min
M136	MB, SSS and SBP survey NNW slope side. Planned altitude 90m.	No mag circles on ascent. Removed to save time. Large difference in recovery time due to responding to Mayday.
M137	MB, SSS and SBP survey SE slope side. Planned altitude 90m.	The AUV performed the science tracks before surfacing and being recovered. The ascent seemed to be slower than usual and it was noted that the pitch was only 11 degrees with the stern planes at 7 degrees. Inspection of the EM2040 showed that it stopped working after approximately two and half hours and when back on deck it was seen that the heads could not be seen.
M138	Survey three photo and SSS and SBP areas on top of seamount. Planned Altitude 4 m.	The AUV was monitored for its last science track and it was noted to be off track by approx. 50m to the east. Inspection of the AUV data shows that the AUV did not achieve the 4m altitude requested for the camera survey this is assumed to be due to the collision avoidance, however the images still appear to be good. The AUV was monitored on its ascent and appeared to be taking longer than usual, inspection of the AUV data suggests that the power to the motor was less than expected. Slow ascent rate due to low RPM. Later inspection showed water in motor oil.

M139	Plume experiment 2 (for AUV and rov) track 1 gate then move to survey two photo and SSS and SBP areas on top of seamount.	The AUV performed the plume gates followed by the camera survey. The AUV was monitored on the ships USBL on the final science track and during its ascent. The ascent of the AUV again seemed slower than usual although not as slow as M138, inspection of the data seems to suggest a drop in power to the motor towards the end of the mission but the cause is unclear, the data also seems to show that the AUV timed out on a number of mission legs towards the end of the mission. The camera images seem to be good despite the AUV only achieving an altitude of 4.5m instead of 3m. No mag circles on decent and ascent (removed to save time). Km distance factors in doing the gate at 3 altitudes 12 times.
M140	Survey multiple photo and SSS and SBP areas on top of seamount. Planned Altitude 4 m.	The AUV was monitored on the ships USBL for the last two hours of the science tracks and on its ascent. The AUVs ascent was again slow the root cause of this is still being investigated. Camera and Edgetech data seem good as does the CTD data although this sensor again became blocked towards the end of the mission.
M141	Re shoot of M137 area, to test Multibeam system. This was done with the Edgetech turned off.	The AUV performed the science tracks successfully although for the last hour of the tracks the AUV did not achieve the requested altitude as the maximum depth on the depth control node was set to 2050m based on the available bathymetry for the area, the EM2040 data for this area is still good however. The AUV ascended and was recovered without incident.

4.12 ASUB 6000 DIVE STATISTICS

The table below details all dive times and calculated speeds. The BSP average is calculated over the total time taken from the start of the science track to the time the AUV left bottom.

Mission	Left surface	Start of science mission	Depth	Distance (Km)	Science track time taken (min)	Calculated average BSP m/s	Left bottom	Depth (m)	Ascent rate m/min	Time at surface	Time on deck
M125	07:31	10:14	3896	15.7	261	1.00	14:35	3939	24.31	17:35	18:04
M126	20:45	N/A	509	0	N/A	N/A	N/A	514	10.40	22:25	23:07

M127	19:07	21:07	892	66.6	1021	1.09	14:07	870	29.00	14:07	14:55
M128	03:30	N/A	500	0	N/A	N/A	N/A	500	26.88	04:24	05:06
M129	19:10	20:43	921	84.7	1191	1.19	16:34	980	21.30	17:00	17:38
M130	21:09	22:24	1256	81.2	1134	1.19	17:17	1320	30.28	18:19	18:44
M131	12:40	13:51	1117	81.1	1125	1.20	08:36	2957	31.13	10:28	11:06
M132	16:15	17:25	1075	76.8	1040	1.23	10:36	1497	29.35	11:45	12:06
M133	10:22	16:10	982	15.3	772	N/A	04:50	979.9	16.33	06:12	07:05
M134	00:29	01:21	982	20.9	273	1.27	06:51	986	29.70	06:56	07:32
M135	16:25	18:34	3201	73.3	1057	1.16	12.01	4034	32.01	14:15	14:38
M136	19:15	21:19	2279	74.8	1099	1.13	15:38	2999	38.95	16:55	19:11
M137	15:02	16:11	972	81.5	1170	1.16	11:40	1646	17.89	13:12	13:50
M138	17:34	18:43	988	82.2	1283	1.07	15:55	1094	11.89	17:27	17:44
M139	20:13	21:15	1010	70	1270	0.92	18:25	989	15.82	19:27	19:50
M140	16:08	16:54	1202	86.7	1421	1.02	16:35	1059	12.76	17:58	18:20
M141	19:00	19:52	988	64.5	923	1.16	11:14	2033	22.59	12:44	13:08

4.13 DATA STATISTICS:

The table below details the required data for each mission and how much was actually achieved.

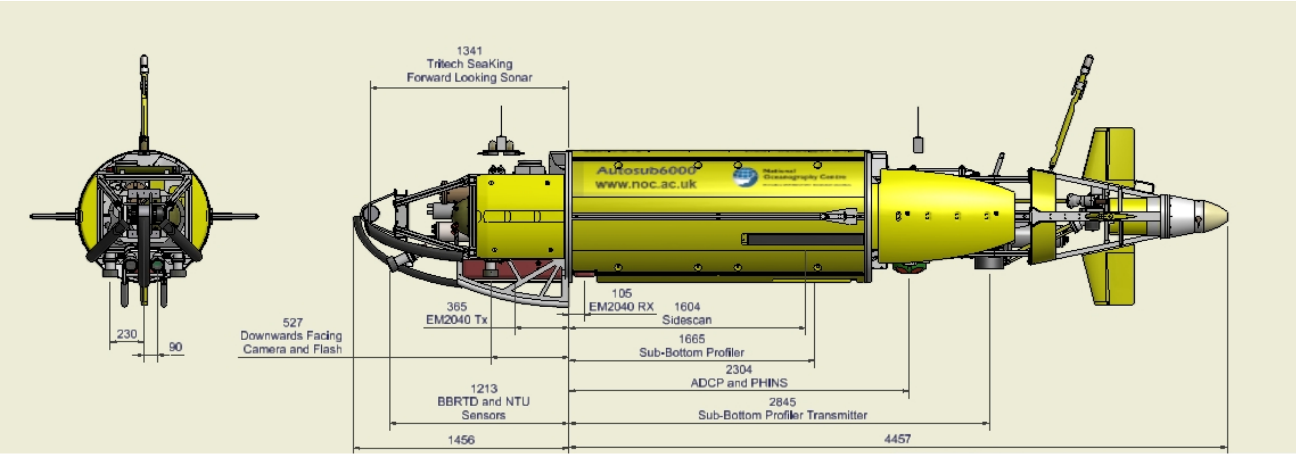
Mission	Mission data criteria	MB	SSS	SBP	Camera	CTD Sensors	Magnetometer	BBRTD	1000 NTU	Comment
M125	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) Line Spacing:	100%	100%	100%	N/A	100%	100%	100%	100%	Test mission to test all systems other than cameras.

M126	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	0	0	0	N/A	0	0	0	0	Propulsion issues resulted in mission being aborted.
M127	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	100%	100%	100%	N/A	100%	100%	100%	100%	
M128	Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	N/A	0	0	0	0	0	0	0	Tritech head issues resulted in the mission being manually ended.
M129	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	100%	100%	100%	N/A	100%	100%	100%	100%	
M130	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	82%	72%	72%	N/A	0	100%	0	0	Approx. 5 hours 26min of Edgetech data not recorded. (Total potential time: 18hours 54 min.) This was due to the disk filling up. 3 hours 26min of MB data not recorded.
M131	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	89.35%	100%	100%	N/A	100%	100%	100%	100%	Approx. 2 hours of multibeam not recorded.
M132	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	100%	100%	100%	N/A	100%	100%	100%	100%	
M133	EM2040 multibeam, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) Downwards looking camera	100%	N/A	N/A	0	100%	100%	100%	100%	Altitude too high (7m approx.) for usable camera images.

M134	Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) downwards looking camera.	N/A	100%	100%	100%	100%	100%	100%	100%	
M135	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	95.60%	100%	100%	N/a	100%	100%	100%	100%	3 restarts in the Multibeam. Gaps of approx. 20mins, 13 min and 14 min.
M136	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	5%	100%	100%	N/a	100%	100%	100%	100%	Only the first hour of multibeam collected.
M137	EM2040 multibeam, Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	12%	100%	100	N/a	100%	100%	100%	100%	Only the 2.5 hours of multibeam collected.
M138	Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) Downward looking camera	N/A	100%	100%	100%	100%	100%	100%	100%	
M139	Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) Downward looking camera	N/A	100%	100%	100%	100%	100%	100%	100%	
M140	Edgetech SSS and SBP, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale) Downward looking camera	N/A	100%	100%	100%	100%	100%	100%	100%	
M141	EM2040 Multibeam, Seabird CTD, EH sensor, BBRTD (5NTU scale, OBS NTU sensor (1000NTU scale)	100%	N/A	N/A	N/A	100%	100%	100%	100%	

4.14 DIAGRAM OF CURRENT CONFIGURATION OF AS6K.

The diagram below details the current offsets for the main systems on the AUV.



Output from Main processing stored in mission directory.

ProcessedLogData\Mxxx.mat	The variable data extracted from the log file and stored as Matlab workspace variables.
ProcessedLogData \MxxxCTD.cnv	The CTD data converted into engineering units.
ProcessedLogData\Mxxx_CTD.mat	The converted CTD data stored as Matlab workspace variables.
ProcessedLogData\Mxxx_ADCPdown.mat	The ADCP data stored as Matlab workspace variables.
ProcessedLogData\MxxxLS2.mat	Contains interpolated variable data from different nodes of Autosub logger, data is reduced to a common time base set to an interval of 2 seconds currently. Saved as Matlab workspace variables.
ProcessedLogData\MxxxLS2.ls2	Contains interpolated variable data from different nodes of Autosub logger, data is reduced to a common time base set to an interval of 2 seconds currently. Saved as a comma separated file.

Output from SensorProcess.m (mainly science data)

ProcessedLogData\MxxxScienceLS2.csv	Contains the position along with the date and time for every recording of a variable. Saved as a comma separated file.
ProcessedLogData\Mxxxcam.txt	Contains the date, time, size and filename of every frame taken.
ProcessedLogData\MxxxScienceLS2.mat	Contains the position along with the date and time for every recording of a variable. Saved as Matlab workspace variables.

5 NMF-SS SENSORS CRUISE REPORT

5.1 CTD SYSTEM CONFIGURATIONS

by J. Benson/N. Rundle

One CTD system was prepared. The water sampling arrangement was a 24-way stainless steel frame system (s/n SBE CTD6), the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-87077-1257
Sea-Bird 3P temperature sensor, s/n 03P-5835, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3873, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 134949, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-5838, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-4065, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-3607, (primary)
Sea-Bird 5T submersible pump, s/n 05T-3609, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-77801-1005
Sea-Bird 11plus deck unit, s/n 11P-22559-0532 (main)
Sea-Bird 11plus deck unit, s/n 11P-19817-0495 (back-up logging)

The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-1882 (V0)
Benthos PSA-916T altimeter, s/n 47957 (V2)
WETLabs light scattering sensor, s/n BBRTD-182 (V3)
Chelsea Aquatracka MKIII fluorometer, s/n 88-2615-124 (V6)
WETLabs C-Star transmissometer, s/n CST-1718TR (V7)

Additional instruments:

TRDI WorkHorse Monitor LADCP, down-ward looking, s/n 24397
TRDI WorkHorse Monitor LADCP, up-ward looking, s/n 1855
NOCS LADCP re-chargeable battery pressure case, s/n WH007

The Sea-Bird 9*plus* configuration file JC142_1257_NMEA.xmlcon was used for all the CTD casts.

The spare water sampling arrangement was a 24-way stainless steel frame system (s/n SBE CTD9), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-77801-1182
Sea-Bird 3P temperature sensor, s/n 03P-4782, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3567, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 129735, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-5495, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-4140, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-6320, (primary)
Sea-Bird 5T submersible pump, s/n 05T-6916, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-34173-0493
Sea-Bird 11plus deck unit, s/n 11P--22559-0532 (main)
Sea-Bird 11plus deck unit, s/n 11P-19817-0495 (back-up logging)

The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-2831 (V0)
Benthos PSA-916T altimeter, s/n 41302 (V2)
WETLabs light scattering sensor, s/n BBRTD-1163 (V3)
Chelsea Aquatracka MKIII fluorometer, s/n 88-2615-126 (V6)
WETLabs C-Star transmissometer, s/n CST-1719TR (V7))

Additional instruments:

TRDI WorkHorse Monitor LADCP, down-ward looking, s/n 4275
TRDI WorkHorse Monitor LADCP, up-ward looking, s/n 13329
NOCS LADCP re-chargeable battery pressure case, s/n WH009T

5.2 TECHNICAL DETAIL REPORT

5.2.1 STAINLESS STEEL CTD ON CTD2

The termination on CTD 2 was found to be removed and a new termination was done prior to commencing CTD operations. An insulation test was carried out and it achieved >1000 MOhms with a resistance of ~74 Ohms prior to the re-termination. After the electrical and mechanical re-termination, as well as after the load test, a further insulation test was carried out and it achieved >1000 MOhms with a resistance of ~77 - 80 Ohms. A newly supplied electromechanical swivel, manufactured by MDS, was tested for ease of movement under load with a 1T anchor weight to a depth of 1000m, prior to installation on the CTD frame. The swivel performed as expected for cast JC142_001 through JC142_037. The soft splice CTD termination failed during deployment JC142_038, and was aborted at 895m on the downcast.

Approximately half way through the casts the SBE 3P, SBE 4C and SBE 43 were all cleaned according to the relevant SBE application notes to reduce any risk of bio-fouling.

During deployment JC142_011 at approximately 750m on the downcast, the secondary temperature and conductivity sensors became erratic. Their values did not resume in comparison to the primary sensors for the remainder of the profile. Upon recovery a large segment of bio-fouling was stuck in the secondary temperature intake. This was removed, the cells flushed, and re-deployed for the next cast. Deployment JC142_012 reverted to a normal profile.

No further issues were experienced with the CTD package.

After the last successful CTD the CTD wire was measured again and achieved values of:

Insulation test ->5 Ohms. Resistance -> ~74 - 84 Ohms

5.2.2 AUTOSAL

A Guildline 8400B, s/n 68958, was installed in the Electronics Workshop as the main instrument for salinity analysis. A second Guildline 8400B, s/n 65764, was ready to be installed in the Electronics Workshop as a spare instrument. The Autosal set point was 24C, and samples were processed according to WOCE cruise guidelines: The salinometer was standardized at the beginning of the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardized the Autosal was not adjusted for the duration of sampling, unless the set point had to be changed. Additional standards were analysed every 24 samples to monitor & record drift. These were labeled sequentially and increasing, beginning with number 9001. Standard deviation set to 0.00002

5.2.3 5.2.3 LADCP

Two command files were used during the cruise, one for the Master and one for the Slave systems. These were provided by RSMAS/Miami as used on DY053/054 where relatively low scattering water was likely, and the Master was very similar to the one suggested by HR Wallingford for a Master only configuration. The changes were made to accommodate syncronisation between the two LADCP's, and to prevent ping interference.

On cast JC142_008, the Master command file was sent in error to the Slave LADCP. There was also no log file saved for the communications & pre-deployment checklist with the Master LADCP.

The pressure sensor installed on s/n 24397 began to display erratic readings after deployment JC142_028m. As this sensor is not used for LADCP analysis the failure is noted only in the log file and does not impact data quality.

5.3 5.3 SUMMARY OF CASTS

Total number of CTD casts – 38 S/S frame.
Casts deeper than 2000m - 15 S/S frame.
Deepest cast - 4151m S/S frame.

5.4 5.3 CONFIGURATION FILES

For the Stainless CTD frame, date: 10/30/2016:

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC142\SeaSave set-up files\JC142_1257_NMEA.xmlcon

5.4.1 5.3.1 CONFIGURATION REPORT FOR SBE 911PLUS/917PLUS CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

Configured ports

5.4.1.1 5.3.1.1 CONFIGURED PORTS

1) Frequency 0, Temperature

Serial number : 03P-5835

Calibrated on : 14 July 2015

G : 4.37848242e-003

H : 6.72527358e-004

I : 2.71314047e-005

J : 2.00717943e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-3873

Calibrated on : 21 July 2015

G : -1.01873888e+001

H : 1.35598519e+000

I : -6.95774139e-004

J : 1.18392715e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 134949

Calibrated on : 9 November 2015

C1 : -3.695717e+004

C2 : -2.691791e-001

C3 : 1.143300e-002

D1 : 3.349300e-002

D2 : 0.000000e+000

T1 : 3.049225e+001

T2 : -3.372510e-004

T3 : 3.990980e-006

T4 : 3.875890e-009

T5 : 0.000000e+000

Slope : 1.00000000

Offset : 0.00000

AD590M : 1.280300e-002

AD590B : -9.092836e+000

4) Fequency 3, Temperature, 2Serial number : 03P-5838

Calibrated on : 14 July 2015

G : 4.34188455e-003

H : 6.69071098e-004

I : 2.66457779e-005

J : 2.11139139e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-4065

Calibrated on : 21 July 2015

G : -9.85127554e+000

H : 1.48613324e+000

I : -2.02882111e-003

J : 2.34885493e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

6) A/D voltage 0, oxygen, SBE 43

Serial number : 43-1882

Calibrated on : 24 November 2015

Equation : Sea-Bird

Soc : 4.33900e-001

Offset : -4.98400e-001

A : -3.61000e-003

B : 1.84670e-004

C : -2.75540e-006

E : 3.60000e-002

Tau20 : 1.25000e+000

D1 : 1.92634e-004

D2 : -4.64803e-002

H1 : -3.30000e-002

H2 : 5.00000e+003

H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

Serial number : 47597

Calibrated on : 22 February 2010

Scale factor : 15.000

Offset : 0.000

9) A/D voltage 3, OBS, WET Labs, ECO-BB

Serial number : BBRTD-182

Calibrated on : 5 September 2013

ScaleFactor : 0.002931

Dark output : 0.068000

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-124

Calibrated on : 21 January 2015

VB : 0.463400

V1 : 2.044300

Vacetone : 0.474400

Scale factor : 1.000000

Slope : 1.000000

Offset : 0.000000

13) A/D voltage 7, Transmissometer, WET Labs C-Star

Serial number : CST-1718TR

Calibrated on : 15 April 2015

M : 21.1798

B : -0.1292

Path length : 0.250

Scan length : 45

5.4.2 5.3.2 LADCP COMMAND FILES:

RSMAS

whm300

WV250	; ambiguity velocity [cm/s]
WN25	; number of depth cells; NBP0402
WS1000	; bin size [cm]; NBP0402: WS1000
WF0	; blank after transmit [cm]; NBP0402
WB1	; narrow bandwidth mode
EZ0011101	; Sensor source: (NBP0402: EZ0111111)
EX00100	; coordinate transformation: (NBP0402: 11111)

WP1	; single-ping ensembles; NBP0402: WP3 most of the time
TP 00:00.90	; time between pings; NBP0402
TE 00:00:01.50	; time per ensemble
CF11101	; Flow control:
SM1	; set to master
SA011	; send pulse before ensemble
SW5500	; master waits .5500 s after sending sync pulse
RNmast_	
CK	; keep params as user defaults (across power failures)
W?	
T?	
CS	; start pinging

whs300

WV250	; ambiguity velocity [cm/s]
WN25	; number of depth cells; NBP0402
WS1000	; bin size [cm]; NBP0402: WS1000
WF800	; blank after transmit [cm]; NBP0402
WB1	; narrow bandwidth mode
EZ0011101	; Sensor source: (NBP0402: EZ0111111)
EX00100	; coordinate transformation: (NBP0402: 11111)
WP1	; single-ping ensembles; NBP0402: WP3 most of the time
TP 00:00.00	; time between pings; NBP0402
TE 00:00:01.50	; time per ensemble
CF11101	; Flow control:
SM2	; set to slave
SA011	; waits for pulse before ensemble

```
ST120      ; waits 120s for ma-signal before running single^M
RNslav_
CK         ; keep params as user defaults (across power failures)
W?
T?
CS         ; start pinging
```

6 HR WALLINGFORD HYDROGRAPHY REPORT

The following document details the contribution made by staff of HR Wallingford to the Marine E-Tech cruise undertaken on the RRS James Cook (JC142) from 28th October to 8th December 2016.

Specifically this document covers the water column measurements undertaken in support of the development of a three dimensional hydrodynamic model of the interaction between the Tropic Seamount and the prevailing regional flows (Work Package 2) and the measurement of plume dispersion and behaviour undertaken for Work Package 3.

6.1 MOORING DEPLOYMENTS

6.1.1 OBJECTIVES

A total of three oceanographic moorings were deployed during the JC142 cruise. Table 1 lists the positions of the moorings, the water depth at these positions, deployment duration, the instrumentation used and their depths in the water column. Positions correspond to the "as deployed" locations. Figure 1 shows the deployed locations of the moorings.

The three moorings and their associated instrumentation were intended to provide data with which to calibrate and validate the three dimensional TELEMAC model of the seamount being developed by the Hydrodynamics and Metocean Group of HR Wallingford.

In particular, the upward looking profiling ADCP deployed at a depth of 6m above the seabed on the central mooring (B) was positioned to allow an assessment of whether or not a Taylor cap exists above the seamount summit.

The two other moorings (A and C) were positioned to capture data above the flank and at the foot of the seamount respectively.

The moorings were intended to be deployed for a duration of order 30 days in order to provide a snapshot of the behaviour of the currents within the vicinity of the sea mount.

Mooring design, fabrication and operational aspects on board the vessel were undertaken by staff of NERC National Marine Facilities based at the National Oceanography Centre Southampton with the instrumentation deployed provided from the National Marine Facilities Equipment pool. A description of the equipment and methods is provided in the technical report prepared by NMF staff on the oceanographic moorings deployed.

In addition to specifying the requirements of the measurements needed to support the modelling work HR Wallingford staff participating in the cruise took responsibility for the analysis of all water column data including that delivered by the three moorings.

The analytical approach taken and initial results are detailed in the following sections.

ID	Location	Position (WGS84 UTM 27N E/N (m))	Position (WGS84 Lat/Lon (DD))	Water Depth (m)	Deployment duration (days)	HASB (m) - lower instruments	Parameters - lower instruments	Lower Instruments	HASB Bed (m) Upper instruments	Parameters - upper instruments	Upper Instruments
A	Seamount Slope	530395	2656381	3084	31.79	1000	UVW, salinity, temperature	Nortek Aquadopp DW Current Meter, Seabird SBE37 CTD	2000	UVW, salinity, temperature.	Nortek Aquadopp DW Current Meter, Seabird SBE37 CTD
B	Seamount Summit	530630	2641479	1007	30.59	9	UVW, salinity, temperature (Profiler Upward Looking)	TRDI Workhorse Sentinel ADCP (300 kHz), Seabird SBE37 CTD	900	UVW, salinity, temperature	Nortek Aquadopp DW Current Meter, Seabird SBE37 CTD
C	Abyssal Plain	527542	2618338	4172	31.70	1000	UVW, salinity, temperature	Nortek Aquadopp DW Current Meter, Seabird SBE37 CTD	3500	UVW, salinity, temperature	Nortek Aquadopp DW Current Meter, Seabird SBE37 CTD

Table 1: Oceanographic mooring positions, water depths, instrumentation used and instrument nominal height above seabed.

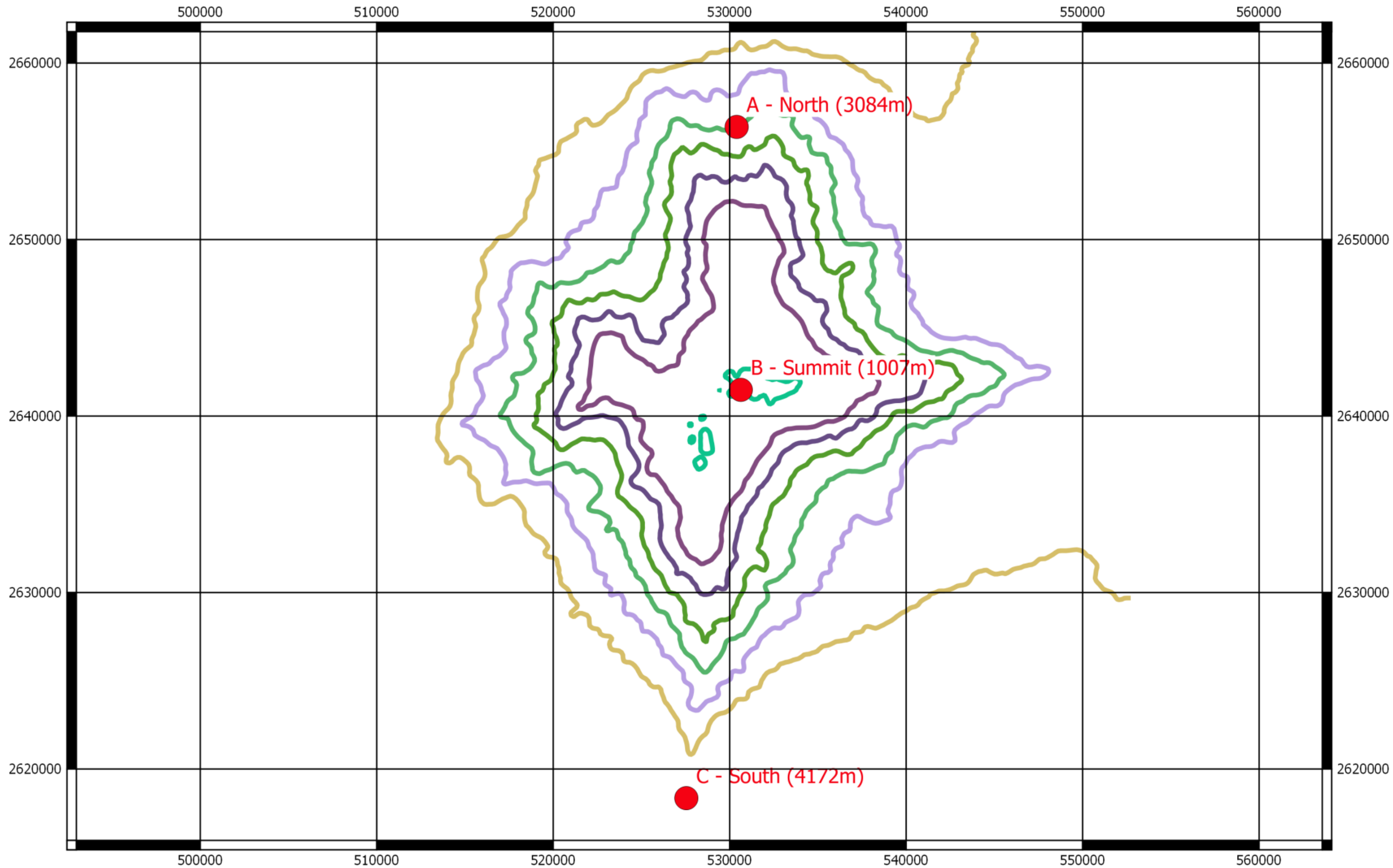


Figure 1: Oceanographic moorings location map

6.1.2 DATA ANALYSIS

Following recovery of the recording oceanographic instrumentation the data was downloaded using the manufacturer’s proprietary software before being analysed using HR Wallingford’s Geo-Temporal Editor software (GTE). The GTE tool has been specifically developed for analysis and presentation of oceanographic datasets from a variety of instrument types including current meters and current profilers as well as instruments such as profiling and fixed point CTDs. The tool decodes the complex data structures associated with proprietary binary files such as those produced by the Nortek AquaDopp current meters and Teledyne RDI ADCPs. In the case of the Sea Bird Electronics (SBE) Type 37 CTD recorders the most recent sensor calibration data available was applied to the recorded data during data conversion. All the processed data files were subsequently imported into the GTE database.

Once imported the recorded data were visually inspected to ensure that the instrument timings were in agreement using the time of deployment and recovery information, before quality assuring the data using the methodology developed by Taylor and Jonas (2008) for the analysis of moored ADCP datasets, which is appropriate for use with Teledyne RDI instrumentation. The approach makes an assessment of the various quality assurance (QA) information provided in the PD0 dataset (correlation magnitude, percentage of good pings, etc.) to assign a quality threshold to each individual measurement acquired by the ADCP such that a simple filter can be used to exclude poor quality measurements from subsequent analysis.

Although the level of QA information available within binary data files recorded by the Nortek Aquadopp current meters is not as extensive, within the data structure a similar approach has been taken to screen erroneous or poor quality data.

The approach taken to QA the data recorded by the CTDs installed on the moorings was based on assessment of the range of the measurements, their rate of change (spikes), and deviations from a running mean of the data with each parameter being assigned a QA value.

Although the data presented in this report has only been subject to an initial screening due to the limited time available following recovery, the instrumentation deployed on the three moorings have, in general, performed to their specified limits. It is noteworthy however that the profiling range of the 300 kHz ADCP deployed on mooring B is approximately 50% of that stated by the manufacturers due largely to the low number of scatters in the water column, a feature that has been previously noted (King pers comm) and has also been evident in the data returned by other acoustic profiling instrumentation deployed during this cruise.

With respect to the CTD the short duration of the deployment resulted in the surface instruments to be relatively free of bio-fouling, with only a small number of records (~300) being rejected by the QA of the data from the near surface CTD deployed on mooring B. The CTDs placed at depth on the 3 moorings have revealed no data quality issues in the present time.

6.6.3 SUMMARY OF INITIAL RESULTS

Results of the current meter records obtained from the three moored datasets all show a pattern of oscillatory flows indicative of the presence of internal tides generated by the seamount. However, at first sight, there would appear to be little evidence of a zone of weak or rotating flows centred on the seamount that might suggest the presence of a Taylor cap.

Figure 2 shows an example of the time series obtained from the current meters deployed at 1000m depth on moorings A and B. The tidal nature of the signal is evident in the 14 day cycle of current speeds and directions with spring tides falling around November 16th and a weaker set of springs around November 30th.

Generally the currents show a semi-diurnal pattern of variation although strong diurnal inequalities are evident and a tendency to a more diurnal pattern of variation on neap tides. It is intended that both the currents and elevation records obtained during the mooring deployments will be subjected to harmonic analysis at a later date to confirm this.

This pattern of tidal variation is set within the pattern of regional current flows which, from the progressive vector diagrams (PVDs), appears to be dominantly to the south. Figure 3 shows the progressive vector plots, again at the 1000m level from the same two moorings, together with that for the 3300m current meter deployed on the southern mooring. As can be seen the tidal variation is strongest at the summit of the seamount with tidal ellipses clearly evident in the PVD. Whilst still present at the northern mooring these ellipses are less prominent and generally the regional flow is more dominant. Note the change in the net direction of water movement from south–south west to south-south east. This may or may not be coincident with a period of strong north easterly winds experienced during the early part of the cruise.

At the southern mooring the pattern of net water movement shown by the PVD, whilst not completely dissimilar to that seen in the other figures, shows much slower currents prevailing with again a much weaker tidal signal evident in the data.

Comparing this against the CTD data set obtained at 1000m depth shows some discrepancies. Figure 4 shows the CTD time series from the 3 moorings. Pressure records show a semi-diurnal pattern of variation with an amplitude of order 1.5m on spring tides around November 16th, ignoring the effects of knock down of the moorings. Indeed the temperature and salinity variations at the central and southern moorings also show tidally induced variation.

What is more interesting is the propagation of the temperature and salinity signal southwards across the study area. This signal reaches its minimum around 13/11/2016 and appears to reach the central mooring almost 7 days later than at the northern mooring, despite the fact that the two sites were within 15 km of each other. The southern mooring does not appear to detect the signal at all during the 30 days of observation. The reasons for this cannot be determined at the present time.

It is hoped that through use of the TELEMAC model it will be possible to simulate the patterns of variation seen in the field observations and from this provide an insight into the control exerted by the seamount on the regional flow patterns.

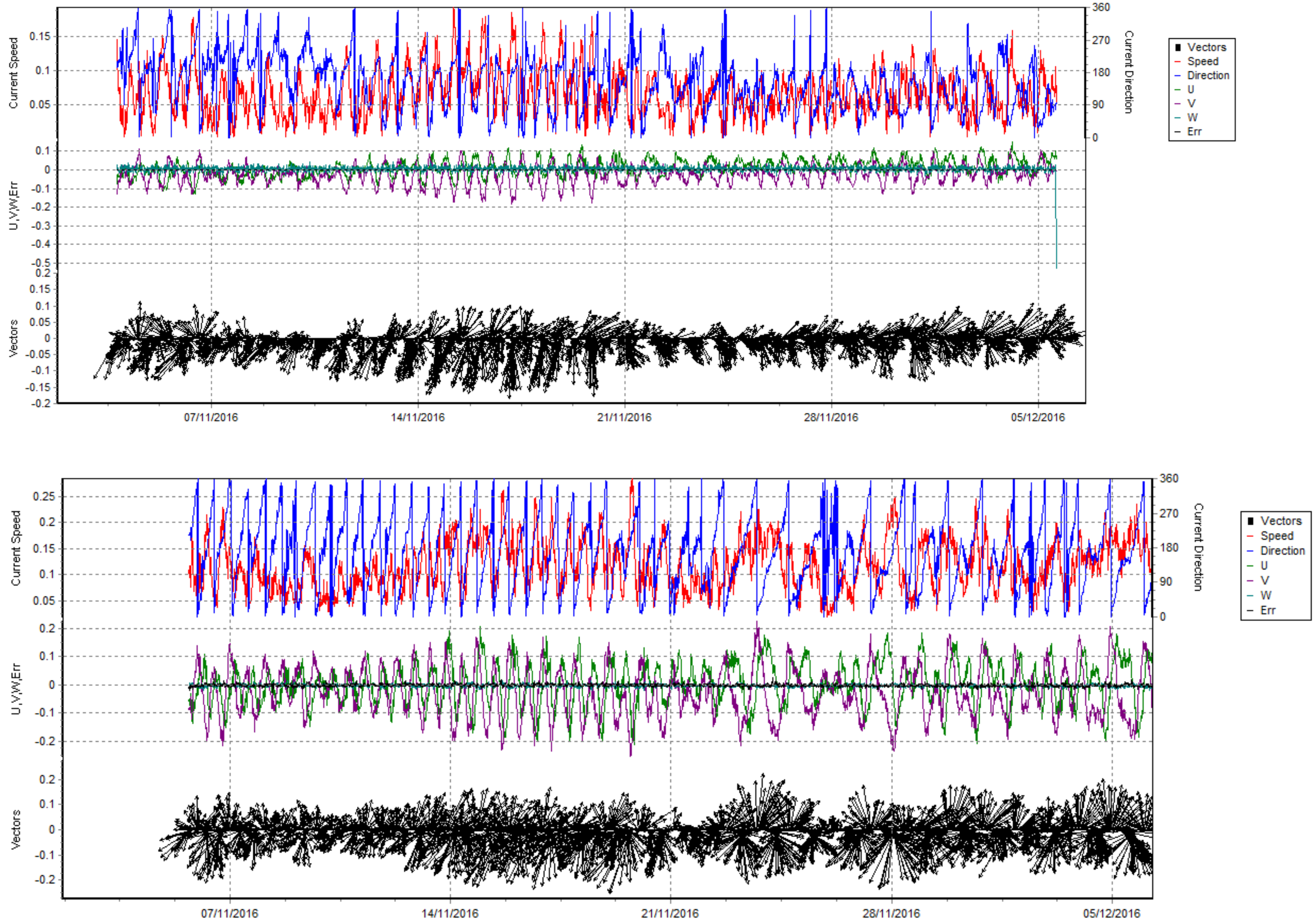


Figure 2: Time-Series of currents at 1000m depth from Mooring A - North (upper plot) and Mooring B - Summit (lower plot) showing influence of internal tides in the records obtained.

JC142 Tropic Seamount,

23°55'N: 20°45'W

National Oceanography Centre
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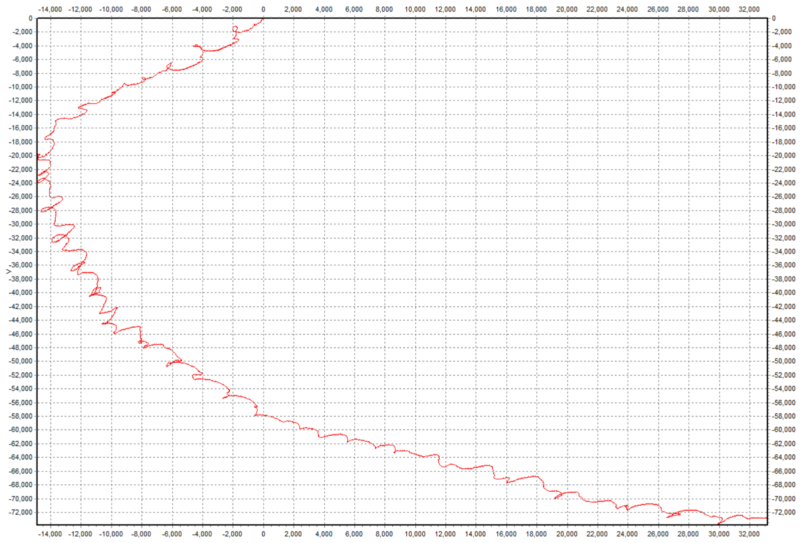
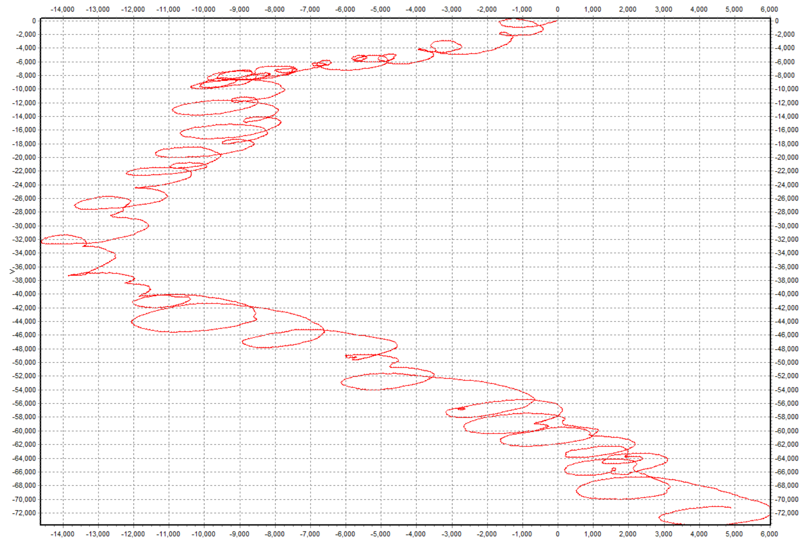




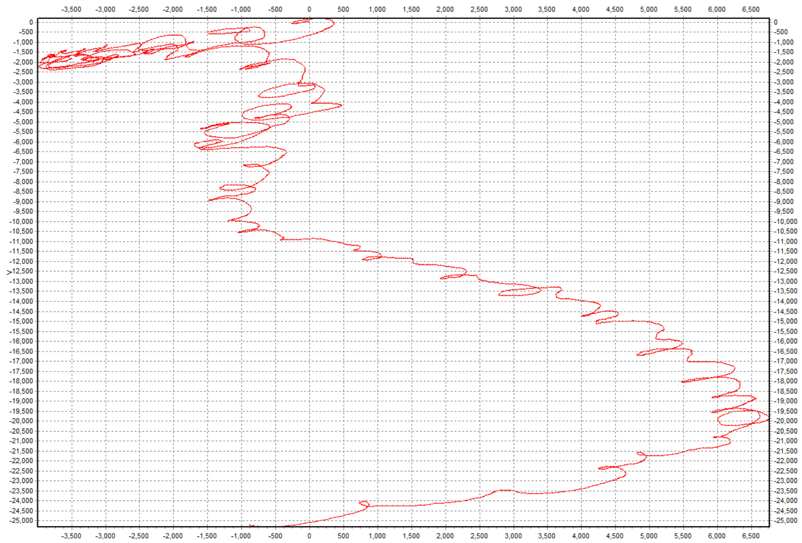
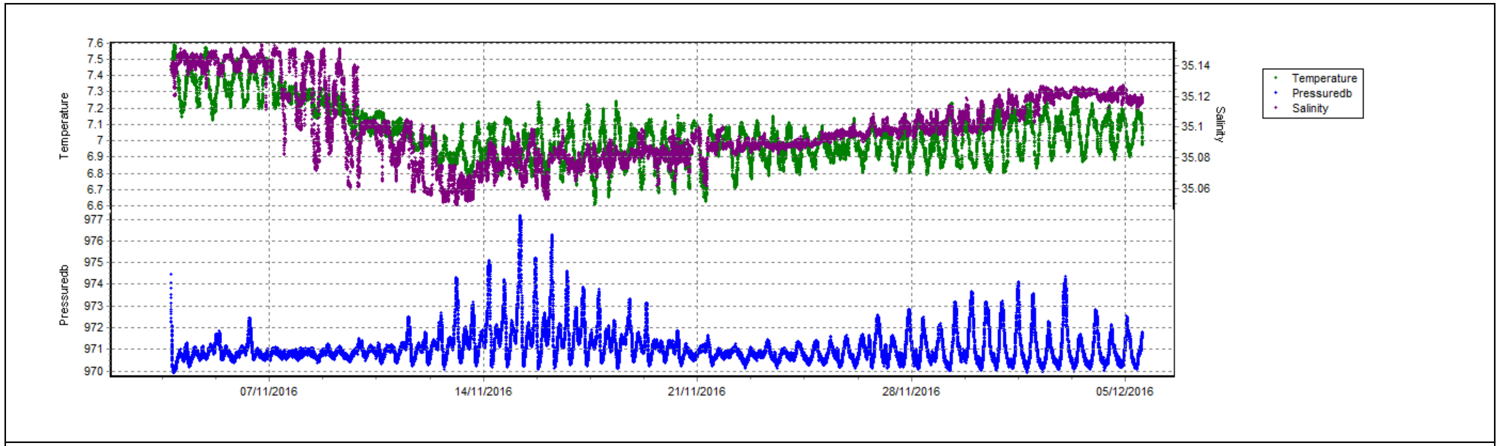
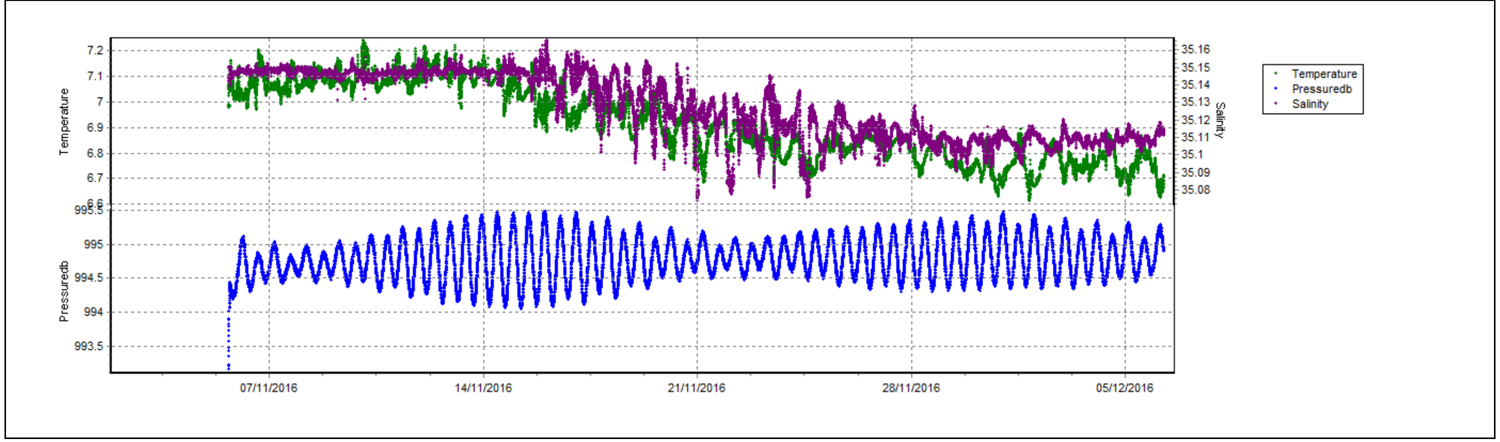


Figure 3: Progressive vector plots of currents at 1000m depth from Mooring A - North (top left), Mooring B - Summit (top right) and for 3300m depth from Mooring C - South. The 1000m instrument on Mooring C failed to return data. The plots show the influence of the internal tides and regional flow patterns.


Temperature
Pressuredb
Salinity
07/11/2016
14/11/2016
21/11/2016
28/11/2016
05/12/2016
Temperature
Pressuredb
Salinity


Temperature
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28/11/2016
05/12/2016
Temperature
Pressuredb
Salinity

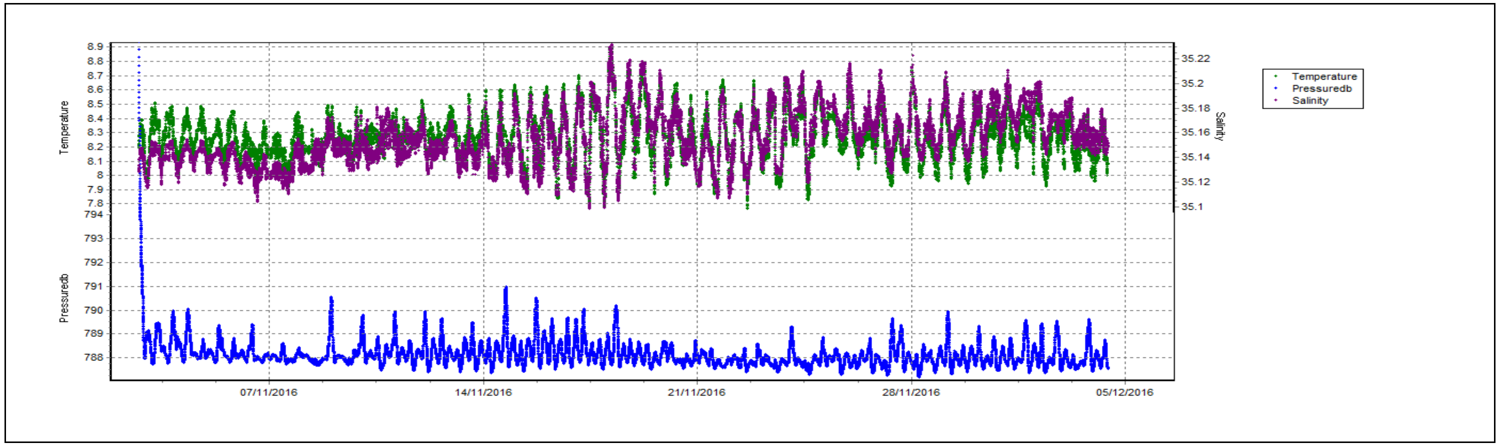


Figure 4: Recording CTD time series at 1000m depth from Mooring A - North (top), Mooring B - Summit (centre) and Mooring C (bottom) showing propagation of a temperature-salinity signal across the area.

6.2 CTD PROFILES

6.2.1 OBJECTIVES

As with the moorings the CTD profiles were primarily intended to provide verification data for the numerical model being developed by HR Wallingford.

The datasets and associated water samples collected on each cast have however provided an opportunity to provide data for a number of additional studies notably those being performed by Lizette Victorero (NOCS) for particulate organic carbon and Gretta Gilian (University of Bremen) / Mike Zubkov (NOCS) for microbiological studies as well as a means of collecting water for the calibration of the optical sensors used for the tasks performed under Work Package 3.

In the initial cruise planning 18 stations where identified by HR Wallingford to validate the numerical model with the plan that a single station at the centre of the seamount's plateau area should be occupied to perform a CTD yo-yo to detect the presence of internal tides and internal waves. The locations selected were positioned so as to capture hydrodynamic features of interest around the seamount (based on updated model runs) as well as to determine the "far-field" conditions away from the seamount.

To this dataset a further 19 casts were added including the 8 casts undertaken as part of the yo-yo-ing exercise performed at station 69 close to the site of mooring B located at the seamount summit.

The timings and locations of the 37 casts under taken are listed in Table 2.

Cast No.	JC142 Station	DateTime (GMT)	Easting (UTM 27N)	Northing (UTM 27N)	Comment
1	3	31/10/2016 00:49	522544	2622747	
2	8	01/11/2016 08:38	531626	2641732	
3	13	03/11/2016 00:36	530900	2648060	
4	14	03/11/2016 02:28	531534	2644740	
5	15	03/11/2016 04:17	534782	2641537	
6	16	03/11/2016 06:01	537123	2641875	
7	17	03/11/2016 08:14	527589	2641041	

Cast No.	JC142 Station	DateTime (GMT)	Easting (UTM 27N)	Northing (UTM 27N)	Comment
8	18	03/11/2016 10:30	523991	2641902	
9	33	07/11/2016 05:55	531558	2641843	
10	35	08/11/2016 10:04	529376	2638314	
11	36	08/11/2016 13:01	528654	2634770	
12	37	08/11/2016 15:09	535821	2633365	
13	42	09/11/2016 22:29	542195	2648089	
14	43	10/11/2016 02:27	536267	2651449	
15	44	10/11/2016 05:54	529609	2657136	
16	51	12/11/2016 21:54	523004	2654079	
17	57	14/11/2016 12:06	521003	2642949	
18	59	15/11/2016 14:27	522513	2643117	
19	69	17/11/2016 23:36	531018	2640384	
20	69	18/11/2016 00:37	531001	2640384	YoYo Cast 1
21	69	18/11/2016 01:22	531018	2640384	YoYo Cast 2
22	69	18/11/2016 02:05	531001	2640384	YoYo Cast 3
23	69	18/11/2016 02:50	531018	2640384	YoYo Cast 4

Cast No.	JC142 Station	DateTime (GMT)	Easting (UTM 27N)	Northing (UTM 27N)	Comment
24	69	18/11/2016 03:35	531018	2640384	YoYo Cast 5
25	69	18/11/2016 04:19	531018	2640384	YoYo Cast 6
26	69	18/11/2016 05:04	531018	2640384	YoYo Cast 7
27	71	18/11/2016 08:14	525510	2646259	YoYo Cast 8
28	73	18/11/2016 22:39	529286	2640897	
29	75	19/11/2016 02:41	536634	2647206	
30	82	21/11/2016 15:41	520116	2646066	
31	87	26/11/2016 10:58	525626	2628509	
32	92	28/11/2016 13:54	545198	2642359	
33	98	30/11/2016 04:08	522454	2648192	
34	99	30/11/2016 07:12	518797	2643315	
35	110	03/12/2016 14:45	529520	2634642	
36	112	03/12/2016 19:06	529106	2629346	
37	120	06/12/2016 03:16	521743	2635735	

Table 2: Timings and locations of CTD casts.

The locations of the CTD stations undertaken around the seamount are shown in Figure 5.

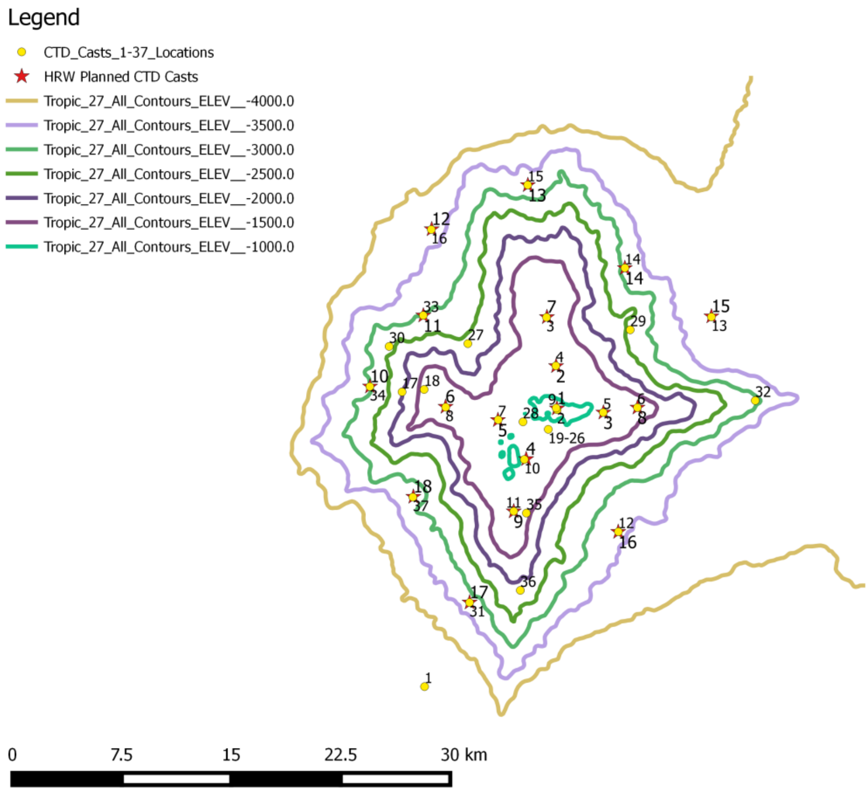


Figure 5: Location of all CTD stations undertaken on the JC142 Cruise

6.2.2 INSTRUMENTATION

The equipment provided by National Marine Facilities for this work included a CTD rosette bearing two SBE CTD profilers with their associated sensors (transmissometer, optical backscatter sensor, fluorimeter and altimeter) together with upward and downward looking 300 kHz Teledyne RDI ADCPs. The rosette was equipped with 24 x 20l water bottles for the collection of in-situ samples, with samples acquired on each cast for calibration purposes as well as to meet the sampling requirements of the scientific team.

A full description of the technical and operational aspects of the CTD profiling system can be found in the technical report provided by the National Marine Facilities staff responsible for the operational aspects of this equipment. A copy of this is included in the main cruise report.

6.2.3 DATA PROCESSING

For each cast undertaken the data collected with the CTD profiler was processed using SBE software by staff from the National Marine Facilities (Jeff Benson). Processing was in accordance with the BODC guidelines Version1.0 October 2010. The processing steps involved were:

- Application of sensor calibrations
- Conversion of data from manufacturers proprietary format to XML/ASCII

- Adjustment for the lag in response of the CTD's dissolved oxygen sensor (alignment)

- Compensation for the CTD cell's thermal mass
- Derivation of additional parameters as per scientific party requirements - Oxygen Concentration (umol/kg), Latitude and Longitude (degrees) and Density
- Removal of spikes in the pressure record (filter)
- Averaging of the recorded data from 16 Hz to 2 Hz
- Extraction of CTD data for bottle stations

The 2 Hz cast and bottle files derived from each profile were uploaded into a GTE database along with cast metadata (station number, maximum depth etc., where they were split into up/down casts and the bottle stations applied).

The data was then quality-controlled with the first 5 minutes of data flagged to account for the "soaking" of the sensors when the profiling rig is held at the surface to allow the sensors to stabilise.

Erroneous records arising from the soaking of the sensors that were not captured by the automatic quality control process were adjusted manually with a quality flag added to each record. These records were typically recorded within the first minute or so of the profile.

Following this the data was plotted using a Matlab script to provide plots of the CTD up and downcast of the following parameters against depth:

- salinity
- temperature
- density
- potential temperature
- optical backscatter
- beam transmittance
- dissolved oxygen
- fluorescence

T-S diagrams were also generated, consisting of the temperature and salinity plotted against each other with each plotted point coloured by measurement depth.

For the purposes of analysis CTD profiles were grouped together to allow CTD sections to be plotted of key parameters including salinity, temperature and dissolved oxygen. This was achieved using a Matlab script to extract the profile plots from the databases, grid the data and provide a contoured representation of the variation of the vertical structure of the water column as a function of distance north - south or west to east across the seamount, or, in the case of the CTD yo-yo station data, as a function of time from the start of the first CTD yo-yo cast.

6.2.4 WATER SAMPLING

Over the course of the cruise at total of 436 water samples were collected using the rosette water sampler. A complete list of the water samples collected can be found in Appendix of this document.

6.2.5 INITIAL RESULTS

6.2.5.1 WATER MASSES

Figure 6 shows the T-S diagram from the deepest cast collected during the survey.

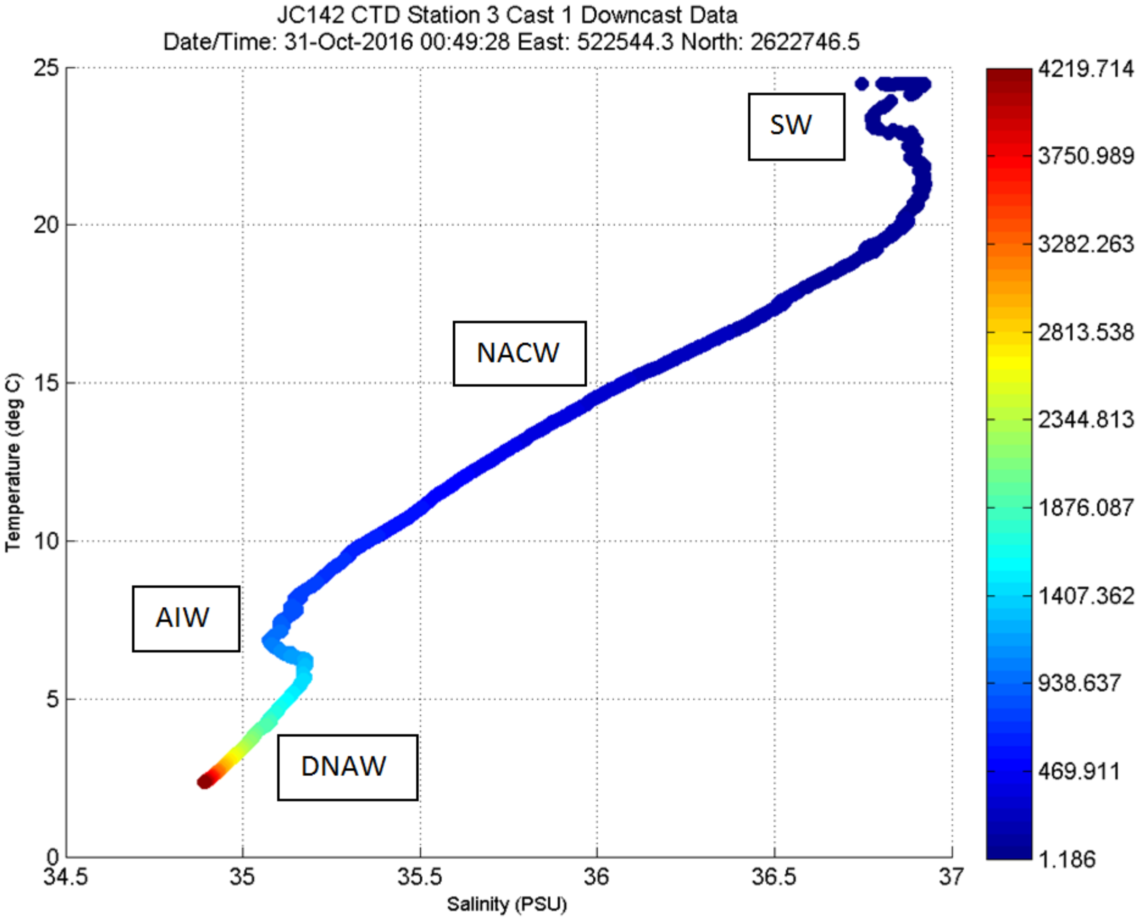


Figure 6: Water mass (T-S) diagram obtained from Cast 1.

The lowest water mass evident in the plot is the North Atlantic Deep Water Mass which is present below a depth of order 1200m. Overlying this is a water mass of uncertain origin with a salinity of 35.2 and a temperature of around 5.5 degrees C. The Antarctic Intermediate Water mass which is characterised by a salinity of 35.05 and a temperature of 7 degrees sits above this and extends up to approximately 1000m depth and hence is the water mass in which the sea mount crest sits and which is in turn overlain by the North Atlantic Central Water Mass. This water mass occupies most of the profile above 800m depth and is in turn overlain by the Surface Water Mass extending to a depth of order 50m.

6.2.5.2 CROSS SECTIONS

Two cross sections running north-south (Figure 7) and west-east (Figure 8) over the seamount have been compiled from the CTD profiles collected to date with sections produced from each for salinity, temperature and dissolved oxygen. The casts included in each section are given at the top of the figures.

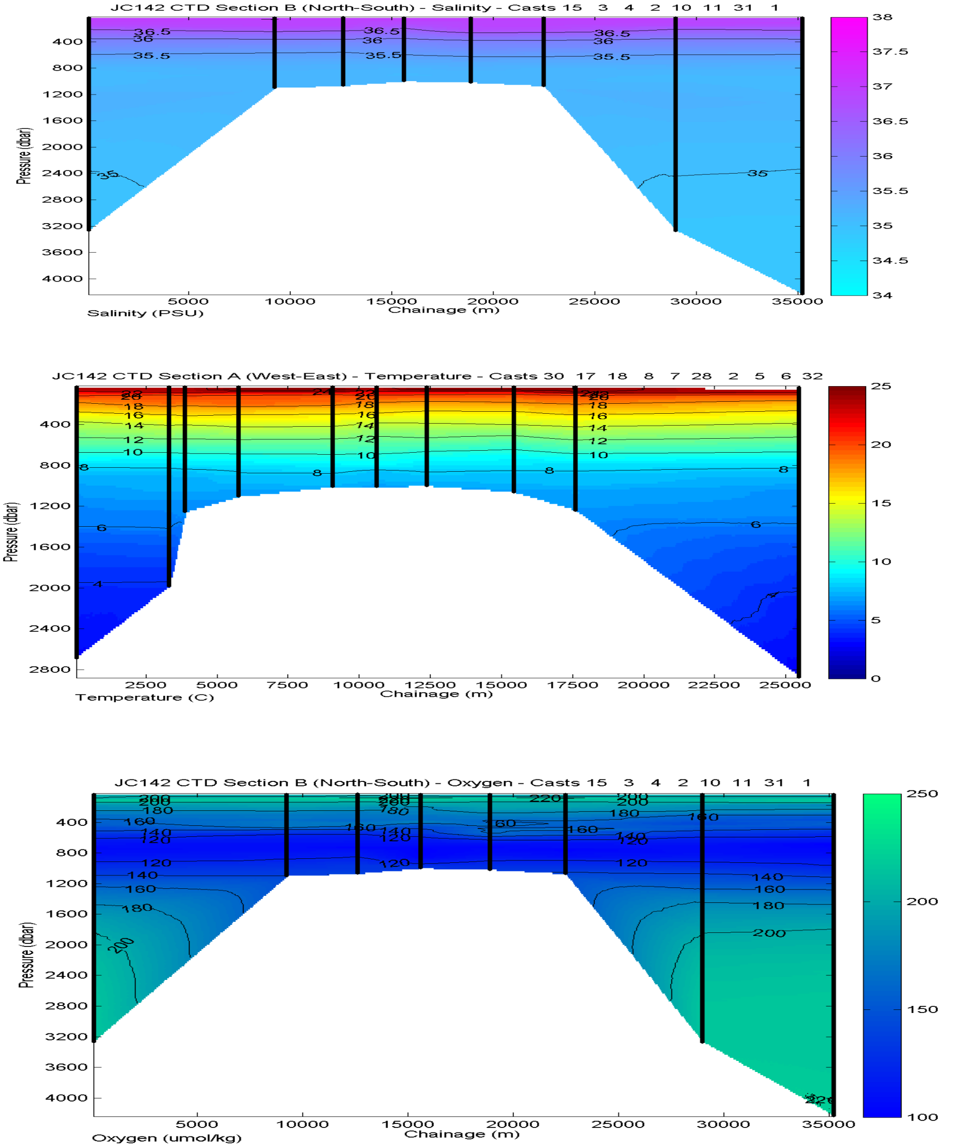
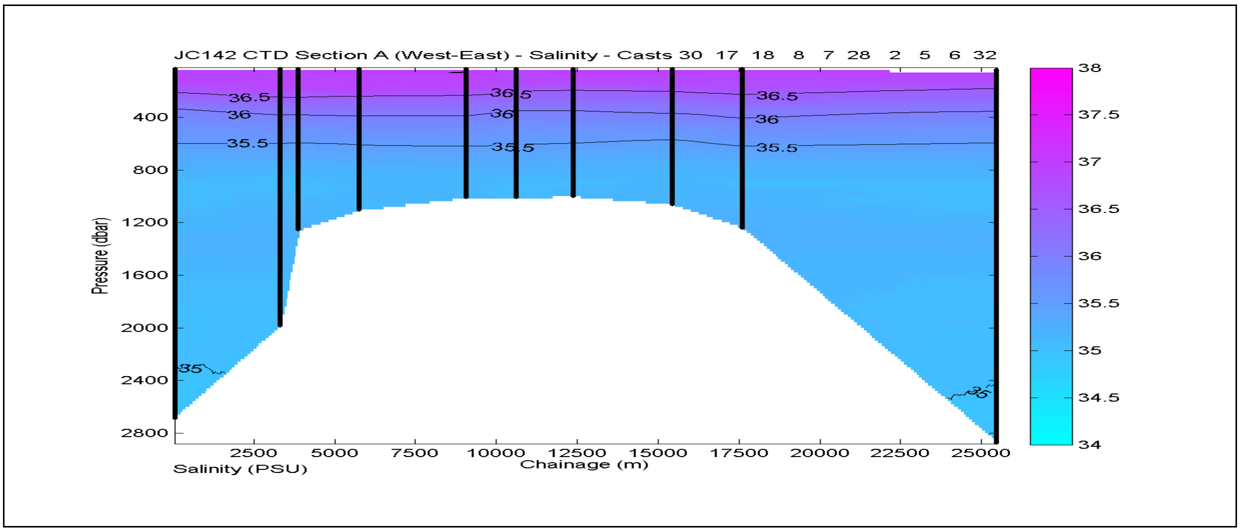


Figure 7: North-South CTD section. Salinity (upper), temperature (middle) and oxygen (lower).



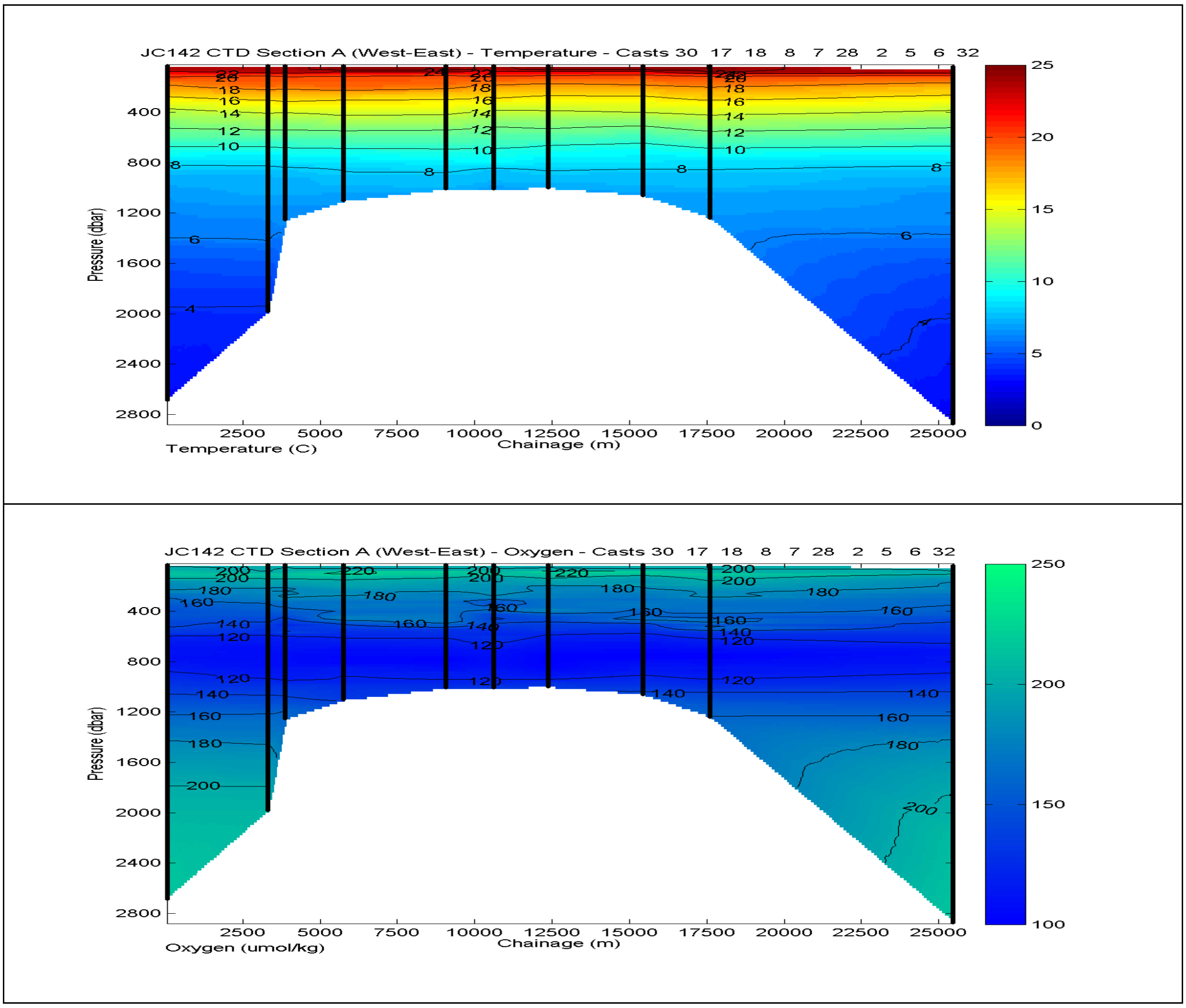


Figure 8: West-East CTD section. Salinity (upper), temperature (middle) and oxygen (lower).

Despite the artefacts produced in the contours due to the gridding method selected there is some evidence for a doming of the thermohaline structure over the seamount crest evident in both the sections. More noticeable however is the sloping of the oxygen minimum from West to East across the section.

These features and their causal links will be the focus of the investigation undertaken as part of the HR Wallingford modelling studies and will be reported at a later date.

6.2.5.3 CTD YO-YO STATION

Due to the time available only a partial CTD yo-yo was possible with data collected over a 5.5 hour period between 17/11/2016 23:36 and 18/11/2016 05:04. The yo-yo was performed at the crest of the seamount with each cast coming to within 10m of the surface before descending. In terms of the timing of the casts with respect to the timing of internal tide (predicted from analysis of satellite altimeter records) this would correspond to approximately 2.7 hours before high water (HW) with the last cast being taken some 2.8 hours after HW (Cast 22 being closest to the time of actual HW).

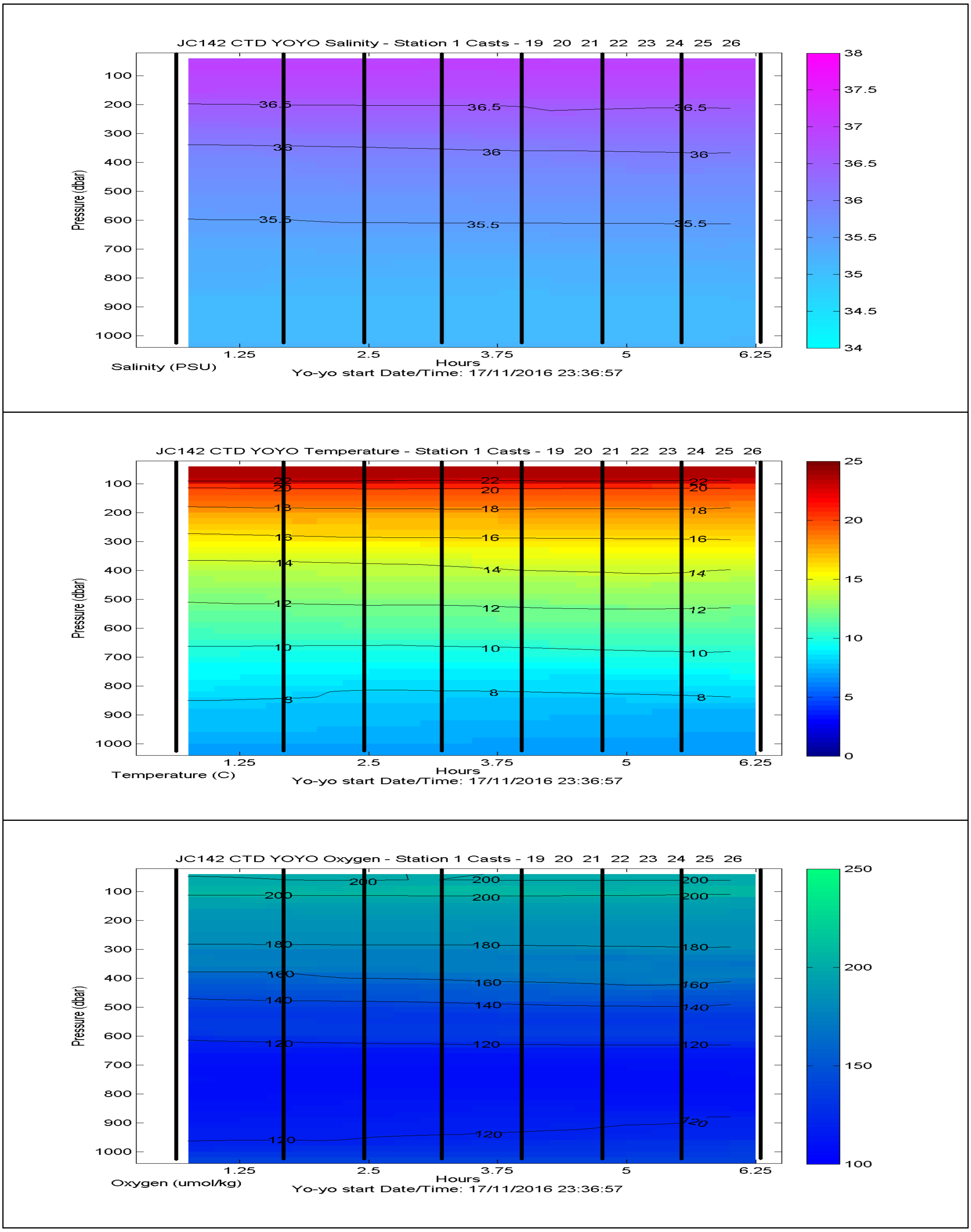


Figure 9: Variation seen in water column structure seen in the 5.5 hour CTD yo-yo undertaken at Station 69, located at the seamount summit. Salinity (upper), temperature (middle) and oxygen (lower).

The variation in water column structure, which is presented in Figure 9, is relatively small, however there is some evidence of a cooling in the bottom waters as the ebbing tide sets in which may account for the deepening of the oxygen minimum seen to occupy a position approximately 200m above the seamount crest. Also noticeable at the bed is an increase in the thickness of the slightly more oxygenated water sitting in contact with the sea mount crest over the course of the CTD yo-yo time-series.

As with the data present in the cross sections made across the seamount it is hoped that through comparison of these data sets with modelling a better understanding of water exchange mechanism at the seamount crest will be achieved.

6.3 LOWERED ADCP PROFILES

6.3.1 INTRODUCTION

The use of upward and downward looking ADCPs deployed on the CTD profiler provides the opportunity to not only acquire more information on current structure over the seamount but to extend the profiling range of the vessel and bottom mounted sensors deployed during the cruise. This limitation in ADCP profiling range arises from the relative paucity of scatterers in the water column and effectively reduces the profiling range of the ADCPs deployed on this project by a factor of 2.

6.3.2 INSTRUMENTATION

Two 300 kHz ADCP profilers where provided from the NMF equipment pool and operated by the NMF staff responsible for CTD profiling operations on the cruise

Prior to mobilisation HR Wallingford provided an instrument configuration which was agreed with the NMF staff responsible for the CTD profiling operations prior to the cruise mobilising.

6.3.3 DATA PROCESSING

Following some research into the methodology and with the assistance from Dr B King of the National Oceanographic Centre at Southampton it was decided to use the LDEO-XII software for the purpose of analysing the data acquired on each CTD cast.

The LDEO-XII software runs in Matlab and is based on the method of Visbeck and is accompanied by a useful guide (Thurnherr (2016)) which explains the operational aspects of the process.

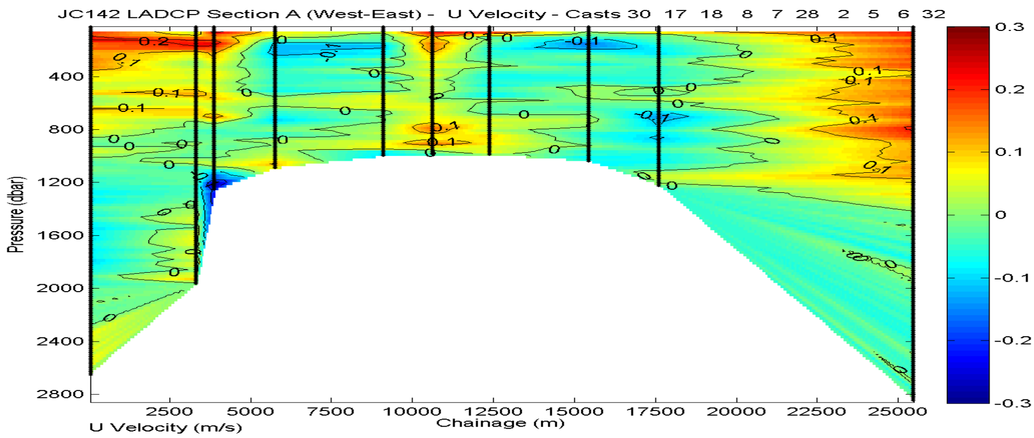
Using this information the lowered ADCP data acquired from each cast has been combined with its corresponding CTD and navigation to allow processing of the acquired data to derive a full current profile through the water column. Additional information is available from the downward looking instrument in the near bed region once the ADCP's bottom tracking functionality can be used.

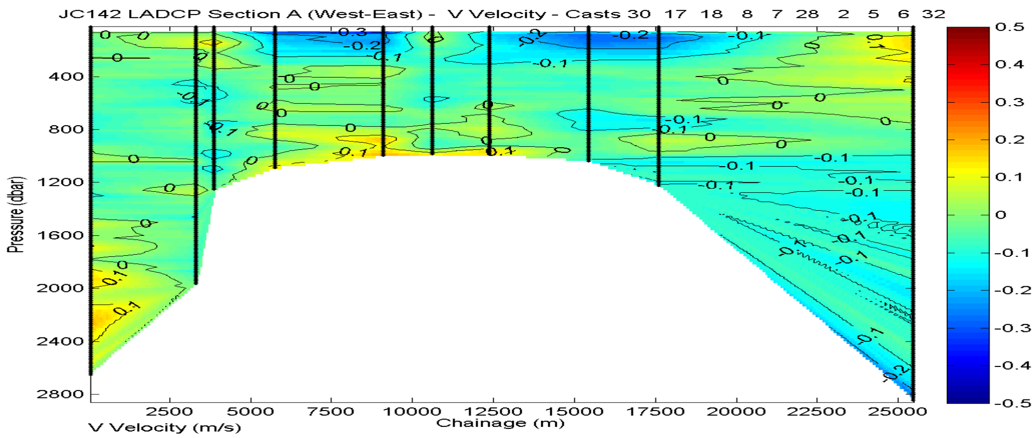
Unfortunately given the limitations experienced with the vessel mounted ADCP data, which are discussed in Section 6.4 of this report, it has not been possible to merge the LADCP dataset with the profiles obtained from the vessel mounted ADCPs and in so doing provide a constraint on the inverse difference in the shear calculation which would normally be used. However it is anticipated that the LADCP dataset will be reprocessed once the rotation error in the vessel mounted ADCP data has been corrected.

The LDEO IX LADCP software's output provides a variety of plots against which to quality assure the results obtained. However at the present stage there is little information in the guide as to how to improve the results obtained or how to optimise the ADCP measurements so as to maximise the chances of returning the highest quality data. Despite these limitations and the relative inexperience of the HR Wallingford team in using this technique, of the 37 casts for which data was collected 38% of the casts have returned a "LADCP profile OK" message returned following analysis. The remaining 62% of the data analysed yielded warnings, the most common being "Warning: cast duration differs in downlooker/uplooker data" (15 occurrences). Other warnings which are thought to have only a minor impact on the quality of data returned included "Weak up looking beam 2" (2 occurrences) and "Removed ## pressure spikes during: # scans" (4 occurrences). However some 11 casts yielded a warning "Increased error because of shear - inverse difference". Further effort is needed to fully QA this data and this will be undertaken following discussion with NOC staff familiar with the technique.

For the purposes of this report the vessel profiles derived from this analysis are presented on an "as is basis" and comprise the same N-S and W-E sections and yo-yo sections as has been presented for the CTD dataset albeit with no interpretation of the results obtained.

6.3.4 RESULTS (PRELIMINARY)





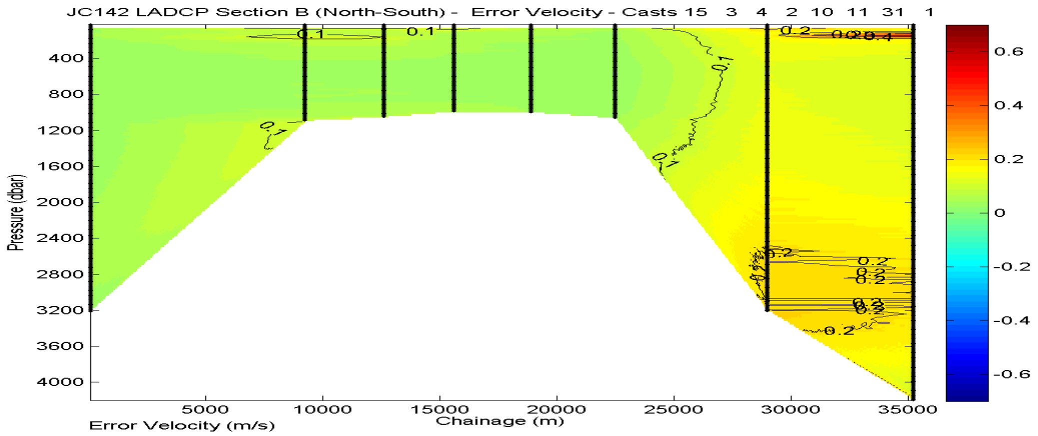


Figure 10: Variation in velocity profile seen on the North - South section. U component (upper), V component

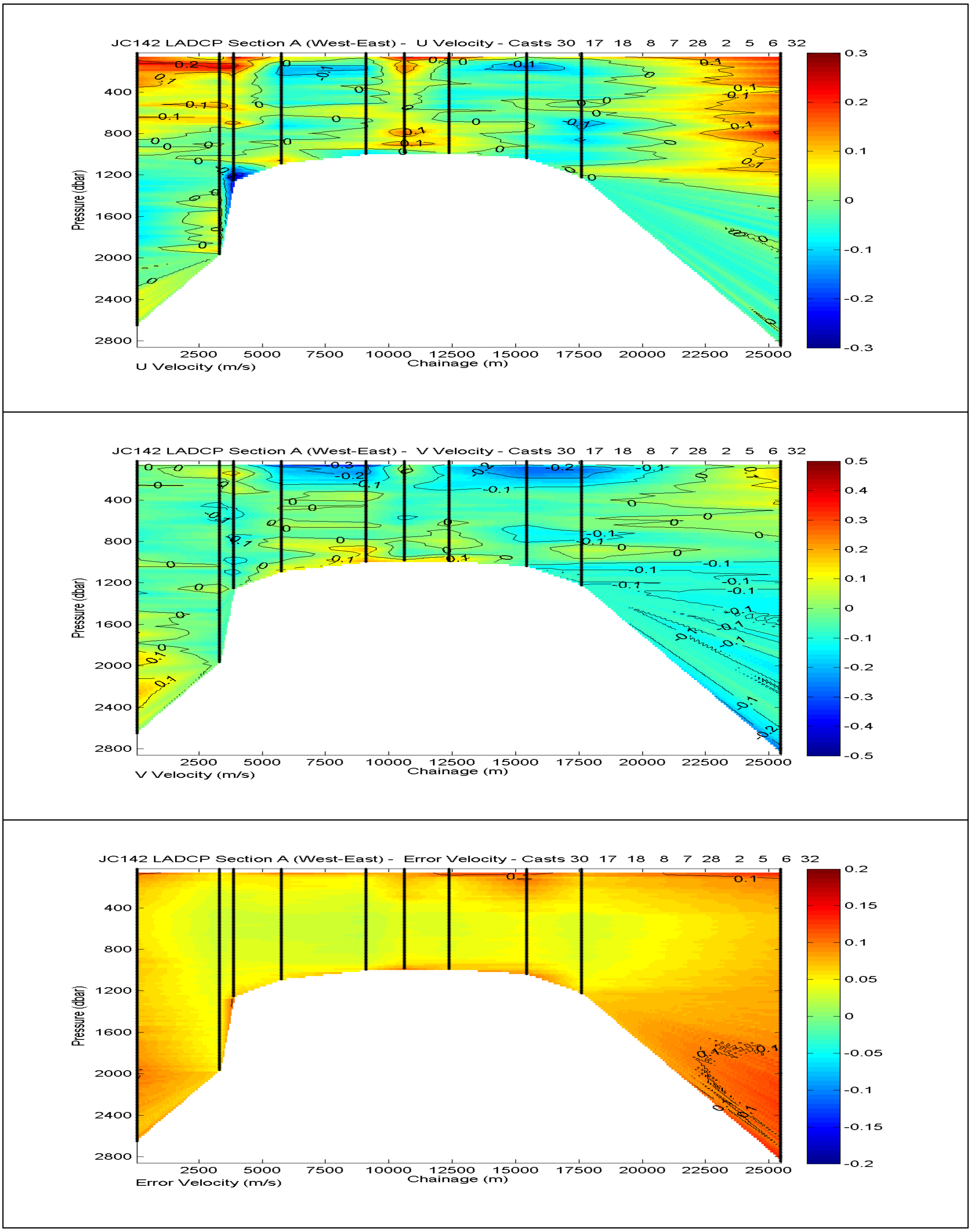


Figure 11: Variation in velocity profile seen on the North - South section. U component (upper), V component (middle) and LADCP Error velocity (lower).

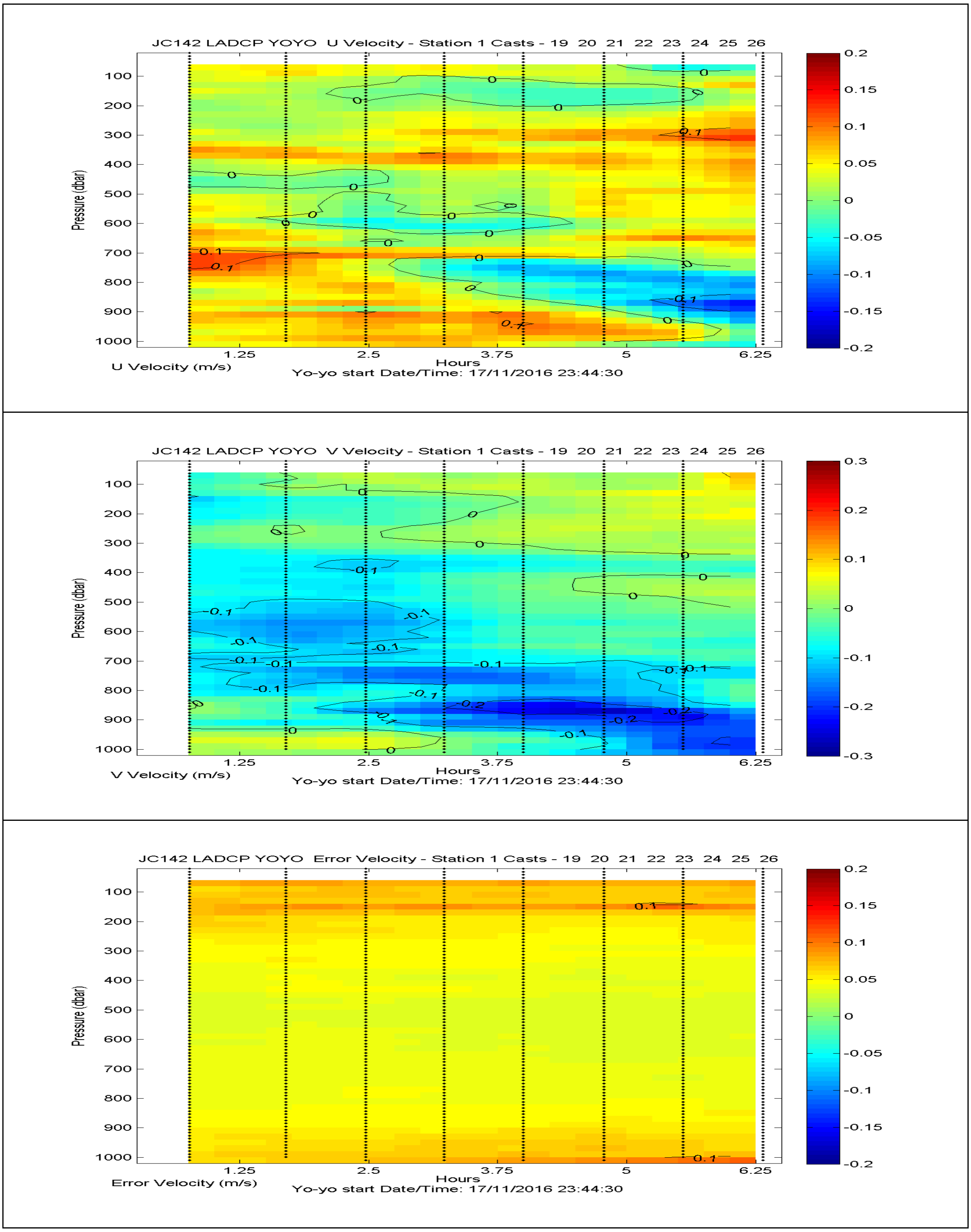


Figure 12: Variation seen in velocity profiles seen in the 5.5 hour CTD yo-yo undertaken at Station 69 located at the seamount summit. U component (upper), V component (middle) and LADCP Error velocity (lower).

6.4 VESSEL-MOUNTED ADCP

6.4.1 AIMS AND OBJECTIVES

6.4.2 EQUIPMENT

The James Cook has two Teledyne RDI Ocean Surveyor vessel-mounted ADCP systems installed on the port retractable keel, operating at frequencies of 75 kHz and 150 kHz. Both systems are integrated with the vessel's navigation system and receive heading and GPS navigational information from the primary (Applanix POS MV) and secondary (Seapath 300) ship's navigational systems. These are installed and operated by NMF – further details for the units can be found in the technical report prepared by NMF staff.

In order to maximise data quality it is believed that it is normal to operate these instruments with the keel down. However this was only possible when it was operationally expedient to run with the vessel in this configuration since in the keel down position vessel speed is restricted. Thus it was not until, in an attempt to improve data quality, a request was made on the 12 of November that the keel was actually lowered.

It is also the case that best results will always be obtained when the vessel is acoustically quiet but since the primary objective of the survey involved the use of the vessel's multi-beam equipment the amount of time when this condition was met was somewhat limited.

Table 3 denotes the times when the drop keels were in the up and down positions during the cruise.

Date	Time	Transducer Depth
29/10/16	00:00:00	6 m
12/11/16	19:38:00	8.7 m
23/11/16	14:27:00	6 m
26/11/16	12:00:00	8.7 m
01/12/16	13:38:00	6 m

Table 3: Log of modifications to the position of the vessel drop keels

6.4.3 DATA PROCESSING

In order to derive the velocity profile information data from the ADCP it must be merged with data from the ship's navigation systems by the Teledyne RDI VMDAS software. Normally these systems run in a totally unattended mode throughout the cruise with the data passed to BODC without any quality checking.

Since the HR Wallingford scientific team required immediate access to the data a regime of stopping and restarting the ADCP at midnight each day was implemented (whenever practical for the HR Wallingford staff to do so) in order to limit the size of the data files requiring processing each day.

In order to further reduce processing time the majority of the analysis described here has been undertaken on the Short Term Average (STA) files computed by the VMDAS data acquisition software, consisting of 120 second averages of the raw data recorded by the two ADCPs.

Limited analysis has however been performed with examples of the raw data sets to confirm that the problems identified in this analysis were also present in the raw data, a fact which has now been confirmed.

All post processing of the data has been performed using HR Wallingford's bespoke ADCP analysis software (GTE). The software is capable of analysing data collected in the various reference systems used by the ADCPs to collect data (beam, instrument, ship and earth) with reference velocities calculated to correct for the ship's motion using either vessel track or bottom track. These reference velocity values are then subtracted from the water column estimates of currents recorded by the ADCP to reveal the true current in the same manner as is undertaken by Teledyne RDI's own software.

6.4.4 PROBLEMS IDENTIFIED IN THE VMADCP DATA

The processing undertaken by HR Wallingford has revealed a couple of issues with the data collected by the vessel ADCP systems. Specifically the problems identified in the data take the form of:

- Interference from other sonar systems on-board the vessel.
- Differences in the direction and magnitude at all levels through the water column between the 75 kHz and 150 kHz ADCPs.

This section of the cruise report details the issues found in the VMADCP data collected and discusses the testing undertaken to resolve these issues. Unfortunately the information available on-board during the cruise as to how the two instruments were set up was somewhat limited. Inspection of the command files used to run the instruments revealed that no offsets were applied to the data during acquisition to account for misalignment of the transducers with respect to the ships centreline.

This has meant that for the majority of the cruise the data collected has been of poor quality and time has been spent identifying the issue. This will also mean that an extensive amount of effort will be necessary to reprocess the data once ashore.

It is noteworthy that previous cruise reports have identified a misalignment of 9 degrees between the 75 kHz and 150 KHz instruments, a finding which has subsequently been confirmed by Dr B King of NOCS, however this information was not available aboard the ship.

As previously stated when the retractable keels on which the two ADCPs are mounted are withdrawn such that the ADCP transducers are flush with the vessels hull the data acquired are of lower quality due to the effects of bubbles entrained under the ship's hull which both reduces profiling range and increases noise levels in the data.

It should be noted that on one occasion at least the drop keel was retracted in error without informing the scientific team. This is problematic since the only repeater for the bridge display of drop keel position is placed within a restricted area such that neither scientific or NMF staff can access information on the keels position. It would thus be advisable if this information could be displayed outside the restricted area to which the scientific team have access.

6.4.4.1 INTERFERENCE FROM OTHER SONAR SYSTEMS

Cross talk between sonars is a common problem and it is noted that the 150 kHz VMADCP is particularly susceptible to picking up this interference from other sonars including the 75 kHz VMADCP unit which is located in the same drop keel only a short distance away. An example of the interference picked up by the 150 kHz VMADCP is shown in Figure 13 taken from the STA file collected on 22/11/2016 and is evident by the diagonal stripe of higher current speeds running through the data.

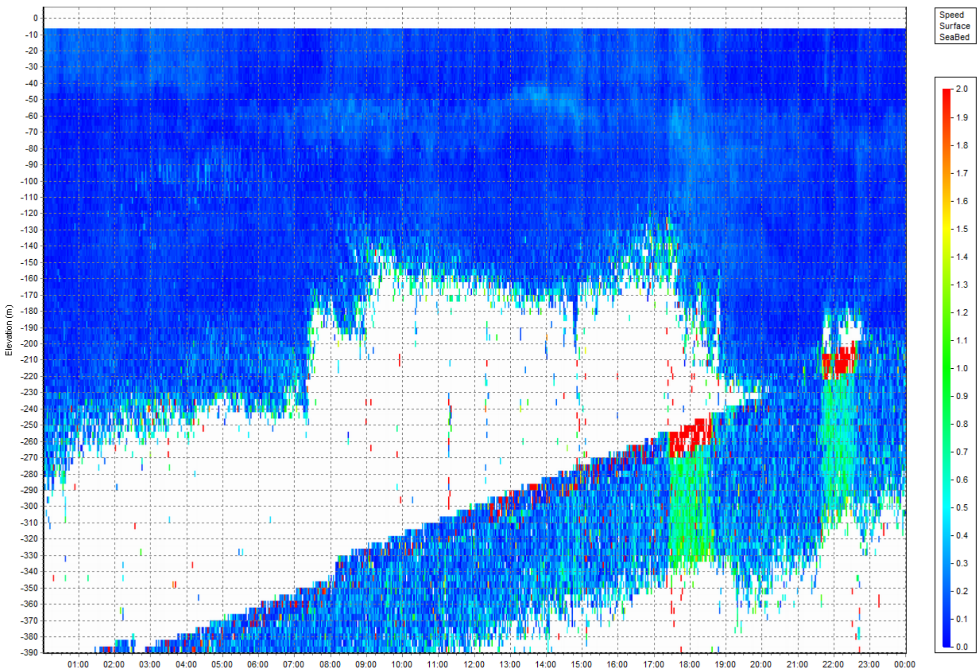


Figure 13: Current speeds recorded by the 150 kHz VMADCP on 22/11/2016

It is noted that two variants of the command files used to configure each ADCP are available; one in which the ADCP pinging is controlled by a synchronising pulse generated by ships data acquisition system (K-Sync) and a second where the ADCP is free running, i.e. working to its own duty cycle.

For the present application both VMADCP systems have been operated in the free running mode since it would not possible to use the K-Sync facility as this controls the synchronisation of all sonars operating on-board the vessel and not just the two VMADCPs. Consequently this would have impacted on the data acquisition rates achieved by the other acoustic instruments notably the multi-beam echo sounder which was to be the focus of research effort for the present cruise.

The GTE software used to analyse the VMADCP data includes a quality flag based on the standard ADCP data quality parameters (Correlation Magnitude, Number of 3 Beam

Solutions etc.) and which is assigned to the velocity data recorded in each measurement bin on import to allow filtering of the data to remove extraneous data records. The methodology underpinning this data quality assurance strategy is described in the work by Taylor and Jonas (2008). Suffice to say that these contaminated records are picked out in the data quality records for each measurement bin, as shown in Figure 14, even where it is not immediately evident in the recorded velocity data itself. This allows contaminated bins to be isolated and removed from all subsequent data analysis.

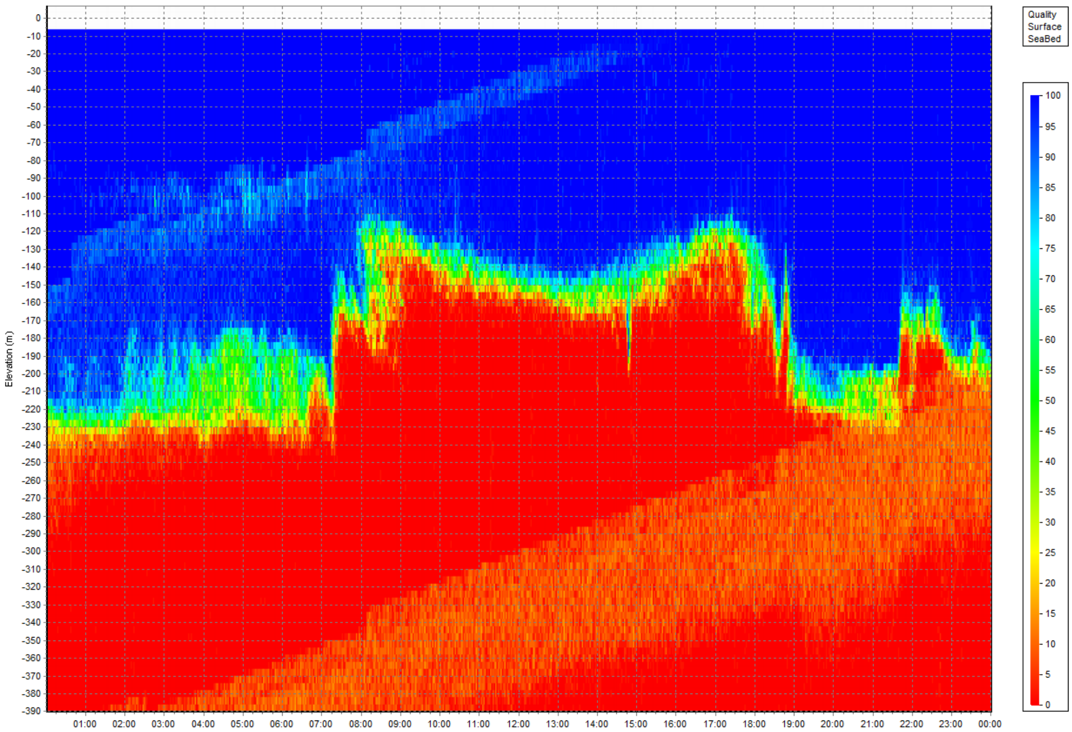


Figure 14: Data quality screening of the 150 kHz VMADCP dataset for the 22/11/2016

For this reason a data quality screening level of >80 has been applied to all data collected by both VMADCP systems.

6.4.5 ADCP MISALIGNMENT

The problems identified in direction and magnitude of the current vectors determined by the 75 kHz and 150 kHz ADCPs is evident in the testing undertaken on 11/11/2016 between 19:47 and 20:42 when the vessel was asked to perform a circular track such that currents on different headings could be ascertained. The circular track was completed over a period of order 54 minutes to produce a slow change in the vessels heading. The results are displayed in Figure 15 and Figure 16 below.

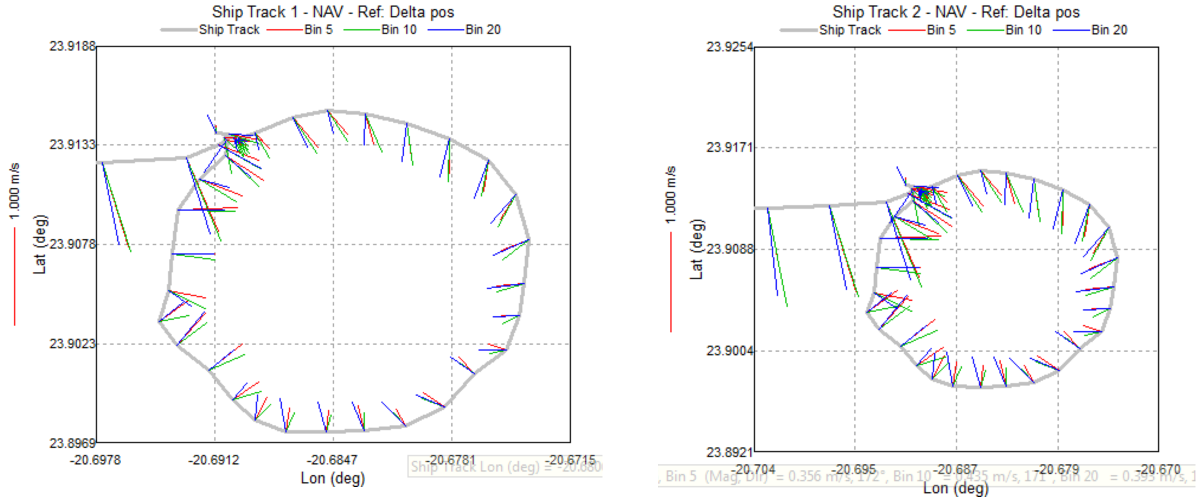


Figure 15: (UPPER) Ship Track with velocity vectors at 3 different levels in the water column determined by the 75kHz VMADCP system.

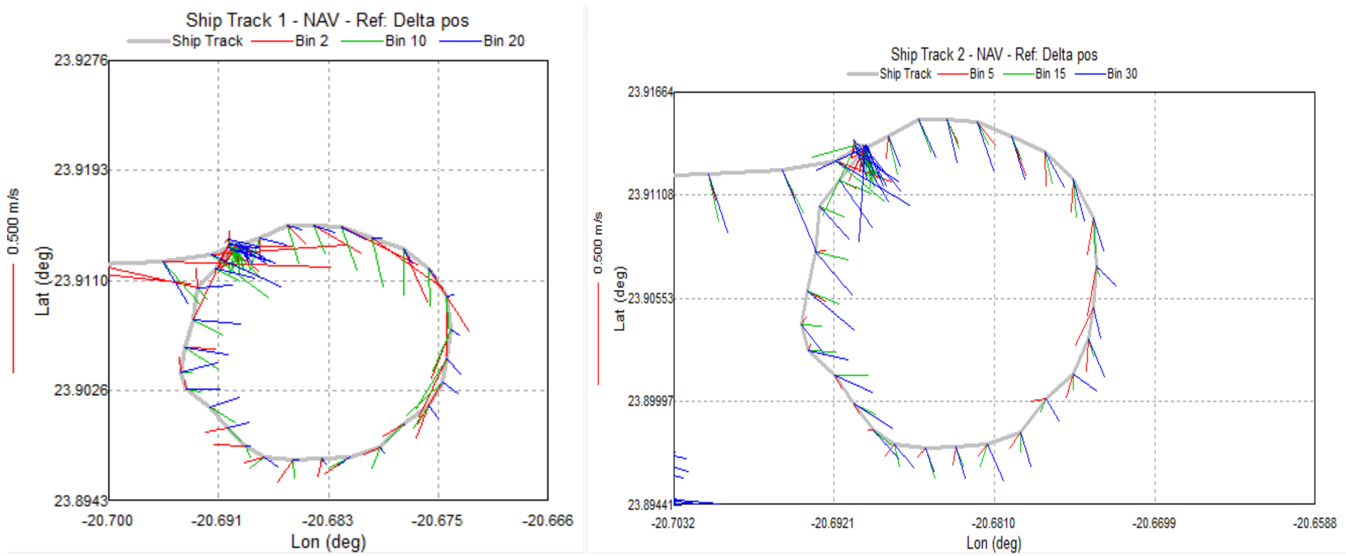


Figure 16: Ship Track with velocity vectors at 3 different levels in the water column determined by the 150 kHz VMADCP system.

As can be seen the performance of the 75 kHz system is poor with the vectors showing little consistency as the vessel’s heading changes. The vectors recorded by the 150 kHz are somewhat improved at depth although performance in the surface layers is poor.

The patterns revealed in this data are considered to be indicative of a misalignment between the orientation of the ADCP and the vessel’s heading reference (normally the vessel centreline) and for this reason a more detailed analysis of the data was considered necessary.

As a means of identifying the cause of the problem data collected in bottom track mode has been analysed to provide a comparison against the JC142 datasets. This bottom track data was collected during JC137 in June/July 2016 as the RRS James Cook was transiting through the English Channel in water depths of <100m.

Figure 17 shows the data collected by the 150 kHz system in vessel track and bottom track modes. The VMADCP configuration files used were the same as those used on JC142 with the data collected in beam coordinates with no misalignments applied. Both plots show the derived current directions in degrees magnetic with the upper plot showing the vessel tracked data and the lower plot the bottom tracked data.

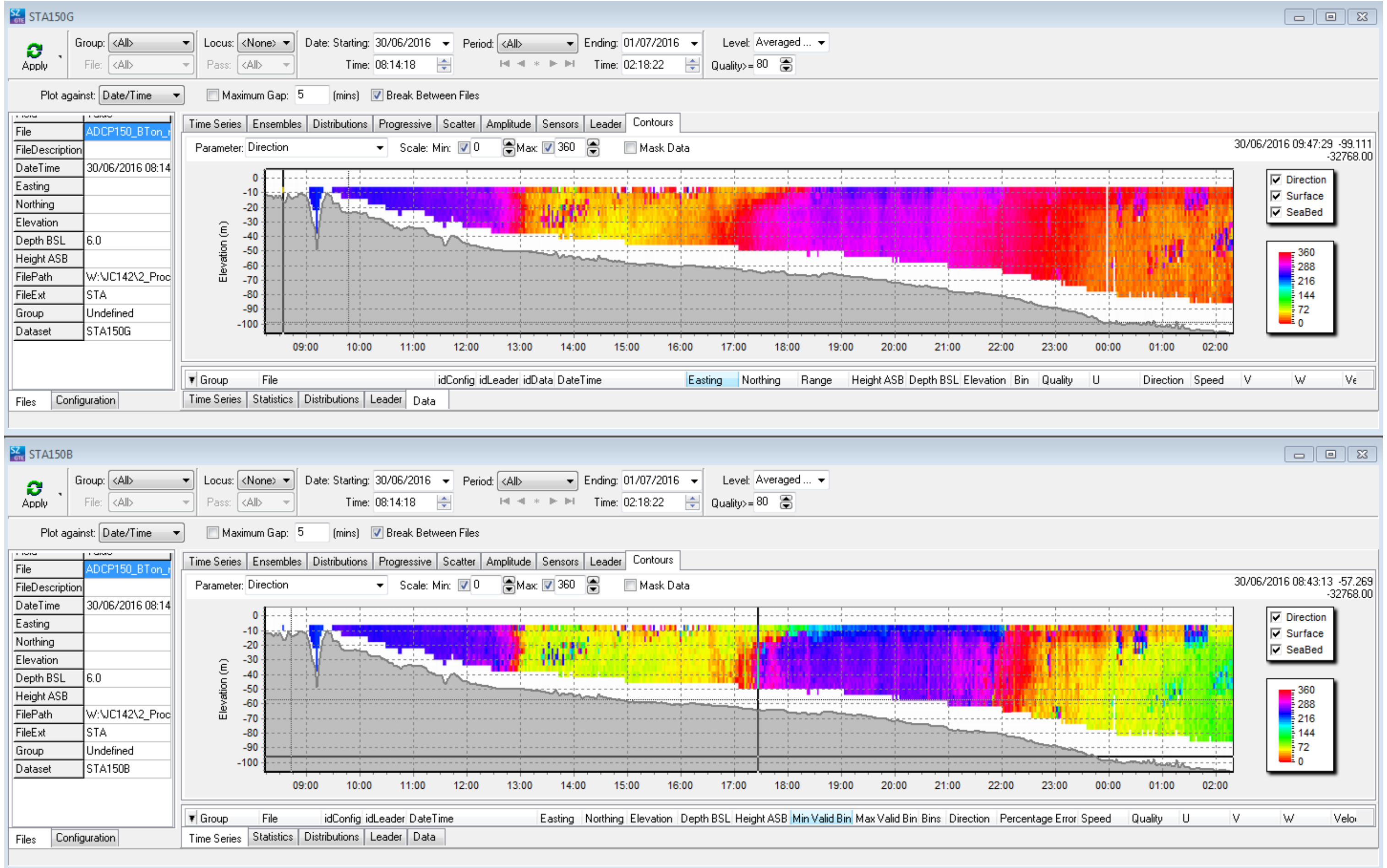


Figure 17: 150 kHz VMADCP dataset from a 24 hour period during the transit leg of JC137 when bottom tracking was possible. Upper plot shows data with vessel track correction applied and lower plot data with bottom tracking applied.

The data shown here was collected over a period of almost 24 hours with 2 semi-diurnal tidal cycles evident in the data. It is notable however that the current directions obtained from the vessel tracked data show a slightly more northerly trend than is evident in the bottom tracked data. This suggests a misalignment of the 150 kHz instrument with the vessel’s centreline. However, this is not apparent in the bottom tracked data as both the reference velocity and the water column velocities are determined in the same reference frame (beam coordinates) and then subtracted from each other.

A check was performed on this finding using Teledyne RDI’s own WinADCP software to confirm this, as shown in Figure 18.

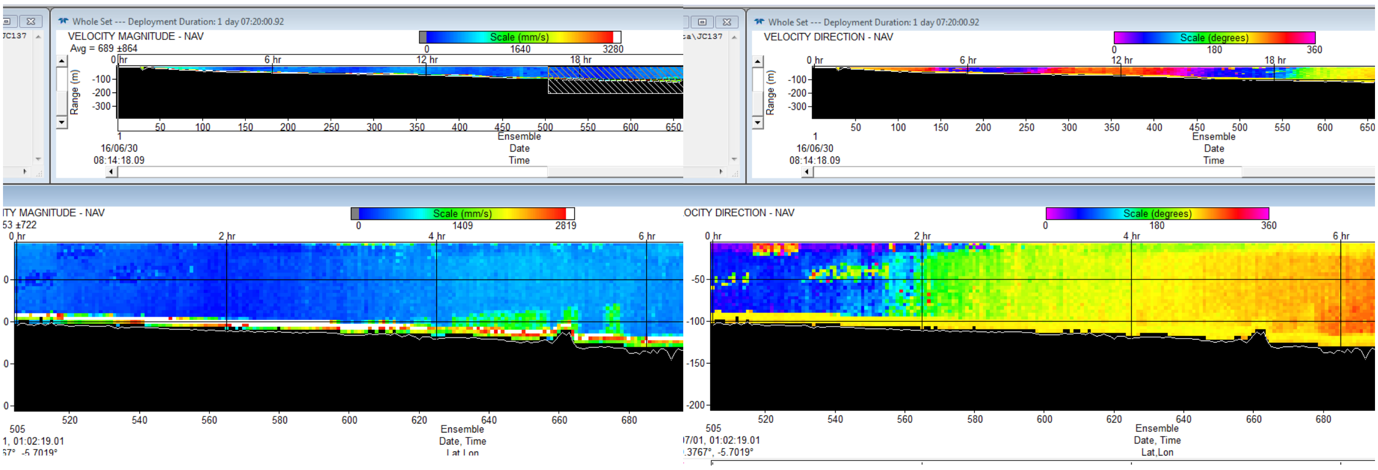


Figure 18: JC137 150 kHz dataset with vessel tracking applied (viewed in TRDI WinADCP software). Left panel - current speed. Right panel - current direction.

An analysis of the JC137 dataset for the 75kHz VMADP showed similar results with again a pronounced northerly bias evident in the data when a vessel tracked velocity reference was applied to the data as is evident in Figure 19 and Figure 20 below.

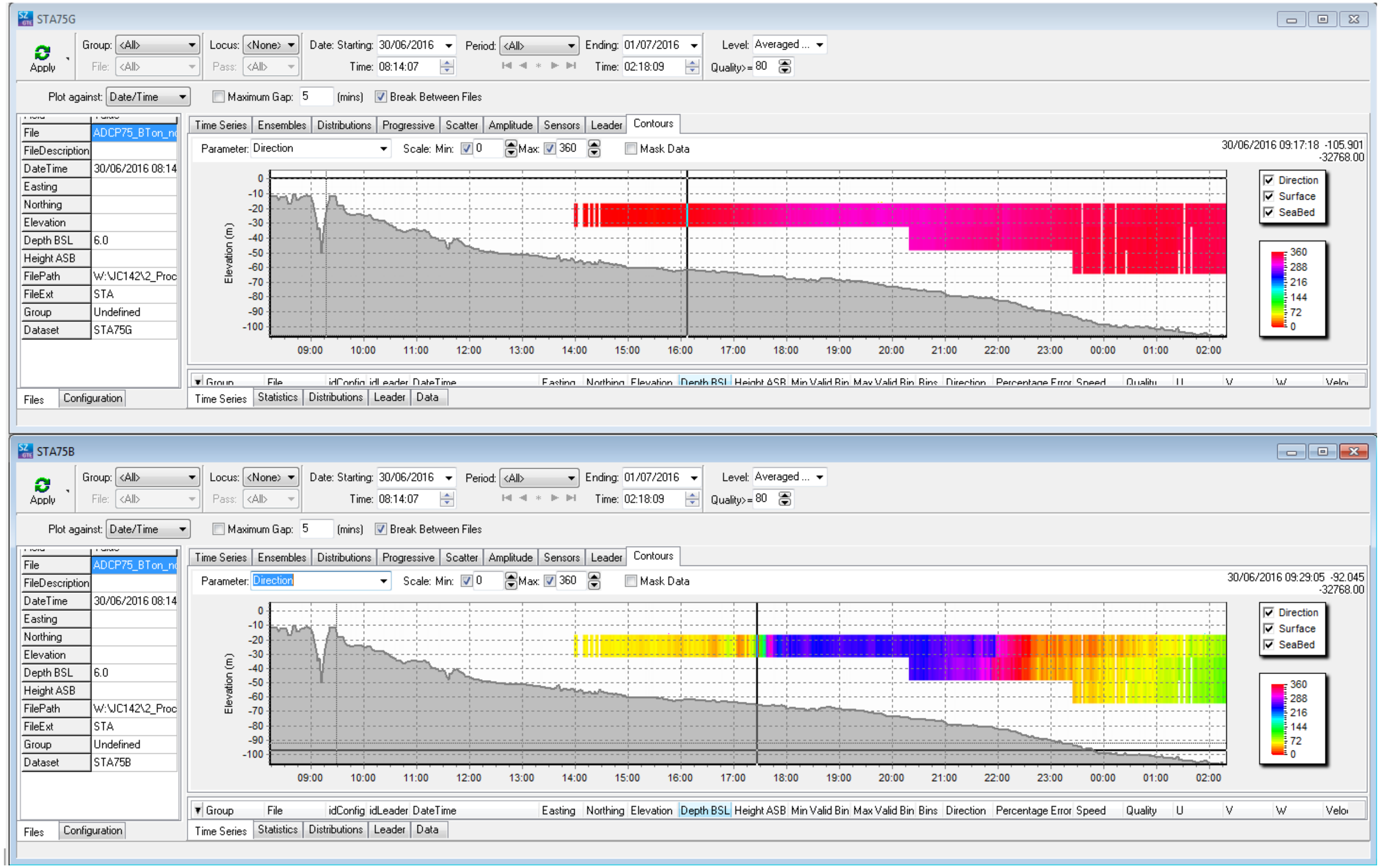


Figure 19: 75 kHz VMADCP dataset from a 24 hour period during the transit leg of JC137 when bottom tracking was possible. Upper plot shows data with vessel track correction applied and lower plot data with bottom tracking applied.

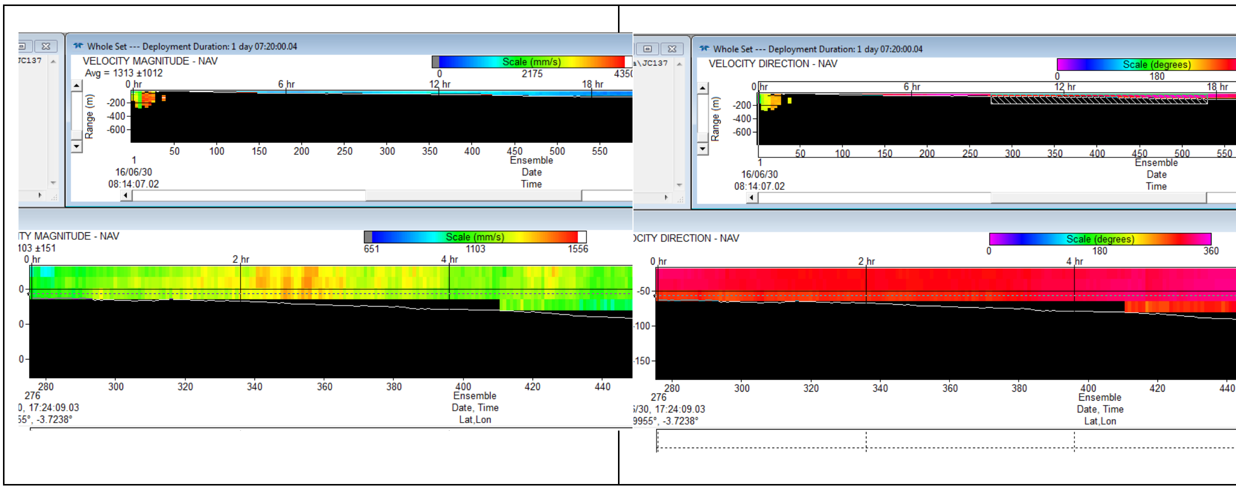


Figure 20: JC137 75 kHz dataset with vessel tracking applied (viewed in TRDI WinADCP software). Upper left panel - current speed. Upper right panel - current direction.

When viewed in vector form this northerly bias is evident in the vessel tracked data for the 75 and 150 kHz data as shown by the brown and pink vectors displayed in Figure 21 when compared against the blue and turquoise vectors obtained using a bottom tracked velocity reference.

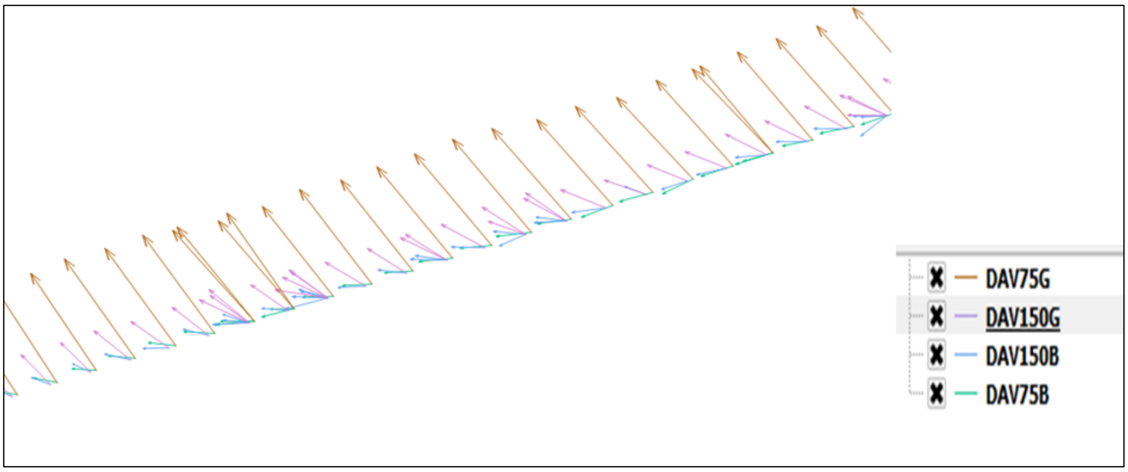


Figure 21: Depth averaged current vectors from a portion of the JC137 dataset for both 75 and 150 kHz VMADCP datasets with vessel tracked and bottom tracked references applied.

Comparison of the vectors obtained from the bottom tracked data for the period 30/06/2016 11:48:20 - 01/07/2016 02:18:22 confirms that the misalignment of the two systems with respect to each other is of the order of 9° as shown by the calcluation in Table 4. This confirms the information provided by Dr King from previous deployments.

Vessel Mounted ADCP	Average Bottom Track U velocity (m/s)	Average Bottom Track V velocity (m/s)		Bottom Track Reference Speed (m/s)	Bottom Track Reference Direction (°M)
150kHz	5.04	2.79		5.76	60.989
75kHz	4.57	3.55		5.77	52.243
Misalignment 75-150kHz					8.746

Table 4: Comparison of the current vectors (bottom tracked data) collected over the period 30/06/2016 11:48 – 01/07/2016 02:18.

Whilst this effectively quantifies the relative misalignment of the two systems these calculations do not quantify the gross misalignment of the the two ADCPs with respect to the centreline of the vessel.

6.4.6 ADCP MIS-ALIGNMENT CHECKS USING DATA ACQUIRED ON 11/11/2016

In order to confirm the misalignment and to work out which ADCP was rotated with respect to the other checks were performed using the data acquired during testing on 11/11/2016 between 19:47 and 20:42 (when the vessel performed a circular track). 75 kHz and 150 kHz data were re-processed in VMDAS again with varying ADCP alignment corrections (EA command) applied. The different rotation cases applied are shown in Table 5.

	Case 1	**Case 2**	**Case 3**	**Case 4**	**Case 5**
75kHz	0	45	-45	-8.7	8.7
150kHz	8.7	53.7	-36.3	-8.7	0

Table 5: Rotations applied to data collected during the "circle" testing on 11/11/2016.

Following re-processing in VMDAS the rotated datasets were then imported into GTE and vector plots produced of data averaged over the top 100m of the water column. Data used to generate the vector plots were filtered using a quality flag of >=100. Figure 22 shows the general location of the circle testing. Figure 23 to Figure 27 show the vector plots for re-processed data for each of the cases listed in Table 5.

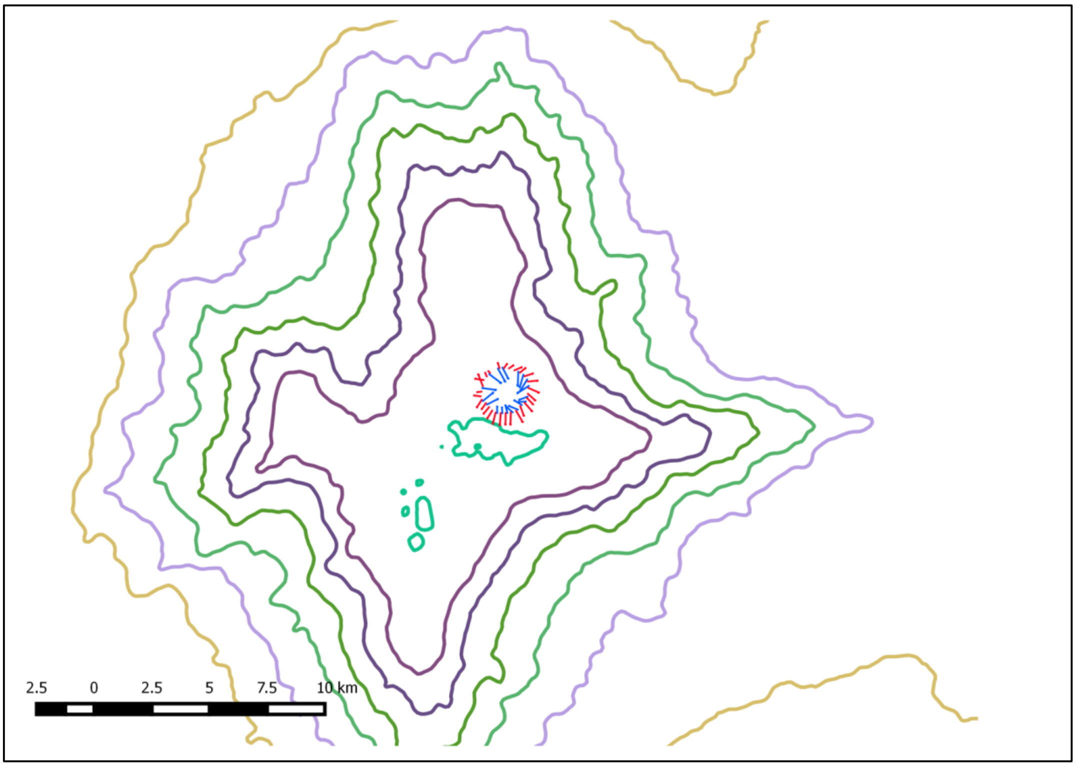


Figure 22: Circle testing location map. Vectors shown for Case 1, 75 kHz (Blue) & 150 kHz (Red). Vector scale: 1500m = 1m/s.

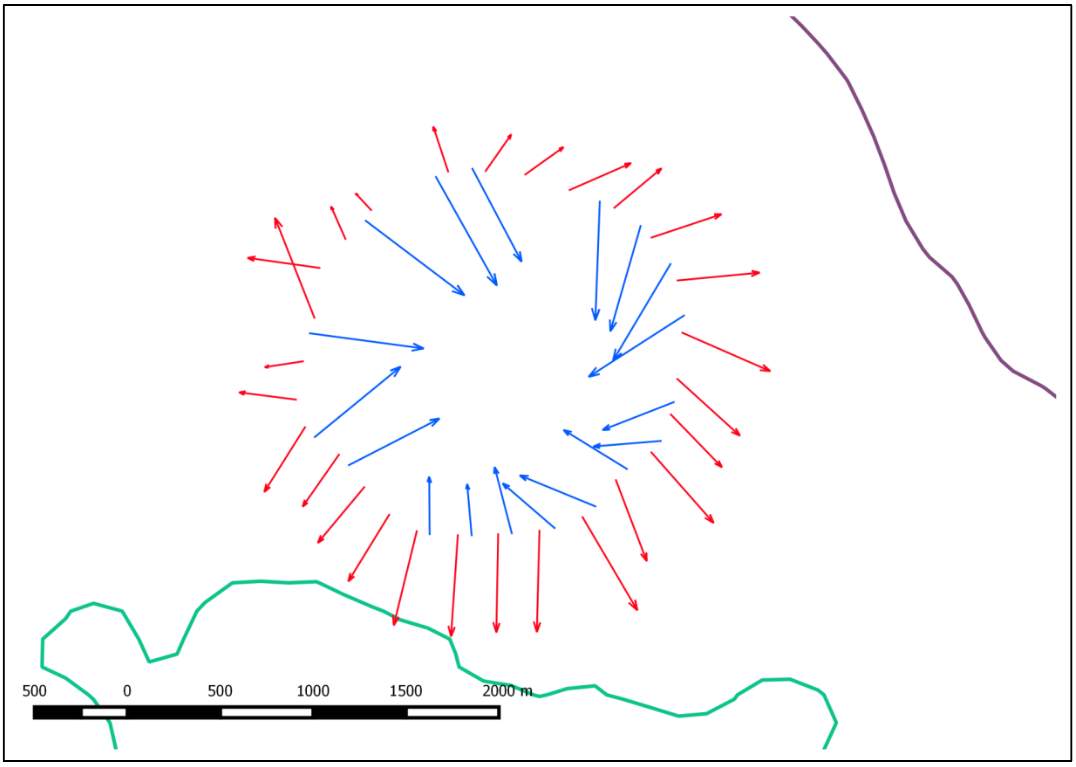


Figure 23: Circle testing Case 1 Vectors, 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

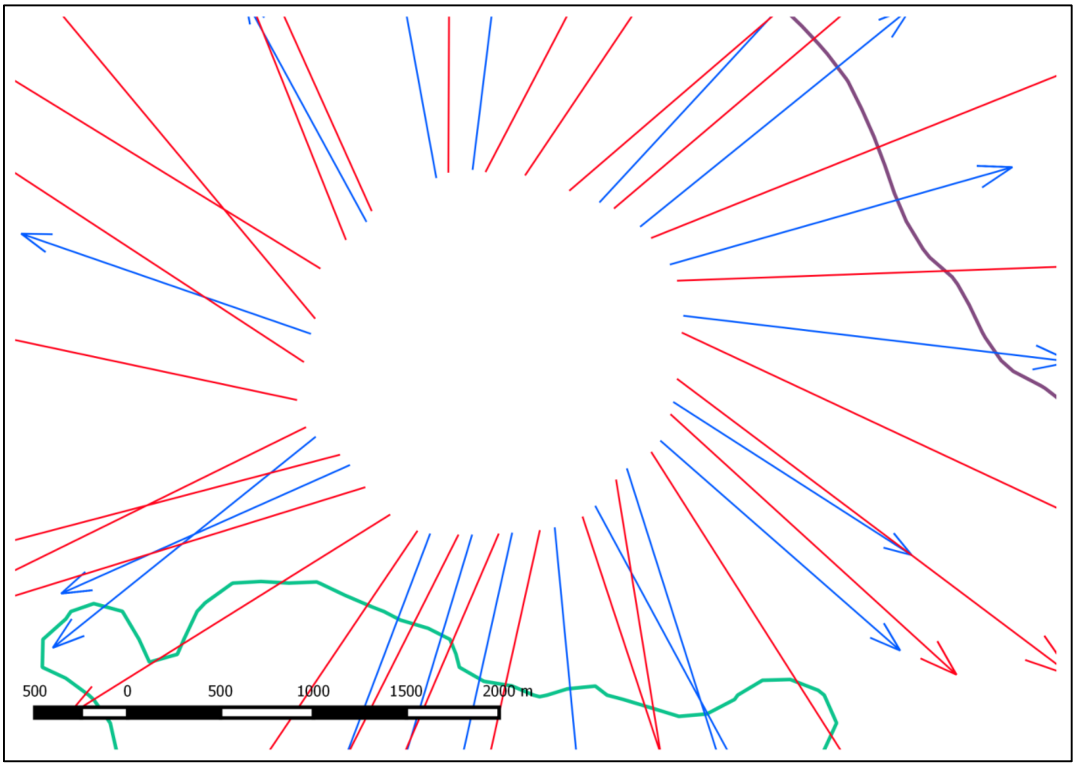


Figure 24: Circle testing Case 2 Vectors, 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

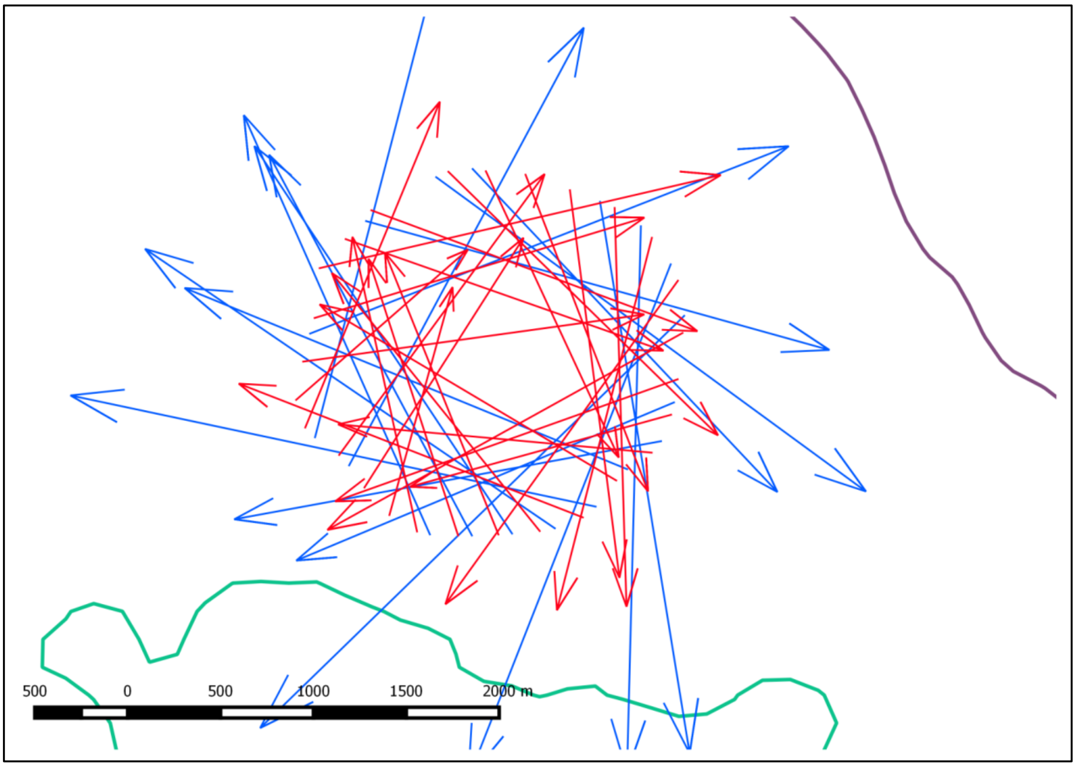


Figure 25: Circle testing Case 3 Vectors, 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

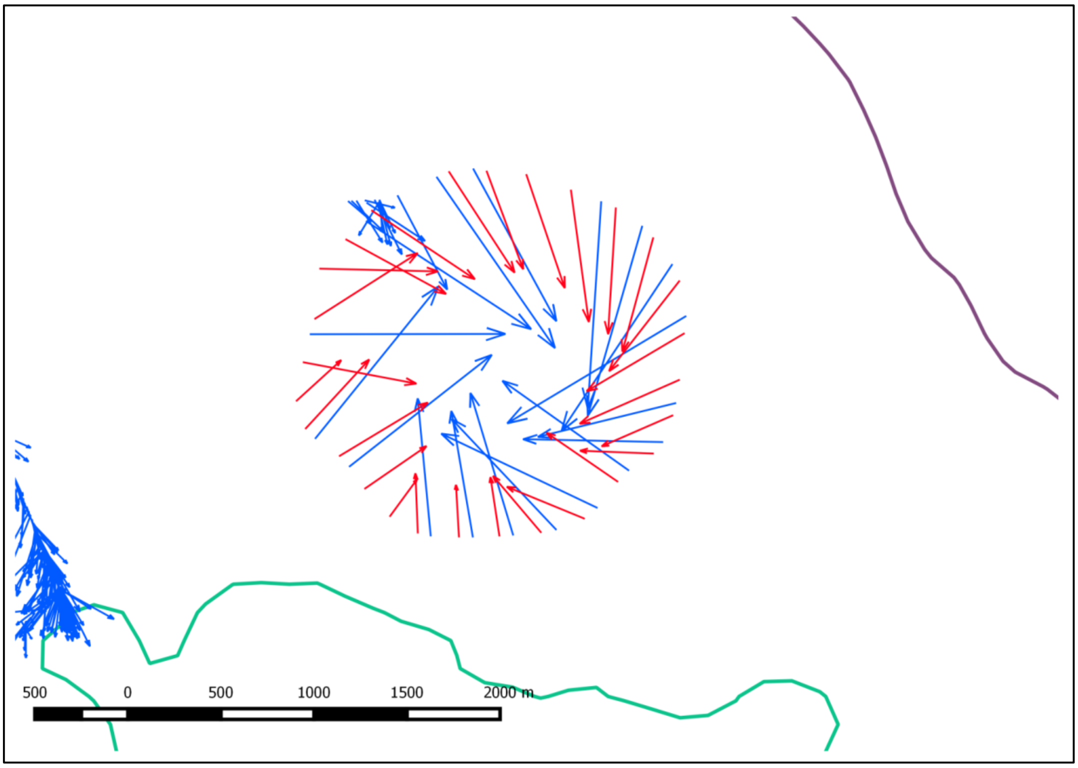


Figure 26: Circle testing Case 4 Vectors, 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

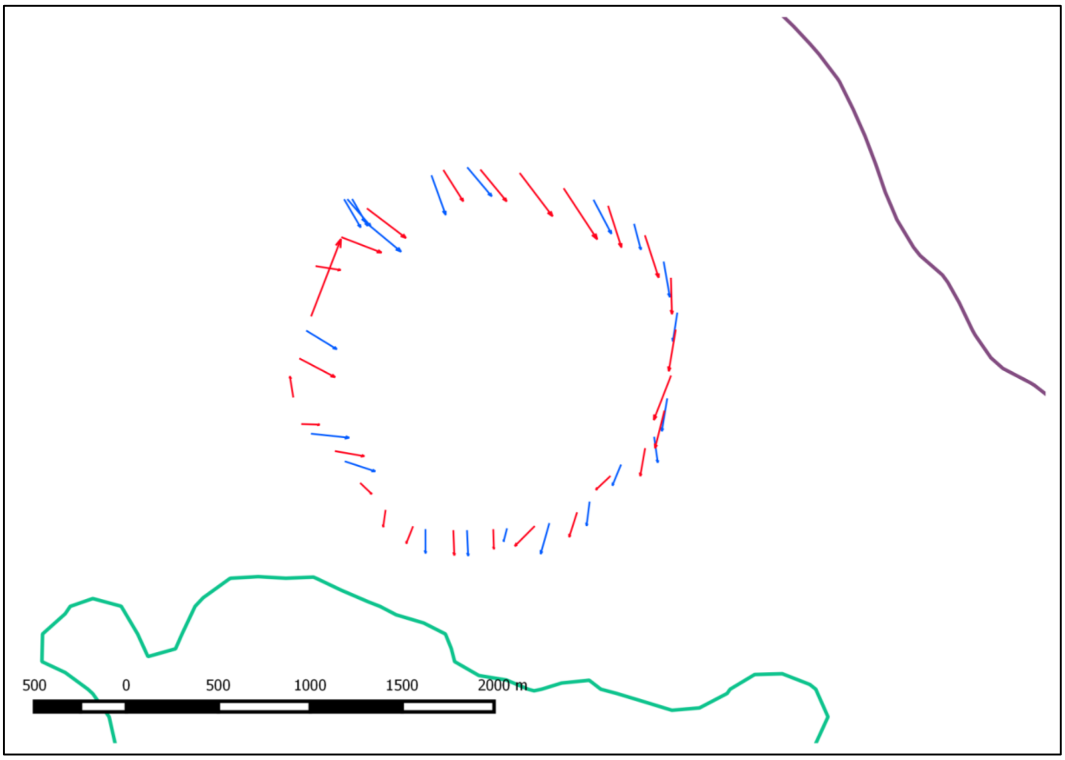


Figure 27: Circle testing Case 5 Vectors, 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

The vector plots show case 5 to be the best case out of those tested. With the exception of a portion of the circle where no 75 kHz data passed the quality flag and where a couple of vectors in the 150 kHz dataset do not align with the remainder of the dataset, vectors between the two datasets align well, both in terms of current direction and magnitude.

This would seem to suggest that a rotation of +8.7 deg should be applied to the 75 kHz data and no rotation should be applied to the 150 kHz system.

6.4.7 VERIFICATION OF ROTATIONS DERIVED FOLLOWING ANALYSIS OF DATA ACQUIRED ON 11/11/2016

The rotation settings applied to the data for case 5 of the 11/11/2016 "circle" analysis were subsequently applied to the data collected from 16-18/11/2016. Following re-processing in VMDAS, the data were again re-imported into GTE and depth average vectors (over the top 100m of each dataset) derived. The result is shown in Figure 28 and Figure 29.

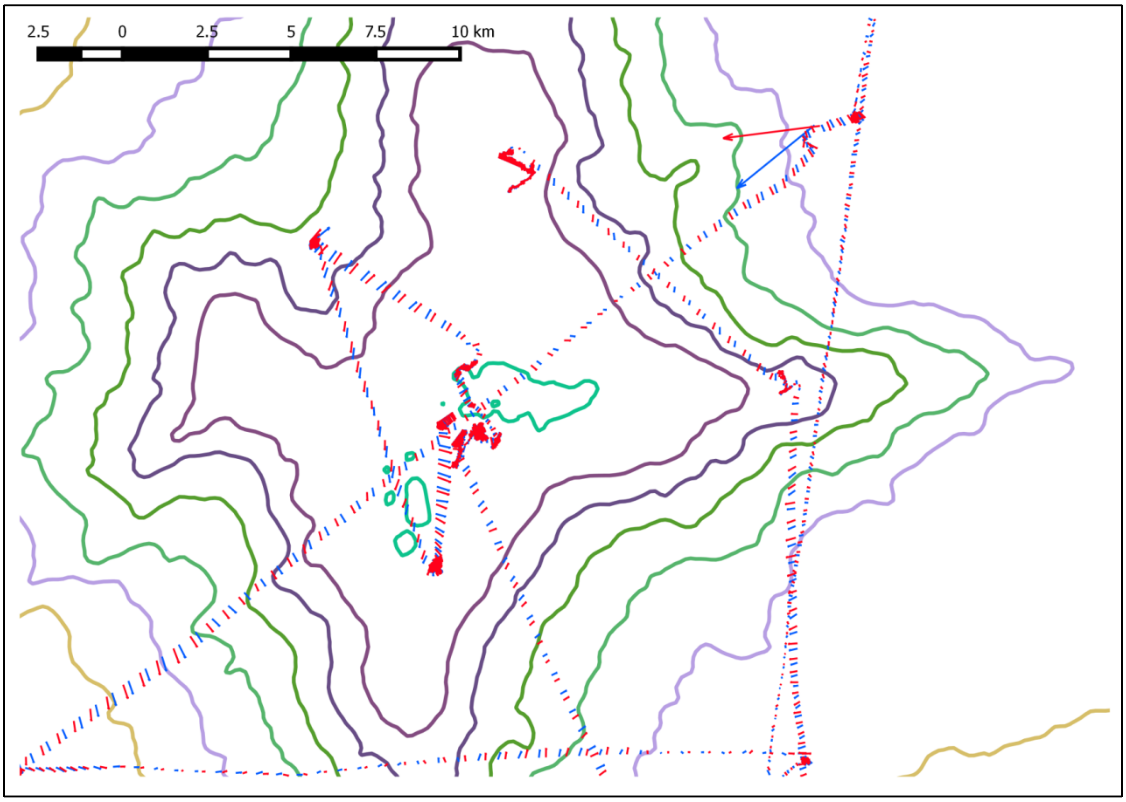


Figure 28: 16-18 Nov 2016 data with Case 5 rotations from "circle" testing applied, shown for the entire seamount summit. Vectors 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

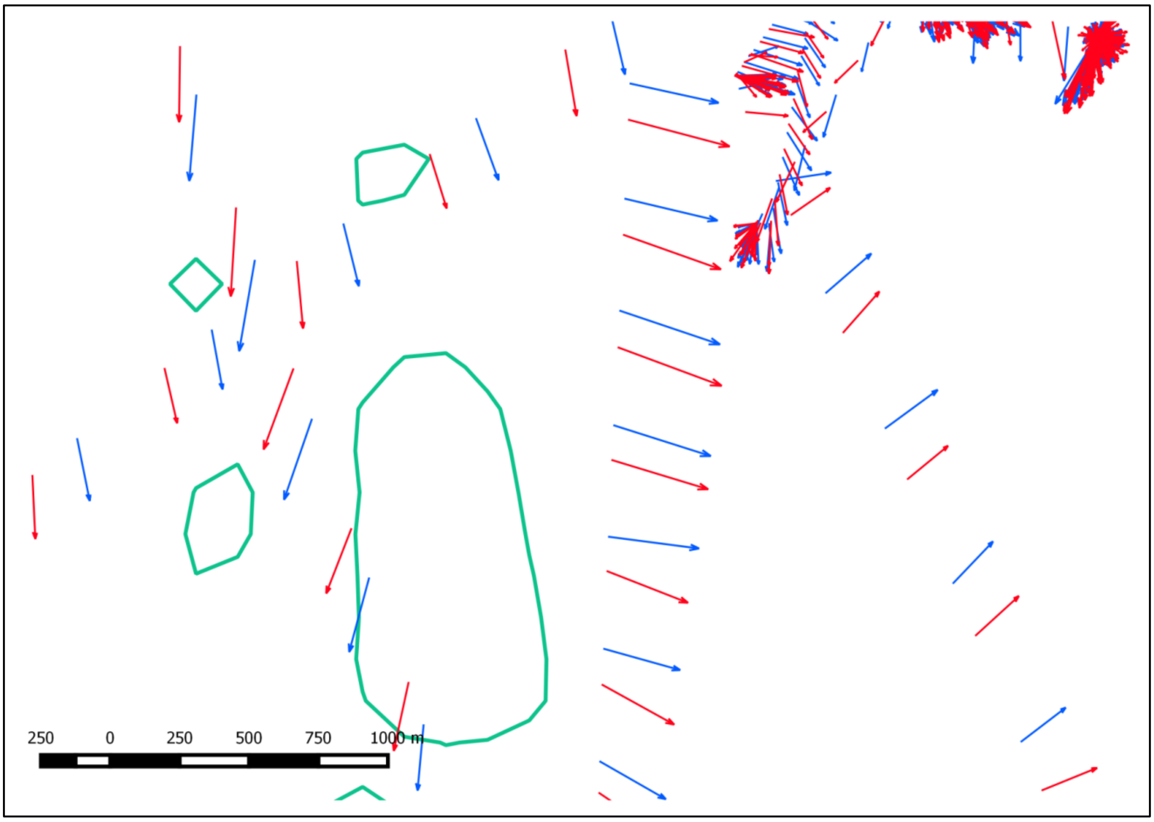


Figure 29: 16-18 Nov 2016 data with Case 5 rotations from "circle" testing applied, shown for a smaller area to better highlight vectors. Vectors 75 kHz (Blue) & 150 kHz (Red). Vector Scale 1500m = 1m/s.

The figures illustrate that agreement is once again good between the two datasets, both in terms of current directions and magnitudes. The vectors in Figure 29 suggest depth average current speeds of order 0.1-0.25 m/s which is confirmed by the data from the current meter placed in the upper part of the water column around mooring B.

The data collected during the JC142 cruise will thus require reprocessing using this mis-alignment.

6.5 LANDER DEPLOYMENTS

6.5.1 AIMS, OBJECTIVES AND METHOD DESCRIPTION SUMMARY

A series of plume experiments were conducted in order to simulate the behaviour of debris plumes created by the release of particulates from the removal of the sedimentary overburden and mining operations that could take place if the crust resource were to be extracted. The data recorded during the plume simulation experiments will be used in conjunction with information about the benthic communities that exist on the seamount to assess the potential environmental impact of mining operations.

6.5.2 LANDER DESIGN

The benthic lander was designed to be sufficiently small and light for deployment by the ISIS ROV but also to provide a secure and stable platform on which to deploy the spread of instrumentation required during the plume experiments. This consisted of:

- TRDI 600 kHz Workhorse Sentinel Acoustic Doppler Current Profiler (ADCP)
- 3x Aqualogger 210TY Deep Optical backscatter sensors (OBSs)
- Valeport (Seapoint) OBS (with MONITOR CTD+ data logger)
- Seabird SBE37 Conductivity, temperature, depth (CTD) sensor
- Sonardyne WMS Mini USBL transponder beacon

The OBSs were supplied by HR Wallingford. All other instrumentation was provided from National Marine Facilities equipment pool.

In addition the lander also included two funnel-shaped sediment traps for the purposes of collecting settling suspended sedimentary material entrained into the water column during the plume experiments.

In order to minimise its weight the lander was constructed principally out of marine grade aluminium alloy (5081). The total weight of the lander, with all instrumentation deployed, was estimated to be 45kg (in water).

The overall dimensions of the lander's main body were 1.0 m x 0.5 m x 0.5 m. Optical sensors were deployed on a "mast" which reached a maximum height above the base of the lander of 1.5 m. The three Aqualogger optical sensors were deployed at heights above the lander base of 0.48 m, 1.0 m and 1.5 m. The Valeport OBS was deployed at a height of 1.3 m above the lander base. These heights were taken to represent the height above the seabed once the lander was deployed. The ADCP, CTD and USBL beacon were all deployed on the lander's main body (Figure 30), with the ADCP mounted in a gimbal system. The ADCP was orientated such that beam three was orientated at 45 degrees relative to the lander's main (long) axis. "Bungs" were deployed and secured over the sediment traps during the ROV's ascent and descent and were removed once the lander had been deployed on the seabed by the ROV.

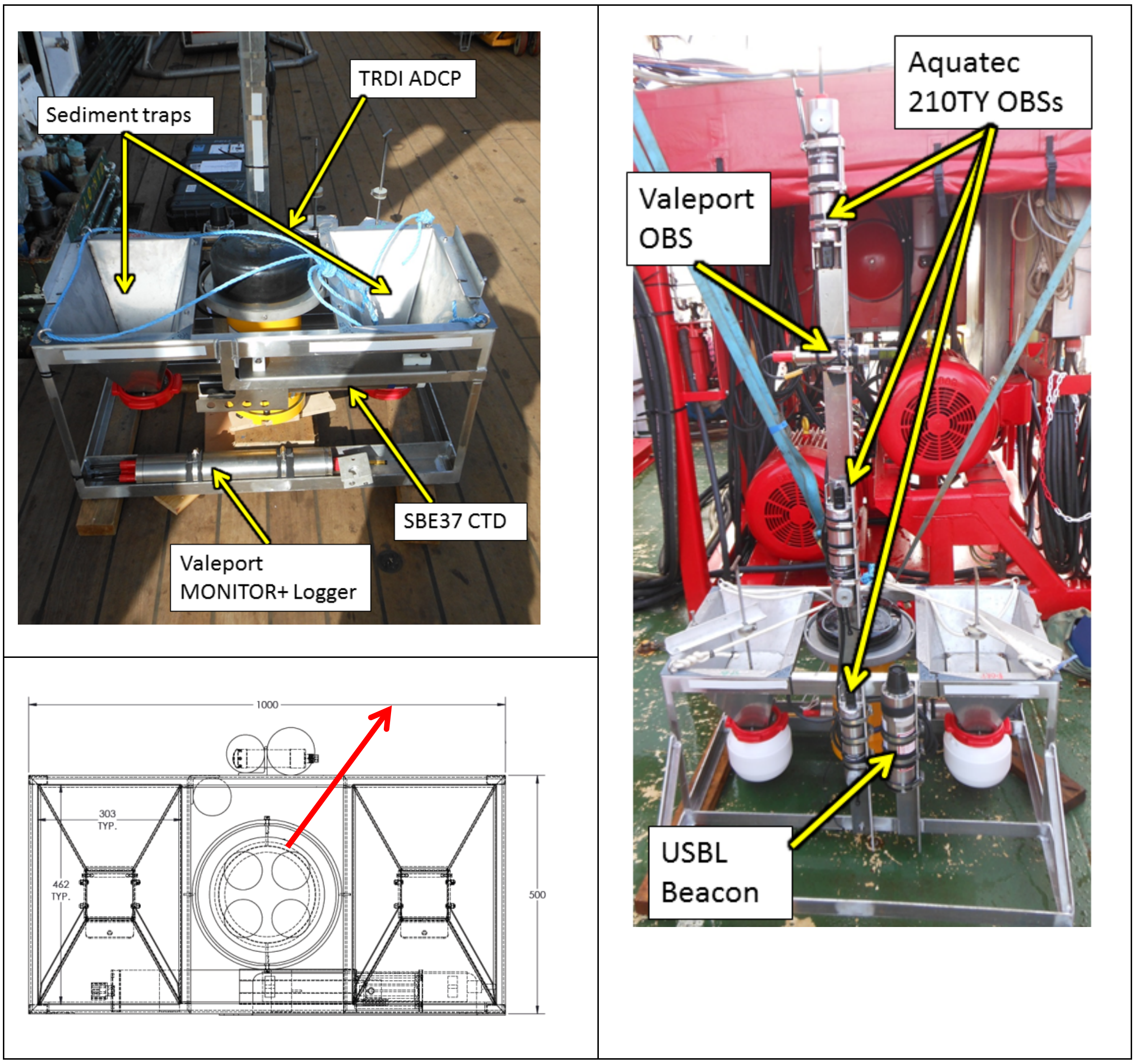
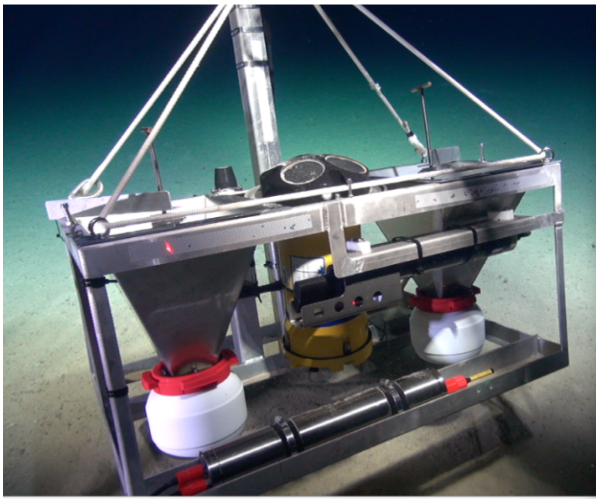


Figure 30: Annotated images of benthic lander and diagram with arrow illustrating the alignment of beam three on the ADCP.

6.5.3 LANDER DEPLOYMENT

Prior to the cruise HR Wallingford and ISIS ROV personnel performed lifting trials with the instrumentation deployed on the lander at the NOC to verify that it could be deployed using one of the ROV's manipulator arms. These tests showed that the lander's centre of gravity was sufficiently low for this proposed method of deployment to work. An additional deployment requirement was identified during the tests – this was to ensure that the pots at the base of the sediment traps were filled with water prior to the ROV launches.

Lander deployment was successfully achieved using the ROV's manipulator arm for all lander deployments. Figure 31 shows video stills taken from one of the deployments. During the ROV's ascent/descent the lander was secured to the ROV's sampling platform.



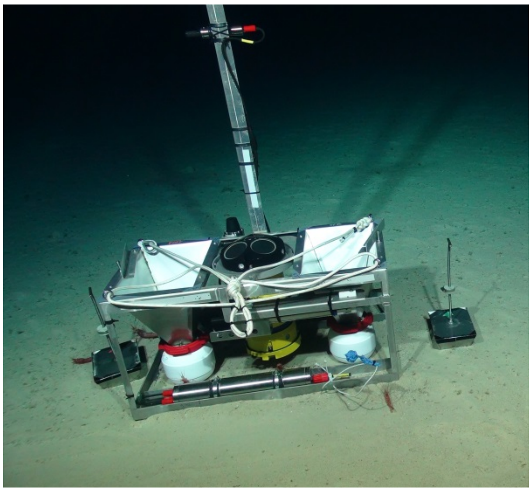


Figure 31: Lander deployment using the ROV (photo credit ISIS ROV).

6.5.4 LANDER EXPERIMENTS

The ISIS ROV was used to conduct three plume experiments during the JC142 research cruise using the vehicle as a means of deploying the lander as well as for the collection sediment push cores and to generate sediment plumes which were to be monitored.

6.5.4.1 RECONNAISSANCE DEPLOYMENT

In order to provide background current information to inform the planning of the plume experiments, the benthic lander was deployed for a “reconnaissance” deployment prior to the experiments being conducted. The location for this measurement campaign was selected based on an analysis of the data acquired from the vessel’s multi-beam echo sounder and sub-bottom profiler data combined with the latest available hydrodynamic model runs available at the time. At the position selected the vessel-based datasets suggested the seabed was composed of sedimentary material with a thickness of several metres. The model data indicated that the current directions were relatively stable in direction during the flood or ebb periods of the internal tide generated at the seamount despite flowing in opposing directions during these periods. Table 6 and Table 7 provide the instrument configurations and position/duration information for this initial deployment respectively. The location of the deployment is shown in Figure 32.

Instrument	**Sampling Configuration**
TRDI ADCP	10 minute ensemble interval (150 pings at 0.5 Hz)
Aqualogger 210TY	10 minute burst interval (60 samples per burst at 5s sample

OBSs	rate)
Valeport OBS	5 minute burst interval (60 samples per burst at 1s sample rate)
Seabird SBE37 CTD	Continuous sampling every 10s

Table 6: Lander reconnaissance deployment instrument configurations

UTM 27N Easting (m)	UTM 27N Northing (m)	WGS84 Lat (DD)	WGS84 Lon (DD)	Deployment Start (UTC)	Deployment Finish (UTC)
529148	2636711	23.84152	-20.71377	01/11/2016 13:35:00	05/11/2016 22:19:00

Table 7: Lander reconnaissance deployment position and duration

Preliminary ADCP and OBSs time series plots for the reconnaissance deployment are shown in Figure 37 and Figure 38.

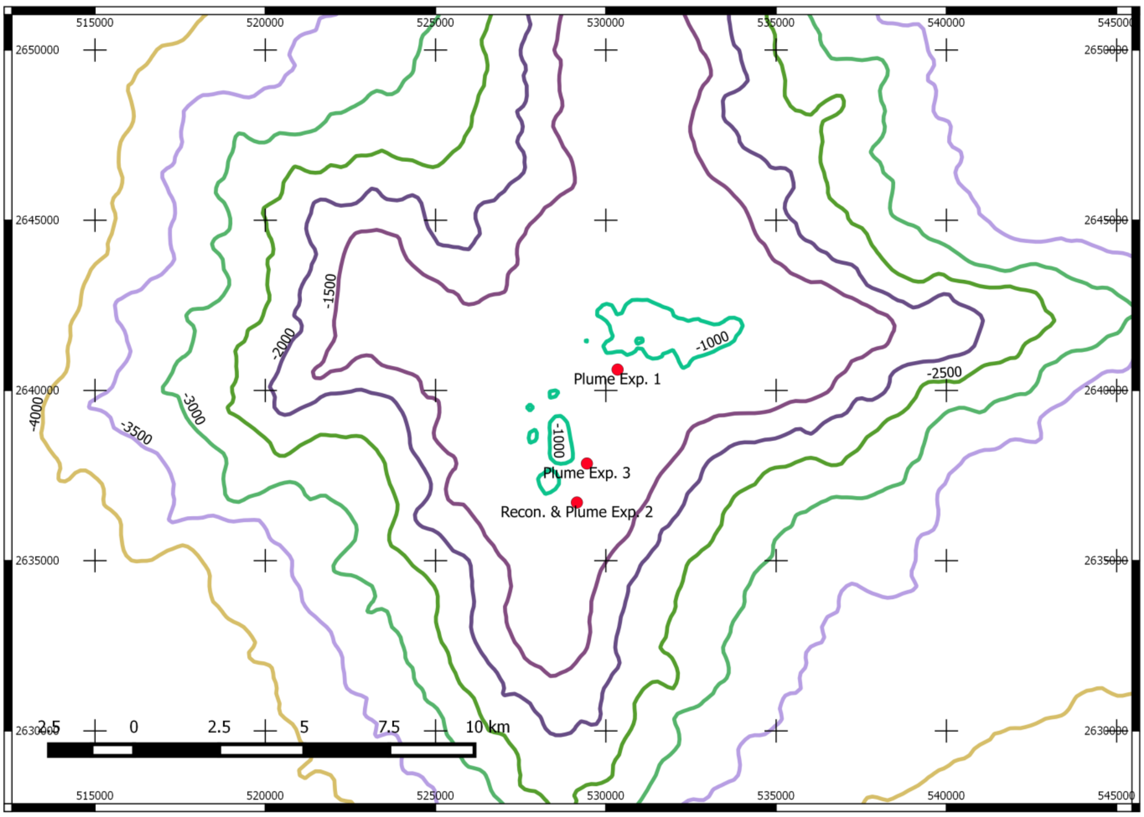


Figure 32: Lander deployment location map.

6.5.4.2 PLUME EXPERIMENT PLANNING AND METHODOLOGY

The sub-sections below detail the principle considerations in the planning process that was undertaken in advance of each plume generation experiment.

6.5.4.2.1 PLANNING

6.5.4.2.1.1EXPERIMENT TIMING

The reconnaissance current data collected at the seamount summit during the first few days of the JC142 cruise showed that the currents at the seabed followed an elliptical (tidal) pattern with a peak current flow attaining 0.3m/s (depth averaged) during the ebb tide in a S-SW direction.

A pseudo tidal diamond for this deployment site was created using this dataset by assigning each measurement to its time relative to local HW and then averaging the results. Based on this information the plume experiments were planned such that they would take place over a phase of the tide when current directions were at their most consistent in terms of the trajectory which the plume would take over the course of the experiment. The period selected was approximately between high water +2 hours and high water -6 hours (i.e. for the majority of the ebb tide), when the principal direction of current flow was S-SW.

Based on the watch patterns of the ROV team and the predicted times of high water, based on analysis of TOPEX altimeter data, the dates selected for the plume experiments were 17/11/2016, 18/11/2016 and 01/12/2016.

6.5.4.2.1.2SITE SELECTION

Specific sites for the experiments were selected using the following information:

- Autosub multi-beam echo sounder and side-scan sonar datasets. At the sites selected the seabed was comprised of sediments and showed little topographical variation. In the case of experiments 1 and 3 the seabed also showed little topographical over the area of planned Autosub mission survey lines.
- The latest available model data time series data.
- ROV video data captured in the vicinity of the proposed experiment sites. In the case of the site selected for plume experiment 1 this showed the presence of bedforms which were orientated perpendicular to anticipated dominant current direction (the latter being determined from analysis of the reconnaissance dataset).

Table 8 shows the position/timing information for the plume experiments.

The locations of the deployment sites are shown in Figure 32.

Experiment Number	Predicted high water	Date and time range	UTM 27N Easting	UTM 27N Northing	WGS84 Lat (DD)	WGS84 Lon

	time (UTC)	(UTC)	(m)	(m)		(DD)
1	17/11/2016 14:00	17/11/2016 13:38 - 21:32	530342.2	2640615	-20.702	23.87677
2	18/11/2016 14:45	18/11/2016 13:31 - 20:18	529148	2636711	-20.7138	23.84153
3	01/12/2016 00:45	30/11/2016 23:46 - 01/12/2016 08:33	529441.7	2637856	23.85187	-20.7109

Table 8: Plume experiments lander deployment locations and experiment timings

6.5.4.2.1.3SUB-SITE ORIENTATION RELATIVE TO LANDER

During each experiment plumes were planned to be generated by the ROV at three sets of positions at varying distances from the lander (nominally 25m, 50m and 100m).

Each set consisted of five stations - three "fixed" plume generation stations and one "trench" (where the ROV would move at a constant rate in a straight line perpendicular to the current direction whilst generating a sediment plume).

The station locations were selected based on anticipated experiment timings, with associated current directions relative to high water for the day of the experiment. Figure 33 shows the positions derived for one of the plume generation experiments. Since the current direction was expected to change over the course of the experiment it was necessary to predict the bearing from each set of stations to the lander in order to ensure that the plumes generated by the ROV would pass over the lander site. In the figure green dots correspond to the start and end of the trenches. Positions 1, 2 and 3 represent the fixed stations at 25m from the lander.

The positions were loaded into the DVL navigation suite used by the ISIS ROV team and were intended to act as a guide during the experiment. Stations were adjusted as the experiment was being conducted based on currents observed from the ROV at the time.

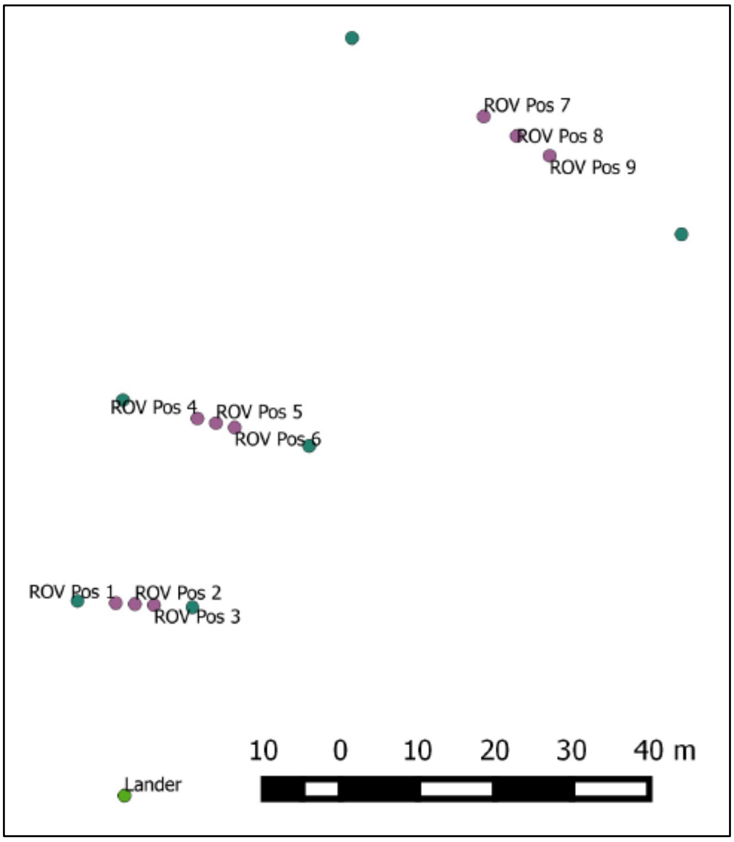


Figure 33: Guideline plume generation stations at nominal distances from the lander

6.6.3.1.1.1 INSTRUMENT CONFIGURATIONS

Table 9 shows the instrument configurations used during the plume experiments.

Instrument	Sampling Configuration
TRDI ADCP	1 minute ensemble interval (50 pings every 1.2s)
Aqualogger OBSs	1 minute burst interval (50 samples per burst at 1s sample rate)
Valeport OBS	Continuous sampling at 1Hz
Seabird SBE37 CTD	Continuous sampling every 10s

Table 9: Lander plume experiments instrument configuration

6.5.4.2.1.4AUTOSUB 6000 MISSION PLANNING

In order to plan the Autosub missions for the plume generation experiments predicted tracks for the plumes emanating from the central station at each of the nominal distances from the lander were generated. Tracks were based on the 4.5 day reconnaissance deployment dataset and the anticipated timing for plume generation at each central station, taking into account a minimum safe operating distance between the ROV and Autosub of 1km.

Autosub mission lines were then setup to attempt to transect the plume, approximately at right angles to the predicted trajectory of the plume. Figure 34 and Figure 35 show the location of the Autosub transects for the portion of the mission associated with the plume experiments. The Autosub was used for plume experiments 1 and 3 only. For each planned survey line the Autosub AUV was configured to sail transects at heights of 3m, 10m and 20m above the bed.

In the case of experiment 1, transects were divided into two sets (a northern set and a southern set), based on the predicted paths of the plumes being generated at different states of the tide.

The order of transects for plume experiment 1 was as follows:

1. Southern set of transects:
    - Transect 1 – 3m above seabed
    - Transect 1 – 10m above seabed
    - Transect 1 – 25m above seabed
    - Transect 2 – 3m above seabed
    - Transect 2 – 10m above seabed
    - Transect 2 – 25m above seabed
2. Northern set of transects
    - WSW-ENE transect – 3m above seabed
    - WSW-ENE transect – 10m above seabed
    - WSW-ENE transect – 25m above seabed
    - NNW-SSE transect – 3m above seabed
    - NNW-SSE transect – 10m above seabed
    - NNW-SSE transect – 25m above seabed

In the case of experiment 2, a single transect was sailed at heights above the seabed of 3m, 10m and 25m a total of 13 times.

It can be seen that the planned survey lines are in places within 1km of the proposed lander deployment locations. Missions were timed such that the ROV and lander were recovered prior to the Autosub AUV entering the 1km safe operating limit.

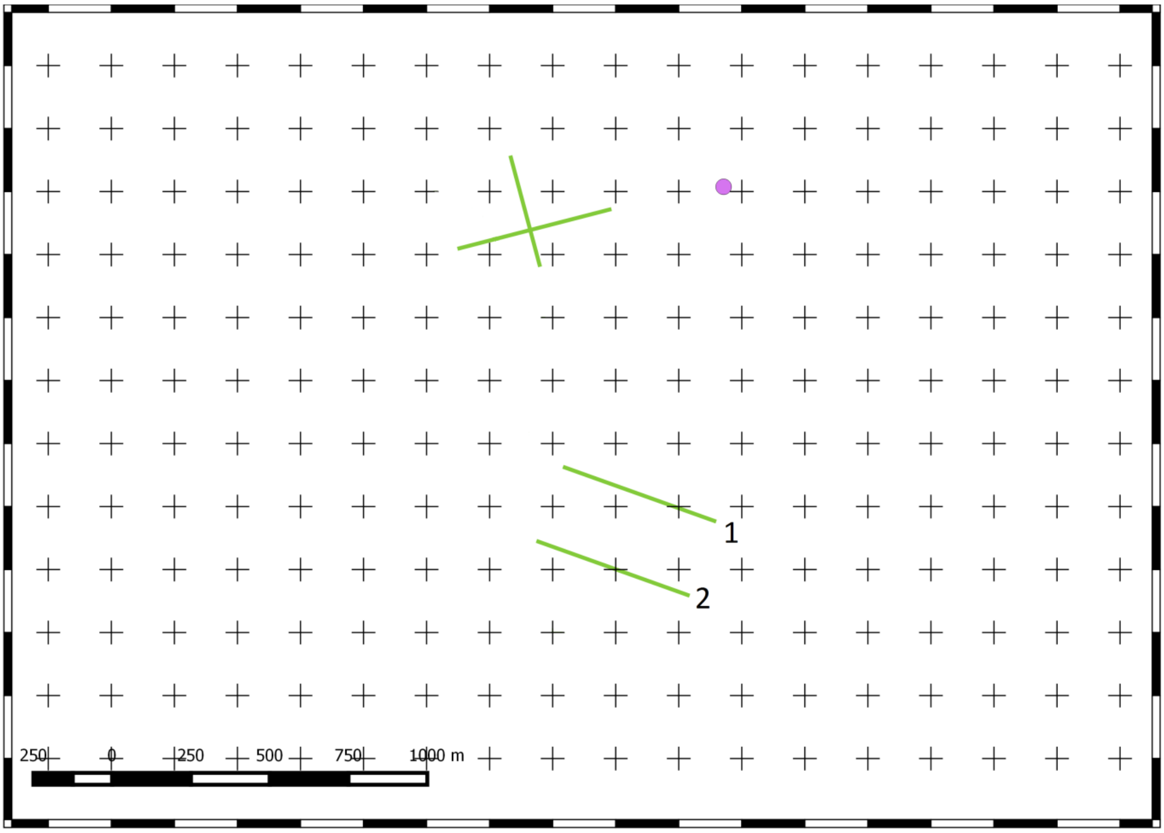


Figure 34: Autosub mission track lines for plume experiment 1

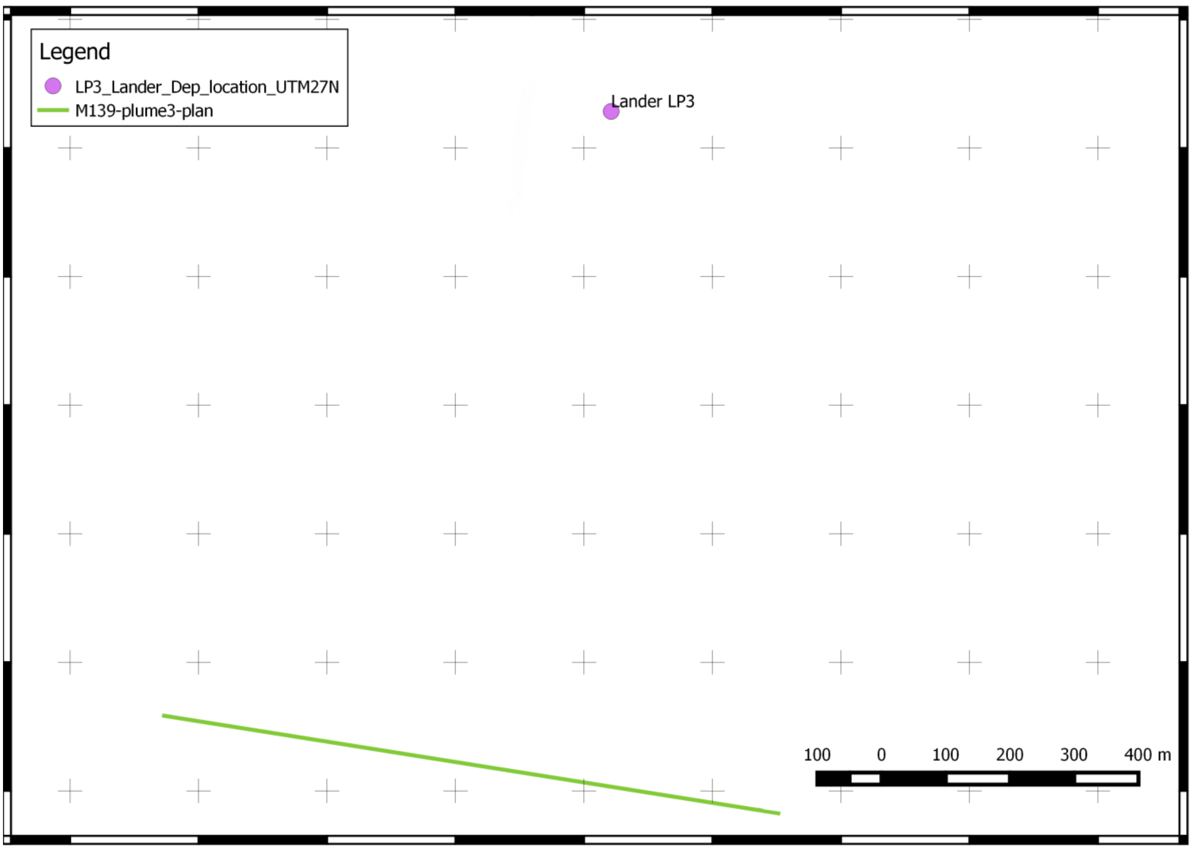


Figure 35: Autosub mission track lines for plume experiment 3

Two Wetlabs OBSs with varying sensitivities were mounted at the front of the Autosub AUV. Details of the sensitivities of each of these sensors are provided in Section 6.5.5. Multi-beam echo sounder water column data was also recorded during plume experiment 1.

It should be emphasized that the predicted plume tracks were based on a current dataset with duration of 4.5 days (lander reconnaissance dataset). This dataset is sufficient to provide a general indication of the direction of current flow relative to the time of high water. However, reliably predicting the path of a sediment plume over a distance of a few km (and over several hours) is not considered to be realistic given the length of the current dataset on which the variation in currents relative to HW are based and the lack of any other near bed current data at other locations around the seamount. Nevertheless the reconnaissance dataset represented the best information available with which to plan the plume experiments at the time.

6.5.4.2.2 METHODOLOGY

6.5.4.2.2.1EXPERIMENT SEQUENCE

The main steps in the experiment sequence were broadly as follows:

1. Deploy lander
2. Acquire push cores
3. Move to the first range from the lander (nominally 25m)
4. Generate plumes along 1 “trench” and three fixed stations at this range.
5. Move to the second range from the lander (nominally 50m)
6. Generate plumes along 1 “trench” and three fixed stations at this range.
7. Move to the final range from the lander (nominally 100m)
8. Generate plumes along 1 “trench” and three fixed stations at this range.
9. Recover lander

Push cores were taken at each nominal distance from the lander site in order to provide information with which to calibrate the responses of the various OBSs deployed on the lander to suspended sediment concentration.

Plumes were generated for 15 minutes at each fixed station during experiment 1. This duration was decreased to 10 minutes for experiments 2 and 3. Plume generation along trenches took place over approximately 10 minutes in all three experiments.

Prior to and immediately after each fixed station the intact and then disturbed seabed was imaged using the cameras on board the ROV. This was done with the intention that photogrammetric analysis be performed on stills extracted from the video to quantify the depth of the pit created and hence estimate the volume of material removed at each plume generation station.

Seawater was also collected for the purposes of OBS calibration during CTD casts performed as soon as possible after the plume experiments.

6.5.4.2.2.2PLUME GENERATION

A Hydra-tech Pumps Inc. 2'' hydraulic submersible utility pump system was used to generate the plumes, entraining sediment from the seabed and ejecting above the vehicle. The outlet of the pump was located adjacent to the ROV's starboard down-thruster. As the ROV was constantly thrusting down to maintain a steady altitude, a significant portion of the plume ejected from the hose was entrained into the jet created by the thruster. This effectively resulted in a portion of the plume being lifted higher into the water column than would be possible using the pump alone.

During the experiments the ROV was held at an altitude of 1.1-1.3m, giving the source of the plumes a height above seabed of between 3.3m and 3.5m. A bespoke handle was attached to the intake end of the pump to allow the ROV manipulator arm to control the position and depth of the intake as it was used to "mine" the sediments.

A check on the current direction was made immediately before each set of plume generation positions using a streamer mounted on a metal pole and base (Figure 36). Generation locations were, modified from the planned generation point based on these observations of current direction, if required.

It was noted that for two of the three experiments there seemed to be a lag of between 1 and 2 hours in the observed current directions and those predicted based on the tidal diamond.

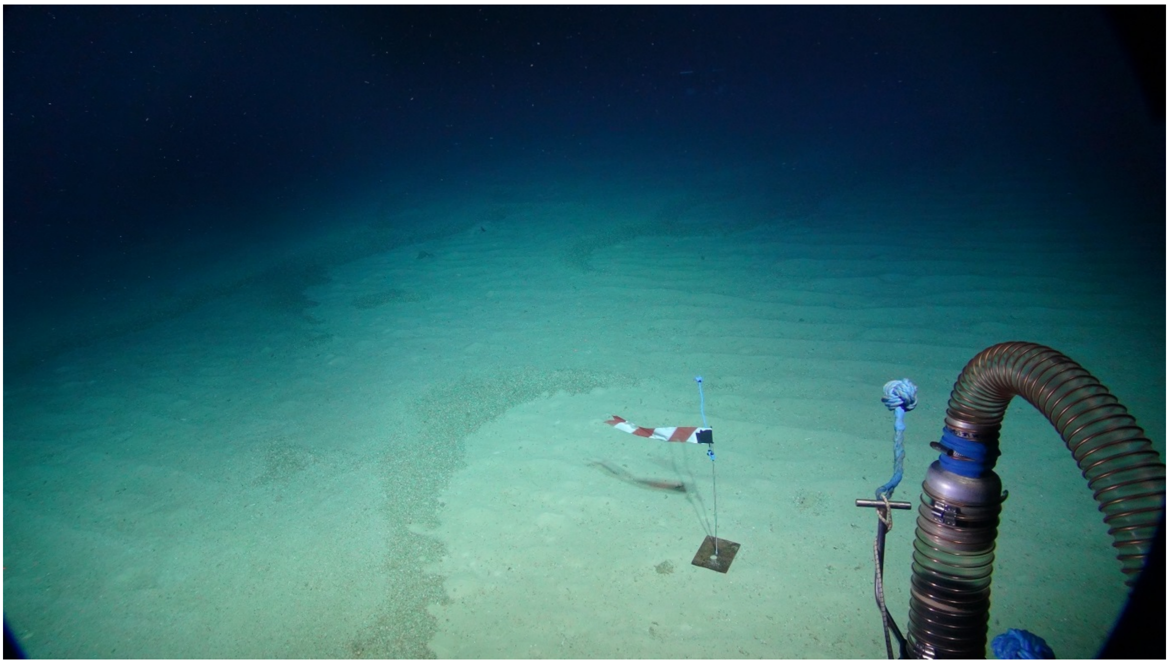


Figure 36: Streamer used during plume experiments to indicate current direction

6.5.4.3 DATA PREPARATION AND INITIAL RESULTS

Following ROV recovery the lander oceanographic instrumentation data was download using manufacturers proprietary software before being imported and analysed using HR Wallingford's Geo-Temporal Editor software (GTE). Additional background information about the GTE software is provided in Section 6.1.2. Once imported the time-series data were trimmed to the duration that the lander was deployed on the seabed.

Using the experiment methodology detailed above sediment plumes generated were successfully directed over the lander in each of the experiments as shown in the OBS time series plots (Figure 40, Figure 41,

Figure 43).

Initial ADCP data analysis consisted of applying a quality filter to the dataset of >=80 (the quality field being comprised of values between 0 and 100 where 100 is best) and running a depth average over the data passing the quality field filter. Depth averaged time series data collected by the ADCP during experiments 1 and 3 is shown in Figure 39 and Figure 42. No ADCP data was collected during experiment 2 due to technical issues.

Analysis performed on the OBS data has so far only consisted of making an initial association between increases in turbidity observed in the OBS record and plumes generated at each of the nominal sub-sites (nominally 25m, 50m or 100m from the lander).

At the time of writing Autosub AUV OBS data files are yet to be processed and so cannot be commented on.

Following recovery of the ROV push cores and lander sediment trap samples were taken into the vessel's controlled temperature lab for initial sealing and storage. Samples were eventually stored in the reefer container in the vessel's hold for onward transport to the UK.

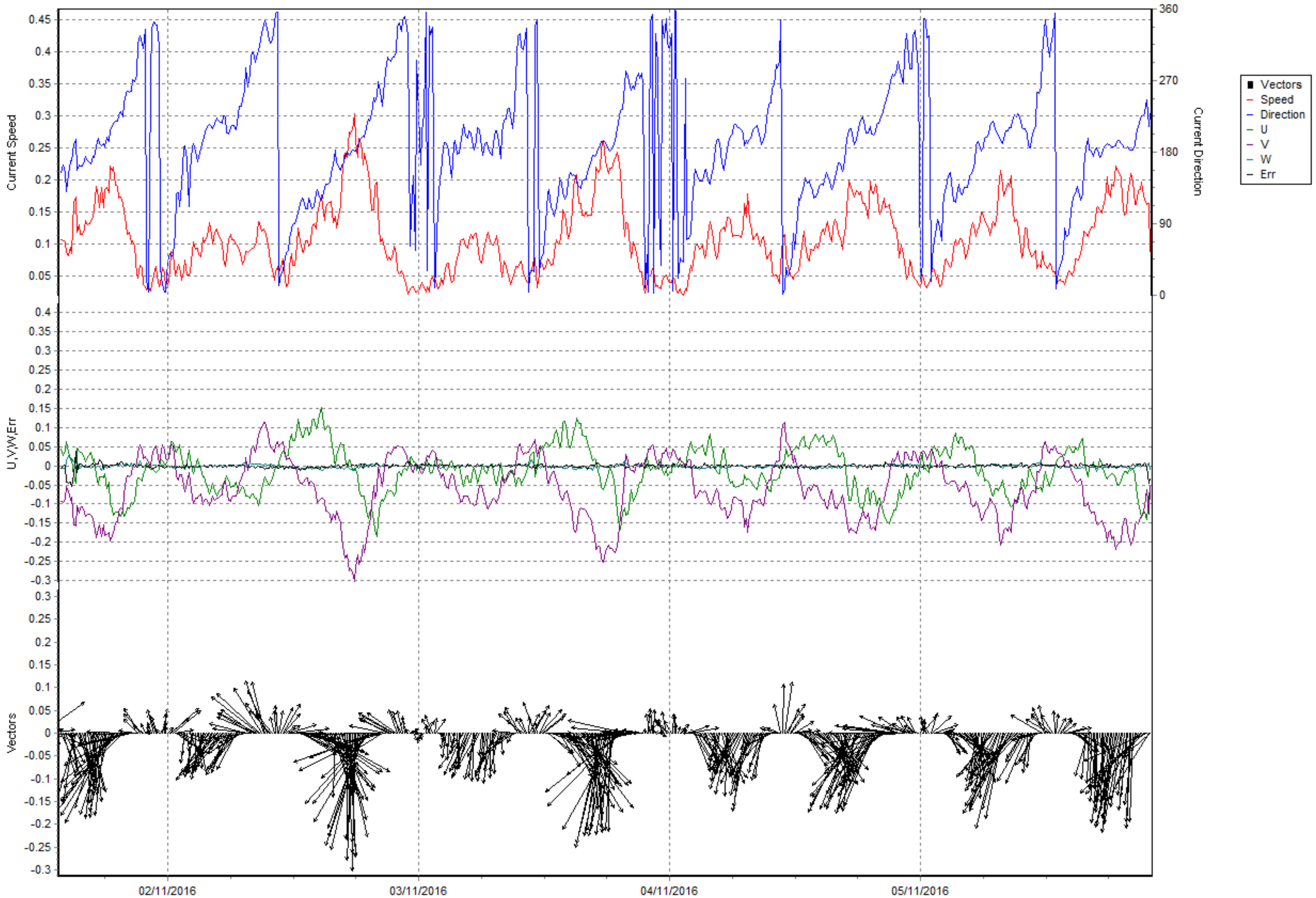


Figure 37: Preliminary ADCP (depth average) time series plot for the lander reconnaissance deployment. Current speed, U, V, W, Error and vectors given in m/s. Current direction given in degM.

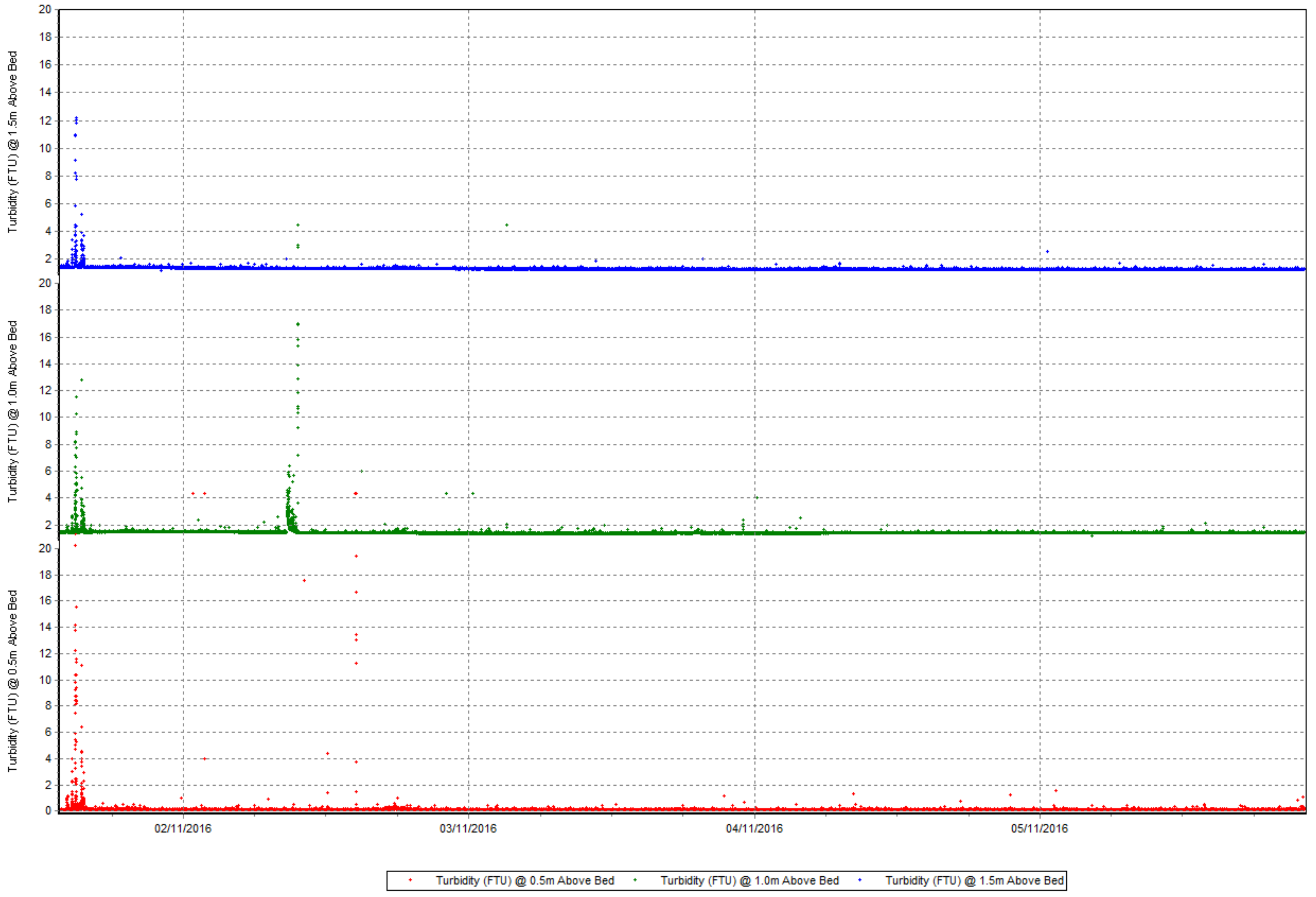


Figure 38: Preliminary Aqualogger OBS time series plot for the lander reconnaissance deployment.

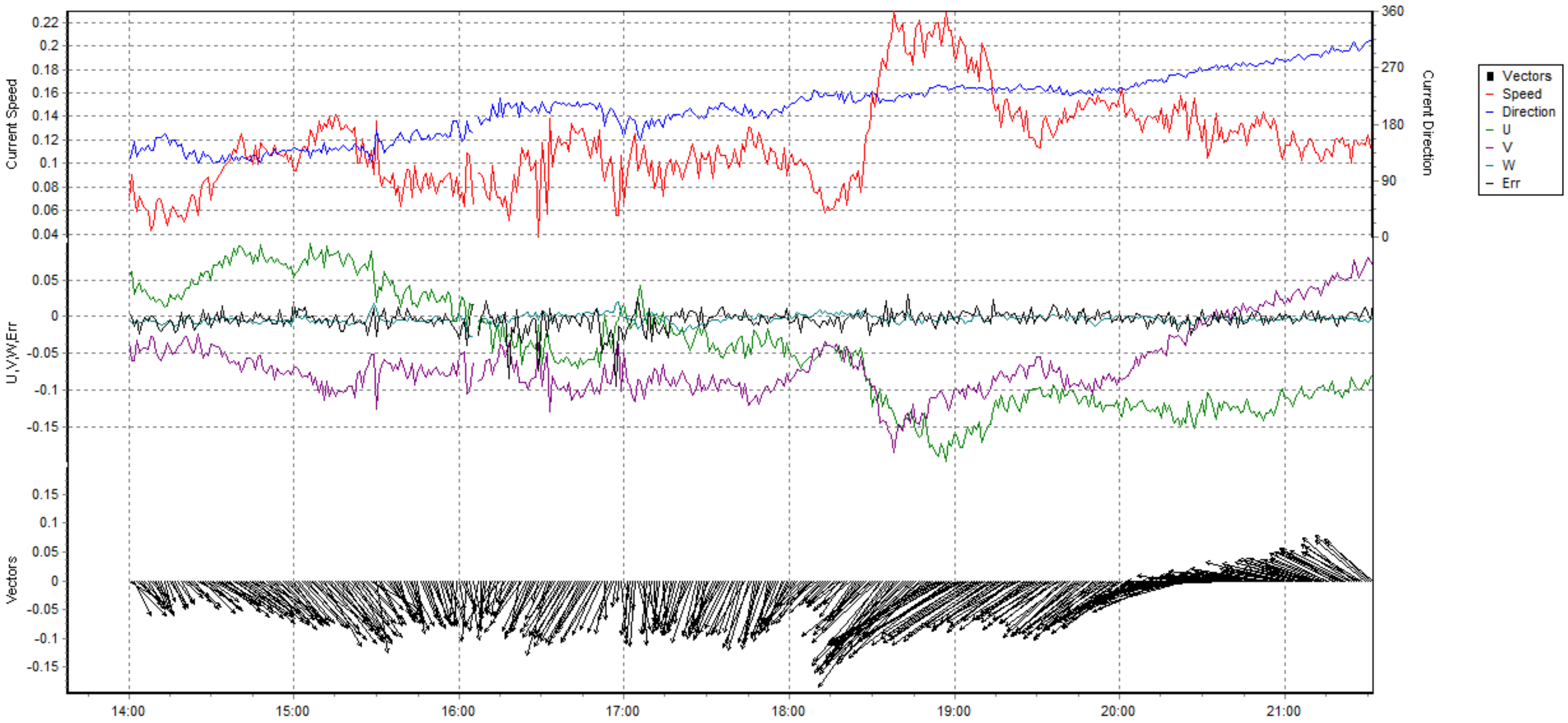


Figure 39: Preliminary ADCP (depth average) time series plot for plume experiment 1. Current speed, U, V, W, Error and vectors given in m/s. Current direction given in degM.

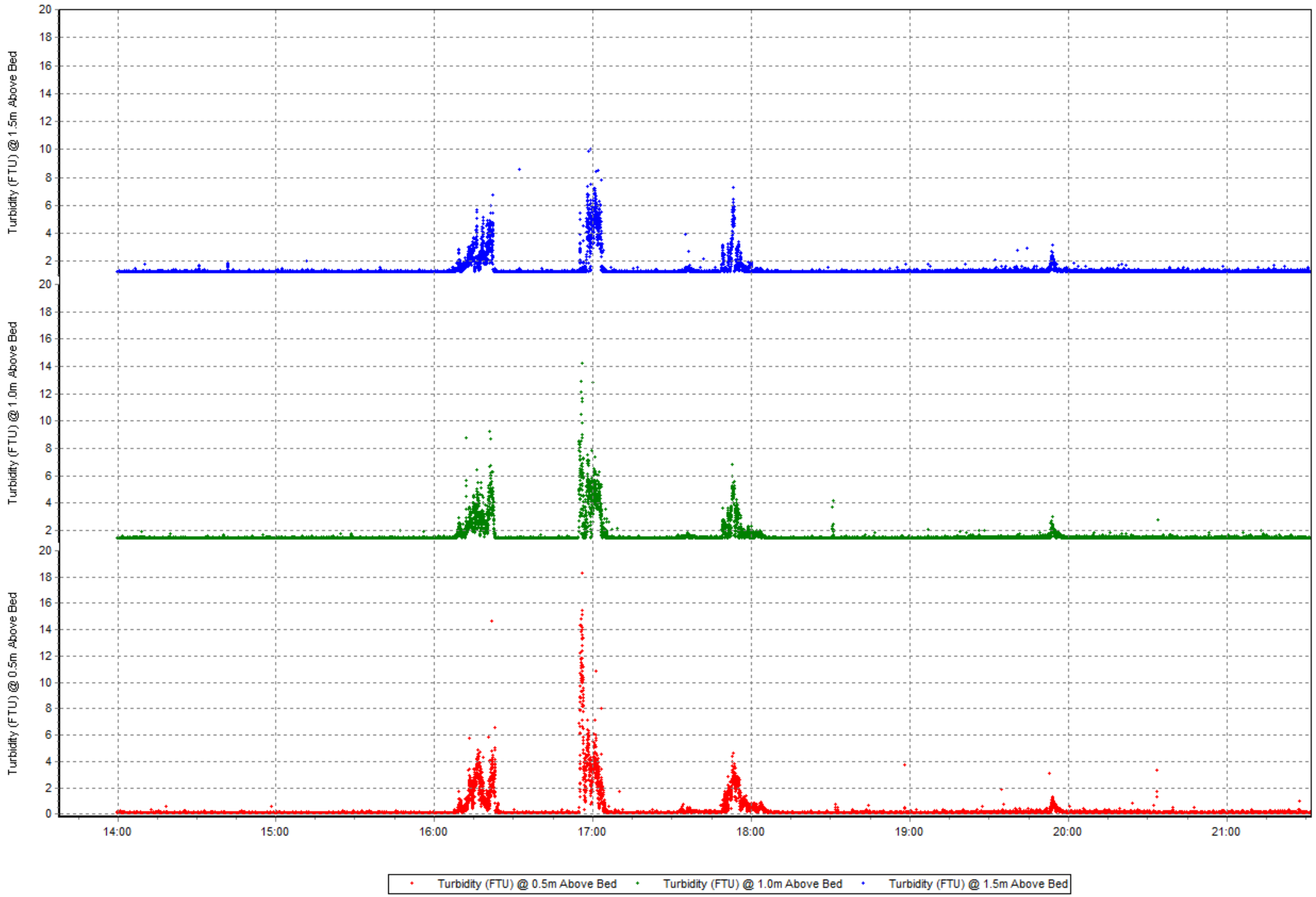


Figure 40: Preliminary Aqualogger OBS time series plot for plume experiment 1.

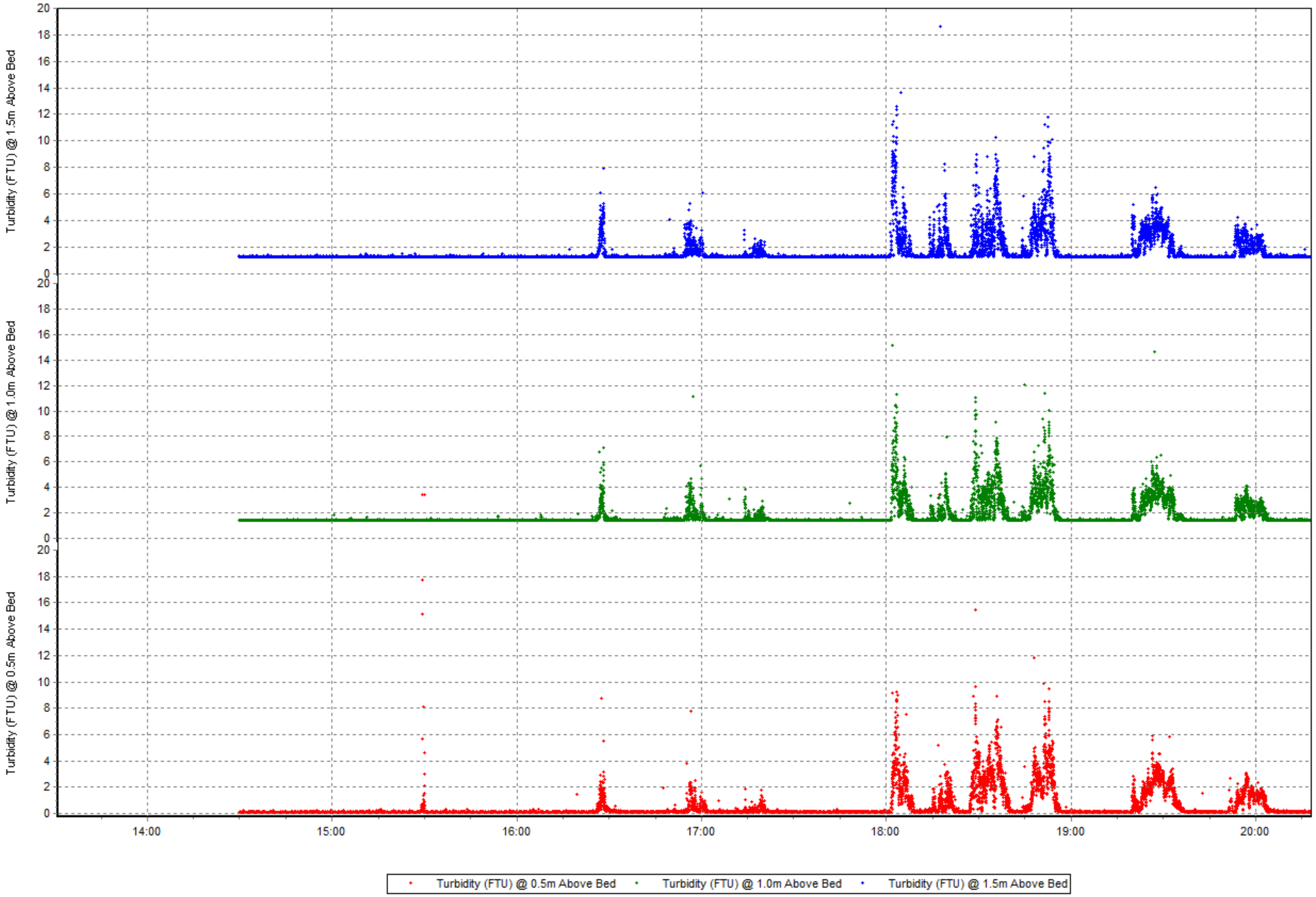


Figure 41: Preliminary Aqualogger OBS time series plot for plume experiment 2.

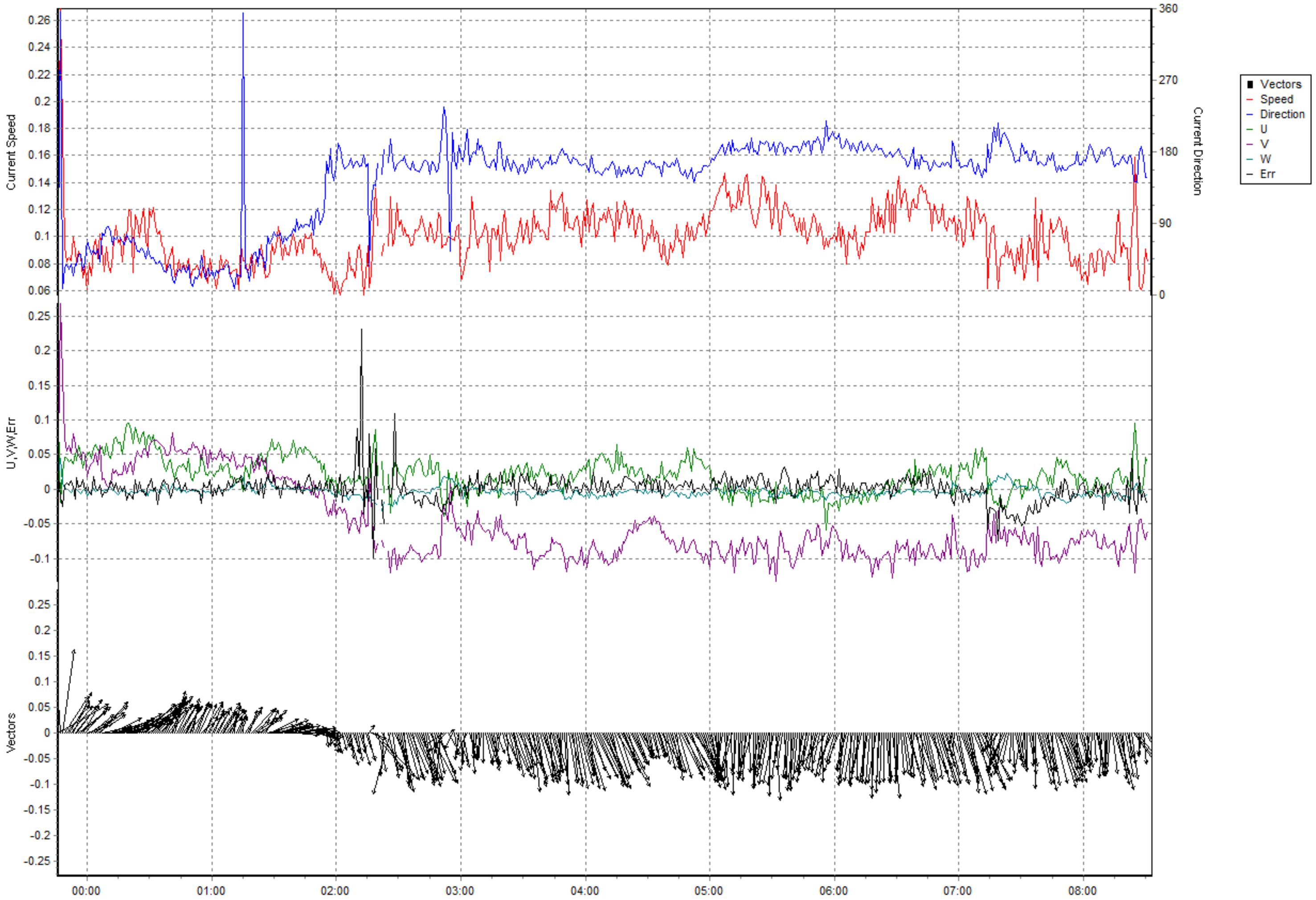


Figure 42: Preliminary ADCP (depth average) time series plot for plume experiment 3. Current speed, U, V, W, Error and vectors given in m/s. Current direction given in degM.

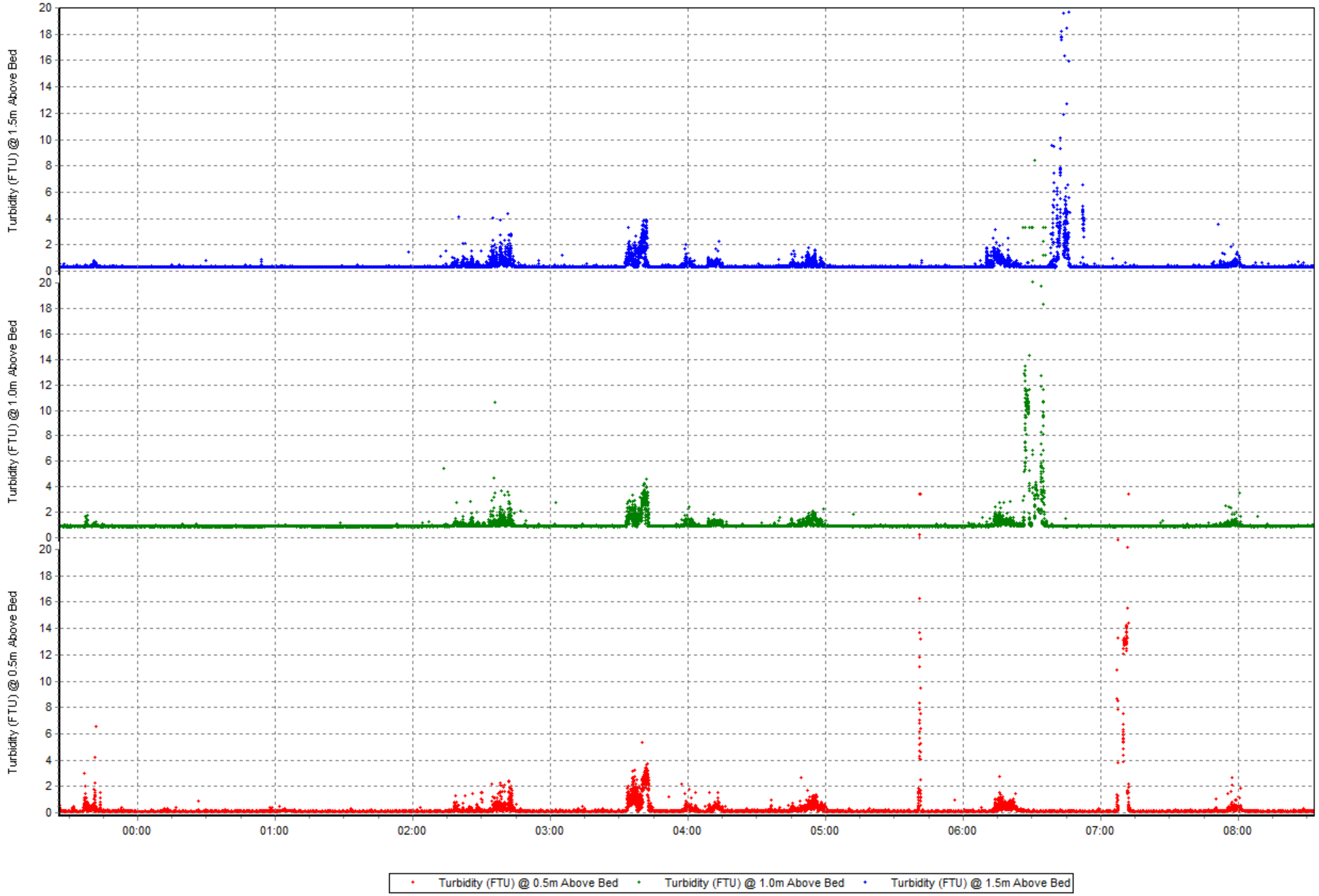


Figure 43: Preliminary Aqualogger OBS time series plot for plume experiment 3.

6.5.5 OPTICAL BACKSCATTER SENSOR DIPPING

A total of 7 OBSs were deployed during JC142 as part of the scientific instrument suites of the various platforms used on this cruise. Details of these sensors and the equipment they were deployed on are provided in Table 10.

Sensor	Serial Nos.	Mounted on	Gain Setting / Scaling	Wavelength
Wetlabs BBRTD	169	AUV	full scale range 5m^-1 which is approximately 5 NTU	660 nm
Wetlabs BBRTD	182	CTD Profiler	See above	660 nm
Wetlabs BBRTD	1163	CTD Profiler (spare)	See above	660 nm
Wetlabs NTURTD	637	Autosub AUV	Scaled to 1000 NTU	700 nm
Valeport Seapoint Sensor	15336	Lander	Gain set to x1 (linear response up to 1250 NTU)	880 nm
Aqualogger 210TY	024-266, 024-267, 024-268	Lander	Auto Gain – instrument automatically chooses most appropriate gain setting to use. Gain settings available and their typical ranges are: - x100; 0-25 NTU - x20; 0-125 NTU - x5; 0-500 NTU - x1; 0-2000 NTU	880 nm

Table 10: Summary of OBSs deployed during JC142

As Table 10 shows, a variety of instrument models were used with a range of sensitivities (gain / scaling settings). The Wetlabs instruments output data in instrument counts whilst the Aqualogger and Valeport sensors output data in Formazin Turbidity Units (FTU) using a calibration stored in the instruments internal memory. Whilst the Wetlabs NTURTD sensor had a conversion to FTU provided with it, the other Wetlabs sensor did not. A conversion from instrument counts to Beta values ($\beta(\Theta_c)$) is however provided in the manufacturer's calibration documentation.

In order to relate readings obtained with BBRTD units to readings obtained with the Valeport and Aqualogger instruments (for data collected during the plume experiments when all of these units, with the exception of those mounted on the CTD, were deployed simultaneously) instruments were dipped in varying concentrations of formazin turbidity standard. Formazin concentrations ranged from 0.5 – 400 FTU and were made up with the intention of providing a suitable range of concentrations for the varying sensitivities of OBSs deployed.

The three BBRTD sensors were dipped over the range 0.5-4 FTU, apart from one (s/n 169) which was also dipped in 12.5 and 25 FTU concentrations. The readings from this instrument were off scale in both these concentrations.

The NTURTD, one Aqualogger and the Valeport sensor were dipped over the range 4 – 400 FTU.

Whilst the dipping in formazin standardises the readings obtained from the various sensors it should still be appreciated that a calibration between FTU/instrument counts and suspended sediment concentration is still required. This is planned to be undertaken in early 2017 via a laboratory dilution approach with the sediment obtained from the push cores.

6.5.6 ISSUES ENCOUNTERED

Issues encountered during the experiments are as follows:

1. The first plume experiment did not keep to the scheduled timing (plume generation ceased about 60 minutes after the time that the plume generation had been planned to end).
    - This was largely down to an underestimation of the length of time involved in the ROV manoeuvring between stations, setting up for plume generation, etc.
    - Anticipated timing was adjusted for subsequent experiments to ensure that the experiment did not overrun.
2. During the first experiment the handle at the intake end of the hose was accidentally ripped from the hose itself. This necessitated that the ROV manipulator arm grip the hose itself as opposed to the bespoke handle. This was rectified in time for subsequent experiments.

6.5.7 RECOMMENDATIONS FOR FUTURE

If similar plume experiments are to be conducted in the future it is suggested that a dedicated current measurement device is deployed on the ROV.

The sediment traps deployed on the lander are somewhat limited given that there is only one void in which sediment will collect. The sediment collected therefore represents an amalgamation of all sediment plumes that passed the lander as opposed to, for example, those generated from a certain station. An improvement which could be made is to design a mechanism whereby the vessels in which the sediments are collected are divided into different compartments which can be opened or closed, either at timed intervals or remotely.

6.5.8 CONCLUDING REMARKS

It should be stated that, overall, each of the experiments was considered to be a success with multiple “hits” achieved on the lander at varying distances, making for some very interesting datasets to analyse.

6.6 HYDRODYNAMIC MODELLING

Hydrodynamic modelling was performed throughout the duration of the cruise by the Hydrodynamics and & Metocean group of HR Wallingford. Modelling was used to help inform the planning of some of the cruise missions, principally ROV dives and AUV missions associated with the plume experiments but also other vessel operations.

Where possible oceanographic, hydrodynamic and meteorological (wind) data collected during the cruise was sent back to the modellers at HR Wallingford's offices in the UK. This allowed for some preliminary refinement of the models. With these enhancements included in subsequent model runs this then in turn allowed for improved model outputs to be supplied to the vessel so that better predictions of prevailing current could be provided for operational planning.

A brief description of the modelling is given below.

- The model runs use Mercator Ocean boundary conditions with 49 planes (which are the same as the Mercator Ocean planes).
- The model imposes elevation, velocity, temperature and salinity in a "sponge layer" around the outer boundary.
- The model domain is a square 500 km by 500 km.
- All the runs are with tide and with wind. Where no wind data were available the model was run with a wind of 10m/s from the north-east.
- The output is every 1 hour.
- The size of the model mesh is variable but has the greatest density over the seamount where it is 500x500m.

Immediately before the cruise the latest models had been run for November 2015 using archived data and a low resolution bathymetry. Once the cruise started the model was run for November 2016. Each new model run received generally predicted currents for up to about 1 week ahead of the time that the model was run.

Datasets supplied to the modellers over the duration of the cruise included ADCP and CTD data collected during the lander deployments, lowered ADCP and CTD profile data (datasets used to produce section and yo-yo plots) and hourly average wind speed and direction data.

The outputs from model runs passed onto the field team included time series data near bed and near surface for a selection of sites around the seamount, individual model frames (images) of velocity and animations (successive frames concatenated). Individual animations were generated for 2 days only due to the restrictions on the capability to download large volumes of data whilst offshore.

Additional analysis performed on model results to provide specific inputs into the selection of CTD profile locations and planning of plume experiments also included the production of vertical velocity sections, analysis of average velocity and speed and analysis of mean direction variation.

6.6.1 INITIAL RESULTS

Once the initial lander deployment dataset had been provided to the modellers the subsequent model runs were able to capture the tidal periodicity in the current flows around the seamount.

Seabed features encountered during ROV dives generally showed good correlation with the model outputs insofar as the model was predicting highest current flows where, based on the features observed at the seabed, stronger currents seemed to be present. These features included the presence and orientation of bedforms, areas of bare rock outcrop and information about locations where the ROV had experienced significant currents (most notably on the eastern and western spurs of the seamount).

Evaluation of the agreement between the field datasets collected during JC142 and the hydrodynamic model results will be undertaken as part of the next phase of the Marine E-tech project and will be reported at a later date.

6.7 ACKNOWLEDGEMENTS

HR Wallingford would like to express their appreciation for all the efforts made by the ISIS ROV and Autosub teams, and all scientific and technical staff who provided assistance in the planning and execution of the plume experiments, deployment of the moorings and acquisition of the shipborne datasets which we discuss here.

We would also like to express our thanks to Dr Bramley Murton (Principle Scientist on JC142) for his advice, patience and understanding in undertaking all the measurements described in this report.

6.8 REFERENCES

Taylor, J. A. and Jonas, A. M., 2008. Maximising data return: a quality control strategy for managing and processing TRDI ADCP datasets from moored instrumentation. Proc. 9th IEEE-OES-CMTC working conference on current measurement technology, 7/03/2008 – 19/03/2008, Charleston, South Carolina.

Thurnherr A.M., 2016. How To Process LADCP Data With the LDEO Software. (ftp://ftp.ldeo.columbia.edu/pub/LADCP)

7 ROV ROCK SAMPLING REPORT

Rock samples have been acquired using two mechanisms: i) grab sampling with the ROV manipulator arms; and ii) using an ROV-mounted hydraulic core drill specifically designed for this expedition (Figure 1).

Figure 1. The core drill mounted on the front of the ROV draw.

7.1 ROV GRAB SAMPLES

The ROV drill requires a relatively flat seafloor surface to operate, in order for the ROV to remain stable and stationary whilst leaving sufficient power reserve to operate the manipulator arms and the drill. Hence its use was restricted to larger, flat areas of outcrop, which typically occur on the summit of the seamount or larger benches (Figure 2). However, a key objective of the research was to collect crust samples across the complete depth range of the seamount, from the abyssal plain at depths >4000 m to the summit at about 1000 m. This required depth transects up the relatively steep arms and flanks of the seamount, which have few locations suitable for drilling (Figure 3). In this environment rock sampling was only possible using the manipulator arms on the ROV. Collection of in situ samples, obtained by breaking material off rock outcrops was the priority (Figure 4). However, this was frequently not possible due to the shape of the outcrop and/or the strength of the rock. When in situ sampling was not possible loose blocks were collected. Each sample was allocated a unique identification number comprising the expedition number, station number and sample number (e.g. JC142_001_001). Once obtained the sample was photographed and then stowed in one of the individual compartments in the baskets on the ROV draw (Figures 5 and 6). A sample log and ROV draw plan were used to record the location of the sample in the draw (Figure 7), location data and other pertinent information (Appendix XX). A record of the sample, its location, water depth and time was also made in the JC142 General Log (Appendix XX).

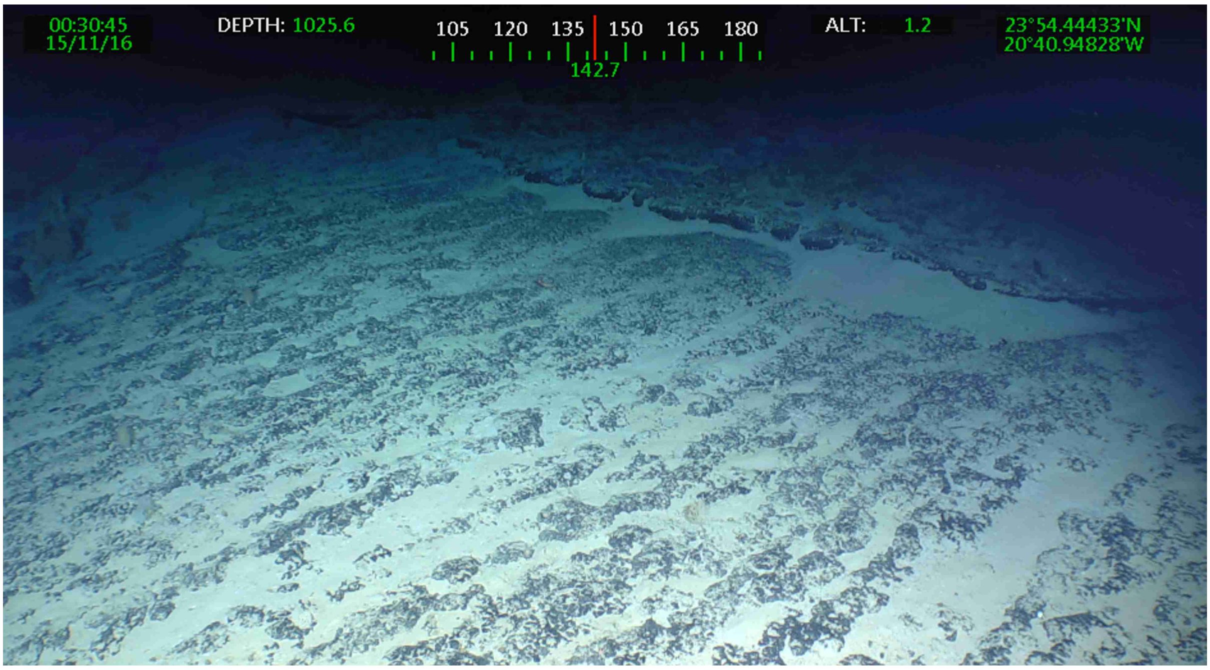


Figure 2. Pavement type exposure on the summit of the seamount suitable for the ROV drilling.

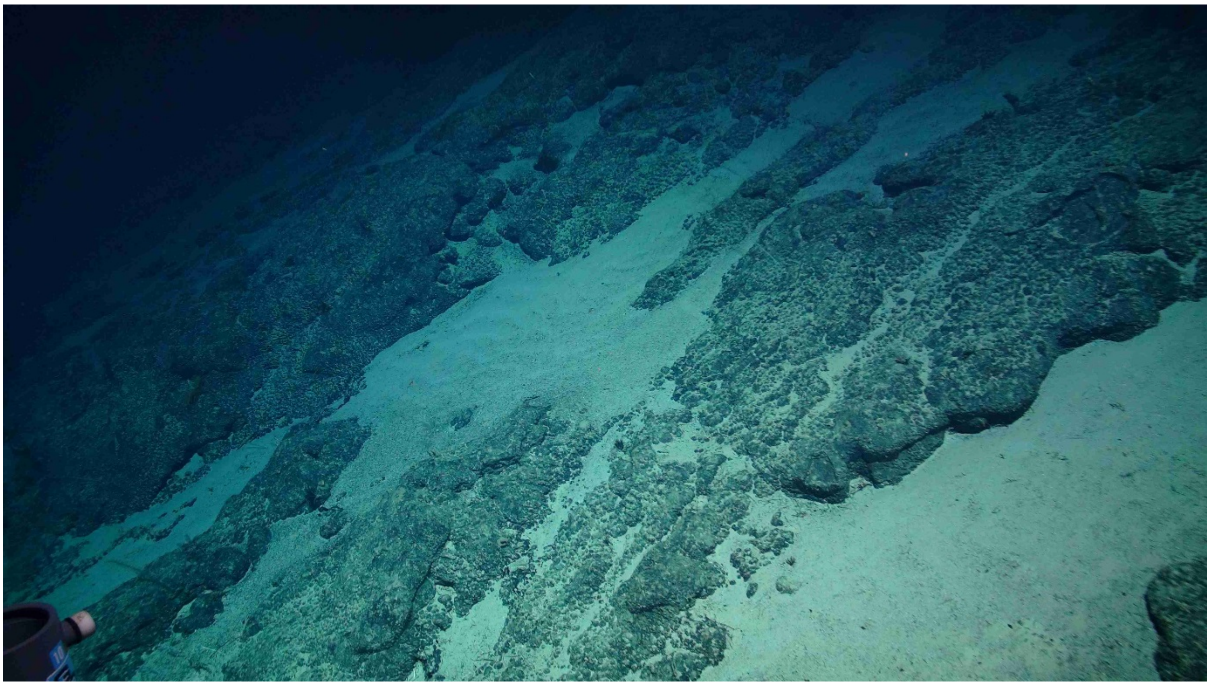


Figure 3. Typical steep and uneven topography on the arms and flanks of the seamount, unsuitable as a ROV drilling platform and only possible to sample using the ROV manipulator arms.

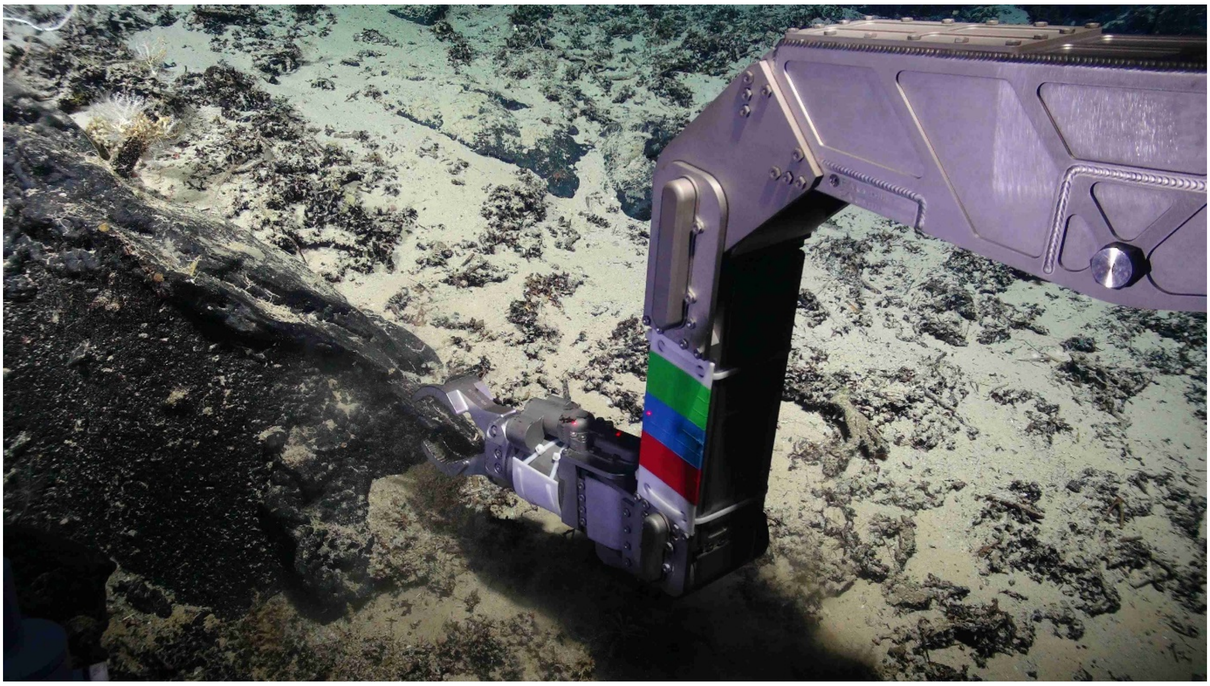


Figure 4. Collection of an in situ rock by snapping a sample off an outcrop with the manipulator arm.

Figure 5. Typical sample collected with the manipulator arm being stowed in one of the numbered compartments in the basket on the ROV draw. The rock drill is visible on the left side of the image.

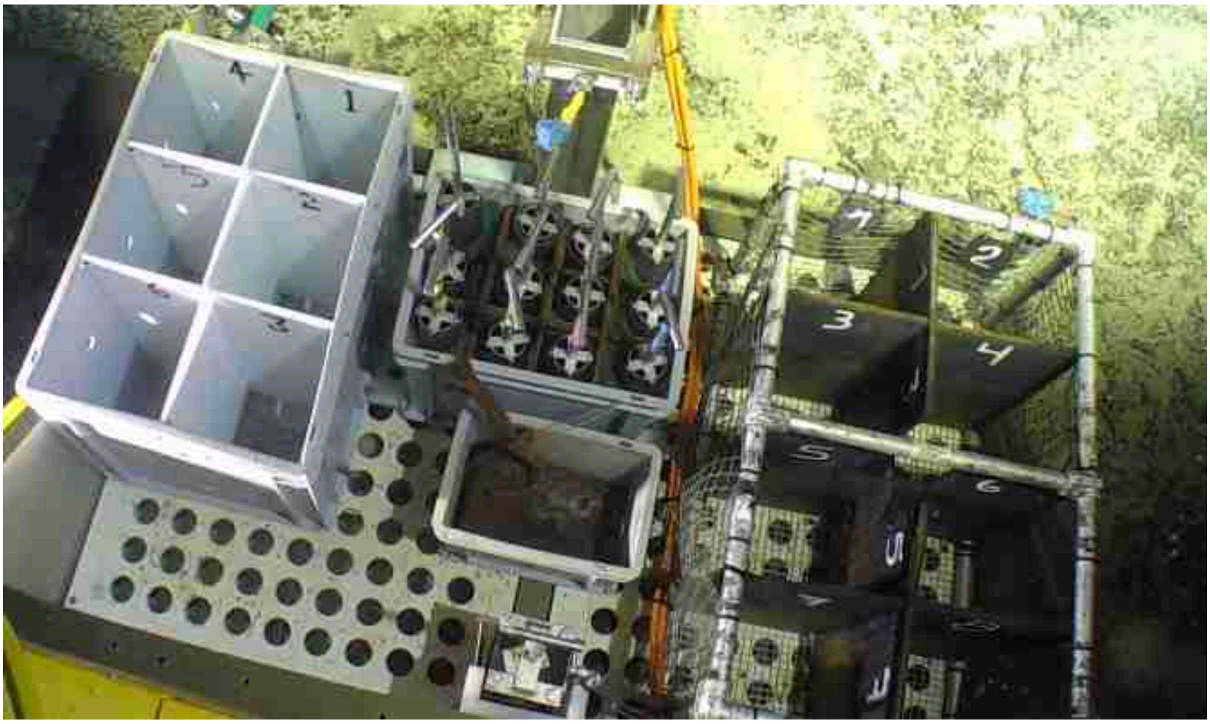


Figure 6. A typical ROV draw configuration for a rock sampling and drilling dive, with 12 core catchers and two compartmentalised and numbered crates, and the weights box.

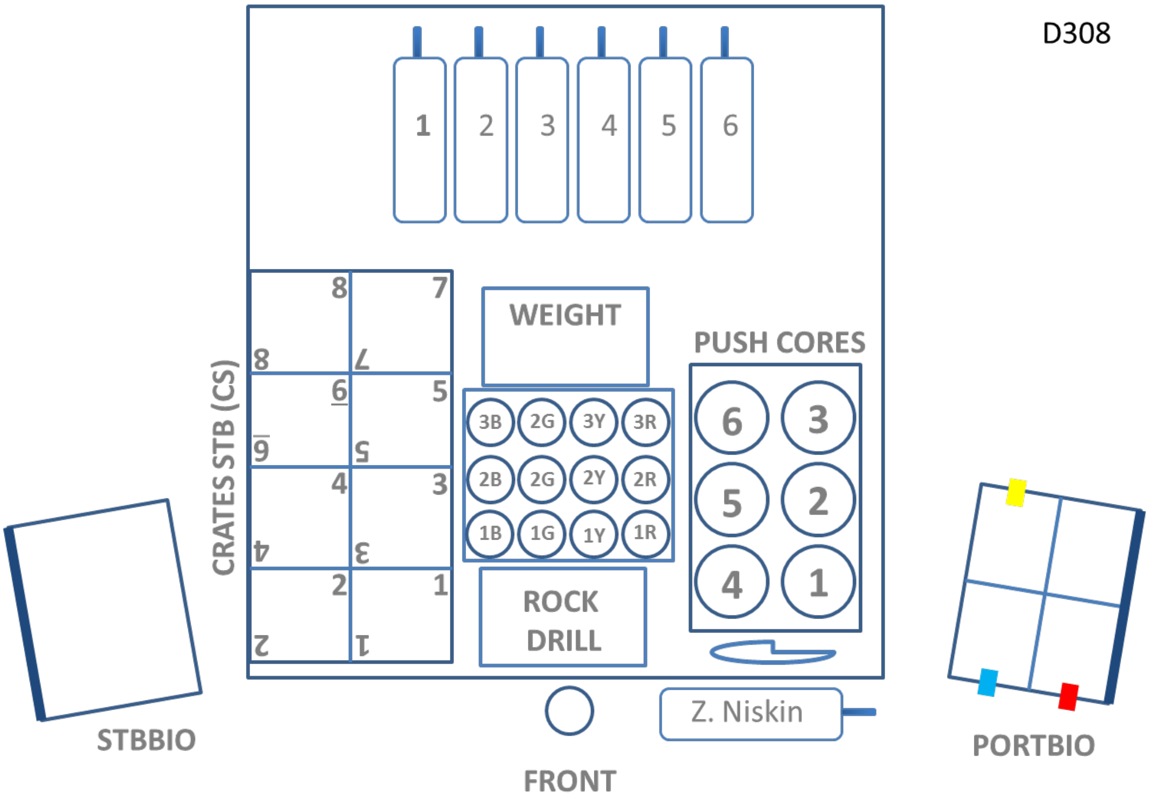


Figure 7. Example of ROV drawer layout plan used for recording the location of individual samples on the ROV. The layout for Dive 308 shows the rock drill (centre front) and associated 12 core catchers, a crate on starboard side for grab samples, 6 push cores on the port side, 2 biology boxes

on either side, 6 Niskin bottles and an additional Zubkov Niskin at the front (for sealing rock samples in their ambient environment at the time of collection).

7.2 ROV DRILL SAMPLES

Core drilling is the optimum method for obtaining continuous, in situ samples of ferromanganese crust and the underlying substrate. The off the shelf core bit used had a total length of 530 mm, with an internal depth of 460 mm. The core bit, designed for drilling in asphalt, has a diameter of 55 mm and produces a 50 mm core (Figure 8). The core catchers which are 290 mm long and 52 mm wide are capable of recovering a core with a maximum length of 280 mm (Figure 8). However, cores approaching the maximum potential length (the maximum length core recovered was 210 mm and the mean length was 115 mm; Table 1, Figure 9) were rarely obtained due to the geological drilling conditions encountered, technical problems (e.g. stalling of the drill and/or misalignment of the bit, potentially resulting from slight movements of the ROV), or a decision to terminate a hole once it was considered to have penetrated to a sufficient depth into the substrate. Following a number of attempts the optimum drilling approach appeared to be lowering the drill so that the core barrel was in contact with the rock surface and then starting the drilling at a low RPM. Only once the core barrel was well seated in the rock (typically 1–3 minutes of rotation) was the speed of the drill increased. This approach appeared to help preserve the more fragile and friable crust in the upper part of the hole and in some samples prevent disaggregation from the substrate. If the drill stalled nudging or taking the weight off the bit with the manipulator arm generally resulted in it restarting. If rotation continued but a lack of penetration over several minutes was observed additional weight was sometimes applied to the drill using the manipulator arms. It was generally considered necessary for the holes to reach a depth of about 150 mm before attempting to recover the core to permit the core catcher to apply sufficient force to break the core at its base. Drilling times varied greatly between holes depending on the time take to set up the drilling operation, lithologies encountered and weight placed on the drill. It estimated that it generally took about 50 minutes to setup, drill a hole and recover a core.

Drill_ID	Sample number	Lat. (deg)	dec. min.	Long. (deg)	dec. min.	Core length (mm)	Crust thickness (mm)	Substrate
1	x	23	53.579	-20	42.311			
2	JC142_020_001	23	53.579	-20	42.311	130	0	Carbonate and phosphrite
4	JC142_047_001	23	53.454	-20	43.059	230	10	Phosphorite
5	JC142_047_011	23	53.860	-20	42.802	100	15	Carbonate and phosphrite
6	x	23	53.866	-20	42.495			
7	JC142_047_021	23	53.867	-20	42.496			
8	JC142_047_026	23	53.731	-20	42.435	240	20	Carbonate
	JC142_047_027	23	53.732	-20	42.436			
9	JC142_058_009	23	54.412	-20	41.365	20	20	NA
10	JC142_058_011	23	54.409	-20	41.308	100	40	Phosphorite
11	x	23	54.444	-20	40.948			
12	JC142_058_029	23	54.445	-20	40.948	150	0	Phosphorite
13	JC142_058_033	23	54.283	-20	40.720	180	30	Phosphorite
14	x	23	54.205	-20	40.493			

15	JC142_058_034	23	54.205	-20	40.492	50	50	Phosphorite
16	JC142_058_035	23	54.205	-20	40.492	40	40	NA
17	JC142_058_036	23	54.204	-20	40.491	130	20	Phosphorite
18	JC142_058_037	23	54.103	-20	40.405	210	10	Phosphorite
19	JC142_058_043	23	53.277	-20	40.050	50	0	Carbonate
20	JC142_058_044	23	53.269	-20	40.050	30	30	Phosphorite
21	JC142_061_010	23	56.557	-20	41.468	50	30	Phosphorite
22	JC142_061_013	23	56.811	-20	41.111	30	30	Phosphorite
23	x	23	56.859	-20	41.249			
24	JC142_061_015	23	56.857	-20	41.249	15	15	NA
25	JC142_080_009	23	54.441	-20	46.493	140	70	Carbonate
26	JC142_080_010	23	54.350	-20	46.64500	40	40	NA
27	JC142_080_023	23	53.970	-20	46.40100	25	25	NA
28	x	23	53.825	-20	46.108			
29	JC142_080_025	23	53.822	-20	46.10700	205	105	Carbonate
30	JC142_080_026	23	53.762	-20	46.04700	50	50	NA
31	JC142_085_001	23	53.77000	-20	46.05900	190	140	Phosphorite

32	JC142_085_002	23	53.76800	-20	46.05800	150	150	Phosphorite
33	x	23	53.7696	-20	46.0596			
34	JC142_085_003	23	53.76800	-20	46.06000	75	75	NA
35	JC142_085_004	23	53.76800	-20	46.05600	26	150	Carbonate and phosphrite
36	JC142_085_006	23	53.76200	-20	46.04700	23	90	Carbonate and phosphrite
37	x	23	53.762	-20	46.044			
38	JC142_085_007	23	53.76100	-20	46.04300	50	50	NA
39	JC142_085_008	23	53.74800	-20	46.04200	160	100	Carbonate and phosphrite
40	JC142_085_009	23	53.76800	-20	46.05900	130	125	Semi indurated clay
41	x	23	54.229	-20	40.516			
42	JC142_089_001	23	54.23440	-20	40.51691	40	20	Phosphorite
43	JC142_089_002	23	54.23591	-20	40.52067	110	80	Phosphorite
44	x	23	54.244	-20	40.524			
45	JC142_089_003	23	54.25571	-20	40.53005	180	60	Phosphorite
46	JC142_089_004	23	54.25612	-20	40.52961	130	60	Phosphorite
47	JC142_089_005	23	54.25724	-20	40.52982	190	70	Phosphorite

48	JC142_089_006 & 008	23	54.26532	-20	40.53674	160	60	Phosphorite
49	JC142_089_007	23	54.26532	-20	40.53780	160	70	Phosphorite
50	JC142_089_009	23	54.27219	-20	40.53780	200	65	Phosphorite
51	JC142_089_010	23	54.28240	-20	40.54501	205	55	Phosphorite
52	JC142_089_011	23	54.28751	-20	40.55156	60	60	NA
53	x	23	54.281	-20	40.556			
54	JC142_089_012	23	54.28835	-20	40.55254	185	65	Phosphorite
55	JC142_089_013	23	54.28110	-20	40.55591	30	30	NA
56	JC142_089_014	23	54.26762	-20	40.54773	200	50	Phosphorite
57	x	23	51.610	-20	44.615			
58	JC142_116_001	23	51.61002	-20	44.61498	50	35	Carbonate and phosphorite
59	JC142_116_002	23	51.59298	-20	44.61402	110	20	Carbonate
60	JC142_116_003	23	51.567	-20	44.60202	150	25	Carbonate
61	JC142_116_004	23	51.564	-20	44.60400	130	20	Carbonate

62	JC142_116_005	23	51.546	-20	44.59902	90	40	Phosphorite
63	JC142_116_006	23	51.51702	-20	44.58900	150	50	Carbonate
64	JC142_116_007	23	51.513	-20	44.57898	170	50	Carbonate
65	JC142_116_008	23	51.52698	-20	44.57700	145	26	Carbonate
66	JC142_116_009	23	51.498	-20	44.55702	105	31	Carbonate
67	JC142_116_010	23	51.4896	-20	44.51472	140	10	Carbonate
68	JC142_116_017	23	51.489	-20	44.50500	90	40	Carbonate and phosphorite

Table 1. Summary of drill core samples.

A maximum of 12 cores, limited by the number of core catchers on the ROV draw (Figure 6 and 7), could be acquired per dive. A total of 68 holes were drilled and samples were recovered from 54 holes (Table 1). The lack of sample recovery from some holes resulted from either an inability to insert the core catcher due to a blockage, lack of drill penetration resulting in the core being too short to snap off at its base or loss of the core into an underlying cavity.

Figure. 8. New and used core bits and a T-handled core catcher. The used bit has drilled 15 holes and has negligible wear when compared with the new bit.

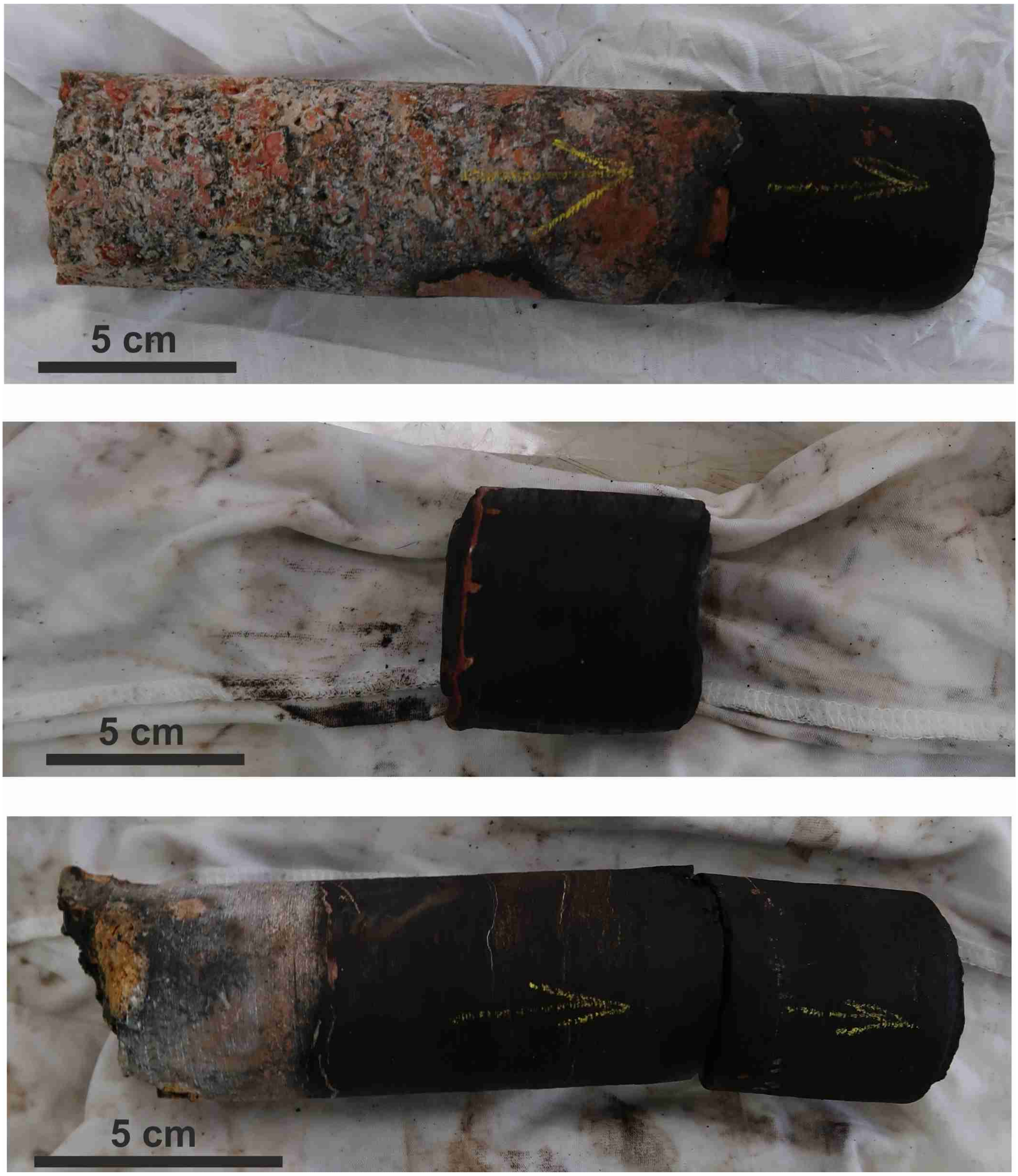


Figure 9. Example core samples, from top to bottom: JC142_089_010 (continuous core with no breaks), JC142_085_005 (the core has snapped close to the crust/substrate contact) and JC142_089_001 (a complete core, which has broken along a weakness in the crust).

Sample handling and preservation

Prior to arrival on deck temporary labels were produced for each sample. To ensure the correct sample was retrieved from the ROV draw and associated with its correct sample number, sample numbers were taken individually to ROV where the appropriate sample was collected (Figure 10A,B,C), according to the draw plan and log (Figure 7), to then be moved to the lab (Figure 10D). Once the samples were in the lab the following procedure was followed:

1. Samples were covered with wet cloth to prevent dehydration.
2. The way up on collection (orientation on seabed) was marked on the sample (Figure 10E).
3. The complete sample was photographed on both sides (Figure 10E).
4. An initial description of the sample was made (Appendix XX).
5. The sample was cut into multiple sections (Figure 10F,G)
6. The subsamples were marked with way up.
7. Samples were covered with wet cloth to prevent dehydration.
8. A photograph of a representative subsample slice was taken (Figure 10E)
9. The sample description sheet was completed based on the internal features revealed.
10. Samples bags were labelled externally and a printed label was inserted.
11. Samples were inserted into the labelled bag along with a piece of wet tissue to maintain moisture levels and the bags were sealed (Figure 11A).
12. Sampling parties took place at regular intervals to determine the distribution of sample between project partners (Appendix XX).

Core samples were handled in a similar way but not subsampled. They were described and photographed and the entire sample was placed in a single bag for future sub-sampling (Figure 11B). Each core catcher was numbered so that the core samples could be related to the sample log and draw plan on recovery of the ROV (Figure 6 and 7).

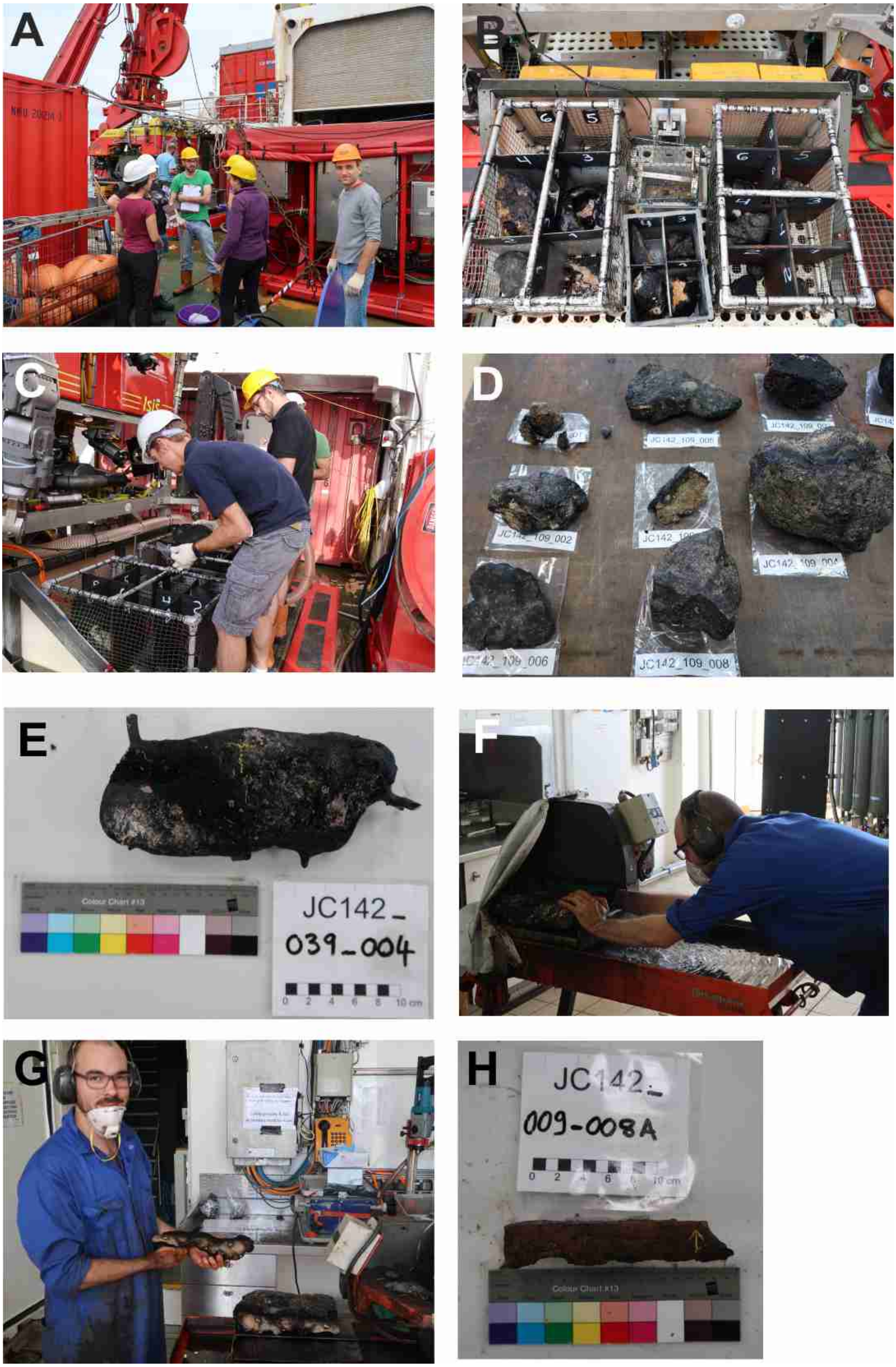

A
B
C
D
JC142_109_002
JC142_109_004
JC142_109_006
JC142_109_008
E
Colour Chart #13
JC142_
039_004
0 2 4 6 8 10 cm
F
G
H
JC142_
009-008A
0 2 4 6 8 10 cm
Colour Chart #13

Figure 10. Rock sample handling and preservation procedure. A. Team assembled ready to collect samples and transport to the lab. B. Samples in numbered basket compartments, which can be related to sample log and tray layout plan. C. Association of sample number with physical sample based on log and tray layout plan. D. Samples laid out on lab. bench for initial description and photography. E. Example photograph of complete rock sample. F and G. Subsampling using a rock saw. H. Example photograph of cut sample.

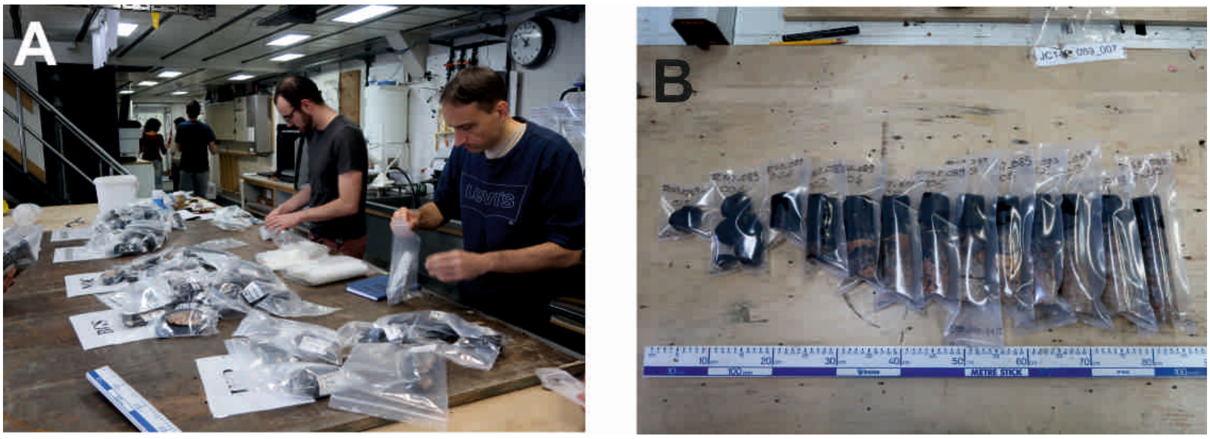


Figure 11. Sample preservation. A. Bagging of grab rock samples and sample distribution. B. Drill core placed in labelled bags, which have been heat sealed.

7.3 RECOMMENDATIONS

Whilst ROV drilling is the optimum method for obtaining continuous vertical sections of the stratigraphy, the NOC ROV-mounted drill in its current design and with the power available can only be deployed on relatively flat and stable surfaces. However, some of the thickest crusts observed were on steep, slopes and typically had a tabular to bulbous form (Figure 12), which also prevented in situ grab sampling. To sample these types of outcrop using the ROV manipulator arm would require initial cutting or breaking of the rock. This could potentially be done with a rock saw and/or hydraulic shear tool held by the manipulator.

7.4 ROV DIVES

22 ROV dives were primarily devoted to rock, sediment and biological sampling (Figure 13). During the sampling dives seafloor observations and mapping was undertaken using both OFOP and a hardcopy paper base map. Images of each rock sample (generally cut face) collected on the expedition are presented in Appendix XX, along with accompanying maps showing the dive line trace, sample locations and their unique ID number. Three of the dives (310, 311 and 321) were dedicated to drilling and therefore only the sample location is shown on the map. Similarly, dive 316 focused on push coring and associated grab samples for microbiology analysis and only sample locations are shown.

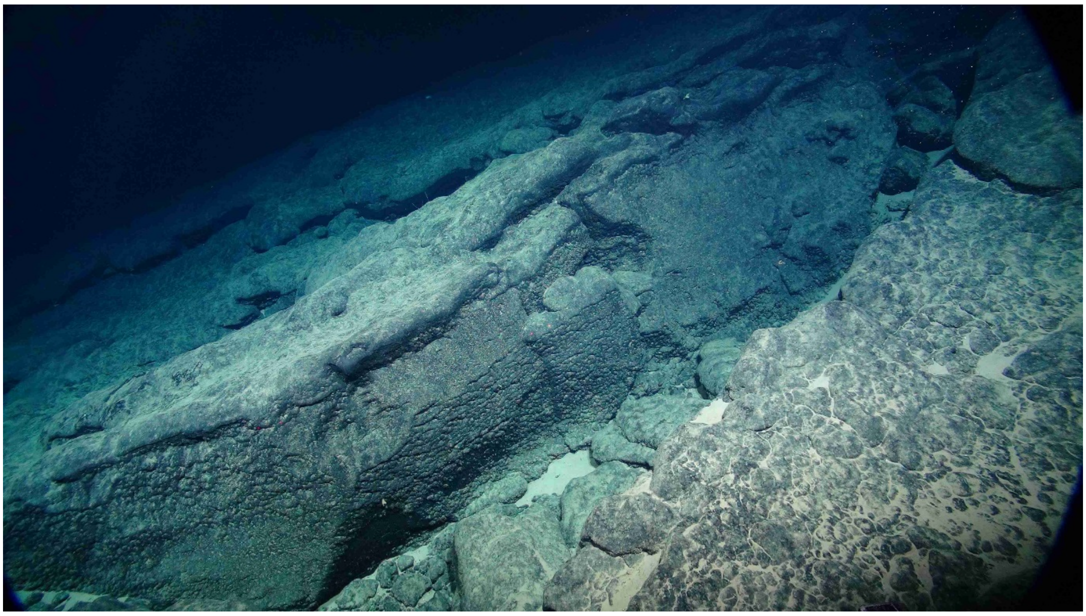


Figure 12. Exposure of crust which is not possible to drill due to the slope angle, but is also challenging to sample using the ROV manipulator arms due its strength and form.

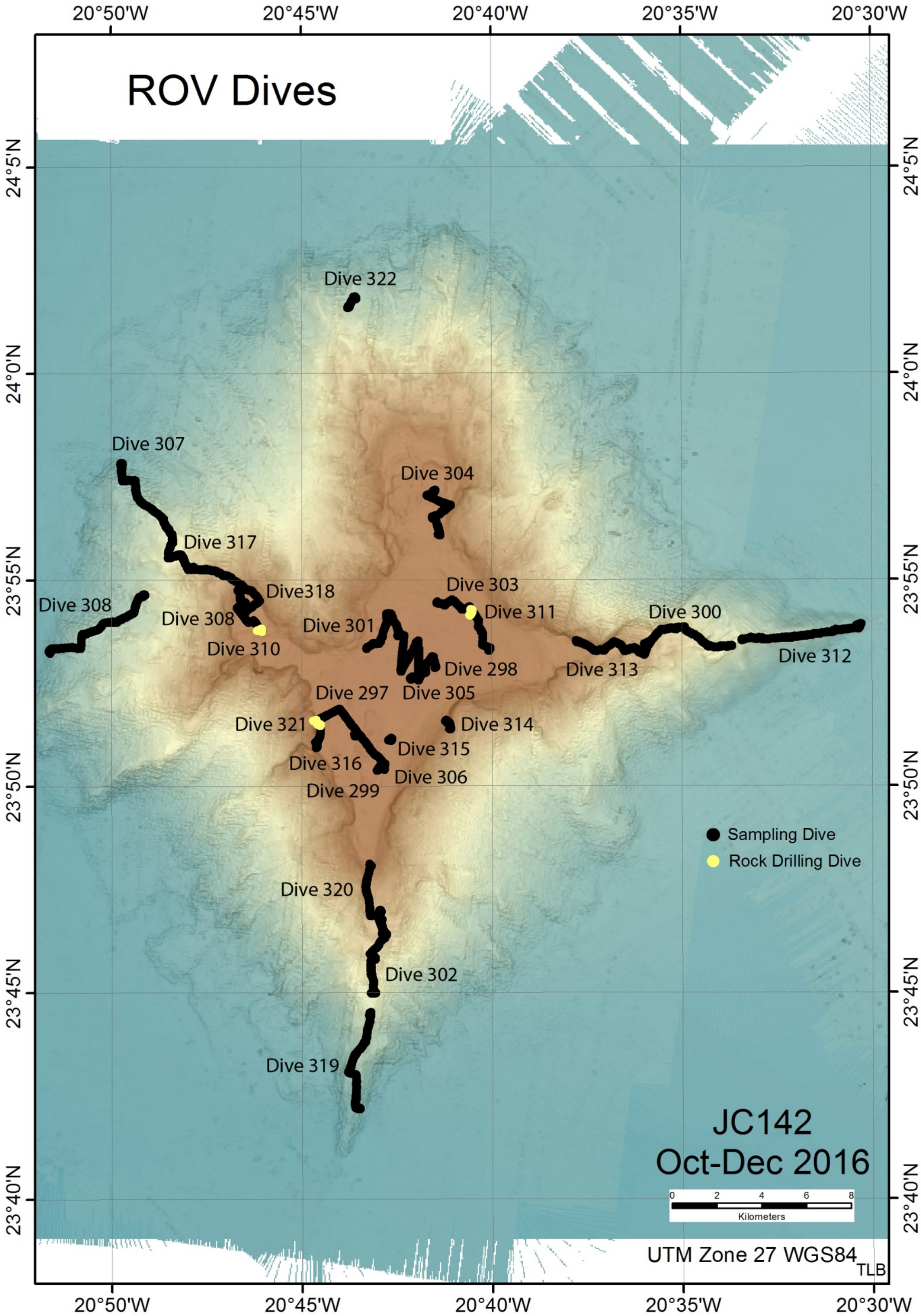


Figure 13. Trace of ROV dives on Tropic seamount primarily devoted to rock, sediment and biological sampling.

8 GRAVITY CORING REPORT

8.1 AIMS AND OBJECTIVES

Gravity cores were collected on the flanks of Tropic Seamount in order to obtain sediment cores of up to 3m depth. The aim of the gravity cores was to intersect sediment packages within the collapse flank structures of Tropic Seamount in order to investigate past sedimentary and tectonic history.

8.2 SITE LOCATIONS

Overall 6 gravity core stations were completed during JC142 (see Table 1). These locations were chosen based on high resolution AUV bathymetrical maps and ship bathymetry from this cruise. These locations aimed to target areas on the collapsed flanks of Tropic Seamount in order to intersect thick sediment packages created through mass wasting processes, as well as on the summit for comparative studies.

Table 11 Location of the 6 gravity coring sites and associated samples.

Station	Sample ID	Date	Water Depth (m)	Location		
				Region	Latitude	Longitude
063	JC142_063_001A	16/11/16	3969	SE flank	23° 47.321	-20° 36.351
	JC142_063_001B	16/11/16	3969	SE flank	23° 47.321	-20° 36.351
064	JC142_064_001A	16/11/16	4195	SW flank	23° 47.225	-20° 50.121
	JC142_064_001B	16/11/16	4195	SW flank	23° 47.225	-20° 50.121
065	JC142_065_001	17/11/16	3964	NE flank	23° 57.698	-20° 35.462
097	JC142_097_001A	30/11/16	4105	NW flank	24° 0.403	-20° 49.302
	JC142_097_001B	30/11/16	4105	NW flank	24° 0.403	-20° 49.302
124	JC142_124	06/12/16	1023	Summit	23° 50.559	-20° 42.784
125	JC142_125	06/12/16	1000	Summit	23° 50.559	-20° 42.784

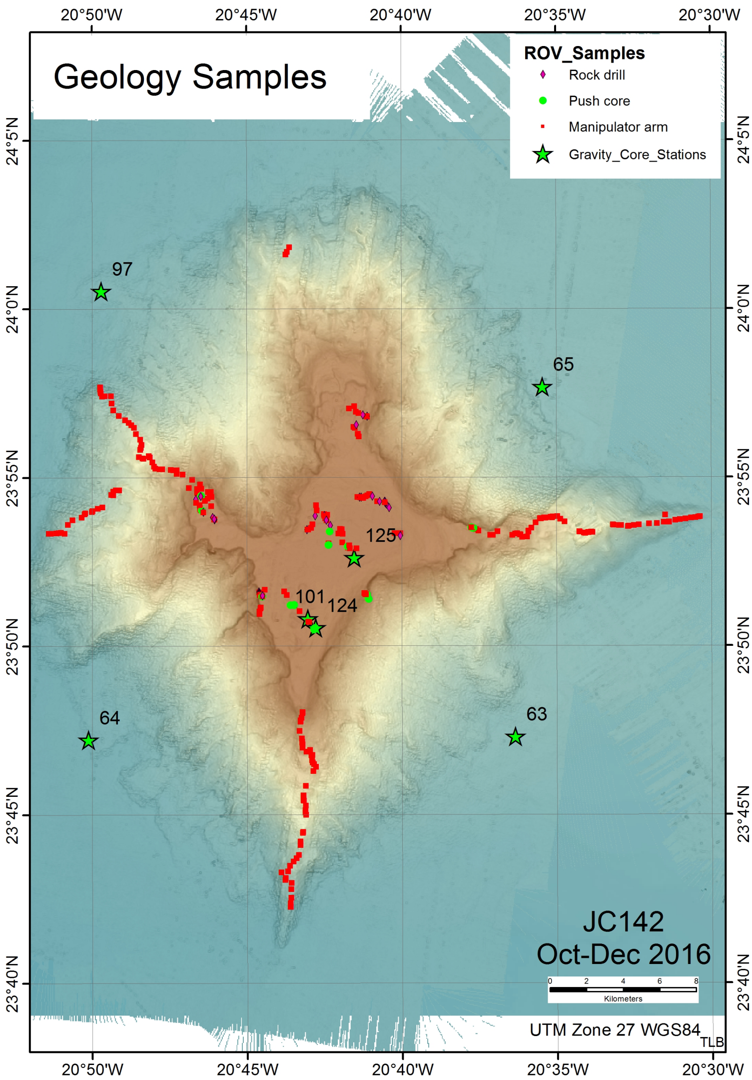


Figure 44 Map to show location of all geology samples, with gravity core samples indicated by green stars.

8.3 DEPLOYMENT METHOD

A 3m long, 70 mm diameter core barrel was used, with a 1 tonne weight attatched to the top. Samples consist of sediment from the core catcher and core tubes a maximum of 1m in length. The gravity corer was lowered to 100 metres above seafloor (m.a.s.f) at which point it is lowered quickly in order to penetrate underlying sediment.

8.4 CORE RECOVERY AND HANDLING

During recovery the core catcher is firstly removed and any sediment within bagged and stored. Core liners are cut into 1m sections, or shorter is less than 1m of sediment is recovered, and the ends capped. The bottom and top ends are indicated through coloured tape (yellow for top, black for bottom) and written on the core barrel as well as an arrow to indicate the way up. The deepest 1m section is labeled A and the subsequent metre-section labeled B if more than 1m is recovered.

These cores are then photographed, described through the core tubes and stored in the controlled temperature lab. Processing, including core splitting and subsampling is to be carried out post-cruise at NOCS, Southampton.

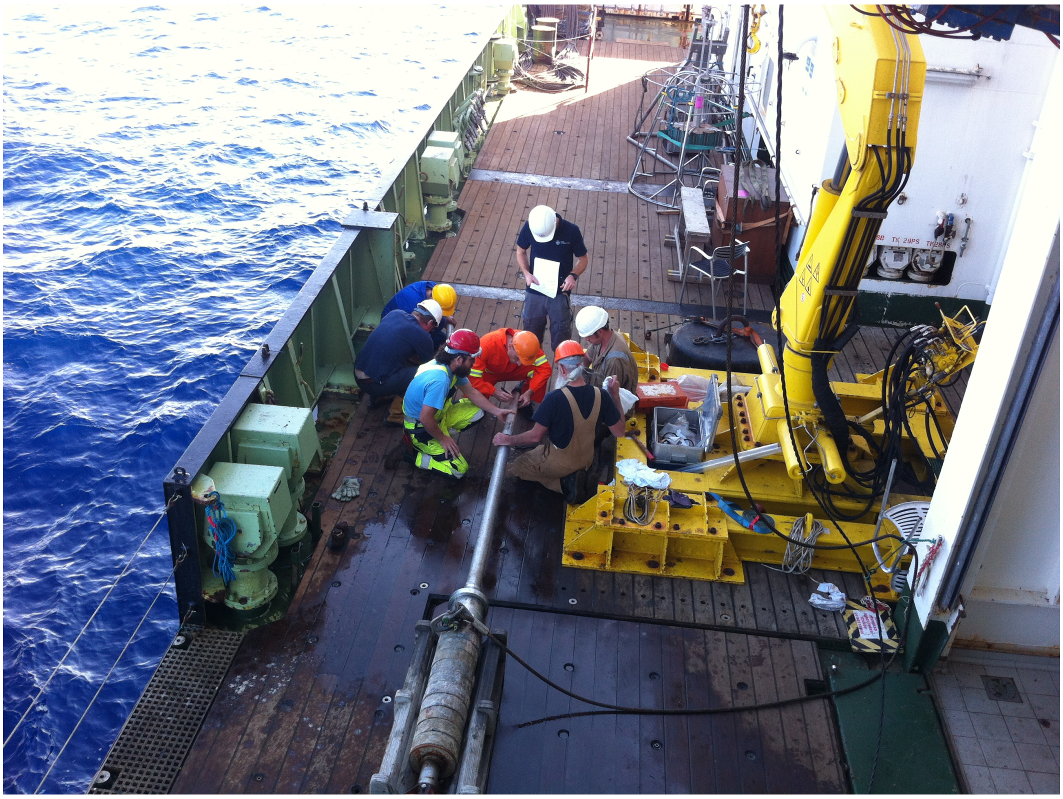


Figure 45 Gravity corer on deck and core being recovered.

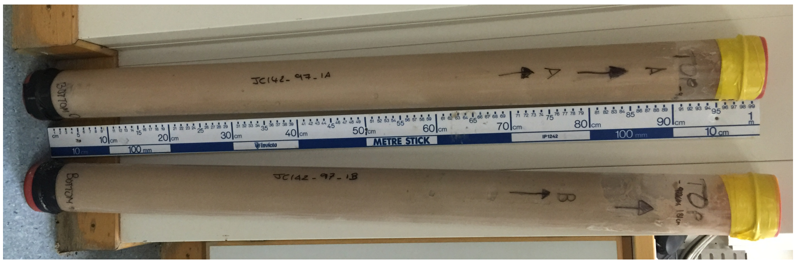


Figure 3 Processed gravity cores (sample JC142_097_001A and JC142_097_001B). Core tubes are labelled with the sample name, a letter indicating relative sections (A is first out of the barrel and deeper and B is the overlying section), the tops and bottoms of each tube and the way up.

8.5 SAMPLES

Lengths of sediment core recovered are given in Table 2. Of the 6 gravity core stations 5 collected sediment and 1 returned no core (Station 125). All of the sediment cores recovered homogenous beige sand and carbonate ooze that lacked internal structures. Further, more in-depth sample description and logging will be carried out on split samples. For sample images see Geological Sample Photographs.

Table 12 Recovery and description of the 6 gravity cores.

Station	Sample ID	Water Depth (m)	Location		Recovery	General Description
			Latitude	**Longitude**		
063	JC142_063_001A	3969	23° 47.321	-20° 36.351	1.00	Uniform sand with carbonate bioclasts.
	JC142_063_001B	3969	23° 47.321	-20° 36.351	0.50	Uniform sand with carbonate bioclasts.
064	JC142_064_001A	4195	23° 47.225	-20° 50.121	1.00	Uniform sand and carbonate ooze.
	JC142_064_001B	4195	23° 47.225	-20° 50.121	0.80	Uniform sand and carbonate ooze.
065	JC142_065_001	3964	23° 57.698	-20° 35.462	0.72	Uniform carbonate ooze.
097	JC142_097_001A	4105	24° 0.403	-20° 49.302	0.91	Uniform sand and carbonate ooze.
	JC142_097_001B	4105	24° 0.403	-20° 49.302	0.90	Uniform sand and carbonate ooze.
124	JC142_124	1023	23° 50.559	-20° 42.784	0.10	Coarse sand and shell fragments.
125	JC142_125	1000	23° 50.559	-20° 42.784	0.00	No recovery.

9 BIOLOGY REPORT

9.1 ROV VIDEO TRANSECTS - SUMMARY OF BIOLOGY SEEN ON *ISIS* ROV DIVES

For the purposes of characterising the biological communities on Tropic Seamount, opportunistic video imagery and photographic stills were generated during Isis ROV dives. The vehicle's altitude above the seabed was aimed to be kept at a constant height of ~ 2-3 m to ensure a consistent field of view. Voucher specimens were collected from the most abundant organisms to confirm future identifications from imagery. Future analyses will aim to combine faunal information with bathymetry, backscatter, sidescan sonar and water-column data gathered during the expedition to enhance our understanding of the environmental drivers which shape the structure of seamount communities. This will provide information on how seabed mining could impact the local biological communities and if impacts could be mitigated by devising management scenarios underpinned by a thorough understanding of the spatial distribution of biodiversity. Below we provided a more detailed description on the summit, eastern and southern spur habitats with the rest to be viewed in more detail at a later date.

9.1.1 SUMMIT (DIVES 297, 298, 301, 302, 304, 308, 309, 310, 316)

As Tropic Seamount is a guyot, a vast amount of the substrate consisted of sandy habitats with the occasional exposed FeMn crust and/or FeMn nodules. The summit was characterised by a sponge community, which is tentatively identified as *Pheronema carpenteri* or a very similar morphotype. This sponge species, which is an OSPAR priority habitat and designated as a vulnerable marine ecosystem, was found sometimes growing atypically on exposed areas of the FeMn crusts. Another consistent feature of the summit were small terraces of ~2 m height. These were often colonised by other sponge species and deep-sea corals and the associated invertebrate species. Similarly, large boulders were often spotted that seemed to have high abundance and diversity in comparison to neighbouring hard substrate habitats.

9.1.2 EASTERN SPUR (DIVES 312, 300 AND 313)

The deepest part of the seamount was mostly barren, until ~ 3300 m depth where extensive sponge gardens of the species *Poliopogon* sp.(?) occurred on complex substrate covered with a FeMn coating. Abundant bamboo coral gardens were also encountered with specimens extending regularly over 1.5 m height. These gardens hosted a variety of associated filter-feeders, such as crinoids and asteroids, which appeared to be predating on the bamboo coral polyps. An asteroid voucher specimen was collected to verify the observation.

At intermediate depths of the eastern spur, we found areas with abundant communities of bamboo corals and sponge gardens, though there appears to be a slight shift in the dominant species illustrating a zonation pattern with depth. At these depth *Chrysogorgia* sp. also became dominant, often covering boulders and/or any slightly vertical surfaces, interspersed with *Metallogorgia* sp.

This spur provided us with one of the most spectacular faunal occurrences seen in the whole seamount. It covered a variety of habitats ranging from slightly sloping substrate to vertical walls and overhangs with biological assemblage zonation being relatively apparent. Deep-sea corals were very abundant and we encountered a large Primnoid coral garden, most likely of comprising of *Candidella* sp. Here, we also noted an octopus from the genus Grimpoteuthis, swimming around the habitat. We also saw a variety of other Primnoids, *Paramuricea* sp., abundant bushy thickets of

Lophelia pertusa and the occasional Antipatharian. High density crinoid fields were also encountered with the dominant species changing along the transect. Initial observations of this spur suggest that this site is one of the most species rich and has high abundance of habitat-forming fauna.

9.1.3 SOUTHERN SPUR (DIVES 319, 320)

The majority of dive 319 encompassed very little biology, however around ~ 3000 m depth some bamboo coral gardens were present with associated fauna. Additonally, the deeper half of this dive encompassed some sponge gardens, apparently of the same species of *Poliopogon* sp. as found on the eastern spur, but not in such high abundance. Dive 320 comprised some vertical habitats with abundant fauna comprising of variety of coral species. *Paragorgia* sp., was also noted during this dive. Regular features of this dive included brisingid assemblages living among Primnoid corals on small outcrops. In the close vicinity of this type of habitat, another octopus was observed, again of the genus Grimpoteuthis.

9.2 SEAWATER SAMPLING AND ANALYSES - PARTICULATE ORGANIC CARBON AND NITROGEN AND LIPIDS FOR BIOMARKER ANALYSIS

Water profiling and sampling were conducted on the RRS James Cook for the purposes of filtrating seawater for on-shore measurements of the concentration of particulate organic carbon and nitrogen and for biomarker analysis of lipids. These data will contribute towards understanding the amount and quality of food supply in Tropic Seamount and how it affects the spatial distribution of benthic fauna. For the distribution of sampling locations around the seamount (see Figure 1). Water samples were collected at regular depth intervals (see Table 1.) by niskin bottles attached to the CTD rosette with CTD profiles obtained during each CTD deployment and throughout the ROV dives. For all analyses 8-12 litres of seawater were filtered through 25mm pre-combusted GF/F filters using a filtering rig with a vacuum pump. The vacuum pump pressure was kept ~20/200 mm hg to maintain cellular integrity and prevent filters from tearing. Forceps were cleaned with ethanol prior to use. The volume of seawater filtered was recorded and samples were immediately frozen at -80°C instead of the conventionally used -20°C due to freezer instability. The institution for future measurements is yet to be determined.

10 MICROBIOLOGY REPORT

(by Mike Zubkov, Greta Giljan (National Oceanography Centre, Southampton; Max Planck Institute for marine microbiology, Bremen)

10.1 ABUNDANCE AND METABOLIC ACTIVITIES OF PLANKTONIC MICROBES IN VICINITY OF TROPIC SEAMOUNT

10.2 THE AIM

To assess abundance, composition and metabolic activities of dominant planktonic microbial groups in vicinity of the Tropic seamount.

10.3 OBJECTIVES

1) To determine bacterioplankton abundance and spatial distribution in vicinity of the Tropic seamount using flow cytometry.
2) To analyse bacterioplankton composition using flow sorting and molecular approaches.
3) To estimate microbial turnover rates of dissolved organic nutrients at ambient concentrations using amino acid isotopic tracers.
4) To field test the deep-sea incubator for determining metabolic activity of bacterioplankton in situ.
5) To isolate manganese oxidisers from manganese-rich crusts collected by the ROV.

10.3.1 BACTERIOPLANKTON ABUNDANCE AND COMPOSITION

Seawater samples for flow cytometric analyses were collected from Niskin bottles of the CTD probe, of the ROV water sampling carousel and of the Deep-sea Incubator at stations and depths listed in the Tables 1-3. Briefly a subsample of 1.6 ml from each bottle sampled was fixed with paraformaldehyde (PFA, final concentration 1%) and stained with SYBR Green I DNA dye. Stained subsamples were analysed using an Analytical Flow Cytometer (FACSort instrument, BD Biosciences). Bacterioplankton populations were visualised using bivariate dotplots of 90^{o} light scatter (cell size index) against green fluorescence (cellular DNA content). A total of 13 CTD profiles (Table 1), 15 sets of water samples from the ROV water sampling carousel (Table 2) and 3 sets of samples from the Deep-Sea Incubator (Table 3) were analysed by flow cytometry.

Cytograms of light scatter vs green fluorescence of DNA stained cells showed that bacterioplankton structure varied little at the sampled depths. Bacterioplankton abundance in the studied waters varied two orders of magnitude from 0.04 million cells mL^{-1} at depth to 5.0 million cells mL^{-1} at the surface.

Table 1. CTD samples from JC142

Date	Station	Lat. [N]	Long. [W]	Sample no.	depth [m]
161031	3	23° 42.930	20° 16.725	CTD001	4100
					4000
					3750
					3500
					3250
					3000
					2750

					2500
					2250
					2000
					1750
					1500
					1250
					1000
					750
					500
					400
					300
					200
					150
					100
					75
					50
					25
161101	8	23° 53.209	20° 41.365	CTD002	987
					950
					900

850

800

700

600

550

500

450

400

350

300

250

200

180

160

140

130

100

80

60

40

					20
161103	17	23° 52.840	20° 43.733	CTD007	1085
					1000
					900
					800
					775
					750
					725
					700
					650
					600
					500
					400
					300
					250
					200
					180
					160
					140
					120

					100	
					60	
					40	
					25	3
161107	33	23° 53.269	20° 41.399	CTD009	991	
					900	
					800	
					700	
					650	2
					600	
					500	
					400	
					300	
					200	
					100	
					50	
					25	3
161108	35	23° 51.375	20° 42.629	CTD010	1006	
					900	
					800	

					750	
					725	
					700	2
					675	
					650	
					600	
					550	
					500	
					450	
					400	
					350	
					300	
					200	
					150	
					125	
					100	
					75	
					50	
					25	
161110	42	23° 56.635	20° 35.125	CTD013	3889	

					2000	
					1250	
161115	59	23° 53. 473	20° 46.732	CTD018	1240	[1,2]
					1100	
					1000	
					800	
					600	
					500	
					400	
					200	
					50	
161118	71	23° 55.671	20° 44.959	CTD027	2394	[1]
					2200	
					2000	
					1800	
					1600	
					1400	
					1200	
					1000	
					900	

161121	82	23° 55.569	20° 48.138	CTD030	2637	[1,2]
					2610	
					2500	
					2400	
					2200	
					2000	
					1800	
					1600	
					1500	
					1400	
					1200	
					1000	
					25	
161126	87	23° 46.050	20° 44.906	CTD31	3215	[1,2]
					3000	
					2800	
					2600	
					2400	
					2200	
					1800	

					1600	
					1500	
					1000	
					25	3
161128	92	23° 53.528	20° 33.354	CTD32	2820	1,2
					2600	
					2500	
					2300	
					2000	
					1800	
					1600	
					1500	
					1400	
					1200	
					1000	
					25	3
161130	99	23° 54.080	20° 48.920	CTD34	3030	1,2
					2800	
					2200	
					1800	

					1400	
					1000	
					800	
					400	
					25	[1,3]
161202	110	23° 49.368	20° 42.614	CTD35	1270	[1,2]
					25	[3]
161202	112	23° 36.500	20° 42.858	CTD36	2062	
					2000	
					1800	
					1600	
					1500	
					1400	
					1200	
					1000	
					900	
					300	
					50	
					25	[1]

Table 2. ROV water sampling carousel samples

Date	Station	Lat. [N]	Long. [W]	Sample no.	depth [m]
161114	55	23° 45.295	20° 43.126	ROV302	2501
		23° 45.575	20° 43. 189	ROV302	2422
		23° 45.866	20° 43.116	ROV302	2382
		23° 46.552	20° 42.881	RVO302	2066
		23° 46.992	20° 42.946	ROV302	1898 [2]
161115	58	23° 54.477	20° 41.107	ROV303	1022
		23° 54.282	20° 40.721	ROV303	1019
		23° 53.902	20° 40.230	ROV303	1006
161116	61	23° 56.239	20° 41.395	ROV304	1136
		23° 56.230	20° 41.554	ROV304	1112
		23° 56.990	20° 41.561	ROV304	1076
		23° 57.125	20° 41.470	ROV304	1087
161117	68	23° 87.741	20° 70.160	ROV305	988
161118	72	23° 50.540	20° 42.806	ROV306	1029 [2]
161120	78	23° 53.271	20° 47.953	ROV307	2400 [2]
161121	80	23° 54.457	20° 46.483	ROV308	1253
		23° 54.038	20° 46.462	ROV308	1209
		23° 54.010	20° 46.433	RVO308	1208
161122	83	23° 54.633	20° 49.117	ROV309	2895

161123	85	23° 53.771	20° 46.056	ROV310	1130
161127	89	23° 54.265	20° 40.521	ROV311	1027
161128	91	23° 53.828	20° 30.370	ROV312	3872
		23° 53.548	20° 33.416	ROV312	2786
161129	94	23° 53.329	20° 36.332	ROV313	1669
		23° 53.515	20° 37.755	ROV313	1318
161201	104	23° 85.359	20° 72.490	ROV316	1015
		23° 85.358	20° 72.670	ROV316	1013
161202	107	23° 55.100	20° 46.943	ROV318	1858
		23° 54.184	20° 46.527	ROV318	1222
161203	109	23° 42.268	20° 43.609	ROV319	3851
		23° 44.509	20° 43.193	ROV319	2912
161204	113	23° 47.088	20° 43.220	ROV320	1780
		23° 48. 115	20° 43.222	ROV320	1170
161205	116	23° 51. 488	20° 44.506	ROV321	1017
161206	119	24° 01.621	20° 43.733	ROV322	3247

Table 3. Deep-Sea Incubator samples

Date	Station	Lat. [N]	Long. [W]	Sample no.	depth [m]
161109	41	23° 53.892	20° 44.080	DI002	1100

					900	
					800	
					750	
					700	
161112	50	23° 54.827	20° 41.399	DI003	1000	1
161206	122	23° 53.322	20° 41.510	DI004	950	

10.3.2 COLLECTION OF MICROBIAL CELL FOR MOLECULAR ANALYSES OF THEIR PHYLOGENETIC COMPOSITION

Seawater samples were collected from CTD bottles (Table 1 & 3, sampled depths labelled with superscript [1]). Live and Lugol-fixed 2-3 L subsamples were concentrated using sterivex filtration units (Millipore). The cell concentrates were flow sorted using the MoFlo flow cytometer (Beckman Coulter). Sorted cells were fast frozen and stored at -80°C for further analyses ashore.

10.3.3 ASSESSMENT OF METABOLIC ACTIVITIES OF DOMINANT PLANKTONIC MICROBES

Seawater subsamples were collected from CTD bottles (Table 1, sampled depths labelled with superscript [2]) and the ROV water sampler to assess ambient concentrations and turnover rates of two amino acids (leucine and/or lysine) by bacterioplankton using isotopic dilution time-series bioassays. On six occasions (Table 1, sampled depths labelled with superscript [3]) surface water samples were collected and bioassayed to compare microbial metabolic rates in surface and deep waters.

10.3.4 DEEP-SEA INCUBATOR TESTS

A Deep-Sea incubator was developed to incubate microorganisms at conditions close to in situ over a user-defined time periods. The incubator comprises 12 modified Niskin bottles, which are paired

Fig. 1. *Deployment of Deep-Sea incubator*

into 6 sets. The paired bottles are connected by a pumping system allowing circulation of sampled water between the bottles. An on-deck operator can introduce nutrients and/or tracers into each set independently. Incubated samples of each set can also be fixed separately. Three technical deployments were carried out. Although malfunctioning of the pressure sensor negatively affected the tests, the incubated samples were collected and concentrated for flow sorting. The flow sorted microbial cells were frozen for further analyses ashore.

10.3.5 ISOLATION OF MANGANESE OXIDISING BACTERIA

Subsamples of water samples collected by the ROV water sampling carousel were plated on two different selective media (J- and M-medium) supplemented with magnesium chloride to isolate manganese oxidisers from deep water above seamounts crust. Additionally, to minimise their microbial contamination rock samples were collected by the ROV into a modified Niskin bottle with false bottom to retain collected stones. Subsamples of rock surface were also plated on the two selective media. The plates were incubated at +4°C for on shore analyses.

10.4 POC WATER SAMPLING STATIONS

date	time	station		Lat °N	Long °W	depth
07/11/16	06:24	33	CTD	23.88778333	-20.69	990
08/11/16	10:12	35	CTD	23.85626667	-20.7105	1004
08/11/16	13:34	36	CTD	23.82401	-20.71865	1055
08/11/16	16:14	37	CTD	23.81115	-20.64838333	3357
14/11/16	12:53	57	CTD	23.89796667	-20.79371667	1953
15/11/16	14:30	59	CTD	23.89955	-20.77886667	1234

11 GEOMICROBIOLOGY REPORT

11.1 AIMS

We sampled nodules, crust and sediments from six different sites in the Tropic seamount to better understand the biogenic controls associated to nodule and crust formation and cycling. The Fe-Mn crusts, nodules and surrounding sediment (push cores) samples were collected by the Remotely Operated Vehicle ISIS (NOC-NERC) during the JC142 cruise (october-december 29–08, 2016) on board RR/V James Cook (NOC-NERC, UK).

Sea bottom water temperature and salinity were 6.8°C and 35.15 PSU, respectively. Fe-Mn crusts and nodules were carefully collected using the ROV manipulator arm while video recording. Samples of sandy sediments were collected approximately 5 m from the Fe-Mn crust and nodule sampling point using push-cores.

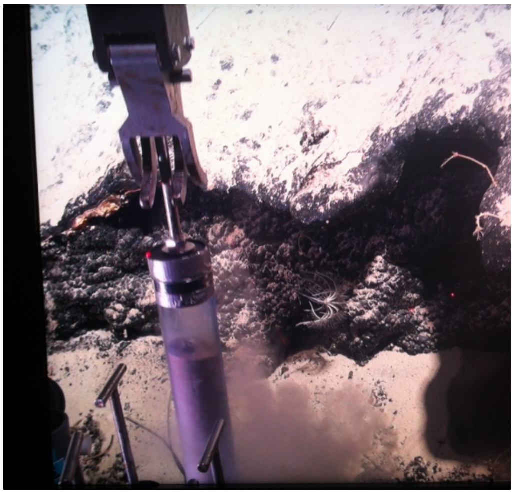


Figure 1. Sediment collected next to Fe-Mn crust using the ROV manipulator arm.

11.2 SAMPLING

Once retrieved on-board, push-cores sub-samples were collected from 0–5 cm and 5-10 cm by using a push-core sampler. The Fe-Mn crusts, nodules and sediment sub-samples were transferred to a DNA/RNA-free plastic bag, added RNA latter and stored at -80 °C until transport to the Oceanographic Institute, University of Sao Paulo (Brazil), for molecular biology analysis.

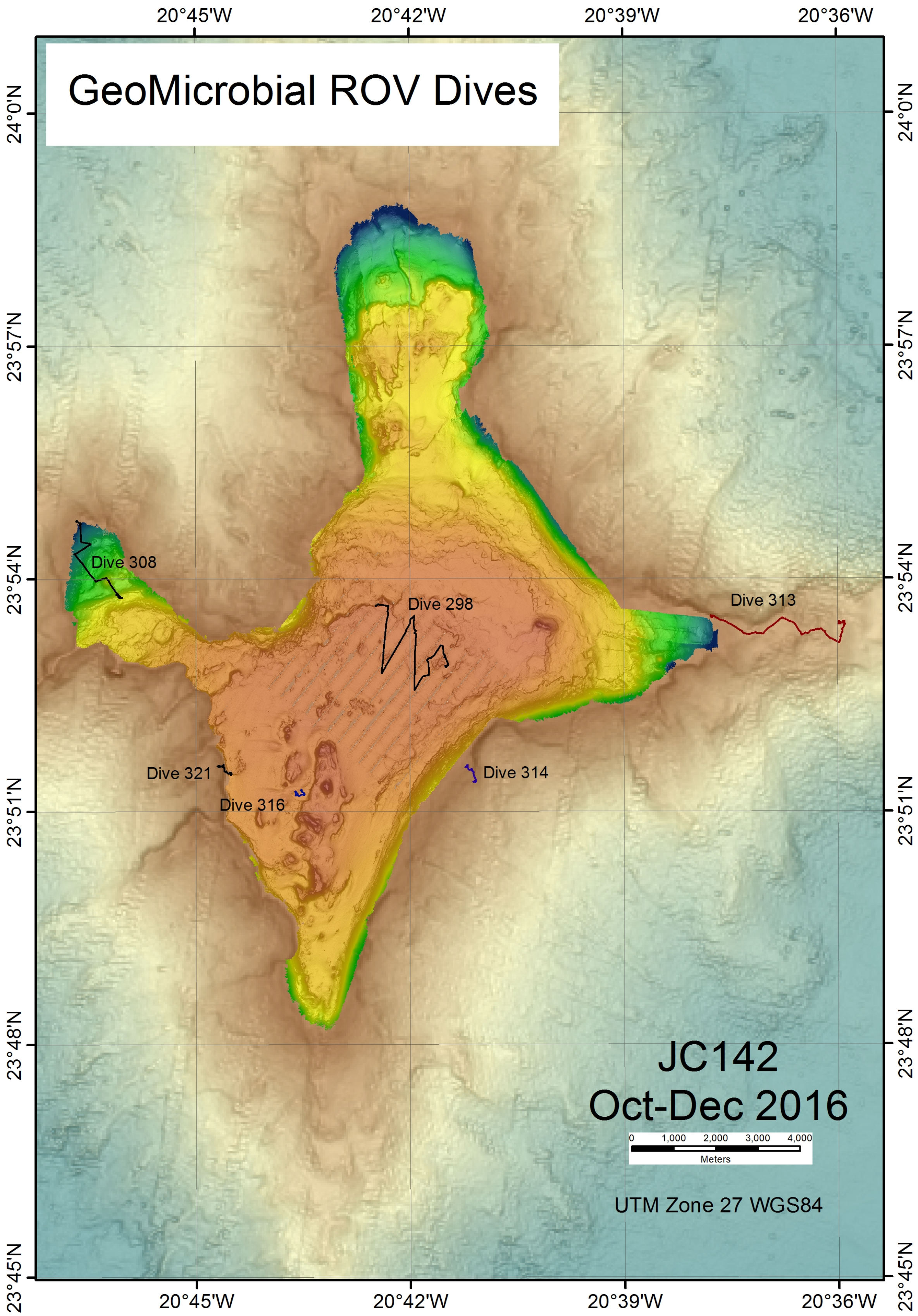


Figure 2: Geomicrobial Dives

12 JC142 SUB-BOTTOM PROFILER (SBP) SURVEY REPORT

12.1 SHIP MOUNTED TOPAS SYSTEM

12.2 ACQUISITION

12.2.1 SYSTEM OVERVIEW

The SBP120 Sub-bottom profiler is a high-resolution seismic system capable of emitting narrow acoustic pulses. This is achieved by using an arrangement of two linear transducers: the projector array - mounted along the vessel keel - that produces a wide footprint acrosstrack and narrow alongtrack, and one hydrophone array (receiver) mounted orthogonal to the keel producing a narrow acrosstrack footprint and wide alongtrack.

The effect of this arrangement is an increasing in directivity that combined with individual hydrophone sampling allows the SBP120 to produce a fan of narrow beams acrosstrack. This multibeam capability is useful for:

Finding specular returns in rough terrain.

Resolving lateral specular returns in rough terrain.

Obtaining information about the sloping angle of sediments.

The beams are electronically compensated for pitch, roll, and heave.

The SBP120 allows the emission of acoustic pulses in three different ways. Figure 1.

12.2.1.1 LINEAR/HYPERBOLIC CHIRP

Chirp pulses are frequency-modulated signals that have a range resolution approximately given by the inverse of the sweep frequency range, which in this case is limited to 2.5 to 6.5 kHz, providing a maximum vertical resolution of 0.3 ms.

12.2.1.2 CW PULSES

CW pulse is a signal consisting of a sinusoidal wave of frequency f_c enclosed by an envelope of duration T and its resolution is given by the pulse length.

12.2.1.3 RICKER PULSE

The Ricker pulse is a short pulse of high bandwidth and as in CW pulses, its resolution is also given by the trace length.

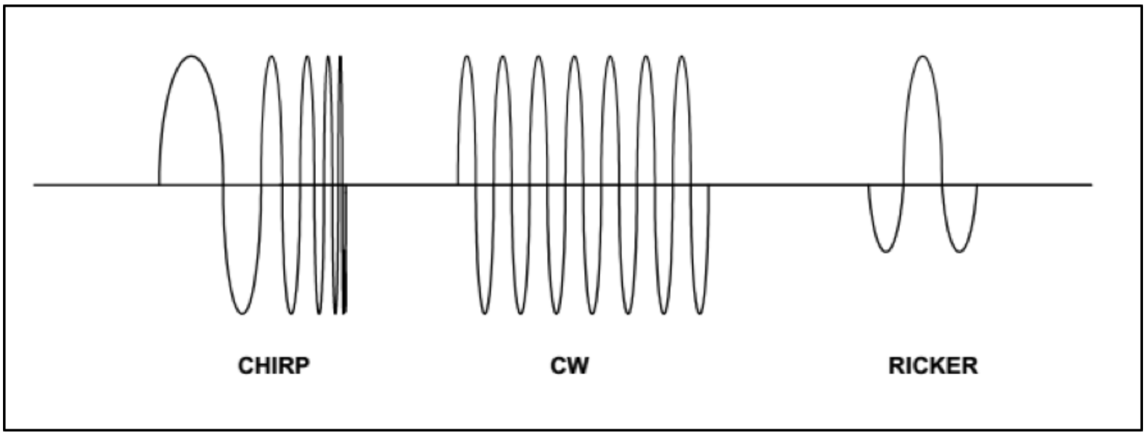


Figure 1. Conceptual signal waveforms generated by SBP 120 in time domain.

The SBP120 consists in the following sub-systems (Figure):

Tx Transducer Array

Tx/Rx Junction Box

Transceiver Unit

Operator Station

Beamformer Unit

Remote Control Unit

Mp

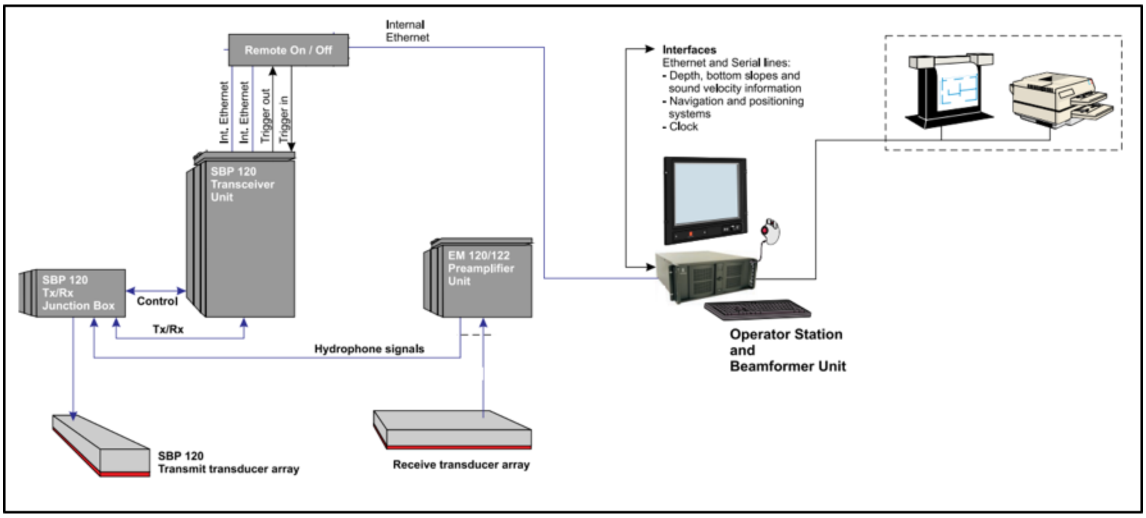


Figure 2. SBP120 System diagram (modified from SBP120 Operator manual).

12.2.2 ACQUISITION PARAMETERS

The default set-up for high resolution seismic data acquisition consisted mainly of chirp pulses ranging from 2.5 to 5.5 kHz and 40 ms long. The trigger was synchronized with the EM120 in order to prevent interferences between both SBP120 and EM120 transceivers, and the priority in the ping rate was given to EM120. Acquisition time delay was automatically calculated from the depth. Main acquisition parameter are summarized in Table 13.

Table 13. SBP120 acquisition setup

Runtime Parameters		Processing	
Transmit mode	Normal (chirp)	Transmission loss	0.7 dB/km
Synchronization	EM trigger		
Acquisition delay	From depth	Filter type	Matched
Pulse form	Linear chirp Up		
Frequency range	2500 – 5500 Hz	Corner frequency	Automatic
Beam width (Tx –Rx)	Normal		
Number of beams	3	Attribute processing	Inst. amplitude
Slope correction	Automatic		
Pulse length	40 ms	Gain	Auto gain
Source power	-10 dB		

All SBP data were stored in both KONSBERG .raw format and SEG-Y .seg.

12.3 PROCESSING AND DATA

For data quality control it was used SonarWiz® 5. This program does not provide useful seismic post-processing tools, thus any usual seismic workflow steps were applied to the data set. Although, it was possible to observe that data acquired over the slopes of the seamount present poor quality, while over the summit and the base data seem to be useful (

Figure).

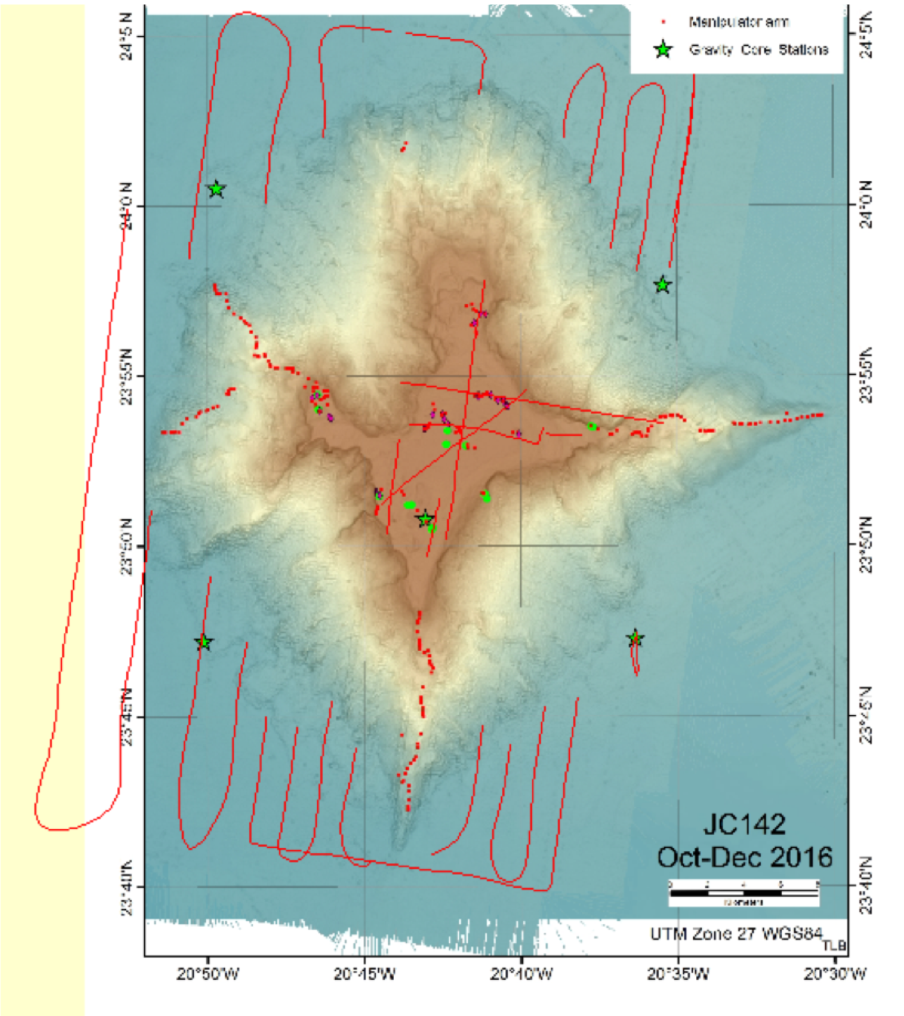


Figure 3. Spatial distribution of seismic acquisition lines with good data quality.

During acquisition it was observed that neither the automatic slope correction, nor the manual couldn't manage to fin find a proper setup in order to detect specular reflection from the rough bottom observed over slopes. Figure 4 shows examples of good and poor data quality.

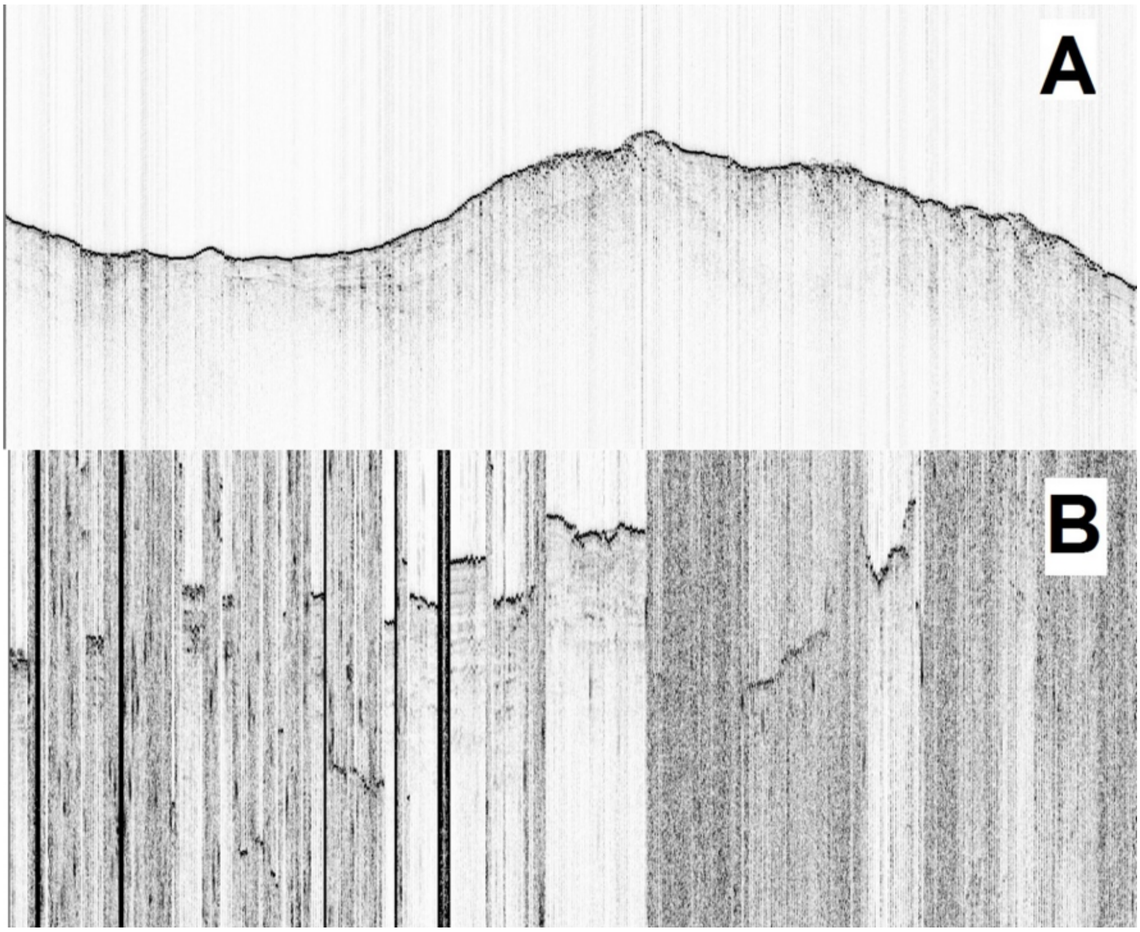


Figure 4: Examples of good and bad data quality

12.4 AUTOSUB MOUNTED EDGETECH 4200-MP SYSTEM

Sub-bottom profiler data were acquired alongside high-resolution 100 and 410 khz sidescan sonar data during all bathymetry dives flown at higher altitudes (120 – 90 m – missions 125, 127, 129, 130, 131, 132, 135, 136, 137 and 141) and during all but one of the photographic missions (4 – 6 m altitude – missions 134, 138, 139 and 140). The chirp pulse was altered depending on the altitude the vehicle was flying at. The same bespoke chirp, 1.5 – 13 kHz 32 ms duration, was used for all the higher altitude dives and two standard 2 – 15 kHz pulses were used for the near bottom photographic surveys. The first, with a pulse length of 20 ms (mission 134) was deemed too long for the near bottom work so a shorter 5 ms pulse was used thereafter (missions 138, 139 and 140). These pulses should provide the optimum trade-off between resolution and penetration.

The bathymetry dives focussed predominantly on the summit of the seamount, meaning extremely good coverage along tracks with a 250 m spacing across the entire summit area. A few patches of higher altitude SBP were also collected on the flanks of the seamount. These surveys showed good correlation between hard and soft grounds and were used, alongside backscatter, sidescan sonar, ROV video observations and measured crustal thicknesses from samples and drill cores to design the near-bottom SBP survey patterns. Surveys were designed to target a range of measured crustal thicknesses and observed contacts between crustal pavements, nodule fields and sediment ponds as well as provide high-resolution “mini-surveys” (15 m spaced lines) forming a roughly NE – SW transect across the summit. The final mission covered areas on the western spur, where the thickest measured crusts of the expedition (up to 14 cm) were found, towards the centre of the seamount where the seafloor was covered entirely by sediment.

Survey planning was restricted by the capabilities of the AUV to slopes of less than 10° and obstacles of below 2 m. This excluded some areas on the summit that were brightly backscattering, however, comparable areas with similar backscattering qualities were surveyed. During mission M138 (Figure X.X) the area around 23°54.3 N 20°40.5 W was surveyed comprehensively. This area was ground truthed by two ROV dives, one normal sampling dive and one focussed on drilling in a small area. These well constrained crustal thicknesses will be used to calibrate the SBP interpretation at a later stage.

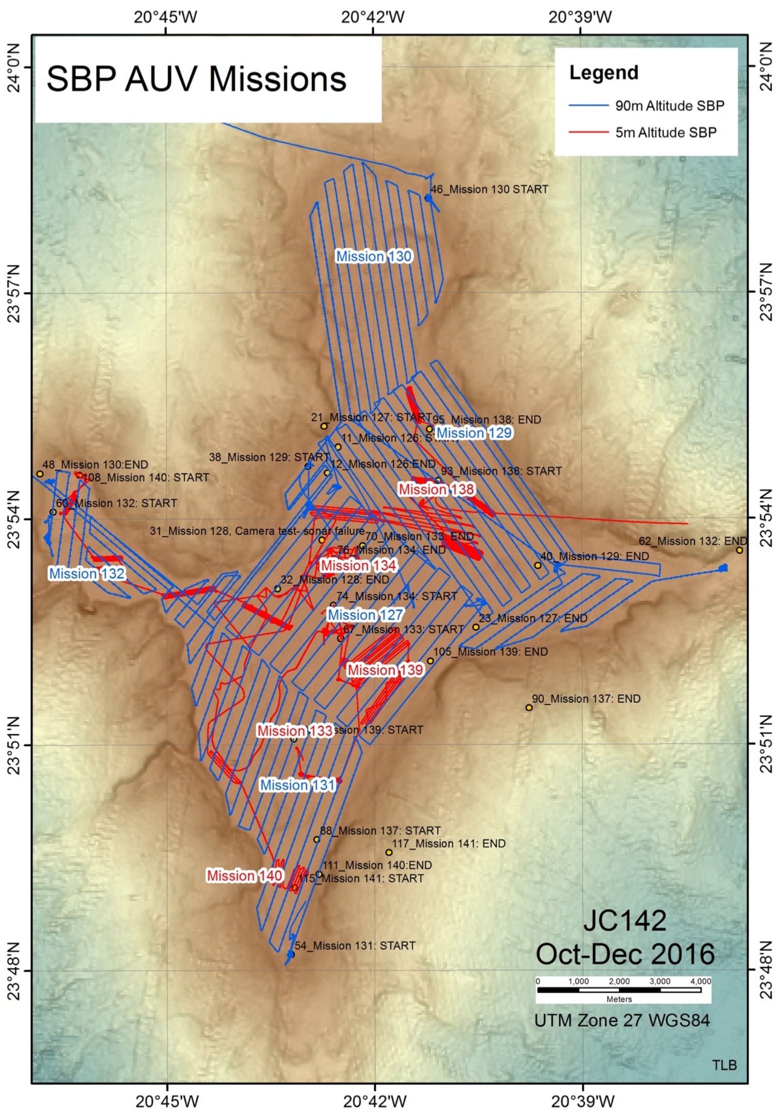


Figure 5: Map showing the lines along which SBP data was collected. Line colour corresponds to the altitude the dives were flown at – blue is 120- 90 m and red is between 4 and 6 m.

12.5 PROCESSING

All information from the Edgetech system is written out into .jsf files containing all the data and broken according to a maximum file size defined by the user – in this case 900 mb. These files do not contain navigation, pitch, roll or yaw information so this must be written into the data before display. This was done using a Matlab script that takes a navigational file containing the vehicle data and writes it into a new .jsf file with "_output" appended to the file name.

These files were then quality checked using Discover SB, a piece of Edegetch software designed for parsing .jsf files and, if required, exporting different formats. Files can be replayed one by one and viewed but no processing is possible. Ideally the data would then have been imported into Sonarwiz so that it could be exported and displayed in Fledermaus. Unfortunately the .jsf files being produced by the Autosub Edgetech record sub-bottom profiler data across more than one channel, meaning it is impossible to display the data or export it correctly. Instead the true reflections were almost invisible in the data display, hidden behind high amplitude, lower frequency noise. Filtering and bottom tracking were impossible and altering the import settings did not improve the data appearance. Discover was also unable to successfully write the data out in a different format. We contacted SonarWiz customer support who responded to inform us that the issues we were experiencing were due to SBP data being recorded in more than one channel, which is unusual for SBP data. As a result no SonarWiz versions were able to successfully read the files, however the new version (after 6.03) will be updated to fix the issues reading .jsf data in this format. Unfortunately, the new version was not available during the cruise so no processing or interpretation was possible. Unprocessed Discover playback files were pulled out and georeferenced for the important areas, however full processing of the Autosub SBP data will be carried out at NOC.

12.6 INITIAL RESULTS AND EXAMPLES

Without further processing, and only an uncorrected replay, it is difficult to draw conclusions based on the SBP data. Both datasets show obvious distinction between hard and soft ground, which correlates with observations from the ROV and photographs, and in many places sediment layers between a few and several metres of sediment can be seen overlying a harder layer, which may be either crust or basement rock. The bottom track of the near bottom surveys is dominated by the vehicle pitch, which will be corrected for in post processing. Differences in the amplitude of the first return probably correspond to differences in seafloor lithology, with stronger returns from crusts than sedimented surfaces. Some thin layering is observable in the near-bottom data, likely corresponding to thin (< 2m) sediment layers overlying crust. Further interpretation will be carried out once the data is processed in an effort to delineate finer structure.

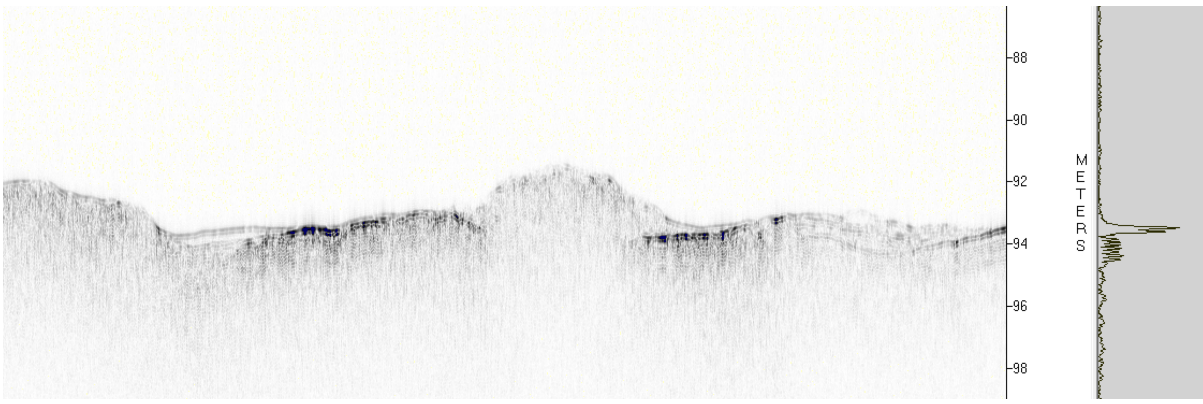


Figure 6 Example line of data from survey flown at 90 m (mission 129) showing varying strengths of seafloor reflection

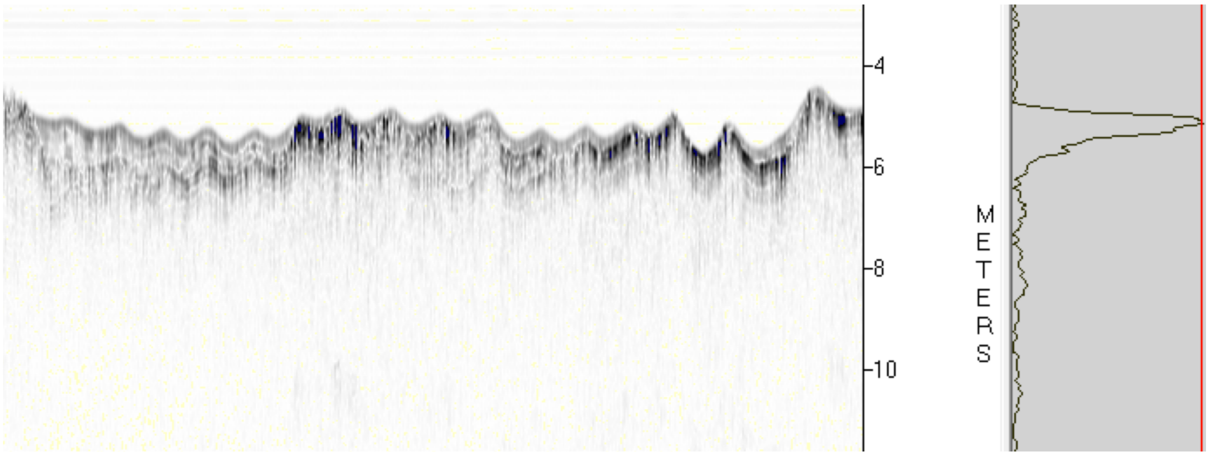


Figure 7 Example line of data from mission flown at 4 m (mission 140) showing variable seafloor character and the strong pitch artefact

13 DATA PROCESSING REPORT

(By Tim LeBas and Isobel Yeo)

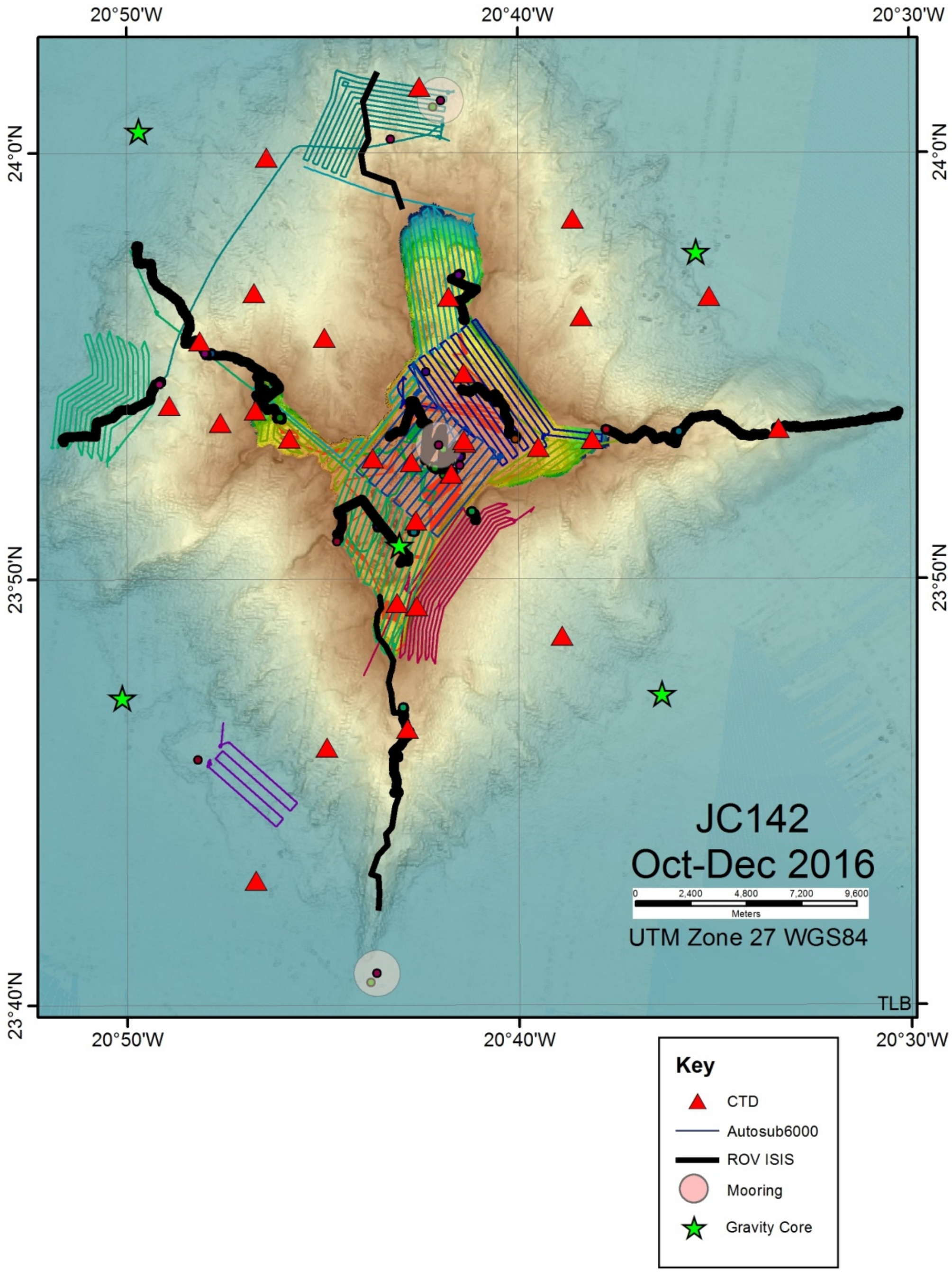


Figure 1: Map showing all stations occupied during JC142.

13.1 EM120 BATHYMETRY

The EM120 multibeam system was switched on during most of the expedition. Over 400 .all files of 2 hour duration were collected. Only a small proportion of data were used for processing as much of the data was collected whilst stationary or during very slow movement of the ship. Data was transferred from the ship network to the processing system. It was processed in CARIS HIPS and SIPS v9.0 using previously defined vessel configuration and calibration values.

Transducer #1:		Transducer #2:	
Pitch Offset:	-3.000	Pitch Offset:	0.000
Roll Offset:	0.000	Roll Offset:	0.000
Azimuth Offset:	0.000	Azimuth Offset:	0.000
DeltaX:	1.832	DeltaX:	0.954
DeltaY:	19.199	DeltaY:	14.092
DeltaZ:	6.944	DeltaZ:	6.926
Manufacturer:	Simrad		
Serial Number:	203		

Tide was added from tropic.tid - predicted values given HR Wallingford personnel . Values varied from -0.5m to 0.5m. Sound Velocity profile data was utilised from all CTD stations and processed using the nearest time and distance model.
Files used were 0001-0011, 0054-0064, 0107-0118, 0128-0147, 0151, 0154-0171, 0284-0290, 0377-0389. Cleaning of the data was done using both the swath and subset editors.
The data were gridded at 50m and 100m resolution, the former only being possible on the seamount plateau (at 1000m depth). Slope maps were created utilising the RSOBIA toolbar (as the Spatial analyst tools failed on the GeoTiff output).

13.2 EM120 BACKSCATTER

The same files that were used in the bathymetry processing were entered into FM Geocoder Toolbox v7.6.3 64 bit Edition Build 262. Certain lines and partial lines were removed dependant on data quality and coverage available. The data were gridded on a 5m grid.

13.3 AUTOSUB 6000 EM2040 BATHYMETRY

The EM2040 multibeam system was used on most missions. It was found that the slant range was about 200m and a maximum angle of 62°. This limits the ground range and thus the line spacing if 100% coverage is required. Theory gives at 200kHz and gaining 200m slant range

altitude	Range from nadir	Suggested line spacing (if flat)
120m	159m	280m
110m	163m	290m
100m	166m	300m
90m	169m	300m
80m	150m	270m
70m	132m	240m
60m	113m	200m
50m	94m	170m
40m	75m	130m
30m	56m	90m
20m	38m	50m
10m	19m	25m

15 missions were successfully completed.

Mission	Sidescan	EM2040	Camera	Altitude	Line Spacing	Range Obtained	Comment
M125	✓	✓		120	450	165	Plain
M127	✓	✓		100	350	156	Seamount Top
M129	✓	✓		90	280	160	Seamount Top
M130	✓	✓		90	280	166	Seamount Top
M131	✓	✓		90	250	170	Seamount Top
M132	✓	✓		90	250	160	Seamount Top
M133		✓	✓	7.5		13	Plume exp
M134	✓		✓	5			Seamount Top
M135	✓	✓		90	220	120 & 80	West flank
M136	✓	✓		90	200	120 & 80	North flank
M137	✓	✓		90	120	100 & 70	East flank
M138	✓		✓	5	15		Seamount Top
M139	✓		✓	5	50		Plume exp
M140	✓		✓	5	50		Seamount Top
M141	✓	✓		90	120	100 & 70	East flank

It was processed in CARIS HIPS and SIPS v9.0 using defined vessel configuration and calibration values:

Pitch Offset:	0.000
Roll Offset:	0.000
Azimuth Offset:	0.000
DeltaX:	0.000
DeltaY:	2.199
DeltaZ:	0.407
Manufacturer:	Simrad EM2040 200kHz 0.5x1_Normal Mode

Tide was added from tropic.tid - predicted values given HR Wallingford personnel . Values varied from -0.5m to 0.5m. No SVP was applied as the process removed the vehicle depth values. The sound velocity values pre-assigned to the Autosub were correct in all missions except M127 and had to be processed and corrected separately in MB system software. Very little cleaning of the data was required as the data appeared to have very little noise. The data were gridded at 5m resolution though reprocessing may show that 2m resolution is possible. Slope maps were then created using the RSOBIA toolbar.

The Autosub6000 navigation can drift slightly during a mission and thus once given a USBL fix to start this provides an anchor point of navigation. At the end of the mission the ship can record the Autosub actual position (by USBL) at a given time and compare this with the Autosub recorded position. This is only possible if the ship is close to the Autosub location i.e. within USBL range.

13.3.1 NAVIGATION DRIFT OF AUTOSUB6000

Mission	Start Date	Science Start Time	AUV Start Location	Science End Time	AUV End Location	USBL data time	USBL End Location	Notes
M125	31/10/2016	10:14	23:46.100,20:47.607	14:27	23:45.543,20:48.144		No data available	
M127	04/11/2016	21:03	23:54.423,20:42.505	13:12	23:52.870,20:40.422	13:13	23:52.848,20:40.506	
M129	08/11/2016	20:43	23:54.141,20:42.952	15:58	23:53.385,20:39.310		No data available	
M130	10/11/2016	22:22	23:58.237,20:41.181	17:07	23:54.504,20:46.725		No data available	
M131	13/11/2016	13:48	23:48.238,20:43.226	08:27	23:56.527,20:49.640		No data available	
M132	15/11/2016	17:24	23:53.694,20:46.695	10:37	23:53.308,20:36.930		No data available	
M133	17/11/2016	16:08	23:52.124,20:42.446	04:47	23:53.504,20:42.269		No data available	
M134	18/11/2016	01:22	23:52.507,20:42.726	06:00	23:53.275,20:42.588	05:57	23:53.367,20:42.604	

M135	20/11/2016	18:34	23:52.783,20:50.502	12:00	23:53.101,20:51.909	12:32	23:53.073,20:52.037	200m from End Location on a bearing of 245 degrees @ 3040m depth
M136	22/11/2016	21:18	24:00.383,20:41.979	15:16	24:01.443,20:41.792	14:17	24:01.886,20:44.023	Not final waypoint, left due to mayday
M137	26/11/2016	16:11	23:49.736,20:42.845	11:20	23:51.327,20:40.108	11:19	23:51.577,20:40.085	
M138	28/11/2016	18:43	23:53.666,20:40.469	15:49	23:55.291,20:41.351	15:52	23:55.320,20:41.299	
M139	30/11/2016	21:15	23:50.604,20:43.063	18:21	23:52.058,20:41.643	18:20	23:52.000,20:41.627	
M140	02/12/2016	16:54	23:54.333,20:46.331	16:30	23:49.369,20:42.990	16:34	23:49.229,20:42.979	
M141	04/12/2016	19:51	23:48.776,20:43.213	11:07	23:49.350,20:41.916		No data available	

13.4 AUTOSUB 6000 EM2040 BACKSCATTER

The same files that were used in the bathymetry processing were entered into FM Geocoder Toolbox v7.6.3 64 bit Edition Build 262. No data was excluded and the data were gridded on a 0.5m grid.

13.5 AUTOSUB 6000 EDGETECH 4200 SIDESCAN - 100KHZ

The Edgetech system records data in .jsf format and occasionally suffers from errors in file writing. A utility called "SalvageCorruptZeroes.exe" was run to repair all the files. Secondly the conversion utility to XTF format (JSF2XTF.exe) also failed on these data. The data was replayed using the "Discover 4200 MP 2.03.exe" program. Video gains were set to 10dB + 3dB per 100m. This requires the operator to play every datafile individually and record the replayed data. A separate navigation file is also available as no navigation was held in the .jsf files. If navigation was held in the files they could be processed more easily in the "SonarWiz" software.

The XTF files were read into the PRISM software and converted into .cdf format. The Autosub 6000 was travelling at 1.2m/s and pinging at 2Hz the along track ping spacing was 0.575m. Across track resolution is initially 0.0345m. The data were subsampled across-track by a factor of 4 and limited to 5000 pixels (345m range each side at 0.138m resolution). No altitude value is stored in the .jsf and this is therefore calculated from the first break in the imagery. The PRISM command "do_alt_index" was used with threshold grey of 25 and using "rocky" or "extreme" terrain. The survey area was divided into overlapping map areas (tiles) and processed in PRISM at 0.5m resolution. The processing commands configuration was:

```
mrgnav_inertia -i %1 -o %0 -u 0 -r 0.0,0.0 -n navfile.veh_nav

tobslr -i %1 -o %0 -r0.1382 , res #  100 kHz

edge16 -i %1 -o %0 -m

shade_tobi -i %1 -o %0 -n 1000

filter -i %1 -o %0 -b 1,351 -h -v 1,5000

filter -i %2 -o %0 -b 21,351 -l -v 1,5000

wtcombo -i %2 , %1 -o %0 -c 1,1

restorehdr_tobi -i %1 -h %5

lowpass2b2 -i %2 -o %0

restorehdr_tobi -i %1 -h %3
```

```
mrgheading -i %2 -o %0 -n navfile.nav -t -f
blankfar -i %1 -o %0
```

This configuration adds in the navigation from the Autosub 6000, slant range corrects the imagery (using the flat bottom assumption), and equalises the illumination using the average pixel value per range per segment of data. Some high and low pass filters are applied to remove speckle and dropout pings. Autosub heading is also merged with each ping to allow correct mosaicing . Processing edge effects at far range often cause issues on the final mosaic and so a blanking function of a small percentage of the far range imagery is applied to remove such data. As the survey was designed for 100% coverage of multibeam bathymetry the overlap of sidescan imagery is considerably more and this removal of far range data is irrelevant. When the survey was over the flanks of the seamount the up-slope imagery was much better than the down-slope imagery and so an additional line was added to the configuration (the s value dependant on the azimuth of the slope):

```
lookdirec -i %1 -o %0 -s -45
```

Again data coverage was considerably better than the multibeam data and 100% coverage was obtained using just one side of the sidescan - generally up-slope was of better quality than down-slope.

13.6 AUTOSUB 6000 EDGETECH 4200 SIDESCAN - 400KHZ

Processing of the high resolution sidescan was very similar to the low frequency sidescan. Video gains of 29dB and 3dB per 100m were used. The data was subsampled by a factor of 2 and range limited to 86m (7500 pixels at 0.023m resolution). The PRISM command "do_alt_index" was used with threshold grey of 50 and rocky or extreme terrain. The PRISM configuration was:

```
mrgnav_inertia -i %1 -o %0 -u 0 -r 0.0,0.0 -n navfile.veh_nav
tobslr -i %1 -o %0 -r0.023 , res #  400 kHz
edge16 -i %1 -o %0 -m
shade_tobi -i %1 -o %0 -n 1000
filter -i %1 -o %0 -b 1,351 -h -v 1,5000
filter -i %2 -o %0 -b 21,351 -l -v 1,5000
wtcombo -i %2 , %1 -o %0 -c 1,1
```

```
restorehdr_tobi -i %1 -h %5
lowpass2b2 -i %2 -o %0
restorehdr_tobi -i %1 -h %3
mrgheading -i %2 -o %0 -n navfile.nav -t -f
blankfar -i %1 -o %0
# lookdirec -i %1 -o %0 -s 15
```

This configuration adds in the navigation from the Autosub 6000, slant range corrects the imagery (using the flat bottom assumption), and equalises the illumination using the average pixel value per range per segment of data. Some high and low pass filters are applied to remove speckle and dropout pings. Autosub heading is also merged with each ping to allow correct mosaicing . Processing edge effects at far range often cause issues on the final mosaic and so a blanking function of a small percentage of the far range imagery is applied to remove such data. Many of the high resolution sidescan surveys were designed for camera runs and the line spacing was much less than the range of the sidescan and this allowed the creation of single look direction mosaics or processing using the option of nadir removal, using data from other tracks to fill in the area of nadir which was often of poor quality. Some high frequency sidescan mosaics were processed at 0.2m but had many along track gaps as the ping spacing was 0.6m and so were reprocessed at 0.5m resolution.

13.7 AUTOSUB 6000 EDGETECH SUB BOTTOM PROFILER

13.8 SBP120 - TOPAS SUB BOTTOM PROFILER

13.8.1 CONTOURS

Contours for the EM120 Multibeam were created at 50m intervals. The contour tool does not work with GeoTiffs, being the output from CARIS, and consequently the bathymetry grid had to be exported to Imagine images for the tool to operate. The EM2040 bathymetry were treated similarly and contoured at 5m intervals

13.9 PLANNING

- AUV Mission plans - bathymetry

  Planning for AUV Missions was done within the ArcMap GIS system. Initially lines were drawn using the Draw function and then converted into a feature shapefile. The survey lines were then inspected for line length and bathymetric variation, taking into account the flying height was usually 90m. Each mission was planned for 24 hours being the battery life Ground speed for Autosub 6000 is 1.15m/s equivalent to 4.14km/hour. Survey length then depends the water depths at the beginning and end of the mission (at 30 minutes per 1000m descent or ascent), 45 minutes for magnetometer calibration and 15 minutes for mission navigation start, giving:

  survey length (km) = (24 - (start depth/2000) - (end depth/2000) - 0.75 - 0.25) * 4.14

  This was used as an approximation as turns at the end of lines will incur a time delay (about 1 minute extra per turn). Once the survey line was completed and checked the line was converted into a series of waypoints using the new tool "Create Geographic points from line" in the newly created JC142_tools toolbox and the datapoints plus a location map transferred to the AUV system

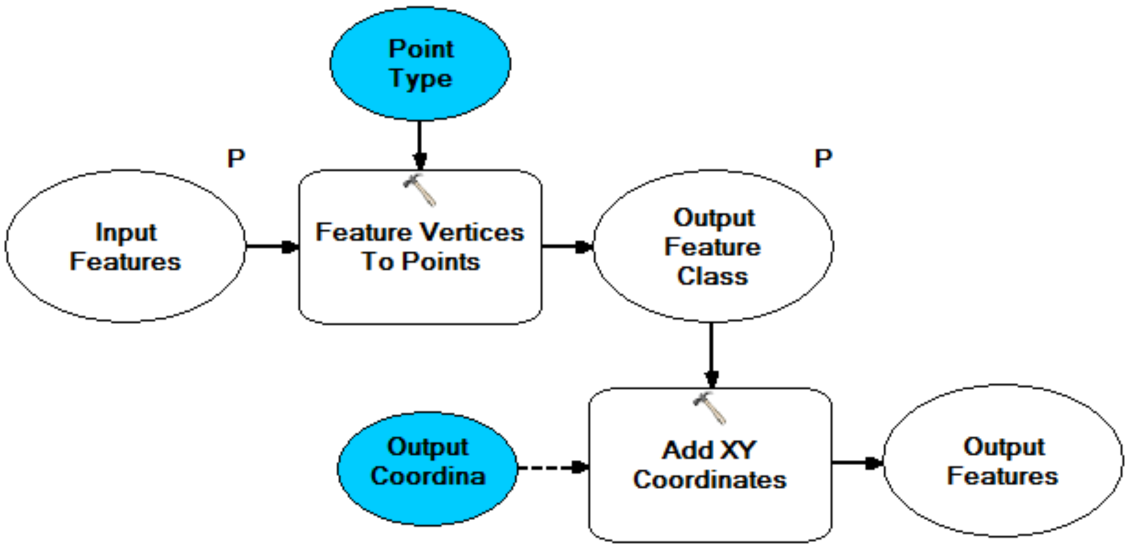


Figure 2: "Create Geographic points from line" modelbuilder tool - converting a feature line into geographic points

13.9.1 AUV MISSION PLANS - CAMERA

Camera missions had to planned with considerably more precision than bathymetry as the Autosub was flying at an altitude of 4m off the bottom. Slope maps and contours from previous Autosub missions were utilised for checking terrain suitability. Slopes of more than 1 in 6 were avoided.

13.9.2 ROV DIVES

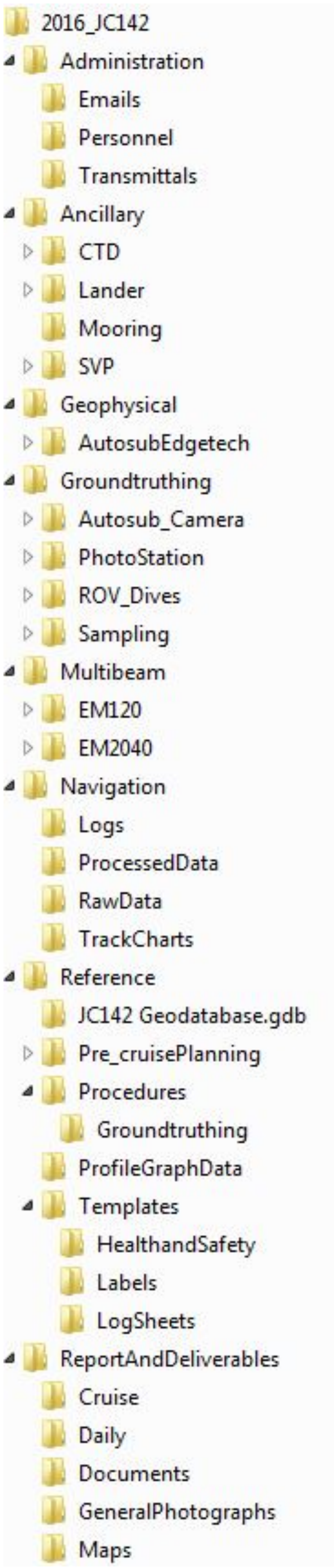
The planning lines for ROV Dives was done using the bathymetry, backscatter and sidescan mosaics. Feature lines were created and then maps exported for the OFOP and DVL systems on the ROV computer system. For the OFOP maps a printable map was created in layout view with an appropriate grid spacing. The map is exported as a .jpg at 300dpi. Projections used were UTM and Mercator, the former preferred as much of the data was created with UTM Zone 27. The DVL map was more complex. Projection needed to set to Geographic coordinates and a map was exported in mapview (NOT layout view). The export function then gave the option to output both a .jpg and an associated world file (.jgw). The export resolution was also reduced to 100dpi as the DVL system seems not to be able to handle jpg files of greater than 1Mb. In association with the jpg an Excel spreadsheet was included that calculates the four corners of the image in geographic coordinates. Input are from the jgw file and the jpg image size.

	world file parameters		pixel coordinates		map coordinates in decimal degrees		map coordinates in lat/long			
A	5.51742E-05		x	y	X	Y	deg N	min N	deg W	min W
D	0	UL	0	0	-20.75776414	23.83054487	23	49.8327	20	45.46585
B	0	UR	1397	0	-20.68068579	23.83054487	23	49.8327	20	40.84115
E	-5.51834E-05	LL	0	1077	-20.75776414	23.77111235	23	46.2667	20	45.46585
C	-20.75776414	LR	1397	1077	-20.68068579	23.77111235	23	46.2667	20	40.84115
F	23.83054487									
	jpg parameters									
rows	1077	height								
columns	1397	width								

Figure 3: Excel spreadsheet Divxxx_nav.xls for the DVL navigation system on the ROV. The jgw variables are inserted in to the pink area and the jpg image size into the lilac. The values in the yellow area are used by the ROV DVL system.

13.10 DATA MANAGEMENT

Over 3Tb of data has been generated and put into the standard Marine Geoscience data structure.



The files are divided into categories of type and then into raw and processed data and data products. The six main data categories are: Ancillary, Groundtruthing, Geophysical, Multibeam, Navigation and Reference. These are mirrored in the GIS Map structure though many of the files stored there are not displayed directly in the GIS.

The data structure was periodically (every two days) backed up onto the RAID 6 QNAP using the SyncBack v3.2.19.0 . Files were copied from the source directory 2016_JC142 to the destination directory of the same name but on the QNAP server. All the sub-directories and their files in the source were copied if new or if modified. If modified the source file replaced the destination directory. If a file is only in the destination then no change is made in the source.

A second backup was then made from the QNAP server to a portable external USB drive, though excluding all the AUV camera photos, as the external USB only holds 2.72Tb and the QNAP server backup was over 3.5Tb. The AUV camera photos are also held on 2.5" disk drives (as supplied by the AUV).

Figure 4: Cruise data structure

Autosub 6000:	EM2040 Raw Data Files	Camera photographs	Edgetech 4200 sidescan files
	.all	.raw	.jsf
M125	17	0	25
M127	66	0	74
M129	76	0	88
M130	62	0	59
M131	67	0	79
M132	67	0	77
M133	52	73186	0
M134	0	24138	10
M135	67	0	72
M136	3	0	73
M137	13	0	79
M138	0	86304	45
M139	0	84529	43
M140	0	93487	48
M141	62	0	0

Other files include: Planned Navigation, Recorded Navigation, Photo number and navigation point and sensor data (CTD, etc)

ROV Dives	OFOP log (lines)	Description	Station Number
297	387	Top and south flank	9
298	990	Top before Mooring B	20
299	-	plume exp1	25
300	1707	East ridge middle	39
301	699	Top (north west central)	47
302	936	South Ridge middle	55

303	982	Top (north spur)	58
304	618	Top (north)	61
305	-	plume exp2	68
306	-	plume exp2	72
307	1513	West North West ridge lower	78
308	1092	West ridge top	80
309	1493	West ridge lower	83
310	8	West Top Drilling	85
311	13	Central North Top Drilling	89
312	1116	East ridge lower	91
313	1330	East ridge upper	94
314	383	East flank	100
315	-	plume exp3	103
316	30	Natasha's push cores	104
317	-	aborted	106
318	1846	West ridge upper	107
319	1069	South Ridge lower	109
320	965	South Ridge upper	113
321	11	West Top Drilling	116
322	177	North Ridge	119

Other data collected on the ROV were recorded in Excel spreadsheets such as: Planned Navigation, Recorded Navigation, OFOP log, and sample log and navigation point and sensor data (CTD, etc). A highlight video compilation was created for each dive.

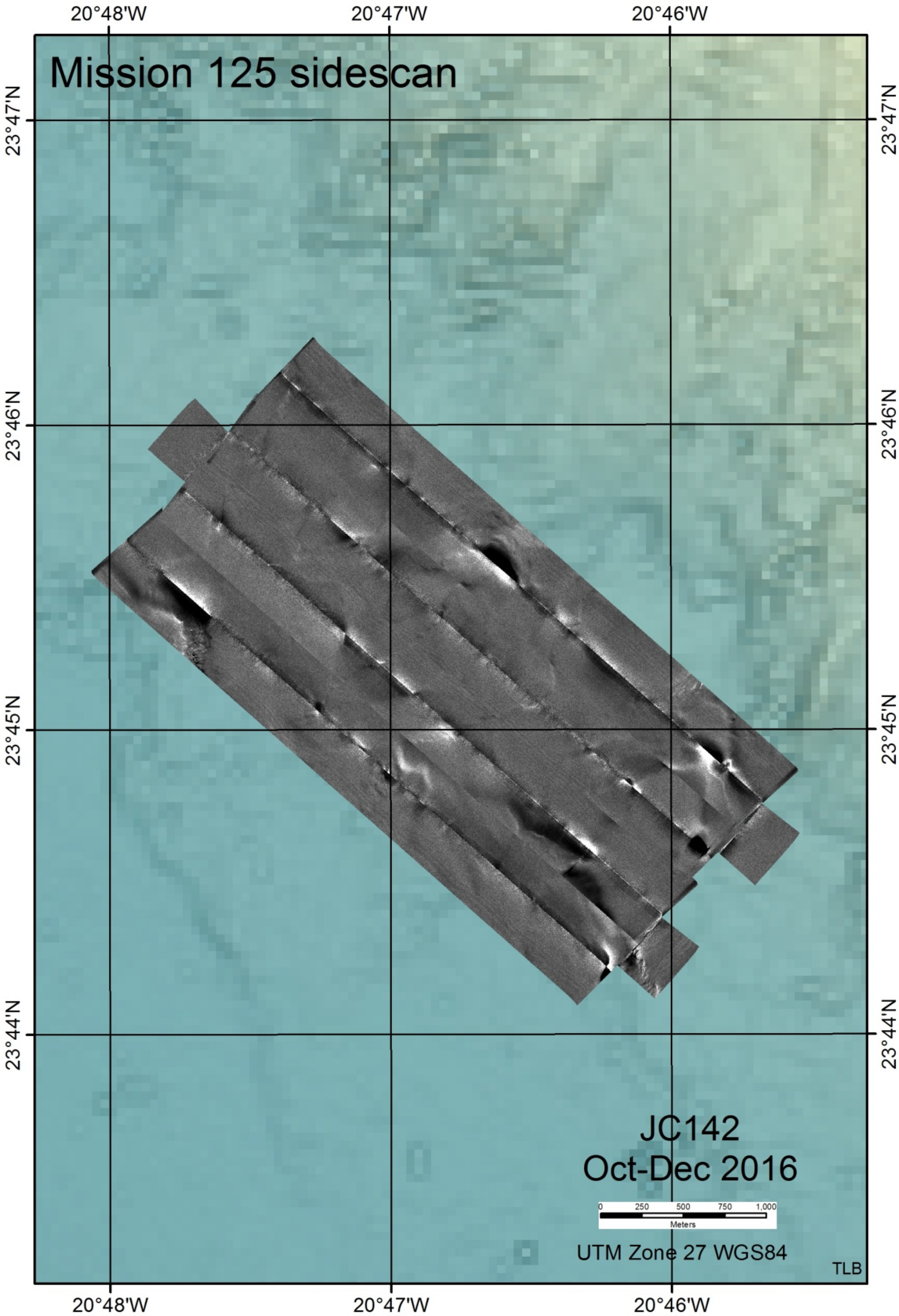
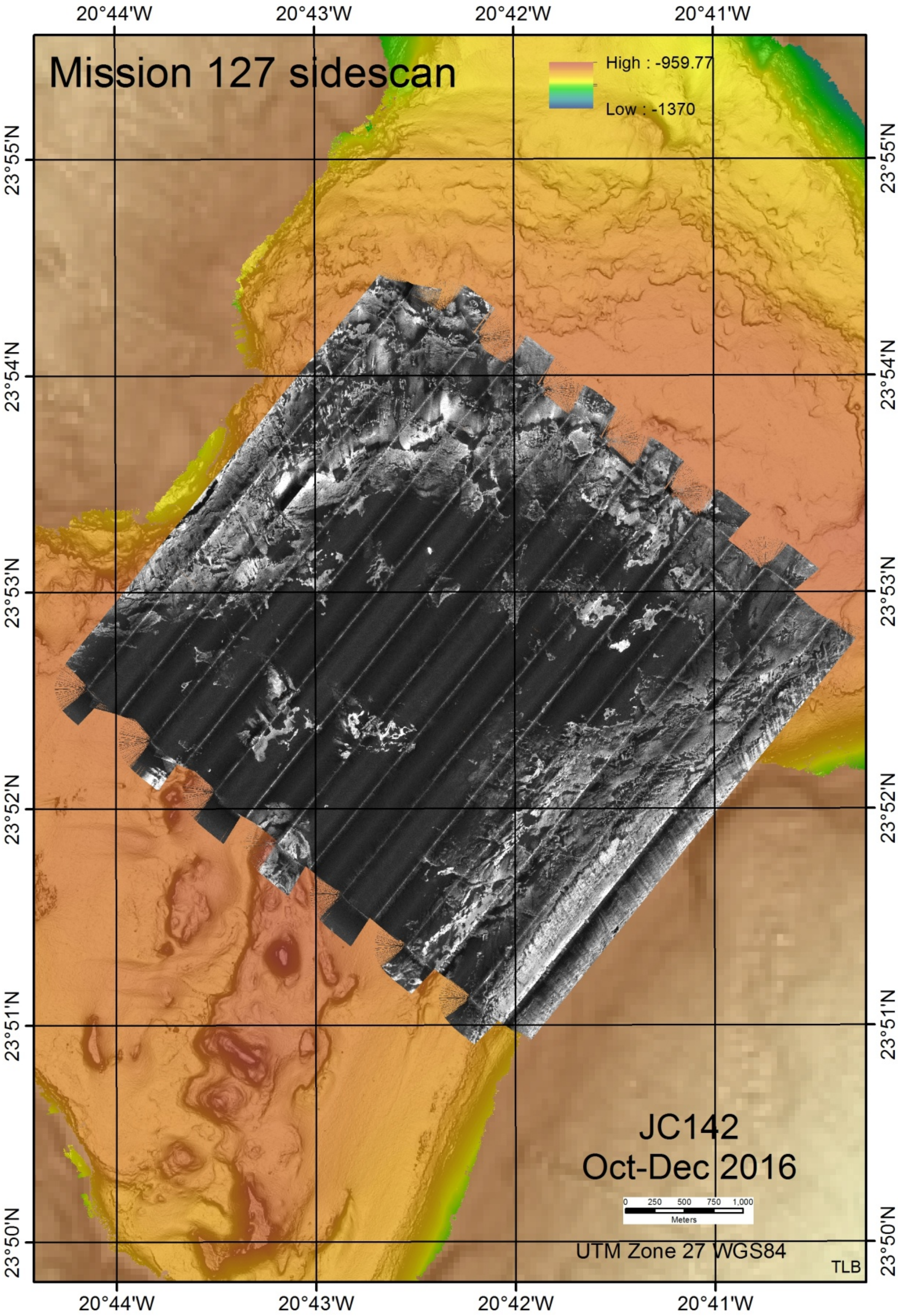


Figure 5: example of AUV sidescan sonar imagery.


Mission 127 sidescan
High : -959.77
Low : -1370
20°44'W
20°43'W
20°42'W
20°41'W
23°55'N
23°54'N
23°53'N
23°52'N
23°51'N
23°50'N
JC142
Oct-Dec 2016
0 250 500 750 1,000
Meters
UTM Zone 27 WGS84
TLB

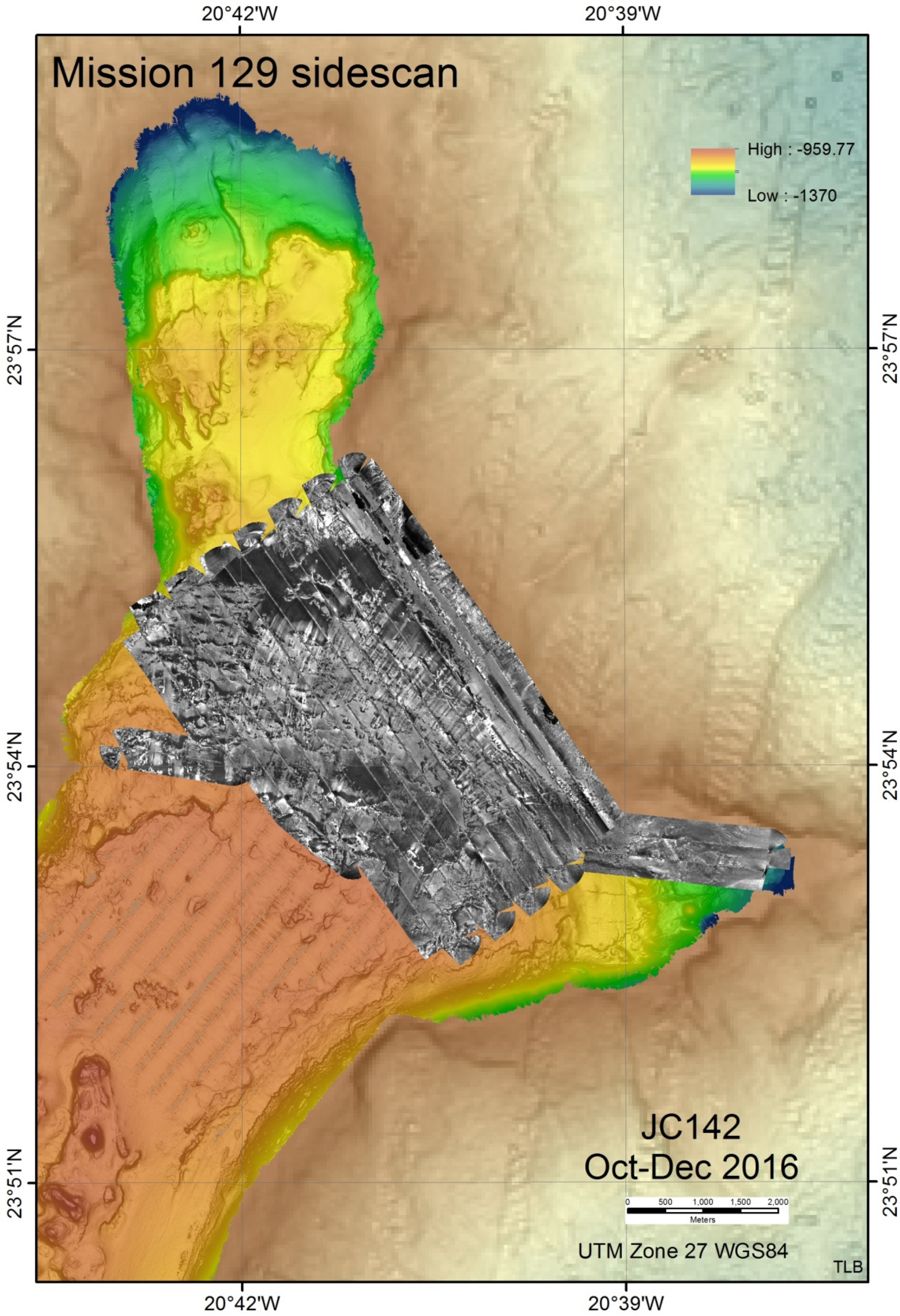
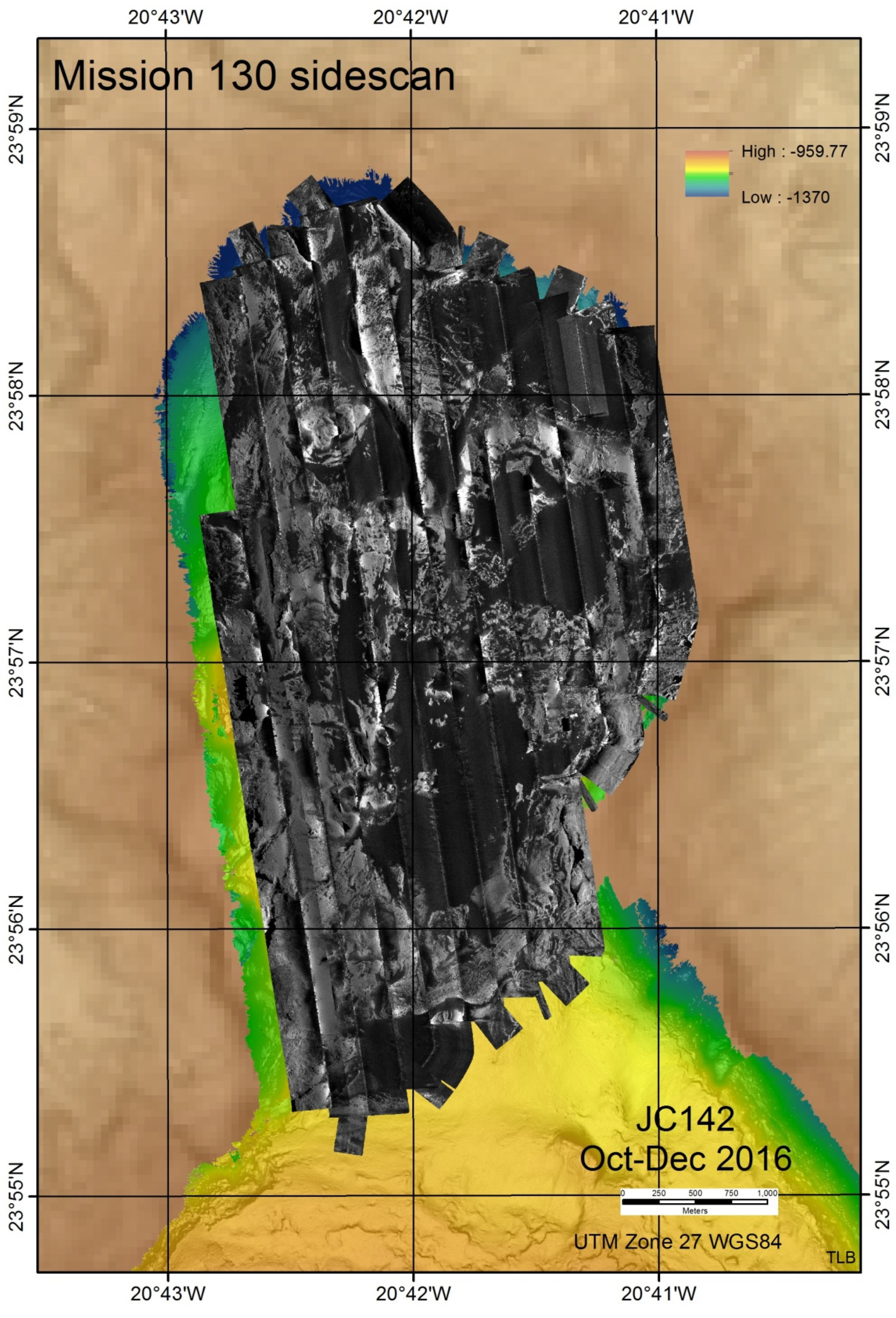


Figure 5: example of AUV sidescan sonar imagery


Mission 130 sidescan
20°43'W
20°42'W
20°41'W
23°59'N
23°58'N
23°57'N
23°56'N
23°55'N
High : -959.77
Low : -1370
JC142
Oct-Dec 2016
0 250 500 750 1,000
Meters
UTM Zone 27 WGS84
TLB

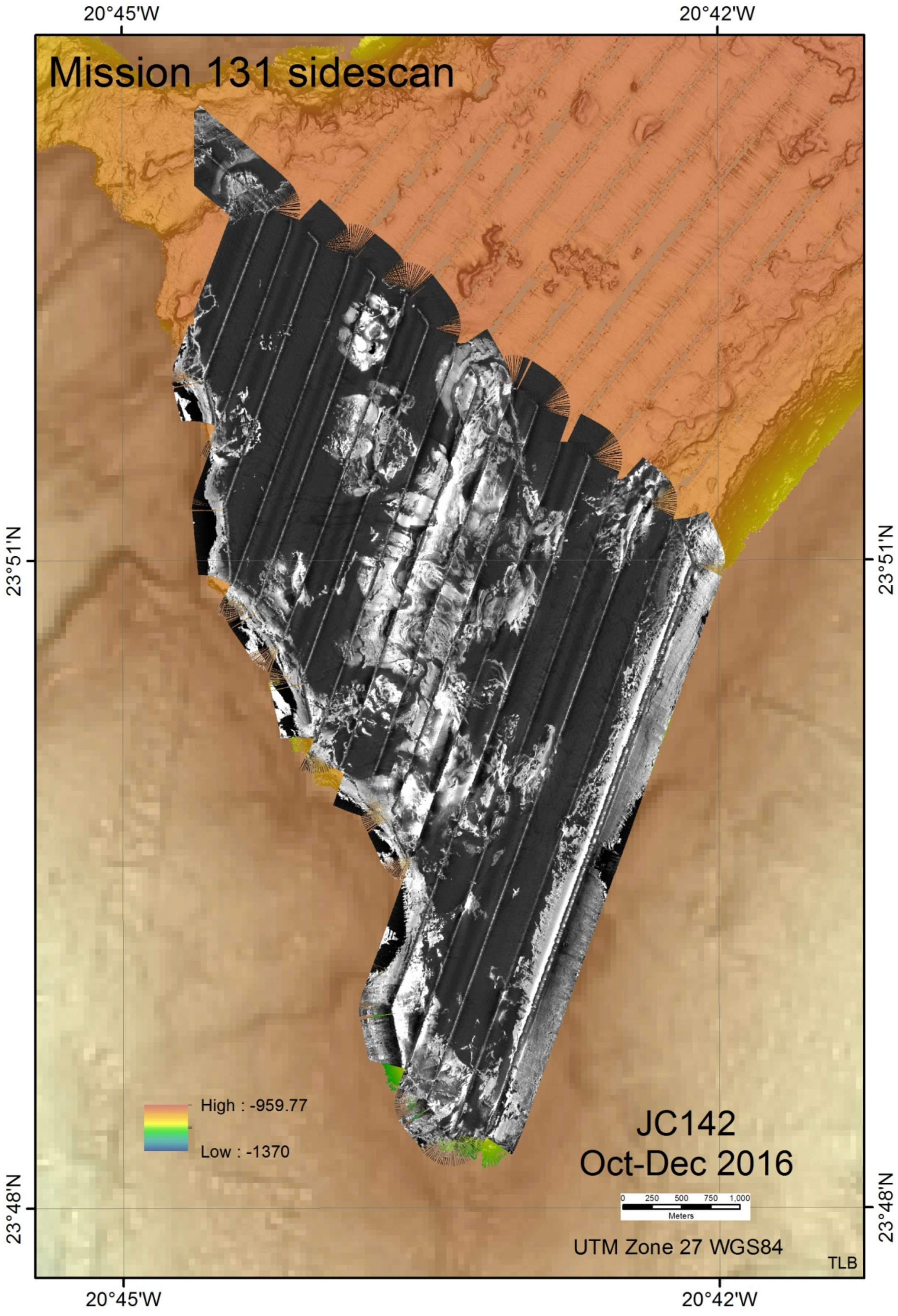


Figure 6: example of AUV sidescan sonar imagery

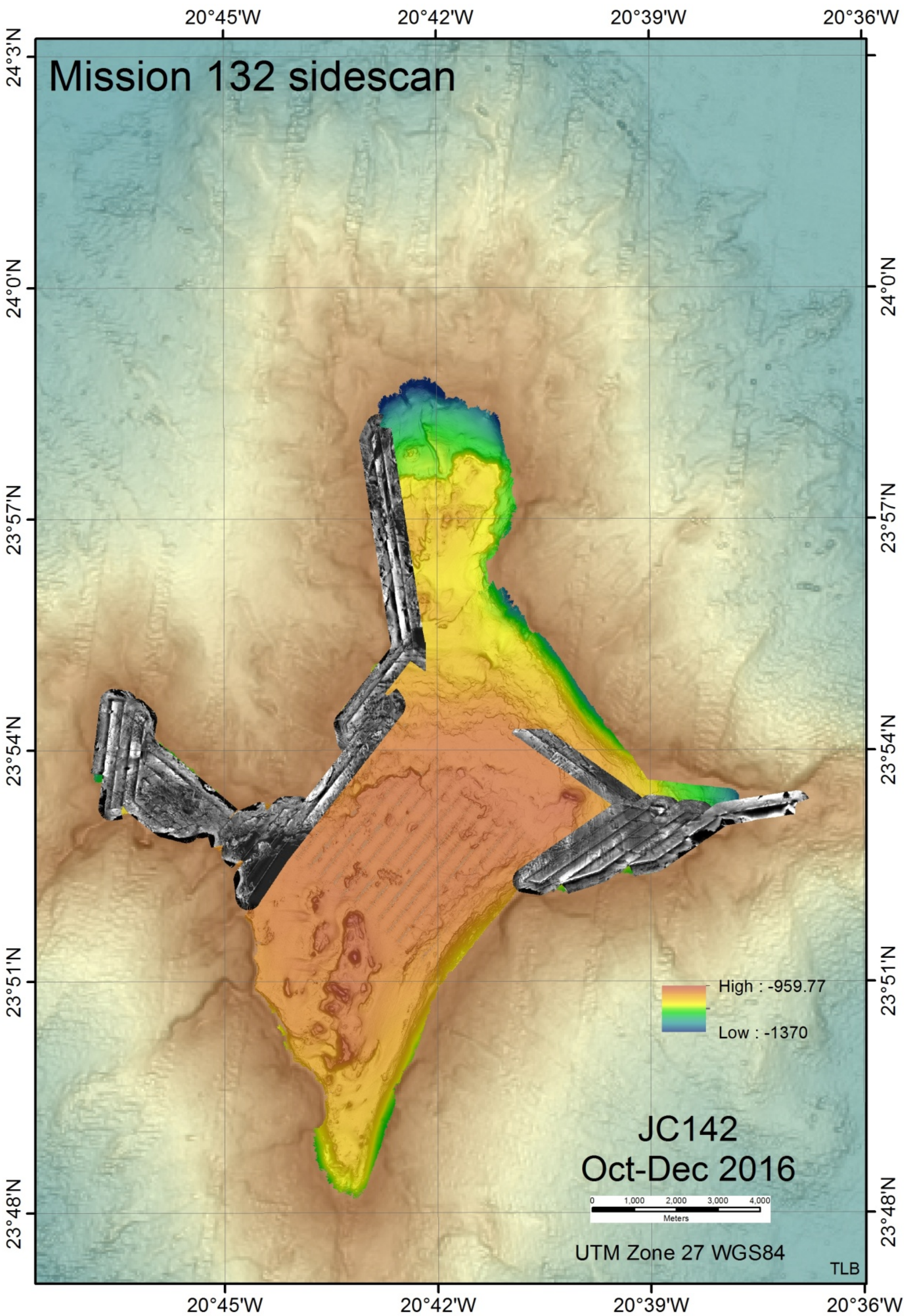


Figure 7: example of AUV sidescan sonar imagery

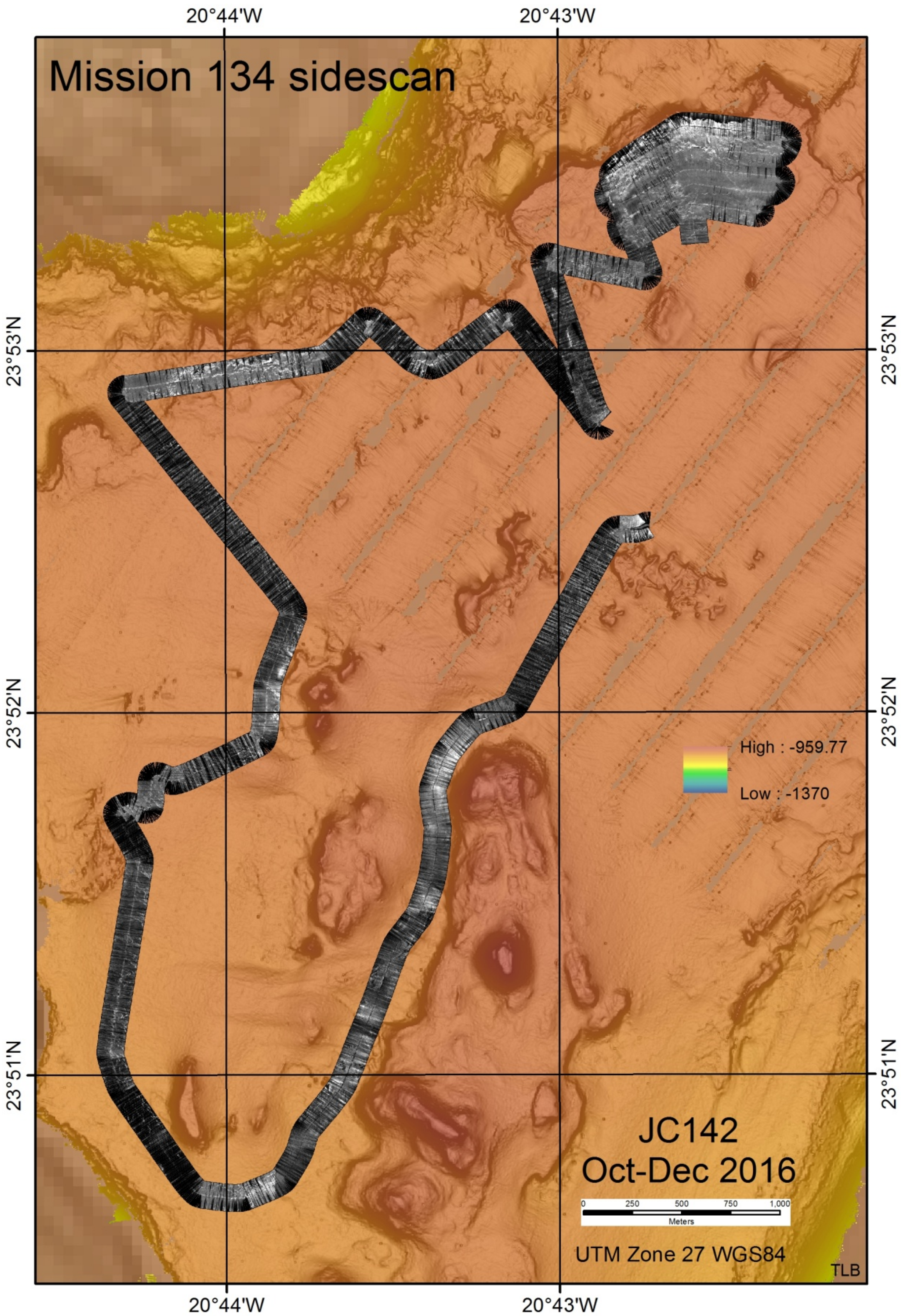


Figure 8: example of AUV sidescan sonar imagery

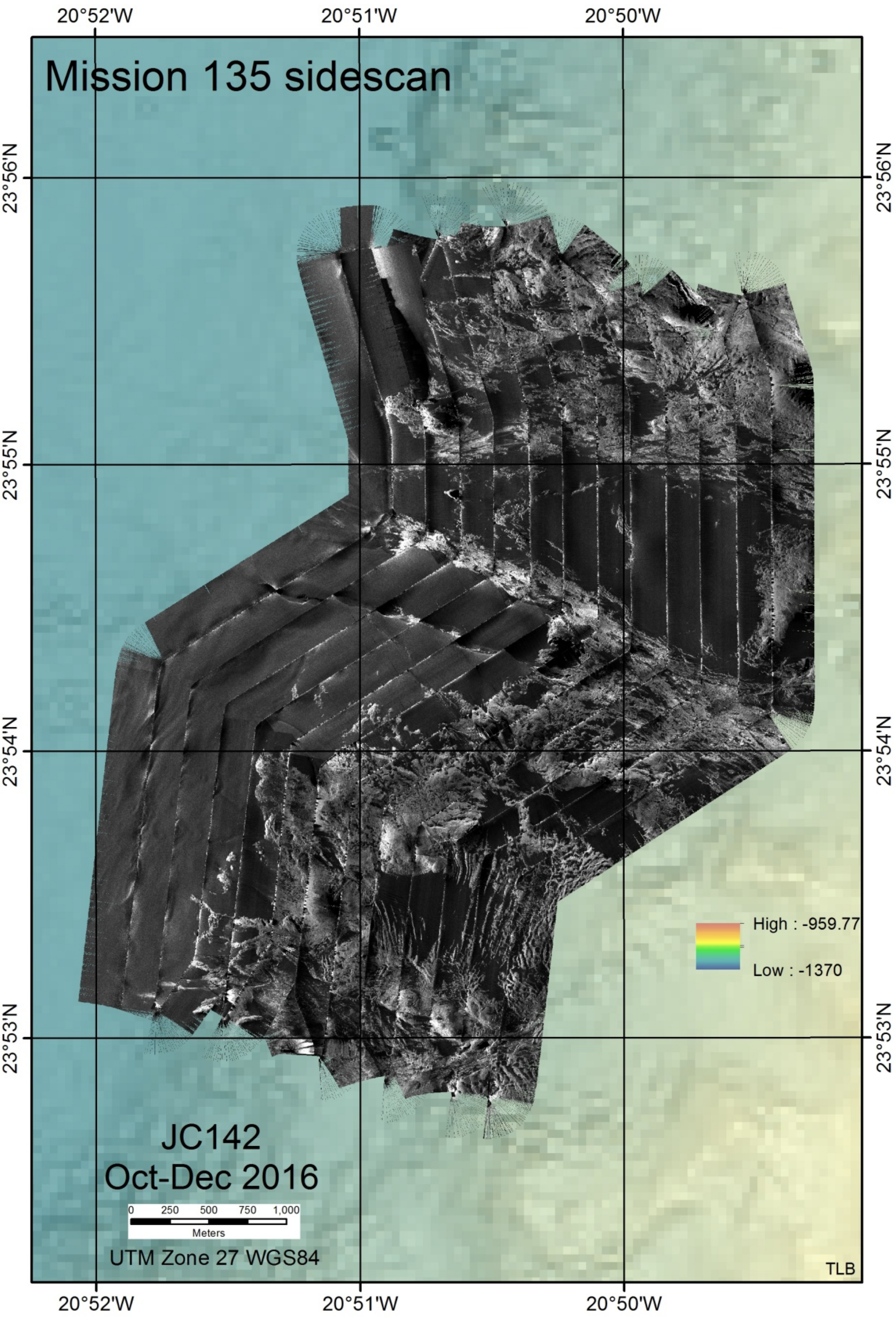


Figure 9: example of AUV sidescan sonar imagery

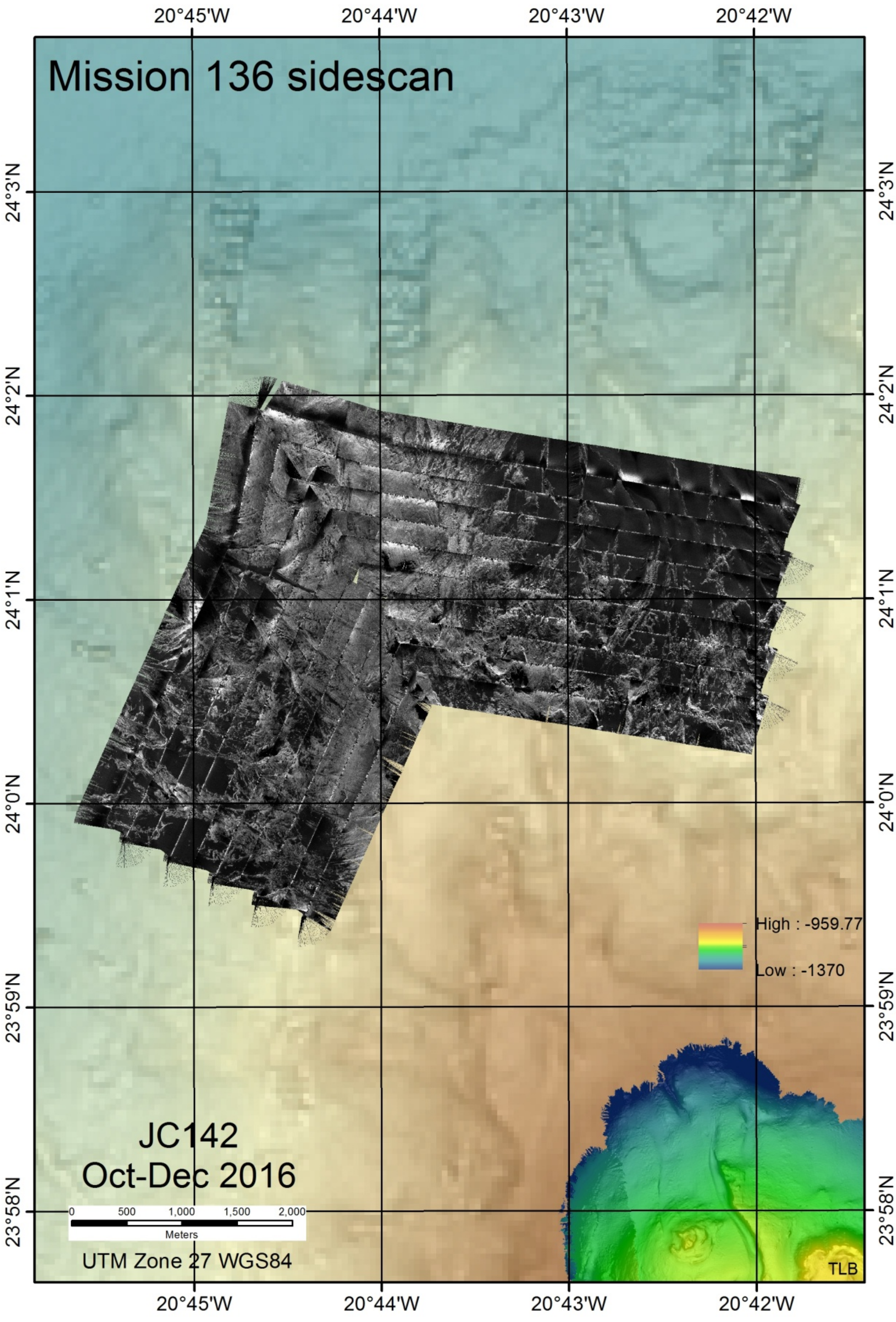


Figure 10: example of AUV sidescan sonar imagery

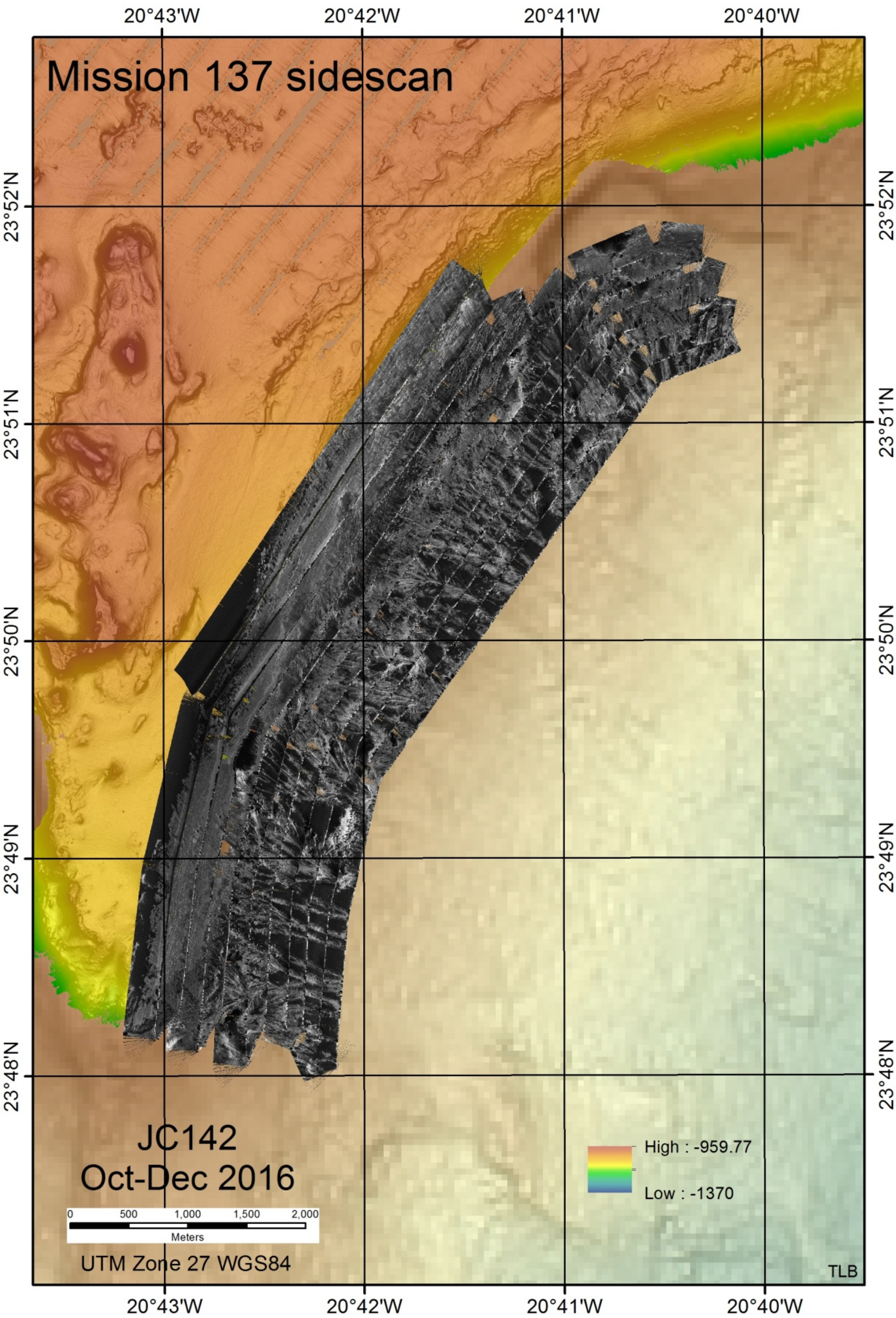


Figure 11: example of AUV sidescan sonar imagery

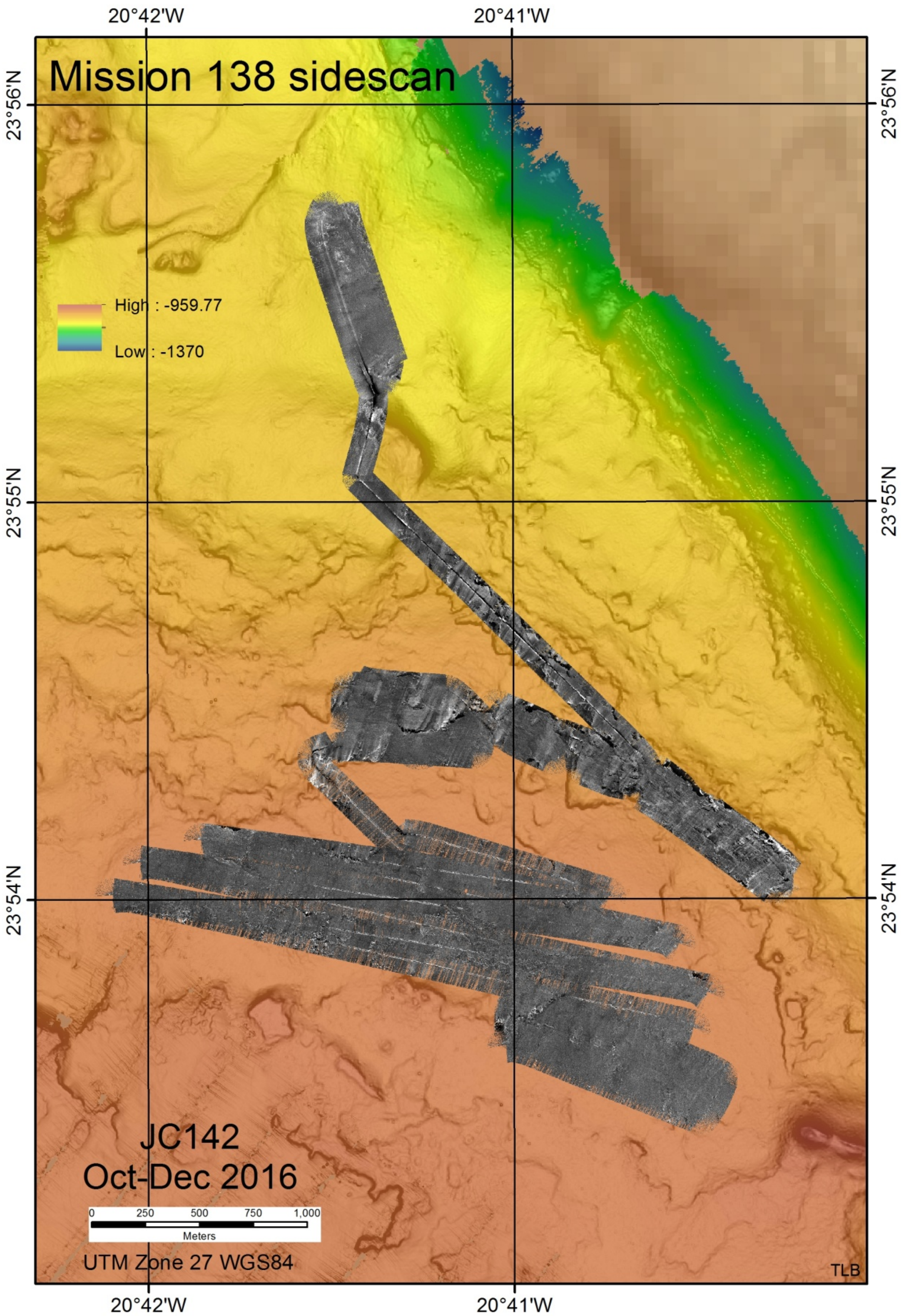


Figure 12: example of AUV sidescan sonar imagery

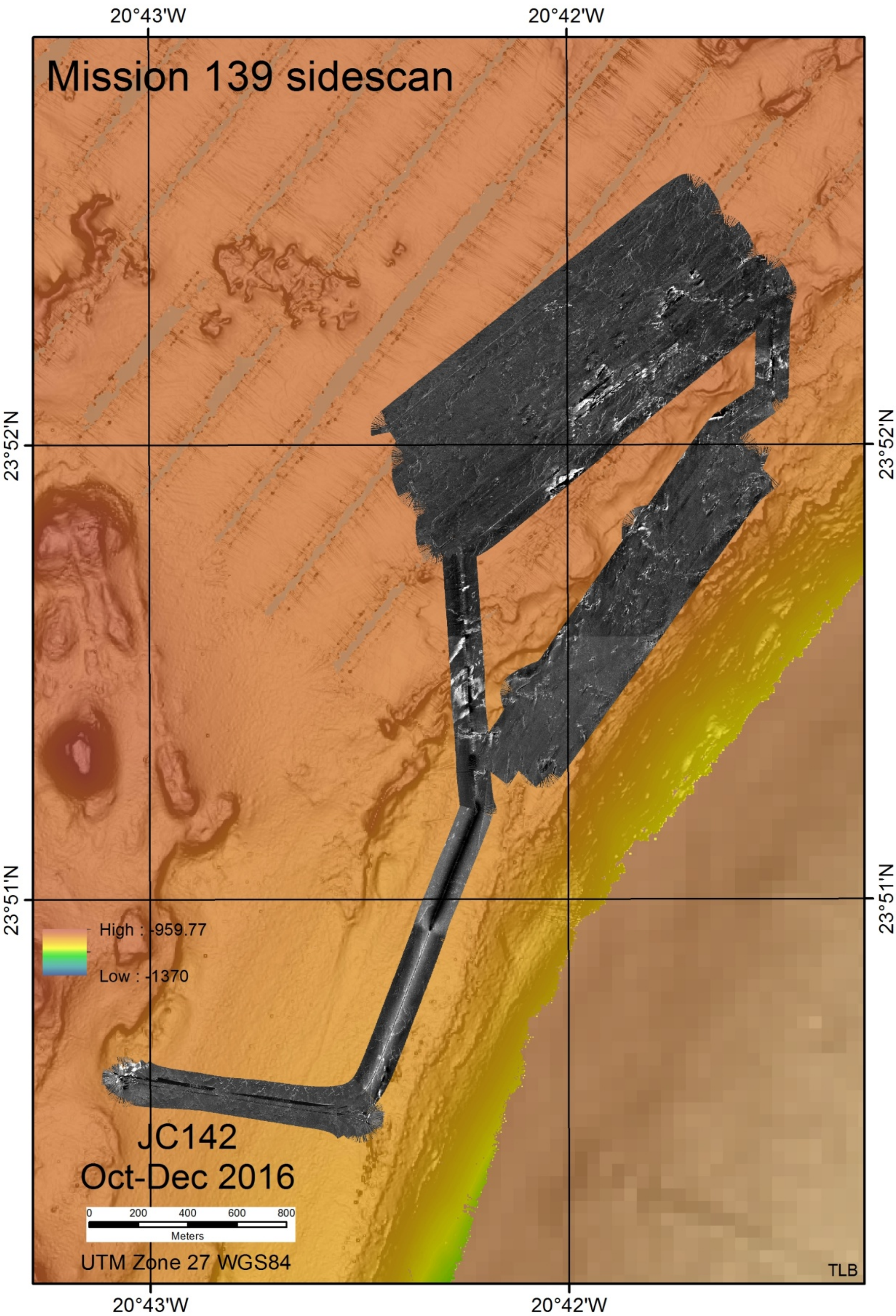


Figure 13: example of AUV sidescan sonar imagery

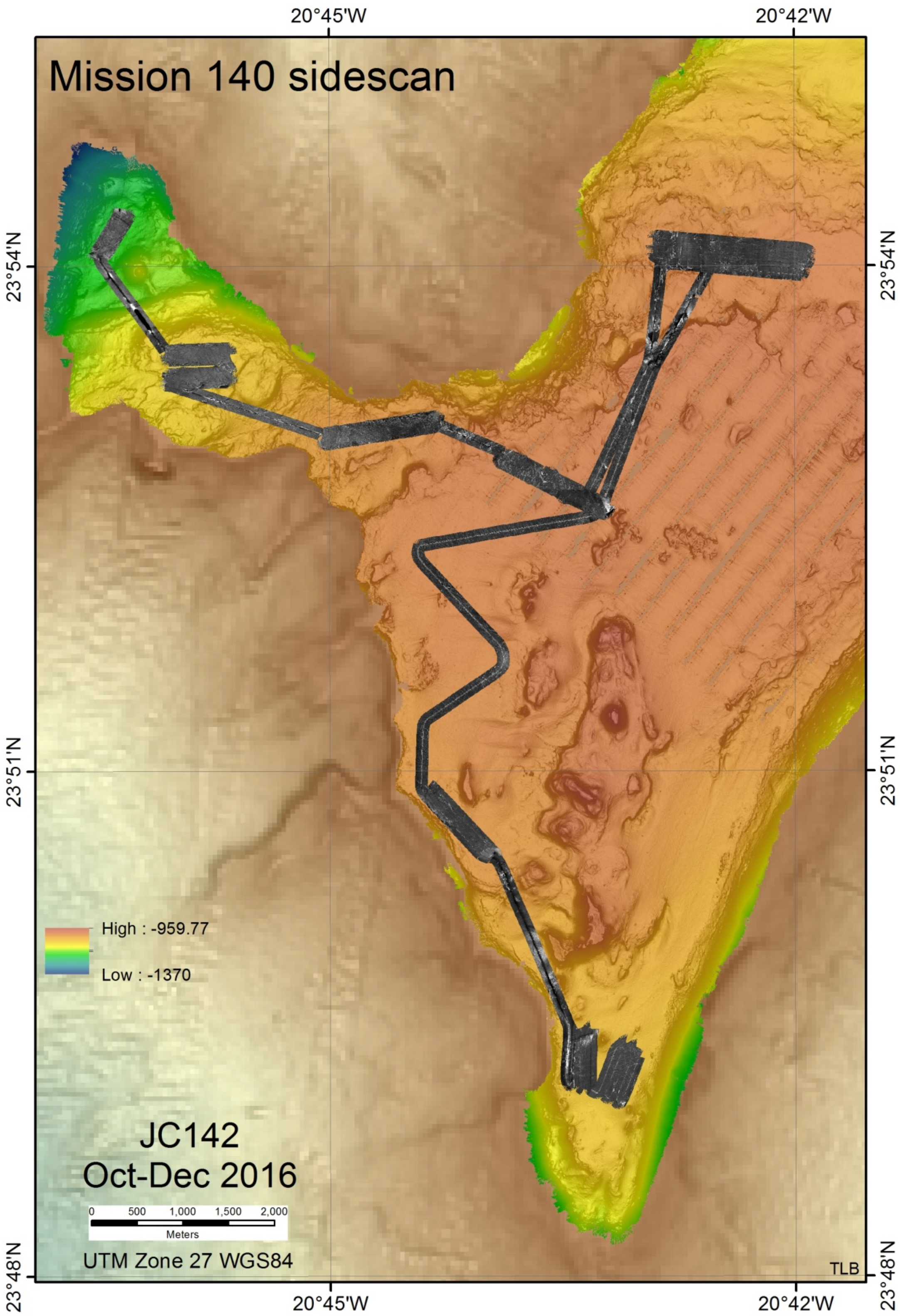


Figure 14: example of AUV sidescan sonar imagery

Appendix A. General Log

JC142: GENERAL LOG SHEET

SHEET #

DATE	TIME (UTC)	Station	Ops.	Ship position		speed	corse	depth	Fish position		Depth	Hding	comments
dd/mm/yy	hh/mm/ss	#		Lat	Long	kts	°	m	Lat	Long	m		
10/30/16	17:15	1	ROV wire	23.7154	-20.7790								Streaming of ROV cruise to 400m
10/30/16	17:30		CABLE	23.7154	-20.7790								Clump weight deployed
10/30/16	22:42		CABLE	23.7154	-20.7790								Clump weight recovered
10/30/16	23:15	2	CTD wire	23.7155	-20.7788								CTD overboard
10/31/16	4:40	3	CTD	23.7155	-20.7788								CTD recovered microbiology samples taken-
10/31/16	5:20		TRANSIT	23.7155	-20.7787								CTD station ended. Transit to AUV launch position
10/31/16	6:14	4	AUV	23.7779	-20.7933								On station for AUV deployment (1km N start line 1)
10/31/16	7:14	4	AUV	23.7779	-20.7933								AUV in LARS, launch begun
10/31/16	7:24	4	AUV	23.7803	-20.7917								AUV in water/ MISSION 125
10/31/16	10:23	4	AUV	23.7683	-20.7935								AUV mission begun.
10/31/16	11:06	5	MB	23.7663	-20.7880	6	260						Start MB survey + SBP
10/31/16	13:11	5	MB	23.8711	-20.7317	6	170	981					End of line/start new line.
10/31/16	14:26	5	MB	23.7707	-20.7504	4.8	182	2459					End of survey.

10/31/16	15:08	6	AUV	23.7615	-20.8041	0.4	191	4053					On station for AUV recovery.
10/31/16	17:36	6	AUV	23.7608	-20.8043	0.4	189	?					AUV on surface/END MISSION 125
10/31/16	18:07	6	AUV	23.7527	-20.8075	0.2	320	4152					AUV on deck.
10/31/16	18:25	7	MB and SBP	23.7287	-20.7920								Start of swath leading beginning line 10.
10/31/16	19:04	7	MB and SBP	23.6825	-20.7310	5.2	013	4177					Starting swath line 10.
10/31/16	23:42	7	MB and SBP	24.0723	-20.6688	5.2							End swath line 10. Starting line 11.
11/1/16	0:05	7	MB and SBP										Starting line 11.
11/1/16	4:39	7	MB and SBP	23.6748	-20.7158	5.2		4167					End swath line 11.
11/1/16	5:00	7	MB and SBP	23.6838	-20.6977	5.6		4161					Start line 12.
11/1/16	8:00	7	MB	23.9359	-20.6591	4.8		2004					End of line 12- heading for CTD station.
11/1/16	8:43	8	CTD	23.8868	-20.6894	0.7		988					CTD in water
11/1/16	9:16	8	CTD	24.4780	-21.1491	0.42		987					1st CTD fired
11/1/16	10:28	8	CTD	23.8867	-20.6894	0.42							CTD END
11/1/16	11.26	9	ROV	23.8416	-20.7140								On station for ROV, DIVE 297.
11/1/16	11:37	9	ROV	23.8407	-20.7152	1.14		1022					ROV in water.
11/1/16	11:45	9	ROV	23.8401	-20.7157	0.76		1019					ROV dive started.
11/1/16	12:36	9	ROV			0.3			23.8400	19.2835	1017		Rov bottom in sight
11/1/16	13:13	9	ROV						23.8415	19.2835	1030		At planned lander deployment location.
11/1/16	13:17	9	ROV	23.8412	-20.7137		0.5		23.8415	19.2835	1030		Lander deployment started.
11/1/16	13:34	9	ROV	23.8412	-20.7137		0.5		23.8415	19.2835	1030		Lander on seabed

11/1/16	13:45	9	ROV	23.8412	-20.7137		0.5		23.8414	19.2863	1027		End of deployment - taken off
11/1/16	13:50	9	ROV	23.8412	-20.7137		0.5		23.8410	19.2863	1026		Ship move 183° -> SOM
11/1/16	14:08	9	ROV						23.8412	19.2858	1028	30	Fish moving on summit (possible micronodules observed)
11/1/16	14:23	9	ROV						23.8417	19.2862	1030	142	Plume deneration 15 m away from the lander ready to
11/1/16	14:38	9	ROV						#VALUE!	19.2862	1030	142	Start of plume generation in direct 142°
11/1/16	14:47	9	ROV						#VALUE!	19.2862	1030	142	Pump is back on
11/1/16	15:02	9	ROV						#VALUE!	19.2862	1030	142	Plume generation stopped
11/1/16	15:14	9	ROV						#VALUE!	19.2862	1030	142	No more "dust" visible
11/1/16	15:18	9	ROV						#VALUE!	19.2862	1030	142	Leaving the sea floor
11/1/16	15:24	9	ROV						23.8413	19.2865	1030	324	ROV heading to new way point. We did not see any plume
11/1/16	15:30	9	ROV						23.8418	19.2860	1027	350	Ship moved 100 m north
11/1/16	15:46	9	ROV						23.8425	19.2857	1025	321	Ship move; Brg 322° range 3103 m
11/1/16	16:23	9	ROV						23.8453	19.2835	1022	321	Stop moving the ROV; Brg 321° range 2717 m
11/1/16	16:34	9	ROV						23.8453	19.2835	1022	321	Collect of sample (crust)
11/1/16	16:41	9	ROV						23.8453	19.2834	1022	315	ROV move and stop for sample crust
11/1/16	16:59	9	ROV						23.8453	19.2834	1021	319	ROV move; Brg 321° range 2704 m
11/1/16	17:15	9	ROV						23.8456	19.2830	1015	354	ROV stop moving
11/1/16	17:21	9	ROV						23.8456	19.2829	1013	341	Collect of sample (crust); Brg 322° range 2663 m
11/1/16	17:28	9	ROV						23.8457	19.2828	1008	318	ROV moving; Brg 322° range 2643 m
11/1/16	17:54	9	ROV										Reset Doppler

11/1/16	18:04	9	ROV						23.8477	19.2805	991	333	ROV stopped
11/1/16	18:07	9	ROV						23.8478	19.2803	995	332	ROV moving
11/1/16	18:43	9	ROV						23.8507	19.2782	994	320	ROV stop; Brg 322° range 1928 m
11/1/16	18:54	9	ROV						23.8508	19.2781	994	322	ROV moving; Brg 322° range 1900 m
11/1/16	19:31	9	ROV						23.8537	19.2756	1013	322	ROV stop; Brg 322° range 1513 m
11/1/16	19:44	9	ROV						23.8537	19.2755	1012	321	ROV moving; Brg 323° range 1498 m
11/1/16	20:59	9	ROV						23.8586	19.2715	993	322	ROV stopped; samples crust + big sponge collected
11/1/16	21:17	9	ROV						23.8587	#VALUE!	991	322	ROV moving
11/1/16	21:48	9	ROV						23.8605	19.2700	1010	359	ROV crust sample JC142_09_006 - nodule like
11/1/16	22:03	9	ROV						23.8604	19.2700	1010	358	Continue down line to WP2
11/1/16	22:16	9	ROV						23.8612	#VALUE!	1009	329	Doppler reset
11/1/16	22:54	9	ROV						23.8637	19.2672	1001	317	Continue down line to WP2
11/1/16	23:10	9	ROV						23.8646	19.2665	1002	242	Reached WP2, pointing to WP3
11/1/16	23:15	9	ROV										Doppler reset
11/1/16	23:43	9	ROV						23.8636	19.2643	1002	243	Continue line to WP3
11/2/16	0:15	9	ROV										Speed of ROV increased to 0,4 kn
11/2/16	0:32	9	ROV										Sed crusts / crusts, some plateu
11/2/16	0:36	9	ROV										Stopping to sample plateu manganese crust in small
11/2/16	0:49	9	ROV						23.8613	19.2595	1001		Sample 007, large slab crust, broken in half to fit in stbd
11/2/16	0:56	9	ROV						23.8612	19.2593	999		Back to 100% sed cover

11/2/16	1:03	9	ROV						23.8607	19.1646	1002		Small patch crusts 10-20% seafloor
11/2/16	1:05	9	ROV						23.8607	19.2582	1003		100% sed cover again
11/2/16	1:07	9	ROV						23.8609	19.2579	1004		Crusts - big sponge, small area pavement
11/2/16	1:09	9	ROV										Sed again 100%
11/2/16	1:11	9	ROV						23.8602	19.2573	1005		Crusts 20-30%
11/2/16	1:14	9	ROV						23.8602	19.2572			Crusts 10-20%
11/2/16	1:18	9	ROV						23.8601	19.2568	1018		Crusts 50% - drill site?; pavements
11/2/16	1:21	9	ROV						23.8600	19.2556	1005		Pavements 70-80% exposed; stopping to take sample
11/2/16	1:34	9	ROV						23.8599	19.2565	1006		Sample taken n° 008 from pavement, in Ptbio; few cm
11/2/16	1:37	9	ROV						23.8599	19.2565	1004		Droppler reset
11/2/16	1:37	9	ROV						23.8599	19.2565	1004		90% crusts, break slope pavements, many large sponges
11/2/16	1:40	9	ROV						23.8591	19.2567	1004		@ WP3,Heading to WP 4, following edge of seamount
11/2/16	1:49	9	ROV						23.8589	19.2567	1005		Fairly thick >5 cm, up to 10 pavements
11/2/16	1:51	9	ROV						23.8624	19.2569	1005		Stopping to sample coral, stbd biobox sample 009, broken
11/2/16	2:09	9	ROV						23.8586	19.2569	1006		Thick crusts, stopping to sample; too hard to break,
11/2/16	2:18	9	ROV						23.8585	19.2570	1007		Thick crusts, 10-20 cm on top of basalts. Too hard to
11/2/16	2:34	9	ROV										Passing WP4 on E side - following edge
11/2/16	2:56	9	ROV						23.8624	19.2578	1005		Stopping to sample coral. Too dofficult to sample
11/2/16	2:45	9	ROV										Countinuing on to WP5
11/2/16	2:47	9	ROV						23.8581	19.2579	1005		Slightly less exposure, waiting for ship

11/2/16	2:50	9	ROV										Continuing on
11/2/16	2:51	9	ROV						23.8582	19.2580	1003		Pavements + plates w/ 50% sed cover
11/2/16	2:55	9	ROV						23.8581	19.2584			Turning off edge towards WP5
11/2/16	2:56	9	ROV						23.8577	19.2584	1007		Platey, much higher sed cover
11/2/16	2:57	9	ROV						23.8577	19.2583	1009		100% sed cover
11/2/16	3:00	9	ROV										Doppler reset
11/2/16	3:39	9	ROV						23.8532	19.2578	1011		Small pieces crust 90-95% sed
11/2/16	3:41	9	ROV						23.8531	19.2577	1012		Pavements crust 40-50% sed cover
11/2/16	3:44	9	ROV						23.8527	19.2575	1012		Big smooth pavement, good for drilling
11/2/16	3:51	9	ROV						23.8525	19.2574	1013		Stopping to sample 010; Block from overhang, Ptbio
11/2/16	3:58	9	ROV						23.8525	19.2574			Samples taken but too big, put down, searching for
11/2/16	4:14	9	ROV						23.8526	19.2574			Samples 010 taken in Ptbio
11/2/16	4:20	9	ROV						23.8526	19.2574			Heading towards WP6
11/2/16	4:27	9	ROV						23.8521	19.2573			Coral debris, chamber, top right (2), sample 011
11/2/16	4:29	9	ROV										Big sponge
11/2/16	4:40	9	ROV						23.8516	19.2569			Off edge seamount. Tiny blue hop - 200 m to W
11/2/16	4:53	9	ROV						23.8511	19.2560			Finishing blue jump, coming down
11/2/16	4:57	9	ROV						23.8511	19.2560			On bottom; lots of dead corals; heading to WP6
11/2/16	4:58	9	ROV						23.8509	19.2561			Lots of dead corals; some blocks of crusts; semi lith +
11/2/16	5:01	9	ROV						23.8508	19.2561			Mn crusts on outcropping hard surfaces, but prob < 2-3

11/2/16	5:06	9	ROV						23.8507	19.2563			Massive walls of basaltic- jointing + sharp corners w/ thin
11/2/16	5:13	9	ROV						23.8506	19.2565			Dead coral + sed, less steep
11/2/16	5:16	9	ROV						23.8505	19.2566			Back to steep coall, sed + Mn coated, thin
11/2/16	5:18	9	ROV						23.8505	19.2567			Thicker crusts and vertical slopes
11/2/16	5:20	9	ROV										Craggy near vertical cliffs, thin Mn coating
11/2/16	5:22	9	ROV						23.8505	19.2567			Plateau, thicker crusts
11/2/16	5:29	9	ROV						23.8505	19.2567			Setting down to collect sample 012, small broken piece
11/2/16	5:36	9	ROV						23.8504	19.2568			Continuing to WP6 / E
11/2/16	5:38	9	ROV						23.8504	19.2569	1009		Heading directly WP6
11/2/16	5:44	9	ROV						23.8503	19.2568	1014		Setting down to collect small brown thing, is brachiopod,
11/2/16	5:45	9	ROV										Continuing on
11/2/16	5:49	9	ROV										Heading WP7
11/2/16	5:51	9	ROV						23.8497	19.2566	1012		Crusts on exposed cracks, sed elsewhere
11/2/16	6:00	9	ROV						23.8492	19.2567	1012		Stopping to collect nodules; 3 collected, tube 1
11/2/16	6:07	9	ROV						23.8492	19.2567	1013		Dive ended
11/2/16	6:08	9	ROV						23.8492	19.2567	1013		ROV off bottom
11/2/16	7:11	9	ROV						23.8470	19.2558			ROV out of water
11/2/16	7:12	9	ROV	23.8474	-20.7443								ROV on deck
11/2/16	8:42	10	MOORING	23.6465	-20.7527								On station for mooring C (S-site)
11/2/16	10:20	10	MOORING	23.6502	-20.7492								Spooling winch hydraulic failure; delay to mooring

11/2/16	17:36	10	MOORING	23.6793	-20.7273	0.8	125	4172					Mooring released C
11/2/16	17:48	10	SWATH										Moving to MB line 9 (transit)
11/2/16	18:29	10	SWATH	23.6769	-20.7469	4.9	10	4213					Commencing MB line 9
11/2/16	18:58	10											Decided to speed up ship to reach AUV deployment
11/2/16	20:11	11	AUV	23.9159	-20.7086	0.7	80	998					On station 11 for AUV deployment
11/2/16	20:40	11	AUV	23.9180	-20.7070	0.5	19	1058					AUV deployed MISSION 126
11/2/16	21:50	11	AUV	23.9128	-20.7080	1.1	352	?	23.9039	19.2888	295		AUV appears to be on way up - decided to abort
11/2/16	22:26	12	AUV	23.9102	-20.7113	2.3	226						AUV recovery END OF MISSION 126
11/2/16	23:08	12	AUV	23.8986	-20.7209	1.1	216						Autosub on deck
11/2/16	23:50			23.9046	-20.7182	5.6	025						Proceeding to station 13, CTD #7
11/3/16	00:42	13	CTD	23.9440	-20.6963	0							on station for CTD #7
11/3/16	1:10	13	CTD										CTD at the bottom
11/3/16	1:43	13	CTD	23.9436	-20.6943	0		1097					CTD on deck
11/3/16	2:23	14	CTD	23.9140	-20.6901	0		1055					on station 14, CTD #2
11/3/16	2:30	14	CTD	23.9140	-20.6901	0		1054					CTD in the water
11/3/16	2:57	14	CTD	23.9140	-20.6901	0		1055					CTD at the bottom
11/3/16	3:28	14	CTD	23.9140	-20.6901	0		1054					CTD on deck
11/3/16	3:40	---	TRANSIT										moving to station 15, CTD #3
11/3/16	4:10	15	CTD	23.8850	-20.6583	0.1		1040					on station CTD #3
11/3/16	4:20	15	CTD	23.8850	-20.6583	0.1		1043					CTD in the water

11/3/16	4:44	15	CTD	23.8850	-20.6583	0		1043					CTD AT BOTTOM
11/3/16	5:17	15	CTD	23.8850	-20.6583	0		1044					CTD ON DECK
11/3/16	6:00	16	CTD	23.8880	-20.6354	0		1225					ON STATION FOR CTD #8
11/3/16	6:05	16	CTD	23.8880	-20.6354	0		1216					CTD ON THE WATER
11/3/16	6:37	16	CTD	23.8880	-20.6353	0		1222					CTD AT BOTTOM
11/3/16	7:10	16	CTD	23.8880	-20.6354	0		1222					CTD ON DECK
11/3/16	7:57	17	CTD	23.8813	-21.5622	0.1		992					ON STATION 17 FOR CTD #5
11/3/16	8:18	17	CTD	23.8806	-20.7290	0.3		990					CTD IN THE WATER
11/3/16	9:20	17	CTD										CTD OUT OF WATER / ON DECK
11/3/16	9:32		TRANSIT	23.9100	-20.7079			1005					TRANSIT TO NEXT CTD ST 18
11/3/16	9:58	18	CTD	23.8886	-20.7651			1080					CTD #6 ON STATION
11/3/16	10:37	18	CTD	23.8886	-20.7644			1082					CTD #6 IN WATER
11/3/16	11:16	18	CTD	23.8886	-20.7644			1084					CTD #6 AT BOTTOM
11/3/16	12:34	18	CTD	23.8886	-20.7644			1083					CTD #6 ON DECK
11/3/16	12:42		TRANSIT	23.8855	-20.7603	6.6		1061					TRANSIT TO NEXT CTD ST 19, CTD #4
11/3/16	13:20		TRANSIT	23.8564	-20.7103			1003					ON STATION ST 19 FOR CTD #4 (CANCELLED AND
11/3/16	14:20		TRANSIT	23.8800	-20.7137	11	356	995					IN TRANSIT TO MOORING ETA 15.15
11/3/16	15:30	19	MOORING	24.0055	-20.7209	0.5	51	2236					ON STATION A
11/3/16	19:04	19	MOORING	24.0207	-20.6996			2974					MOORING DEPLOYMENT A
11/3/16	19:34		TRANSIT	24.0162	-20.6973		110	2857					IN TRANSIT TO ST20 FOR ROV DIVE

11/3/16	20:30		TRANSIT	23.8828	-20.6973		65	999					WRONG LOCATION (MOORING SITE)
11/3/16	21:04		TRANSIT	23.8829	-20.6975		42	999					MOVING TO CORRECT ST20 LOCATION
11/3/16	21:25	20	ROV	23.8941	-20.7064		40	999					STATION 20 FOR ROV
11/3/16	21:45	20	ROV	23.8940	-20.7065	0.2	40	999					ROV IN WATER (ISIS DIVE 298)
11/3/16	22:46	20	ROV						23.8942	19.2951	988		BOTTOM INSIGHT
11/3/16	22.54	20	ROV										WHITE BALANCE CARRIED
11/3/16	23.02	20	ROV						#VALUE!	#VALUE!	988	188	HEADING TO WP2
11/3/16	23:19	20	ROV						#VALUE!	#VALUE!	991	190	START DRILLING
11/3/16	23:32	20	ROV						#VALUE!	#VALUE!	991	190	STOP DRILLING
11/3/16	23:50	20	ROV						#VALUE!	#VALUE!	991	190	STOP DRILLING MATERIAL WAS COLLECTED
11/4/16	0:05	20	ROV						#VALUE!	#VALUE!	991	190	CORE NOT RECOVERED
11/4/16	0:14	20	ROV						#VALUE!	#VALUE!	992		START DRILLING - REATTEMPT
11/4/16	1:01	20	ROV						#VALUE!	#VALUE!	992		STOP DRILLING
11/4/16	1:03	20	ROV						#VALUE!	#VALUE!	992		POWER OUTAGE IN CONTROL VAN
11/4/16	1:10	20	ROV						#VALUE!	#VALUE!	992		SEARCHING FOR FAULT
11/4/16	1:15	20	ROV						#VALUE!	#VALUE!	992		BLOWN FUSE LOCATED
11/4/16	1:30	20	ROV						#VALUE!	#VALUE!	978		ROV BACK ONLINE - STILL ON SEAFLOOR
11/4/16	1:40	20	ROV						#VALUE!	#VALUE!	978		ROV POWER + HYDRAULICS BACK. CORE APPEARS TO BE
11/4/16	1:42	20	ROV						#VALUE!	#VALUE!	978		CHECKING TO SEE IF ANY MORE CORE IN HOLE
11/4/16	1:45	20	ROV						#VALUE!	#VALUE!	978		ATTEMPTING TO COLLECT CORE - CORE COLLECTION

11/4/16	1:49	20	ROV						#VALUE!	#VALUE!	978		ATTEMPTING TO REMOVE CORE FROM DRILL BARREL
11/4/16	2:15	20	ROV										CANNOT GET CORE OUT OF BARREL - CANNOT DRILL
11/4/16	2:19	20	ROV										WHITE BALANCE
11/4/16	2:23	20	ROV										PREPARING TO BEGIN VIDEOTRANSECT
11/4/16	2:35	20	ROV										CRUST A LITTLE SORT
11/4/16	2:41	20	ROV										SEDIMENT DESPITE BRIGHT BACKSCATTER
11/4/16	2:49	20	ROV										CRUST (PATCHY)
11/4/16	2:57	20	ROV										PUSH CORE SAMPLING (CORE IN ~ 20 cm), Sample #2
11/4/16	3:01	20	ROV										PUSH CORE 2, GOING IN ~20 cm SAMPLE #3
11/4/16	3:18	20	ROV										SEDIMENT
11/4/16	3:36	20	ROV						23.8869	19.2942			STILL IN SEDIMENT FIELD
11/4/16	4:00	20	ROV						23.8843	19.2939			MN CRUST LUMPS - 50% SEAFLOOR. STOP TO SAMPLE
11/4/16	4:22	20	ROV						23.8843	19.2939	983		SAMPLE TAKEN | BLUE CAGE (5). SAMPLE #4. BROKEN
11/4/16	4:23	20	ROV										SAMPLING SPONGE ON Mn CRUST (3x SPONGE) - STBBIO
11/4/16	4:27	20	ROV						23.8843	19.2939	982		SECOND SAMPLE CRUST - POSS PHOS INTERIOR (2-3 cm
11/4/16	4:31	20	ROV										CONTINUING TO WP2
11/4/16	4:37	20	ROV						23.8834	19.2937			SPREAD OUT CRUST LUMP - 20%
11/4/16	4:38	20	ROV						23.8997	19.2937	979		SAMPLE TAKEN. ROUNDED LUMP WITH POSSIBLE
11/4/16	4:47	20	ROV						23.8997	19.2937	979		TAKING PUSHCORE 4 - SAMPLE #8. NEXT TO Mn CRUSTS.
11/4/16	4:49	20	ROV						23.8997	19.2937	979		TAKING SECOND CORE NEAR Mn CRUST. APROX. 25 cm

11/4/16	4:52	20	ROV						23.8997	19.2937	979		CONTINUING TO WP3
11/4/16	4:56	20	ROV						23.8825	#VALUE!	979		20% Mn LUMPS - 50%
11/4/16	4:59	20	ROV										70% Mn
11/4/16	5:00	20	ROV										100 % Sediment
11/4/16	5:26	20	ROV						23.8797	19.2935			Doppler reset
11/4/16	5:30	20	ROV						23.8798	19.2935	984		at WP 2, heading to WP3, starting new transect
11/4/16	6:18	20	ROV						23.8845	19.2965	956		100 % sediment ripples
11/4/16	6:28	20	ROV						23.8854	19.2971			Poss single block Mn crust
11/4/16	7:05	20	ROV						23.8888	19.2992			single Mn covered rock
11/4/16	7:07	20	ROV						23.8890	19.2992			more Mn crust 20-50% stopping to sample
11/4/16	7:09	20	ROV										Sampling crusts along poss fracture, x-section floor looks
11/4/16	7:16	20	ROV						23.8891	19.2992	981		Sample taken, crust from vertical column with flat top,
11/4/16	7:23	20	ROV										Continuing on to WP3, checking if core still is in barrel
11/4/16	7:51	20	ROV						23.8912	19.3001	981		Small outcrop crusts, stopping to take sample
11/4/16	8:01	20	ROV						23.8912	19.3002	995		small crust sample # 11, crate No. 6
11/4/16	8:15	20	ROV						23.8915	19.3005	993		tried to sample exposed crust, not successful
11/4/16	8:38	20	ROV						23.8867	19.3012	993		start of 3rd transect line
11/4/16	8:38	20	ROV						23.8913	19.3010	979		pavement slabs, no loose material
11/4/16	8:42	20	ROV										stopping to obtain sample
11/4/16	8:46	20	ROV										Sample taken, nose botroidal pavement, fell into crate 2,

11/4/16	8:48	20	ROV						23.8911	19.3010	979		pieces broken off botroidal materials (2 bits), crate 7,
11/4/16	8:53	20	ROV										continuing towards WP4
11/4/16	9:06	20	ROV						23.8898	19.3011	980		broken crust stopping to sample
11/4/16	9:09	20	ROV						23.8898	19.3011	980		small sample taken from sediment around base crust,
11/4/16	9:14	20	ROV						23.8898	19.3011	980		big botroidal slab, crate 3, Sample #14B, now sample #26
11/4/16	9:16	20	ROV										continuing to WP4
11/4/16	9:17	20	ROV						23.8896	19.3010			30-50% Mn crust in sediment
11/4/16	9:19	20	ROV						23.8896	19.3010			
11/4/16	9:20	20	ROV										patch Mn crust, ~40% coverage
11/4/16	9:23	20	ROV										turning to investigate bright backscatter
11/4/16	9:24	20	ROV										crust >50%
11/4/16	9:31	20	ROV						23.8888	19.3015			Stopping to sample relatively dense patch
11/4/16	9:35	20	ROV						23.8888	19.3014			sampled, Mn-crust, thick botroidal thick slab, ~0.5m, on
11/4/16	9:42	20	ROV										coming back towards lander position
11/4/16	9:45	20	ROV						23.8885	19.3012			100% sediment
11/4/16	9:59	20	ROV										ripple strike 90-270, longitudinal furrows strikes 020°
11/4/16	10:29	20	ROV						23.8847	19.3013	995		Sample #16, Urchin, portside bio box section 3
11/4/16	10:49	20	ROV						23.8823	19.3012	996		outcrop of Fe-Mn pavement, attempt to sample botroidal
11/4/16	11:19	20	ROV										failed to sample crust, too strong
11/4/16	11:24	20	ROV						23.8817	19.3012			sediment 100%

11/4/16	12:05	20	ROV						23.8761	19.3011	984		at WP4, changing to head for WP5
11/4/16	12:08	20	ROV										doppler reset
11/4/16	12:35	20	ROV						23.8790	19.3030	997		ripple marks, orienation 015°, shell mounds at 90° angle
11/4/16	12:37	20	ROV										change of heading , new heading 076,5°, still only
11/4/16	12:54	20	ROV						23.8794	19.3039	999		stop to collect samples, ROV moved slightly ahead, no
11/4/16	13:03	20	ROV						23.8794	19.3045	999		ROV moving again
11/4/16	13:05	20	ROV										Doppler reset
11/4/16	13:05	20	ROV						23.8795	19.3045	999		new heading 356.9°
11/4/16	13:10	20	ROV										still only sediments in sight, still mounds of shell material
11/4/16	13:39	20	ROV						23.8821	19.3044	996		ROV stops
11/4/16	13:40	20	ROV						23.8821	19.3043	997		crust sample collected, Sample #17
11/4/16	13:56	20	ROV									326	ROV moving again
11/4/16	13:59	20	ROV						23.8822	19.3043	995	326	Fe-Mn crust present
11/4/16	14:06	20	ROV						23.8827	19.3042	996	339	ROV stop small nodules in sight
11/4/16	14:13	20	ROV						23.8827	19.3125	996		push core retrieved (in position1), another pushcore take
11/4/16	14:26	20	ROV						23.8829	19.3043	995	065	ROV moving again, no more crusts in sight
11/4/16	14:34	20	ROV						23.8831	19.3051	996		ROV stopping, small Fe-Mn pebbles observed, nodule
11/4/16	14:45	20	ROV										another nodule collected, Sample #22
11/4/16	14:49	20	ROV						23.8832	19.3051	995	037	ROV moving again
11/4/16	14:52	20	ROV										Doppler reset

11/4/16	15:06	20	ROV						23.8845	19.3064	994	032	ROV heading to WP6, only sediment in sight
11/4/16	15:22	20	ROV						23.8855	19.3078	993		ROV change heading to 173°
11/4/16	15:43	20	ROV						23.8838	19.3080	994		continue on heading 161°
11/4/16	15:48	20	ROV						23.8834	19.3082			crusts in sight again, ROV stop
11/4/16	16:07	20	ROV						23.8832	19.3083			ROV heading for 157°
11/4/16	16:27	20	ROV						23.8817	19.3090	993	154	ROV stop, crusts present & nodules
11/4/16	16:35	20	ROV										nodule collected grey box 4 (#23), another collected in
11/4/16	16:42	20	ROV						#VALUE!	#VALUE!	994	155	END OF DIVE
11/4/16	17:52	20	ROV	23.8805	-20.6906		0	989					ROV ON DECK
11/4/16	19:00	21	AUV	23.9205	-20.7121		339	1174					AUV IN WATER / MONITORING ~20:30 MISSION 127
11/4/16	21:55	22	MB	23.9348	-20.6596		20.5	2085					TURNING ON TO SWATH LINE
11/4/16	23:33	22	MB	24.0680	-20.6372		8.9	4004					COMPLETED SWATH LINE #12 & TURNING
11/4/16	23:53	22	MB	24.0560	-20.6229		182	3975					STARTING SWATH LINE #13
11/5/16	4:32	22	MB	23.6683	-20.6841		182	4161					SWATH LINE #13 COMPLETED, TURNING
11/5/16	4:50	22	MB	23.6731	-20.6669		5	4148					STARTING SWATH LINE #14
11/5/16	9:33	22	MB	24.0636	-20.6051		10	3989					SWATH LINE #14 COMPLETED, TURNING
11/5/16	9:49	22	MB	24.0553	-20.5904		189	3985					STARTING SWATH LINE #15
11/5/16	11:20	22	MB	23.9310	-20.6100		95	3339					BREAK OFF SWATH LINE #15
11/5/16	11:55	23	AUV	23.8805	-20.6748		349	1000					ON STATION FOR AUV RECOVERY
11/5/16	12:10	23	AUV	23.8867	-20.6771		296	989					TURN OFF OF SHIPS ACOUSTICS

11/5/16	15:01	23	AUV	23.8759	-20.6755		305	993					AUV RECOVERED, END MISSION 127
11/5/16	15:09		TRANSIT	23.8768	-20.6821		289	993					TRANSIT TO STATION 24 (MOORING)
11/5/16	15:45	24	MOORING	23.8779	-20.6917		295	1008					ON STATION TO DEPLOY MOORING B
11/5/16	16:35	24	MOORING	23.8859	-20.7006	0.1	317	1006					MOORING B RELEASED
11/5/16	16:50		TRANSIT	23.8664	-20.7081	10.5	191	994					IN TRANSIT TO STATION #25
11/5/16	17:35	25	ROV	23.8419	-20.7140		312	1021					ON STATION #25
11/5/16	18:07	25	ROV	23.8410	-20.7138	1	311	1024	#VALUE!	#VALUE!			ROV IN WATER
11/5/16	19:08	25	ROV	#VALUE!	#VALUE!			109	#VALUE!	#VALUE!	1019		BOTTOM REACHEAD
11/5/16	20:07	25	ROV						23.8414	19.2860	1027		LANDER IN SIGHT
11/5/16	20:14	25	ROV										FLAG IN PLACE
11/5/16	20:23	25	ROV										PUSH CORE TAKEN (SAMPLE #1) IN SLOT N° 4 - SAMPLE #2
11/5/16	20:28	25	ROV										CONTINUED: COLLECTED PUSH CORE SAMPLE #3 IN SLOT
11/5/16	20:40	25	ROV						23.8416	19.1195	1028		PLUME GENERATED
11/5/16	20:48	25	ROV						23.8416	19.1195	1028		PLUME OFF
11/5/16	20:53	25	ROV						23.8417	19.2862	1028		ROV IN NEW POSITION (PLUME N°2)
11/5/16	20:54	25	ROV						23.8417	19.2862	1028		PLUME GENERATED
11/5/16	21:09	25	ROV						23.8417	19.2862	1028		PLUME OFF
11/5/16	21:09	25	ROV										ROV MOVING 5m
11/5/16	21:12	25	ROV						23.8417	19.2863	1029		ROV IN POSITION
11/5/16	21:13	25	ROV						23.8417	19.2863	1029		PLUME GENERATED

11/5/16	21:28	25	ROV						23.8417	19.2863	1029		PLUME OFF - WAITING 10 MINUTES BEFORE LANDER
11/5/16	21:28	25	ROV										MOVING TO RETRIEVE LANDER
11/5/16	22:19	25	ROV						23.8414	19.2862	1029		LANDER RECOVERED
11/5/16	22:19	25	ROV						23.8415	-20.7137	1019		ROV LEAVING SEABED
11/5/16	23:07	25	ROV						23.8416	-20.7136			ROV ON DECK
05/11/216	23:30		TRANSIT			2.2	313	2055					IN TRANSIT TO STATION #26
05/11/216	23:42	26	CTD	23.8510	-20.7432		315						ON STATION FOR CTD
05/11/216	23:56	26	CTD	23.8510	-20.7432								CTD IN WATER BUT WRONG LOCATION (TOO SHALLOW)
11/6/16	0:07	26	CTD	23.8510	-20.7432								CTD ON DECK
11/6/16			TRANSIT										IN TRANSIT TO NEW CTD LOCATION
11/6/16	0:32	27	CTD	23.8500	-20.7534			1500					NEW CTD IN RIGHT LOCATION - ON STATION FOR CTD
11/6/16	0:36	27	CTD	23.8334	-20.7534			1500					CTD IN WATER
11/6/16	1:18	27	CTD	23.8334	-20.7534			1500			1400		SAMPLE SET 1/BOTTLES 1&3
11/6/16	1:15	27	CTD	23.8334	-20.7534			1500			1300		SAMPLE SET 2/BOTTLES 5&7
11/6/16	1:23	27	CTD	23.8334	-20.7534			1500			1200		SAMPLE SET 3/BOTTLES 9&11
11/6/16	1:32	27	CTD	23.8334	-20.7534			1500			1100		SAMPLE SET 4/BOTTLES 13&15
11/6/16	1:40	27	CTD	23.8334	-20.7534			1500			1000		SAMPLE SET 5/BOTTLES 17&19
11/6/16	1:54	27	CTD	23.8334	-20.7534			1500			75		SAMPLE SET 6/BOTTLES 19&23
11/6/16	2:18	27	CTD	23.8334	-20.7534			1500					CTD ON DECK - BOTTLES DID NOT CLOSE - NO SAMPLES
11/6/16	2:24		TRANSIT										TRANSIT TO START MB SURVEY

11/6/16	3:02	28	MB	23.8587	-20.7194			980					START MB LINE #9
11/6/16	5:11	28	MB	23.6786	-20.7480			4237					END OF SWATH LINE #9 - TURNING
11/6/16	5:31	28	MB	23.6835	-20.7638			4242					TURN FINISHED - START SWATH LINE #8
11/6/16	10:15	28	MB	24.6755	-20.7017			4071					END OF SWATH LINE #8 - TURNING
11/6/16	10:28	28	MB	24.6751	-20.7172			4082					START OF SWATH LINE #7
11/6/16	14:50	28	MB	23.6793	-20.7806			4229					END OF SWATH LINE #7
11/6/16	14:55	29	AUV	23.6780	-20.7894			4228					TEST OF FISH ACOUSTICS
11/6/16	15:20	29	AUV	23.6839	-20.7964			4235					FISH TEST COMPLETE
11/6/16	15:24	30	MB	23.6848	-20.7963			4231					STARTING SWATH LINE #6
11/6/16	17:15	30	MB										MB SYSTEM NOT LOGGING - RELOADED BY MARK - GAP
11/6/16	19:48	30	MB	24.0819	-20.7329	6	340	4107					END OF LINE 6 - TRANSIT TO START LINE #5
11/6/16	20:02	30	MB	24.0803	-20.7500	6	191	4131					START OF LINE #5
11/6/16	20:48	30	MB	24.0055	-20.7618	3	191	3422					NOTICE: "LINE CNT" BUTTON NOT CLICKED WHEN LINE #5
11/6/16	22:22	30	MB	23.8625	-20.7843	5	282	2429					END OF LINE #5
11/6/16	22:36	30	MB	23.8632	-20.7991	4	358	2077					START OF LINE #4
11/7/16	1:02	30	MB	24.0872	-20.7649	5.5	6	4117					FINISH OF SWATH LINE #4 - HEADING TO LINE #9 (11
11/7/16	1:35	30	MB	24.0720	-20.6858	5.5	189	3990					START OF LINE #9
11/7/16	2:20	30	MB	23.9981	-20.6975	7.7	187	2114					BREAK OFF SWATH LINE #9 - HEADING TO AUV LAUNCH
11/7/16	3:13	31	AUV	23.8953	-20.7126	0		1011					ON STATION FOR AUV LAUNCH - PORT SIDE USBL POLE
11/7/16	3:27	31	AUV	23.8976	-20.7126	0.1		998					AUV IN THE WATER - M128

11/7/16	3:36	31	AUV	23.8987	-20.7126	0.2	356	998					SHIP ACOUSTICS TURNED OFF
11/7/16	4:33	31	AUV	23.8938	-20.7131								AUV FORWARD LOOKING SONAR NOT WORKING -
11/7/16	5:06	31	AUV	23.8679	-20.7232			998					AUV ON DECK.
11/7/16	5:20		TRANSIT	23.8848	-20.7225	2.5	66	1005					TRANSIT TO NEXT CTD ST
11/7/16	5:51	32	CTD	23.8878	-20.6900	0.2		987					On station for CTD
11/7/16	6:00	33	CTD	23.8878	-20.6900			989					CTD in water
11/7/16	6:24	33	CTD	23.8878	-20.6900			990			990		CTD @ bottom, Bottle 1/2
11/7/16	6:29	33	CTD	23.8878	-20.6900			990			900		Bottle 3/4
11/7/16	6:33	33	CTD	23.8878	-20.6900			990			800		Bottle 5/6
11/7/16	6:37	33	CTD	23.8878	-20.6900			990			700		Bottle 7/8
11/7/16	6:41	33	CTD	23.8878	-20.6900			990			650		Bottle 9
11/7/16	6:43	33	CTD	23.8878	-20.6900			990			600		Bottle 10/11
11/7/16	6:48	33	CTD	23.8878	-20.6900			990			500		Bottle 12/13
11/7/16	6:52	33	CTD	23.8878	-20.6900			990			400		Bottle 14/15
11/7/16	6:56	33	CTD	23.8878	-20.6900			990			300		Bottle 16/17
11/7/16	7:00	33	CTD	23.8878	-20.6900			990			200		Bottle 18/19
11/7/16	7:05	33	CTD	23.8878	-20.6900			990			100		Bottle 20/21
11/7/16	7:09	33	CTD	23.8878	-20.6900			990			50		Bottle 22
11/7/16	7:12	33	CTD	23.8878	-20.6900			990			5		Bottle 23/24
11/7/16	7:17	33	CTD	23.8878	-20.6900			990					CTD on deck

11/7/16	7:49	34	SWATH	23.8515	-20.7203	4.3	11.9	1002					Start survey line 9 northwards
11/7/16	9:31	34	SWATH	23.0053	-20.6963	5.5		2413					Increase speend to 10 knots, end of extra line 4, heading
11/7/16	10:29	34	SWATH	23.0964	-20.8605	5.5		4224					START OF LINE #1
11/7/16	14:45	34	SWATH	23.7036	-20.9230	5.5		4276					END OF LINE #1
11/7/16	15:12	34	SWATH	23.7011	-20.8869	5		4282					START OF LINE #2
11/7/16	19:55	34	SWATH	24.0927	-20.8250	5		4162					END OF LINE #2
11/7/16	20:20	34	SWATH	24.0859	-20.7890	6	193	4166					START OF LINE #3 (line count 163)
11/8/16	0:40	34	SWATH	24.7262	-20.8551	5.6	83	4274					END OF LINE #3
11/8/16	1:03	34	SWATH	23.6881	-20.8276	5.2	006	4266					START OF LINE #4 (line count 165)
11/8/16	3:03	34	SWATH	23.8720	-20.7989	5.4	013	1881					END OF LINE #4 (line count 167)
11/8/16	3:18	34	SWATH	23.8654	-20.7839	5.5	189	2322					START OF LINE #5 (line count 168)
11/8/16	5:15	34	SWATH	23.6894	-20.8112	5.1	144	4260					END OF LINE #5, steaming towards line #15 (line count
11/8/16	6:13	34	SWATH	23.6701	-20.6510	4.9	015	4172					START LINE #15, new sbp file started (line count 170)
11/8/16	9:15	34	SWATH	23.9309	-20.6100	5.1	334	3369					END Line (lc 171) #15
11/8/16	10:07	35	CTD	23.8563	-20.7105		67	1015					On station for CTD #4
11/8/16	10:12	35	CTD	23.8563	-20.7105			1004					CTD in the water
11/8/16	10:44	35	CTD	23.8563	-20.7105			1006				1005	CTD at bottom
11/8/16	10:46	35	CTD	23.8563	-20.7105			1005				1005	Bottles #1+2
11/8/16	10:51	35	CTD	23.8563	-20.7105			1004				900	Bottles #3+4
11/8/16	10:56	35	CTD	23.8563	-20.7105			997				800	Bottle #5

11/8/16	10:59	35	CTD	23.8563	-20.7105			1004				750	Bottle #6
11/8/16	11:01	35	CTD	23.8563	-20.7105			1002				725	Bottle #7
11/8/16	11:04	35	CTD	23.8563	-20.7105			1005				700	Bottle #8
11/8/16	11:06	35	CTD	23.8563	-20.7105			1002				675	Bottle #9
11/8/16	11:09	35	CTD	23.8563	-20.7105			1005				650	Bottle #10
11/8/16	11:12	35	CTD	23.8563	-20.7105			1006				600	Bottle #11
11/8/16	11:15	35	CTD	23.8563	-20.7105			1007				550	Bottle #12
11/8/16	11:18	35	CTD	23.8563	-20.7105			1003				500	Bottle #13
11/8/16	11:21	35	CTD	23.8563	-20.7105			1003				450	Bottle #14
11/8/16	11:23	35	CTD	23.8563	-20.7105			1003				400	Bottle #15
11/8/16	11:26	35	CTD	23.8563	-20.7105			1003				350	Bottle #16
11/8/16	11:29	35	CTD	23.8563	-20.7105			1003				300	Bottle #17
11/8/16	11:33	35	CTD	23.8563	-20.7105			1005				200	Bottle #18
11/8/16	11:35	35	CTD	23.8563	-20.7105			1004				150	Bottle #19
11/8/16	11:38	35	CTD	23.8563	-20.7105			1005				125	Bottle #20
11/8/16	11:40	35	CTD	#VALUE!	-20.7105			1005				100	Bottle #21
11/8/16	11:43	35	CTD	23.8563	-20.7105			1005				75	Bottle #22
11/8/16	11:45	35	CTD	23.8563	-20.7105			996				50	Bottle #23
11/8/16	11:48	35	CTD	23.8563	-20.7105			996				25	Bottle #24
11/8/16	11:52	35	CTD	23.8563	-20.7105			996				0	CTD on deck

11/8/16	11:59	TRANSIT	TRANSIT	23.8240	-20.7102			1018					On route to CTD #9
11/8/16	13:03	36	CTD	23.8240	-20.7187			1054					On position for CTD #9
11/8/16	13:05	36	CTD	23.8240	-20.7186			1055					CTD in water
11/8/16	13:34	36	CTD	23.8240	-20.7187			1055				1059,6	CTD reached bottom: bottle #1 fired
11/8/16	13:35	36	CTD	23.8240	-20.7187							1059	Bottles #2 and 3 fired
11/8/16	13:40	36	CTD	23.8240	-20.7187							901	Bottle #4
11/8/16	13:41	36	CTD	23.8240	-20.7187							901	Bottle #5
11/8/16	13:41	36	CTD	23.8240	-20.7187							901	Bottle #6
11/8/16	14:06	36	CTD	23.8240	-20.7187			1053					CTD on deck
11/8/16	14:10	TRANSIT	TRANSIT	23.8241	-20.7182			1056					moving to station 37
11/8/16	14:52	37	CTD	23.8111	-20.6484			3357					On station 37
11/8/16	15:15	37	CTD	23.8112	-20.6484			3376					CTD in water
11/8/16	16:14	37	CTD	23.8112	-20.6484			3369					CTD at bottom
11/8/16	16:14	37	CTD	23.8112	-20.6484							3301	Bottle #1
11/8/16	16:15	37	CTD	23.8112	-20.6484							3301	Bottle #2
11/8/16	16:30	37	CTD	23.8112	-20.6484							2502	Bottle #3
11/8/16	16:31	37	CTD	23.8112	-20.6484							2402	Bottle #4
11/8/16	16:35	37	CTD	23.8112	-20.6484							2402	Bottle #5
11/8/16	16:35	37	CTD	23.8112	-20.6484							2402	Bottle #6
11/8/16	16:41	37	CTD	23.8112	-20.6484							2202	Bottle #7

11/8/16	16:41	37	CTD	23.8112	-20.6484							2202	Bottle #8
11/8/16	16:47	37	CTD	23.8112	-20.6484							2203	Bottle #9
11/8/16	16:48	37	CTD	23.8112	-20.6484							2202	Bottle #10
11/8/16	16:53	37	CTD	23.8112	-20.6484							1803	Bottle #11
11/8/16	16:57	37	CTD	23.8112	-20.6484							1803	Bottle #12
11/8/16	16:59	37	CTD	23.8112	-20.6484							1604	Bottle #13
11/8/16	16:59	37	CTD	23.8112	-20.6484							1604	Bottle #14
11/8/16	17:03	37	CTD	23.8112	-20.6484							1504	Bottle #15
11/8/16	17:03	37	CTD	23.8112	-20.6484							1504	Bottle #16
11/8/16	17:07	37	CTD	23.8112	-20.6484							1404	Bottle #17
11/8/16	17:07	37	CTD	23.8112	-20.6484							1404	Bottle #18
11/8/16	17:13	37	CTD	23.8112	-20.6484							1204	Bottle #19
11/8/16	17:13	37	CTD	23.8112	-20.6484							1204	Bottle #20
11/8/16	17:18	37	CTD	23.8112	-20.6484							1005	Bottle #21
11/8/16	17:18	37	CTD	23.8112	-20.6484							1005	Bottle #22
11/8/16	17:22	37	CTD	23.8112	-20.6484							905	Bottle #23
11/8/16	17:23	37	CTD	23.8112	-20.6484								Bottle #24
11/8/16	17:44	37	CTD	23.8112	-20.6484			3352					CTD on deck
11/8/16	17:49		TRANSIT			10	330						In transit to next station #38
11/8/16	18:42	38	AUV	23.9116	-20.7159	0.3	85						On station 38, AUV mission 129

11/8/16	19:01	38	AUV	23.9118	-20.7137								AUV in water
11/8/16	21:15		TRANSIT			10.3	094						Transit to ROV dive site
11/8/16	22:01	39	ROV	23.8901	-20.5634		050						on station but concerns about wind speed
11/8/16	22:40	39	ROV	23.8897	-20.5649			2661					ROV in Water
11/9/16	0:21	39	ROV						23.8900	-20.5615	2662		ROV at bottom, start of dive 300
11/9/16	0:30	39	ROV										White balance correction
11/9/16	0:39	39	ROV						23.8900	-20.5615	2660		start of survey
11/9/16	0:54	39	ROV						23.8895	-20.5629	2702		stop for sampling: biology
11/9/16	1:03	39	ROV						23.8895	-20.5629	2701		Sample #1, piece of coral, black slurp champer
11/9/16	1:05	39	ROV						23.8895	-20.5629	2701		Sample #2, piece of sponge, black slurp chamber
11/9/16	1:11	39	ROV						23.8895	-20.5629	2701		rock sampling attempt failed, moving on
11/9/16	1:20	39	ROV						23.8894	-20.5638	2716		change of zoom at scorpio camera to compile with Lizzies
11/9/16	1:22	39	ROV						23.8894	-20.5638	2716		stop for sampling attempt
11/9/16	1:27	39	ROV						23.8894	-20.5638	2714		no sample taken, all material solid, moving on
11/9/16	1:34	39	ROV						23.8895	-20.5641	2713		Sample #3, manipulator arm, crust with coral, starboard
11/9/16	1:39	39	ROV										scorpio camera checked, all ok
11/9/16	1:43	39	ROV						23.8897	-20.5648	2696		stop for sampling attempt
11/9/16	1:49	39	ROV						23.8897	-20.5648	2696		Sample #4, Manipulator arm, starboard carte No. 2, Crust
11/9/16	1:52	39	ROV						23.8897	-20.5648	2694		moving on
11/9/16	2:03	39	ROV										scorpio camera checked, adjusted

11/9/16	2:07	39	ROV						23.8894	-20.5662	2663		stop for sampling attempt
11/9/16	2:18	39	ROV						23.8895	-20.5662	2662		sample #5, manipulator arm, starboard crate 3, crust
11/9/16	2:22	39	ROV						23.8895	-20.5662	2662		sample #6, manipulator arm, starboard crate 4, small
11/9/16	2:28	39	ROV										scorpio camera checked
11/9/16	2:30	39	ROV						23.8893	-20.5666	2645		moving on
11/9/16	2:43	39	ROV						23.8891	-20.5678	2608		coral debris associated withs ediment covering seafloor,
11/9/16	2:47	39	ROV						23.8891	-20.5680	2606		stop for sampling attempt
11/9/16	2:57	39	ROV						23.8891	-20.5682	2605		sample #7, manipulator arm, starboard crate 6,
11/9/16	3:01	39	ROV						23.8891	-20.5681	2603		moving on, sediment with coral debris
11/9/16	3:13	39	ROV						912.1500	-20.5687	2580		stop fpr sampling
11/9/16	3:16	39	ROV						23.8892	-20.5686	2581		sample #8, manipulator arm, starboard crate 5, crust with
11/9/16	3:19	39	ROV						23.8892	-20.5687	2576		moving on, sediment associated with Mn-coated crust
11/9/16	3:25	39	ROV						23.8893	-20.5689	2569		stop for sampling
11/9/16	3:39	39	ROV						23.8893	-20.5690	2567		sampling abandoned, in-situ rocks, to difficult to sample,
11/9/16	4:02	39	ROV						23.8898	-20.5710	2570		stopping for sampling
11/9/16	4:07	39	ROV						23.8898	-20.5709	2567		Sample #9, manipulator arm, starboard crate no.9, shiny,
11/9/16	4:09	39	ROV						23.8898	-20.5709	2567		Sample #10, smaller crust fragment, starboard crate no.
11/9/16	4:11	39	ROV						23.8898	-20.5709	2567		Sample #11, small crust fragment, starboard crate no. 11
11/9/16	4:13	39	ROV						23.8898	-20.5710	2567		continue on track, crust with sediment cover
11/9/16	4:20	39	ROV						23.8895	-20.5716	2579		WP 02

11/9/16	4:22	39	ROV						23.8894	-20.5716	2579		doppler reset
11/9/16	4:31	39	ROV						23.8899	-20.5720	2357		stopped to sample
11/9/16	4:40	39	ROV						23.8899	-20.5720	2556		abandon sampling, continue on track, volcanic-crust
11/9/16	4:48	39	ROV						23.8904	-20.5723	2566		restart of OFOP, (crashed at 04:25, recovered 04:40)
11/9/16	5:12	39	ROV										check pf Scorpio camera
11/9/16	5:13	39	ROV						23.8918	-20.5745	2576		sediment with corel debris covering Fe/Mn crust, ~ 5 %
11/9/16	5:26	39	ROV						23.8927	-20.5756	2565		corel debris
11/9/16	5:40	39	ROV						23.8935	-20.5764	2553		sediment with corel debris, rare pieces of crust, <10%
11/9/16	5:42	39	ROV										Scorpio camera setting ok
11/9/16	5:50	39	ROV						23.8940	-20.5772	2538		corel debris and sediment covering Mn crust, sponges and
11/9/16	5:59	39	ROV						23.8945	-20.5781	2524		Mn crust outcrop, almost no sediment present, no coral
11/9/16	6:09	39	ROV						23.8947	-20.5791	2499		stop for sampling
11/9/16	6:15	39	ROV						23.8947	-20.5791	2499		Samle #12, manipulator arm, grey box no. 1, encrusted
11/9/16	6:17	39	ROV						23.8948	-20.5791	2499		moving on
11/9/16	6:18	39	ROV										Scorpio camera checked
11/9/16	6:31	39	ROV						23.8955	-20.5805	2468		sediment and coral debris covering outcroping Mn-coated
11/9/16	6:34	39	ROV										Scorpio camera checked
11/9/16	6:42	39	ROV						23.8960	-20.5812	2439		sediment with coral debris on top of encrusted rocks, <5%
11/9/16	6:45	39	ROV						23.8961	-20.5814	2438		stopping to sample
11/9/16	6:50	39	ROV						23.8961	-20.5814	2438		Sample #13, gey box no. 2, manipulator arm, <10 cm

11/9/16	6:53	39	ROV						23.8961	-20.5814	2438		Sample #14, grey box no.2, manipulator arm, similar to
11/9/16	6:54	39	ROV						23.8961	-20.5816	2438		moving on
11/9/16	7:06	39	ROV						23.8972	-20.5822	2472		sediment with corel debris, covering rocks, rare sponges
11/9/16	7:08	39	ROV										doppler reset
11/9/16	7:09	39	ROV						23.8976	-20.5821	2485		WP03
11/9/16	7:20	39	ROV						23.8974	-20.5827	2480		sediment with corel debris, covering crust, rare sponges
11/9/16	7:22	39	ROV						23.8974	-20.5829	2480		crash of OFOP
11/9/16	7:23	39	ROV						23.8974	-20.5829	2480		stop for sampling
11/9/16	7:27	39	ROV						23.8974	-20.5829	2480		sample #15, manipulator arm, grey box no. 4, encrusted
11/9/16	7:56	39	ROV						23.8972	-20.5853	2419		sediment with corel debris on top encrusted
11/9/16	7:59	39	ROV						23.8972	-20.5854	2418		stop for sampling
11/9/16	8:02	39	ROV						23.8972	-20.5854	2416		sample #16, manipulator arm, starboard crate no.2, piece
11/9/16	8:21	39	ROV						23.8971	-20.5854	2411		rock sampling attempt failed, moving on
11/9/16	8:31	39	ROV						23.8967	-20.5858	2377		stop for sampling
11/9/16	8:38	39	ROV						23.8967	-20.5691	2377		sample #17, manipulator arm, portside crate no. 1,
11/9/16	8:42	39	ROV						23.8967	-20.5691	2377		sample #18, corel, slurp chamber green
11/9/16	8:43	39	ROV						23.8967	-20.5691	2377		white balance check
11/9/16	8:46	39	ROV						23.8967	-20.5691	2377		restart track to WP04
11/9/16	8:50	39	ROV						23.8967	-20.5691	2377		small blue hop to rjoin track
11/9/16	8:51	39	ROV						23.8970	-20.5864	2430		rejoined track

11/9/16	8:53	39	ROV						23.8970	-20.5865	2430		stopped to take sample
11/9/16	9:01	39	ROV						23.8970	-20.5865	2430		sample #19, ~1cm, smooth crust around core, portside
11/9/16	9:04	39	ROV						23.8970	-20.5865	2430		drop a weight
11/9/16	9:06	39	ROV						23.8970	-20.5865	2430		finish sampling and moving on
11/9/16	9:07	39	ROV						23.8969	-20.5867	2423		doppler reset
11/9/16	9:17	39	ROV						23.8970	-20.5874	2400		restart screen overlay
11/9/16	9:19	39	ROV						23.8970	-20.5874	2400		moving on
11/9/16	9:29	39	ROV						23.8971	-20.5882	2367		moving into FeMn-encrusted columnar basalt (steep)
11/9/16	9:40	39	ROV						23.8968	-20.5889	2305		stopping for samples
11/9/16	9:45	39	ROV						23.8968	-20.5889	2306		sample #20, grey box no.3
11/9/16	9:47	39	ROV						23.8968	-20.5889	2306		continuing onwards
11/9/16	9:53	39	ROV						23.8967	-20.5895	2267		stopping to sample
11/9/16	9:55	39	ROV						23.8967	-20.5895	2267		sample #21, portside crate no. 3, smooth nodule
11/9/16	10:02	39	ROV						23.8967	-20.5895	2267		moving on
11/9/16	10:09	39	ROV						23.8966	-20.5899	2262		stopping to sample
11/9/16	10:11	39	ROV						23.8967	-20.5900	2263		sample #22, portside crate no. 4, smooth crust with
11/9/16	10:13	39	ROV						23.8967	-20.5900	2263		dropping weight
11/9/16	10:13	39	ROV						23.8966	-20.5900	2262		MOVING ON CRUST PAVEMENT
11/9/16	10:25	39	ROV						23.8965	-20.5907	2236		THICK, BOTROYDAL CRUST WTIH VISIBLE LAYERING BUT
11/9/16	10:34	39	ROV						23.8963	-20.5913	2220		STOP TO SAMPLE

11/9/16	10:31	39	ROV						23.8963	-20.5915	2214		MOVING ALONG CRUST OF PAVEMENT LOOKING FOR
11/9/16	11:03	39	ROV						23.8963	-20.5917	2215		SAMPLE JC142_039_023 INTO PT CRATE 4 (PLUG-SHAPED
11/9/16	11:06	39	ROV						23.8963	-20.5917	2215		SAMPLE JC142_039_024 INTO PT CRATE 5 (FeMn CRUST
11/9/16	11:10	39	ROV						23.8963	-20.5917	2215		MOVING ON
11/9/16	11:18	39	ROV						23.8965	-20.5925	2218		AT WP4
11/9/16	11:20	39	ROV						23.8965	-20.5924	2216		DOPPLER RESET
11/9/16	11:22	39	ROV						23.8965	-20.5924	2216		CHANGE COURSE TO 220° FOR 1200 m TO NEXT WP
11/9/16	11:22	39	ROV						23.8964	-20.5924	2215		STOPPING TO SAMPLE
11/9/16	11:24	39	ROV						23.8964	-20.5924	2215		JC142_039_025 INTO PT CRATE 6 (FeMn CRUST,
11/9/16	11:26	39	ROV						23.8964	-20.5924	2215		MOVING ON
11/9/16	12:10	39	ROV						23.8962	-20.5927			TRANSECTING ON ROCKS, PATCHY CRUSTS PRESENT
11/9/16	12:13	39	ROV						23.8944	-20.5946	2063		STOPPED TO SAMPLE
11/9/16	12:40	39	ROV						23.8924	-20.5963	2065	220	STOPPING TO SAMPLE, NOT COLLECTED
11/9/16	12:45	39	ROV						23.8924	-20.5963	2065	217	MOVING ALONG CRUST PAVEMENT LOOKING FOR
11/9/16	12:59	39	ROV						23.8919	-20.5968	2036	210	STOOPING TO SAMPLE, NOT COLLECTED
11/9/16	13:06	39	ROV						23.8918	-20.5968	2037	221	MOVING ALONG CRUST PAVEMENT LOOKING FOR
11/9/16	13:09	39	ROV						23.8917	-20.5969	2033	221	STOP TO SAMPLE
11/9/16	13:16	39	ROV						23.8917	-20.5969	2033	264	SAMPLE JC142_039_27 INTO PT CRATE 7
11/9/16	13:20	39	ROV						23.8916	-20.5969	2030	230	MOVING ON
11/9/16	13:49	39	ROV						23.8902	-20.5980	1068	310	STOOPING TO SAMPLE, NOT COLLECTED

11/9/16	14:00	39	ROV						23.8903	-20.5986	1957	222	STOP TO SAMPLE - JC142_039_28 - SAMPE INTO WEIGHT
11/9/16	14:06	39	ROV						23.8903	-20.5986	1957	222	SAMPLE JC142_039_29
11/9/16	14:09	39	ROV						23.8902	-20.5867	1940	22	LEAVING BOTTOM
11/9/16	15:34	39	ROV	23.8903	-20.6148			1969					ROV AT SURFACE
11/9/16	15:45	39	ROV	23.8903	-20.6148			1969					ROV OUT OF WATER
11/9/16	15:45	39	ROV	23.8903	-20.6148			1969					ROV ON DECK
11/9/16	16:10		TRANSIT										IN TRANSIT TO AUV PICK LOCATION
11/9/16	16:42	40	AUV	23.8896	-20.6553	0.5	67	1068					ON ST40 FOR AUV PICKUP
11/9/16	17:40	40	AUV	23.8833	19.3394	0.5	359	1034					AUV ON DECK.
11/9/16	17:44		TRANSIT										IN TRANSIT TO ST41
11/9/16	18:38	41	INC	23.8982	-20.7347		65	1366					INCUBATOR IN WATER
11/9/16	20:51	41	INC	23.8982	-20.7347		58	1370					INCUBATOR ON DECK
11/9/16	21:25		TRANSIT	23.9041	-20.7138		70	1020					MOVING TO ST42
11/9/16	22:24	42	CTD	23.9439	-20.5854	0.3	71	3870					ON STATION HRW CTD #15
11/9/16	22:30	42	CTD	23.9439	-20.5854	0.3	71	3870					CTD IN WATER
11/10/16	0:02	42	CTD	23.9439	-20.5854	0.3	71	3870				3889	CTD AT BOTTOM
11/10/16	0:03	42	CTD	23.9439	-20.5854	0.3	71	3870				3889	BOTTLED 2 FIRED
11/10/16	0:37	42	CTD	23.9439	-20.5854	0.3	71	3870				2002	BOTTLED 10 FIRED
11/10/16	0:52	42	CTD	23.9439	-20.5854	0.3	71	3870				1205	BOTTLED 18 FIRED
11/10/16	1:19	42	CTD	23.9439	-20.5854	0.3	71	3870					CTD ON DECK

11/10/16	1:25		TRANSIT	23.9439	-20.5854	1.1	88	3872					MOVING TO ST 43 - (CTD #14)
11/10/16	2:17	43	CTD	23.9741	-20.6434	0.5	30	3039					ON STATION HRW CTD #14
11/10/16	2:32	43	CTD	23.9745	-20.6435	0.1		3187					CTD IN THE WATER
11/10/16	3:42	43	CTD	23.9745	-20.6435	0.1		3187				3135	CTD AT BOTTOM (MAXIMUM WIRE OUT)
11/10/16	3:42	43	CTD	23.9745	-20.6435	0.1		3187				3135	BOTTLED #1 FIRED
11/10/16	3:55	43	CTD	23.9745	-20.6435	0.1		3187				2500	BOTTLED #7 FIRED
11/10/16	4:14	43	CTD	23.9745	-20.6435	0.1		3187				1500	BOTTLED #13 FIRED
11/10/16	4:25	43	CTD	23.9745	-20.6435	0.1		3187				1000	BOTTLED #19 FIRED
11/10/16	4:50	43	CTD	23.9745	-20.6435	0.1		3187				0	CTD ON DECK
11/10/16	4:55		TRANSIT			10.2	304						on transit to station 44, CTD#13
11/10/16	5:53	44	CTD	24.0260	-20.7088	0.2		3136					on station for HRW CTD #13
11/10/16	5:57	44	CTD	24.0260	-20.7087	0.1		3162					CTD in the water
11/10/16	7:10	44	CTD	24.0260	-20.7088	0.1		3173				3210	CTD AT BOTTOM (MAXIMUM WIRE OUT)
11/10/16	7:12	44	CTD	24.0260	-20.7088	0.1		3173				3210	Bottle 1 fired
11/10/16	7:35	44	CTD	24.0260	-20.7088	0.1		3173				2000	bottle 5 fired
11/10/16	7:51	44	CTD	24.0260	-20.7088	0.1		3173				1400	bottle 11 fired
11/10/16	8:05	44	CTD	24.0260	-20.7088	0.1		3173				700	bottle 22 fired
11/10/16	8:23	44	CTD	24.0260	-20.7088	0.1		3173				20	bottle 23 fired
11/10/16	8:29	44	CTD	24.0260	-20.7088	0.1		3173				0	CTD on deck
11/10/16	8:40		TRANSIT										On transit to wire stream station

11/10/16	9:41	45	ROV CABLE	23.9820	-20.7927	0.2		3615					On station for ROV cable stream
11/10/16	9:47	45	ROV CABLE	23.9820	-20.7927	0.1		3619					Streaming Cable
11/10/16	11:43	45	ROV CABLE	23.9820	-20.7927	0.2		3617					Cntinue Streaming Cable
11/10/16	19:36	45	ROV CABLE	24.0123	-20.8178	0.2	98	3980					ROV cable back on board
11/10/16	19:40		TRANSIT			10.1	103						In transit to ST46
11/10/16	20:30	46	AUV	23.9754	-20.6870			1382					On station 46
11/10/16	20:36	46	AUV	23.9754	-20.6870								AUV fish deployment
11/10/16	20:45	46	AUV										Ship ACOUSTICS TURNED OFF
11/10/16	21:01	46	AUV	23.9765	-20.6849	0.8	61	1376					AUV in water
11/10/16	21:19	46	AUV	23.9757	-20.6833	1.3	60	1376					Starting 1 km circle
11/10/16	21:30	46	AUV	23.9754	-20.6898	2	117	1376					Abort circle so James can get Comms with AUV
11/10/16	22:39	46	AUV	23.9709	-20.6868	0.2	35	1290					AUV released on way
11/10/16	22:49	46	AUV										Fish out of water
11/10/16	22:56	---	TRANSIT				196						In transit toStation 47
11/10/16	23:50	47	ROV	23.8908	-20.7195		32	1015					On station 47
11/11/16	0:13	47	ROV	23.8899	-20.7201								ROV in water
11/11/16	0:20	47	ROV	23.8900	-20.7201								Dive start
11/11/16	0:21	47	ROV	23.8900	-20.7201								Kipros Recording
11/11/16	1:11	47	ROV						23.8902	-20.7186			ROV at bottom
11/11/16	1:27	47	ROV						23.8910	-20.7189			Starting towards WP1, some blocks of crust (10-20%)

11/11/16	1:29	47	ROV										At WP1 - 100% sed
11/11/16	1:35	47	ROV						23.8910	-20.7183			Botroidal slope Mn crusts
11/11/16	1:36	47	ROV						23.8910	-20.7182			Pavement, slope
11/11/16	1:37	47	ROV										100% sediment
11/11/16	1:39	47	ROV										Scarp - mostlys eidmented, top Mn crusts
11/11/16		47	ROV										Top scarp - Mn crcust pavement
11/11/16	1:43	47	ROV						23.8909	-20.7177			stopping on pavement, trying to sample, too solid,
11/11/16	1:53	47	ROV										stopping to drill
11/11/16	2:15	47	ROV						23.8909	-20.7180			Drill on seafloor, 10 (corner) 5 (straight) @ top metal
11/11/16	2:22	47	ROV										Begin drilling
11/11/16	2:31	47	ROV										At 15cm level with metal block
11/11/16	2:37	47	ROV										At 20cm level with metal block
11/11/16	2:43	47	ROV										At 25cm - hard to see behind weight
11/11/16	2:47	47	ROV										White dust (previously beige)
11/11/16	2:49	47	ROV										At almost full penetration, pulling out
11/11/16	2:51	47	ROV										Drill bit out
11/11/16	3:03	47	ROV										Attempting to recover core
11/11/16	3:07	47	ROV										Core captured
11/11/16	3:09	47	ROV										Core stored in drawer Yellow 3 core catcher
11/11/16	3:12	47	ROV						23.8909	-20.7176			On to WP2

11/11/16	3:14	47	ROV						23.8909	-20.7175			Stopping to sample
11/11/16	3:20	47	ROV						23.8910	-20.7174			Stopping to sample dead coral
11/11/16	3:25	47	ROV						23.8910	-20.7174			Sample dead coral - 002, in STB Crate 3
11/11/16	3:28	47	ROV						23.8910	-20.7174			Second sample dead coral - 003, in stb crate 3
11/11/16	3:32	47	ROV						23.8910	-20.7173			stopping to sample, failed
11/11/16	3:37	47	ROV										moving again
11/11/16	3:40	47	ROV										stopping to sample
11/11/16	3:43	47	ROV						23.8905	-20.7170			sampling crust 004 in pt crate 1
11/11/16	3:44	47	ROV										trying for second sample
11/11/16	3:47	47	ROV						23.8910	-20.7171	995		sample 5 in pt crate, crust piece from sediment
11/11/16	3:49	47	ROV										looking for third sample, failed
11/11/16	3:53	47	ROV						23.8910	-20.7171	994		heading to WP2
11/11/16	3:58	47	ROV						23.8912	-20.7164	995		Passing WP2 - boundary between sed and Mn crusts
11/11/16	4:22	47	ROV						23.8919	-20.7157	993		Scarp edge
11/11/16	4:23	47	ROV										Stopping to try and sample scarp edge
11/11/16	4:32	47	ROV										coral - solitary - dropped
11/11/16	4:37	47	ROV										stb crate 1 sample number 6
11/11/16	4:59	47	ROV										loose block/nodule from base slope taken, sample 7, crate
11/11/16		47	ROV						23.8919	-20.7154	997		sample 8 in next to pt crate, loose block from base slope
11/11/16	5:03	47	ROV						23.8922	-20.7154			edge aprox 120º strike, 1m high, Mn pavement above

11/11/16	5:05	47	ROV						23.8923	-20.7154	1004		edge crusts into 100% sed
11/11/16	5:22	47	ROV						23.8937	-20.7147	1011		stopping to sample small crust exposure
11/11/16	5:25	47	ROV										sample 9, small piece that has fallen off sedge in CP4
11/11/16	5:28	47	ROV						23.8937	-20.7147	1011		second sample in cp4, sample 10, slab same loc, sample 9
11/11/16	5:46	47	ROV										on toward WP5 (skipped others)
11/11/16	6:22	47	ROV						23.8977	-20.7134	1006		stopping to collect sample - loose rounded piece from on
11/11/16		47	ROV										sampling attempted but failed
11/11/16	6:25	47	ROV						23.8977	-20.7134	1006		dave edge drilling attempt
11/11/16	6:45	47	ROV						23.8977	-20.7134	1006		drilling about to start, initial fine = black, larger plume
11/11/16	6:47	47	ROV						23.8977	-20.7134	1006		drilling plume chnaged colour to beige
11/11/16	7:11	47	ROV						23.8977	-20.7134	1006		stopped drilling, preparing to retrieve core
11/11/16	7:26	47	ROV						23.8977	-20.7134	1006		sample retrieved - jc142_047_011 (drill core) into Yellow
11/11/16		47	ROV										fragment of sample 011 = top of core in 1Y
11/11/16	7:31	47	ROV						23.8977	-20.7134	1006		moving towards end of line
11/11/16	7:38	47	ROV										still just sediment
11/11/16	7:45	47	ROV						23.8988	-20.7129			bots and bobs of crust
11/11/16	7:49	47	ROV						23.8988	-20.7127			increase inc rust
11/11/16	7:52	47	ROV						23.8992	-20.7128			back to sediment
11/11/16	7:57	47	ROV						23.8999	-20.7141			still just sediment
11/11/16	8:00	47	ROV						23.9004	-20.7126			on ridge - will attempt to sample

11/11/16	8:13	47	ROV						23.9005	-20.7124	1009		sampling crust from ridge, sample number 12
11/11/16		47	ROV										box 5 stb
11/11/16	8:22	47	ROV						23.9005	-20.7124	1009		continue moving, sediment ahead
11/11/16	8:28	47	ROV						23.9010	-20.7127			small bits of crust exposed
11/11/16	8:47	47	ROV						23.9030	-20.7127			crusty pavement - will try sampling
11/11/16	9:07	47	ROV						23.9030	-20.7127			sampling proving difficult
11/11/16		47	ROV										ground underneath very solid
11/11/16	9:13	47	ROV						23.9030	-20.7127			sampled flat piece of pavement
11/11/16		47	ROV								1009		`sample 13 no7 stb crate
11/11/16	9:17	47	ROV						23.9030	-20.7127	1008		going to 20 altitude to search for bubbles in water column
11/11/16	9:17	47	ROV						23.9030	-20.7127			looking for evidence of bubbles
11/11/16	9:33	47	ROV						23.9030	-20.7127			no evidence found
11/11/16	9:35	47	ROV						23.9030	-20.7120			transect continuing on crust
11/11/16	9:47	47	ROV						24.0697	-20.7109			moving to next wp (6)
11/11/16	10:21	47	ROV						23.9001	-20.7096	1007		sediment plain
11/11/16	10:30	47	ROV						23.8993	-20.7092			heading off track
11/11/16	10:35	47	ROV						23.8987	-20.7069	1009		sampling for small nodules
11/11/16		47	ROV										sample 14 in portcrate 5
11/11/16		47	ROV										samples 15 and 16 in port crate 5
11/11/16		47	ROV										sample 17 in port crate 5

11/11/16		47	ROV										sample 18 in port crate 5
11/11/16	10:47	47	ROV						23.8983	-20.7084	1008		stopped to sample again
11/11/16		47	ROV										sample 19 and 20 in pt crate 6
11/11/16	10:54	47	ROV						23.8983	-20.7084	1008		sediment thickness half
11/11/16		47	ROV						23.8983	-20.7084	1008		crowbar
11/11/16	11:00	47	ROV						23.8982	-20.7084	1007		transecting across sediment again
11/11/16	11:02	47	ROV						23.8978	-20.7083	1008		stopping to attempt sampling
11/11/16	11:10	47	ROV						23.8978	-20.7083	1008		pushing crowbar in to test
11/11/16		47	ROV						23.8978	-20.7083	1008		sediment thickness half
11/11/16	11:12	47	ROV						23.8978	-20.7083	1008		decided to drill a hole through sediment
11/11/16	11:35	47	ROV						23.8978	-20.7083	1008		drill stuck, trying to free
11/11/16	11:39	47	ROV										freed - setting up drill
11/11/16	11:44	47	ROV						23.8978	-20.7083	1008		drilling hole - very quickly at limit - aprox. 3 mins drilling
11/11/16	12:02	47	ROV										trying to retrieve core - suceeded sample 21
11/11/16	12:08	47	ROV										nodule recovered - sample 22
11/11/16	12:10	47	ROV										nodule recovered - sample 23
11/11/16	12:12	47	ROV						23.8977	-20.7083	1008	158	ROV moving
11/11/16	12:29	47	ROV						23.8966	-20.7078	1007		ROV stop for sampling
11/11/16	12:36	47	ROV						23.8966	-20.7078	1007		ROV M/A slab - sample 24
11/11/16	12:42	47	ROV						23.8962	-20.7076	1006	157	ROV moving

11/11/16	12:51	47	ROV						23.8957	-20.7073	998		ROV hovering on crusts over columns
11/11/16	12:59	47	ROV						23.8956	-20.7073	999		ROV stopped to collect sample in situ - not grabbed
11/11/16	13:02	47	ROV										ROV moving positiong
11/11/16	13:07	47	ROV						23.8961	-20.7072	999		crust slab taken (sample 25)
11/11/16	13:12	47	ROV						23.8955	-20.7073	998		rov stopped to drill
11/11/16	13:17	47	ROV										drill in action
11/11/16	13:43	47	ROV										drilling stopped
11/11/16	13:56	47	ROV										core pushed through hole, blue core 2 on ROV, sample 26
11/11/16	14:00	47	ROV										core 3B inserted into hole too, core 3B on ROV (sample
11/11/16	14:08	47	ROV						23.8955	-20.7073	998		ROV moving up
11/11/16	14:51	47	ROV										ROV CTD stopped
11/11/16	15:01	47	ROV	23.8934	-20.7085								ROV at surface
11/11/16	15:09	47	ROV	23.8934	-20.7086								ROV on deck
11/11/16	15:35		TRANSIT	23.9000	-20.7349	7.4	278	1484					Transit to recover AUV
11/11/16	16:03	48	AUV	23.9088	-20.7791			1261					AUV recovery: on station
11/11/16	18:25	48	AUV	23.9085	-20.7799		57	1278					AUV on surface
11/11/16	18:42	48	AUV	23.9101	-20.7805		56	1336					AUVonboard
11/11/16	18:55		TRANSIT			9	90						in transit to station 49
11/11/16	19:36	49	ADCP	23.9138	-20.6916			1049					on station
11/11/16	19:45	49	ADCP										starting 1 km radius 360 circle to calibrate ADCP while inc.

11/11/16	20:50	49	ADCP	23.9138	-20.6916	0.5	40	1004					completed ADCP test
11/11/16	21:18	50	INCUBATOR	23.9138	-20.6900	0.3	274	1053					Incubator in water
11/12/16	20:00	50	INCUBATOR	23.9138	-20.6900	0.1							Incubator recovering
11/12/16	20:37	50	INCUBATOR	23.9138	-20.6900								Incubator on deck
11/12/16	21:03		TRANSIT										in transit to station 51, CTD HRW#12
11/12/16	21:48	51	CTD	23.9985	-20.7739	0.2	84						arrive on station
11/12/16	22:19	51	CTD	23.9984	-20.7739								CTD in water
11/12/16	23:23	51	CTD									3614	Bottle #2 fired
11/12/16	23:37	51	CTD									3005	Bottle #6fired
11/12/16	23:44	51	CTD									2755	Bottle #10 fired
11/12/16	23:50	51	CTD									2506	Bottle #14 fired
11/12/16	23:57	51	CTD									2255	Bottle #19 fired
11/13/16	0:03	51	CTD									2005	Bottle #22fired
11/13/16	0:44	51	CTD	23.9984	-20.7739	0.1							CTD on deck
11/13/16	2:10												Problem with winch for gravity corer, trying to fix problem
11/13/16	4:25		TRANSIT	23.9985	-20.7740	1.9							starting transit to SBP line, winch stil not working
11/13/16													increased SBP pulse rate
11/13/16	4:42		SBP	24.0088	-20.8117	6.6						4040	starting SBP line
11/13/16	5:04		SBP	24.0092	-20.8457			4153					END SBP LINE - TURNING TO COME BACK ALONE - SAME
11/13/16	5:17		SBP	24.0092	-20.8457			4157					COMING BACK ALONG LINE

11/13/16	5:35	52	GC	24.0091	-20.8282			4081					ON STATION FOR GC - WILL RUN WINCH MANUALLY
11/13/16	5:44	52	GC	24.0091	-20.8283			4079					GC IN THE WATER
11/13/16	5:51	52	GC										WIRE COUNT NOT WORKING - TRYING TO FIX IT
11/13/16	6:01	52	GC										GC BACK ON DECK
11/13/16	6:21	53	MB	24.0091	-20.8283			4081					STARTING TOWARDS LINE 16 MB SURVEY
11/13/16	7:50	53	MB										2 km FROM START LINE
11/13/16	8:11	53	MB	24.9163	-20.5962		16	3599					START SURVEY LINE (233)
11/13/16	9:18	53	MB										REDUCING MB SWATH WIDTH 30/30 BECAUSE OF WAVES
11/13/16	9:59	53	MB	24.0480	-20.5755			3999					Beam back to 45, MB crahed for 5 minutes
11/13/16	10:11	53	MB	24.0620	-20.5712								end of line
11/13/16	10:14		TRANSIT	24.0624	-20.5706								heading to AUV launch position (station 54)
11/13/16	12:11	54	AUV	23.8071	-20.7202								on station for AUV launch
11/13/16	12:34	54	AUV	23.8080	-20.7187								AUV in the water
11/13/16	14:07	54	AUV	23.8035	-20.7201			1124					fish up
11/13/16	14:08		TRANSIT										in transit to station 55
11/13/16	14:39	55	ROV	23.7505	-20.7184	0.4							on station for launch
11/13/16	15:14	55	ROV	23.7500	-20.7188								ROV in water
11/13/16	16:57	55	ROV						23.7501	-20.7184	2685		bottom in sight
11/13/16	17:24	55	ROV										trying to sample
11/13/16	17:25	55	ROV										DOPPLER RESET

11/13/16	17:26	55	ROV										moving north
11/13/16	17:30	55	ROV						23.7501	-20.7185	2684		stopped to sample, sample #1
11/13/16		55	ROV						23.7508	-20.7185	2658		stopped to sample, not possible
11/13/16	18:02	55	ROV						23.7512	-20.7187	2654		sample #2
11/13/16	18:39	55	ROV						23.7524	-20.7188	2586		sample #3
11/13/16	18:46	55	ROV										moving north
11/13/16	19:10	55	ROV										DOPPLER RESET
11/13/16	19:19	55	ROV						23.7546	-20.7186	2498		stopped, trying to sample
11/13/16	19:21	55	ROV										sample #4, (2 pieces same sample)
11/13/16	19:28	55	ROV										moving
11/13/16	19:34	55	ROV						23.7549	-20.7188	2500		Niskin #1 fired (sample #5)
11/13/16	19:36	55	ROV									344	moving north
11/13/16	20:10	55	ROV						23.7570	-20.7196	2452	344	stopped
11/13/16	20:20	55	ROV										sample #6
11/13/16	20:24	55	ROV										sample #7
11/13/16	20:27	55	ROV									295	moving NW
11/13/16	20:40	55	ROV						23.7573	-20.7198	2449	288	sample#8
11/13/16	21:05	55	ROV						23.7578	-20.7198	2442	287	sample #9
11/13/16	21:35	55	ROV						23.7596	-20.7198	2420		sample attempt
11/13/16	21:49	55	ROV										moving NE

11/13/16	21:59	55	ROV						23.7604	-20.7198	2388		stop
11/13/16	22:07	55	ROV										sample #10
11/13/16	22:13	55	ROV										Niskin #3 fired (sample #11), NOTE: Niskin 2 is not good
11/13/16	22:15	55	ROV										DOPPLER RESET
11/13/16	22:16	55	ROV									019	moving NE
11/13/16	22:25	55	ROV						23.7612	-20.7189	2385		stop
11/13/16	22:40	55	ROV						23.7612	-20.7189	2385		sample 12 collected
11/13/16	22:43	55	ROV									19	moving NE
11/13/16	22:58	55	ROV										DOPPLER RESET
11/13/16	23:01	55	ROV						23.7633	-20.7199	2386	80	heading E
11/13/16	23:05	55	ROV						23.7632	-20.7195	2366	60	change headig to 060°
11/13/16	23:13	55	ROV										DOPPLER RESET - heading to N
11/13/16	23:21	55	ROV						23.7644	-20.7185	2381		stop
11/13/16	23:30	55	ROV						23.7644	-20.7185	2381		sample #13 collected
11/13/16	23:40	55	ROV										niskin #4 fired (sample #14)
11/13/16	23:42	55	ROV									315	moving NW
11/14/16	0:26	55	ROV										looks like sediment - pavement again after 100%
11/14/16	1:18	55	ROV										doppler reset - bio transect (started ~01:10)
11/14/16	1:41	55	ROV						23.7716	-20.7146	2176		stopping to sample coral
11/14/16	1:47	55	ROV						23.7716	-20.7146	2176		sample #15 - coral slurp black

11/14/16	1:48	55	ROV						23.7716	-20.7146	2176		sample #16 - brittle star - slurp black
11/14/16	1:52	55	ROV										continuing NE
11/14/16	1:56	55	ROV										stopping to sample - it´s very solid
11/14/16	2:05	55	ROV										trying to sample again
11/14/16	2:07	55	ROV						23.7717	-20.7145	2164		sample taken - broken off cliff face - sample #17
11/14/16	2:11	55	ROV										moving again
11/14/16	2:27	55	ROV										stopping to sample coral with slurp
11/14/16	2:34	55	ROV						23.7727	-20.7136	2122		coral taken - sample #18 in slurp pipe
11/14/16	2:39	55	ROV										continuing
11/14/16	2:50	55	ROV										stopping to sample
11/14/16	2:53	55	ROV						23.7237	-20.7131	2178		sample broken off slab on slope - sample #19 in port crate
11/14/16	2:57	55	ROV										at WP06 - continuing on
11/14/16	3:00	55	ROV										heading upslope to fix wire
11/14/16	3:10	55	ROV						23.7740	-20.7141	2060		wire better - returning to line
11/14/16	3:20	55	ROV						23.7749	-20.7142	2070		transecting along contours
11/14/16	3:29	55	ROV						23.7752	-20.7142	2070		ofop crashed, resumed <30s
11/14/16	3:40	55	ROV						23.7759	-20.7147	2066		niskin bottle, sample #20 on top of crust
11/14/16	3:41	55	ROV										continuing
11/14/16	4:26	55	ROV						23.7795	-20.7156	2041		stopping to sample
11/14/16	4:30	55	ROV						23.7795	-20.7156	2041		sample #21 taken - loose block broken from edge

11/14/16	4:31	55	ROV										continuing on doppler reset
11/14/16	4:41	55	ROV						23.7802	-20.7154	2028		stopping to collect coral sample
11/14/16	4:44	55	ROV						23.7802	-20.7154	2028		sampled coral, sample #22 poss in slurp green or in tube
11/14/16	4:46	55	ROV										continuing on
11/14/16	5:12	55	ROV										Stopping to try and sample too tough - continuing on
11/14/16	5:16	55	ROV										stopping again to sample
11/14/16	5:17	55	ROV						23.7820	-20.7163	1935		sample block that has slid downslope - sample #23 in
11/14/16	5:20	55	ROV										at WP07 - heading off on bearing 045° - no payload left -
11/14/16	5:37	55	ROV						23.7332	-20.7158	1897		niskin #6, sample #24
11/14/16	6:00	55	ROV						23.7332	-20.7158	1897		end of dive - spectacular black coral
11/14/16	7:45	55	ROV						23.7823	-20.7159			ROV on surface
11/14/16	7:51	55	ROV										ROV on deck
11/14/16	8:05		TRANSIT										transit to AUV recovery - ST 56
11/14/16	9:25	56	AUV	23.9428	-20.8239		63						swath EM120 turned off - Auv on site for recovery
11/14/16	10:24	56	AUV	23.9567	-20.8317	2.1	187	3699					sub on surface end M131
11/14/16	11:05	56	AUV										AUV recovered, moving to CTD station
11/14/16	11:15		TRANSIT										In transit to CTD st 57
11/14/16	12:06	57	CTD	23.8980	-20.7937			1953					On station for CTD, CTD in water
11/14/16	12:52	57	CTD	23.8980	-20.7937			1953				1956	CTD AT BOTTOM (MAXIMUM WIRE OUT)
11/14/16	12:53	57	CTD	23.8980	-20.7937			1953				1950	Bottle 1 + 2 fired

11/14/16	12:54	57	CTD	23.8980	-20.7937			1953				1950	Bottle 3
11/14/16	12:58	57	CTD	23.8980	-20.7937			1953				1800	Bottle 4
11/14/16	12:59	57	CTD	23.8980	-20.7937			1953				1800	Bottle 5 + 6
11/14/16	13:04	57	CTD	23.8980	-20.7937			1953				1600	Bottle 7
11/14/16	13:05	57	CTD	23.8980	-20.7937			1953				1600	Bottle 8
11/14/16	13:06	57	CTD	23.8980	-20.7937			1953				1600	Bottle 9
11/14/16	13:08	57	CTD	23.8980	-20.7937			1953				1500	Bottle 10 + 11
11/14/16	13:10	57	CTD	23.8980	-20.7937			1953				1500	Bottle 12
11/14/16	13:13	57	CTD	23.8980	-20.7937			1953				1400	Bottle 13
11/14/16	13:14	57	CTD	23.8980	-20.7937			1953				1400	Bottle 14 + 15
11/14/16	13:19	57	CTD	23.8980	-20.7937			1953				1200	Bottle 16 + 17
11/14/16	13:20	57	CTD	23.8980	-20.7937			1953				1200	Bottle 18
11/14/16	13:25	57	CTD	23.8980	-20.7937			1953				1000	Bottle 19 + 20
11/14/16	13:26	57	CTD	23.8980	-20.7937			1953				1000	Bottle 21
11/14/16	13:30	57	CTD	23.8980	-20.7937			1953				900	Bottle 22 + 23
11/14/16	13:31	57	CTD	23.8980	-20.7937			1953				900	Bottle 24
11/14/16	13:56	57	CTD	23.8980	-20.7937			1863					CTD on deck
11/14/16	14:20												Transit to Station 58
11/14/16	15:05	58	ROV	23.9079	-20.6906			1022					ON STATION 58
11/14/16	15:37	58	ROV										ROV in water

11/14/16	16:19	58	ROV						23.9078	-20.6904	1012		Bottom in sight
11/14/16	16:29	58	ROV										DOPPLER RESET
11/14/16	16:33	58	ROV						23.9077	-20.6904	1018		Stop, sample 1 collected + sample 2, 3, 4, 5, 6, 7, big fish
11/14/16	16:48	58	ROV									147	Moving
11/14/16	16:57	58	ROV						23.9071	-20.6902	1016		Stop
11/14/16	17:01	58	ROV									107	Moving
11/14/16	17:01	58	ROV						23.9070	-20.6899	1016		Stop
11/14/16	17:12	58	ROV										Sample 8 collected
11/14/16	17:14	58	ROV									108	Moving
11/14/16	17:17	58	ROV										DOPPLER RESET
11/14/16	17:18	58	ROV						23.9069	-20.6894	1015		Stop
11/14/16	17:34	58	ROV										Start drilling
11/14/16	18:06	58	ROV										Core withdrawn (Sample 9)
11/14/16	18:40	58	ROV										Moving
11/14/16	18:41	58	ROV										DOPPLER RESET
11/14/16	18:43	58	ROV						23.9069	-20.6891	1014		Stop
11/14/16	18:46	58	ROV										Sample 10 collected
11/14/16	18:49	58	ROV										Moving
11/14/16	18:56	58	ROV						0.9068	-20.6885	1013		Stop
11/14/16	19:04	58	ROV										Start drilling

11/14/16	20:38	58	ROV										Drilling terminated
11/14/16	20:53	58	ROV										Drill case withdrawn (sample 11)
11/14/16	20:55	58	ROV										Moving
11/14/16	21:05	58	ROV						23.9070	-20.6883	1016		Stop. Terrace-like structure
11/14/16	21:11	58	ROV										Sample 12 collected
11/14/16	21:15	58	ROV										Giant crabs observed
11/14/16	21:21	58	ROV						23.9070	-20.6884	1015		Stop on top terrace
11/14/16	21:25	58	ROV										Sample 13 collected
11/14/16	21:31	58	ROV										Stop in front of terrace, immediately moves away
11/14/16	21:33	58	ROV						23.9069	-20.6880	1015		Seen layering of Mn-Fe alternate with an unknown
11/14/16	21:46	58	ROV						23.9066	-20.6875	1013		Stop. Sample 14 collected +15, 16, 17, 18, 19, 20 collected
11/14/16	22:03	58	ROV									164	Moving
11/14/16	22:32	58	ROV						23.9073	-20.6861	1016		Stop. Sample 21 collected
11/14/16	22:44	58	ROV									050	Moving
11/14/16	23:01	58	ROV						23.9079	-20.6852	1024		Stop
11/14/16	23:06	58	ROV										Sample 22
11/14/16	23:12	58	ROV									045	Moving
11/14/16	23:14	58	ROV						23.9083	-20.6851	1022		Stop. Niskin 1 fired (sample 23)
11/14/16	23:22	58	ROV									056	Moving
11/14/16	23:27	58	ROV						23.9084	-20.6842	1027		Stop

11/14/16	23:34	58	ROV										Sample 24 collection
11/14/16	23:50	58	ROV										Sample 25 collection
11/14/16	23:52	58	ROV										Samples 26 +27+28 collection
11/14/16	23:54	58	ROV						23.9085	-20.6837	1032		Stop, observing crust slabs dipping downslope.
11/14/16	23:55	58	ROV									033	Moving
11/14/16	23:58	58	ROV										Doppler reset
11/15/16	0:30	58	ROV						23.9074	-20.6825	1026		Stopping to drill on pavement area
11/15/16	0:38	58	ROV						23.9074	-20.6825	1026		Begun drilling, start corner met block fr. 5
11/15/16	0:49	58	ROV										Drill stalled repeatedly- will attempt to recover.
11/15/16	0:55	58	ROV										Drilling again
11/15/16	1:07	58	ROV										Stopping drilling ~25cm
11/15/16	1:08	58	ROV										Drill bit out- top looks a bit rubbly
11/15/16	1:22	58	ROV						23.9074	-20.6825			Core catcher into full depth and recovered- sample 29 in
11/15/16	1:23	58	ROV										Attempting to sample solitary coral- FAILED
11/15/16	2:16	58	ROV										stopping to sample in nodule field
11/15/16	2:19	58	ROV						23.9049	-20.6798			sample #30, elongate nodule, CS3
11/15/16	2:21	58	ROV										sample 31, lumpy nodule, CS1
11/15/16	2:29	58	ROV										doppler reset
11/15/16	2:35	58	ROV						23.9047	-20.6787	1018		stopping to drill
11/15/16	2:39	58	ROV						23.9047	-20.6787	1019		sample 32, Niskin 4, over pavement area

11/15/16	2:47	58	ROV										drill started
11/15/16	3:05	58	ROV						23.9047	-20.6787	1019		full penetration
11/15/16	3:10	58	ROV										drill bit out
11/15/16	3:19	58	ROV										sample 33, core stored in yellow 2,
11/15/16		58	ROV										continuing on bio transect (Allan cannot hold constant
11/15/16	3:50	58	ROV										at WP5, end of bio transect, doppler reset
11/15/16	4:25	58	ROV						23.9034	-20.6749	1024		stopping to drill on pavement area neard edge
11/15/16	4:29	58	ROV										starting to drill, ROV moved, stopped
11/15/16	4:29	58	ROV						23.9034	-20.6749	1024		trying again
11/15/16	4:46	58	ROV										appear to have hit hard layer, drill won't move further,
11/15/16		58	ROV										piece that fell out of core broken in 2 then broke again
11/15/16	4:59	58	ROV										will try to recover what is in drill hole, then move on and
11/15/16	5:04	58	ROV						23.9034	-20.6749	1024		sample 34, core in Y3
11/15/16	5:06	58	ROV						23.9034	-20.6749	1024		attempting to pick up bit that fell out of drill again
11/15/16	5:07	58	ROV						23.9034	-20.6749	1024		sanple 35, picked up onpiece CS4
11/15/16	5:12	58	ROV						23.9034	-20.6749	1024		sample 35A,B,C, 3 pieces of piece that dropped out, CS4
11/15/16	5:13	58	ROV						23.9034	-20.6749	1024		stopping to drill again
11/15/16	5:17	58	ROV						23.9034	-20.6749	1024		beginn drilling
11/15/16	5:42	58	ROV										drill no longer penetrating, stopping
11/15/16	5:44	58	ROV										drill out

11/15/16		58	ROV										sample 36, core recovered in G1
11/15/16	6:03	58	ROV										continuing on bio transect
11/15/16	6:29	58	ROV						23.9017	-20.6734	1019		stopping on pavement to drill
11/15/16	6:37	58	ROV						23.9017	-20.6734	1019		begin of driling
11/15/16	7:04	58	ROV										full penetration
11/15/16	7:09	58	ROV										drill bit out
11/15/16	7:14	58	ROV										core stuck in dril barrel, collecting anything left in hole
11/15/16		58	ROV										appears to be empty
11/15/16	7:23	58	ROV										core freed from barrel, trying to collect
11/15/16	7:25	58	ROV						23.9017	-20.6735	1018		sample 37, collected with arm in CS2, did not break
11/15/16	7:48	58	ROV										at WP6, continuing on to WP7
11/15/16	8:47	58	ROV						23.8984	-20.6705	1006		Sample 38, NISKIN 6, on pavement (5 failed)
11/15/16	8:49	58	ROV						23.8984	-20.6705	1006		continue moving on
11/15/16	10:16	58	ROV						23.8903	-20.6707	978		doppler reset
11/15/16		58	ROV						23.8903	-20.6707	978		moving towards WP9, bearing 110
11/15/16	10:16	58	ROV						23.8885	19.3330			sample 39, solitary coral
11/15/16	10:20	58	ROV						23.8885	19.3330			sample 40, 41 (lophilia), 42 (dead lophilia)
11/15/16	10:46	58	ROV						23.8880	-20.6675			stopping to drill on top mound, covered coral debris, no
11/15/16	10:48	58	ROV										start of drilling, stopped after 5 cm
11/15/16	11:03	58	ROV						23.8879	-20.6675	971		Sample 43, short piece drill core from sed/carb/coral area

11/15/16	11:06	58	ROV										lost GPS fix, back
11/15/16	11:12	58	ROV						23.8878	-20.6675			stopping to sample , isolated slabs, not loose
11/15/16	11:24	58	ROV						23.8878	-20.6675	976		stopping to drill
11/15/16	11:29	58	ROV						23.8878	-20.6675	975		start of drilling
11/15/16	11:43	58	ROV						23.8878	-20.6675	975		stop drilling
11/15/16	12:16	58	ROV						23.8887	-20.6676	976		
11/15/16	12:22	58	ROV						23.8886	-20.6676			core not recovered
11/15/16	12:26	58	ROV										ROV leaving seafloor
11/15/16	13:09	58	ROV										ROV at surface
11/15/16	13:17	58	ROV										ROV on deck
11/15/16	13:38		TRANSIT										transit to AUV launch site
11/15/16	14:30	59	CTD	23.8996	-20.7789			1234					CTD in the water
11/15/16	15:50	59	CTD	23.8996	-20.7789			1234					CTD in the back
11/15/16	16:10	60	AUV	23.9016	-20.7773	0.6	054	1172					AUV in the water
11/15/16	17:45		TRANSIT										in transit to station 61
11/15/16	18:45	61	ROV	23.9348	-20.6891			1155					on ROV station
11/15/16	19:17	61	ROV	23.9348	-20.6900			1135	23.9350	19.3100			ROV in the water
11/15/16	20:08	61	ROV						23.9347	19.3112			bottom in sight
11/15/16	20:58	61	ROV						23.9370	-20.6898	1150		Sample 001, (CP1)
11/15/16	21:14	61	ROV						23.9373	-20.6899			Sample 002, NISKIN Water, above lobate crust/sediment

11/15/16	21:44	61	ROV						23.9383	-20.6903	1134		stopped to drill, but then moved when weights added
11/15/16	22:08	61	ROV						23.9382	-20.6903	1134		Sample 003, grab sample port 04
11/15/16	22:10	61	ROV						23.9382	-20.6903	1134		Sample 004, nodule, grab sample port 04
11/15/16	22:11	61	ROV						23.9382	-20.6903	1134		Sample 005, nodule, grab sample port 04
11/15/16	22:15	61	ROV						23.9382	-20.6903	1134		Sample 006, nodule, grab sample port 04
11/15/16	22:44	61	ROV						23.9403	-20.6908	1131		stopped to sample, not possible
11/15/16	23:06	61	ROV						23.9413	-20.6918	1127		sample 007, CP2
11/15/16	23:22	61	ROV						23.9418	-20.6925	1116		sample 008, PT05
11/15/16	23:32	61	ROV						23.9418	-21.6925	1116		sample 009, port bio blue, starfish
11/15/16	23:38	61	ROV						23.9422	-20.6926	1112		NISKIN 2, over sediment, was not logged in the master
11/16/16	0:02	61	ROV						23.9426	-20.6911	1114		drilling on sedimented pavement
11/16/16	0:29	61	ROV										full depth reached
11/16/16	0:37	61	ROV										drill bit out
11/16/16	0:52	61	ROV										sample 10, in yellow 3 core collected, could not insert
11/16/16	0:55	61	ROV										continuing on
11/16/16	0:57	61	ROV										doppler reset
11/16/16	1:41	61	ROV										blue hop to WP 5, not very steep can see sediment slope
11/16/16	2:16	61	ROV						23.9469	-20.6846	1211		sample 011, dead coral sample, PT04
11/16/16	2:29	61	ROV										moving on
11/16/16	2:39	61	ROV						23.9468	-20.6848	1202		attempted to sample on little terrace without luck

11/16/16	2:48	61	ROV						23.9468	-20.6852	1179		sampling rock, attempt failed
11/16/16	3:07	61	ROV						23.9468	-20.6852	1179		sample 12, lophelia
11/16/16	3:15	61	ROV						23.9385	-20.6852	1178		drilling attempt on pavement
11/16/16	3:35	61	ROV						23.9385	-20.6852	1178		no more penetration, stopping, trying to recover
11/16/16	3:47	61	ROV						23.9385	-20.6852	1178		sample 13, taken in yellow2, 5-10 cm on pavement slab
11/16/16	4:02	61	ROV						23.9471	-20.6855			stopping to try and sample Mn crust bridge
11/16/16	4:04	61	ROV						23.9471	-20.6856	1182		sample 14, broke off section from crust bridge
11/16/16	4:18	61	ROV						23.9474	-20.6867	1150		attempted to sample, but failed
11/16/16	4:30	61	ROV						23.9477	-20.6875	1133		drilling
11/16/16	4:55	61	ROV						23.9477	-20.6875	1133		drill bit out, only 5-10 cm penetration, poss something in
11/16/16	5:00	61	ROV										hole appears to be missing top - catcher Y1 came back
11/16/16	5:17	61	ROV										managed to catch section but it fell onto seafloor and
11/16/16	5:21	61	ROV						23.9476	-20.6875	1147		trying to drill again in same loc. - same problem - likely
11/16/16	5:41	61	ROV										drill bit out
11/16/16	5:51	61	ROV						23.9476	-20.6875	1147		sample #15 in Y1 - small core - no more drilling
11/16/16	5:52	61	ROV										Doppler reset
11/16/16	6:18	61	ROV						23.9485	-20.6899	1122		Stopping to try sample to sample small crust - outcrop on
11/16/16	6:21	61	ROV						23.9485	-20.6899	1122		Sample #16 - slab from center outcrop in CS3
11/16/16	6:35	61	ROV										Noticed sample Niskin 2 missing from sample log - added
11/16/16	6:46	61	ROV						23.9492	-20.6913	1100		sample #18 - slab from exposed outcrop in sed. - in CS2

11/16/16	7:12	61	ROV						23.9498	-20.6927	1176		Stopping on pavement to fire Niskin sample #19 - bottle 3
11/16/16		61	ROV										Not sure if happened here. #20 Niskin 4
11/16/16		61	ROV										Sampling effort
11/16/16	8:02	61	ROV										trying to sample
11/16/16	8:05	61	ROV						23.9508	-20.6950	1059		sample #21 crust slab from pavement exposure in CS4
11/16/16	8:35	61	ROV										continuing on
11/16/16	8:43	61	ROV										doppler reset
11/16/16	8:47	61	ROV						23.9520	-20.6921	1083		sample #22 large rounded lump from sediment outcrop in
11/16/16	8:58	61	ROV										doppler reset
11/16/16	9:03	61	ROV						23.9527	-20.6912	1101		stopping to fire niskin
11/16/16	9:04	61	ROV						23.9527	-20.6911	1101		Niskin 5 fired succesfully, sample #23
11/16/16	9:06	61	ROV						23.9527	-20.6911	1101		Niskin 6 sample #24
11/16/16	9:08	61	ROV						23.9529	-20.6912	1101		Off bottom
11/16/16	10:14	61	ROV	23.9521	-20.6915								ROV on deck
11/16/16	11:06	62	AUV	23.8928	-20.6120			1599					on station for AUV recovery
11/16/16	11:49	62	AUV	23.8911	-20.6114								AUV on surface
11/16/16	12:03	62	AUV	23.8874	-20.6114								AUV recovered
11/16/16	12:22		TRANSIT										Transit to ST63
11/16/16	13:04	63	GC	23.8048	-20.6074			3854					Starting 1 mille approach to gravity core station
11/16/16	13:51	63	GC	23.7888	-20.6057			3970					on st. For gravity core

11/16/16	13:59	63	GC	23.7887	-20.6059			3970					gravity core in water, pay out c60mmin
11/16/16	15:22	63	GC	23.7887	-20.6059			3969					gravity core on bottom
11/16/16	16:39	63	GC	23.7887	-20.6059			3967					GC on deck
11/16/16	17:05		TRANSIT										in transit to GC St64
11/16/16	17:15	64	GC										Starting 1 mile approach to GC St.
11/16/16	18:56	64	GC	23.7872	-20.8354			4195					GC in water (st64)
11/16/16	20:15	64	GC	23.7872	-20.8354			4196					GC stationary @ 80m altitude
11/16/16	20:24	64	GC	23.7872	-20.8354								GC at bottom
11/16/16	21:45	64	GC	23.7872	-20.8354			4197					GC on deck
11/16/16	22:00		TRANSIT										In transit to st.65
11/17/16	0:19	65	GC	23.9618	-20.5906			3864					on station 65 for GC
11/17/16	0:28	65	GC	23.9616	-20.5910			3926					GC in water (st64)
11/17/16	1:37	65	GC	23.9616	-20.5911			3924					GC stationary @80m
11/17/16	1:43	65	GC	23.9616	-20.5911			3924					GC at bottom
11/17/16	3:06	65	GC	23.9616	-20.5911			3924					GC on deck - 0.7 m recovered
11/17/16	3:15		TRANSIT										Transit to MB station 66 (line 16 S)
11/17/16	4:10	66	MB	24.0588	-20.5733			4004					Starting line 16 S (line 287)
11/17/16	8:11	66	MB	23.7134	-20.6282								Breaking off line 6 to head for AUV launch position (line
11/17/16	9:23	67	AUV	23.8735	-20.7081								On station for AUV launch (m133)
11/17/16	9:57	67	AUV	23.8735	-20.7081								AUV ready for launch

11/17/16	10:13	67	AUV	23.8746	-20.7072								AUV in the water
11/17/16	11:25	67	AUV	23.8746	-20.7072								Sub on bottom
11/17/16	11:49		TRANSIT	23.8768	-20.7020								On st68 ROV launch
11/17/16	12:24	68	ROV	23.8768	-20.7020								ROV in water
11/17/16	13:17	68	ROV						23.8768	-20.7021	983		Seabed insight
11/17/16	13:29	68	ROV						23.8768	-20.7019	985		ROV stopped
11/17/16	13:40	68	ROV						23.8768	-20.7019	986		Lander on site
11/17/16	13:47	68	ROV										ROV moving
11/17/16	15:31	68	ROV										AUV team switcho off EM120/EA600
11/17/16	16:03	68	ROV						23.8770	-20.7019	985		ROV started plume exp.
11/17/16	22:00	68	ROV						23.8771	-20.7020	980		ROV off bottom
11/17/16	22:03	68	ROV										ROV at bottom
11/17/16	22:09	68	ROV										ROV off bottom
11/17/16	22:14	68	ROV										ROV at bottom to collect flag
11/17/16	22:16	68	ROV										ROV moving towards the surface
11/17/16	23:10	68	ROV	23.8767	-20.7015								ROV on deck
11/17/16	23:25												In transit to ST69
11/17/16	23:33	69	CTD	23.8747	-20.6954								On station 69
11/17/16	23:41	69	CTD	23.8747	-20.6954			1005					CTD in water
11/18/16	0:15	69	CTD	23.8747	-20.6954			995					CTD at bottom

11/18/16	0:35	69	CTD	23.8747	-20.6954			996					CTD back on surface
11/18/16	0:39	69	CTD	23.8747	-20.6954			995					CTD down again
11/18/16	1:01	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	1:24	69	CTD	23.8747	-20.6954			996					CTD at top
11/18/16	1:45	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	1:57	69	CTD	23.8747	-20.6954			996					CTD at top
11/18/16	2:22	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	2:48	69	CTD	23.8747	-20.6954			996					CTD at top
11/18/16	3:05	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	3:32	69	CTD	23.8747	-20.6954			996					CTD at top
11/18/16	3:55	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	4:17	69	CTD	23.8747	-20.6954			996					CTD on the surface
11/18/16	4:42	69	CTD	23.8747	-20.6954			996					CTD at bottom
11/18/16	5:02	69	CTD	23.8747	-20.6954			996					CTD on the surface
11/18/16	5:30	69	CTD	23.8747	-20.6954			996					CTD at bottom (bottles fired)
11/18/16	5:51	69	CTD	23.8747	-20.6954			996					CTD on deck
18/11/206	6:15		TRANSIT										Transit to AUV recovery
11/18/16	6:57	70	AUV	23.8941	-20.7028			994					Start AUV retrieval
11/18/16	7:03	70	AUV	23.8941	-20.7028			994					AUV on deck
11/18/16	7:10		TRANSIT										Transit to CTD

11/18/16	7:47	71	CTD	23.9279	-20.7493			2262					On station for CTD
11/18/16	8:18	71	CTD	23.9279	-20.7493			2262					CTD in the water
11/18/16	9:16	71	CTD	23.9279	-20.7493			2262					CTD at bottom
11/18/16	9:17	71	CTD	23.9279	-20.7493			2262					Bottles #1-2-3
11/18/16	9:25	71	CTD	23.9279	-20.7493			2262					Bottles #4-5-6
11/18/16	9:31	71	CTD	23.9279	-20.7493			2262					Bottles #7-8-9
11/18/16	9:38	71	CTD	23.9279	-20.7493			2262					Bottles #10-11-12
11/18/16	9:43	71	CTD	23.9279	-20.7493			2262					Bottles #13-14-15
11/18/16	9:49	71	CTD	23.9279	-20.7493			2262					Bottle #16
11/18/16	9:53	71	CTD	23.9279	-20.7493			2262					Bottles #17-18
11/18/16	10:00	71	CTD	23.9279	-20.7493			2262					Bottles #19-20
11/18/16	10:05	71	CTD	23.9279	-20.7493			2262					Bottles #21-22
11/18/16	10:10	71	CTD	23.9279	-20.7493			2262					Bottles #23-24
11/18/16	10:33	71	CTD	23.9279	-20.7493			2262					CTD on deck
18/11/206	10:40		TRANSIT										Transit to ROV launch
11/18/16	11:26	72	ROV	23.8403	-20.7130								On station 72 for ROV launch
11/18/16	12:32	72	ROV	23.8411	-20.7140								ROV on water
11/18/16	13:17	72	ROV						23.8414	-20.7140	1027		bottom in sight
11/18/16	13:33	72	ROV						23.8416	-20.7140	1028		Lander in position
11/18/16	13:39	72	ROV										ROV moving

11/18/16	13:47	72	ROV						23.8418	-20.7139	1029		ROV touches floor
11/18/16		72	ROV										Push core 1 retrieved
11/18/16	13:53	72	ROV										Push core 2 retrieved
11/18/16	13:55	72	ROV										ROV moving
11/18/16	14:01	72	ROV						23.8420	-20.7138	1029		ROV at bottom - push core 3 retrieved
11/18/16	14:03	72	ROV										Push core 4 retrieved
11/18/16	14:05	72	ROV										ROV moving
11/18/16	14:11	72	ROV						23.8423	-20.7134	1030		ROV at bottom
11/18/16	14:14	72	ROV										Push core 5 retrieved
11/18/16	14:15	72	ROV										Push core 6 retrieved
11/18/16		72	ROV										6 niskins bottles all fired
11/18/16	14:24	72	ROV										moving
11/18/16	14:41	72	ROV						23.8417	-20.7139	1027		ROV at bottom - flag in position
11/18/16		72	ROV										ROV at 30 m from flag - waiting
11/18/16	20:42	72	ROV						23.8416	-20.7156			ROV off seabed
11/18/16	20:45	72	ROV										ROV on deck
11/18/16	22:10		TRANSIT										In transit to AUV launch site
11/18/16	22:43	73	CTD	23.8793	-20.7124			994					CTD in water
11/18/16	23:14	73	CTD	23.8793	-20.7124			996					CTD on bottom
11/18/16	23:44	73	CTD	23.8793	-20.7124								CTD on deck

11/19/16	0:19	74	AUV	23.8809	-20.7098			994					AUV launch (M134)
11/19/16	2:45	75	CTD	23.9362	-20.6400			2561					CTD in water
11/19/16	3:38	75	CTD	23.9362	-20.6400							2578	CTD at bottom
11/19/16	3:41	75	CTD	23.9362	-20.6400							2578	Bottles #1+2
11/19/16	3:44	75	CTD	23.9362	-20.6400							2498	Bottles #3+4
11/19/16	3:48	75	CTD	23.9362	-20.6400							2398	Bottles #5+6
11/19/16	3:53	75	CTD	23.9362	-20.6400							2198	Bottles #7+8
11/19/16	3:58	75	CTD	23.9362	-20.6400							1998	Bottles #9+10
11/19/16	4:04	75	CTD	23.9362	-20.6400							1799	Bottles #11+12
11/19/16	4:09	75	CTD	23.9362	-20.6400							1599	Bottles #13+14
11/19/16	4:13	75	CTD	23.9362	-20.6400							1499	Bottles #15+16
11/19/16	4:16	75	CTD	23.9362	-20.6400							1399	Bottles #17+18
11/19/16	4:22	75	CTD	23.9362	-20.6400							1200	Bottles #19+20
11/19/16	4:27	75	CTD	23.9362	-20.6400							1000	Bottles #21+22
11/19/16	4:30	75	CTD	23.9362	-20.6400							900	Bottles #23 + 24
11/19/16	4:50	75	CTD	23.9362	-20.6400								CTD at surface
11/19/16	4:52	75	CTD	23.9362	-20.6401								CTD on deck
11/19/16	5:05												In transit to AUV recovery
11/19/16	5:45	76	AUV	23.8888	-20.7040								On ST76 for AUV recovery
11/19/16	7:33	76	AUV	23.8911	-20.7096								AUV on deck

11/19/16	7:39												Transit to ROV launch
11/19/16	8:46			23.9673	-20.8410			4057					On station for ROV launch- postponed as early
11/19/16	9:05	77	SBP	23.9673	-20.8434			4086					SBP LINE
11/19/16	9:40	77	SBP	23.9383	-20.8381		225	3655					Changing course, new bearing 225
11/19/16	9:53	77	SBP	23.9453	-20.8508			3975					Start of new line
11/19/16	11:03	78	ROV	23.9636	-20.8281			3970					On station for ROV launch- new position
11/19/16	11:26	78	ROV	23.9635	-20.8282			3970					ROV in water
11/19/16	13:28	78	ROV						23.9637	-20.8285	3969		ROV at bottom
11/19/16	14:28	78	ROV						23.9125	-20.8286	3936		Stop to check wire
11/19/16	14:38	78	ROV										Big fish
11/19/16	14:53	78	ROV						23.9624	-20.8286	3933		Moving on
11/19/16	15:06	78	ROV						23.9614	-20.8289			First rock visible
11/19/16	15:08	78	ROV						23.9614	-20.8289	3894		Stop to try get a sample
11/19/16	15:09	78	ROV						23.9612	-20.8290			Sample 001 into GB01
11/19/16	15:21	78	ROV						23.9612	-20.8290			Sample 002 (two pieces) into STB (CS) 1
11/19/16	15:28	78	ROV						23.9611	-20.8289	3881		Sample 4 (in two) into GB 03
11/19/16	15:39	78	ROV						23.9610	-20.8289	3880		Moving on
11/19/16	15:51	78	ROV						23.9604	-20.8290	3849		Stopped to collect
11/19/16	15:59	78	ROV						23.9603	-20.8290	3846		Sample 005 into CS2
11/19/16	16:03	78	ROV						23.9603	-20.8289	3846		Moving

11/19/16	16:23	78	ROV						23.9592	-20.8287	3750		Stop to get sample 006
11/19/16	16:30	78	ROV										Moving
11/19/16	16:41	78	ROV						23.9586	-20.8286	3771		Stopped to get sample
11/19/16	17:02	78	ROV										Still stopped
11/19/16	17:07	78	ROV									180	Moving/doppler reset
11/19/16	17:22	78	ROV										Doppler reset
11/19/16	17:27	78	ROV						23.9569	-20.8279	3705		Stopped to sample
11/19/16	17:31	78	ROV						23.9569	-20.8279	3705		Sample 008 into CP 01
11/19/16	17:34	78	ROV										Continuing on
11/19/16	17:36	78	ROV										Doppler reset
11/19/16	17:47	78	ROV						23.9570	-20.8266			Stopped to collect sample
11/19/16	17:51	78	ROV						23.9570	-20.8265			Collect sample 009 into CP 2
11/19/16	17:56	78	ROV										Continuing on
11/19/16	17:59	78	ROV						23.9571	-20.8264			Stopped to collect sample
11/19/16	18:03	78	ROV						23.9571	-20.8264			Samples 010, 011, 012 into CP2 (nodules)
11/19/16	18:05	78	ROV										Moving
11/19/16	18:51	78	ROV						23.9571	-20.8231			Stopped to collect sample
11/19/16		78	ROV						23.9571	-20.8230			Sample 013A collected into CP3
11/19/16	19:08	78	ROV						23.9571	-20.8229			Sample 013B into CP3
11/19/16	19:11	78	ROV										Doppler reset

11/19/16	19:14	78	ROV										Moving
11/19/16	19:25	78	ROV						23.9560	-20.8229			Stop
11/19/16	19:29	78	ROV									170	Moving
11/19/16	20:07	78	ROV										Stop
11/19/16	20:11	78	ROV						23.9534	-20.8228			Sample 014 to CP4
11/19/16		78	ROV									155	Moving
11/19/16	20:28	78	ROV						23.9518	-20.8224			Stopped
11/19/16	20:38	78	ROV									150	Moving
11/19/16	20:56	78	ROV						23.9507	-20.8221			Stopped
11/19/16	20:59	78	ROV										Moving
11/19/16	21:06	78	ROV						23.9500	-20.8167			Stopped to collect sample
11/19/16	21:08	78	ROV										Moving
11/19/16	21:13	78	ROV						23.9501	-20.8219			Stopped to collect sample
11/19/16	21:20	78	ROV						23.9502	-20.8219			Sample 015 into CP5
11/19/16	21:21	78	ROV									135	Moving
11/19/16	21:56	78	ROV						23.9477	-20.8195		146	Stopped to collect
11/19/16	22:02	78	ROV										Continuing on
11/19/16	22:12	78	ROV						23.9473	-20.8188		127	Stopped
11/19/16	22:14	78	ROV										Continuing on
11/19/16	22:15	78	ROV						23.9472	-20.8188	3325		stopped to sample

11/19/16	22:24	78	ROV						23.9472	-0.8189	3324		sample 016 into cp6
11/19/16	22:26	78	ROV									120	moving
11/19/16	23:23	78	ROV						23.9451	-20.8155	3213		stop for sampling JC142_078_017 in cp7
11/19/16	23:58	78	ROV						23.9438	-0.8136	3151		stop
11/20/16	?	78	ROV										sample 018 in cp8
11/20/16	0:29	78	ROV						23.9427	-20.8121	3102		sample 19 - block off wall with caral attach in sb crate 5
11/20/16	0:41	78	ROV										doppler reset
11/20/16	0:55	78	ROV						0.9415	-0.8108	3034		broke piece off steep cliff, sample 20 - in sb crate 6
11/20/16	1:20	78	ROV										high currents and numerous sponges on plateau and cliff
11/20/16	1:53	78	ROV						0.9383	-0.8096	2939		lump of pavement slope, sampe 21 in cs3, quite big
11/20/16	2:16	78	ROV										doppler reset
11/20/16	2:45	78	ROV						23.9356	-20.8074	2828		lump broken from slope with coral for sample #22 in cs4
11/20/16	3:38	78	ROV										Doppler reset
11/20/16	3:50	78	ROV										have tried sampling in 3 locations, crust will not break
11/20/16	3:53	78	ROV						23.9331	-20.8066	2821		loose block taken from same location sample 23 in cs4
11/20/16	3:57	78	ROV										doppler reset
11/20/16	4:29	78	ROV						23.9312	-20.8071	2817		sample 24, sponge piece in stb bio
11/20/16	4:37	78	ROV						23.9311	-20.8071	2815		tried sampling what looks like normal crust but is actually
11/20/16	5:02	78	ROV						23.9305	-20.8073	2803		platou slab from below edge sa,ple 25 in cs4
11/20/16	5:38	78	ROV										doppler reset

11/20/16	6:08	78	ROV						23.9269	-20.8082	2648		sample 26 in GB2 base steep cliff - accidentally dropped
11/20/16	6:36	78	ROV						23.9258	-20.8083	2574		tried to sample steep slope but impossible, continuing on
11/20/16	7:16	78	ROV						23.9263	-20.8061	2675		sample 27, in ptbio white piece of coral
11/20/16	7:19	78	ROV						23.9263	-20.8061	2675		tried to sample - nothing free continuing on
11/20/16	7:26	78	ROV						23.9262	-20.8056	2676		sample 28 in cp5, block (possibly already loose) from
11/20/16	8:30	78	ROV						23.9269	-20.8026	2660		rounded knobly lump loose on pavement, sample 29 in
11/20/16	8:32	78	ROV										moving directly to final WP
11/20/16		78	ROV						23.9260	-20.8021	2601		no. 30 piece crust snapped off pavement in gb3
11/20/16		78	ROV						23.9260	-20.8021	2601		no.31 as above, may have crumbled
11/20/16	9:02	78	ROV						23.9260	-20.8022	2606		no. 32 whole sponge
11/20/16	10:02	78	ROV						23.9230	-20.8007			broken piece from isolated outcrop sample no. 33 in gb1
11/20/16	10:24	78	ROV						23.9221	-20.7999			rounded sample from pavement edge, no 34 in greybox 2
11/20/16	10:46	78	ROV						23.9212	-20.7992			no. 35 loose block from slope with coral on it in cs 5
11/20/16	10:49	78	ROV						23.9212	-20.7992			samples 36-41 niskins fired
11/20/16	10:51	78	ROV						23.9212	-20.7992			rov off bottom
11/20/16	12:31	78	ROV						23.9187	-20.7845			rov at the surface, ctd station abandoned due to winch
11/20/16	15:30	79	TRANSIT										in transit to st. 79 for the auv launch
11/20/16	16:00	79	AUV										at auv launch position +500
11/20/16	16:28	79	AUV										auv deployed st. 79
11/20/16	19:20		transit										in transit to to st 80

11/20/16	19:50	80	ROV										on station 80
11/20/16	20:17	80	ROV										rov in water
11/20/16	21:24	80	ROV						23.9120	-20.7770			bottom in sight
11/20/16	21:35	80	ROV						23.9120	-20.7771			white balance completed
11/20/16	22:05	80	ROV						23.9111	-20.7769			collected sample 001
11/20/16	22:11	80	ROV										doppler reset
11/20/16	23:31	80	ROV						23.9077	-20.7749	1257		moving
11/20/16	23:43	80	ROV						23.9077	-20.7749	1257		sample 003 in cs2
11/20/16	23:52	80	ROV						23.9077	-20.7749	1257		sample 004 in cs3
11/21/16	0:06	80	ROV						23.9077	-20.7749	1257		sampled nodule and 2 push cores and 2 niskins
11/21/16	0:15	80	ROV						23.9074	-20.7749	1252		stopping to drill on pavement area
11/21/16	0:33	80	ROV						23.9074	-20.7749	1252		Begun drilling
11/21/16	1:11	80	ROV						23.9074	-20.7749	1252		25cm mark - 20 cm pen. Pulling out
11/21/16	1:14	80	ROV						23.9074	-20.7749	1252		drill bit out - core appears in tact in hole
11/21/16	1:23	80	ROV						23.9074	-20.7749	1252		core recovered in y1 sample 9
11/21/16	1:27	80	ROV						23.9074	-20.7749	1252		doppler reset beginning bio transect
11/21/16	2:06	80	ROV						23.9059	-20.7774	1272		stopping to drill on pavement area
11/21/16	2:12	80	ROV						23.9225	-20.7774	1273		begun drilling
11/21/16	2:52	80	ROV						23.9392	-20.7775	1274		20 cm penetration - stopping drill
11/21/16	2:54	80	ROV						23.9559	-20.7775	1275		drill bit out - looks like top missing, rest recovered in

11/21/16	3:15	80	ROV						23.9725	-20.7775	1276		cannot remove piece from barrel, but definitely present -
11/21/16	3:19	80	ROV						23.9892	-20.7775	1277		doppler reset
11/21/16	3:38	80	ROV						23.9090	-20.7783	1269		Sotopped to attempt o sample, but too hard - doppler
11/21/16	4:03	80	ROV						23.9042	-20.7769	1247		CS4 - Rock Sample #11
11/21/16	4:42	80	ROV						23.9017	-20.7753	1207		CS05 sample #12 (small) + sample #13 (big)
11/21/16	4:47	80	ROV						23.9017	-20.7753	1207		doppler reset
11/21/16	4:54	80	ROV						23.9012	-20.7782	1196		Sample #14 - STBIO (seapen)
11/21/16	5:22	80	ROV						23.9005	-20.7777	1196		Sample #15 Rock
11/21/16	5:32	80	ROV						23.9006	-20.7743	1196		Sample #16 PC3 + Sample #17 PC4 for Natascha
11/21/16	5:37	80	ROV						23.9006	-20.7743	1196		Sample #18 Niskin 3 + Sampe #19 Niskin 5
11/21/16	5:51	80	ROV						23.9002	-20.7739	1194		Sample #20 PC3 + Sample #21 PC6
11/21/16	5:55	80	ROV						23.9002	-20.7739	1194		Sample #22 Niskin 6
11/21/16	5:57	80	ROV										doppler reset
11/21/16	6:11	80	ROV						23.8995	-20.7734	1189		Stop to drill
11/21/16	6:15	80	ROV						23.8995	-20.7734	1189		Begin Drilling
11/21/16	6:45	80	ROV						23.8995	-20.7734	1189		15 cm Stop drilling - core looks complete
11/21/16	6:47	80	ROV						23.8995	-20.7734	1189		Lump in core catcher Y3 sample #23 - will try for rest with
11/21/16	6:48	80	ROV						23.8995	-20.7734	1189		Second attempt at cor with G1 - Plug knocked out of hole
11/21/16		80	ROV										Cannot collect with catcher - collected with MA in GB1
11/21/16	7:27	80	ROV										Doppler Reset

11/21/16	8:14	80	ROV						23.8971	-20.7685	1149		Stop to drilling
11/21/16	8:18	80	ROV						23.8971	-20.7685	1149		Drilling begun on pavement area platform
11/21/16	8:20	80	ROV										Drill not on ground - shifting vehicle
11/21/16	8:29	80	ROV						23.8971	-20.7685	1149		Trying to drill again
11/21/16	8:31	80	ROV						23.8971	-20.7685	1149		Drilling begun
11/21/16	8:59	80	ROV						23.8971	-20.7685	1149		Core recovered in G2 sample #25
11/21/16	9:01	80	ROV										Doppler reset
11/21/16	9:09	80	ROV										Doppler reset
11/21/16	9:35	80	ROV						23.8960	-20.7674	1128		Stop to drilling
11/21/16	9:36	80	ROV						23.8960	-20.7674	1128		Drilling begun - Dropped 2 minutes in
11/21/16	9:50	80	ROV						23.8960	-20.7674	1128		15cm penetration. Removing drill
11/21/16	9:52	80	ROV						23.8960	-20.7674	1128		Drill bit out
11/21/16	10:01	80	ROV						23.8960	-20.8960	1128		Core sample #26 in GB from pavement - possible piece fell
11/21/16	10:05	80	ROV						23.8960	-20.8960	1128		extra sample piece collected with MA - sample #27
11/21/16	10:11	80	ROV						23.8960	-20.7674	1119		rov off bottom
11/21/16	11:15	80	ROV	23.8966	-20.7683								ROV at surface
11/21/16	11:22	80	ROV	23.8966	-20.7683								rov on deck
11/21/16	11:40	81	transit										In transit to station 81 (CTD)
11/21/16	15:38	82	CTD	23.9262	-20.8023			2667					on station 81 (CTD)
11/21/16	16:41	82	CTD	23.9262	-20.8023							2637	Fired bottle 01

11/21/16	16:42	82	CTD	23.9262	-20.8023							2637	Fired bottle 02
11/21/16	16:44	82	CTD	23.9262	-20.8023							2610	Fired bottle 03
11/21/16	16:45	82	CTD	23.9262	-20.8023							2610	Fired bottle 04
11/21/16	16:48	82	CTD	23.9262	-20.8023							2500	Fired bottle 05
11/21/16	16:49	82	CTD	23.9262	-20.8023							2500	Fired bottle 06
11/21/16	16:51	82	CTD	23.9262	-20.8023							2400	Fired bottle 07
11/21/16	16:52	82	CTD	23.9262	-20.8023							2400	Fired bottle 08
11/21/16	16:56	82	CTD	23.9262	-20.8023							2400	Fired bottle 09
11/21/16	16:57	82	CTD	23.9262	-20.8023							2200	Fired bottle 10
11/21/16	17:02	82	CTD	23.9262	-20.8023							2200	Fired bottle 11
11/21/16	17:02	82	CTD	23.9262	-20.8023							2000	Fired bottle 12
11/21/16	17:07	82	CTD	23.9262	-20.8023							1800	Fired bottle 13
11/21/16	17:08	82	CTD	23.9262	-20.8023							1800	Fired bottle 14
11/21/16	17:13	82	CTD	23.9262	-20.8023							1600	Fired bottle 15
11/21/16	17:13	82	CTD	23.9262	-20.8023							1600	Fired bottle 16
11/21/16	17:16	82	CTD	23.9262	-20.8023							1500	Fired bottle 17
11/21/16	17:17	82	CTD	23.9262	-20.8023							1500	Fired bottle 18
11/21/16	17:19	82	CTD	23.9262	-20.8023							1400	Fired bottle 19
11/21/16	17:20	82	CTD	23.9262	-20.8023							1400	Fired bottle 20
11/21/16	17:25	82	CTD	23.9262	-20.8023							1200	Fired bottle 21

11/21/16	17:26	82	CTD	23.9262	-20.8023							1200	Fired bottle 22
11/21/16	17:30	82	CTD	23.9262	-20.8023							1000	Fired bottle 23
11/21/16	17:58	82	CTD	23.9262	-20.8023								CTD on deck
11/21/16	17:59	82	CTD	23.9262	-20.8023								ROV camera being repaired
11/21/16	20:20	transit											in transit to station 83 (ROV)
11/21/16	21:44	83	ROV	23.8892	-20.8583								ROV in water
11/22/16	0:14	83	ROV						23.8890	-20.8593	3932		bottom in sight
11/22/16	0:27	83	ROV										white balance
11/22/16	0:36	83	ROV										Doppler reset
11/22/16	0:36	83	ROV										WP01
11/22/16	1:13	83	ROV						23.8890	-20.8568	3794		have tried sampling for 45 minutes - crust will not break
11/22/16	1:21	83	ROV						23.8891	-20.8565	3777		Sample #001 - Loose block from steep slope in CP2
11/22/16	1:40	83	ROV						23.8891	-20.8557	3754		Block from slope - sample #002 in CP1
11/22/16	1:43	83	ROV						23.8891	-20.8558	3735		As above - sample #002 in GB3
11/22/16	2:39	83	ROV						23.8893	-20.8525	3613		Small piece broken off cliff face - sample #004 in CS3
11/22/16	2:58	83	ROV						23.8894	-20.8514	3579		Small piece broken off cliff face - sample #005 in GB1
11/22/16	3:21	83	ROV						23.8896	-20.8500	3550		Lobate FeMn sample #006 in CP3
11/22/16	3:57	83	ROV						23.8891	-20.8481	3512		Boulder with FeMn crust in CP4 - sample #007
11/22/16	5:20	83	ROV						23.8934	-20.8464	3466		Block off patchy outcrop on slope - Sample #008 in CS1
11/22/16	5:44	83	ROV										Doppler reset

11/22/16	12:24	83	ROV										Doppler reset
11/22/16	12:51	83	ROV						23.9062	-20.8228	3215		Stop
11/22/16	13:06	83	ROV										Moving
11/22/16	13:13	83	ROV						23.9063	-20.8230	3215		Sample #19 to CS8
11/22/16	13:16	83	ROV										Moving
11/22/16	13:39	83	ROV						23.9082	-20.8219	3103		Stop
11/22/16	13:47	83	ROV						23.9082	-20.8219	3103		Sample #20 to GB 2 (encrusted coral)
11/22/16	14:00	83	ROV										Sample #21 in CP 5
11/22/16	14:07	83	ROV										Moving
11/22/16	14:30	83	ROV										Doppler Reset
11/22/16	14:33	83	ROV						23.9098	-20.8205	2999		Stop
11/22/16	14:41	83	ROV										Moving
11/22/16	14:42	83	ROV						23.9098	-20.8206	2998		Stop
11/22/16	14:46	83	ROV										Sample 22 in CP 6
11/22/16	14:48	83	ROV										Moving
11/22/16	15:08	83	ROV						23.9105	-20.8186	2895		Stop
11/22/16	15:14	83	ROV										Sample #23 in Cp 8
11/22/16	15:18	83	ROV										6 niskin fired (samples 24 to 29)
11/22/16	15:19	83	ROV										ROV leaving seafloor
11/22/16	17:12	83	ROV										ROV on deck

11/22/16	17:35	TRANSIT											In transit to station 136 (AUV) st 84
11/22/16	19:15	84	AUV										AUV in water
11/22/16	21:32	84	AUV	24.0150	-20.6987	2849							Pilling up fish
11/22/16	21:40	TRANSIT											In transit to st 85
11/22/16	22:49	85	ROV	23.8963	-20.7683	1135							At ST85
11/22/16	23:15	85	ROV	23.8969	-20.7692	1087							ROV in water
11/23/16	0:20	85	ROV						23.8960	-20.7679	1131		ROV at bottom
11/23/16	0:26	85	ROV						23.8960	-20.7679	1131		White balance
11/23/16	0:32	85	ROV						23.8960	-20.7679	1131		Heading to WP1
11/23/16	0:43	85	ROV										Trying to solve video issues (pilot camera)
11/23/16	0:48	85	ROV						23.8962	-20.7677	1130		WP01
11/23/16	0:58	85	ROV						23.8962	-20.7677	1130		ROV landed
11/23/16	1:16	85	ROV						23.8962	-20.7677	1130		Start drilling
11/23/16	1:18	85	ROV						23.8962	-20.7677	1130		Increasing rotation
11/23/16	1:22	85	ROV						23.8962	-20.7677	1130		Full speed
11/23/16	1:48	85	ROV						23.8962	-20.7677	1130		Barrel stopped ~20cm penetration
11/23/16	1:51	85	ROV						23.8962	-20.7677	1130		Stop drilling
11/23/16	1:55	85	ROV						23.8962	-20.7677	1130		attempting to recover core with catcher Y1
11/23/16	2:00	85	ROV						23.8962	-20.7677	1130		Core recovered - Y1 sample #01
11/23/16	2:04	85	ROV						23.8962	-20.7677	1130		Heading to WP2 (bearing 152 - 10m)

11/23/16	2:09	85	ROV						23.8966	-20.7676	1130		Sediments at WP2
11/23/16	2:12	85	ROV										Coming back to firts drilling point
11/23/16	2:16	85	ROV						23.8961	-20.7676	1130		Moving to bearing 152 - 2m
11/23/16		85	ROV						23.8961	-20.7676	1130		At drilling point #2
11/23/16	2:20	85	ROV										Returning to WP01 (first drill)
11/23/16	2:29	85	ROV										Doppler reset
11/23/16	2:33	85	ROV						23.8961	-20.7676	1130		ROV landed on drilling point #2
11/23/16	2:37	85	ROV						23.8961	-20.7676	1130		Start drilling
11/23/16	3:12	85	ROV						23.8961	-20.7676	1130		Stop drilling ~20cm penetration - Attempt #2
11/23/16	3:22	85	ROV						23.8961	-20.7676	1130		Core retrieved - Catcher Y2 sample #02
11/23/16	3:26	85	ROV										Moving aft 3.5m to drill point 1
11/23/16	3:36	85	ROV										Moving 1m bearing 264
11/23/16	3:38	85	ROV						23.8962	-20.7677	1130		
11/23/16	3:40	85	ROV						23.8962	-20.7677	1130		Start drilling
11/23/16	3:46	85	ROV						23.8962	-20.7677	1130		Stop drilling (ROV off bottom - drill pulled out so drill
11/23/16	3:58	85	ROV										Return to WP1
11/23/16	3:59	85	ROV										Moving 2m bearing 227
11/23/16	4:10	85	ROV						23.8961	-20.7677	1130		Star drilling - Attempt #4
11/23/16	4:38	85	ROV						23.8961	-20.7677	1130		Stop drilling ~25cm penetration - Sampe #3 into Y3 (top in
11/23/16	4:51	85	ROV						23.8961	-20.7677	1130		Moving back to WP1

11/23/16	4:51	85	ROV						23.8961	-20.7677	1130		Doppler reset
11/23/16	4:58	85	ROV						23.8962	-20.7677	1130		Core catcher left in hole 1 - used as a way marker
11/23/16	5:03	85	ROV						23.8961	-20.7676	1130		arrive at WP4
11/23/16	5:05	85	ROV						23.8961	-20.7676	1130		Return to WP1 to reset doppler
11/23/16	5:06	85	ROV						23.8962	-20.7677	1130		Arrive at WP1
11/23/16	5:06	85	ROV						23.8962	-20.7677	1130		Doppler reset
11/23/16	5:08	85	ROV						23.8962	-20.7676	1130		Arrive at WP4
11/23/16	5:12	85	ROV						23.8961	-20.7677	1130		Start drilling
11/23/16	5:43	85	ROV						23.8961	-20.7677	1130		Stop drillin - attempt #5
11/23/16	5:55	85	ROV						23.8961	-20.7677	1130		Core retrieved - sample #4
11/23/16	5:57	85	ROV						23.8961	-20.7677	1130		Piece of core crust near drillhole - loose top of sample #5
11/23/16	5:59	85	ROV						23.8961	-20.7677	1130		Return to WP1
11/23/16	6:10	85	ROV						23.8962	-20.7676	1130		Moving on to WP5 along bearing 125° for 10m
11/23/16	6:12	85	ROV						23.8961	-20.7676	1130		Continue along for another 15m to reach crust
11/23/16	6:16	85	ROV						23.8961	-20.7675	1130		Arrive at WP5 (within 1m from drillhole form previous
11/23/16	6:21	85	ROV						23.8961	-20.7675	1130		Star drilling core #5 (sample #6)
11/23/16	6:45	85	ROV						23.8961	-20.7675	1130		Stop drilling (attempt #6)
11/23/16	6:47	85	ROV						23.8961	-20.7675	1130		Attempt to recover core
11/23/16	6:55	85	ROV						23.8961	-20.7675	1130		Core recovered - sample #6 into G2
11/23/16	6:59	85	ROV						23.8961	-20.7675	1130		Return to WP1

11/23/16	7:02	85	ROV						23.8962	-20.7677	1130		Arrive at WP1 - new move of 20m along 166° to WP6
11/23/16	7:11	85	ROV						23.8960	-20.7676	1128	166°	Arrive at WP6 - no crust
11/23/16	7:13	85	ROV						23.8960	-20.7676	1128	166°	moving along another 10m
11/23/16	7:15	85	ROV						23.8960	-20.7676	1128	256°	move 5m to find crust
11/23/16	7:16	85	ROV						23.8960	-20.7676	1128	345°	no crust - return to WP1
11/23/16	7:20	85	ROV						23.8962	-20.7677	1130		arrive at WP1
11/23/16	7:22	85	ROV						23.8962	-20.7677	1130	130°	New move - bearing 130° for 40m
11/23/16	7:30	85	ROV						23.8960	-20.7674	1130	310°	arrive at WP6 - no crust so move back 10m
11/23/16	7:34	85	ROV						23.8960	-20.7674	1128		arrive at new WP6 - prepare to drill
11/23/16	7:42	85	ROV						23.8960	-20.7674	1128		Start drilling (attempt #7)
11/23/16	8:26	85	ROV						23.8960	-20.7674	1128		Stop drilling - drilling attempt #7 failed.
11/23/16	8:28	85	ROV						23.8960	-20.7674	1128		re-attempt drilling
11/23/16	8:34	85	ROV						23.8960	-20.7674	1128		Core retrieved - sample #7 in G3
11/23/16	8:36	85	ROV						23.8960	-20.7674	1128		return to WP1
11/23/16	8:43	85	ROV						23.8962	-20.7676	1130		arrive at WP1
11/23/16	8:44	85	ROV						23.8962	-20.7676	1130	150°	move to WP#7 - 35m along bearing 147°
11/23/16	8:54	85	ROV						23.8958	-20.7674	1128	150°	arrived - no crust, move fwd 8m (43m from WP1)
11/23/16	8:57	85	ROV						23.8958	-20.7674	1128		start drilling (attempt #8)
11/23/16	9:32	85	ROV						23.8958	-20.7674	1128		stop drilling
11/23/16	9:45	85	ROV						23.8958	-20.7674	1128		sample retrieved - sample #8 in R1

11/23/16	9:49	85	ROV						23.8958	-20.7674	1128	327°	return to WP1
11/23/16	9:56	85	ROV										arrive at WP1
11/23/16	9:58	85	ROV						23.8962	-20.7677	1130		head tp WP#8 - 10m on bearing 190° no crust
11/23/16	10:00	85	ROV										head to new WP#8, total movement from WP1 to WP8 =
11/23/16	10:08	85	ROV						23.8961	-20.7676	1130		start drilling - attempt #9
11/23/16	10:24	85	ROV						23.8961	-20.7676	1130		stop drilling
11/23/16	10:30	85	ROV						23.8961	-20.7676	1130		portside arm not behaving so use starboard arm
11/23/16	10:41	85	ROV						23.8961	-20.7676	1130		core retrieved - sample #9 into R2
11/23/16	10:50	85	ROV						23.8961	-20.7676	1130		retry drill hole to see if anything left behind - catcher was
11/23/16	10:54	85	ROV						23.8962	-20.7676	1130		back to WP1 to retrieve core catcher left behind
11/23/16	11:01	85	ROV						23.8962	-20.7676	1131		fired Niskins 1,2,3,4,5 and 6
11/23/16	11:08	85	ROV						23.8962	-20.7677	1130		ROV off bottom
11/23/16	12:11	85	ROV	23.8966	-20.7672								ROV at surface
11/23/16	12:17	85	ROV	23.8966	-20.7672								ROV out of water
11/23/16	12:35												in transit to AUV pick up (Station 86)
11/23/16	13:55	86	AUV										On Station 86
11/23/16	14:20												suspended AUV recovery due to may-day call
11/23/16	16:30			23.7291	-20.4819								Rescued crew on board
11/23/16	16:49												Heading to recover AUV and then to Tenerife
11/23/16	18:49	86	AUV	24.0244	-20.6980								On station for AUV pick up

11/23/16	19:20	86	AUV	24.0281	-20.6940								AUV on board
11/23/16	19:24												in transit
11/26/16	3:30			24.7678	-19.6267								Multibeam on, first WP for swath
11/26/16	9:30			23.7979	-20.5627								End of MB line
11/26/16	10:25	87	CTD	23.7679	-20.7481								On Station 87 (CTD, HRW #17)
11/26/16	10:42	87	CTD	23.7675	-20.7484			3176					CTD in water
11/26/16	10:54	87	CTD	23.7675	-20.7484			3176					CTD out of water and on deck due to fault
11/26/16	11:00	87	CTD	23.7675	-20.7484			3187					CTD back in water
11/26/16		87	CTD	23.7675	-20.7484			3230					CTD at bottom
11/26/16	12:16	87	CTD	23.7675	-20.7484			3230				3215	Bottle #1 fired
11/26/16	12:17	87	CTD	23.7675	-20.7484			3230				3215	Bottle #2 fired
11/26/16	12:17	87	CTD	23.7675	-20.7484			3230				3215	Bottle #3 fired
11/26/16	12:18	87	CTD	23.7675	-20.7484			3230				3215	Bottle #4 fired
11/26/16	12:24	87	CTD	23.7675	-20.7484			3230				3000	Bottle #5 fired
11/26/16	12:24	87	CTD	23.7675	-20.7484			3230				3000	Bottle #6 fired
11/26/16	12:28	87	CTD	23.7675	-20.7484			3230				2800	Bottle #7 fired
11/26/16	12:29	87	CTD	23.7675	-20.7484			3230				2800	Bottle #8 fired
11/26/16	12:34	87	CTD	23.7675	-20.7484			3230				2600	Bottle#9 fired
11/26/16	12:34	87	CTD	23.7675	-20.7484			3230				2600	Bottle #10 fired
11/26/16	12:39	87	CTD	23.7675	-20.7484			3230				2400	Bottle #11 fired

11/26/16	12:40	87	CTD	23.7675	-20.7484			3230				2400	Bottle #12 fired
11/26/16	12:45	87	CTD	23.7675	-20.7484			3230				2200	Bottle #13 fired
11/26/16	12:45	87	CTD	23.7675	-20.7484			3230				2200	Bottle #14 fired
11/26/16	12:50	87	CTD	23.7675	-20.7484			3230				2000	Bottle #15 fired
11/26/16	12:51	87	CTD	23.7675	-20.7484			3230				2000	Bottle #16 fired
11/26/16	12:55	87	CTD	23.7675	-20.7484			3230				1800	Bottle #17 fired
11/26/16	12:56	87	CTD	23.7675	-20.7484			3230				1800	Bottle #18 fired
11/26/16	13:01	87	CTD	23.7675	-20.7484			3230				1600	Bottle #19 fired
11/26/16	13:01	87	CTD	23.7675	-20.7484			3230				1600	Bottle #20 fired
11/26/16	13:05	87	CTD	23.7675	-20.7484			3230				1500	Bottle #21 fired
11/26/16	13:06	87	CTD	23.7675	-20.7484			3230				1500	Bottle #22 fired
11/26/16	13:16	87	CTD	23.7675	-20.7484			3230				1000	Bottle #23 fired
11/26/16	13:37	87	CTD	23.7675	-20.7484			3230				25	Bottle #24 fired
11/26/16	13:43	87	CTD	23.7675	-20.7484			3230					CTD on deck
11/26/16	13:53												in transit to Station 88 (AUV)
11/26/16	14:30	88	AUV	23.8336	-20.7137	0.2	9.8	1036					On Station 88 (AUV launch)
11/26/16	14:54	88	AUV	23.8290	-20.7139	0.2	9.8	1050					AUV launched
11/26/16	16:28	88	AUV	23.8290	-20.7139								Fish on board
11/26/16	16:31						9.8						In transit to ROV Dive site
11/26/16	18:18	89	ROV	23.9038	-20.6753	0.1	010	1029					on station 89 for ROV D311 launch

11/26/16	18:46	89	ROV										ROV in the water
11/26/16	19:38	89	ROV						23.9039	-20.6751	1009		at bottom
11/26/16	19:51	89	ROV						23.9038	-20.6753	1025		first drill site reached
11/26/16	20:00	89	ROV										startr driling
11/26/16	20:23	89	ROV										first drill failed (core not retrieved)
11/26/16	20:25	89	ROV										moving backwards 5 m
11/26/16	20:33	89	ROV						23.9039	-20.6753	1025		new first drilling site reached
11/26/16	20:37	89	ROV										start drilling
11/26/16	21:04	89	ROV										stop drilling
11/26/16	21:15	89	ROV										Sample #1, GB1, two pieces of core retrievd,
11/26/16	21:19	89	ROV										moving
11/26/16	21:22	89	ROV						23.9039	-20.6754	1025		reched 2nd drilling site
11/26/16	21:27	89	ROV										start driling
11/26/16	21:58	89	ROV										stop drilling
11/26/16	22:14	89	ROV										Sample #2, recovered core, Yellow 2
11/26/16	22:20	89	ROV										moving to target #4
11/26/16	22:28	89	ROV						23.9041	-20.6754	1026		in position in target #4
11/26/16	22:32	89	ROV										start drilling
11/26/16	22:58	89	ROV										stopped drilling as stucked
11/26/16	23:06	89	ROV										core catcher inserted, no recovery

11/26/16	23:15	89	ROV										heading to target #12
11/26/16	23:20	89	ROV						23.9043	-20.6755	1026		stop, try to drill (not on target #12)
11/26/16	23:23	89	ROV						23.9043	-20.6755			start drilling
11/27/16	0:02	89	ROV										stop drilling
11/27/16	0:13	89	ROV										Sample #3, recovered core in RED1
11/27/16	0:18	89	ROV										moving
11/27/16	0:23	89	ROV						23.9043	-20.6755	1026		in position in target #5
11/27/16	0:25	89	ROV						23.9043	-20.6755	1026		start drilling
11/27/16	1:03	89	ROV						23.9043	-20.6755	1026		stop drilling
11/27/16	1:10	89	ROV						23.9043	-20.6755	1026		Sample #4, recovered core in RED2
11/27/16	1:13	89	ROV						23.9043	-20.6755	1026		moving to new target
11/27/16	1:15	89	ROV						23.9043	-20.8845	1026		in position in target 7
11/27/16	1:17	89	ROV						23.9043	-20.8845	1026		start drilling
11/27/16	1:43	89	ROV						23.9043	-20.8845	1026		stop drilling
11/27/16	1:52	89	ROV						23.9043	-20.8845	1026		recovered core in red 3 sample JC142_089_005
11/27/16	1:54	89	ROV						23.9043	-20.8845	1026		moving to the new target 8
11/27/16	1:59	89	ROV						23.9048	-20.6756	1026		start drilling
11/27/16	2:02	89	ROV						23.9048	-20.6756	1026		stop drilling
11/27/16	2:40	89	ROV						23.9048	-20.6756	1026		recovered core in green 1 sample JC142_089_006
11/27/16	2:42	89	ROV						23.9048	-20.6756	1027		moving to the new target 9

11/27/16	2:49	89	ROV						23.9046	-20.6757	1027		in position in target 9
11/27/16	2:52	89	ROV						23.9046	-20.6757	1027		start drilling
11/27/16	3:23	89	ROV						23.9046	-20.6757	1027		drilling stopped
11/27/16	3:37	89	ROV						23.9046	-20.6757	1027		drill revovered G2
11/27/16	3:39	89	ROV						23.9046	-20.6757	1027		top of sample 006 fallen out from drill and put into into
11/27/16	3:40	89	ROV						23.9046	-20.6757	1027		moving on to next drilling sites 16 m and heading 330
11/27/16	3:44	89	ROV						23.9047	-20.6758	1028		on drill site
11/27/16	3:46	89	ROV						23.9047	-20.6758	1028		start drilling
11/27/16	4:13	89	ROV						23.9047	-20.6758	1028		stopped drilling
11/27/16	4:19	89	ROV						23.9047	-20.6758	1028		sample recovered 009 in G3
11/27/16	4:22	89	ROV						23.9047	-20.6758	1028		moving on to the next drilling site 7m and heading 335,
11/27/16	4:26	89	ROV						23.9048	-20.6759	1028		on drill site
11/27/16	4:30	89	ROV						23.9048	-20.6759	1028		start drilling
11/27/16	4:56	89	ROV						23.9048	-20.6759	1028		stopped drilling
11/27/16	5:03	89	ROV						23.9048	-20.6759	1028		sample 010 in B1
11/27/16	5:05	89	ROV						23.9048	-20.6759	1028		moving 2m and heading 328, next drill site
11/27/16	5:07	89	ROV						23.9048	-20.6759	1028		start drilling
11/27/16	5:54	89	ROV						23.9048	-20.6759	1028		stop drilling
11/27/16	6:00	89	ROV						23.9048	-20.6759	1028		sample 011 in B2
11/27/16	6:04	89	ROV						23.9048	-20.6759	1026		Moving on to next drill site at 15m on bearin 099

11/27/16	6:11	89	ROV						23.9047	-20.6759	1028		On drill site #13
11/27/16	6:12	89	ROV										Start drilling
11/27/16	6:16	89	ROV										Stop drilling- drilling deployment failed
11/27/16	6:20	89	ROV										Moving on- 15m on bearing 270
11/27/16	6:21	89	ROV										Start drilling
11/27/16	6:47	89	ROV										Stop drilling
11/27/16	6:53	89	ROV										Recovered core in Blue3 sample
11/27/16	6:56	89	ROV										Moving to next target #15
11/27/16	7:02	89	ROV						23.9045	-20.6758	1027		On site for drilling target #15
11/27/16	7:07	89	ROV						23.9045	-20.6758	1027		Start drilling
11/27/16	8:00	89	ROV						23.9045	-20.6758	1027		Stop drilling
11/27/16	8:08	89	ROV						23.9045	-20.6758	1027		Sample #013 recovered in Y3
11/27/16	8:10	89	ROV						23.9045	-20.0091	1027		Staying in same location for second attempt
11/27/16	8:13	89	ROV										Start drilling
11/27/16	8:42	89	ROV										Stopped drilling
11/27/16	8:52	89	ROV										Stop drilling Sample 14 in Y1 recovered
11/27/16	8:54	89	ROV						23.9044	-20.6754	1027		Moving to find a rock for Zubkov
11/27/16	9:09	89	ROV						23.9044	-20.6754	1027		Rock sample 15 in CP2
11/27/16	9:28	89	ROV						23.9044	-20.6754	1027		Exploring for a sample for M. Zubkov and sample 16 in
11/27/16	9:30	89	ROV						23.9044	-20.6754	1027		NISKINS fired: samples 17 through to 22

11/27/16	9:37	89	ROV					1028					ROV off bottom
11/27/16	10:23	89	ROV	23.9044	-20.6745			1028					ROV at surface
11/27/16	10:30			23.9044	-20.6745								ROV on deck
11/27/16	10:38		transit										In transit to AUV recovery
11/27/16	11:15	90	AUV	23.8603	-20.6690			1731					on station for AUV recovery
11/27/16	13:51	90	AUV	23.8581	-20.6628			1943					AUV on deck
11/27/16	14:05		transit										In transit to ROV station
11/27/16	15:12	91	ROV	23.8977	-20.5061			3816					On station for ROV dive
11/27/16	15:38	91	ROV	23.8977	-20.5055			3820					ROV in the water
11/27/16	18:10	91	ROV						23.8974	-20.5054	3877		bottom in sight
11/27/16	18:12	91	ROV						23.8973	-20.5056			at bottom
11/27/16	18:35	91	ROV						23.8974	-20.5059	3878		Stop
11/27/16	18:46	91	ROV									265	Moving
11/27/16	18:51	91	ROV						23.8973	-20.5061	3873		Stop
11/27/16	18:55	91	ROV									265	Moving
11/27/16	19:00	91	ROV						23.8971	-20.5062	3872		Stop
11/27/16	19:17	91	ROV						23.8971	-20.5062			Taken sample 001 n GB1
11/27/16	19:29	91	ROV						23.8971	-20.5062			Taken fragment for mike's niskin (sample 002)
11/27/16	19:33	91	ROV										Moving
11/27/16	19:35	91	ROV										Doppler reset

11/27/16	19:41	91	ROV						23.8971	-20.5069	3868		Stop
11/27/16	19:49	91	ROV						23.8971	-20.5069	3868		Sample 003 in GB2
11/27/16	19:52	91	ROV									258	Moving
11/27/16	20:02	91	ROV						23.8970	-20.5072	3860		Attempting sample #004 - Grey crate 3
11/27/16	20:07	91	ROV									263	Moving on
11/27/16	20:26	91	ROV						23.8967	-20.5086	3844		Attempting sample #005 - Grey crate 4
11/27/16	20:59	91	ROV						23.8964	-20.5110	3796		Stopping to sample (006) Port1
11/27/16		91	ROV										Moving on
11/27/16	21:58	91	ROV						23.8960	-20.5139	3773		Attempt sample #07 (CS1)
11/27/16	22:03	91	ROV										Moving on
11/27/16	23:05	91	ROV						23.8958	-20.5003	3701		Attempting sample
11/27/16	23:13	91	ROV								3721		Very slow progress for last 45min due to strrong currents
11/27/16	23:42	91	ROV						23.8950	-20.5190	3671		water more turbid for last 20min
11/27/16	23:54	91	ROV						23.8953	-20.5194	3659		Stopped to sample 009
11/28/16	0:43	91	ROV						23.8945	-20.5229	3599		sottoping to sample coral
11/28/16	1:00	91	ROV						23.8945	-20.5229	3599		Sample #10 -coral from slope in slurp 1W
11/28/16	1:00	91	ROV						23.8945	-20.5229	3599		Sample #11 in CP4 - small piece from steep slope
11/28/16	1:07	91	ROV						23.8946	-20.5231	3595		Stopping to sample
11/28/16	1:11	91	ROV						23.8945	-20.5231	3595		loose block from slope - sample #12 in CP5
11/28/16	1:35	91	ROV						23.8946	-20.5249	3585		Stopping to sample bamboo coral on pavement

11/28/16	1:43	91	ROV						23.8946	-20.5250	3585		Sample #13 - bamboo coral with crinoid in PTBIO yellow
11/28/16	1:55	91	ROV						23.8945	-20.5257	3567		Stopping to sample
11/28/16	2:04	91	ROV						23.8945	-20.5257	3568		Sample #14 coral branches in PTBIO blue
11/28/16	2:05	91	ROV										Redo scorpio white balance after accidentally reset
11/28/16	2:07	91	ROV										Trying to sample rock
11/28/16	2:14	91	ROV						23.8945	-20.5258	3562		Sample #15 - large piece from steep slope in weight box
11/28/16	2:20	91	ROV										Doppler reset
11/28/16	3:01	91	ROV						23.8938	-20.5294	3438		stopping to sample
11/28/16	3:03	91	ROV						23.8938	-20.5294	3437		Rounded loose block from slope - sample #016 in CP6
11/28/16	3:08	91	ROV										Doppler reset
11/28/16	3:38	91	ROV						23.8936	-20.5315	3392		Stopping to sample starfish
11/28/16	3:47	91	ROV						23.8937	-20.5315	3391		Coral sample #17 in red slurp
11/28/16	3:48	91	ROV						23.8937	-20.5315	3391		Starfish #018 in GB4
11/28/16	4:30	91	ROV						23.8936	-20.5337	3338		Stopping to sample
11/28/16	4:39	91	ROV						23.8936	-20.5337	3339		Sample #19 in CS3, block from slope with pavement
11/28/16	4:55	91	ROV						23.8933	-20.5350	3310		stopping to sample sponge
11/28/16	5:06	91	ROV						23.8933	-20.5350	3310		Sample #20 (yellow slurp box) & #21 (black slurp box)
11/28/16	5:24	91	ROV						23.8932	-20.5356	3308		stopping to sample, everything cemented down, moving
11/28/16	6:25	91	ROV						23.8930	-20.5390	3308		Sample #22, Sponge in green slurp box
11/28/16	6:32	91	ROV						23.8931	-20.5391	3313		stopping to sample

11/28/16	6:37	91	ROV						23.8932	-20.5392	3313		Sample #23, CS5, knobbly lump from pavement slope
11/28/16	6:50	91	ROV										doppler reset
11/28/16	7:07	91	ROV						23.8929	-20.5417	3317		stopping to sample
11/28/16	7:10	91	ROV						23.8929	-20.5417	3317		Sample #24, in CS6, block from slope
11/28/16	7:39	91	ROV						23.8925	-20.5443	3223		stopping to sample, crust seems very thin
11/28/16	7:46	91	ROV						23.8926	-20.5443	3224		Sample #25, in CP7, loose block with thin crust, probbaly
11/28/16	7:55	91	ROV						23.8925	-20.5449	3193		Sample #26 in CS7, loose block from pavement
11/28/16	8:19	91	ROV						23.8923	-20.5469	3102		stopping to sample, thin veneer over sediment again,
11/28/16	8:50	91	ROV										Sample #27, sponge in STB 10
11/28/16	9:02	91	ROV										180 heading, currents to strong
11/28/16	9:06	91	ROV						23.8929	-20.5493	3040		Sample #28 into CS8
11/28/16	9:15	91	ROV						23.8929	-20.5496			Sample #29
11/28/16	10:09	91	ROV						23.8928	-20.5524	3003		Very strong currents- hard to move
11/28/16	10:15	91	ROV						23.8931	-20.5527	3006		Stopping to sample
11/28/16	10:19	91	ROV						23.8931	-20.5527	3006		Sample #30 in CP8 Block of crusty area in rubble area
11/28/16	10:36	91	ROV						23.8932	-20.5530	2997		Stopping to sample
11/28/16	10:40	91	ROV						23.8932	-20.5531	2997		Sample #31 in CS2, ledge snapped off below large block
11/28/16	11:35	91	ROV						23.8924	-20.5570	2786		Niskin fired, samples 32 - 37, no pavement, near cliff
11/28/16	11:39	91	ROV						23.8925	-20.5569	2780		ROV off bottom
11/28/16	13:25	91	ROV	23.8921	-20.5560				23.8921	-20.5560	0		ROV on surface

11/28/16	13:55	92	CTD	23.8921	-20.5560								CTD in water
11/28/16	16:08	92	CTD	23.8921	-20.5560								CTD on deck
11/28/16	16:17					8	272						In transit to ST 93
11/28/16	17:15	93	AUV	23.9059	-20.6845			1010					On station- fish in water
11/28/16	17:30	93	AUV	23.9085	-20.6845			978					AUV in water
11/28/16	19:00	93	AUV	23.9018	-20.6842			1024	23.9017	-20.6838	1006		Fish on board
11/28/16	19:02						176						In transit to ST 94
11/28/16	19:48	94	ROV	23.8905	-20.5987			1976					On ST 94
11/28/16	21:09	94	ROV	23.8905	-20.5987								ROV in water after camera fixed
11/28/16	22:34	94	ROV	23.8902	-20.5983			1961					Seabed in sight
11/28/16	23:01	94	ROV	23.8899	-20.5985			1952					Stopped to sample dead coral for Christiam 001 in PT BIO
11/28/16	23:25	94	ROV	23.8899	-20.5984			1952					Slurp sample 2 into RED SLURP CHAMBER
11/28/16	23:37	94	ROV	23.8898	-20.5985			1951					Stopped to sample Rock 003 in CS1
11/28/16	0:28	94	ROV	23.9040	-20.5993			1924					Sample 4 into RED PORT BIO
11/29/16	0:50	94	ROV	23.8862	-20.5996								Doppler reset
11/29/16	1:09	94	ROV	23.8868	-20.6010								Current south-east
11/29/16	1:19	94	ROV										Doppler reset
11/29/16	1:25	94	ROV						23.8872	-20.6019	1834		Stopping to sample, sample 5 into CS2, 2 small pieces of
11/29/16	1:49	94	ROV						23.8883	-20.6028	1805		Stopping to sample
11/29/16	1:52	94	ROV						23.8883	-20.6028	1805		Sample 6 in CS3, block broken from pvmt area

11/29/16	2:02	94	ROV						23.8886	-20.6031	1788		Stopping to sample
11/29/16	2:10	94	ROV						23.8885	-20.6030	1790		Sample 7 - Small piece broken off pvmt, Block from
11/29/16	2:16	94	ROV						23.8885	-20.6030	1790		Sample 008 in CS3
11/29/16	2:27	94	ROV						23.8886	-20.6031	1789		Dropped coral sample
11/29/16		94	ROV						23.8886	-20.6031	1789		Coral sample #009 in PTBIO Yellow
11/29/16	2:42	94	ROV										Stopping to sample coral
11/29/16	2:50	94	ROV						23.8887	-20.6032	1784		Sample #010 in PTBIO White - Coral (lophelia)
11/29/16	3:14	94	ROV										Doppler reset
11/29/16	3:25	94	ROV						23.8890	-20.6046	1732		Stopping to sample - probably thin crust on semi-lithified
11/29/16	3:27	94	ROV						23.8890	-20.6046	1732		Sample #011 in CP1
11/29/16	3:48	94	ROV						23.8888	-20.6054	1670		high currents
11/29/16	3:51	94	ROV						23.8888	-20.6055	1669		Stopping to sample
11/29/16	3:54	94	ROV						23.8888	-20.6055	1669		Sample #012 - Small piece broken of pvmt in Zubkov
11/29/16	4:06	94	ROV						23.8888	-20.6057	1662		Stopping to sample
11/29/16	4:07	94	ROV						23.8888	-20.6057	1662		Small piece from Block in CS5
11/29/16	4:20	94	ROV						23.8888	-20.6057	1662		Sample #014 coral in PTBIO
11/29/16	4:40	94	ROV										Doppler reset
11/29/16	4:45	94	ROV						23.8882	-20.6073	1637		Stopping to sample
11/29/16	4:51	94	ROV						23.8882	-20.6073	1637		Sample #015 block from on top cliff in CP2
11/29/16	5:06	94	ROV										Doppler reset

11/29/16	5:47	94	ROV						23.8900	-20.6099	1644		Skipping ahead to WP9 from half way between 7 & 8as no
11/29/16	6:04	94	ROV						23.8907	-20.6109	1603		Stopping to sample, not possible
11/29/16	6:14	94	ROV						23.8908	-20.6112	1595		Stopping to sample, nothing loose, carrying on
11/29/16	6:30	94	ROV						23.8913	-20.6123	1589		Stopping to sample, nothing loose, carrying on
11/29/16	6:43	94	ROV										Doppler reset
11/29/16	7:24	94	ROV						23.8900	-20.6151	1616		Sample #016 in Red and #017 & #018 in Yellow
11/29/16	7:38	94	ROV						23.8899	-20.6151	1616		Sample #019 rock with bio in CS6
11/29/16	8:06	94	ROV										Doppler reset
11/29/16	8:18	94	ROV						23.8881	-20.6177	1593		Stopping to sample
11/29/16	8:37	94	ROV						23.8882	-20.6177	1589		Sample #020 in CS7 in 2 pieces, blocks from isolated slab
11/29/16	8:56	94	ROV						23.8882	-20.6190	1551		Stopping to sample
11/29/16	9:10	94	ROV						23.8883	-20.6190	1548		Sample #021 in CS8 broken piece from isolated outcrop
11/29/16	9:10	94	ROV						23.8883	-20.6191	1548		Sample #22, crinoid in CS3
11/29/16	9:16	94	ROV						23.8884	-20.6193	1538		Current S to N
11/29/16	9:46	94	ROV						23.8880	-20.6211	1526		High currents
11/29/16	10:10	94	ROV										Doppler reset
11/29/16		94	ROV										Current SW 225
11/29/16		94	ROV										#23 crinoid in black sheep
11/29/16	10:58	94	ROV						23.8903	-20.6255	1433		Stopped to sample #24, slab off an isolated
11/29/16	11:26	94	ROV						23.8909	-20.6266			Stopped to sample #25, CP4 (smaller), #26 CP4 is bigger

11/29/16	12:05	94	ROV						23.8918	-20.6286			#27 sample CP6, Natasha sample
11/29/16	12:09	94	ROV										Pushcore 1 #28
11/29/16	12:12	94	ROV						23.8917	-20.6286			Pushcore 4 #29
11/29/16	12:15	94	ROV										PC2 #30
11/29/16	12:18	94	ROV										Moving
11/29/16	12:21	94	ROV						23.8918	-20.6288	1340		Stop
11/29/16	12:23	94	ROV										Sample #31 collected (2 pieces)
11/29/16	12:37	94	ROV						23.8919	-20.6289	1328		Stop
11/29/16	12:45	94	ROV										Sample 32 collected
11/29/16	12:48	94	ROV										Moving
11/29/16	12:55	94	ROV						23.8919	-20.6292	1319		Stop
11/29/16	13:04	94	ROV										Sample #34 collected
11/29/16	13:12	94	ROV										ROV leaving bottom
11/29/16	14:19	94	ROV	23.8922	-20.6288			1350					ROV on deck
11/29/16	14:40												In transit to AUV M138 recovery position
11/29/16	15:20	95	AUV	23.9262	-20.6880								Arrived on AUV M138 recovery position
11/29/16	17:45	95	AUV	23.9199	-20.6866								AUV on deck
11/29/16	17:51												In transit to ROV launch site
11/29/16	18:35	96	ROV	23.9211	-20.7981			2348					On station for ROV dive
11/29/16	18:59	96	ROV	23.8878	-20.7981			2355					In water

11/29/16	19:03	96	ROV	23.8878	-20.7981			2355					Back on deck- issue with docking head
11/29/16	22:48												Decided to move to gravity core
11/29/16	22:50												In transit to NW gravity core location
11/29/16	23:52	97	GC	24.0067	-20.8217			3985					Gravity core in water
11/30/16	1:00	97	GC	24.0067	-20.8217			4052				4000	Stopped at 100m MASF
11/30/16	1:08	97	GC	24.0067	-20.8217			4052				4105	GC- contact with seafloor
11/30/16	2:30	97	GC	24.0067	-20.8217			4052					GC back on deck
11/30/16	3:10												Transit to ST 98 (HRW CTD#11)
11/30/16	4:00	98	CTD	23.9454	-20.7793			2973					On ST98
11/30/16	4:13	98	CTD	23.9454	-20.7793			2960					CTD in water
11/30/16	5:08	98	CTD	23.9454	-20.7793			2960					CTD at bottom
11/30/16	5:10	98	CTD	23.9454	-20.7793			2960				2942	Bottle #1 fired
11/30/16	5:21	98	CTD	23.9454	-20.7793			2960				2402	Bottle #7 fired
11/30/16	5:46	98	CTD	23.9454	-20.7793			2960				1004	Bottle #13 fired
11/30/16	5:58	98	CTD	23.9454	-20.7793			2960				406	Bottle #19 fired
11/30/16	6:15	98	CTD	23.9454	-20.7793			2960				0	CTD at surface
11/30/16	6:20	98	CTD	23.9465	-20.7794							0	CTD on deck
11/30/16	6:22												In transit to ST99 (CTD#10 HRW)
11/30/16	6:57	99	CTD	23.9013	-20.8153			3072					On station for HRW CTD #10
11/30/16	7:16	99	CTD	23.9013	-20.8153			3069					CTD in water

11/30/16	8:12	99	CTD	23.9013	-20.8153			3014					CTD at bottom
11/30/16	8:15	99	CTD	23.9013	-20.8153							3030	Bottles #1-4 fired
11/30/16	8:27	99	CTD	23.9013	-20.8153							2800	Bottles #5 + 6 fired
11/30/16	8:39	99	CTD	23.9013	-20.8153							2200	Bottles 7+8 fired
11/30/16	8:50	99	CTD	23.9013	-20.8153							1800	Bottles 9+10 fired
11/30/16	8:58	99	CTD	23.9013	-20.8153							1400	Bottles 11+12 fired
11/30/16	9:07	99	CTD	23.9013	-20.8153							1000	Bottles 13-18 fired
11/30/16	9:15	99	CTD	23.9013	-20.8153							800	Bottles 19 +20 fired
11/30/16	9:24	99	CTD	23.9013	-20.8153							400	Bottles 21+22 fired
11/30/16	9:37	99	CTD	23.9013	-20.8153							25	Bottles 23+24 fired
11/30/16	9:42	99	CTD	23.9013	-20.8153			3052					CTD on deck
11/30/16	10:00	99	CTD										Starting transit to ROV
11/30/16	10:51	100	ROV	23.8569	-20.6847								Arrived at ST100_Rov Dive 314
11/30/16	11:14	100	ROV	23.8569	-20.6847								Rov in water
11/30/16	12:10	100	ROV						23.8556	-20.6846	1397		Rov @ bottom
11/30/16	12:19	100	ROV						23.8565	-20.6846	1415		White balance
11/30/16	12:29	100	ROV						23.8567	-20.6846	1407		Sample 001 in port 1
11/30/16	14:49	100	ROV						23.8567	-20.6846	1406		Niskin rod sample (002)
11/30/16	12:58	100	ROV						23.8577	-20.6846	1406		Blach coral- sample 003
11/30/16	13:03	100	ROV						23.8567	-20.6837	1406		Push core -sample 004

11/30/16	13:04	100	ROV						23.8567	-20.6837	1406		Push core -sample 005
11/30/16	14:20	100	ROV										Doppler reset
11/30/16	14:39	100	ROV						23.8589	-20.6855	1253		Push corer 2 -sample 006
11/30/16	14:59	100	ROV						23.8591	-20.6857	1233		Sample 007- coral (Christian), CS01
11/30/16	15:22	100	ROV						23.8590	-20.6860	1233		Sample 008- CP3
11/30/16	15:24	100	ROV						23.8589	-20.6860	1335		Push corer 3 -sample 009
11/30/16	15:32	100	ROV										Push corer 5- sample 010
11/30/16	15:34	100	ROV						23.8589	-20.6860	1235		Push corer 6 - sample 011
11/30/16	15:43	100	ROV						23.8576	-20.6860			Sample 0012 (2 pieces) ST2
11/30/16	15:46	100	ROV						23.8589	-20.6861	1230		Sample 0013 in CS3 (2 pieces)
11/30/16	15:57	100	ROV						23.8591	-20.6863	1214		Sample 14 in CS4
11/30/16	16:20	100	ROV						23.8596	-20.6866	1174		Sample 0015 on STB crate
11/30/16	16:26	100	ROV						23.8596	-20.6866	1174		Sample 0016 in STB6
11/30/16	16:30	100	ROV						23.8596	-20.6867	1163		Sample 0017 in STB5
11/30/16	16:31	100	ROV										Off bottom
11/30/16	17:27	100	ROV										Rov on deck
11/30/16	17:41												Starting transit to AUV
11/30/16	17:53			23.8469	-20.7165			999					On AUV station
11/30/16	18:21	101	GC										GC before AUV launch (same site)
11/30/16	18:39	101	GC	23.8469	-20.7173								GC in water

11/30/16	19:36	101	GC	23.8469	-20.7173			998					GC on deck (3m perfuration, only 3cm of coral +sand
11/30/16	20:13	102	AUV	23.8513	-20.7195			984					AUV in water
11/30/16	21:30	102	AUV	23.8493	-20.7150			1014					Fish out of water e AUV released
11/30/16	22:09	103	ROV	23.8522	-20.7111			1013					ROV in water
11/30/16	23:00	103	ROV						23.8519	-20.7108	1016		ROV at bottom
11/30/16	23:25	103	ROV						23.8519	-20.7109			Lander deployed
11/30/16	23:27	103	ROV										Moving on
11/30/16	23:50	103	ROV						23.8521	-20.7110	1019		Stop to collect push cores
11/30/16	23:53	103	ROV						23.8521	-20.7110	1019		Push core 1 collected
11/30/16	23:56	103	ROV						23.8521	-20.7110	1019		Push core 2 collected
12/1/16	0:11	103	ROV						23.8523	-20.7108	1019		Push core 3 collected
12/1/16	0:13	103	ROV						23.8523	-20.7108	1019		Moving on
12/1/16	0:23	103	ROV						23.8527	-20.7107	1016		Stop to sample
12/1/16	0:33	103	ROV						23.8527	-20.7107	1016		Push core 6 collected
12/1/16	0:34	103	ROV						23.8527	-20.7107	1016		Pucsh core 5 collected
12/1/16	0:35	103	ROV						23.8527	-20.7107	1016		Doppler reset
12/1/16	0:36	103	ROV										Moving on
12/1/16	0:38	103	ROV										Bearing 200 for 85m
12/1/16	0:49	103	ROV						23.8520	-20.7110	1019		Stop to place the flag
12/1/16		103							23.8517	-20.7111			New WP

12/1/16	1:00	103	ROV						23.8520	-20.7110			Currents NE-SW
12/1/16	1:22	103	ROV										Moving on 200 degrees, 35m
12/1/16	1:26	103	ROV						23.8517	-20.7110	1019		Stopped to generate plume
12/1/16	1:38	103	ROV						23.8517	-20.7110	1019		Start generating plume, heading 60.3
12/1/16	1:48	103	ROV						23.8518	-20.7111	1019		Stop plume, heading 59.2
12/1/16	1:51	103	ROV						23.8519	-20.7111	1019		New WP9, 090 and 5m from previous point
12/1/16	1:52	103	ROV						23.8519	-20.7111	1019		Start plume- heading 090 (WP9)
12/1/16	2:02	103	ROV						23.8519	-20.7112	1019		Stop plume
12/1/16	2:03	103	ROV										Stepping 1m back- image of left hole
12/1/16	2:05	103	ROV										Moving to WP10
12/1/16	2:11	103	ROV						23.8521	-20.7109	101		WP10
12/1/16	2:13	103	ROV						23.8521	-20.7109			Start generating plume- heading 179
12/1/16	2:24	103	ROV						23.8521	-20.7109			Stop plume- heading 178
12/1/16	2:25	103	ROV										Moving 1.5m back
12/1/16	2:26	103	ROV										Moving 5m starboard
12/1/16	2:29	103	ROV						23.8521	-20.7110	1019		Start plume- heading 178 WP11
12/1/16	2:39	103	ROV						23.8521	-20.7110	1019		Stop plume- heading 176
12/1/16	2:40	103	ROV										Step 1.5m back and 1.5m starboard
12/1/16	2:45	103	ROV										Moving to flag location
12/1/16	2:48	103	ROV						23.8520	-20.7110			On flag location

12/1/16	2:52	103	ROV						23.8520	-20.7110			Flag recovered
12/1/16	2:54	103	ROV						23.8520	-20.7110			Reset doppler
12/1/16	2:57	103	ROV										Moving to line 02
12/1/16	3:01	103	ROV						23.8523	-20.7108	1018		On new flag location
12/1/16	3:04	103	ROV						23.8523	-20.7108	1018		Flag down (WP13)- flow direction 160
12/1/16	3:13	103	ROV										Moving on (bearing 277 for 27m)
12/1/16	3:20	103	ROV						23.8523	-20.7111			At new wp
12/1/16	3:25	103	ROV						23.8523	-20.7111			Start plume (trench)
12/1/16	3:36	103	ROV						23.8523	-20.7108			Stop plume (at WP15)
12/1/16	3:41	103	ROV										Moving on to WP16
12/1/16	3:45	103	ROV						23.8523	-20.7110			At WP16
12/1/16	3:55	103	ROV						23.8523	-20.7110	1018		Start plume
12/1/16	4:05	103	ROV						23.8523	-20.7110	1018		Stop plume
12/1/16	4:06	103	ROV										Moving on- 350 degrees for 1.5m
12/1/16	4:08	103	ROV										Moving backwards 1m more
12/1/16	4:10	103	ROV										Moving on to WP17 (7m to 080 degrees)
12/1/16	4:12	103	ROV						23.8523	-20.7109	1017		At WP17
12/1/16	4:15	103	ROV						23.8523	-20.7109	1017		Start plume generation
12/1/16	4:25	103	ROV						23.8523	-20.7109	1017		Stop plume
12/1/16	4:25	103	ROV										Moving on

12/1/16	4:28	103	ROV										Moving on bearing 260 for 10m
12/1/16	4:31	103	ROV						23.8523	-20.7110	1017		Doppler reset
12/1/16	4:32	103	ROV						23.8523	-20.7110	1018		At WP18
12/1/16	4:35	103	ROV						23.8523	-20.7110	1018		Start plume
12/1/16	4:45	103	ROV						23.8523	-20.7110	1018		Stop plume
12/1/16	4:48	103	ROV										Moving on
12/1/16	4:51	103	ROV						23.8523	-20.7108			Return to WP13 to collect flag
12/1/16	4:58	103	ROV										Moving on to WP19- heading 006
12/1/16	5:05	103	ROV						23.8528	-20.7108	1014		At WP19- drop flag, flow direction 185 degrees
12/1/16	5:10	103	ROV						23.8528	-20.7108	1014		Head to WP20 (start of trench)
12/1/16	5:18	103	ROV						23.8528	-20.7109	1015		Doppler reset
12/1/16	5:21	103	ROV						23.8527	-20.7110	1016		At WP20
12/1/16	5:24	103	ROV						23.8527	-20.7110	1016		Start plume (trench)
12/1/16	5:26	103	ROV										Plume failed- return to WP20 to restart trench
12/1/16	5:29	103	ROV						23.8527	-20.7110	1017		Start plume (trench)
12/1/16	5:30	103	ROV										Issue with slurp
12/1/16	5:41	103	ROV										Issue fixed
12/1/16	5:45	103	ROV						23.8527	-20.7110	1017		Doppler reset
12/1/16	5:48	103	ROV						23.8527	-20.7110	1017		Restart plume generation
12/1/16	6:00	103	ROV						23.8527	-20.7105	1017		Stop plume

12/1/16	6:08	103	ROV						23.8528	-20.7107			On flag location (WP22)
12/1/16	6:11	103	ROV										Heading to WP23
12/1/16	6:13	103	ROV						23.8526	-20.7105			On WP23
12/1/16	6:21	103	ROV						23.8526	-20.7105	1016		Start pumping- heading 205
12/1/16	6:23	103	ROV						23.8526	-20.7105	1016		After 1.40 since start of pumping ROV takes off from
12/1/16	6:23	103	ROV						23.8526	-20.7105	1016		Pumping again after on 159
12/1/16	6:31	103	ROV						23.8526	-20.7105	1016		Stop pumping- heading 205
12/1/16	6:32	103	ROV										Step back 1.5m
12/1/16	6:33	103	ROV										Moving 10m starboard
12/1/16	6:34	103	ROV										Moving 5m forward
12/1/16	6:35	103	ROV						23.8527	-20.7106			Doppler reset
12/1/16	6:36	103	ROV						23.8527	-20.7106			Start pumping- heading 203
12/1/16	6:42	103	ROV						23.8527	-20.7106			ROV left bottom- landed again, heading 176
12/1/16	6:47	103	ROV						23.8527	-20.7106			Stop pumping- heading 178
12/1/16	6:51	103	ROV						23.8527	-20.7106			Doppler reset
12/1/16	6:52	103	ROV										Moving 10m starboard
12/1/16	6:54	103	ROV										Moving 25m- 090 to WP2
12/1/16	6:55	103	ROV						23.8526	-20.7108			On WP25
12/1/16	6:55	103	ROV										Start pumping
12/1/16	7:07	103	ROV						23.8526	-20.7108	1016		Stop pumping

12/1/16	7:08	103	ROV										Step back .5m to image trench
12/1/16	7:10	103	ROV										Moving 10m starboard to WP26
12/1/16	7:11	103	ROV						23.8525	-20.7109	1016		On WP26
12/1/16	7:15	103	ROV						23.8525	-20.7109	1016		Start pumping
12/1/16	7:25	103	ROV						23.8525	-20.7109	1016		Stop pumping
12/1/16	7:26	103	ROV										Step back 1.5m to image trench
12/1/16	7:27	103	ROV										Moving starboard 10m to WP27
12/1/16	7:31	103	ROV						23.8527	-20.7112	1016		On WP27
12/1/16	7:34	103	ROV						23.8527	-20.7112	1016		Start pumping
12/1/16	7:44	103	ROV						23.8527	-20.7111	1017		Stop pumping
12/1/16	7:50	103	ROV										Moving on
12/1/16	7:56	103	ROV						23.8528	-20.7107			At WP22- flag location
12/1/16	7:59	103	ROV						23.8528	-20.7107			Flag recovered
12/1/16	8:00	103	ROV										Doppler reset
12/1/16	8:01	103	ROV						23.8528	-20.7107			Moving to lander location
12/1/16	8:15	103	ROV						23.8523	-20.7109	1018		Push core -sample 004
12/1/16	8:18	103	ROV						23.8523	-20.7109	1018		Doppler reset
12/1/16	8:34	103	ROV						23.8520	-20.7108	1018		Fired Niskins 1,2,3,4,5 and 6
12/1/16	8:34	103	ROV						23.8519	-20.7108	1019		On lander location
12/1/16	8:39	103	ROV						23.8519	-20.7108	1019		Sediment traps closed

12/1/16	8:42	103	ROV						23.8519	-20.7108	1019		Lander recovered
12/1/16	8:50	103	ROV						23.8519	-20.7108	1019		Leaving bottom
12/1/16	10:00	103	ROV										ROV on deck
12/1/16	14:00	104	ROV	23.8534	-20.7251			1000					ROV in water
12/1/16	14:48	104	ROV						23.8537	-20.7247	1010		Rov @ bottom
12/1/16	14:51	104	ROV						23.8536	-20.7248	1016		Stop to sample
12/1/16	14:55	104	ROV						23.8536	-20.7248	1015		PC1 in box 1, Sample 1
12/1/16	14:56	104	ROV						23.8536	-20.7248	1015		PC2 in box 1, Sample 2
12/1/16	14:58	104	ROV						23.8536	-20.7248	1015		PC3 in box 1, Sample 3
12/1/16	14:59	104	ROV						23.8536	-20.7248	1015		PC4 in box 1, Sample 4
12/1/16	15:06	104	ROV						23.8536	-20.7248	1015		Sample 005 in GB03
12/1/16	15:07	104	ROV						23.8536	-20.7248	1015		Sample 006 in GB01
12/1/16	15:08	104	ROV						23.8536	-20.7249			Sample 007 in Z Niskin
12/1/16	15:15	104	ROV						23.8537	-20.7248			Sample 008 in GB04
12/1/16	15:25	104	ROV						23.8537	-20.7248			PC5 Box 1, broken
12/1/16	15:30	104	ROV						23.8537	-20.7248			PC6 box1, sample 009
12/1/16	15:38	104	ROV						23.8537	-20.7248			PC4 box 2 sample 010
12/1/16	15:45	104	ROV						23.8537	-20.7247			PC1 box 2 sample 011
12/1/16	16:20	104	ROV						23.8536	-20.7267			PC2 box 2 sample 012
12/1/16	16:24	104	ROV						23.8536	-20.7267			PC3 box 2 sample 013

12/1/16	16:26	104	ROV						23.8536	-20.7267			PC5 box 2 sample 014
12/1/16	16:31	104	ROV						23.8536	-20.7267			Ellsworth core, sample 015
12/1/16	16:45	104	ROV						23.8536	-20.7267			Ellsworth core finish
12/1/16	16:56	104	ROV						23.8536	-20.7266			PC6 box 2, Ellsworths sample 016
12/1/16	17:00	104	ROV						23.8536	-20.7267			Niskin 1, sample 017
12/1/16	17:01	104	ROV						23.8536	-20.7267			Niskin 2, sample 018
12/1/16	17:02	104	ROV						23.8536	-20.7267			Niskin 3, sample 019
12/1/16	17:02	104	ROV						23.8536	-20.7266	1012		Niskin 4 sample 020
12/1/16	17:02	104	ROV						23.8536	-20.7266	1012		Niskin 5 sample 021
12/1/16	17:02	104	ROV						23.8536	-20.7266	1012		Niskin 6 sample 022
12/1/16	17:03	104	ROV						23.8536	-20.7266	1012		Leaving bottom
12/1/16	17:45	104	ROV						23.8541	-20.7266	1011		ROV at surface
12/1/16	17:48	104	ROV						23.8541	-20.7266	1011		ROV on deck
12/1/16	20:00	105	AUV	23.8685	-20.6865			1011					AUV on board
12/1/16	20:11		TRANSIT										In transit to ST106
12/1/16	21:00	106	ROV	23.9211	-20.7979			2110					At ST106
12/1/16	21:24	106	ROV	23.9211	-20.7979			2275					ROV in water
12/1/16	22:02	106	ROV										ROV coming up, possible wire problem
12/1/16	22:30	106	ROV	23.9212	-20.7979			2270					ROV at surface
12/1/16	22:35	106	ROV	23.9212	-20.7979			2270					Out of water

12/1/16	22:57	107	ROV	23.9212	-20.7979			2270					ROV in the water
12/2/16	0:31	107	ROV						23.9210	-20.7981	2352		Bottom in sight
12/2/16	0:45	107	ROV										White balance
12/2/16	0:53	107	ROV						23.9209	-20.7980	2347		At WP1
12/2/16	1:07	107	ROV						23.9209	-20.7969	2333		Stopping to sample
12/2/16	1:09	107	ROV						23.9209	-20.7969	2333		Sample #1 in CS1, loose slab from steep slope
12/2/16	1:24	107	ROV						23.9209	-20.7955	2293		Stopping to sample
12/2/16	1:28	107	ROV						23.9209	-20.7955	2293		Broke lump off block on slope, sed with thin crust, sample
12/2/16	2:26	107	ROV						23.9209	-20.7910	1970		Stopping to sample on steep cliff
12/2/16	2:29	107	ROV						23.9209	-20.7910	1970		Sample #3 in CP2, block broken from vertical wall of
12/2/16	2:32	107	ROV										Doppler reset
12/2/16	2:50	107	ROV						23.9206	-20.7895	1910		Stopping to try and sample dead coral Sample #4 in GB1
12/2/16	3:23	107	ROV						23.9204	-20.7878	1816		Stopping to sample
12/2/16	3:25	107	ROV						23.9204	-20.7878	1816		Bock broken from slab on slope, Sample #5 in CP1
12/2/16	3:31	107	ROV						23.9203	-20.7878	1815		Coral from slope, sample 6 in slurp white
12/2/16	3:41	107	ROV						23.9200	-20.7877	1814		Stopping to sample
12/2/16	3:44	107	ROV						23.9203	-20.7877	1814		Broken block from slab, Sample #7 in CP3
12/2/16	3:50	107	ROV										Doppler reset
12/2/16	4:08	107	ROV						23.9197	-20.7867	1780		Stopping to sample
12/2/16	4:16	107	ROV						23.9197	-20.7867	1780		Too well stuck down- carrying on

12/2/16	4:45	107	ROV						23.9187	-20.7846	1847		Stopping to sample
12/2/16	4:48	107	ROV						23.9187	-20.7846	1847		Sample #8 in CS3, block from below edge pavement
12/2/16	5:08	107	ROV						23.9185	-20.7832	1858		Stopping to sample- everything stuck down- moving on
12/2/16	5:16	107	ROV										Doppler reset
12/2/16	5:26	107	ROV						23.9183	-20.7824	1858		Stopping to sample
12/2/16	5:30	107	ROV						23.9184	-20.7824	1858		Sample #9 in 2- Niskin, small piece from slope
12/2/16	5:50	107	ROV						23.9179	-20.7812	1815		Stopping to sample
12/2/16	5:51	107	ROV						23.9179	-20.7812	1815		Sample #10 in CS4, slab broken from slope pavement
12/2/16	6:17	107	ROV						23.9164	-20.7795	1731		Stopping to sample
12/2/16	6:30	107	ROV						23.9163	-20.7794	1729		Sample #11 in CS05, block from slope
12/2/16	6:47	107	ROV						23.9157	-20.7781	1658		Stopping to sample
12/2/16	6:55	107	ROV						23.9157	-20.7781	1664		Crinoid sample #12 in slurp red
12/2/16	7:50	107	ROV						23.9138	-20.7754	1453		Stopping to sample
12/2/16	8:04	107	ROV						23.9137	-20.7752	1452		Block broken from pavement, on steep slope, sample #13
12/2/16	8:00	107	ROV										Doppler reset
12/2/16	8:16	107	ROV						23.9134	-20.7751	1442		Crinoid sample #14 in slurp yellow
12/2/16	8:26	107	ROV						23.9130	-20.7744	1435		Stopping to sample -everthing down- carring on
12/2/16	8:59	107	ROV						23.9125	-20.7727	1372		Stopping to sample
12/2/16	9:02	107	ROV						23.9125	-20.7727	1372		sample #015 in CS7-Broken off PVMT/lob slope
12/2/16	9:10	107	ROV										Doppler reset

12/2/16	9:44	107	ROV						23.9114	-20.7709	1276		Sample #016 in CS8
12/2/16	9:45	107	ROV										Doppler reset
12/2/16	10:08	107	ROV						23.9097	-20.7693	1241		Stopping to sample
12/2/16	10:13	107	ROV						23.9097	-20.7693	1241		Mn crust coral_ sample #017 in CP 6
12/2/16	10:17	107	ROV						23.9097	-20.7693	1241		Crust broke from pvmt area - sample #018 in CS5
12/2/16	10:27	107	ROV						23.9091	-20.7689	1236		Sample #019 in CP7 rounded cobble from nodule/lobate
12/2/16	10:49	107	ROV										Leaving trck to check lateral extent of paviment areas
12/2/16	11:01	107	ROV										Doppler reset
12/2/16	11:10	107	ROV						23.9072	-20.7699	1216		Stopping to sample
12/2/16	11:11	107	ROV						23.9072	-20.7699	1216		Sample #020 inGB2 - Loose brock from Lob. PVMT
12/2/16	11:35	107	ROV						23.9063	-20.7711	1209		Stopping to sample
12/2/16	11:44	107	ROV						23.9064	-20.7712	1208		Sample #021 in GB3, piece snapped off lobate pavement
12/2/16	12:11	107	ROV						23.9052	-20.7726	1214		Samples #22, 23, 24, 25 in GB4, nodule samples from the
12/2/16	12:51	107	ROV						23.9031	-20.7755	1222		Nisins 1, 2, 3, 4, 5, 6 fired
12/2/16	13:00	107	ROV						23.9031	-20.7754	1223		Sample 32, weight box
12/2/16	16:02	108	AUV	23.9097	-20.7709			1227					AUV in water (for 2nd time)
12/2/16	17:12	108	AUV	23.9098	-20.7713			1229					AUV released- fish up
12/2/16	17:20												In transit to ROV dive site
12/2/16	18:42	109	ROV	23.7041	-20.7269			3837					On station for ROV dive ST 109
12/2/16	20:08	109	ROV	23.7040	-20.7266								ROV in water

12/2/16	22:27	109	ROV						23.7034	-20.7267	3888		Bottom in sight
12/2/16	23:06	109	ROV						23.7045	-20.7268	3851		Sample 01 rock, in situ GB1
12/2/16	23:12	109	ROV						23.7045	-20.7268	3851		Sample 02 rock, in situ GB2
12/2/16	23:19	109	ROV						23.7045	-20.7268	3851		Sample 03 Z Niskin
12/2/16	23:34	109	ROV						23.7047	-20.7268	3841		Sample 04 in CP1
12/3/16	23:55	109	ROV						23.7062	-20.7268	3832		Sample 05 in GB3
12/3/16	0:01	109	ROV						23.7062	-20.7268	3832		Moving
12/3/16	0:33	109	ROV						23.7092	-20.7263	3760		Sample 06 GB4
12/3/16	0:34	109	ROV										Moving
12/3/16	1:38	109	ROV						23.7132	-20.7264	3665		Sample 07 CS1
12/3/16	1:43	109	ROV										Moving
12/3/16	2:27	109	ROV						23.7164	-20.7263	3625		Sample 8 CS2
12/3/16	2:29	109	ROV										Moving
12/3/16	2:35	109	ROV						23.7169	-20.7265	3623		WP2
12/3/16	3:12	109	ROV						23.7177	-20.7296	3682		Stopping to sample
12/3/16	3:15	109	ROV						23.7177	-20.7296	3682		Loose block from isolated exposure, sample #09 inCP2
12/3/16	3:20	109	ROV										Doppler reset
12/3/16	3:30	109	ROV						23.7188	-20.7294	3651		Stopping to sample
12/3/16	3:38	109	ROV						23.7188	-20.7294	3651		Sample #010 in loose block from base pavement exposure
12/3/16	4:21	109	ROV						23.7216	-20.7283	3491		Stopping to sample

12/3/16	4:25	109	ROV						23.7216	-20.7283	3492		Sample #011 in CS4 loose block from pavement area slope
12/3/16	4:35	109	ROV						23.7221	-20.7281	3476		Stopping to sample
12/3/16	4:35	109	ROV						23.7221	-20.7281	3476		Sample 012 in CS5, loose block from gap between
12/3/16	5:15	109	ROV						23.7247	-20.7271	3349		Stopping to sample
12/3/16	5:23	109	ROV						23.7248	-20.7271	3348		Loose block from botroidal PVMT, sample #013 in CS6
12/3/16	5:36	109	ROV										Doppler reset
12/3/16	6:04	109	ROV						23.7269	-20.7251	3276		Stopping to sample
12/3/16	6:12	109	ROV						23.7269	-20.7251	3276		Block from lobate PVMT slope, sample #014 in CS7
12/3/16	6:42	109	ROV						23.7286	-20.7236	3211		Stopping to sample
12/3/16	6:50	109	ROV						23.7286	-20.7237	3214		Anenome, sample #015 in PTBIO white
12/3/16	6:56	109	ROV						23.7286	-20.7237	3211		Coral, sample#016 in PTBIO white
12/3/16	7:36	109	ROV						23.7302	-20.7232	3187		Stopping to sample
12/3/16	7:43	109	ROV						23.7303	-20.7224	3186		Sample ~017 in CS8
12/3/16	8:34	109	ROV										Doppler reset
12/3/16	8:55	109	ROV						23.7351	-20.7214	3084		stopping to sample
12/3/16	9:01	109	ROV						23.7351	-20.7215	3084		Sample#018 in CP4
12/3/16	9:26	109	ROV						23.7368	-20.7209	3060		stopping to sample
12/3/16	9:29	109	ROV						23.7368	-20.7209	3058		Small nodule from nod/pvmt area, sample #019 in CP3
12/3/16	10:23	109	ROV						23.7411	-20.7202	2947		stopping to sample
12/3/16	10:24	109	ROV						23.7411	-20.7411	2947		Block from sedimentary outcrop - Lobate pavement.

12/3/16	10:28	109	ROV										Doppler reset
12/3/16	10:35	109	ROV						23.7416	-20.7416	2926		Boulder on top of pavement. Sample #021 in CP6
12/3/16	10:42	109	ROV						23.7418	-20.7418	2912		stopping to fire niskin over lobate pavement. Samples
12/3/16	10:49	109	ROV						23.7421	-20.7421	2894		End dive
12/3/16	10:52	109	ROV						23.7421	-20.7421	2890		ROV off bottom
12/3/16	12:57	109	ROV	23.7407	-20.7200								ROV at surface
12/3/16	13:06	109	ROV	23.7407	-20.7200								On deck
12/3/16	14:17	transit		23.8229	-20.7199								Moving from AUV station to CTD -> 1 km
12/3/16	14:50	110	CTD	23.8228	-20.7102			1280					CTD in water ove SE edge of plateau
12/3/16	16:10	110	CTD	23.8228	-20.7102			1196					CTD back on deck
12/3/16	18:20	111	AUV	23.8213	-20.7135								AUV on deck
12/3/16	19:10	112	CTD	23.7750	-20.7143			2077					CTD in water
12/3/16	19:57	112	CTD	23.7750	-20.7143			2077					Niiskin 1 to 4 fired
12/3/16	20:03	112	CTD	23.7750	-20.7143			2077					5 and 6 fired
12/3/16	20:09	112	CTD	23.7750	-20.7143			2077					Niskin 7 and 8 fired
12/3/16	20:15	112	CTD	23.7750	-20.7143			2077					Niskin 9 and 10 fired
12/3/16	20:19	112	CTD	23.7750	-20.7143			2077					Niskin 11 and 12 fired
12/3/16	20:24	112	CTD	23.7750	-20.7143			2077					Niskin 13 and 14 fired
12/3/16	20:30	112	CTD	23.7750	-20.7143			2077					Niskin 15 and 16 fired
12/3/16	20:35	112	CTD	23.7750	-20.7143			2077					Niskin 17 and 18 fired

12/3/16	20:39	112	CTD	23.7750	-20.7143			2077					Niskin 19 and 20 fired
12/3/16	20:52	112	CTD	23.7750	-20.7143			2077					Niskin 21 and 22 fired
12/3/16	21:01	112	CTD	23.7750	-20.7143			2077					Niskin 23 fired
12/3/16	21:04	112	CTD	23.7750	-20.7143			2077					Niskin 24 fired
12/3/16	21:09	112	CTD	23.7750	-20.7143			2077					CTD on deck
12/3/16	21:36	113	ROV	23.7745	-20.7138								ROV in the water
12/3/16	23:00	113	ROV					2077	23.7748	-20.7139			On bottom
12/3/16	23:07	113	ROV					2069	23.7749	-20.7140			Doppler reset
12/3/16	23:13	113	ROV					2068	23.7750	-20.7142			Sample #001 CS1 - crust
12/3/16	23:34	113	ROV					2067	23.7759	-20.7148			Sample #002 CS2 - crust
12/3/16	23:38	113	ROV					2067	23.7759	-20.7148			Sample #003 also in CS2 - Encrusted coral
12/3/16	23:57	113	ROV					2058	23.7770	-20.7151			Sample #004 into CS3 - Crust
12/4/16	0:15	113	ROV						23.7778	-20.7156	2054		WP2
12/4/16	0:43	113	ROV						23.7795	-20.7149	2048		Sample #005 into GB2 - Crust
12/4/16	0:45	113	ROV										Moving
12/4/16	0:47	113	ROV						23.7796	-20.7150	2045		WP3
12/4/16	1:23	113	ROV						23.7811	-20.7177	1986		Doppler reset and WP4
12/4/16	1:33	113	ROV						23.7813	-20.7015	1945		Sample #006 into CP1 (crust)
12/4/16	1:37	113	ROV										Moving
12/4/16	2:00	113	ROV						23.7811	-20.7201	1932		Doppler reset and WP5

12/4/16	2:37	113	ROV						23.7831	-20.7203	1797		Sample #007 (dead coral) into CP1 - Too hard to sample
12/4/16	2:58	113	ROV						23.7845	-20.7203	1782		Stopping sample - all stuck down - moving on
12/4/16	3:04	113	ROV										Doppler reset
12/4/16	3:09	113	ROV						23.7848	-20.7203	1780		Stopping to sample
12/4/16	3:13	113	ROV						23.7848	-20.7203	1780		sample #008 - piece of crust broken from pavement area
12/4/16	3:17	113	ROV						23.7848	-20.7203	1780		Sample #009 - same area as above into GB1
12/4/16	3:32	113	ROV						23.7856	-20.7204	1783		Stopping to sample
12/4/16	3:35	113	ROV						23.7856	-20.7204	1783		Sample #010 in CS4 - Block with thin crust broken from
12/4/16	3:47	113	ROV						23.7861	-20.7205	1763		Stopping to sample
12/4/16	3:51	113	ROV						23.7861	-20.7205	1765		Sample #011 in CS5 - Sample taken from
12/4/16	4:03	113	ROV										Doppler reset
12/4/16	4:24	113	ROV						23.7878	-20.7040	1686		Stopping to attempt sample
12/4/16	4:27	113	ROV						23.7878	-20.7040	1686		Sample #012 in GB3 - broken from edge pavement
12/4/16	5:16	113	ROV						23.7915	-20.7219	1624		Stopping to attempt sample on broken pavement
12/4/16	5:18	113	ROV						23.7915	-20.7219	1624		Sample #013 in CS6
12/4/16		113	ROV						23.7943	-20.7218	1598		Attempted to sample but crust too thick
12/4/16	6:02	113	ROV										Doppler reset
12/4/16		113	ROV						23.7961	-20.7212			Sample #014 in STBIO (sponge)
12/4/16		113	ROV						23.7961	-20.7212			Sample #015 in CS3
12/4/16	6:51	113	ROV						23.7967	-20.7213	1437		Stopping to attempt sample - broken piece from edge

12/4/16	6:55	113	ROV						23.7967	-20.7213	1437		Sample #016 in GB4
12/4/16	6:58	113	ROV										Doppler reset
12/4/16	7:14	113	ROV						23.7980	-20.7208	1377		Stopping to sample - Broken piece of pavement
12/4/16	7:16	113	ROV						23.7980	-20.7208	1378		Sample #017 in CP 2; very small piece broken off
12/4/16	7:49	113	ROV						23.8002	-20.7203	1257		Stopping to try to sample pavement edge
12/4/16	7:52	113	ROV						23.8002	-20.7203	1257		Sample #18 in CP 7
12/4/16	8:05	113	ROV						23.8008	-20.7202	1216		Stopping to try to sample block off pavement area
12/4/16	8:09	113	ROV						23.8008	-20.7202	1216		Sample #19 in CS 8
12/4/16	8:14	113	ROV						23.8008	-20.7202	1216		Second sample #20 in CS 8; thin sliver from pavement
12/4/16	8:31	113	ROV						23.8019	-20.7204	1172		Stopping to sample - too solid to sample
12/4/16	8:59	113	ROV						23.8019	-20.7204	1170		Niskins fired over isolated pavement block. Sample #21 -
12/4/16	9:05	113	ROV						23.8019	-20.7203	1168		ROV off bottom
12/4/16	10:11	113	ROV	23.8015	-20.7192			1166					ROV on deck
12/4/16	10:15	113	ROV	23.8014	-20.7191								On transit to next station - mooring
12/4/16	11:00	114	Mooring C	23.6788	-20.7335			4191					On station to recover Mooring C. On its way. Up at 11:11
12/4/16	11:11	114	Mooring C	23.6788	-20.7335								Mooring C released
12/4/16	15:15	114	Mooring C	23.6788	-20.7335								Mooring on deck
12/4/16	15:20												In transit to AUV deployment
12/4/16	16:45	115	AUV	23.8175	-20.7183			1067					On station 115 (AUV launch)
12/4/16	18:57	115	AUV	23.8184	-20.7193			1068					AUV in water

12/4/16	20:10		TRANSIT										In transit to ROV dive site
12/4/16	20:40	116	ROV										On station ROV
12/4/16	21:04	116	ROV										ROV in water
12/4/16	21:54	116	ROV						23.8600	-20.7436	1016		Bottom in sight
12/4/16	22:03	116	ROV										White balance
12/4/16	22:23	116	ROV						23.8602	-20.7436	1019		Start drilling (attempt 1)
12/4/16	22:32	116	ROV						23.8602	-20.7436	1019		Stop drilling (no sample)
12/4/16	22:36	116	ROV						23.8602	-20.7436	1019		Start drilling (attempt 2) same site
12/4/16	22:55	116	ROV						23.8602	-20.7436	1019		Stop drilling
12/4/16	23:22	116	ROV						23.8602	-20.7436	1019		Sample #001 - GB2
12/4/16	23:32	116	ROV						23.8602	-20.7436	1019		Stop to drill
12/4/16	23:34	116	ROV						23.8599	-20.7436	1019		Start drilling (attempt 3)
12/5/16	0:03	116	ROV						23.8599	-20.7436	1019		Stop drilling
12/5/16	0:07	116	ROV						23.8599	-20.7436	1019		Top of core e probably not in the hole
12/5/16	0:09	116	ROV						23.8599	-20.7436	1020		Core recovered - Sample #002 into blue2
12/5/16	0:17	116	ROV						23.8599	-20.7436	1020		Trying to recover core top stuck into barrel
12/5/16	0:22	116	ROV						23.8599	-20.7436	1020		Core top recovered into GB1
12/5/16	0:27	116	ROV										Moving to next drill point
12/5/16	0;34	116	ROV						23.8594	-20.7434	1020		In position to drilling attempt #4
12/5/16	0:38	116	ROV						23.8594	-20.7434	1020		Start drilling

12/5/16	1:09	116	ROV						23.8594	-20.7434	1020		Stop drilling
12/5/16	1:23	116	ROV						23.8595	-20.7434	1020		Core recovered - Sample #003 into blue 3
12/5/16	1:25	116	ROV						23.8595	-20.7434	1020		Moving to next drill point
12/5/16	1:26	116	ROV						23.8594	-20.7434	1020		In position to drilling attempt #5
12/5/16	1:28	116	ROV						23.8594	-20.7434	1020		Start drilling
12/5/16	2:16	116	ROV						23.8594	-20.7434	1020		Stop drilling
12/5/16	2:26	116	ROV						23.8594	-20.7434	1020		Sample #004 into yellow 1
12/5/16	2:31	116	ROV										Moving to next drill point
12/5/16	2:36	116	ROV						23.8591	-20.7433	1020		In position to drilling attempt #6
12/5/16	2:40	116	ROV						23.8591	-20.7433	1020		Start drilling
12/5/16	3:10	116	ROV						23.8591	-20.7433	1020		Stop drilling
12/5/16	3:21	116	ROV						23.8591	-20.7433	1020		Core retrieved: sample 5 in Yellow 2
12/5/16	3:23	116	ROV						23.8591	-20.7433	1020		Moving to next drill location
12/5/16	3:29	116	ROV						23.8587	-20.7433	1019		Arrive at drill location
12/5/16	3:29	116	ROV						23.8587	-20.7433	1019		Moving to the next drill location (a more stable one)
12/5/16	3:37	116	ROV						23.8586	-20.7432	1019		At new drill site
12/5/16	3:39	116	ROV						23.8586	-20.7432	1019		Start drill attempt #6
12/5/16	4:15	116	ROV						23.8586	-20.7432	1019		Stop drilling
12/5/16	4:34	116	ROV										Moving to next drill site
12/5/16	4:39	116	ROV						23.8585	-20.7430	1019		On site for drill

12/5/16	4:41	116	ROV						23.8585	-20.7430	1019		Start drilling attempt #7
12/5/16	5:20	116	ROV						23.8585	-20.7430	1019		Stop drilling
12/5/16	5:22	116	ROV						23.8585	-20.7430	1019		Core recovered: Sample 7 into Red 1
12/5/16	5:29	116	ROV										Moving to next drill point/reset doppler
12/5/16	5:32	116	ROV						23.8588	-20.7429	1019		At new drill site
12/5/16	5:34	116	ROV						23.8588	-20.7429	1019		Start drilling- attempt #8
12/5/16	6:15	116	ROV						23.8588	-20.7429	1018		Stop drilling
12/5/16	6:26	116	ROV						23.8588	-20.7429	1018		Core recovered. Sample #8 into red 2
12/5/16	6:27	116	ROV						23.8588	-20.7429	1018		Core recovered. Sample #8 in GB3 (top of sample #8)
12/5/16	6:28	116	ROV						23.8588	-20.7429	1018		Moving to new drill site
12/5/16	6:34	116	ROV						23.8583	-20.7426	1018		Stop at new drill site
12/5/16	6:36	116	ROV						23.8583	-20.7426	1018		Start drilling, attempt #9
12/5/16	6:45	116	ROV						23.8583	-20.7426	1018		Drill jumped slightly
12/5/16	7:14	116	ROV						23.8583	-20.7426	1018		Stop drilling
12/5/16	7:28	116	ROV						23.8583	-20.7426	1018		Core recovery - Nothing in drill hole - core top stuck in
12/5/16	7:32	116	ROV										Moving on
12/5/16	7:39	116	ROV						23.8582	-20.7419	1017		At new drill site
12/5/16	7:51	116	ROV						23.8582	-20.7419	1017		start drilling - attempt #10
12/5/16	8:36	116	ROV						23.8582	-20.7419	1017		Stop drilling
12/5/16	8:42	116	ROV						23.8582	-20.7419	1017		Core recovered - Sample #010 into Green 1

12/5/16		116	ROV										Moving on
12/5/16	8:50	116	ROV						23.8579	-20.7419	109		Push core - PC1, Sample 011
12/5/16	8:51	116	ROV						23.8579	-20.7419	109		Push core - Sample #012 PC4
12/5/16	9:05	116	ROV						23.8579	-20.7419	109		Star coring w/Ellsworth corer
12/5/16	9:13	116	ROV						23.8579	-20.7419	109		Stop coring
12/5/16	9:18	116	ROV						23.8579	-20.7419	109		Ellsworth core collected - Sample #013
12/5/16	9:21	116	ROV										Mooving to next drill site
12/5/16	9:22	116	ROV						23.8581	-20.7418	1017		Doppler reset
12/5/16	9:26	116	ROV						23.8581	-20.7418	1017		Stopping for push core - Sample #014 - PC2
12/5/16	9:28	116	ROV						23.8581	-20.7418	1017		Sample #15, PC5
12/5/16	9:38	116	ROV						23.8581	-20.7418	1017		Sample #016 - Crust fragment broken off - Pavement on
12/5/16	9:40	116	ROV										Moving on
12/5/16	9:41	116	ROV						23.8582	-20.7418	1017		Stop to drill
12/5/16	9:43	116	ROV						23.8582	-20.7418	1017		Start drilling
12/5/16		116	ROV						23.8582	-20.7418	1017		
12/5/16	10:11	116	ROV						23.8582	-20.7418	1017		Stop drilling
12/5/16	10:15	116	ROV						23.8582	-20.7418	1017		Sample #017 into green 2
12/5/16	10:20	116	ROV						23.8582	-20.7418	1017		Dropping weights
12/5/16	10:22	116	ROV						23.8582	-20.7418	1017		Fired niskin 1 to 6
12/5/16	10:24	116	ROV						23.8582	-20.7418	1017		Off bottom

12/5/16	11:05	116	ROV						23.8584	-20.7421			ROV at surface
12/5/16	11:10	116	ROV	23.8589	-20.7416			966					On deck - Transit to AUV recovery
12/5/16	11:54	117	AUV	23.8261	-2.6966			1937					On station for AUV recovery
12/5/16	13:06	117	AUV	23.8261	-2.6966			1937					AUV on deck
12/5/16	13:20		TRANSIT										In transit to mooring A
12/5/16	14:34	118	Mooring	24.0229	-20.7071			3098					On station 118
12/5/16	16:55	118	Mooring										Mooring on board
12/5/16	16:57		TRANSIT										In transit ti ROV dive site
12/5/16	17:30	119	ROV	120.9833	117.0167	119	119	119					On station for ROV dive
12/5/16	18:53	119	ROV	24.0322	-20.7266			3338					ROV in the water
12/5/16	20:58	119	ROV						24.0306	-20.7263	3303		At bottom
12/5/16	21:22	119	ROV						24.0305	-20.7270	3311		Sample #001 - GB1
12/5/16	22:01	119	ROV						24.0283	-20.7283	3277		Sample #002 - GB2
12/5/16	22:22	119	ROV						24.0277	-20.7287	3265		Stopped to slurp sediment sample (0003)
12/5/16	22:54	119	ROV						24.0271	-20.7289	3247		Sample #004 (GB 3)
12/5/16	23:01	119	ROV						24.0271	-20.7289	3247		Sample #005 CP1)
12/5/16	23:08	119	ROV						24.0271	-20.7289	3247		fired Z Niskin
12/5/16	23:10	119	ROV						24.0271	-20.7289	3247		Niskin 1-6 fired
12/5/16	23:14	119	ROV						24.0271	-20.7289	3247		off bottom (loss of hydraulic power)
12/6/16	1:20	119	ROV	24.0273	-20.7287			3247					ROV on deck

12/6/16	1:40												in transit to st. 120
12/6/16	3:02	120	CTD	23.8323	-20.7872			3262					on station for CTD HRW #18
12/6/16	3:21	120	CTD	23.8329	-20.7865			3231					CTD in water
12/6/16	4:30	120	CTD	23.8329	-20.7865			3161					CTD on bottom
12/6/16	5:31	120	CTD	23.8329	-20.7865			3205					CTD on deck
12/6/16	5:45		TRANSIT										in transit to st. 121
12/6/16	6:30	121	Mooring	23.8887	-20.7016			998					on station121 for mooring recovery
12/6/16	6:40	121	Mooring	23.8887	-20.7016			998					mooring recovery start
12/6/16	9:04	121	Mooring	23.8887	-20.6918			998					mooring on deck
12/6/16	10:10	122	Incubator	23.8887	-20.6918			997					incubator in water

Appendix B. Sample log

JC142 Sample Log			LAT/LONG Dec. Degrees								GEOLOGICAL SAMPLES					
Unique_Sample_ID	**Date**	**Sampling_Time**	**LAT (N)**	**LONG (W)**	**Water_Depth**	**Operation**	**Tool**	**Sample_Type**	**In_Situ**	**Seafloor_Surface**	**Fe-Mn**	**Fe-Mn_Thickness_Max**	**Outcrop_Texture**	**Phosphorite**	**Phosphorite_Thickness_Max**	**Basement_Type**
	dd/mm/yy	[hh:mm]	Dec. Deg	Dec. Deg	[m]							[mm]	Tabular/lobate	Yes/No	[mm]	
JC142_008_001	01/11/16	08:43	23.886817	-20.689417	988	CTD	Niskin	Water	na	na	na	na	na	na	na	na
JC142_009_001	01/11/16	16:55	23.845317	-20.716550	1022	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	<1	Tabular	Yes	60	Sedimentary
JC142_009_002	01/11/16	17:24	23.845550	-20.717067	1014	ROV	Manipulator arm	Rock	?	Pavement	Yes	<1	Tabular	Yes	75	Sedimentary
JC142_009_003	01/11/16	18:49	23.850717	-20.721767	995	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	15	Tabular	Yes	20	Sedimentary
JC142_009_004	01/11/16	19:40	23.853683	-20.724400	1014	ROV	Manipulator arm	Rock	?	Pavement	Yes		Tabular	Yes	70	Sedimentary

JC142_009_005	01/11/16	21:10	23.858617	-20.728550	994	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes		Tabular	Yes	90	Sedimentary
JC142_009_006	01/11/16	21:48	23.860467	-20.730017	1010	ROV	Manipulator arm	Rock	?	Nodule	Yes	10		No	10	Sedimentary
JC142_009_007	02/11/16	00:45	23.861317	-20.740517	1015	ROV	Manipulator arm	Rock	?	Debris	Yes	30	Tabular	Yes	45	Sedimentary
JC142_009_008	02/11/16	01:35	23.859933	-20.743467	1021	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	5	Tabular	Yes	40	Sedimentary
JC142_009_009	02/11/16	01:55	23.858633	-20.743150	1020	ROV	Manipulator arm	Biology	Yes	Pavement	na	na	na	na	na	na
JC142_009_010	02/11/16	04:14	23.852550	-20.742600	1025	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	20	Tabular	Yes	40	Sedimentary
JC142_009_011	02/11/16	04:34	23.852067	-20.742750	1027	ROV	Manipulator arm	Biology	No	Isolated slab/s	na	na	na	na	na	na
JC142_009_012	02/11/16	05:26	23.850483	-20.743233	1026	ROV	Manipulator arm	Rock	No	Pavement	Yes	0.1	Tabular	Yes	60	Sedimentary
JC142_009_013	02/11/16	06:00	23.849200	-20.743317	1027	ROV	Manipulator	Rock	?	Nodular	Yes			na	na	

							arm									
JC142_013_000	03/11/16	00:42	23.943950	-20.696300	1097	CTD		Water	Yes							
JC142_014_000	03/11/16	02:23	23.914033	-20.690117	1055	CTD		Water	Yes							
JC142_015_000	03/11/16	04:10	23.884967	-20.658317	1040	CTD		Water	Yes							
JC142_016_000	03/11/16	06:00	23.888000	-20.635350	1225	CTD		Water	Yes							
JC142_017_000	03/11/16	07:57	23.881267	-21.562167	1080	CTD		Water	Yes							
JC142_018_000	03/11/16	09:58	23.888633	-20.765050		CTD		Water	Yes							
JC142_020_001	04/11/16	01:39	23.892983	-20.705183	992	ROV	Rock drill	Rock	Yes	Isolated slab/s						
JC142_020_002	04/11/16	02:59	23.890083	-20.705500	995	ROV	Push core	Sediment	Yes	Sediment	Yes	15	na			Sedimentary
JC142_020_003	05/11/16	03:03	23.890067	-20.705500	996	ROV	Push core	Sediment	Yes	Sediment	No	na	na			Sedimentary
JC142_020_004	06/11/16	04:20	23.884233	-20.706117	995	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	13	Lobate	Yes	20	Sedimentary
JC142_0	07/1	04:23	23.884217	-20.706133	995	ROV	Manipul	Biology	Yes	Isolated	na	na	na	na	na	

20_005	1/16						ator arm			slab/s						
JC142_0 20_006	08/1 1/16	04:27	23.884233	-20.706133	992	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	20	Lobate	Yes	60	Sedimentary
JC142_0 20_007	09/1 1/16	04:44	23.883333	-20.706183	992	ROV	Manipul ator arm	Rock	?	Isolated slab/s	Yes	22	Lobate	Yes	80	Sedimentary
JC142_0 20_008	10/1 1/16	04:48	23.883317	-20.706183	992	ROV	Push core	Sedime nt	Yes	Sediment	No	na	na	na	na	
JC142_0 20_009	11/1 1/16	04:51	23.883300	-20.706167	992	ROV	Push core	Sedime nt	Yes	Sediment	No	na	na	na	na	
JC142_0 20_010	12/1 1/16	07:16	23.889067	-20.700767	995	ROV	Manipul ator arm	Rock	No	Isolated slab/s	Yes	15	Lobate	Yes	60	Sedimentary
JC142_0 20_011	13/1 1/16	08:01	23.891233	-20.699883	996	ROV	Manipul ator arm	Rock	?	Sediment	Yes	4	na	No	na	Sedimentary
JC142_0 20_012	14/1 1/16	08:44	23.891150	-20.698983	995	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	20	Tabular	Yes	30	Sedimentary
JC142_0 20_013	15/1 1/16	08:48	23.891150	-20.698983	995	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	14	Tabular	Yes	60	Sedimentary
JC142_0	16/1	09:09	23.889767	-20.698950	993	ROV	Manipul ator	Rock	?	Isolated	No	na	Lobate	No	na	Sedimentary

20_014	1/16						arm			slab/s						
JC142_0 20_015	17/1 1/16	09:34	23.888833	-20.698550	992	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	20	Lobate	Yes	40	Sedimentary
JC142_0 20_016	18/1 1/16	10:23	23.884667	-20.698733	996	ROV	Manipul ator arm	Biology	Yes	Sediment	na	na	na	na	na	na
JC142_0 20_017	19/1 1/16	13:43	23.882100	-20.695667	997	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	30	Lobate	No	na	Sedimentary
JC142_0 20_018	20/1 1/16	14:09	23.882717	-20.695783	996	ROV	Push core	Sedime nt	Yes	Debris	na	na	na			Sedimentary
JC142_0 20_019	21/1 1/16	14:14	23.882717	-20.695800	996	ROV	Push core	Sedime nt	Yes	Debris	na	na	na			Sedimentary
JC142_0 20_021	23/1 1/16	14:36	23.883117	-20.694933	996	ROV	Manipul ator arm	Rock	?	Nodule	na	na	na	na	na	Sedimentary
JC142_0 20_022	24/1 1/16	14:44	23.883133	-20.694950	996	ROV	Manipul ator arm	Rock	?	Nodule	na	na	na	na	na	Sedimentary
JC142_0 20_023	25/1 1/16	16:34	23.881650	-20.694500	994	ROV	Manipul ator arm	Rock	No	Debris	Yes	na	na	na	na	Sedimentary
JC142_0 20_024	26/1 1/16	16:36	23.881633	-20.691100	994	ROV	Manipul ator	Rock	No	Debris	Yes	1	na	No		Sedimentary

							arm									
JC142_020_025	27/11/16	16:41	23.881650	-20.691100	994	ROV	Manipulator arm	Rock	No	Debris	Yes	na	na			Sedimentary
JC142_020_026	28/11/16	09:10	23.889767	-20.698950	994	ROV	Manipulator arm	Rock	?	Sediment	Yes	9		No		Sedimentary
JC142_025_001	05/11/16	20:22	23.841617	-20.713883	1029	ROV	Push core	Sediment	Yes	Sediment						
JC142_025_002	05/11/16	20:24	23.841617	-20.713883	1029	ROV	Push core	Sediment	Yes	Sediment						
JC142_025_003	05/11/16	20:27	23.841617	-20.713883	1029	ROV	Push core	Sediment	Yes	Sediment						
JC142_039_001	09/11/16	00:59	23.889500	-20.562933	2701	ROV	Slurp	Biology	Yes	Pavement	na	na	na	na	na	na
JC142_039_002	09/11/16	01:01	23.889517	-20.562917	2701	ROV	Slurp	Biology	Yes	Pavement	na	na	na	na	na	na
JC142_039_003	09/11/16	01:32	23.889533	-20.564083	2713	ROV	Manipulator arm	Rock	No	Isolated slab/s	Yes	30	Lobate	Yes	20	Sedimentary
JC142_039_004	09/11/16	01:49	23.889717	-20.564833	2696	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	2	Lobate	No		Volcanic
JC142_0	09/1	02:17	23.889467	-20.566250	2662	ROV	Manipulator	Rock	?	Isolated	Yes	50	Lobate	No		Volcanic

39_005	1/16						arm			slab/s						
JC142_0 39_006	09/1 1/16	02:23	23.889433	-20.566233	2662	ROV	Manipul ator arm	Rock	?	Isolated slab/s	Yes	15	Lobate	Yes	35	Sedimentary
JC142_0 39_007	09/1 1/16	02:50	23.889050	-20.568017	2606	ROV	Manipul ator arm	Rock	?	Isolated slab/s	Yes	20	Lobate	No	na	Volcanic
JC142_0 39_008	09/1 1/16	03:14	23.889167	-20.568633	2580	ROV	Manipul ator arm	Rock	?	Isolated slab/s	Yes	20	Lobate	No	na	Volcanic
JC142_0 39_009	09/1 1/16	04:06	23.889733	-20.571017	2570	ROV	Manipul ator arm	Rock	?	Pavemen t	Yes	15	Lobate	Yes	50	Sedimentary
JC142_0 39_010	09/1 1/16	04:08	23.889733	-20.571017	2570	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	50	Lobate	Yes	35	Sedimentary
JC142_0 39_011	09/1 1/16	04:11	23.889833	-20.571050	2569	ROV	Manipul ator arm	Rock	No	Pavemen t	Yes	45	Lobate	Yes	35	Sedimentary
JC142_0 39_012	09/1 1/16	06:13	23.894717	-20.579017	2499	ROV	Manipul ator arm	Rock	?	Debris	Yes	90	Lobate	Yes	1	Sedimentary
JC142_0 39_013	09/1 1/16	06:50	23.896083	-20.581433	2438	ROV	Manipul ator arm	Rock	?	Cliff	Yes	3	Lobate	No	na	Volcanic

JC142_039_014	09/11/16	06:52	23.896067	-20.581350	2438	ROV	Manipulator arm	Rock	?	Cliff	na		Lobate			Sedimentary
JC142_039_015	09/11/16	07:26	23.897350	-20.582917	2480	ROV	Manipulator arm	Rock	?	Cliff	Yes	40	Lobate	Yes	30	Sedimentary
JC142_039_016	09/11/16	08:02	23.897200	-20.585383	2419	ROV	Manipulator arm	Biology	Yes	Isolated slab/s	na	na	na	na	na	na
JC142_039_017	09/11/16	08:37	23.896667	-20.585817	2377	ROV	Manipulator arm	Rock	Yes	Cliff	Yes	25	Lobate	No	na	Volcanic
JC142_039_018	09/11/16	08:42	23.896633	-20.585867	2378	ROV	Slurp	Biology	Yes	Cliff	na	na	na	na	na	na
JC142_039_019	09/11/16	09:00	23.897017	-20.586483	2430	ROV	Manipulator arm	Rock	?	Debris	Yes	50	Lobate	Yes	40	Sedimentary
JC142_039_020	09/11/16	09:44	23.896817	-20.588900	2307	ROV	Manipulator arm	Rock	?	Debris	Yes	30	Lobate	No	na	Volcanic
JC142_039_021	09/11/16	09:55	23.896650	-20.589550	2267	ROV	Manipulator arm	Rock	?	Debris	Yes	20	Lobate	No	na	Volcanic
JC142_039_022	09/11/16	10:11	23.896683	-20.589933	2264	ROV	Manipulator arm	Rock	?	Debris	Yes	10	Tabular	No	na	Volcanic

JC142_039_023	09/11/16	11:02	23.896317	-20.591717	2215	ROV	Manipulator arm	Rock	?	Pavement	Yes	<1	Tabular	No	na	Sedimentary
JC142_039_024	09/11/16	11:06	23.896317	-20.591717	2215	ROV	Manipulator arm	Rock	?	Pavement	Yes	20	Tabular	Yes	40	Sedimentary
JC142_039_025	09/11/16	11:24	23.896450	-20.592367	2217	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	20	Tabular	Yes	40	Sedimentary
JC142_039_026	09/11/16	12:09	23.894350	-20.594567	2065	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	<1	Lobate	No	na	Volcanic
JC142_039_027	09/11/16	13:15	23.891650	-20.596883	2034	ROV	Manipulator arm	Rock	Yes	Cliff	Yes	<1	Tabular	No	na	Sedimentary
JC142_039_028	09/11/16	13:59	23.890217	-20.598517	1957	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	<1	Lobate	No	na	Volcanic
JC142_039_029	09/11/16	14:05	23.890200	-20.598533	1957	ROV	Slurp	Biology	Yes	Isolated slab/s	na	na	na	na	na	na
JC142_047_001	11/11/16	03:04	23.890900	-20.717650	994	ROV	Rock drill	Rock	Yes	Isolated slab/s	Yes	10	Tabular	Yes	60	Sedimentary
JC142_047_002	11/11/16	03:22	23.891000	-20.717417	994	ROV	Manipulator arm	Biology	No	Isolated slab/s	na	na	na	na	na	na

JC142_047_003	11/11/16	03:27	23.891000	-20.717417	994	ROV	Manipulator arm	Biology	No	Isolated slab/s	na	na	na	na	na	na
JC142_047_004	11/11/16	03:41	23.891017	-20.717117	995	ROV	Manipulator arm	Rock	?	Debris	Yes	10	Tabular	Yes	25	Sedimentary
JC142_047_005	11/11/16	03:46	23.891017	-20.717100	995	ROV	Manipulator arm	Rock	?	Debris	Yes	10	Tabular	Yes	15	Sedimentary
JC142_047_006	11/11/16	04:36	23.891900	-20.715650	995	ROV	Manipulator arm	Biology	No	Sediment	na	na	na	na	na	na
JC142_047_007	11/11/16	04:50	23.891850	-20.715450	999	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	20	Lobate	Yes	45	Sedimentary
JC142_047_008	11/11/16	04:52	23.891850	-20.715450	999	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	30	Lobate	Yes	40	Sedimentary
JC142_047_009	11/11/16	05:24	23.893650	-20.714700	1011	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	20	Tabular	Yes	40	Sedimentary
JC142_047_010	11/11/16	05:28	23.893667	-20.714717	1011	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	10	Tabular	Yes	45	Sedimentary
JC142_047_011	11/11/16	07:21	23.897667	-20.713367	1007	ROV	Rock drill	Rock	Yes	Isolated slab/s	Yes	15		No		Sedimentary

JC142_047_012	11/11/16	08:12	23.900483	-20.712433	1010	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	30	Lobate	Yes	80	Sedimentary
JC142_047_013	11/11/16	09:11	23.902967	-20.712783	1012	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	20	Tabular	Yes	65	Sedimentary
JC142_047_014	11/11/16	10:35	23.898683	-20.708533	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_015	11/11/16	10:37	23.898683	-20.708533	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_016	11/11/16	10:38	23.898683	-20.708533	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_017	11/11/16	10:39	23.898683	-20.708533	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_018	11/11/16	10:40	23.898683	-20.708533	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_019	11/11/16	10:49	23.898333	-20.706767	1009	ROV	Manipulator arm	Rock	?	Nodule						
JC142_047_020	11/11/16	10:50	23.898333	-20.708417	1009	ROV	Manipulator ator	Rock	?	Nodule						

							arm									
JC142_0 47_021	11/1 1/16	12:02	23.897783	-20.708267	1008	ROV	Rock drill	Rock	Yes	Nodule						
JC142_0 47_022	11/1 1/16	12:07	23.897783	-20.708283	1008	ROV	Manipul ator arm	Rock	?	Debris	Yes	1	Tabular	No		Sedimentary
JC142_0 47_023	11/1 1/16	12:10	23.897783	-20.708283	1008	ROV	Manipul ator arm	Rock	?	Nodule						
JC142_0 47_024	11/1 1/16	12:30	23.896567	-20.707783	1007	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	30	Lobate	Yes	50	Sedimentary
JC142_0 47_025	11/1 1/16	13:06	23.895617	-20.707200	999	ROV	Manipul ator arm	Rock	No	Cliff	Yes	15	Lobate	Yes	35	Sedimentary
JC142_0 47_026	11/1 1/16	13:51	23.895517	-20.707250	998	ROV	Rock drill	Rock	Yes	Pavemen t	Yes	20	Tabular	No		Sedimentary
JC142_0 47_027	11/1 1/16	14:01	23.895533	-20.707267	998	ROV	Rock drill	Rock	Yes	Pavemen t						
JC142_0 55_001	13/1 1/16	17:34	23.750083	-20.718467	2700	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	30	Lobate	No		
JC142_0 55_002	13/1 1/16	18:01	23.751150	-20.718667	2654	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	20		No		

JC142_055_003	13/11/16	18:38	23.752350	-20.718800	2598	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	40	Lobate	Yes	60	Sedimentary
JC142_055_004	13/11/16	19:17	23.754517	-20.718617	2509	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	15		No		Sedimentary
JC142_055_005	13/11/16	19:34	23.754917	-20.718767	2501	ROV	Niskin	Water	Yes		Yes	10	Tabular			
JC142_055_006	13/11/16	20:18	23.757050	-20.719617	2463	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	25	Tabular	No		Sedimentary
JC142_055_007	13/11/16	20:24	23.757050	-20.719617	2463	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	25	Tabular	No		Sedimentary
JC142_055_008	13/11/16	20:37	23.757233	-20.719800	249	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	Yes	10	Sedimentary
JC142_055_009	13/11/16	21:00	23.757817	-20.719783	2442	ROV	Manipulator arm	Rock	Yes	Pavement						
JC142_055_010	13/11/16	22:06	23.759583	-20.719817	2422	ROV	Manipulator arm	Rock	Yes	Pavement			Lobate			Volcanic
JC142_055_011	13/11/16	22:12	23.759583	-20.719817	2422	ROV	Niskin	Water								

JC142_055_012	13/11/16	22:40	23.759600	-20.719833	2422	ROV	Manipulator arm	Rock	Yes	Isolated slab/s						
JC142_055_013	13/11/16	23:30	23.764383	-20.718533	2383	ROV	Manipulator arm	Rock	?	Pavement	Yes	4	Tabular	Yes	10	Sedimentary
JC142_055_014	13/11/16	23:40	23.764433	-20.718600	2382	ROV	Niskin	Water								
JC142_055_015	14/11/16	01:46	23.771617	-20.714550	2176	ROV	Slurp	Biology	Yes	Cliff			Lobate			
JC142_055_016	14/11/16	01:47	23.771617	-20.714550	2176	ROV	Slurp	Biology	Yes	Cliff			Lobate			
JC142_055_017	14/11/16	02:07	23.771683	-20.714467	2164	ROV	Manipulator arm	Rock	Yes	Cliff	Yes	30	Lobate	No		Volcanic
JC142_055_018	14/11/16	02:34	23.772717	-20.713567	2122	ROV	Slurp	Biology	Yes	Pavement						
JC142_055_019	14/11/16	02:53	23.773717	-20.713067	2178	ROV	Manipulator arm	Rock	Yes	Cliff	Yes	5		yes	20	Sedimentary
JC142_055_020	14/11/16	03:41	23.775867	-20.714683	2066	ROV	Niskin	Water								
JC142_055_021	14/11/16	04:29	23.779483	-20.715583	2041	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	yes	20	Sedimentary

JC142_055_022	14/11/16	04:44	23.780183	-20.715433	2028	ROV	Slurp	Biology	Yes	Isolated slab/s						
JC142_055_023	14/11/16	05:18	23.781983	-20.716233	1935	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	45	Tabular	Yes	60	Sedimentary
JC142_055_024	14/11/16	05:58	23.783200	-20.715767	1898	ROV	Niskin	Water								
JC142_058_001	14/11/16	16:35	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	20	N/A	No		Sedimentary
JC142_058_002	14/11/16	16:39	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	25	N/A	No		Sedimentary
JC142_058_003	14/11/16	16:40	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	20	N/A	Yes	10	Sedimentary
JC142_058_004	14/11/16	16:41	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	10	N/A	Yes	10	Sedimentary
JC142_058_005	14/11/16	16:42	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	20	N/A	Yes	30	Sedimentary
JC142_058_006	14/11/16	16:43	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	30	N/A	Yes	20	Sedimentary

JC142_058_007	14/11/16	16:15	23.907100	-20.690433	1018	ROV	Manipulator arm	Rock	Yes	Sediment	yes	10	N/A	Yes	35	Sedimentary
JC142_058_008	14/11/16	17:10	23.907000	-20.689917	1015	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	yes	15	Lobate	Yes	60	Sedimentary
JC142_058_009	14/11/16	17:35	23.906867	-20.689417	1015	ROV	Rock drill	Rock	Yes	Pavement	yes	20	Tabular			
JC142_058_010	14/11/16	18:44	23.906933	-20.689117	1015	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	yes	25	Tabular	Yes	30	Sedimentary
JC142_058_011	14/11/16	20:54	23.906817	-20.688467	1013	ROV	Rock drill	Rock	Yes	Pavement	yes	40	Tabular	Yes	9	
JC142_058_012	14/11/16	21:08	23.907000	-20.688283	1016	ROV	Manipulator arm	Rock	Yes	Pavement	yes	30	Tabular	Yes	40	Sedimentary
JC142_058_013	14/11/16	21:25	23.906967	-20.688417	1014	ROV	Manipulator arm	Rock	Yes	Pavement	yes	15	Tabular/lobate	Yes	35	Sedimentary
JC142_058_014	14/11/16	21:46	23.906633	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Pavement	yes	40	Tabular	Yes	5	Sedimentary
JC142_058_015	14/11/16	21:53	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment			N/A			

JC142_058_016	14/11/16	21:54	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment						
JC142_058_017	14/11/16	21:56	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment						
JC142_058_018	14/11/16	21:57	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment						
JC142_058_019	14/11/16	21:58	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment						
JC142_058_020	14/11/16	21:58	23.906617	-20.687483	1014	ROV	Manipulator arm	Rock	Yes	Sediment						
JC142_058_021	14/11/16	22:40	23.907300	-20.686050	1013	ROV	Manipulator arm	Rock	Yes	Pavement	yes	30	Tabular	Yes	10	Sedimentary
JC142_058_022	14/11/16	23:04	23.907917	-20.685150	1024	ROV	Manipulator arm	Rock	No	Pavement	yes	30	Tabular	Yes	Feb-00	Sedimentary
JC142_058_023	14/11/16	23:14	23.907950	-20.685117	1022	ROV	Niskin	Water	N/A	Pavement		20	Lobate			
JC142_058_024	14/11/16	23:31	23.908433	-20.684167	1030	ROV	Manipulator arm	Biology	N/A	Nodule			N/A			

JC142_058_025	14/11/16	23:51	23.908433	-20.684167	1030	ROV	Manipulator arm	Rock	Yes	Nodule	yes	25	N/A	Yes	30	Nodule
JC142_058_026	14/11/16	23:51	23.908433	-20.684167	1030	ROV	Manipulator arm	Rock	Yes	Nodule	yes	15		Yes	40	Nodule
JC142_058_027	14/11/16	23:52	23.908433	-20.684167	1030	ROV	Manipulator arm	Rock	Yes	Nodule	yes	25		Yes	30	Nodule
JC142_058_028	14/11/16	23:53	23.908433	-20.684167	1030	ROV	Manipulator arm	Rock	Yes	Nodule	yes	30		Yes	50	Nodule
JC142_058_029	15/11/16	01:21	23.907417	-20.682467	1026	ROV	Rock drill	Rock	Yes	Pavement	no		Tabular	Yes	20	
JC142_058_030	15/11/16	02:18	23.904850	-20.679767	1022	ROV	Manipulator arm	Rock	Yes	Sediment	yes	60	N/A	Yes	30	Sedimentary
JC142_058_031	15/11/16	02:21	23.904850	-20.679767	1022	ROV	Manipulator arm	Rock	Yes	Sediment	yes	20	N/A	Yes	20	Sedimentary
JC142_058_032	15/11/16	02:41	23.904700	-20.678683	1019	ROV	Niskin	Water	N/A	Pavement			Tabular			
JC142_058_033	15/11/16	03:17	23.904717	-20.678667	1018	ROV	Rock drill	Rock	Yes	Pavement	yes	30	Tabular	Yes	20	Sedimentary
JC142_0	15/1	05:00	23.903417	-20.674867	1024	ROV	Rock	Rock	Yes	Pavemen	yes	50	Tabular	Yes		

58_034	1/16						drill			t						
JC142_0 58_035	15/1 1/16	05:42	23.903417	-20.674867	1024	ROV	Rock drill	Rock	Yes	Pavemen t	yes	40	Tabular	No		
JC142_0 58_036	15/1 1/16	05:46	23.903400	-20.674850	1009	ROV	Rock drill	Rock	Yes	Pavemen t	yes	20	Tabular	Yes	35	Sedimentary
JC142_0 58_037	15/1 1/16	07:25	23.901717	-20.673417	1005	ROV	Rock drill	Rock	Yes	Pavemen t	yes	10	Tabular	Yes	40	Sedimentary
JC142_0 58_038	15/1 1/16	08:47	23.898367	-20.670500	1006	ROV	Niskin	Water	Yes	Pavemen t			Tabular			
JC142_0 58_039	15/1 1/16	10:18	23.889200	-20.670500	970	ROV	Manipul ator arm	Biology	Yes	Pavemen t			Coral debris			
JC142_0 58_040	15/1 1/16	10:28	23.889200	-20.667450	970	ROV	Manipul ator arm	Biology	Yes							
JC142_0 58_041	15/1 1/16	10:32	23.889200	-20.667450	970	ROV	Manipul ator arm	Biology	Yes							
JC142_0 58_042	15/1 1/16	10:33	23.889200	-20.667450	970	ROV	Manipul ator arm	Biology	Yes							
JC142_0 58_043	15/1 1/16	11:03	23.887950	-20.667500	971	ROV	Rock drill	Rock	Yes	Isolated slab/s				No		Sedimentary
JC142_0	15/1	11:45	23.887817	-20.667500	975	ROV	Rock	Rock	Yes	Isolated	yes	30	Lobate	Yes	10	

58_044	1/16						drill			slab/s						
JC142_0 58_045	15/1 1/16		0.000000	0.000000		ROV										
JC142_0 61_001	15/1 1/16	20:59	23.937017	-20.689767	1150	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	1	Tabular	No		Sedimentary
JC142_0 61_002	15/1 1/16	21:14	23.937317	-20.689917	1136	ROV	Niskin	Water	N/A	Pavemen t			Tabular			Sedimentary
JC142_0 61_003	15/1 1/16	22:09	23.938333	-20.690267	1134	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	20	Tabular	yes	5	Sedimentary
JC142_0 61_004	15/1 1/16	22:12	23.938333	-20.690267	1134	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	50	Tabular	yes	30	Sedimentary
JC142_0 61_005	15/1 1/16	22:12	23.938333	-20.690267	1134	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	10	Tabular	yes	10	Sedimentary
JC142_0 61_006	15/1 1/16	22:12	23.938333	-20.690267	1134	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	80	Tabular	Yes	25	Sedimentary
JC142_0 61_007	15/1 1/16	23:05	23.941283	-20.691733	1127	ROV	Manipul ator arm	Rock	Yes	Pavemen t	yes	20	Tabular	Yes	30	Sedimentary
JC142_0 61_008	15/1 1/16	23:26	23.941767	-20.692533	1116	ROV	Manipul ator	Rock	Yes	Pavemen t	yes	10	Tabular	Yes	30	Sedimentary

							arm									
JC142_061_009	15/11/16	23:34	23.941767	-20.692533	1116	ROV	Manipulator arm	Biology	Yes							
JC143_061_017	15/11/16	23:40	23.942167	-20.692567	1112	ROV	Niskin	Water	Yes	Sediment						
JC142_061_010	16/11/16	00:52	23.942617	-20.691133	1114	ROV	Rock drill	Rock	Yes	Pavement	yes	30	Tabular	Yes	30	Sedimentary
JC142_061_011	16/11/16	02:25	23.946883	-20.684517	1223	ROV	Scoop	Biology	N/A	Sediment						
JC142_061_012	16/11/16	03:06	23.946800	-20.685183	1193	ROV	Manipulator arm	Biology	Yes	Pavement			Tabular			
JC142_061_013	16/11/16	03:47	23.946850	-20.685183	1192	ROV	Rock drill	Rock	Yes	Pavement	yes	30	Tabular	Yes	30	Sedimentary
JC142_061_014	16/11/16	04:04	23.947100	-20.685517	1183	ROV	Manipulator arm	Rock	Yes	Pavement	yes	30	Tabular	No		na
JC142_061_015	16/11/16	05:49	23.947617	-20.687483	1147	ROV	Rock drill	Rock	Yes	Pavement	yes	15	Tabular	No		na
JC142_061_016	16/11/16	06:21	23.948533	-20.689833	1122	ROV	Manipulator arm	Rock	Yes	Sediment	yes	25	Tabular	Yes	50	Sedimentary
JC142_0	16/1	06:47	23.949167	-20.691300	1100	ROV	Manipulator	Rock	?	Sediment	yes	90	Tabular	Yes	60	Sedimentary

61_018	1/16						arm									
JC142_061_019	16/11/16	07:13	23.949833	-20.692683	1076	ROV	Niskin	Water	N/A	Sediment			Tabular			
JC142_061_020	16/11/16	07:14	23.949833	-20.692683	1076	ROV	Niskin	Water	N/A	Sediment			Tabular			
JC142_061_021	16/11/16	08:05	23.950833	-20.694967	1059	ROV	Manipulator arm	Rock	?	Pavement	yes	40	Tabular	Yes	35	Sedimentary
JC142_061_022	16/11/16	08:47	23.951983	-20.692083	1068	ROV	Manipulator arm	Rock	?	Pavement	yes	9	Tabular	NO		Volcanic
JC142_061_023	16/11/16	09:03	23.952083	-20.691167	1087	ROV	Niskin	Water	N/A	Sediment	Yes	50	Tabular	No		Sedimentary
JC142_061_024	16/11/16	09:06	23.952083	-20.691167	1087	ROV	Niskin	Water	N/A	Sediment			Tabular			
JC142_063_001	16/11/16	15:22	23.788683	-20.605850	3969	GC		Sediment	Yes	Sediment	no					Sedimentary
JC142_064_001	16/11/16	20:24	23.787167	-20.835350	4195	GC		Sediment	Yes	Sediment	no					Sedimentary
JC142_065_001	17/11/16	01:43	23.961633	-20.591033	3921	GC		Sediment	Yes	Sediment	no					Sedimentary
JC142_072_001	18/11/16	13:50	23.841817	-20.713927	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary

JC142_072_002	18/11/16	13:52	23.841817	-20.713927	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary
JC142_072_003	18/11/16	14:00	23.842012	-20.713813	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary
JC142_072_004	18/11/16	14:03	23.842012	-20.713813	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary
JC142_072_005	18/11/16	14:13	23.842342	-20.713445	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary
JC142_072_006	18/11/16	14:15	23.842342	-20.713445	1029	ROV	Push core	Sediment	Yes	Sediment	na	na	na	na	na	Sedimentary
JC142_072_007	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	
JC142_072_008	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	
JC142_072_009	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	
JC142_072_010	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	
JC142_072_011	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	
JC142_072_012	18/11/16	14:22	23.842340	-20.713438	1029	ROV	Niskin	Water	N/A		na	na	na	na	na	

JC142_078_001	19/11/16	15:11	23.961367	-20.828917	3894	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	25	Lobate	no		Sedimentary
JC142_078_002	19/11/16	15:20	23.961383	-20.828817	3893	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	10	Lobate	no		Sedimentary
JC142_078_003	19/11/16	15:33	23.961083	-20.828917	3881	ROV	Manipulator arm	Rock	Yes		Yes	3	Tabular	no		Sedimentary
JC142_078_004	19/11/16	15:38	23.961067	-20.828817	3880	ROV	Manipulator arm	Rock	Yes		Yes	25	Lobate	no		Sedimentary
JC142_078_005	19/11/16	15:59	23.960283	-20.828933	3845	ROV	Manipulator arm	Rock	Yes		Yes	35	Lobate	no		Sedimentary
JC142_078_006	19/11/16	16:29	23.959217	-20.828700	3790	ROV	Manipulator arm	Rock	Yes		Yes	10	Tabular	no		Sedimentary
JC142_078_007	19/11/16	17:00	23.958583	-20.828583	3772	ROV	Manipulator arm	Rock	Yes		Yes	25	Lobate	no		Sedimentary
JC142_078_008	19/11/16	17:31	23.956917	-20.827917	3705	ROV	Manipulator arm	Rock	Yes		Yes	15	Lobate	no		Sedimentary
JC142_078_009	19/11/16	17:51	23.957017	-20.826533	3694	ROV	Manipulator	Rock	Yes		Yes	60	Lobate	no		

							arm									
JC142_078_010	19/11/16	18:00	23.957017	-20.826417	3693	ROV	Manipulator arm	Rock	no		Yes	10	Lobate	no		Sedimentary
JC142_078_011	19/11/16	18:02	23.957017	-20.826417	3693	ROV	Manipulator arm	Rock	no		Yes	15	Lobate	no		Sedimentary
JC142_078_012	19/11/16	18:03	23.957017	-20.826417	3693	ROV	Manipulator arm	Rock	no		Yes	60	Lobate	no		Sedimentary
JC142_078_013	19/11/16	18:58	23.957017	-20.823017	3669	ROV	Manipulator arm	Rock	Yes		Yes	20	Lobate	no		
JC142_078_014	19/11/16	20:08	23.953433	-20.822733	3576	ROV	Manipulator arm	Rock	?	Sediment	Yes	20	Lobate	no		Sedimentary
JC142_078_015	19/11/16	21:18	23.950100	-20.821867	3476	ROV	Manipulator arm	Rock	Yes		Yes	50	Lobate	no		
JC142_078_016	19/11/16	22:24	23.947200	-20.818917	3325	ROV	Manipulator arm	Rock	?		Yes	35	Lobate	no		Sedimentary
JC142_078_017	19/11/16	23:26	23.945150	-20.815500	3213	ROV	Manipulator arm	Rock	?		Yes	10	Lobate	no		Volcanic

JC142_078_018	20/11/16	00:01	23.943817	-20.813600	3152	ROV	Manipulator arm	Rock	?		Yes	20	Tabular	no		Sedimentary
JC142_078_019	20/11/16	00:30	23.942683	-20.812050	3101	ROV	Manipulator arm	Rock	?		Yes	100	na	no		Sedimentary
JC142_078_020	20/11/16	00:56	23.941450	-20.810783	3024	ROV	Manipulator arm	Rock	Yes		Yes	20	Tabular	no		Volcanic
JC142_078_021	20/11/16	01:55	23.938333	-20.809600	2939	ROV	Manipulator arm	Rock	?		Yes	N/A	Lobate	N/A	N/A	Volcanic
JC142_078_022	20/11/16	02:46	23.935517	-20.807383	2829	ROV	Manipulator arm	Rock	?		Yes	40	Tabular	no	N/A	Volcanic
JC142_078_023	20/11/16	03:53	23.932967	-20.806567	2822	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	90	Lobate	N/A	N/A	Sedimentary
JC142_078_024	20/11/16	04:27	23.931483	-20.807000	2816	ROV	Manipulator arm	Rock	Yes		na		Tabular			
JC142_078_025	20/11/16	05:02	23.930500	-20.807333	2803	ROV	Manipulator arm	Biology	?		Yes	80	Tabular	no		Volcanic
JC142_078_026	20/11/16	06:07	23.926883	-20.808133	2647	ROV	Manipulator	Rock	Yes		Yes	25	Tabular	no		Volcanic

							arm									
JC142_0 78_027	20/1 1/16	07:11	23.926283	-20.806050	2675	ROV	Manipul ator arm	Rock	Yes	Sediment	na	na	Tabular	na	na	
JC142_0 78_028	20/1 1/16	07:28	23.926167	-20.805617	2675	ROV	Manipul ator arm	Rock	Yes		Yes	20	Tabular	no		Volcanic
JC142_0 78_029	20/1 1/16	08:32	23.927450	-20.802700	2666	ROV	Manipul ator arm	Rock	Yes		Yes	15	Tabular	no		Volcanic
JC142_0 78_030	20/1 1/16	08:56	23.926750	-20.802283	2600	ROV	Manipul ator arm	Rock	Yes		Yes	30	Tabular	no		
JC142_0 78_031	20/1 1/16	08:59	23.926750	-20.802283	2600	ROV	Manipul ator arm	Rock	Yes		Yes	30	Tabular	no		
JC142_0 78_032	20/1 1/16	09:02	23.926750	-20.802283	2600	ROV	Manipul ator arm	Rock	Yes		na	N/A	Tabular	N/A	N/A	na
JC142_0 78_033	20/1 1/16	10:00	23.924317	-20.800850	2523	ROV	Manipul ator arm	Rock	Yes		yes	25	Tabular	no		Sedimentary
JC142_0 78_034	20/1 1/16	10:26	23.922133	-20.799967	2471	ROV	Manipul ator arm	Rock	?		Yes	10	Tabular	no		Volcanic

JC142_078_035	20/11/16	10:44	23.921183	-20.799217	2400	ROV	Manipulator arm	Rock	?	Isolated slab/s	Yes	20	Tabular	yes	30	Sedimentary
JC142_078_036	20/11/16	10:48	23.921183	-20.799217	2401	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_078_037	20/11/16	10:49	23.921183	-20.799217	2402	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_078_038	20/11/16	10:50	23.921183	-20.799217	2403	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_078_039	20/11/16	10:50	23.921183	-20.799217	2404	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_078_040	20/11/16	10:50	23.921183	-20.799217	2405	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_078_041	20/11/16	10:51	23.921183	-20.799217	2406	ROV	Niskin	Water	Yes	Isolated slab/s	na	na	Tabular	na	na	na
JC142_080_001	20/11/16	22:05	23.911067	-20.776867	1238	ROV	Manipulator arm	Rock	Yes		Yes	40	Lobate	yes	90	
JC142_080_002	20/11/16	22:49	23.909150	-20.776800	1278	ROV	Manipulator arm	Rock	Yes		Yes	30	Lobate	no	na	
JC142_080_003	20/11/16	23:43	23.907683	-20.774883	1255	ROV	Manipulator arm	Rock	Empty		Yes	60	Tabular	no	na	Volcanic

JC142_080_004	20/11/16	23:52	23.907650	-20.774733	1253	ROV	Manipulator arm	Rock	Yes		na	na	Tabular	na	na	
JC142_080_005	20/11/16	23:59	23.907617	-20.774717	1253	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	
JC142_080_006	21/11/16	00:04	23.907617	-20.774717	1253	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	
JC142_080_007	21/11/16	00:05	23.907617	-20.774717	1253	ROV	Niskin	Water			na	na		na	na	
JC142_080_008	21/11/16	00:06	23.907617	-20.774717	1253	ROV	Niskin	Water			na	na		na	na	
JC142_080_009	21/11/16	01:22	23.907350	-20.774883	1252	ROV	Rock drill	Rock	Yes	Pavement	Yes	70	Tabular	no	na	Sedimentary
JC142_080_010	21/11/16	03:08	23.905833	-20.777417	1273	ROV	Rock drill	Rock	Yes	Pavement	Yes	40	Tabular	no	na	
JC142_080_011	21/11/16	04:03	23.904233	-20.777300	1260	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	50	Tabular	na	na	Sedimentary
JC142_080_012	21/11/16	04:41	23.901733	-20.775217	1213	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	55	Tabular	yes	30	Sedimentary
JC142_080_013	21/11/16	04:45	23.901233	-20.775217	1213	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	50	Tabular	yes	50	Sedimentary

JC142_080_014	21/11/16	05:00	23.900517	-20.774833	1209	ROV	Manipulator arm	Biology			na	na		na	na	
JC142_080_015	21/11/16	05:24	23.900517	-20.774333	1210	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	yes	40	Sedimentary
JC142_080_016	21/11/16	05:33	23.900567	-20.774300	1210	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	
JC142_080_017	21/11/16	05:35	23.900567	-20.774300	1210	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	
JC142_080_018	21/11/16	05:38	23.900633	-20.774367	1209	ROV	Niskin	Water		Sediment	na	na		na	na	
JC142_080_019	21/11/16	05:38	23.900633	-20.774367	1209	ROV	Niskin	Water		Sediment	na	na		na	na	
JC142_080_020	21/11/16	05:51	23.900167	-20.773883	1208	ROV	Push core	Sediment		Sediment	na	na		na	na	
JC142_080_021	21/11/16	05:53	23.900167	-20.773883	1208	ROV	Push core	Sediment		Sediment	na	na		na	na	
JC142_080_022	21/11/16	05:56	23.900167	-20.773883	1208	ROV	Niskin	Water		Sediment	na	na		na	na	
JC142_080_023	21/11/16	06:46	23.899500	-20.773350	1189	ROV	Rock drill	Rock	Yes	Pavement	Yes	25	Tabular	no	na	
JC142_0	21/1	06:56	23.899500	-20.773350	1189	ROV	Manipulator	Rock	Yes	Pavemen	Yes	20	Tabular	no	na	

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JC142_080_025	21/11/16	08:58	23.897033	-20.768450	1149	ROV	Rock drill	Rock	Yes	Pavement	Yes	105	Tabular	no	na	
JC142_080_026	21/11/16	10:01	23.896033	-20.767450	1128	ROV	Rock drill	Rock	Yes	Pavement	Yes	50	Tabular	no	na	
JC142_080_027	21/11/16	10:04	23.896033	-20.767450	1128	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	no	na	
JC142_083_001	22/11/16	01:21	23.889050	-20.856500	3777	ROV	Manipulator arm	Rock			Yes	90	Lobate	no	na	
JC142_083_002	22/11/16	01:39	23.889117	-20.855567	3734	ROV	Manipulator arm	Rock		Debris	Yes	25	Lobate	no	na	
JC142_083_003	22/11/16	01:43	23.889117	-20.855567	3734	ROV	Manipulator arm	Rock		Debris	Yes	20	Lobate	no	na	
JC142_083_004	22/11/16	02:38	23.889283	-20.852500	3613	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	5	Tabular	no	na	Sedimentary
JC142_083_005	22/11/16	02:58	23.889433	-20.851350	3579	ROV	Manipulator arm	Rock	Yes		Yes	30	Lobate	no	na	Sedimentary
JC142_083_006	22/11/16	03:21	23.889533	-20.850000	3530	ROV	Manipulator	Rock		Nodular	Yes	80	Lobate	no	na	Sedimentary

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JC142_083_007	22/11/16	03:56	23.889133	-20.848133	3512	ROV	Manipulator arm	Rock	no	Isolated slab/s	Yes	170	Lobate	no	na	Sedimentary
JC142_083_008	22/11/16	05:19	23.893400	-20.846383	3467	ROV	Manipulator arm	Rock		Cliff	Yes	5	Lobate	no	na	Volcanic
JC142_083_009	22/11/16	06:25	23.895800	-20.843850	3403	ROV	Manipulator arm	Rock		Cliff	Yes	na	Lobate	na	na	
JC142_083_010	22/11/16	07:36	23.897117	-20.838833	3424	ROV	Manipulator arm	Rock		Debris	Yes	30	Lobate	no	na	Sedimentary
JC142_083_011	22/11/16	08:12	23.898633	-20.337233	3437	ROV	Manipulator arm	Rock	no	Cliff	Yes	30	Tabular	no	na	Volcanic
JC142_083_012	22/11/16	08:24	23.899150	-20.837017	3428	ROV	Manipulator arm	Rock	no	Cliff	Yes	coating	Tabular	no	na	Volcanic
JC142_083_013	22/11/16	09:21	23.899750	-20.833367	3348	ROV	Manipulator arm	Biology	Yes	Isolated slab/s	na	na		na	na	
JC142_083_014	22/11/16	09:31	23.900300	-20.833117	3353	ROV	Manipulator arm	Rock		Cliff	Yes	20	Lobate	no	na	

JC142_083_015	22/11/16	10:14	23.901483	-20.830267	3340	ROV	Manipulator arm	Rock		Pavement	Yes	50	Tabular	no	na	Volcanic
JC142_083_016	22/11/16	10:54	23.902017	-20.827683	3331	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	no	na	Sedimentary
JC142_083_017	22/11/16	11:15	23.903217	-20.826400	3332	ROV	Slurp	Biology			na	na		na	na	
JC142_083_018	22/11/16	11:49	23.906300	-20.824233	3308	ROV	Slurp	Biology			na	na		na	na	
JC142_083_019	22/11/16	13:09	23.908167	-20.822933	3215	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	40	Tabular	no	na	Sedimentary
JC142_083_020	22/11/16	13:46	23.908117	-20.821900	3103	ROV	Manipulator arm	Biology	Yes	Debris	na	na		na	na	
JC142_083_021	22/11/16	13:59	23.909800	-20.821867	3103	ROV	Manipulator arm	Rock		Cliff	Yes	20		no	na	Sedimentary
JC142_083_022	22/11/16	14:42	23.910550	-20.820533	2999	ROV	Manipulator arm	Rock		Cliff	Yes	25	Lobate	no	na	
JC142_083_023	22/11/16	15:14	23.910550	-20.818617	2895	ROV	Manipulator arm	Rock		Cliff	Yes	5	Lobate	no	na	Volcanic

JC142_083_024	22/11/16	15:16	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_083_025	22/11/16	15:17	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_083_026	22/11/16	15:17	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_083_027	22/11/16	15:18	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_083_028	22/11/16	15:18	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_083_029	22/11/16	15:18	23.910550	-20.818617	2895	ROV	Niskin	Water			na	na		na	na	
JC142_085_001	23/11/16	02:00	23.896167	-20.767650	1130	ROV	Rock drill	Rock	Yes	Pavement	Yes	140	Tabular	yes	clasts	Sedimentary
JC142_085_002	24/11/16	03:23	23.896133	-20.767633	1130	ROV	Rock drill	Rock	Yes	Pavement	Yes	150	Tabular	yes	clasts	Sedimentary
JC142_085_003	25/11/16	04:45	23.896133	-20.767667	1130	ROV	Rock drill	Rock	Yes	Pavement	Yes	75	Tabular	no	na	na
JC142_085_004	26/11/16	05:55	23.896133	-20.767600	1130	ROV	Rock drill	Rock	Yes	Pavement	Yes	150	Tabular	yes	clasts	Sedimentary
JC142_085_005	27/11/16	05:55	23.896133	-20.767600	1130	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	50	Tabular	no	na	Sedimentary

JC142_085_006	28/11/16	06:47	23.896033	-20.767450	1129	ROV	Rock drill	Rock	Yes	Pavement	Yes	90	Tabular	yes	clasts	Sedimentary
JC142_085_007	29/11/16	08:34	23.896017	-20.767383	1128	ROV	Rock drill	Rock	Yes	Pavement	Yes	50	Tabular	yes	clasts	Sedimentary
JC142_085_008	30/11/16	09:45	23.895800	-20.767367	1127	ROV	Rock drill	Rock	Yes	Pavement	Yes	100	Tabular	yes	60	Sedimentary
JC142_085_009	01/12/16	10:42	23.896133	-20.767650	1130	ROV	Rock drill	Rock	Yes	Pavement	Yes	130	Tabular	no	na	Sedimentary
JC142_085_010	02/12/16	11:00	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_085_011	03/12/16	11:01	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_085_012	04/12/16	11:02	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_085_013	05/12/16	11:02	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_085_014	06/12/16	11:03	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_085_015	07/12/16	11:03	23.896183	-20.767600	1130	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_001	26/11/16	21:03	23.90390663	-20.67528188	1025	ROV	Rock drill	Rock	Yes	Pavement	Yes	20	Tabular	Yes	20	Sedimentary

JC142_089_002	26/11/16	22:05	23.90393178	-20.67534447	1025	ROV	Rock drill	Rock	Yes	Pavement	Yes	80	Tabular	Yes	30	Sedimentary
JC142_089_003	27/11/16	00:05	23.9042618	-20.6755009	1025	ROV	Rock drill	Rock	Yes	Pavement	Yes	60	Tabular	Yes	120	Sedimentary
JC142_089_004	27/11/16	01:08	23.90426868	-20.67549351	1026	ROV	Rock drill	Rock	Yes	Pavement	Yes	60	Tabular	Yes	70	Sedimentary
JC142_089_005	27/11/16	01:48	23.90428733	-20.67549692	1026	ROV	Rock drill	Rock	Yes	Pavement	Yes	70	Tabular	Yes	120	Sedimentary
JC142_089_006 & 008	27/11/16	02:36	23.90442202	-20.6756124	1026	ROV	Rock drill	Rock	Yes	Pavement	Yes	60	Tabular	Yes	100	Sedimentary
JC142_089_007	27/11/16	03:37	23.904422	-20.675630	1027	ROV	Rock drill	Rock	Yes	Pavement	Yes	70	Tabular	Yes	90	Sedimentary
JC142_089_009	27/11/16	04:19	23.90453642	-20.67562997	1028	ROV	Rock drill	Rock	Yes	Pavement	Yes	65	Tabular	Yes	135	Sedimentary
JC142_089_010	27/11/16	05:03	23.90470664	-20.6757501	1028	ROV	Rock drill	Rock	Yes	Pavement	Yes	55	Tabular	Yes	150	Sedimentary
JC142_089_011	27/11/16	06:00	23.90479176	-20.67585933	1028	ROV	Rock drill	Rock	Yes	Pavement	Yes	60	Tabular	No	na	na

JC142_089_012	27/11/16	06:53	23.90480587	-20.67587559	1028	ROV	Rock drill	Rock	Yes	Pavement	Yes	65	Tabular	Yes	120	Sedimentary
JC142_089_013	27/11/16	08:08	23.90468504	-20.67593187	1027	ROV	Rock drill	Rock	Yes	Pavement	Yes	30	Tabular	No	na	na
JC142_089_014	27/11/16	08:52	23.90446026	-20.67579546	1027	ROV	Rock drill	Rock	Yes	Pavement	Yes	50	Tabular	Yes	150	Sedimentary
JC142_089_015	27/11/16	09:09	23.90445114	-20.67579121	1027	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	40	Tabular	No	na	na
JC142_089_016	27/11/16	09:28	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_017	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_018	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_019	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_020	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_089_021	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na

JC142_089_022	27/11/16	09:30	23.904417	-20.675350	1027	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_091_001	27/11/16	19:10	23.897133	-20.506167	3872	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	No	na	Sedimentary
JC142_091_002	27/11/16	19:25	23.897133	-20.622833	3872	ROV	Niskin	Rock	Yes	Pavement	na	na	Tabular	na	na	na
JC142_091_003	27/11/16	19:46	23.897057	-20.506797	3868	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	No	na	Sedimentary
JC142_091_004	27/11/16	20:03	23.897001	-20.507112	3861	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	No	na	Sedimentary
JC142_091_005	27/11/16	20:26	23.896700	-20.508572	3843	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	no	na	Sedimentary
JC142_091_006	27/11/16	21:06	23.896433	-20.511002	3795	ROV	Manipulator arm	Rock	Yes	Debris	Yes	< 2	Tabular	no	na	Volcanic
JC142_091_007	27/11/16	21:56	23.896067	-20.513917	3773	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	10	Lobate	No	na	Volcanic
JC142_091_008	27/11/16	23:08	23.895783	-20.517017	3700	ROV	Manipulator arm	Rock	?	Pavement	Yes	5	Lobate	no	na	Volcanic

JC142_091_009	27/11/16	23:54	23.895333	-20.519417	3657	ROV	Manipulator arm	Rock	?	Cliff	Yes	25	Lobate	No	na	Volcanic
JC142_091_010	28/11/16	00:51	23.894483	-20.522883	3598	ROV	Manipulator arm	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_011	28/11/16	01:01	23.894533	-20.522883	3598	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	50	Lobate	no	na	na
JC142_091_012	28/11/16	01:10	23.894517	-20.523133	3595	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	80	Lobate	no	na	Sedimentary
JC142_091_013	28/11/16	01:37	23.897950	-20.524900	3585	ROV	Manipulator arm	Rock	Yes	Pavement	na	na	Tabular	na	na	na
JC142_091_014	28/11/16	02:04	23.894483	-20.525717	3568	ROV	Manipulator arm	Rock	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_015	28/11/16	02:15	23.894483	-20.525717	3568	ROV	Manipulator arm	Rock	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_016	28/11/16	03:03	23.893767	-20.529367	3436	ROV	Manipulator arm	Rock	Yes	Debris	na	na	Lobate	na	na	na
JC142_091_017	28/11/16	03:47	23.894667	-20.531517	3391	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na

JC142_091_018	28/11/16	03:49	23.893633	-20.531517	3391	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_019	28/11/16	04:39	23.893600	-20.533650	3393	ROV	Manipulator arm	Rock	?	Pavement	Yes	15	Lobate	no	na	Sedimentary
JC142_091_020	28/11/16	05:10	23.899333	-20.534983	3310	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_021	28/11/16	05:13	23.899333	-20.534983	3310	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_022	28/11/16	06:25	23.893017	-20.538967	3308	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_091_023	28/11/16	06:37	23.893150	-20.539117	3313	ROV	Manipulator arm	Rock	Yes	Cliff	na	na	Lobate	na	na	na
JC142_091_024	28/11/16	07:09	23.892850	-20.541683	3317	ROV	Manipulator arm	Rock	Yes	Debris	Yes	2	Lobate	No	na	Volcanic
JC142_091_025	28/11/16	07:47	23.892533	-20.544367	3124	ROV	Manipulator arm	Rock	?	Debris	Yes	2	Lobate	No	na	Volcanic
JC142_091_026	28/11/16	07:57	23.892450	-20.544867	3193	ROV	Manipulator arm	Rock	no	Cliff	Yes	2	Lobate	No	na	Volcanic
JC142_091_027	28/11/16	08:50	23.892833	-20.548650	3028	ROV	Manipulator	Biology	Yes	Pavement	na	na	Lobate	na	na	

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JC142_0 91_028	28/1 1/16	09:06	23.892850	-20.549333	3040	ROV	Manipul ator arm	Rock	?	Debris	Yes	1	Lobate	No	na	Volcanic
JC142_0 91_029	28/1 1/16	09:17	23.892850	-20.549617	3043	ROV	Manipul ator arm	Rock	no	Debris	Yes	2	Lobate	No	na	Volcanic
JC142_0 91_030	28/1 1/16	10:19	23.893100	-20.552700	3006	ROV	Manipul ator arm	Rock	no	Pavemen t	Yes	1	Lobate	No	na	Volcanic
JC142_0 91_031	28/1 1/16	10:40	23.893167	-20.553017	2997	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	40	Tabular	No	na	Volcanic
JC142_0 91_032	28/1 1/16	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 91_033	28/1 1/16	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 91_034	28/1 1/16	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 91_003	28/1 1/16	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 91_036	28/1 1/16	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0	28/1	11:35	23.892467	-20.556933	2786	ROV	Niskin	Water	Yes	Pavemen	na	na	Tabular	na	na	na

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JC142_094_001	28/11/16	23:00	23.889900	-20.598450	1952	ROV	Manipulator arm	Biology	Yes	Debris	na	na		na	na	na
JC142_094_002	28/11/16	23:21	23.889900	-20.598450	1952	ROV	Slurp	Biology	Yes		na	na		na	na	na
JC142_094_003	28/11/16	23:36	23.889817	-20.598450	1951	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	No	na	Tabular	No	na	Sedimentary
JC142_094_004	29/11/16	00:27	23.887383	-20.599283	1943	ROV	Manipulator arm	Biology	Yes	Sediment	na	na		na	na	na
JC142_094_005	29/11/16	01:28	23.887183	-20.601833	1834	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	No	na	na
JC142_094_006	29/11/16	01:52	23.888250	-20.602817	1804	ROV	Manipulator arm	Rock	?	Pavement	Yes	70	Lobate	na	na	na
JC142_094_007	29/11/16	02:09	23.888533	-20.603067	1790	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	10	Tabular	No	na	Sedimentary
JC142_094_008	29/11/16	02:15	23.888533	-20.603067	1790	ROV	Manipulator arm	Rock	Yes	Pavement	No	na	Tabular	No	na	Sedimentary
JC142_0	29/1	02:30	23.888550	-20.603050	1789	ROV	Slurp	Biology	Yes	Pavemen	na	na	Tabular	na	na	na

94_009	1/16									t						
JC142_0 94_010	29/1 1/16	02:52	23.888650	-20.603200	1784	ROV	Slurp	Biology	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 94_011	29/1 1/16	03:27	23.889033	-20.604533	1732	ROV	Manipul ator arm	Rock	Yes	Pavemen t	No	na	Tabular	No	na	Sedimentary
JC142_0 94_012	29/1 1/16	03:54	23.888817	-20.605533	1669	ROV	Manipul ator arm	Water	Yes	Pavemen t	na	na	Tabular	na	na	na
JC142_0 94_013	29/1 1/16	04:08	23.888833	-20.605683	1662	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	40	Tabular	no	na	na
JC142_0 94_014	29/1 1/16	04:19	23.888817	-20.605683	1662	ROV	Slurp	Biology	Yes		na	na	Lobate	na	na	na
JC142_0 94_015	29/1 1/16	04:50	23.888217	-20.607267	1637	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	30	Lobate	No	na	Volcanic
JC142_0 94_016	29/1 1/16	07:26	23.889967	-20.615083	1616	ROV	Slurp	Biology	Yes		na	na		na	na	na
JC142_0 94_017	29/1 1/16	07:26	23.889967	-20.615083	1616	ROV	Slurp	Biology	Yes		na	na		na	na	na
JC142_0 94_018	29/1 1/16	07:30	23.889967	-20.615083	1616	ROV	Slurp	Biology	Yes		na	na		na	na	na
JC142_0	29/1	07:38	23.889967	-20.615083	1616	ROV	Manipul ator	Rock	Yes		Yes	35		No	na	Volcanic

94_019	1/16						arm									
JC142_0 94_020	29/1 1/16	08:39	23.888150	-20.617683	1580	ROV	Manipul ator arm	Rock	Yes		Yes	40		No	na	Sedimentary
JC142_0 94_021	29/1 1/16	09:09	23.888250	-20.619000	1548	ROV	Manipul ator arm	Rock	Yes		Yes	45	Lobate	No	na	Sedimentary
JC142_0 94_022	29/1 1/16	09:12	23.888250	-20.619000	1548	ROV	Manipul ator arm	Biology	Yes		na	na	Lobate	na	na	na
JC142_0 94_023	29/1 1/16	10:39	23.889900	-20.624483	1464	ROV	Slurp	Biology	Yes		na	na		na	na	na
JC142_0 94_024	29/1 1/16	10:57	23.890300	-20.625467	1433	ROV	Manipul ator arm	Rock	Yes	Isolated slab/s	Yes	30	Lobate	No	na	Sedimentary
JC142_0 94_025	29/1 1/16	11:25	23.890933	-20.626633	1411	ROV	Manipul ator arm	Rock	Yes		Yes	20	Lobate	No	na	Sedimentary
JC142_0 94_026	29/1 1/16	11:27	23.890933	-20.626633	1411	ROV	Manipul ator arm	Rock	Yes		Yes	20	Lobate	no	na	Sedimentary
JC142_0 94_027	29/1 1/16	12:06	23.891733	-20.628617	1350	ROV	Manipul ator arm	Rock	Yes		na	na	Lobate	na	na	na
JC142_0	29/1	12:10	23.891717	-20.627983	1352	ROV	Push	Sedime			na	na		na	na	na

94_028	1/16						core	nt								
JC142_094_029	29/11/16	12:13	23.891717	-20.628617	1353	ROV	Push core	Sediment			na	na		na	na	na
JC142_094_030	29/11/16	12:15	23.891717	-20.628000	1351	ROV	Push core	Sediment	Empty		na	na		na	na	na
JC142_094_031	29/11/16	12:21	23.891783	-20.628767	1340	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	40	Lobate	na	na	na
JC142_094_032	29/11/16	12:42	23.891867	-20.628867	1324	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	na	na	na
JC142_094_033	29/11/16	12:55	23.891917	-20.629267	1319	ROV	Push core	Sediment	Empty		na	na		na	na	na
JC142_094_034	29/11/16	13:02	23.891917	-20.629267	1319	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	no	na	na
JC142_094_035	29/11/16	13:08	23.891917	-20.629267	1319	ROV	Niskin	Water			na	na		na	na	na
JC142_094_036	29/11/16	13:08	23.891917	-20.629267	1319	ROV	Niskin	Water			na	na		na	na	na
JC142_094_037	29/11/16	13:08	23.891917	-20.629267	1319	ROV	Niskin	Water			na	na		na	na	na
JC142_094_038	29/11/16	13:08	23.891917	-20.629267	1319	ROV	Niskin	Water			na	na		na	na	na

JC142_094_039	29/11/16	13:08	23.891917	-20.629267	1319	ROV	Niskin	Water			na	na		na	na	na
JC142_100_001	30/11/16	12:37	23.856683	-20.684550	1406	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	Yes	25	Sedimentary
JC142_100_002	30/11/16	12:51	23.856683	-20.684550	1406	ROV	Niskin	Rock	Yes	Pavement	na	na		na	na	na
JC142_100_003	30/11/16	12:58	23.856683	-20.684550	1406	ROV	Manipulator arm	Black coral	Yes	Pavement	na	na		na	na	na
JC142_100_004	30/11/16	13:03	23.856683	-20.684550	1406	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	na
JC142_100_005	30/11/16	13:04	23.856683	-20.684550	1233	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	na
JC142_100_006	30/11/16	14:41	23.858850	-20.685450	1254	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	na
JC142_100_007	30/11/16	15:01	23.859117	-20.685717	1233	ROV	Manipulator arm	Black coral	Yes	Sediment	na	na		na	na	Sedimentary
JC142_100_008	30/11/16	15:23	23.858950	-20.685967	1234	ROV	Manipulator arm	Rock	No	Cliff	na	na		na	na	na
JC142_100_009	30/11/16	15:31	23.858917	-20.685967	1235	ROV	Push core	Sediment	No	Sediment	na	na		na	na	Sedimentary

JC142_100_010	30/11/16	15:33	23.858917	-20.685967	1235	ROV	Push core	Sediment	No	Sediment	na	na		na	na	Sedimentary
JC142_100_011	30/11/16	15:34	23.858917	-20.685967	1235	ROV	Push core	Sediment	No	Sediment	na	na		na	na	Sedimentary
JC142_100_012	30/11/16	15:40	23.858900	-20.686050	1233	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	20	Tabular	No	na	na
JC142_100_013	30/11/16	15:48	23.858917	-20.686100	1217	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	10	Tabular	Yes	40	Sedimentary
JC142_100_014	30/11/16	15:58	23.859050	-20.686300	1212	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	15	Tabular	No	na	na
JC142_100_015	30/11/16	16:21	23.859550	-20.686583	1173	ROV	Manipulator arm	Rock	No	Pavement	Yes	40	Tabular	No	na	na
JC142_100_016	30/11/16	16:25	23.859550	-20.686583	1173	ROV	Manipulator arm	Rock	?	Pavement	Yes	20	Tabular	Yes	15	na
JC142_100_017	30/11/16	16:22	23.859583	-20.686800	1173	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	1	Tabular	No	na	na
JC142_104_001	01/12/16	14:55	23.853567	-20.724800	1015	ROV	Push core	Sediment	Yes	Sediment	na	na		na	na	na
JC142_1	01/1	14:57	23.853567	-20.724800	1015	ROV	Push	Sedime	Yes	Sediment	na	na		na	na	na

04_002	2/16						core	nt								
JC142_1 04_003	01/1 2/16	14:58	23.853567	-20.724800	1015	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_004	01/1 2/16	14:59	23.853567	-20.724800	1015	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_005	01/1 2/16	15:04	23.853567	-20.724800	1015	ROV	Manipul ator arm	Rock	Yes	Sediment	Yes	na		na	na	na
JC142_1 04_006	01/1 2/16	15:05	23.853567	-20.724800	1015	ROV	Manipul ator arm	Rock	Yes	Sediment	Yes	na		na	na	na
JC142_1 04_007	01/1 2/16	15:08	23.853567	-20.724800	1015	ROV	Manipul ator arm	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_008	01/1 2/16	15:14	23.853683	-20.724783	1015	ROV	Manipul ator arm	Rock	Yes	Sediment	Yes	1		no	na	Sedimentary
JC142_1 04_009	01/1 2/16	15:34	23.853717	-20.724750	1015	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_010	01/1 2/16	15:38	23.853717	-20.724733	1015	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_011	01/1 2/16	15:43	23.853717	-20.724733	1015	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1	01/1	16:20	23.853567	-20.726650	1013	ROV	Push	Sedime	Yes	Sediment	na	na		na	na	na

04_012	2/16						core	nt								
JC142_1 04_013	01/1 2/16	16:24	23.853567	-20.726650	1013	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_014	01/1 2/16	16:26	23.853567	-20.726650	1013	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_015	01/1 2/16	16:45	23.853567	-20.726650	1013	ROV		Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_016	01/1 2/16	16:56	23.853567	-20.726650	1013	ROV	Push core	Sedime nt	Yes	Sediment	na	na		na	na	na
JC142_1 04_017	01/1 2/16	17:00	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 04_018	01/1 2/16	17:01	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 04_019	01/1 2/16	17:01	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 04_020	01/1 2/16	17:01	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 04_021	01/1 2/16	17:01	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 04_022	01/1 2/16	17:01	23.853567	-20.726650	1013	ROV	Niskin	Water	Yes	Sediment	na	na		na	na	na
JC142_1 07_001	02/1 2/16	01:08	23.920900	-20.796950	233	ROV	Manipul ator		?	Pavemen t	Yes	70	Lobate	Yes	10	Sedimentary

							arm									
JC142_107_002	02/12/16	01:27	23.920867	-20.795517	2292	ROV	Manipulator arm		?	Pavement	Yes	10	Lobate	No	na	Volcanic
JC142_107_003	02/12/16	02:28	23.920567	-20.790983	1969	ROV	Manipulator arm	slab	Yes	Pavement	Yes	50	Lobate	No	na	Volcanic
JC142_107_004	02/12/16	02:50	23.920350	-20.789517	1898	ROV	Manipulator arm	Sediment	Yes	Sediment	na	na		na	na	na
JC142_107_005	02/12/16	03:28	23.920350	-20.787750	1803	ROV	Manipulator arm	Rock	?	Sediment	Yes	50	Lobate	No	na	Volcanic
JC142_107_006	02/12/16	03:34	23.920333	-20.787750	1803	ROV	Slurp	Biology	Yes	Sediment	na	na	Lobate	na	na	na
JC142_107_007	02/12/16	03:42	23.918667	-20.787683	1801	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	1	Lobate	No	na	Volcanic
JC142_107_008	02/12/16	04:46	23.918333	-20.784583	1846	ROV	Manipulator arm	Rock	?	Sediment	na	na	Lobate	na	na	na
JC142_107_009	02/12/16	05:29	23.917867	-20.782383	1858	ROV	Niskin	NiskinZ	?	Pavement	na	na	Lobate	na	na	na
JC142_107_010	02/12/16	05:51	23.911667	-20.781117	1815	ROV	Manipulator	Rock	Yes	Cliff	Yes	35	Tabular	Yes	10	Sedimentary

							arm									
JC142_107_011	02/12/16	06:30	23.915650	-20.779383	1716	ROV	Manipulator arm	Rock	?	Pavement	Yes	5	Lobate	No	na	Volcanic
JC142_107_012	02/12/16	06:53	23.913717	-20.778067	1647	ROV	Slurp	Biology	Yes	Pavement	na	na		na	na	na
JC142_107_013	02/12/16	08:00	23.913417	-20.775217	1452	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Tabular	No	na	Volcanic
JC142_107_014	02/12/16	08:20	23.912917	-20.775100	1442	ROV	Slurp	Biology	Yes	Pavement	na	na	Lobate	na	na	na
JC142_107_015	02/12/16	08:30	23.911350	-20.774417	1435	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	40	Lobate	Yes	<2	na
JC142_107_016	02/12/16	09:30	23.909650	-20.770900	1276	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	No	na	na
JC142_107_017	02/12/16	10:14	23.909650	-20.769283	1240	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	No	na	na
JC142_107_018	02/12/16	10:17	23.902600	-20.769267	1240	ROV	Manipulator arm	Rock	?	Sediment	Yes	40	Tabular	No	na	na
JC142_107_019	02/12/16	10:28	23.907150	-20.768917	1236	ROV	Manipulator	Rock	?	Sediment	Yes	70	Lobate	Yes	<3	Sedimentary

							arm									
JC142_107_020	02/12/16	11:12	23.907150	-20.769983	1216	ROV	Manipulator arm	Rock	?	Sediment	Yes	90	Lobate	Yes	<10	Sedimentary
JC142_107_021	02/12/16	11:43	23.906350	-20.771167	1209	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	60	Lobate	No		Sedimentary
JC142_107_022	02/12/16	12:14	23.905317	-20.772550	1202	ROV	Manipulator arm	Rock	Yes	Nodular	Yes	15	Nodular	Yes	25	Sedimentary
JC142_107_023	02/12/16	12:15	23.905317	-20.772550	1202	ROV	Manipulator arm	Rock	Yes	Nodular	Yes	10	Nodular	No	na	Sedimentary
JC142_107_024	02/12/16	12:15	23.905317	-20.772550	1202	ROV	Manipulator arm	Rock	Yes	Nodular	na	na	Nodular	na	na	na
JC142_107_025	02/12/16	12:15	23.905317	-20.772550	1202	ROV	Manipulator arm	Rock	Yes	Nodular	Yes	25	Nodular	Yes	20	Sedimentary
JC142_107_026	02/12/16	12:51	23.903067	-20.775450	1222	ROV	Niskin	Water		Nodular	na	na	Nodular	na	na	na
JC142_107_027	02/12/16	12:52	23.903067	-20.775450	1222	ROV	Niskin	Water		Nodular	na	na	Nodular	na	na	na
JC142_107_028	02/12/16	12:52	23.903067	-20.775450	1222	ROV	Niskin	Water		Nodular	na	na	Nodular	na	na	na

JC142_107_029	02/12/16	12:52	23.903067	-20.775450	1222	ROV	Niskin	Water		Nodular	na	na	Nodular	na	na	na
JC142_107_030	02/12/16	12:52	23.903067	-20.775450	1222	ROV	Niskin	Water		Nodular	na	na	Nodular	na	na	na
JC142_107_031	02/12/16	12:52	23.903067	-20.775450	1222	ROV	Niskin	Water		Pavement	na	na	Nodular	na	na	na
JC142_107_032	02/12/16	13:01	23.903067	-20.775433	1222	ROV	Manipulator arm	Rock		Nodular	Yes	40	Nodular	Yes	40	Sedimentary
JC142_107_033	02/12/16	08:26	23.914583	-20.776150	1532	ROV	Isis	Rock	Yes	?	Yes	1	Cave roof	No	na	Volcanic
JC142_109_001	02/12/16	23:05	42.600333	-20.726800	3851	ROV	Manipulator arm	Rock	Yes	B?	Yes	10	Lobate	no	na	Volcanic
JC142_109_002	02/12/16	23:12	42.601333	-20.726817	3851	ROV	Manipulator arm	Rock	Yes	B?	Yes	3	Lobate	no	na	Volcanic
JC142_109_003	02/12/16	23:19	42.601333	-20.726817	3851	ROV	Niskin	Rock	?	Debris	na	na	Lobate	na	na	na
JC142_109_004	02/12/16	23:34	42.613333	-20.726817	3841	ROV	Manipulator arm	Rock	?	Pavement	Yes	na	Lobate	na	na	na
JC142_109_005	02/12/16	23:55	42.705333	-20.726800	3832	ROV	Manipulator arm	Rock	No	Sediment	Yes	4	Lobate	no	na	Volcanic

JC142_109_006	02/12/16	00:33	42.876333	-20.726367	3760	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	15	Lobate	no	na	Volcanic
JC142_109_007	03/12/16	01:18	43.128333	-20.726367	3665	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	10	Lobate	no	na	Volcanic
JC142_109_008	03/12/16	02:26	43.318333	-20.726317	3625	ROV	Manipulator arm	Rock	Yes	Isolated slab/s	Yes	5	Lobate	no	na	Volcanic
JC142_109_009	03/12/16	03:15	43.398333	-20.729617	3683	ROV	Manipulator arm	Rock	No	Sediment	Yes	10		no	na	Sedimentary
JC142_109_010	03/12/16	03:38	43.457333	-20.729400	3651	ROV	Manipulator arm	Rock	No	Pavement	Yes	5	Lobate	no	na	Volcanic
JC142_109_011	03/12/16	04:23	43.629333	-20.731650	3491	ROV	Manipulator arm	Rock	?	Sediment	Yes	3	Tabular	no	na	Volcanic
JC142_109_012	03/12/16	04:36	43.656333	-20.728100	3475	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	10	Tabular	no	na	Sedimentary
JC142_109_013	03/12/16	05:25	23.724783	-20.727067	3347	ROV	Manipulator arm	Rock	?		Yes	30	Lobate	no	na	Sedimentary
JC142_109_014	03/12/16	06:10	23.726933	-20.725083	3276	ROV	Manipulator	Rock	?	Pavement	Yes	30	Lobate	no	na	Sedimentary

							arm									
JC142_109_015	03/12/16	06:51	23.728617	-20.723600	3213	ROV	Manipulator arm	Biology		Pavement	na	na		na	na	na
JC142_109_016	03/12/16	06:55	23.728617	-20.723600	3213	ROV	Manipulator arm	Biology		Pavement	na	na		na	na	na
JC142_109_017	03/12/16	07:42	23.730250	-20.722367	3186	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	35	Lobate	no	na	Sedimentary
JC142_109_018	03/12/16	09:02	23.735133	-20.721450	3084	ROV	Manipulator arm	Rock	?	Pavement	Yes	35	Lobate	no	na	Volcanic
JC142_109_019	03/12/16	09:30	23.736767	-20.721367	3059	ROV	Manipulator arm	Rock	?	Pavement	Yes	10	Lobate	no	na	Volcanic
JC142_109_020	03/12/16	10:26	23.741042	-20.730117	2947	ROV	Manipulator arm	Rock	?	Pavement	Yes	40	Lobate	no	na	Sedimentary
JC142_109_021	03/12/16	10:37	44.829333	-20.720033	2925	ROV	Manipulator arm	Rock	?	Pavement	Yes	20	Lobate	no	na	Volcanic
JC142_109_022	03/12/16	10:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavement	na	na		na	na	na
JC142_1	03/1	11:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavemen	na	na		na	na	na

09_023	2/16									t					
JC142_1 09_024	03/1 2/16	12:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavemen t	na	na		na	na	na
JC142_1 09_025	03/1 2/16	13:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavemen t	na	na		na	na	na
JC142_1 09_026	03/1 2/16	14:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavemen t	na	na		na	na	na
JC142_1 09_027	03/1 2/16	15:43	44.842333	-20.719883	2912	ROV	Niskin	Water	Yes	Pavemen t	na	na		na	na	na
JC142_1 13_001	03/1 2/16	23:12	46.833333	-20.714167	2068	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	30	Tabular	no	na	Sedimentary
JC142_1 13_002	03/1 2/16	23:34	46.885333	-20.714767	2067	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	35	Tabular	Yes	20	Sedimentary
JC142_1 13_003	03/1 2/16	23:38	46.885333	-20.714767	2067	ROV	Manipul ator arm	Biology			Yes	> 1	Tabular	na	na	Sedimentary
JC142_1 13_004	03/1 2/16	23:57	46.952333	-20.715117	2058	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	30	Tabular	no	na	Sedimentary
JC142_1 13_005	04/1 2/16	00:42	47.106333	-20.714983	2047	ROV	Manipul ator arm	Rock	Yes	Pavemen t	Yes	20	Tabular	no	na	Sedimentary

JC142_113_006	04/12/16	01:30	47.206333	-20.718150	1956	ROV	Manipulator arm	Rock	Yes	Sediment	Yes	20	Tabular	no	na	Sedimentary
JC142_113_007	04/12/16	02:37	47.320333	-20.720283	1797	ROV	Manipulator arm	Biology	No	Cliff	na	na		na	na	na
JC142_113_008	04/12/16	03:14	47.421333	-20.720333	1780	ROV	Manipulator arm	Rock	Yes	Pavement	na	na	Tabular	na	na	na
JC142_113_009	04/12/16	03:15	47.421333	-20.720333	1780	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	no	na	Sedimentary
JC142_113_010	04/12/16	03:36	47.469333	-20.720383	1783	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	< 1	Tabular	no	na	Sedimentary
JC142_113_011	04/12/16	03:50	47.497333	-20.720467	1765	ROV	Manipulator arm	Rock	No	Slab	Yes	20 - 30	Tabular	no	na	Volcanic
JC142_113_012	04/12/16	04:27	47.598333	-20.720683	1686	ROV	Manipulator arm	Rock	Yes	Pavement		25	Tabular	no	na	na
JC142_113_013	04/12/16	05:17	47.825333	-20.721883	1624	ROV	Manipulator arm	Rock		Slab	Yes	25		no	na	Sedimentary
JC142_113_014	04/12/16	06:36	48.103333	-20.721250	1463	ROV	Manipulator ator	Biology	Yes	Debris	na	na		na	na	na

							arm									
JC142_113_015	04/12/16	06:40	48.100333	-20.721250	1464	ROV	Manipulator arm	Biology	No	Debris	na	na		na	na	na
JC142_113_016	04/12/16	06:56	48.137333	-20.721283	1437	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	25	Tabular	Yes	10	Sedimentary
JC142_113_017	04/12/16	07:19	48.214333	-20.720783	1375	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	2	Tabular	no	na	Sedimentary
JC142_113_018	04/12/16	07:53	48.347333	-20.720283	1258	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	20	Tabular	no	na	Sedimentary
JC142_113_019	04/12/16	08:09	48.379333	-20.720183	1217	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30	Tabular	Yes	10	Sedimentary
JC142_113_020	04/12/16	08:15	48.379333	-20.720167	1217	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	40	Tabular	Yes	10	Sedimentary
JC142_113_021	04/12/16	08:58	48.447333	-20.720350	1170	ROV	Niskin	Water	Yes	Pavement	na	na	Tabular	na	na	na
JC142_113_022	04/12/16	08:59	48.448333	-20.720367	1170	ROV	Niskin	Water	Yes	Pavement	na	na	Tabular	na	na	na
JC142_113_023	04/12/16	08:59	48.448333	-20.720367	1170	ROV	Niskin	Water	Yes	Pavement	na	na	Tabular	na	na	na

JC142_113_024	04/12/16	09:00	48.448333	-20.720367	1170	ROV	Niskin	Water	Yes	Pavement	na	na	Tabular	na	na	na
JC142_113_025	04/12/16	09:00	48.448333	-20.720367	1170	ROV	Niskin	Water	Yes	Pavement	na	na	Tabular	na	na	na
JC142_113_026	04/12/16	09:01	48.448333	-20.720367	1170	ROV	Niskin	Water	Yes	Pavement			Tabular			
JC142_116_001	04/12/16	23:21	51.943333	-20.743583	1019	ROV	Drill	Drill Core	Yes	Pavement	Yes	35		Yes	15	Sedimentary
JC142_116_002	05/12/16	00:09	51.926333	-20.743467	1020	ROV	Drill	Drill Core	Yes	Pavement	Yes	20		No	na	Sedimentary
JC142_116_003	05/12/16	01:23	51.899333	-20.743367	1020	ROV	Drill	Drill Core	Yes	Pavement	Yes	25		No	na	Sedimentary
JC142_116_004	05/12/16	02:26	51.896333	-20.743333	1020	ROV	Drill	Drill Core	Yes	Pavement	Yes	20		No	na	Sedimentary
JC142_116_005	05/12/16	03:21	51.880333	-20.743167	1020	ROV	Drill	Drill Core	Yes	Pavement	Yes	40		Yes	50	Sedimentary
JC142_116_006	05/12/16	04:31	51.850333	-20.743167	1019	ROV	Drill	Drill Core	Yes	Pavement	Yes	50		No	na	Sedimentary
JC142_116_006	05/12/16	04:31	51.850333	-20.742983	1019	ROV	Drill	Drill Core	Yes	Pavement						
JC142_116_007	05/12/16	05:27	51.846333	-20.742950	1019	ROV	Drill	Drill Core	Yes	Pavement	Yes	50		No	na	Sedimentary

JC142_116_008	05/12/16	06:26	51.860333	-20.742950	1019	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	25		No	na	Sedimentary
JC142_116_008	05/12/16	06:27	51.860333	-20.742950	1019	ROV	Manipulator arm	Rock	Yes	Pavement						
JC142_116_009	05/12/16	07:28	51.831333	-20.741917	1018	ROV	Manipulator arm	Rock	Yes	Pavement	Yes	30		No	na	na
JC142_116_010	05/12/16	08:42	51.823333	-20.741867	1017	ROV	Drill	Drill Core	Yes	Pavement	Yes	10		No	na	na
JC142_116_011	05/12/16	08:50	51.809333	-20.741867	1019	ROV	Push core	Sediment		Sediment	na	na		na	na	na
JC142_116_012	05/12/16	08:51	51.809333	-20.741883	1019	ROV	Push core	Sediment		Sediment	na	na		na	na	na
JC142_116_013	05/12/16	09:15	51.810333	-20.741850	1020	ROV	Ellsworth Core	Sediment		Sediment	na	na		na	na	na
JC142_116_014	05/12/16	09:26	51.816333	-20.741850	1018	ROV	Push core	Sediment		Sediment	na	na		na	na	na
JC142_116_015	05/12/16	09:28	51.816333	-20.741833	1018	ROV	Push core	Sediment		Sediment	na	na		na	na	na
JC142_116_016	05/12/16	09:38	51.817333	-20.741767	1018	ROV	Manipulator arm	Rock	Yes	Pavement	yes	20		yes	20-70	Sedimentary

JC142_116_017	05/12/16	10:15	51.821333	-20.741767	1017	ROV	Drill	Drill Core	Yes	Pavement	yes	40		yes	25	Sedimentary
JC142_116_018	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_116_019	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_116_020	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_116_021	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_116_022	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_116_023	05/12/16	10:22	51.821333	-20.741767	1017	ROV	Niskin	Water		Pavement	na	na		na	na	na
JC142_119_001	05/12/16	21:22	2.165333	-20.726983	3310	ROV	Manipulator arm	Rock	No	Debris	Yes	20	Lobate	No	na	Volcanic
JC142_119_002	05/12/16	22:01	2.032333	-20.728300	3277	ROV	Manipulator arm	Rock	No	Debris	Yes	6	Lobate	No	na	Volcanic
JC142_119_003	05/12/16	22:22	1.998333	-20.728667	3265	ROV	Slurp	Sediment	No	Sediment	na					
JC142_1	05/1	22:54	1.955333	-20.728867	3247	ROV	Manipulator	Rock	No	Debris	Yes	1	Lobate	No	na	Volcanic

19_004	2/16						arm									
JC142_1 19_005	05/1 2/16	23:01	1.954333	-20.728883	3247	ROV	Manipul ator arm	Rock	Yes	Boulder	Yes	20	Lobate	No	na	Volcanic
JC142_1 19_006	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_007	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_008	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_009	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_010	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_011	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								
JC142_1 19_012	05/1 2/16	23:08	1.954333	-20.728883	3247	ROV	Niskin	Water								