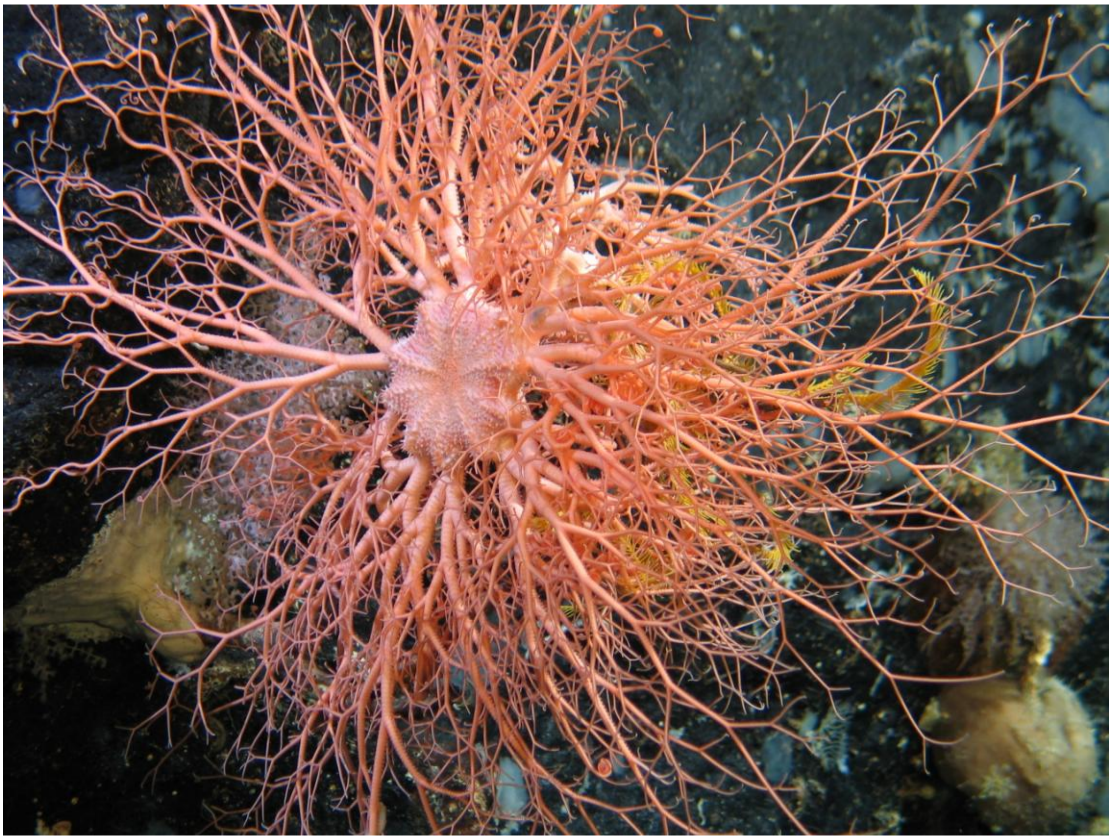
Benthic biodiversity of seamounts in the southwest Indian Ocean

Cruise report – R/V *James Cook* 066

Southwest Indian Ocean Seamounts expedition – November 7th – December 21st, 2011



Edited by A.D. Rogers and M.L. Taylor

1 Summary

Seamounts are ubiquitous yet poorly understood oceanic ecosystems. They are hotspots of biodiversity and biomass in the open ocean and of commercial importance for fisheries. At the same time they are locations where VMEs (vulnerable marine ecosystems) are often found and are thus at danger from significant adverse impacts from fishing. This is the case in the Southwest Indian Ocean where there is a paucity of data from seamounts but an active deep-sea trawling fishery for species such as alfonsino (*Beryx splendens*) and orange roughy *(Hoplostethus atlanticus*). Thus the aims of the present cruise were to ground-truth models of habitat suitability for deep-sea stony corals which are associated with VME formation and to analyse the fauna and oceanography of five seamounts of the Southwest Indian Ocean Ridge. Two of these are voluntary protected areas by the Southern Indian Ocean Deep-Sea Fishers Association (SIODFA).

Biological sampling was undertaken, using cores, grabs, and the ROV (remotely operated vehicle) Kiel 6000. Examples of the majority of common benthic megafauna and sediments, containing a range of macro- and meiofauna, were collected. Hard coral framework, octocorals, and sponges were the most frequent benthic organisms observed and a wide diversity of species were sampled and preserved. Video surveys were undertaken to examine the association of fauna with specific geomorphological features and environmental conditions. As whole specimens were collected intact it was possible to record the associations between different fauna that are not maintained using towed benthic sampling gear. Although limited in number, the sediment cores procured represent a rare opportunity to study the species diversity, and species diversity changes with depth, on seamounts of meiofauna and macrofauna.

In a continuation of work on bentho-pelagic coupling over seamounts, net samples were also collected. Opportunistic collection of deep-scattering layer acoustic data supplemented this work.

In addition multibeam mapping surveys were undertaken on all target seamounts. The resultant bathymetric maps will be compared with those obtained in 2009 on a cruise on the RV *Fridtjof Nansen*, and will be used to investigate seamount geological processes. Physical oceanographic data were also collected on all seamounts using CTDs and turbulence probes. Water samples were also filtered for microbial communities.

This report lays out an overview of the background to this expedition, the scientific activities completed, as well as the extensive media outreach and education accomplished. Details of all data collection techniques and recording methods are listed in addition to comprehensive reports on equipment performance (ships systems, mechanical and moorings), data logging and storage.

This cruise would not have been possible without the dedication and commitment of the staff, scientists, and crew on board the RSS *James Cook* and we would like to recognize their effort and help here.

1.1 Table of Contents

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ERPO	James Harris
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3 Cruise science

3.1 Introduction: seamounts & fisheries

Globally, fisheries have expanded across latitudes (Swartz *et al*., 2010) and into deeper water (Morato *et al*., 2006) over the last fifty years. In oceanic waters, beyond the exclusive economic zones (EEZs) of States, these fisheries have been subject to limited regulation and have reached depths greater than 2000m. During this time, aggregations of fish associated with elevated or complex topographic features such as seamounts and canyons have become targeted. The high longevity, high age at maturity and sporadic reproduction of some of these species, such as orange roughy (*Hoplostethus atlanticus*), cardinal fish (*Epigonus* spp.), and oreos (Oreosomatidae), render these species highly vulnerable to overfishing. However, the localities in which these species aggregate also host communities of sessile species, such as cold-water coral reefs, octocoral and sponge gardens. Given that the usual form of exploitation of seamount species such as orange roughy has been bottom trawling, fishing has also been observed to have a highly destructive impact on the ecosystem (e.g. Koslow & Gowlett-Holmes, 2001; Waller, 2007; Althaus *et al*., 2009). Thus, there is increasing concern about the potential irreversible effects of these fisheries, not only on target and by-catch fish populations, but also on the complex and diverse benthic assemblages with which they often co-occur. These concerns have resulted in several resolutions by the United Nations General Assembly (UNGA), including 64/72 and 74/105, which have called for measures to improve the management of high seas deep-sea bottom fisheries with respect to both target and by-catch fish species and vulnerable marine ecosystems (VMEs; Rogers & Gianni, 2010).

One of the deep-sea ecosystems most often associated with VMEs and with deep-sea fisheries are seamounts. These are topographic rises of the seabed with a limited extent across the summit. Traditionally they have been defined as features with an elevation of more than 1000m, although biologists also often refer to smaller features as seamounts as they are ecologically similar to larger features. A recent analysis based on satellite bathymetry estimated that there are >33,400 large seamounts and >138,400 smaller features covering an area of 17.2 million km^2 (Yesson *et al*., 2011). The remote location of many seamount regions has resulted in most studies on their biology being conducted in waters readily accessible from a few countries with large-budget research programmes. Thus, seamounts in temperate regions around the USA, Australia, New Zealand, and western Europe have been visited relatively frequently for research whereas those in more remote regions remain unexplored (Rogers *et al*., 2007). This is particularly true for the southern Indian Ocean (Rogers *et al*., 2007), which, unlike other oceans of the world, was also explored relatively little during the “heroic age” of deep-sea exploration. It was only during the Indian Ocean Expedition of 1962-1965 that deep-sea areas were extensively sampled. Since that time, deep-sea research in the Indian Ocean has largely focused on the Arabian Sea, and in general, the deep-sea ecosystems of the rest of the region remain poorly explored (Banse, 1994; Ingole & Koslow, 2005). The fauna inhabiting seamounts in the Indian Ocean are particularly poorly known and there is an urgent requirement to explore these ecosystems to complete the picture of the biodiversity and productivity associated with the Indian Ocean (Demopoulos *et al*., 2003). There have been limited studies of seamount geology and physical oceanography, but what little biological data exists come almost exclusively from the deep-sea fishing industry or from national fisheries research programmes prospecting for exploitable fish stocks (FAO, 2002; Romanov, 2003). It is symptomatic of this situation that up until recently the most detailed bathymetric charts of seamounts in the region are those generated by fishing companies (Shotton, 2006), and that the two major international scientific databases of seamount information held predicted bathymetries for only three seamounts in this region and few biological records (Seamounts Catalog www.earthref.org/databases/SC/main.htm; Seamounts Online www.seamounts.sdsc.edu). The southern Indian Ocean remains the most significant gap in current knowledge of global seamount ecology and biodiversity. This is not only of concern because of the possibly increasing levels of fishing within the region but also because of recent claims initiated by China for deep-sea mining targeted at the South West Indian Ocean Ridge (SWIOR).

3.2 Southwest Indian Ocean Ridge (SWIOR)

3.2.1 Geology

This major ocean ridge extends southwestwards from its junction with the Central Indian and Southeast Indian ridges, at approximately 25° S 75° E, to the region between South Africa and Antarctica where it is contiguous with the Mid-Atlantic Ridge (Fig. 1).

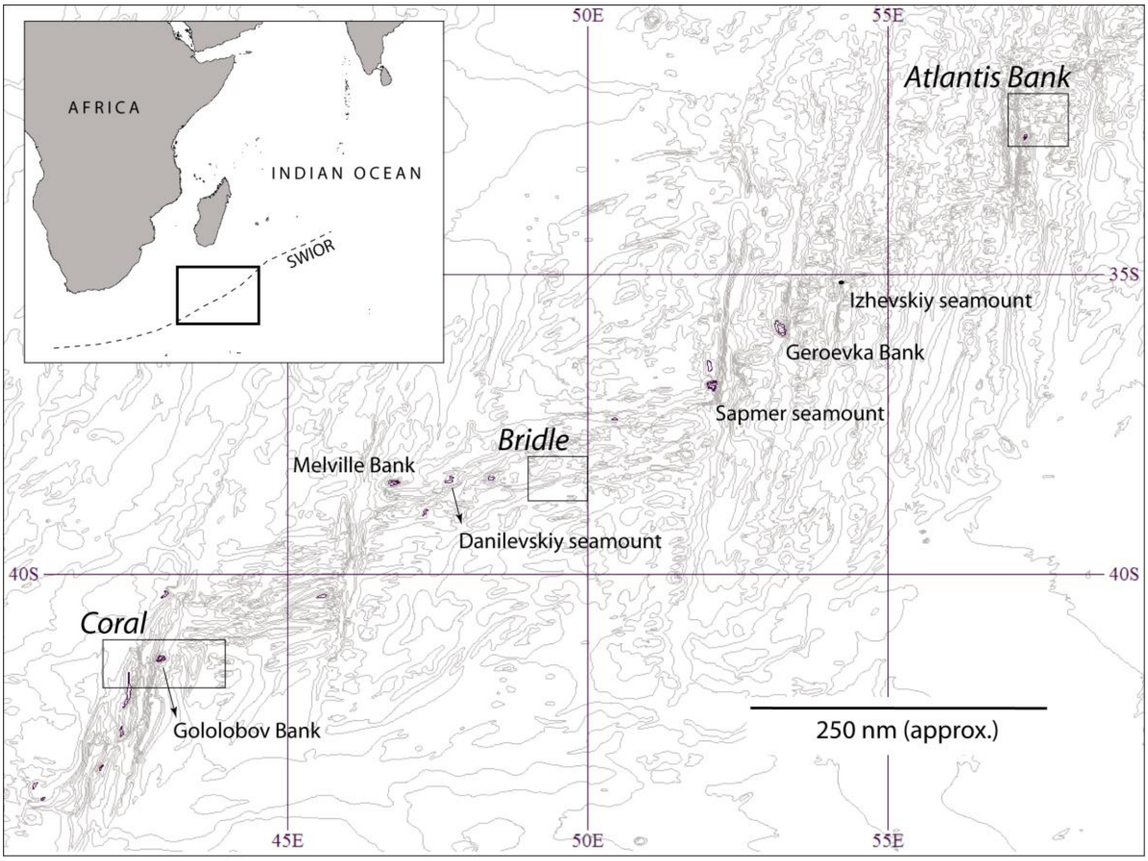

Figure 1. Southwest Indian ridge (inset – boxed area enlarged in main chart) showing proposed benthic protected areas (BPAs: boxed with names in italics) and features shallower than 1000 m in the area of the proposed study (1000 m and 500 m isobaths in black).

The NE part of the ridge lies beneath the centre of the South Indian Ocean Gyre in a region of weak currents and low primary production. Central and SW sections of the ridge, however, are influenced by higher current velocities and enhanced primary production resulting from upwelling in the region of turbulent mixing between the east-going Agulhas Return Current and the Southern Ocean circulation (Longhurst, 1995). Marked seasonal variation in primary production occurs in the region.

The South West Indian Ocean Ridge (SWIOR) has been subject to numerous geological investigations and was key to the discovery that ultraslow spreading ridges were distinct from slow and fast spreading ridges (Dick *et al*., 2003). One result of this is that rather than being formed of volcanic rock, parts of the ridge comprises large areas where mantle has been extruded onto the seafloor. Atlantis Bank, in particular, has been subject to intensive geological study and has been the subject of many scientific publications. However, the biological observations on this seamount have been confined to comments that Atlantis Bank was host to large populations of lobsters, crabs, sharks, sea fans, siphonophores and other “critters” (Dick, 1998). Side scan sonar imaging of the ridge has identified a number of different types of geological formations. These include flat-topped volcanoes, hummocky terrains (<500 m diameter sub-circular mounds) formed by flows of pillow lavas, and smooth flat areas formed of smooth lava flows or lava ponds, all of which may or may not be draped with sediment (Sauter *et al*., 2002). Such terrains are likely to provide a variety of attachment surfaces and niches for benthic fauna.

Hydrothermal vents were first observed on the Central Indian Ocean Ridge in 2000 (Hashimoto *et al.*, 2001; Van Dover *et al.*, 2001). This site comprised a fauna with affinities to western Pacific hydrothermal vent fields but with the addition of shrimps, *Rimicaris karei*, closely related to the visually dominant species at some Atlantic hydrothermal vents, *Rimicaris exoculata* (Komai *et al.*, 2007; Komai & Segonzac, 2008). Vent plumes were first identified along the South West Indian Ocean Ridge in 1997 (German *et al*., 1998) but the first vent has only just been discovered using an autonomous underwater vehicle (Tao *et al*., 2007). The vent field is located close to the Middle of What Seamount at a depth of ~2800 m. It includes black smokers, sulphide edifices and a fauna comprising stalked barnacles, anemones and gastropods. Because of its west-east orientation and continuity with other major ridge systems, there has been speculation that the SWIOR acts as a pathway for the dispersal of vent fauna, between the Atlantic, Indian, and Pacific oceans (German *et al*., 1998); a hypothesis of particular relevance to the CHESSO project, also recently funded by NERC, and which has resulted in the discovery of new hydrothermal vent communities in the Southern Ocean (Rogers *et al*., 2012). Add on cruise JC067, which took place part way through JC066, was aimed at exploring this vent field as part of the second NERC funded cruise to the Indian Ocean (see Copley, 2011 JC067 report).

3.2.2 Oceanography

The water circulation of the upper layers of the southern Indian Ocean is dominated by a Sub-Tropical Anticyclonic Gyre which is mainly located in the western half of the ocean (Demopolous *et al*., 2003; Sultan *et al*., 2007). The eastern extension of the gyre is mainly blocked by the South-East Indian Ocean Ridge, although some water penetrates further east to be blocked by the Ninety-East Ridge. Topographic constraints exerted by the Madagascar and South West Indian Ocean Ridges forces the separation of three small anticyclonic cells within the Sub-Tropical Anticyclonic Gyre, two to the east of the Madagascar Ridge and one between the Madagascar Ridge and South Africa (Sultan *et al*., 2007). The western boundary of the Sub-Tropical Anticyclonic Gyre is associated with a strong southward transport of water (~55Sv) associated with the Aghulas Current. This current retroflects eastwards as the Aghulas Return Current between 16^{o} and 20^{o}E to become the Aghulas Return Current (Lutjeharms & Van Ballegooyen, 1988). Through the region of the present investigation, the southern boundary of the Aghulas Return Current is marked by the Aghulas Front which lies to the north of the Sub-Tropical Front, to the south of which lies the Antarctic Circumpolar Current (ACC; Read *et al*., 2000). The Aghulas Front has the steepest density gradient of any in the Southern Ocean, is narrow, with an average width of only 96km, has a temperature of 21^{o}C – 15.7^{o}C, is optically clear and nutrient impoverished and is limited to about 40^{o}S (Read *et al*., 2000). The Aghulas Front can compress closely to the Sub-Tropical Front so the two are difficult to distinguish. The proximity of the Aghulas Return Current and the Sub-Tropical Front can lead to extreme temperature gradients (up to 1^{o}C per km; Read *et al*., 2000).

The Sub-Tropical Front forms the poleward boundary of warm salty water from the South Atlantic sub-tropical gyre (Read *et al*., 2000). It has a mean latitude of 41^{o}40'S (Lutjeharms & Valentine, 1984), although its north-south position varies considerably. It is associated with a marked gradient in temperature of up to 7^{o}C and salinity of up to 0.5‰ (Lutjeharms, 1985; Whitworth & Nowlin, 1987; Lutjeharms *et al*., 1993). It is a surface feature associated with the upper 300m of the water column and its position and shape are influenced by bottom topography (Weeks & Shillington, 1996).

Below the surface water layers in the regions to the north of the front (all but Coral Seamount and occasionally Melville Bank), Sub-Antarctic Mode Water is located in the thermocline. This water is ventilated in the Southern Ocean, north of the Sub-Antarctic Front, and is associated with a maximum in oxygen; it moves with the subtropical gyre (McDonagh *et al*., 2008). This water mass is found down to about 500m depth in the vicinity of the SWIOR. Below it occurs Antarctic Intermediate Water, which is also ventilated in the Southern Ocean, but is identified by a salinity minimum (McDonagh *et al*., 2008); this water reaches to about 1500m around the SWIOR. Underlying this water mass is Upper Deep Water which comprises mainly Indian deep water. It flows south and forms part of the Indian Ocean overturning circulation. It exhibits an oxygen minimum, high levels of inorganic nutrients (McDonagh *et al*., 2008), and penetrates to about 2000m depth.

The deep-water circulation of the region is quite different to the shallow circulation. Between 2000 and 3,500m depth modified North Atlantic Deep Water (NADW) flows into the Indian Ocean (McDonagh *et al*., 2008) along the African continental slope, up through the Mozambique Channel, and also around the southern SWIOR and Del Cano Rise (Fig. 2; Van Aken *et al*., 2004). In the northwestern part of the region the NADW flows up along the eastern slope of the Madagascar Ridge and then on over the Madagascar Ridge at about 35°S. An additional flow comes through the SWIOR via the Discovery Fracture Zone in the south (Van Aken *et al*., 2004). This water eventually forms Circumpolar Deep Water (McDonagh *et al*., 2008).

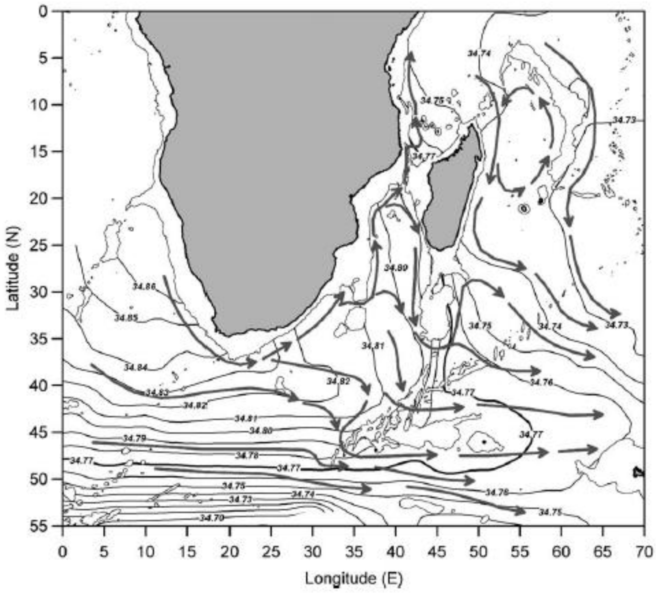

Figure 2. Deep-circulation in the SW Indian Ocean at 2000 – 3,500m depth (Van Aken *et al*., 2004).

Deeper still, the flow of Antarctic Bottom Water into the Indian Ocean is controlled by the SWIOR. The main flow, from the Enderby Basin into the Aghulas Basin, is over a saddle in the ridge between 20° and 30°E, probably via deep channels (>4,000m depth) in the ridge (Boswell & Smythe-Wright, 2002). This water continues to flow northwards between the gap between the Aghulas Plateau and SWIOR and then onto the Mozambique Channel. Another branch crosses the ridge at 35-36°S through the Prince Edward Fracture Zone whilst a third branch passes along the southern flank of the Del Cano Rise (Boswell & Smythe-Wright, 2002).

Overall, the SWIOR is set within an area where the Aghulas Return Current, the Sub-Tropical Front and the Sub-Antarctic Front, further to the south, create one of the most energetic and important hydrographic regions of the world (Read *et al*., 2000). The seamounts of the ridge lie within an area of complex biogeochemistry, phytoplankton composition and productivity associated with the transition from sub-tropical conditions to sub-Antarctic (Bathmann *et al*., 2000). The Sub-Tropical/Sub-Antarctic Front front is also thought to represent a major biogeographic boundary in the Southern Indian Ocean dividing two distinct faunal provinces (Vierros *et al*., 2009). In deeper water, the SWIOR acts as a major physical barrier to the flow of deep water masses and separates areas of deep-sea floor on the Enderby Abyssal Plain, the Aghulas Basin and the Crozet Basin.

3.2.3 Biology

Despite being an area of downwelling, the sub-tropical convergence within the region has been associated with elevated concentrations of phytoplankton and zooplankton compared to the seas to the north and south, and has been identified as a region important in carbon sequestration in the oceans (Llido *et al*., 2005). In the front peak chlorophyll concentrations of >1μg l^{-1} have been recorded with microphytoplankton making up a significant proportion (~10%) of total chlorophyll. Outside this region, with the exception of the sub-Antarctic Front, chlorophyll concentrations have been measured at <0.9μg l^{-1} and the phytoplankton assemblages may be dominated by nano- and picophytoplankton. It is thought that the accumulation of phytoplankton cells at the front, stability of the water column, and availability of nutrients (especially iron) may all contribute to elevated chlorophyll measurements (Lutjeharms *et al*., 1985; Weeks & Shillington, 1996). The enhanced primary productivity of the sub-tropical convergence zone occurs in intermittent pulses in spring and summer (Llido *et al*., 2005). Likewise, species diversity of microphytoplankton may also peak at the sub-tropical convergence as a result of mixing of species from different water masses and unique biochemical conditions which lead to a unique planktonic community that is poorly characterised, especially in regions away from continents (Barange *et al*., 1998; Longhurst, 1998; Richoux & Froneman, 2009). Recent stable-isotope studies have also demonstrated that planktonic foodwebs undergo significant changes across the sub-tropical covergence in response to differing availability of phytoplankton and smaller zooplankton size classes (Richoux & Froneman, 2009). Thus, seamounts along the SWIOR are likely to be in contrasting productivity regimes depending on their proximity to the sub-tropical convergence and the sub-Antarctic front. Advection of surface production to the benthos of seamounts will depend on the depth of the seamount summit and the current regimes around seamounts (Rowden *et al*., 2005; White *et al*., 2007).

The recent Global Open Oceans and Deep Seabed report classified the pelagic ecosystems of the South West Indian Ocean into several different regions: The Indian Ocean Gyre, The Aghulas Current, The Sub-Tropical Covergence and the Sub-Antarctic Region (Vierros *et al*., 2009). This biogeographic analysis was focused on the upper 200m of the water column and it was unknown how much it was likely to reflect the distribution of deeper pelagic communities, although it was felt that patterns would diverge from that at the surface with increasing depth (Vierros *et al*., 2009). The same classification identified the lower bathyal benthic fauna of the SWIOR as all falling into one biogeographic area, The Indian Ocean, the southern limit of which coincided with the Antarctic Convergence (Vierros *et al*., 2009). At present there are few data available to test this proposed scheme of biogeography but data on the pelagic biota was collected during the RV Dr Fridtjof Nansen cruise in 2009, as part of this project. This study indicated that communities of aquatic predators and birds change moving from north to south along the ridge, and there is also a striking change in communities of pelagic fish and zooplankton (Rogers *et al*. 2009).

Data on the diversity of biological communities of the southern Indian Ocean are sparse. More studies have been undertaken on Walter's Shoal, probably because the region is closer to land than the South West Indian Ocean Ridge, and because of interests in commercial fisheries in the region. Walter's Shoal was sampled during the Indian Ocean expedition in 1964 by the *R/V Anton Bruun* and subsequently by the *Vityaz*. These collections included a new endemic sub-species of crinoid, *Comanthus wahlbergi tenuibrachia* (Clark, 1972), prevalent in the shallow-waters of the shoal (Collette & Parin, 1991), and several crustaceans including an endemic species of alpheid shrimp (*Alpheus waltervadi*; Kensley, 1981) and an endemic isopod, *Jaeropsis waltervadi* (Kensley, 1975). Recently, an endemic species of rock lobster, *Palinurus barbarae*, has been described from the shoals following the landing of the species from commercial fishing vessels (Groeneveld *et al*., 2006). Collette and Parin (1991) described the fish fauna from ~400m depth to the surface on the shoal (summit depth approx. 15m) and identified 20 species of which several were potentially endemic undescribed species, several were widespread temperate or sub-tropical species and several were Indo-Pacific reef associated species. Biogeographic affinities of elements of the shallow fish fauna with Gough Island, Tristan da Cunha and St Pauls and Amsterdam Islands (West Wind Drift Islands) were identified, particularly in the occurrence of species such as *Helicolenus mouchezi*, *Trachurus longimannus* and *Serranus novemcinctus* (Collette & Parin, 1991). Others are found in Australia and New

Zealand (*Acantholatris monodactylus*, *Lepidoperca coatsii*, *Nelabrichthys ornatus*). *Helicolenus mouchezi* and possibly several other species from Walter's Shoal also occur on the South West Indian Ocean Ridge. The implication here is that the Sub-Tropical Anticyclonic Gyre and Antarctic Circumpolar Current and/or other westerly flowing currents have assisted in transoceanic dispersal of these species, with islands and seamounts acting as stepping stones. Russian exploration of the Madagascar Ridge in the search of fisheries resources identified: dories (Oreosomatidae), sharks, *Alepocephalus* sp., *Beryx* sp., Macrouridae, Moridae, *Plagiogeneion rubiginosum*, *Polyprion americanus*, *Polyprion oxygeneios*, *Pseudopentaceros richardsoni*, scabbard fish, Scorpaenidae, *Trachurus longimannus*, tuna, Uranoscopidae.

Vereshchaka (1995) summarised several investigations on the macroplankton occurring on slopes and seamounts in the Indian Ocean. The paper lists a large number of taxa as occurring on Walter's Shoal including: Mysidacea - *Gnathophausia ingens*, *G. gracilis*, *Siriella thompsoni*, *Euchaetomera typica*, *E. glythidophthalmica*, *Metamblyops macrops*; Euphausiacea – *Thysanopoda monacantha*, *T. tricuspidata*, *T. aequalis*, *T. obtusifrons*, *T. pectinata*, *T. orientalis*, *T. egregia*, *Nematobrachion flexipes*, *N. boopis*, *Euphausia recurva*, *E. diomedeae*, *E. mutica*, *E. similis*, *E. spinifera*, *E. hemigibba*, *E. paragibba*, *E. pseudogibba*, *Thysanoessa gregaria*, *Nematoscelis megalops*, *N. microps*, *N. atlantica*, *N. gracilis*, *N. tenella*, *Stylocheiron carinatum*, *S. affine*, *S. suhmi*, *S. longicorne*, *S. elongatum*, *S. abbreviatum*, *S. maximum*; Decapoda – *Funchalia villosa*, *Gennadas parvus*, *G. propinquus*, *G. scutatus*, *G. bouvieri*, *G. incertas*, *G. tinnayrei*, *G. gilchristi*, *Sergestes corniculum*, *S. disjunctus*, *S. atlanticus*, *S. sargassi*, *S. pectinatus*, *S. armatus*, *S. orientalis*, *Sergia prehensilis*, *Sergia scintillans*, *Sergia splendens*, *Sergia grandis*, *Sergia laminata*, *Lucifer typus*, *Pasiphaea natalensis*, *Acanthephyra quadrispinosa*, *Notostomus elegans*, *Oplophorus spinosus*, *O. novaezelandiaea*, *Systellaspis debilis*, *S. guillei*, *Stylopandalus richardi*; Larvae – *Penaeus* sp., *Solenocera* sp., *Gennadas* sp., *Sergestes* sp., *Acanthephyra* sp., Palaemoninae, Pontoniinae, Pandalidae, Nematocarcinidae, *Lysmata* sp., *Alpheus* sp., *Pontophilus* sp., *Stenopus* sp., *Panulirus* sp., *Jasus* sp., *Scyllarides* sp., Paguridae, *Galathea* sp., *Callianassa* sp., *Homola* sp., Dromiidae, *Albunea* sp., Cancridae, Majidae, Calappidae, Brachyura, *Amphionides reynaudi*. These animals fall into two distinct groups: species that were associated mainly with the water column and decrease in number towards the seabed, and those that are associated with the seabed. The latter group fall into several categories including: animals that are found near the seabed at night but disappear by day, presumably because they migrate to benthic habitats during daylight hours; animals found well above the seabed by night and descend to the seabed by day; larval animals which are found mainly over areas of seabed inhabited by adults (Vereshchaka, 1995).
The RV *Dr Fridtjof Nansen* Cruise in 2009 sampled zooplankton, micronekton and nekton including invertebrates using a combination of nets. These samples are still being worked upon but analyses of the micronekton communities indicates that although there is no latitudinal pattern in species richness, community composition is influenced by the presence of seamounts and water mass (Letessier *et al*., In prep.). The cephalopod fauna of the SWIOR was also found to be particularly rich in this region (Lapitovski *et al*., In prep.).

Investigations of fish resources of Indian Ocean high seas areas were undertaken by Soviet research vessels and exploratory fishing vessels from the 1960s to 1998. Whilst detailed information is not available, data on the fish species present on the SWIOR has been published. The following species were identified as being present: *Alepocephalus* sp., *Antimora rostrata*, *Beryx splendens*, *Beryx decadactylus*, *Centrolophus niger*, Chauliodontidae, *Dissostichus eleginoides*, *Electrona carlsbergi*, *Epigonus* spp., Gonostomatidae, *Helicolenus mouchezi*, *Hyperoglyphe antarctica*, *Lepidopus caudatus*, *Macrourus carinatus*, Myctophidae, *Nemadactylus macropterus*, *Neocyttus rhomboidalis*, *Notothenia squamifrons*, *Plageogeneion rubiginosum*, *Polyprion americanus*, *Polyprion oxygeneios*, *Promethichthys prometheus*, *Pseudopentaceros richardsoni*, rays, *Ruvettus pretiosus*, *Schedophilus huttoni*, *Schedophilus maculatus*, *Schedophilus velaini*, sharks, and *Trachurus longimannus* (Romanov, 2003). A more extensive species list is given in Romanov (2003) but this list is for all the seamounts sampled in the Indian Ocean from 1969-1998. It was noted that seamounts on the SWIOR showed a marked variation in the fish present. For example, pelagic armourhead, *Pseudopentaceros richardsoni*, was only caught in commercial quantities on Seamount 690 (Romanov, 2003), which corresponds in position to Atlantis Seamount. The species has also been found on Sapmer Seamount (López-Abellán *et al*., 2008). Some of the species listed are exclusively Antarctic / Sub-Antarctic and so probably occur further south than the seamounts sampled on the present expedition. The RV *Dr Fridtjof Nansen* cruise sampled the pelagic fish communities along the SWIOR and to date 60 species have been identified (Rogers *et al*. 2009) with work on further identification continuing at this time (December, 2011).

As, with invertebrates and fish, knowledge of the distribution of aquatic predators, including cetaceans and birds in the region are sparse. There have been sightings of concentrations of humpback whales in the vicinity of Walter's Shoal (e.g. Collette & Parin, 1991; Shotton, 2006), suggesting that it may be an important migratory area between high latitude feeding grounds and low latitude breeding grounds off Madagascar. There are reports of pilot whales, humpback whales and sperm whales in the areas of deep-water fishing in the Southern Indian Ocean although it is not clear where these were (Shotton, 2006). This would seem to be confirmed by the sea mammal sightings during the RV *Dr Fridtjof Nansen* cruise during which sperm whales, humpback whales and short-finned pilot whales were encountered although there were possible sightings of blue whales and fin whales as well (Rogers *et al*., 2009).

Shotton (2006) report that sightings of birds are rare in the fishing areas and these were rarely seen north of 35^{o}S. White chinned petrels (*Procellaria aequinoctialis*) had been reported as occurring in areas of deep-water fishing and cape pigeons (*Daption capense*) and sooty shearwaters (*Puffinus griseus*) were reported as being observed from fishing vessels (Shotton, 2006). Bird observations taken from a cruise between La Réunion, Crozet, Kerguelen, St. Paul, Amsterdam Islands, and Perth, Western Australia identified 51 species of birds from over 15,000 sightings (Hyrenbach *et al*., 2007). During this cruise the density of birds increased significantly across the sub-tropical convergence from 2.4 birds km^{-2} in sub-tropical waters to 23.8 birds km^{-2} in sub-Antarctic waters. The taxonomic composition of birds also differed markedly in the 3 areas, with prions (*Pachyptila* sp.) accounting for 57% of all sub-Antarctic birds, wedge-tailed shearwaters (*Puffinus pacificus*) accounting for 46% of all subtropical birds, and Indian Ocean yellow-nosed albatross (*Thallasarche carteri*) accounting for 32% of all birds in the sub-tropical convergence zone (Hyrenbach *et al*., 2007). Given that this cruise transited part of the SWIOR it would seem likely that significant numbers of seabirds are present in the vicinity of the seamounts, particularly in the more southerly areas. This was confirmed during the RV *Dr Fridtjof Nansen* cruise in 2009 where 37 species were identified along the cruise track including a variety of prions, petrels, albatrosses, fulmars and terns were observed. These birds formed three distinct communities from sub-Antarctic, sub-tropical and tropical waters (Rogers *et al*., 2009).

3.2.4 Benthic protected areas

In the early 1990s a commercial deep-water trawl fishery was developed on the SWIOR by fleets from several countries. At its peak in 2000 to 2001 at least 40 vessels were engaged in the fishery but in 2006 only 4 remained, indicating a dramatic decline in populations of the target species. In July 2006, the remaining companies involved in the fishery, under the aegis of the Southern Indian Ocean Deep-Water Fisheries Operators Association (SIODFA), in consultation with the Food and Agricultural Organisation of the UN (FAO), announced a unilateral proposal to establish 10 benthic protected areas (BPAs) in the southern Indian Ocean. This initiative was launched to conserve deep-sea marine benthic biodiversity and was a response to pressure from NGOs for a global ban on deep-sea bottom trawling. There are precedents in New Zealand, Australia, North America, and the Atlantic for the establishment of BPAs on seamounts and cold-water coral reefs previously subject to trawling. However, this proposal was unique in that the areas in question were in international waters, span a much greater geographical range than previous initiatives, and have been initiated by the fishing industry. It is critical to evaluate the effectiveness of the proposed BPAs in conserving habitats and species representative of the seamounts along the SWIOR. Collaboration with the FAO and the fishing industry therefore formed a significant aspect of the original proposal for this project and a joint proposal to the Global Environment Facility with IUCN. This project therefore represents an important opportunity to study the impact of fisheries disturbances on deep-water benthic assemblages on seamounts at the same time as gathering fundamental benthic biodiversity data from a currently unstudied region.

3.2.5 Modelling seamount biodiversity

As a result of the lack of knowledge on the distribution of fauna on seamounts, especially vulnerable, habitat-forming corals, studies modelling global habitat suitability for Scleractinia and Octocorallia have recently been undertaken (Tittensor *et al.,* 2009; Davies & Guinotte, 2011; Yesson *et al.*, In press). These studies have used two approaches to modeling coral distribution on seamounts from presence data, Environmental Niche Factor Analysis (ENFA) and Maximum Entropy modeling. These models use different approaches; the first essentially representing a multivariate approach to modeling, the second uses the simplest possible model to explain the observed data. The data in this case are coral presence records and the ocean environmental parameters including depth, aragonite saturation, calcite saturation, dissolved oxygen concentration, temperature, primary production, nutrient concentrations and current speed. These models originally produced depth-stratified predictions of areas most favourable to the growth of corals (e.g. Tittensor *et al*., 2009) but now use an approach whereby high resolution satellite bathymetry data is incorporated with other physical datasets to model the actual environmental parameter values on the seabed (Davies & Guinotte, 2011). The SW Indian Ocean, from the surface down to 2500 m, emerged as being one of the most favourable habitats for stony corals in the world (Figs 3, 4).

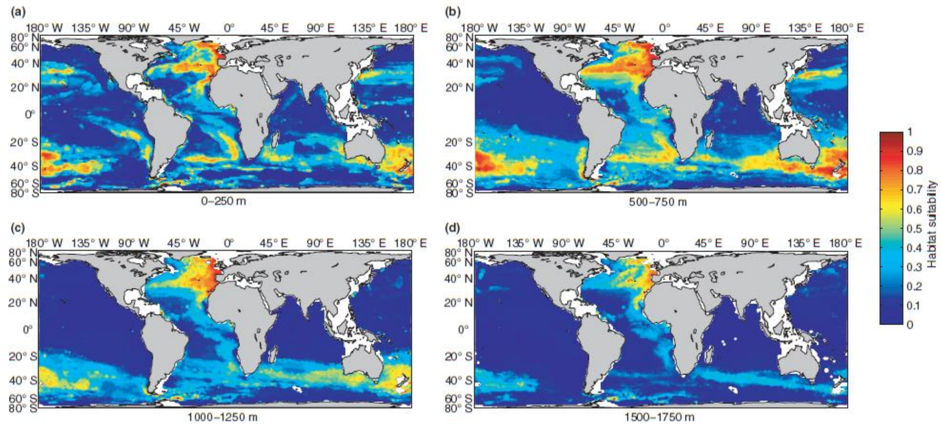

Figure 3. Map of global habitat suitability for Scleractinia created using Maximum Entropy modeling (Tittensor *et al*., 2009)

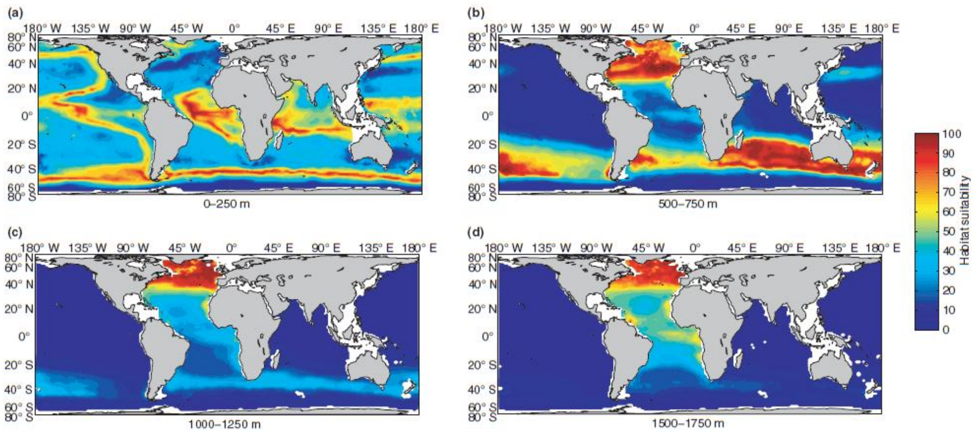

Figure 4. Map of global habitat suitability for Scleractinia created using Environmental Niche Factor Analysis (Tittensor *et al*., 2009)

For the proposed study area on the SWIOR, the model predicts both horizontal and vertical gradients in the occurrence of corals: at 500 m depth conditions are more favourable in the NE; below 1000 m, however, there is an increasing trend with depth for the SW section to be more favourable (Figs 3,4). When this cruise was proposed we hypothesised that cold-water scleractinian corals would be abundant in the study area, and their depth distribution will follow a gradient from more shallow habitats in the NE of the region, to deeper habitats in the SW.

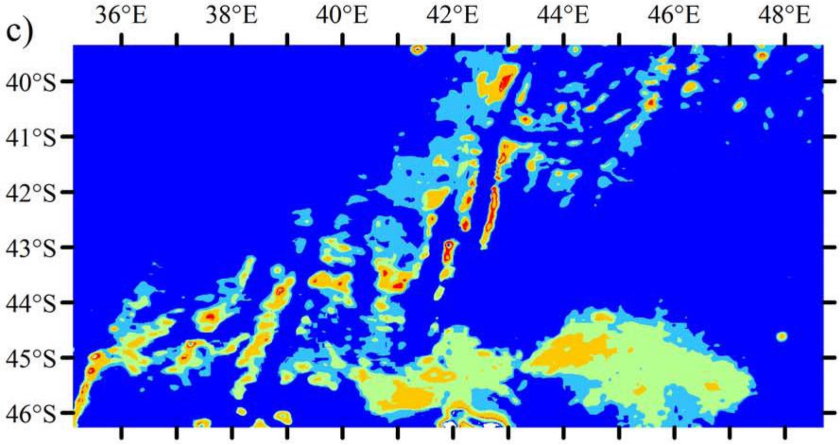

Figure 5. Modelled distribution for *Solenosmilia variabilis* using Maximum Entropy, 30-arc second bathymetry and environmental parameters estimated at the seafloor (Davies & Guinotte, 2011).

Higher resolution models now available have made it possible to predict the exact topographic features that should host cold water coral ecosystems (Fig. 5), including for octocorallia (Fig. 6). Again the present cruise provided a good opportunity to assess the effectiveness of these models.

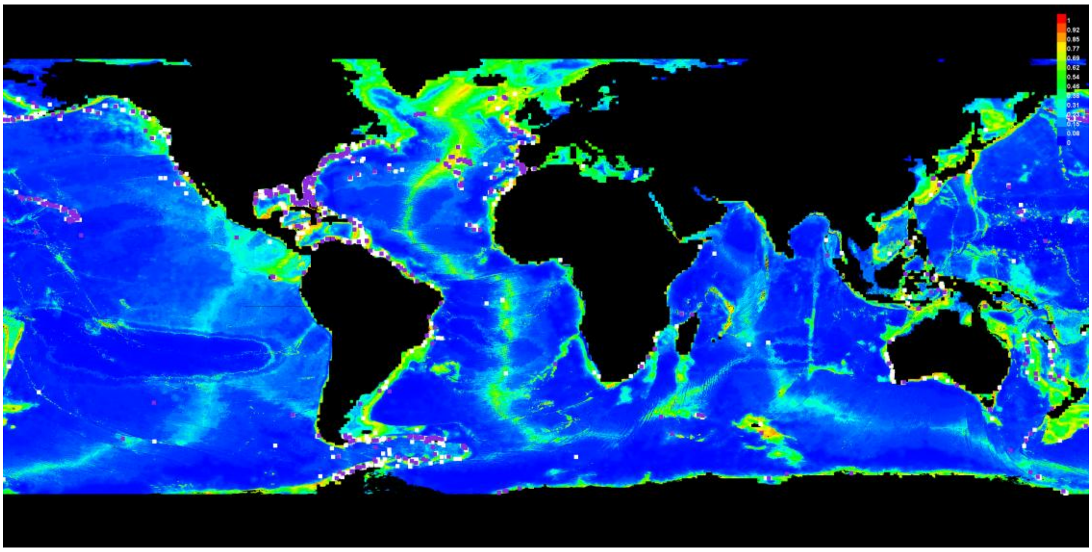

Figure 6. Predicted habitat suitability for Calcaxonia in the global deep ocean (Yesson *et al.,* In press).

Models of habitat suitability have also predicted that coral distribution is strongly influenced by the aragonite saturation depth: that is, the depth below which aragonite dissolves. If the predictions of this model are supported, they will have major implications for the future distribution of these corals in relation to increases in atmospheric CO_2 levels. Hard corals build their skeletal structure from aragonite; a metastable form of calcium carbonate ($CaCO_3$) in equilibrium with other carbonate species in seawater. Formation of aragonite depends on carbonate ions (CO_3^{2-}) being at saturation in the water column. This concentration is strongly influenced by pH which is affected by levels of dissolved CO_2. Post-industrial increases in atmospheric CO_2 are raising the concentration of dissolved CO_2 in the oceans and as a consequence the pH of seawater is decreasing (Orr *et al*., 2005). This increasing acidity lowers the concentration of carbonate ions and as a result the aragonite saturation horizon is predicted to become shallower as atmospheric CO_2 levels increase (Orr *et al*., 2005; Tittensor *et al*., 2010). If the study proposed here confirms the predicted present-day distribution of cold water corals, it would be strong evidence in support of predictions that there will be significant range shifts through the 21st Century resulting from increased anthropogenic CO_2 emissions (Tittensor *et al*., 2010).

3.2.6 Productivity, currents, and distributions

The predictions of coral distribution arising from habitat suitability modeling are consistent with our knowledge of the surface productivity and oceanography of the SW Indian Ocean. Satellite sea-surface colour indicate that there is a strong and consistent gradient of primary productivity across the study area in which production is greatest in the SW and declines with distance along the SWIOR to the NE (Longhurst *et al*., 1995; see also http://daac.gsfc.nasa.gov/oceancolor/scifocus/space/ocdst_indian_ocean_monsoon.shtml for CZCS image). This gradient is paralleled by a gradient in mean surface current speed, where strong east-going currents in the SW of the region give way to weaker and more variable currents in the NE. Because the growth of sessile suspension-feeding taxa is favoured in areas of strong currents with high primary productivity, these gradients have implications for the predicted distributions of epifaunal assemblages.

While the study of the sediment-dwelling infaunal assemblages of seamounts has lagged behind that of the epifauna, studies in the Pacific have shown that they are also affected by hydrodynamic gradients (Levin *et al*., 1991; Levin & Thomas, 1989; Thistle & Levin, 1998; Thistle *et al*., 1999). In areas of strong currents, abundance and diversity are reduced. Productivity also can enhance local diversity of infaunal sediment dwelling groups. The gradients of physical disturbance and productivity along the SWIOR provide an opportunity to test predictions from Huston's General Equilibrium Model (Huston *et al.,* 1995) for the dominant infaunal groups - nematodes and polychaetes. In areas of higher productivity and physical disturbance the sediment dwelling communities should have lower diversity than more quiescent sites. Existing oceanographic data enable us to order the sites along the axes of Huston's model. Thus, we hypothesise that sampling locations in the SW of the study area will have more abundant and diverse benthic epifaunal assemblages but that infauna will be reduced while the reverse would be the case on those seamount locations further to the NE. This, in turn, has implications for the relative importance of different BPAs in terms of biodiversity conservation; areas in the SW, potentially harbouring higher diversity in epifauna but lower diversity in infaunal groups, while those in the NE may reflect the opposite. However, coral distribution and that of other elements of the seamount fauna may well be influenced by local-scale current topography interactions that are below the scale of the modelling studies and physical observations carried out to date. Thus an alternative situation where patterns of species richness and abundance of corals and associated communities are less predictable may exist.

This study will also provide an opportunity to test an important aspect of seamount ecology. Studies of the benthic fauna of seamounts have reported the occurrence of many new species leading to a general view that seamount faunas are highly endemic (e.g. Richer de Forges *et al*., 2000). This suggests that seamount populations can be reproductively isolated, leading to speciation *in situ*. If this is the case, gene flow between populations on neighbouring seamounts has to be restricted. An alternative hypothesis has been postulated for the meiofaunal elements suggesting that chains of seamounts may act as stepping-stones such that there should be a more uniform fauna, albeit undescribed. However, recent observations have suggested that levels of endemism on seamounts may be a lot lower than previously suspected and that in general their fauna reflects the regional species pool. Thus, in the original proposal for which JC066 was funded, one of the aims was to compare the genetic relatedness of populations of selected species across the study area in order to estimate the frequency and direction of exchange between them. The linear nature of the ridge system, and the predominantly east-going currents in the study area, suggest that there will be faunal connections between the benthic assemblages along its length, and that most dispersal will be from west to east. There are, however, several fracture zones running north to south across the ridge system including the Atlantis II, Gauss, Gazelle, Gallieni and Indomed and it is possible that locally-modified currents around these features might affect dispersal, or even isolate sections of the ridge from each other, as has been found in hydrothermal vent communities.

4 RRS *James Cook* Cruise JC066

RRS *James Cook* cruise JC066 is the second of two cruises, the first being a cruise to study the pelagic ecosystems of the SWIOR on the NORAD EAF-Nansen Project supported cruise on their vessel, the RV *Fridtjof Nansen*. This first cruise was part of a UNDP (United Nations Development Programme)/IUCN (International Union for the Conservation of Nature), project funded by GEF (Global Environment Facility)[1] and the ASCLME (Aghulas and Somali Current Large Marine Ecosystem) Project. It concentrated on investigating the pelagic biology, physical oceanography, avifauna and cetacean activity around seamounts of the South West Indian Ocean Ridge (Rogers *et al.,* 2009). During the Nansen cruise two whale bone and wood moorings were also deployed to study the fauna invading these types of organic food falls in the region for the first time. The present cruise was sponsored by NERC (Natural Environment Research Council) and focused on sampling and recording the benthic ecosystems on five seamounts along the South West Indian Ocean Ridge, Coral Bank, Melville Bank, Middle of What Seamount, Sapmer Bank and Atlantis Bank. An add-on cruise, JC067, PSO Dr Jon Copley, University of Southampton also took place; this was aimed at collecting the fauna from the Dragon hydrothermal vent site close to Middle of What Seamount. The objectives of the cruise were to:

- Obtain high-resolution multibeam sonar maps of each site.
- At each seamount use an ROV to undertake eight transects arranged in a "starburst" pattern centred on the seamount peak and extending from the base of the seamount (or the operational depth limit of sampling gear) to its summit.
- During each transect undertake continuous video recording and also take high resolution stills images: 1) at each 100m depth increment; 2) where there are noticeable habitat changes; 3) where an image would aid species identification or where benthic biodiversity is especially high.
- Undertake further ROV dives for specimen collection during which samples will be taken of selected epifaunal species for identification, and 'blade' corers will be used to take sediment samples for macro- and meio-infauna.
- Preliminary evaluation of transect videos, along with multibeam and SWATH data, will identify areas that do not host fragile epibenthic communities (e.g. coral habitat). These areas, primarily soft sediments, were to be subject to trawl or dredge sampling for megafauna.
- Box core and megacore deployments were to be used to sample the macrofauna and meiofauna. Sediment cores will be sectioned at 0.5cm depth intervals in the top 1cm and then 1cm intervals for the rest of the core and sieved on 500 µm, and 48 µm meshes for macro- and meio- infauna. Retained material will be preserved in buffered formalin for preservation of morphological features in fragile organisms, such as polychaetes, and in DESS solution for morphological and molecular analysis.
- Oceanographic and productivity measurements will be made during the cruise, using CTD castes although the bulk of work on pelagic biology was to be undertaken on the RV *Dr Fridtjof Nansen* cruise funded by the FAO and the World Bank.

Originally it was planned to use the UK's *Isis* ROV system to undertake most of the benthic work for JC066. This plan was changed following an accident with the *Isis* ROV on RRS *James Cook* Cruise JC055 which

[1] Applying an ecosystem-based approach to fisheries management: focus on seamounts in the Southern Indian Ocean; GEF Project ID 3657.

resulted in the partial destruction of the vehicle. Following a decision not to immediately repair the *Isis* ROV an alternative vehicle was sourced by NERC NMF-SS, the *Kiel 6000* ROV system.

Figure 7. IFM Geomar *Kiel 6000* ROV system being recovered on *James Cook* Cruise JC066. Photography © Philipp Boersch-Supan.

As a result of the limitation of this vehicle to 12-hour operations two towed camera systems were also taken on the cruise: SHRIMP (Seabed High Resolution Imaging Platform) and HYBIS. HYBIS is equipped with several cameras but also is equipped with a grab system originally designed to take rock samples.

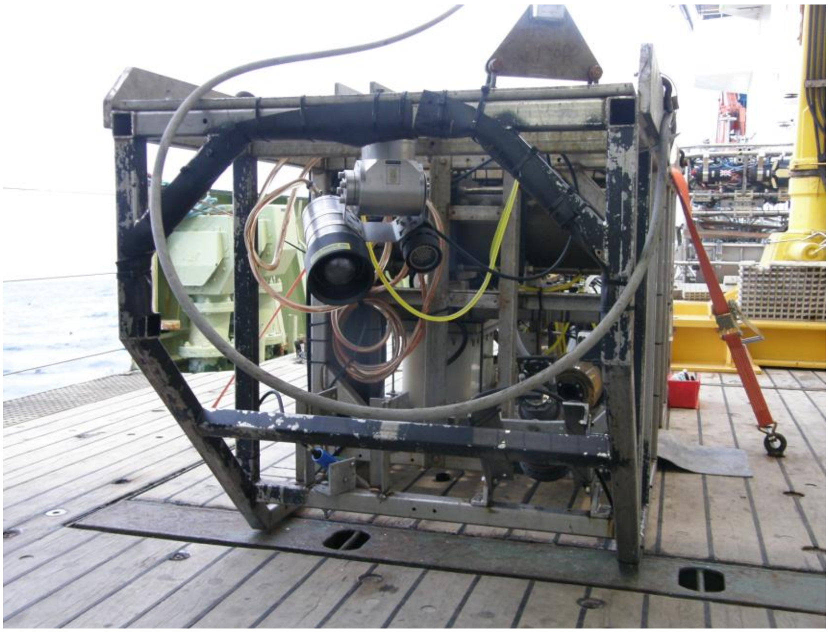

Figure 8. SHRIMP (Seabed High Resolution Imaging Platform) towed camera system. Photograph © Dr Jane Read, NERC.

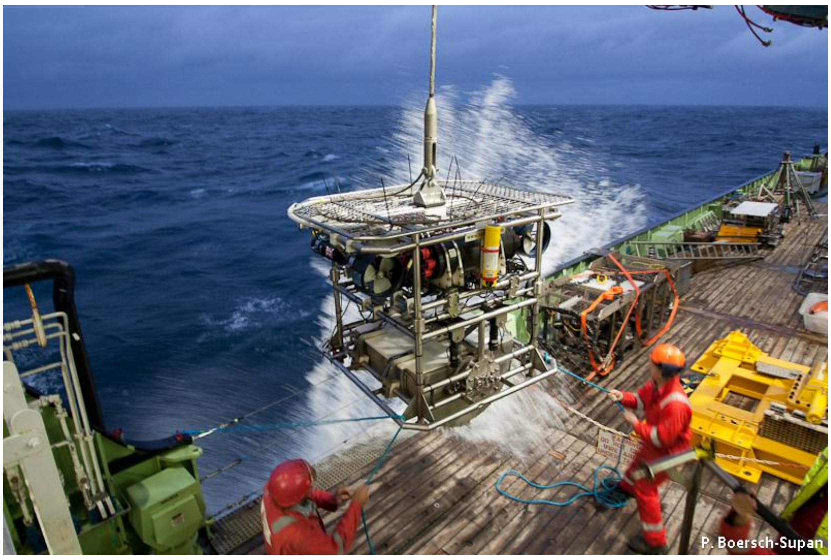

Figure 9. HYBIS towed camera and grab system being recovered on James Cook Cruise JC055. Photograph © Philipp Boersch-Supan.

4. Overview of *James Cook* Cruise JC066

4.1 Timetable of events

Date	Julian Day	Time (GMT)	Position Latitude	Longitude	Station	Event	Equipment	Operation
07/11/11	311	12.00	33° 54.2429'S	18° 25.405'E	-	-		Ship leaves Cape Town
07/11/11	311	13.26	33° 53.7734'S	18° 14.6799'E	1	1	CTD+SVP	CTD+SVP for acoustic 07 calibration
07/11/11	311	14.08	33° 53.7740'S	18° 14.6742'E	1	1	CTD+SVP	CTD in water
07/11/11	311	14.17	33° 53.7736'S	18° 14.6751'E	1	1	CTD+SVP	CTD stopped at 99.5m
07/11/11	311	14.19	33° 53.7736'S	18° 14.6751'E	1	1	CTD+SVP	Firing Niskin bottles
07/11/11	311	14.23	33° 53.7738'S	18° 14.6740'E	1	1	CTD+SVP	CTD hauling in
07/11/11	311	14.29	33° 53.7731'S	18° 14.6734'E	1	1	CTD+SVP	CTD on deck
07/11/11	311	15.25	33° 53.7123'S	18° 14.712'E	1	2	Calibration sphere	EK60 Calibration deployment of sphere
07/11/11	311	16.35	33° 53.72'S	18° 14.82'E	1	2	Calibration sphere	Sphere in place
07/11/11	311	23.13	33° 53.8'S	18° 15.0'E	1	2	Calibration sphere	Calibration complete
07/11/11	311	23.39	33° 53.8692'S	18° 15.2014'E	2	1	EM120 & EM710	EM120 & EM710 on for geophysical survey of SA EEZ
07/11/11	311	23.42	33° 53.8'S	18° 15.0'E	2	-		Steam towards Coral Bank
09/11/11	313	01.00	36° 10.0'S	22° 57.9'E				Clocks advanced 1 hour to GMT+3
09/11/11	313	06.12	36° 37.0263'S	24° 41.8362'E	3	1	Clump weight	Core wire test
09/11/11	313	10.22	36° 37.0263'S	24° 41.8362'E	3	1	Clump weight	Weight at surface
09/11/11	313	10.24	36° 37.0263'S	24° 41.8362'E	3	1	Clump weight	Weight on deck
09/11/11	313	14.24	36° 37'S	24° 41.8'E	-	-		Resumed passage to Coral
11/11/11	315	01.00	39° 14.3'S	34° 38.3'E	-	-		Clocks advanced 1 hour to GMT+4
12/11/11	316	03.45	41° 20.83'S	42° 55.47'E	4	-		Arrive Coral Bank
12/11/11	316	04.00	41° 20.785'S	42° 55.435'E	4	1	CTD+SVP	CTD in water
12/11/11	316	04.44	41° 20.785'S	42° 55.435'E	4	1	CTD+SVP	CTD at 1250m start haul
12/11/11	316	05.29	41° 20.785'S	42° 55.435'E	4	1	CTD+SVP	CTD at surface
12/11/11	316	05.31	41° 20.785'S	42° 55.435'E	4	1	CTD+SVP	CTD on deck
12/11/11	316	06.06	41° 20.708'S	42° 55.292'E	4	2	ROV	ROV in water
12/11/11	316	15.50	41° 20.99'S	42° 55.12'E	4	2	ROV	ROV on surface
12/11/11	316	16.00	41° 20.99'S	42° 55.12'E	4	2	ROV	ROV out of water
12/11/11	316	16.02	41° 20.99'S	42° 55.12'E	4	2	ROV	ROV on deck
12/11/11	316	16.02	41° 20.99'S	42° 55.12'E	4	-	-	Transit to SHRIMP site
12/11/11	316	17.30	41° 28.1222'S	42° 54.33'E	4	3	SHRIMP	SHRIMP in water
13/11/11	317	04.22	41° 24.57'S	42° 52.82'E	4	3	SHRIMP	SHRIMP at surface
13/11/11	317	04.24	41° 24.57'S	42° 52.82'E	4	3	SHRIMP	SHRIMP on deck
13/11/11	317	04.24	41° 24.57'S	42° 52.82'E	4	-	-	Transit to ROV site
13/11/11	317	04.50	41° 22.8'S	42° 50.6'E	4	-	-	Arrive at ROV site
13/11/11	317	05.31	41° 22.8371'S	42° 50.6024'E	4	4	ROV	ROV in water
13/11/11	317	15.40	41° 22.85'S	42° 51.59'E	4	4	ROV	ROV at surface
13/11/11	317	16.10	41° 22.88'S	42° 51.68'E	4	4	ROV	ROV out of water
13/11/11	317	16.14	41° 22.88'S	42° 51.68'E	4	4	ROV	ROV out of water
13/11/11	317	16.18	41° 22.88'S	42° 51.68'E	4	-	-	Transit to net site
13/11/11	317	17.06	41° 22.6'S	42° 48.8'E	4	-	-	At net site
13/11/11	317	17.16	41° 22.65'S	42° 48.8933'E	4	5	Ring net	Ring net deployed
13/11/11	317	17.17	41° 22.65'S	42° 48.8933'E	4	5	Ring net	Ring net in water
13/11/11	317	18.18	41° 22.6'S	42° 48.1'E	4	5	Ring net	Net at 1500m wire out
13/11/11	317	18.23	41° 22.6'S	42° 48.1'E	4	5	Ring net	Begin hauling net
13/11/11	317	19.21	41° 22.6'S	42° 46.8'E	4	5	Ring net	Net out of water
13/11/11	317	19.24	41° 22.6'S	42° 46.8'E	4	5	Ring net	Net on deck
13/11/11	317	19.24	41° 22.6'S	42° 46.8'E	4	-	-	Transit to megacore site
13/11/11	317	20.54	41° 28.1'S	42° 54.32'E	4	-	-	Arrive megacore site
13/11/11	317	20.57	41° 28.1'S	42° 54.3166'E	4	6	Megacore	Megacore in water
13/11/11	317	22.01	41° 28.1'S	42° 54.3166'E	4	6	Megacore	Megacore triggers 1508m
13/11/11	317	22.50	41° 28.1'S	42° 54.3166'E	4	6	Megacore	Megacore at surface
13/11/11	317	23.06	41° 28.1'S	42° 54.3166'E	4	6	Megacore	Megacore on deck
13/11/11	317	23.18	41° 28.1'S	42° 54.3166'E	4	7	Megacore	Megacore in water
14/11/11	318	01.05	41° 28.1'S	42° 54.3166'E	4	7	Megacore	Megacore in at surface
14/11/11	318	01.07	41° 28.1'S	42° 54.3166'E	4	7	Megacore	Megacore on deck
14/11/11	318	01.07	41° 28.1'S	42° 54.3166'E	4	-	-	Transit to megacore site
14/11/11	318	01.48	41° 26.37'S	42° 53.71'E	4	-	-	Arrive at megacore site
14/11/11	318	01.55	41° 26.3770'S	42° 53.7131'E	4	8	Megacore	Megacore in water
14/11/11	318	02.32	41° 26.3770'S	42° 53.7131'E	4	8	Megacore	Megacore triggers 1070m

14/11/11	318	03.10	41° 26.3770’S	42° 53.7131’E	4	8	Megacore	Megacore at surface
14/11/11	318	03.12	41° 26.3770’S	42° 53.7131’E	4	8	Megacore	Megacore on deck
14/11/11	318	03.12	41° 26.3770’S	42° 53.7131’E	4	-	-	Transit to ROV site
14/11/11	318	04.25	41° 21.02’S	42° 55.15’E	4	-	-	At ROV dive site
14/11/11	318	05.02	41° 21.0283’S	42° 55.145’E	4	9	ROV	ROV in water
14/11/11	318	06.30	41° 21.0283’S	42° 55.145’E	4	9	ROV	ROV at seabed
14/11/11	318	06.48	41° 21.0283’S	42° 55.145’E	4	9	ROV	Difficulty in moving ROV
14/11/11	318	07.00	41° 21.0283’S	42° 55.145’E	4	9	ROV	ROV investigating problem
14/11/11	318	08.30	41° 21.07’S	42° 53.24’E	4	9	ROV	ROV at surface
14/11/11	318	08.48	41° 21.0283’S	42° 55.145’E	4	9	ROV	ROV submerged again
14/11/11	318	17.05	41° 21.7’S	42° 54.8’E	4	9	ROV	ROV on surface
14/11/11	318	17.20	41° 21.7’S	42° 54.8’E	4	9	ROV	ROV out of water
14/11/11	318	17.23	41° 21.7’S	42° 54.8’E	4	9	ROV	ROV on deck
14/11/11	318	17.23	41° 21.7’S	42° 54.8’E	4	-	-	Transit to multiprofiler position
14/11/11	318	18.37	41° 25.3’S	42° 50.7’E	4	-	-	At multiprofiler position
14/11/11	318	18.39	41° 25.33’S	42° 50.575’E	4	10	Multiprofiler	Multiprofiler in water
15/11/11	319	07.45	41° 25.3’S	42° 50.7’E	4	10	Multiprofiler	Multiprofiler at surface
15/11/11	319	07.55	41° 25.3’S	42° 50.7’E	4	10	Multiprofiler	Multiprofiler on deck
15/11/11	319	07.55	41° 25.3’S	42° 50.7’E	4	-	-	Transit to SWATH grid
15/11/11	319	08.23	41° 23.19’S	41° 50.19’E	4	-	-	Arrive SWATH grid start
15/11/11	319	08.23	41° 23.187’S	41° 50.292’E	4	11	EM120 + SBP	Start SWATH grid
16/11/11	320	01.20	41° 23.42’S	42° 52.68’E	4	11	EM120 + SBP	End SWATH grid
16/11/11	320	01.20	41° 23.42’S	42° 52.68’E	4	-	-	Move to ROV dive site
16/11/11	320	02.05	41° 23.34’S	42° 54.60’E	4	-	-	Arrive ROV dive site
16/11/11	320	03.17	41° 22.3333’S	42° 54.6066’E	4	12	ROV	ROV in water
16/11/11	320	08.50	41° 23.0’S	42° 54.1’E	4	12	ROV	ROV at surface, early recovery because of bad weather
16/11/11	320	08.58	41° 23.0’S	42° 54.1’E	4	12	ROV	ROV on deck
16/11/11	320	08.58	41° 23.0’S	42° 54.1’E	4	-	-	Transit to coring site
16/11/11	320	10.02	41° 26.38’S	42° 53.71’E	4	-	-	Arrive coring site
16/11/11	320	10.02	41° 26.373’S	42° 53.714’E	4	13	Boxcore	Boxcore in water
16/11/11	320	10.43	41° 26.373’S	42° 53.714’E	4	13	Boxcore	Boxcore triggers 1035m
16/11/11	320	11.18	41° 26.373’S	42° 53.714’E	4	13	Boxcore	Boxcore at surface
16/11/11	320	11.21	41° 26.373’S	42° 53.714’E	4	13	Boxcore	Boxcore on deck
16/11/11	320	11.21	41° 26.373’S	42° 53.714’E	4	-	-	Hove too
16/11/11	320	12.07	41° 25.30’S	42° 53.13’E	4	14	Boxcore	Boxcore in water
16/11/11	320	12.40	41° 25.30’S	42° 53.13’E	4	14	Boxcore	Boxcore triggers 570m
16/11/11	320	13.04	41° 25.30’S	42° 53.13’E	4	14	Boxcore	Boxcore on deck – failed to trigger.
16/11/11	320	13.04	41° 25.30’S	42° 53.13’E	4	-	-	Hove to
16/11/11	320	13.15	41° 25.30’S	42° 53.13’E	4	15	Boxcore	Boxcore in water
16/11/11	320	14.12	41° 25.30’S	42° 53.13’E	4	15	Boxcore	Boxcore on deck
16/11/11	320	14.12	41° 25.30’S	42° 53.13’E	4	-	-	Transit to new core site
16/11/11	320	15.00	41° 20.74’S	42° 55.53’E	4	-	-	Arrive new core site
16/11/11	320	15.10	41° 20.7412’S	42° 55.3725’E	4	16	Boxcore	Boxcore in water
16/11/11	320	15.54	41° 20.7412’S	42° 55.3725’E	4	16	Boxcore	Boxcore triggers 1395m
16/11/11	320	16.29	41° 20.7412’S	42° 55.3725’E	4	16	Boxcore	Boxcore at surface
16/11/11	320	16.30	41° 20.7412’S	42° 55.3725’E	4	16	Boxcore	Boxcore on deck
16/11/11	320	16.38	41° 20.7412’S	42° 55.3725’E	4	-	-	Transit to new core site
16/11/11	320	17.26	41° 21.3’S	42° 55.1’E	4	-	-	Arrive new core site
16/11/11	320	17.27	41° 21.364’S	42° 55.1101’E	4	17	Boxcore	Boxcore in water
16/11/11	320	18.00	41° 21.364’S	42° 55.1101’E	4	17	Boxcore	Boxcore triggers 950m
16/11/11	320	18.40	41° 21.364’S	42° 55.1101’E	4	17	Boxcore	Boxcore at surface
16/11/11	320	18.41	41° 21.364’S	42° 55.1101’E	4	17	Boxcore	Boxcore on deck
16/11/11	320	18.41	41° 21.364’S	42° 55.1101’E	4	-	-	Hove to
16/11/11	320	19.15	41° 21.3483’S	42° 55.1083’E	4	18	Boxcore	Boxcore in water
16/11/11	320	20.55	41° 21.3483’S	42° 55.1083’E	4	18	Boxcore	Boxcore on deck
16/11/11	320	20.55	41° 21.3483’S	42° 55.1083’E	4	-	-	Hove to
16/11/11	320	21.12	41° 21.345’S	42° 55.105’E	4	19	Megacore	Megacore in water
16/11/11	320	21.59	41° 21.345’S	42° 55.105’E	4	19	Megacore	Megacore triggers 944m
16/11/11	320	22.52	41° 21.345’S	42° 55.105’E	4	19	Megacore	Megacore on deck
16/11/11	320	22.52	41° 22.35’S	42° 54.64’E	4	-	-	Hove to
16/11/11	320	23.11	41° 22.35’S	42° 54.64’E	4	20	Megacore	Megacore in water
16/11/11	320	23.11	41° 22.35’S	42° 54.64’E	4	20	Megacore	Megacore triggers 732m
17/11/11	321	00.18	41° 22.34’S	42° 54.61’E	4	20	Megacore	Megacore on deck
17/11/11	321	00.18	41° 22.34’S	42° 54.61’E	4	-	-	Hove to
17/11/11	321	00.27	41° 22.348’S	42° 54.609’E	4	21	Megacore	Megacore in water
17/11/11	321	01.06	41° 22.348’S	42° 54.609’E	4	21	Megacore	Megacore triggers 739m
17/11/11	321	01.28	41° 22.348’S	42° 54.609’E	4	21	Megacore	Megacore at surface
17/11/11	321	01.30	41° 22.348’S	42° 54.609’E	4	21	Megacore	Megacore on deck

17/11/11	321	01.30	41^{o} 22.348'S	42^{o} 54.609'E	4	-	-	Transit to new site
17/11/11	321	02.00	41^{o} 22.98'S	42^{o} 54.24'E	4	-	-	At new core site
17/11/11	321	02.02	41^{o} 22.998'S	42^{o} 54.232'E	4	22	Megacore	Megacore in water
17/11/11	321	02.30	41^{o} 22.998'S	42^{o} 54.232'E	4	22	Megacore	Megacore triggers 552m
17/11/11	321	02.49	41^{o} 22.998'S	42^{o} 54.232'E	4	22	Megacore	Megacore at surface
17/11/11	321	02.50	41^{o} 22.998'S	42^{o} 54.232'E	4	22	Megacore	Megacore on deck
17/11/11	321	02.50	41^{o} 22.998'S	42^{o} 54.232'E	4	-	-	Weather poor considering next action
17/11/11	321	03.23	41^{o} 22.98'S	42^{o} 54.24'E	4	22A	EM120 + SBP	SWATH run
17/11/11	321	03.54	41^{o} 23.6'S	42^{o} 53.2'E	4	22A	EM120 + SBP	Through waypoint SWATH
17/11/11	321	03.54	41^{o} 23.6'S	42^{o} 53.2'E	4	-	-	Move to CTD position
17/11/11	321	05.40	41^{o} 21.2'S	42^{o} 50.3'E	4	-	-	At CTD position hove to for bad weather
17/11/11	321	16.57	41^{o} 21.189'S	42^{o} 50.28'E	4	-	-	CTD downtime because of technical issue
17/11/11	321	18.39	41^{o} 21.189'S	42^{o} 50.28'E	4	23	CTD	CTD in water
17/11/11	321	19.43	41^{o} 21.189'S	42^{o} 50.28'E	4	23	CTD	CTD at 1980m wire out
17/11/11	321	19.43	41^{o} 21.189'S	42^{o} 50.28'E	4	23	CTD	CTD haul
17/11/11	321	21.05	41^{o} 21.189'S	42^{o} 50.28'E	4	23	CTD	CTD at surface
17/11/11	321	21.10	41^{o} 21.189'S	42^{o} 50.28'E	4	23	CTD	CTD on deck
17/11/11	321	21.10	41^{o} 21.189'S	42^{o} 50.28'E	4	-	-	Transit to CTD site
17/11/11	321	23.01	41^{o} 23.3'S	42^{o} 51.26'E	4	24	CTD	CTD in water
17/11/11	321	23.25	41^{o} 23.3'S	42^{o} 51.26'E	4	24	CTD	Loss of power to winch due to power blackout in lab/plot
18/11/11	322	00.20	41^{o} 23.49'S	42^{o} 51.25'E	4	24	CTD	CTD aborted on deck
18/11/11	322	00.20	41^{o} 23.49'S	42^{o} 51.25'E	4	-	-	Resolving technical issues
18/11/11	322	01.21	41^{o} 23.4983'S	42^{o} 51.25'E	4	25	CTD	CTD in water
18/11/11	322	02.20	41^{o} 23.4983'S	42^{o} 51.25'E	4	25	CTD	CTD at 945m wire out
18/11/11	322	03.04	41^{o} 23.4983'S	42^{o} 51.25'E	4	25	CTD	CTD at surface
18/11/11	322	03.07	41^{o} 23.4983'S	42^{o} 51.25'E	4	25	CTD	CTD on deck
18/11/11	322	03.07	41^{o} 23.4983'S	42^{o} 51.25'E	4	-	-	Transit to CTD site
18/11/11	322	03.52	41^{o} 24.27'S	42^{o} 51.66'E	4	-	-	At CTD site – hove to
18/11/11	322	04.11	41^{o} 24.27'S	42^{o} 51.66'E	4	26	CTD	CTD in water
18/11/11	322	04.30	41^{o} 24.27'S	42^{o} 51.66'E	4	26	CTD	CTD at 183m wire out
18/11/11	322	04.53	41^{o} 24.27'S	42^{o} 51.66'E	4	26	CTD	CTD at surface
18/11/11	322	04.59	41^{o} 24.27'S	42^{o} 51.66'E	4	26	CTD	CTD on deck
18/11/11	322	04.59	41^{o} 24.27'S	42^{o} 51.66'E	4	-	-	Transit to CTD site
18/11/11	322	05.37	41^{o} 25.7'S	42^{o} 52.5'E	4	-	-	At CTD site – hove to
18/11/11	322	05.51	41^{o} 25.709'S	42^{o} 52.507'E	4	27	CTD	CTD in water
18/11/11	322	06.21	41^{o} 25.709'S	42^{o} 52.507'E	4	27	CTD	CTD at 565m wire out
18/11/11	322	06.55	41^{o} 25.709'S	42^{o} 52.507'E	4	27	CTD	CTD at surface
18/11/11	322	06.58	41^{o} 25.709'S	42^{o} 52.507'E	4	27	CTD	CTD on deck
18/11/11	322	06.58	41^{o} 25.709'S	42^{o} 52.507'E	4	-	-	Transit to CTD site
18/11/11	322	07.29	41^{o} 27.0'S	42^{o} 53.0'E	4	-	-	At CTD site – hove to
18/11/11	322	07.42	41^{o} 27.091'S	42^{o} 53.077'E	4	28	CTD	CTD in water
18/11/11	322	09.22	41^{o} 27.091'S	42^{o} 53.077'E	4	28	CTD	CTD at surface
18/11/11	322	09.25	41^{o} 27.091'S	42^{o} 53.077'E	4	28	CTD	CTD on deck
18/11/11	322	09.28	41^{o} 27.091'S	42^{o} 53.077'E	4	-	-	Transit to CTD site
18/11/11	322	10.03	41^{o} 29.1'S	42^{o} 54.0'E	4	-	-	At CTD site – hove to
18/11/11	322	10.25	41^{o} 29.13'S	42^{o} 54.01'E	4	29	CTD	CTD in water
18/11/11	322	12.13	41^{o} 29.13'S	42^{o} 54.01'E	4	29	CTD	CTD at surface
18/11/11	322	12.15	41^{o} 29.13'S	42^{o} 54.01'E	4	29	CTD	CTD on deck
18/11/11	322	12.15	41^{o} 29.13'S	42^{o} 54.01'E	4	-	-	Transit to HYBIS site
18/11/11	322	13.30	41^{o} 23.67'S	42^{o} 52.90'E	4	-	-	Arrive HYBIS site
18/11/11	322	13.30	41^{o} 23.67'S	42^{o} 52.90'E	4	-	-	Downtime resulting from technical issues with HYBIS comms.
18/11/11	322	16.23	41^{o} 23.6737'S	42^{o} 52.8981'E	4	30	HYBIS	HYBIS in water
18/11/11	322	18.26	41^{o} 23.5'S	42^{o} 52.8'E	4	30	HYBIS	HYBIS at surface, dive aborted because of camera failure
18/11/11	322	18.26	41^{o} 23.5'S	42^{o} 52.8'E	4	30	HYBIS	HYBIS on deck
18/11/11	322	18.27	41^{o} 23.5'S	42^{o} 52.8'E	4	-	-	Transit back to HYBIS site
18/11/11	322	19.50	41^{o} 23.6'S	42^{o} 52.9'E	4	-	-	At HYBIS site
18/11/11	322	19.54	41^{o} 23.675'S	42^{o} 52.9'E	4	31	HYBIS	HYBIS in water
18/11/11	322	20.33	41^{o} 23.675'S	42^{o} 52.9'E	4	31	HYBIS	HYBIS at surface, dive aborted because of faulty camera
18/11/11	322	20.35	41^{o} 23.675'S	42^{o} 52.9'E	4	31	HYBIS	HYBIS on deck
18/11/11	322	20.35	41^{o} 23.675'S	42^{o} 52.9'E	4	-	-	Downtime while preparing SHRIMP for dive

18/11/11	322	23.05	41° 23.5368'S	42° 52.0489'E	4	32	SHRIMP	SHRIMP in water
19/11/11	323	03.21	41° 22.83'S	42° 52.46'E	4	32	SHRIMP	Loss of power to SHRIMP
19/11/11	323	03.38	41° 22.83'S	42° 52.46'E	4	32	SHRIMP	SHRIMP at surface
19/11/11	323	03.38	41° 22.83'S	42° 52.46'E	4	32	SHRIMP	SHRIMP on deck
19/11/11	323	03.40	41° 22.83'S	42° 52.46'E	4	-	-	Downtime for repairs to SHRIMP
19/11/11	323	05.50	41° 22.838'S	42° 52.473'E	4	33	SHRIMP	SHRIMP in water
19/11/11	323	06.33	41° 22.8'S	42° 54.4	4	33	SHRIMP	Winch fault, reverse ship to pull SHRIMP off seabed
19/11/11	323	06.45	41° 22.8'S	42° 54.4	4	33	SHRIMP	Fault rectified resume transect
19/11/11	323	07.30	41° 22.9'S	42° 52.5'E	4	33	SHRIMP	SHRIMP at surface, recovered due to fault
19/11/11	323	07.33	41° 22.9'S	42° 52.5'E	4	33	SHRIMP	SHRIMP on deck
19/11/11	323	07.33	41° 22.9'S	42° 52.5'E	4	-	-	Downtime while trying to repair SHRIMP
19/11/11	323	14.27	41° 22.304'S	42° 52.503'E	4	34	Ring net	Deploying ring net
19/11/11	323	14.40	41° 22.304'S	42° 52.503'E	4	34	Ring net	Ring net in water
19/11/11	323	15.05	41° 22.30'S	42° 51.92'E	4	34	Ring net	Net towing west 2.2 kts
19/11/11	323	15.20	41° 22.31'S	42° 51.12'E	4	34	Ring net	750m wire out stop winch
19/11/11	323	15.30	41° 22.31'S	42° 50.67'E	4	34	Ring net	Hauling net
19/11/11	323	16.00	41° 22.32'S	42° 49.52'E	4	34	Ring net	Net at surface
19/11/11	323	16.01	41° 22.32'S	42° 49.52'E	4	34	Ring net	Net on deck
19/11/11	323	16.01	41° 22.32'S	42° 49.52'E	4	-	-	Transit to SHRIMP site
19/11/11	323	17.05	41° 22.8'S	42° 52.4'E	4	-	-	At SHRIMP site
19/11/11	323	17.12	41° 22.8507'S	42° 52.4773'E	4	35	SHRIMP	SHRIMP in water
19/11/11	323	20.58	41° 23.1'S	42° 52.9'E	4	35	SHRIMP	SHRIMP at surface
19/11/11	323	20.59	41° 23.1'S	42° 52.9'E	4	35	SHRIMP	SHRIMP at surface
19/11/11	323	20.59	41° 23.1'S	42° 52.9'E	4	-	-	Transit to SHRIMP site
19/11/11	323	21.30	41° 23.1'S	42° 54.2'E	4	-	-	At SHRIMP site - hove to
19/11/11	323	21.47	41° 23.0940'S	42° 54.2294'E	4	36	SHRIMP	SHRIMP in water
20/11/11	324	02.16	41° 23.70'S	42° 53.40'E	4	36	SHRIMP	SHRIMP at surface
20/11/11	324	02.17	41° 23.70'S	42° 53.40'E	4	36	SHRIMP	SHRIMP on deck
20/11/11	324	02.17	41° 23.70'S	42° 53.40'E	4	-	-	Transit to ROV site
20/11/11	324	02.50	41° 21.78'S	42° 54.59'E	4	-	-	Arrive ROV site – hove to
20/11/11	324	03.15	41° 21.7673'S	42° 54.9067'E	4	37	ROV	ROV in water
20/11/11	324	10.29	41° 22.4'S	42° 54.6'E	4	37	ROV	ROV at surface
20/11/11	324	10.31	41° 22.4'S	42° 54.6'E	4	37	ROV	ROV on deck
20/11/11	324	10.31	41° 22.3'S	42° 54.6'E	4	37A	HYBIS	HYBIS in water for test
20/11/11	324	11.17	41° 22.3'S	42° 54.6'E	4	37A	HYBIS	HYBIS on deck
20/11/11	324	11.17	41° 22.3'S	42° 54.6'E	4	-	-	Hove to
20/11/11	324	11.42	41° 22.3'S	42° 54.6'E	4	-	-	Loss of electrical supply to ROV
20/11/11	324	12.06	41° 22.31'S	42° 54.57'E	4	-	-	ROV power reset
20/11/11	324	12.40	41° 22.3138'S	42° 54.579'E	4	38	ROV	ROV in water
20/11/11	324	14.54	41° 22.31'S	42° 54.48'E	4	38	ROV	ROV at surface
20/11/11	324	15.02	41° 22.31'S	42° 54.48'E	4	38	ROV	ROV on deck
20/11/11	324	15.02	41° 22.31'S	42° 54.48'E	4	-	-	Hove to
20/11/11	324	15.30	41° 22.31'S	42° 54.48'E	4	-	-	Steam for Melville Bank
21/11/11	325	09.54	38° 30.3'S	46° 40.3'E	5	-	-	Arrive Melville Bank – hove to
21/11/11	325	10.24	38° 30.499'S	46° 40.332'S	5	1	CTD+SVP	CTD in water
21/11/11	325	12.02	38° 30.499'S	46° 40.332'S	5	1	CTD+SVP	CTD at surface
21/11/11	325	12.07	38° 30.499'S	46° 40.332'S	5	1	CTD+SVP	CTD on deck
21/11/11	325	12.07	38° 30.499'S	46° 40.332'S	5	-	-	Hove to
21/11/11	325	12.23	38° 30.4806'S	46° 40.3329'S	5	2	EM120+SBP	Start SWATH grid
22/11/11	326	02.30	38° 27.55'S	46° 44.97'S	5	2	EM120+SBP	End SWATH grid
22/11/11	326	02.30	38° 27.55'S	46° 44.97'S	5	-	-	Transit to CTD site
22/11/11	326	03.22	38° 31.55'S	46° 45.74'S	5	-	-	At CTD site – hove to
22/11/11	326	03.32	38° 31.599'S	46° 45.734'S	5	3	CTD	CTD in water
22/11/11	326	04.18	38° 31.599'S	46° 45.734'S	5	3	CTD	CTD at 1960m wire out
22/11/11	326	05.41	38° 31.599'S	46° 45.734'S	5	3	CTD	CTD at surface
22/11/11	326	05.42	38° 31.599'S	46° 45.734'S	5	3	CTD	CTD on deck
22/11/11	326	05.42	38° 31.599'S	46° 45.734'S	5	-	-	Transit to CTD site
22/11/11	326	06.07	38° 30.1'S	46° 45.3'E	5	-	-	At CTD site – hove to
22/11/11	326	06.24	38° 30.169'S	46° 45.319'E	5	4	CTD	CTD in water
22/11/11	326	06.53	38° 30.169'S	46° 45.319'E	5	4	CTD	CTD at 1195m wire out
22/11/11	326	07.40	38° 30.169'S	46° 45.319'E	5	4	CTD	CTD at surface
22/11/11	326	07.45	38° 30.169'S	46° 45.319'E	5	4	CTD	CTD on deck
22/11/11	326	07.48	38° 30.169'S	46° 45.319'E	5	-	-	Transit to CTD site
22/11/11	326	08.06	38° 29.5'S	46° 45.1'E	5	-	-	At CTD site – hove to
22/11/11	326	08.35	38° 29.22'S	46° 44.97'E	5	5	CTD	CTD in water
22/11/11	326	09.30	38° 29.22'S	46° 44.97'E	5	5	CTD	CTD at surface

22/11/11	326	09.32	38^o 29.22'S	46^o 44.97'E	5	5	CTD	CTD on deck
22/11/11	326	09.32	38^o 29.22'S	46^o 44.97'E	5	-	-	Transit to CTD site
22/11/11	326	09.47	38^o 29.22'S	46^o 44.97'E	5	-	-	At CTD site – hove to
22/11/11	326	10.09	38^o 28.68'S	46^o 44.75'E	5	6	CTD	CTD in water
22/11/11	326	11.03	38^o 28.68'S	46^o 44.75'E	5	6	CTD	CTD at surface
22/11/11	326	11.08	38^o 28.68'S	46^o 44.75'E	5	6	CTD	CTD on deck
22/11/11	326	11.08	38^o 28.68'S	46^o 44.75'E	5	-	-	Transit to CTD site
22/11/11	326	11.43	38^o 28.2833'S	46^o 44.6667'E	5	7	CTD	CTD in water
22/11/11	326	11.55	38^o 28.2833'S	46^o 44.6667'E	5	7	CTD	CTD 120m wire out
22/11/11	326	12.02	38^o 28.2833'S	46^o 44.6667'E	5	7	CTD	CTD at surface
22/11/11	326	12.02	38^o 28.2833'S	46^o 44.6667'E	5	-	-	Transit to CTD site
22/11/11	326	12.30	38^o 27.82'S	46^o 44.41'E	5	-	-	At CTD site – hove to
22/11/11	326	12.35	38^o 27.8268'S	46^o 44.4195'E	5	8	CTD	CTD in water
22/11/11	326	13.15	38^o 27.8268'S	46^o 44.4195'E	5	8	CTD	CTD at 1035m wire out
22/11/11	326	13.50	38^o 27.8268'S	46^o 44.4195'E	5	8	CTD	CTD at surface
22/11/11	326	13.50	38^o 27.8268'S	46^o 44.4195'E	-	-	-	Transit to CTD site
22/11/11	326	14.07	38^o 26.814'S	46^o 44.006'E	5	-	-	At CTD site – hove to
22/11/11	326	14.27	38^o 26.8121'S	46^o 44.0068'E	5	9	CTD	CTD in water
22/11/11	326	15.30	38^o 26.8121'S	46^o 44.0068'E	5	9	CTD	CTD at 1972m wire out
22/11/11	326	16.24	38^o 26.8121'S	46^o 44.0068'E	5	9	CTD	CTD at surface
22/11/11	326	16.27	38^o 26.8121'S	46^o 44.0068'E	5	9	CTD	CTD on deck
22/11/11	326	16.27	38^o 26.8121'S	46^o 44.0068'E	5	-	-	Transit to multiprofiler site
22/11/11	326	16.55	38^o 28.2'S	46^o 43.9'E	5	-	-	At multiprofiler site – hove to
22/11/11	326	17.00	38^o 28.256'S	46^o 43.917'E	5	10	Multiprofiler	Start multiprofiler
23/11/11	327	06.00	38^o 28.25'S	46^o 43.52'E	5	10	Multiprofiler	Multiprofiler on deck
23/11/11	327	06.00	38^o 28.25'S	46^o 43.52'E	5	-	-	Transit to ROV site
23/11/11	327	06.44	38^o 28.25'S	46^o 43.52'E	5	-	-	At ROV site – hove to
23/11/11	327	07.02	38^o 29.8992'S	46^o 43.3967'E	5	11	ROV	ROV in water
23/11/11	327	12.07	38^o 29.77'S	46^o 43.85'E	5	11	ROV	Power cut main lab/plot
23/11/11	327	16.19	38^o 29.60'S	46^o 44.15'E	5	11	ROV	ROV at surface
23/11/11	327	16.22	38^o 29.60'S	46^o 44.15'E	5	11	ROV	ROV on deck
23/11/11	327	16.22	38^o 29.60'S	46^o 44.15'E	5	-	-	Transit to HYBIS site
23/11/11	327	17.03	38^o 28.7'S	46^o 42.5'E	5	-	-	At HYBIS position–hove to
23/11/11	327	17.09	38^o 28.7745'S	46^o 42.5025'E	5	12	HYBIS	HYBIS in water
23/11/11	327	22.25	38^o 28.3'S	46^o 42.6'E	5	12	HYBIS	Thruster fault – recover
23/11/11	327	23.06	38^o 28.3'S	46^o 42.6'E	5	12	HYBIS	HYBIS at surface
23/11/11	327	23.06	38^o 28.3'S	46^o 42.6'E	5	12	HYBIS	HYBIS on deck
23/11/11	327	23.06	38^o 28.3'S	46^o 42.6'E	5	-	HYBIS	Downtime for HYBIS repairs
24/11/11	328	00.07	38^o 28.256'S	46^o 42.499'E	5	13	HYBIS	HYBIS in water
24/11/11	328	04.23	38^o 27.8'S	46^o 42.5'E	5	13	HYBIS	HYBIS at surface
24/11/11	328	04.23	38^o 27.8'S	46^o 42.5'E	5	13	HYBIS	HYBIS on deck
24/11/11	328	04.23	38^o 27.8'S	46^o 42.5'E	5	-	-	Transit to ROV site
24/11/11	328	05.46	38^o 27.7'S	46^o 45.2'E	5	-	-	At ROV site – hove to
24/11/11	328	06.03	38^o 27.724'S	46^o 45.266'E	5	14	ROV	ROV in water
24/11/11	328	15.22	38^o 28.28'S	46^o 45.73'E	5	14	ROV	ROV at surface
24/11/11	328	15.36	38^o 28.28'S	46^o 45.73'E	5	14	ROV	ROV on deck
24/11/11	328	15.36	38^o 28.28'S	46^o 45.73'E	5	-	-	Transit to net site
24/11/11	328	16.18	38^o 30.2'S	46^o 43.4'E	5	-	-	At net site – hove to
24/11/11	328	16.23	38^o 30.2500'S	46^o 43.42'E	5	15	Ring net	Ring net in water
24/11/11	328	16.39	38^o 30.2500'S	46^o 43.42'E	5	15	Ring net	Problems with wind and current – recover net
24/11/11	328	16.42	38^o 30.7'S	46^o 42.9'E	5	15	Ring net	Net at surface
24/11/11	328	16.47	38^o 30.7'S	46^o 42.9'E	5	15	Ring net	Net on deck
24/11/11	328	16.47	38^o 30.7'S	46^o 42.9'E	5	-	-	Transit to net site
24/11/11	328	17.23	38^o 32.4'S	46^o 43.1'E	5	-	-	At net site - hove to
24/11/11	328	17.28	38^o 32.4400'S	46^o 43.12'E	5	16	Ring net	Ring net in water
24/11/11	328	18.06	38^o 30.9'S	46^o 43.1'E	5	16	Ring net	Wire at 900m
24/11/11	328	18.51	38^o 30.9'S	46^o 43.1'E	5	16	Ring net	Net at surface
24/11/11	328	18.54	38^o 30.9'S	46^o 43.1'E	5	16	Ring net	Net on deck
24/11/11	328	19.07	38^o 30.9'S	46^o 43.1'E	5	-	-	Transit to HYBIS site
24/11/11	328	19.43	38^o 30.2'S	46^o 43.4'E	5	-	-	At HYBIS site - hove to
24/11/11	328	19.59	38^o 30.2105'S	46^o 43.4126'E	5	17	HYBIS	HYBIS in water
25/11/11	329	02.00	38^o 30.62'S	46^o 42.75'E	5	17	HYBIS	HYBIS at surface
25/11/11	329	02.04	38^o 30.62'S	46^o 42.75'E	5	17	HYBIS	HYBIS on deck
25/11/11	329	02.04	38^o 30.62'S	46^o 42.75'E	5	-	-	Transit to HYBIS site
25/11/11	329	02.45	38^o 29.89'S	46^o 43.39'E	5	-	-	At HYBIS site
25/11/11	329	02.47	38^o 29.898'S	46^o 43.394'E	5	18	HYBIS	HYBIS in water
25/11/11	329	04.42	38^o 29.86'S	46^o 43.31'E	5	18	HYBIS	HYBIS at surface
25/11/11	329	04.45	38^o 29.86'S	46^o 43.31'E	5	18	HYBIS	HYBIS on deck
25/11/11	329	04.45	38^o 29.86'S	46^o 43.31'E	5	-	-	Transit to HYBIS site

25/11/11	329	05.10	38° 29.856'S	46° 43.572'E	5	-	-	At HYBIS site – hove to
25/11/11	329	05.14	38° 29.856'S	46° 43.572'E	5	19	HYBIS	HYBIS in water
25/11/11	329	06.50	38° 29.856'S	46° 43.572'E	5	19	HYBIS	HYBIS at surface
25/11/11	329	06.53	38° 29.856'S	46° 43.572'E	5	19	HYBIS	HYBIS on deck
25/11/11	329	06.53	38° 29.856'S	46° 43.572'E	5	-	-	Transit to ROV site
25/11/11	329	07.28	38° 28.4'S	46° 44.4'E	5	-	-	At ROV site
25/11/11	329	07.44	38° 28.472'S	46° 44.455'E	5	20	ROV	ROV in water
25/11/11	329	15.42	38° 28.29'S	46° 45.16'E	5	20	ROV	ROV lifted out of water
25/11/11	329	15.50	38° 28.29'S	46° 45.16'E	5	20	ROV	ROV on deck
25/11/11	329	15.50	38° 28.29'S	46° 45.16'E	5	-	-	Transit to HYBIS site
25/11/11	329	16.17	38° 28.6'S	46° 47.3'E	5	-	-	At HYBIS site – hove to
25/11/11	329	16.20	38° 28.6002'S	46° 47.3172'E	5	21	HYBIS	HYBIS in water
26/11/11	330	00.18	38° 28.83'S	46° 48.66'E	5	21	HYBIS	HYBIS at surface
26/11/11	330	00.20	38° 28.83'S	46° 48.66'E	5	21	HYBIS	HYBIS on deck
26/11/11	330	00.20	38° 28.83'S	46° 48.66'E	5	-	-	Downtime to disconnect HYBIS & transfer to coring wire
26/11/11	330	01.10	38° 28.83'S	46° 48.66'E	5	-	-	Transit to core site
26/11/11	330	02.00	38° 27.74'S	46° 42.59'E	5	-	-	At core site – hove to
26/11/11	330	02.08	38° 27.745'S	46° 22.600'E	5	22	Megacore	Megacore in water
26/11/11	330	02.55	38° 27.745'S	46° 22.600'E	5	22	Megacore	Megacore - 1383m depth
26/11/11	330	03.32	38° 27.745'S	46° 22.600'E	5	22	Megacore	Megacore at surface
26/11/11	330	03.33	38° 27.745'S	46° 22.600'E	5	22	Megacore	Megacore on deck
26/11/11	330	03.33	38° 27.745'S	46° 22.600'E	5	-	-	Transit to core site
26/11/11	330	04.04	38° 27.7'S	46° 42.6'E	5	-	-	At core site – hove to
26/11/11	330	04.07	38° 27.743'S	46° 42.628'E	5	23	Megacore	Megacore in water
26/11/11	330	05.02	38° 27.743'S	46° 42.628'E	5	23	Megacore	Megacore – 1388m depth
26/11/11	330	05.45	38° 27.743'S	46° 42.628'E	5	23	Megacore	Megacore at surface
26/11/11	330	05.46	38° 27.743'S	46° 42.628'E	5	23	Megacore	Megacore on deck
26/11/11	330	05.46	38° 27.743'S	46° 42.628'E	5	-	-	Transit to ROV site
26/11/11	330	06.19	38° 30.0'S	46° 45.7'E	5	-	-	At ROV site – hove to
26/11/11	330	06.36	38° 30.081'S	46° 45.780'E	5	24	ROV	ROV in water
26/11/11	330	13.36	38° 29.77'S	46° 45.58'E	5	24	ROV	ROV at surface
26/11/11	330	13.42	38° 29.77'S	46° 45.58'E	5	24	ROV	ROV on deck
26/11/11	330	13.45	38° 29.77'S	46° 45.58'E	-	-	-	Transit to Dragon (JC67)
JC067 Survey and Sampling of the Dragon Hydrothermal Vent Field (Jon Copley PSO, University of Southampton)								
Resume JC066								
30/11/11	334	04.41	37° 57.4'S	50° 24.8'E	6	-	-	At CTD site – hove to
30/11/11	334	04.50	37° 57.41'S	50° 24.83'E	6	1A	CTD+SVP	CTD in water
30/11/11	334	06.22	37° 57.41'S	50° 24.83'E	6	1A	CTD+SVP	CTD at surface
30/11/11	334	06.24	37° 57.41'S	50° 24.83'E	6	1A	CTD+SVP	CTD on deck
30/11/11	334	06.27	37° 57.41'S	50° 24.83'E	6	1B	CTD	CTD in water for Yo-Yo
30/11/11	334	18.40	37° 57.41'S	50° 24.83'E	6	1B	CTD	CTD at surface
30/11/11	334	18.45	37° 57.41'S	50° 24.83'E	6	1B	CTD	CTD on deck
30/11/11	334	18.45	37° 57.41'S	50° 24.83'E	6	-	-	Transit to HYBIS site
30/11/11	334	19.21	37° 58.8'S	50° 22.8'E	6	-	-	At HYBIS site – hove to
30/11/11	334	19.45	37° 58.727'S	50° 22.847'E	6	2	HYBIS	HYBIS in water
1/12/11	335	02.53	37° 59.13'S	50° 20.58'E	6	2	HYBIS	HYBIS at surface
1/12/11	335	03.00	37° 59.13'S	50° 20.58'E	6	2	HYBIS	HYBIS on deck
1/12/11	335	03.00	37° 59.13'S	50° 20.58'E	6	-	-	Transit to ROV site
1/12/11	335	04.00	37° 57.4'S	50° 26.3'E	6	-	-	At ROV site – hove to
1/12/11	335	04.06	37° 57.418'S	50° 26.344'E	6	3	ROV	ROV in water
1/12/11	335	05.21	37° 57.2'S	50° 26.3'E	6	3	ROV	ROV problems, suspected entanglement but probably current and snagged wire
1/12/11	335	09.20	37° 57.3'S	50° 26.3'E	6	3	ROV	ROV at surface
1/12/11	335	09.55	37° 57.2'S	50° 26.4'E	6	3	ROV	ROV on deck
1/12/11	335	09.55	37° 57.2'S	50° 26.4'E	6	-	-	Downtime to investigate ROV control systems
1/12/11	335	11.14	37° 57.915'S	50° 24.426'E	6	4	ROV	ROV in water
1/12/11	335	15.17	37° 57.40'S	50° 24.73'E	6	4	ROV	ROV out of water
1/12/11	335	15.18	37° 57.40'S	50° 24.73'E	6	4	ROV	ROV on deck
1/12/11	335	15.19	37° 57.40'S	50° 24.73'E	6	-	-	Transit to SWATH grid start
1/12/11	335	16.01	37° 54.5'S	50° 28.5'E	6	5	EM120+SBP	SWATH grid start
2/12/11	336	01.15	37° 57.58'S	50° 24.74'E	6	5	EM120+SBP	End SWATH grid
2/12/11	336	01.15	37° 57.58'S	50° 24.74'E	6	-	-	Transit to megacore site
2/12/11	336	01.45	37° 57.43'S	50° 24.73'E	6	-	-	At core site – hove to
2/12/11	336	01.51	37° 57.431'S	50° 24.737'E	6	6	Megacore	Megacore in water
2/12/11	336	02.23	37° 57.431'S	50° 24.737'E	6	6	Megacore	Winch stopped, mechanical problem
2/12/11	336	02.27	37° 51.431'S	50° 24.737'E	6	6	Megacore	Continue paying out

2/12/11	336	02.30	37° 51.431'S	50° 24.737'E	6	6	Megacore	Megacore - 1009m depth
2/12/11	336	03.29	37° 51.431'S	50° 24.737'E	6	6	Megacore	Megacore at surface
2/12/11	336	03.30	37° 51.431'S	50° 24.737'E	6	6	Megacore	Megacore on deck
2/12/11	336	03.30	37° 51.431'S	50° 24.737'E	6	-	-	Transit to ROV site
2/12/11	336	04.53	37° 56.7'S	50° 27.2'E	6	-	-	At ROV site – hove to
2/12/11	336	05.23	37° 56.795'S	50° 27.240'E	6	7	ROV	ROV in water
2/12/11	336	13.35	37° 56.58'S	50° 26.69'E	6	7	ROV	Possible snag on ROV
2/12/11	336	14.00	37° 56.58'S	50° 26.69'E	6	7	ROV	ROV on seabed
2/12/11	336	15.20	37° 56.48'S	50° 26.53'E	6	7	ROV	ROV sampling
2/12/11	336	16.21	37° 56.48'S	50° 26.53'E	6	7	ROV	ROV on surface
2/12/11	336	16.24	37° 56.48'S	50° 26.53'E	6	7	ROV	ROV on deck
2/12/11	336	16.24	37° 56.48'S	50° 26.53'E	6	-	-	Transit to net site
2/12/11	336	16.28	37° 56.0'S	50° 26.6'E	6	-	-	At net site - hove to
2/12/11	336	16.50	37° 56.12'S	50° 26.63'E	6	8	Ring net	Net in water
2/12/11	336	17.40	37° 56.9'S	50° 26.1	6	8	Ring net	Wire out 1000m
2/12/11	336	17.50	37° 56.9'S	50° 26.1'E	6	8	Ring net	Start hauling
2/12/11	336	18.21	37° 57.4'S	50° 25.9'E	6	8	Ring net	Tunnel thrusters failure
2/12/11	336	18.33	37° 57.6'S	50° 25.8'E	6	8	Ring net	Net lost – no recovery
2/12/11	336	18.33	37° 57.6'S	50° 25.8'E	6	-	-	Downtime while checking ship
2/12/11	336	19.00	37° 57.6'S	50° 25.8'E	6	-	-	Transit to core site
2/12/11	336	19.44	37° 59.6'S	50° 20.6'E	6	-	-	At core site – hove to
2/12/11	336	19.47	37° 59.6667'S	50° 20.6687'E	6	9	Boxcore	Boxcore in water
2/12/11	336	22.06	37° 59.6667'S	50° 20.6687'E	6	9	Boxcore	Boxcore at surface
2/12/11	336	22.06	37° 59.6667'S	50° 20.6687'E	6	9	Boxcore	Boxcore on deck
2/12/11	336	22.06	37° 59.6667'S	50° 20.6687'E	6	-	-	Transit to core site
2/12/11	336	23.22	37° 57.4258'S	50° 24.7212'E	6	-	-	At core site
2/12/11	336	23.22	37° 57.4258'S	50° 24.7212'E	6	10	Megacore	Megacore in water
3/12/11	337	00.50	37° 57.4258'S	50° 24.7212'E	6	10	Megacore	Megacore at surface
3/12/11	337	00.51	37° 57.4258'S	50° 24.7212'E	6	10	Megacore	Megacore on deck
3/12/11	337	00.51	37° 57.4258'S	50° 24.7212'E	6	-	-	Transit to next site
3/12/11	337	01.44	37° 57.4688'S	50° 24.709'E	6	-	-	Arrive core site
3/12/11	337	01.44	37° 57.4688'S	50° 24.709'E	6	11	Megacore	Megacore in water
3/12/11	337	03.05	37° 57.4688'S	50° 24.709'E	6	11	Megacore	Megacore at surface
3/12/11	337	03.06	37° 57.4688'S	50° 24.709'E	6	11	Megacore	Megacore on deck
3/12/11	337	03.07	37° 57.4688'S	50° 24.709'E	6	-	-	Transit to HYBIS site
3/12/11	337	03.42	37° 56.52'S	50° 26.47'E	6	-	-	At HYBIS site – hove to
3/12/11	337	05.25	37° 56.596'S	50° 26.413'E	6	12	HYBIS	HYBIS in water
3/12/11	337	08.49	37° 56.3'S	50° 26.7'E	6	12	HYBIS	HYBIS at surface
3/12/11	337	08.49	37° 56.3'S	50° 26.7'E	6	12	HYBIS	HYBIS on deck
3/12/11	337	08.52	37° 56.3'S	50° 26.7'E	6	-	-	Transit to HYBIS site
3/12/11	337	09.38	37° 57.6'S	50° 25.1'E	6	-	-	At HYBIS site
3/12/11	337	09.40	37° 57.534'S	50° 25.086'E	6	13	HYBIS	HYBIS in water
3/12/11	337	12.35	37° 57.65'S	50° 24.92'E	6	13	HYBIS	HYBIS at surface – dive aborted because of bad weather
3/12/11	337	12.36	37° 57.65'S	50° 24.92'E	6	13	HYBIS	HYBIS on deck
3/12/11	337	12.36	37° 57.65'S	50° 24.92'E	6	-	-	Hove to – bad weather
4/12/11	338	01.00	37° 33.8'S	50° 35.7'E	6	-	-	Slow transit to CTD site
4/12/11	338	06.44	37° 55.9'S	50° 22.2'E	6	-	-	At CTD site – hove to bad weather
4/12/11	338	10.58	37° 57.524'S	50° 21.892'E	6	14	CTD	CTD in water
4/12/11	338	12.55	37° 57.524'S	50° 21.892'E	6	14	CTD	CTD at surface
4/12/11	338	13.00	37° 57.524'S	50° 21.892'E	6	14	CTD	CTD on deck
4/12/11	338	13.00	37° 57.524'S	50° 21.892'E	6	-	-	Transit to CTD station
4/12/11	338	14.00	37° 57.58'S	50° 26.63'E	6	-	-	At CTD station – hove to
4/12/11	338	14.07	37° 57.558'S	50° 23.642'E	6	15	CTD	CTD in water
4/12/11	338	16.05	37° 57.558'S	50° 23.642'E	6	15	CTD	CTD at surface
4/12/11	338	16.08	37° 58.4'S	50° 24.1'E	6	15	CTD	CTD on deck
4/12/11	338	16.08	37° 58.4'S	50° 24.1'E	6	-	-	Transit to CTD station
4/12/11	338	17.01	37° 58.5'S	50° 24.9'E	6	-	-	At CTD site – hove to
4/12/11	338	17.05	37° 58.5841'S	50° 24.9451'E	6	16	CTD	CTD in water
4/12/11	338	18.09	37° 58.5841'S	50° 24.9451'E	6	16	CTD	CTD 1065m wire out
4/12/11	338	18.50	37° 57.3'S	50° 25.4'E	6	16	CTD	CTD at surface
4/12/11	338	18.51	37° 57.3'S	50° 25.4'E	6	16	CTD	CTD on deck
4/12/11	338	18.51	37° 57.3'S	50° 25.4'E	6	-	-	Transit to CTD site
4/12/11	338	19.42	37° 59.265'S	50° 25.424'E	6	-	-	At CTD site – hove to
4/12/11	338	19.53	37° 59.265'S	50° 25.424'E	6	17	CTD	CTD in water
4/12/11	338	22.00	37° 57.8'S	50° 26.2'E	6	17	CTD	CTD at surface
4/12/11	338	22.01	37° 57.8'S	50° 26.2'E	6	17	CTD	CTD on deck
4/12/11	338	22.04	37° 57.8'S	50° 26.2'E	6	-	-	Transit to CTD site
4/12/11	338	22.50	37° 59.8'S	50° 25.8'E	6	-	-	At CTD site – hove to
4/12/11	338	23.05	37° 59.6833'S	50° 25.8833'E	6	18	CTD	CTD in water

5/12/11	339	00.46	37° 58.54'S	50° 26.40'E	6	18	CTD	CTD at surface
5/12/11	339	00.50	37° 58.54'S	50° 26.40'E	6	18	CTD	CTD on deck
5/12/11	339	00.50	37° 58.54'S	50° 26.40'E	6	-	-	Transit to CTD site
5/12/11	339	01.42	38° 00.82'S	50° 27.26'E	6	-	-	At CTD site
5/12/11	339	01.48	38° 00.776'S	50° 27.289'E	6	19	CTD	CTD in water
5/12/11	339	03.22	37° 59.58'S	50° 27.77'E	6	19	CTD	CTD at surface
5/12/11	339	03.28	37° 59.58'S	50° 27.77'E	6	19	CTD	CTD on deck
5/12/11	339	03.30	37° 59.57'S	50° 27.77'E	6	-	-	Transit to Sapmer Bank
5/12/11	339	11.37	36° 51.0'S	52° 09.4'E	7	-	-	Arrive Sapmer – hove to
5/12/11	339	11.43	36° 50.992'S	52° 09.402'E	7	1	CTD+SVP	CTD in water
5/12/11	339	12.26	36° 50.992'S	52° 09.402'E	7	1	CTD+SVP	CTD at 1340m wire out
5/12/11	339	12.51	36° 50.992'S	52° 09.402'E	7	1	CTD+SVP	CTD on deck
5/12/11	339	12.55	36° 50.992'S	52° 09.402'E	7	-	-	Transit to multiprofiler site
5/12/11	339	13.50	36° 50.5865'S	52° 08.4829'E	7	-	-	At multiprofiler site
5/12/11	339	13.51	36° 50.5865'S	52° 08.4829'E	7	2	Multiprofiler	Multiprofiler in water
6/12/11	340	03.02	36° 50.56'S	52° 08.47'E	7	2	Multiprofiler	Multiprofiler at surface
6/12/11	340	03.05	36° 50.56'S	52° 08.47'E	7	2	Multiprofiler	Multiprofiler on deck
6/12/11	340	03.05	36° 50.56'S	52° 08.47'E	7	-	-	Transit to SWATH grid
6/12/11	340	03.42	36° 52.59'S	52° 03.30'E	7	-	EM120+SBP	At SWATH grid start
6/12/11	340	03.42	36° 52.59'S	52° 03.30'E	7	3	EM120+SBP	Start SWATH grid
6/12/11	340	16.30	36° 46.28'S	52° 05.92'E	7	3	EM120+SBP	End SWATH grid - incomplete
6/12/11	340	16.30	36° 46.28'S	52° 05.92'E	7	-	-	Transit to CTD site
6/12/11	340	17.03	36° 32.1'S	52° 10.4'E	7	-	-	At CTD site – hove to
6/12/11	340	17.06	36° 52.033'S	52° 5.983'E	7	4	CTD	CTD in water
6/12/11	340	19.01	36° 52.033'S	52° 5.983'E	7	4	CTD	CTD at surface
6/12/11	340	19.06	36° 52.1'S	52° 5.10.4'E	7	4	CTD	CTD on deck
6/12/11	340	19.06	36° 52.1'S	52° 5.10.4'E	7	-	-	Transit to CTD site
6/12/11	340	19.35	36° 51.2'S	52° 09.1'E	7	-	-	At CTD site – hove to
6/12/11	340	19.45	36° 51.236'S	52° 09.1333'E	7	5	CTD	CTD in water
6/12/11	340	21.11	36° 51.236'S	52° 09.1333'E	7	5	CTD	CTD at surface
6/12/11	340	21.12	36° 51.236'S	52° 09.1333'E	7	5	CTD	CTD on deck
6/12/11	340	21.12	36° 51.236'S	52° 09.1333'E	7	-	-	Transit to CTD site
6/12/11	340	22.00	36° 49.6'S	52° 07.2'E	7	-	-	Arrive CTD site
6/12/11	340	22.00	36° 49.63'S	52° 07.24'E	7	6	CTD	CTD in water
6/12/11	340	22.53	36° 51.236'S	52° 09.1333'E	7	6	CTD	CTD at surface
6/12/11	340	22.56	36° 51.236'S	52° 09.1333'E	7	6	CTD	CTD on deck
6/12/11	340	22.56	36° 51.236'S	52° 09.1333'E	7	-	-	Transit to CTD site
6/12/11	340	23.20	36° 48.95'S	52° 06.3833'E	7	-	-	At CTD site
6/12/11	340	23.20	36° 48.95'S	52° 06.3833'E	7	7	CTD	CTD in water
7/12/11	341	00.06	36° 48.95'S	52° 06.3833'E	7	7	CTD	CTD at surface
7/12/11	341	00.07	36° 48.95'S	52° 06.3833'E	7	7	CTD	CTD on deck
7/12/11	341	00.15	36° 48.95'S	52° 06.3833'E	7	-	-	Transit to CTD site
7/12/11	341	00.45	36° 48.16'S	52° 05.36'E	7	-	-	Arrive CTD site
7/12/11	341	00.49	36° 48.164'S	52° 05.366'E	7	8	CTD	CTD in water
7/12/11	341	01.18	36° 48.164'S	52° 05.366'E	7	8	CTD	CTD at 998m wire out
7/12/11	341	01.49	36° 48.164'S	52° 05.366'E	7	8	CTD	CTD at surface
7/12/11	341	01.52	36° 48.164'S	52° 05.366'E	7	8	CTD	CTD on deck
7/12/11	341	01.53	36° 48.164'S	52° 05.366'E	7	-	-	Transit to CTD site
7/12/11	341	02.28	36° 46.62'S	52° 03.45'E	7	-	-	At CTD site – hove to
7/12/11	341	02.31	36° 46.627'S	52° 03.461'E	7	9	CTD	CTD in water
7/12/11	341	03.20	36° 46.627'S	52° 03.461'E	7	9	CTD	CTD at 2045m wire out
7/12/11	341	04.16	36° 46.627'S	52° 03.461'E	7	9	CTD	CTD at surface
7/12/11	341	04.18	36° 46.627'S	52° 03.461'E	7	9	CTD	CTD on deck
7/12/11	341	04.20	36° 46.627'S	52° 03.461'E	7	-	-	Transit to ROV site
7/12/11	341	04.50	36° 47.7'S	52° 06.3'E	7	-	-	At ROV site – hove to
7/12/11	341	05.03	36° 47.798'S	52° 06.315'E	7	10	ROV	ROV in water
7/12/11	341	15.59	36° 48.18'S	52° 07.27'E	7	10	ROV	ROV at surface
7/12/11	341	16.02	36° 48.18'S	52° 07.27'E	7	10	ROV	ROV on deck
7/12/11	341	16.02	36° 48.18'S	52° 07.27'E	7	-	-	Downtime as USBL receiver stuck down
07/12/11	341	16.21	36° 48.18'S	52° 07.27'E	7	-	-	Transit to SWATH grid site
07/12/11	341	16.47	36° 47.8'S	52° 09.1'E	7	11	EM120+SBP	Restart SWATH grid
07/12/11	341	18.30	36° 42.9'S	52° 05.8'E	7	11	EM120+SBP	End of SWATH grid
07/12/11	341	18.38	36° 42.9'S	52° 05.8'E	7	-	-	Transit to Atlantis Bank
08/12/11	342	00.00	35° 58.3'S	53° 13.1'E	-	-	-	Transit to Atlantis Bank
08/12/11	342	22.42	32° 48.3'S	57° 18.3'E	8	-	-	Arrive CTD site – hove to
08/12/11	342	22.53	32° 48.5457'S	57° 18.2757'E	8	1	CTD + SVP	CTD in water
09/12/11	343	00.45	32° 48.5457'S	57° 18.2757'E	8	1	CTD + SVP	CTD at surface
09/12/11	343	00.47	32° 48.5457'S	57° 18.2757'E	8	1	CTD + SVP	CTD on deck
09/12/11	343	00.47	32° 48.5457'S	57° 18.2757'E	8	-	-	Transit to SWATH grid
09/12/11	343	01.05	32° 49.08'S	57° 18.22'E	8	2	EM120+SBP	Start SWATH grid

09/12/11	343	01.43	32° 45.67'S	57° 18.52'E	8	2	EM120+SBP	Suspend SWATH line as off track
09/12/11	343	01.43	32° 45.67'S	57° 18.52'E	8	2	EM120+SBP	Transit to SWATH grid start
09/12/11	343	02.25	32° 48.25'S	57° 17.32'E	8	2	EM120+SBP	Restart SWATH grid
09/12/11	343	03.30	32° 41.82'S	57° 18.48'E	8	2	EM120+SBP	End SWATH grid – partially complete
09/12/11	343	03.30	32° 41.82'S	57° 18.48'E	8	-	-	Transit to ROV site
09/12/11	343	04.00	32° 42.6'S	57° 16.3'E	8	-	-	At ROV site – hove to for technical problem with ROV
09/12/11	343	04.37	32° 42.658'S	57° 16.371'E	8	3	ROV	ROV in water
09/12/11	343	16.10	32° 42.64'S	57° 17.58'E	8	3	ROV	ROV at surface
09/12/11	343	16.15	32° 42.64'S	57° 17.58'E	8	3	ROV	ROV on deck
09/12/11	343	16.15	32° 42.64'S	57° 17.58'E	8	-	-	Transit to HYBIS site
09/12/11	343	16.45	32° 42.3'S	57° 16.4'E	8	-	-	Arrive HYBIS position
09/12/11	343	16.47	32° 42.43'S	57° 16.48'E	8	4	HYBIS	HYBIS in water
10/12/11	344	02.58	32° 42.17'S	57° 14.42'E	8	4	HYBIS	HYBIS at surface
10/12/11	344	02.59	32° 42.17'S	57° 14.42'E	8	4	HYBIS	HYBIS on deck
10/12/11	344	03.00	32° 42.17'S	57° 14.42'E	8	-	-	Transit to ROV site
10/12/11	344	03.27	32° 42.88'S	57° 14.60'E	8	-	-	At ROV site - hove to
10/12/11	344	04.02	32° 42.862'S	57° 14.666'E	8	5	ROV	ROV in water
10/12/11	344	11.13	32° 43.3'S	57° 15.2'E	8	5	ROV	ROV dead on seabed
10/12/11	344	12.45	32° 43.28'S	57° 15.30'E	8	5	ROV	ROV on deck major fault with high voltage supply / transformer on vehicle
10/12/11	344	12.45	32° 43.28'S	57° 15.30'E	8	-	-	Transit to multiprobe site
10/12/11	344	13.12	32° 42.72'S	57° 16.33'E	8	-	-	At multiprofiler site–hove to
10/12/11	344	13.36	32° 42.7295'S	57° 16.3301'E	8	6	Multiprofiler	Start multiprofiler
11/12/11	345	03.08	32° 42.7295'S	57° 16.3301'E	8	6	Multiprofiler	Multiprofiler at surface
11/12/11	345	03.09	32° 42.7295'S	57° 16.3301'E	8	6	Multiprofiler	Multiprofiler on deck
11/12/11	345	03.12	32° 42.7295'S	57° 16.3301'E	8	-	-	Transit to SWATH grid
11/12/11	345	03.55	32° 48.74'S	57° 17.22'E	8	-	-	At SWATH grid start
11/12/11	345	03.55	32° 48.8233'S	57° 17.1383'E	8	7	EM120+SBP	Start SWATH grid
11/12/11	345	12.19	32° 44.1'S	57° 16.2'E	8	7	EM120+SBP	End SWATH grid
11/12/11	345	12.20	32° 44.1'S	57° 16.2'E	8	-	-	Transit to HYBIS site
11/12/11	345	12.55	32° 41.83'S	57° 17.18'E	8	-	-	At HYBIS site – hove to
11/12/11	345	12.59	32° 41.835'S	57° 17.187'E	8	8	HYBIS	HYBIS in water
11/12/11	345	14.17	32° 41.83'S	57° 17.18'E	8	8	HYBIS	HYBIS at surface
11/12/11	345	14.20	32° 41.83'S	57° 17.18'E	8	8	HYBIS	HYBIS on deck to remove loose tape from camera
11/12/11	345	14.37	32° 41.837'S	57° 17.187'E	8	9	HYBIS	HYBIS in water
11/12/11	345	20.48	32° 41.2'S	57° 16.0'E	8	9	HYBIS	HYBIS at surface
11/12/11	345	20.50	32° 41.2'S	57° 16.0'E	8	9	HYBIS	HYBIS on deck – dive aborted because of unfavourable wind direction
11/12/11	345	20.52	32° 41.2'S	57° 16.0'E	8	-	-	Transit to HYBIS site
11/12/11	345	21.52	32° 40.3'S	57° 13.9'E	8	-	-	At HYBIS site – hove to
11/12/11	345	22.05	32° 40.535'S	57° 13.868'E	8	10	HYBIS	HYBIS in water
12/12/11	346	02.53	32° 40.64'S	57° 14.58'E	8	10	HYBIS	HYBIS at surface
12/12/11	346	02.55	32° 40.64'S	57° 14.58'E	8	10	HYBIS	HYBIS on deck
12/12/11	346	02.55	32° 40.64'S	57° 14.58'E	8	-	-	Downtime while considering options
12/12/11	346	03.22	32° 40.64'S	57° 14.58'E	8	-	-	Transit to core site
12/12/11	346	04.00	32° 43.32'S	57° 15.02'E	8	-	-	At core site – hove to
12/12/11	346	05.08	32° 43.323'S	57° 15.028'E	8	11	Megacore	Core in water
12/12/11	346	06.33	32° 43.323'S	57° 15.028'E	8	11	Megacore	Core at surface
12/12/11	346	06.34	32° 43.323'S	57° 15.028'E	8	11	Megacore	Core on deck – hove to
12/12/11	346	06.41	32° 43.3292'S	57° 15.0274'E	8	12	Megacore	Megacore in water
12/12/11	346	08.16	32° 43.3292'S	57° 15.0274'E	8	12	Megacore	Megacore at surface
12/12/11	346	08.18	32° 43.3292'S	57° 15.0274'E	8	12	Megacore	Megacore on deck
12/12/11	346	08.18	32° 43.3292'S	57° 15.0274'E	8	-	-	Transit to core site
12/12/11	346	08.55	32° 43.2340'S	57° 16.1265'E	8	-	-	At megacore site
12/12/11	346	08.55	32° 43.2340'S	57° 16.1265'E	8	13	Megacore	Megacore in water
12/12/11	346	10.37	32° 43.2340'S	57° 16.1265'E	8	13	Megacore	Megacore at surface
12/12/11	346	10.39	32° 43.2340'S	57° 16.1265'E	8	13	Megacore	Megacore on deck
12/12/11	346	10.39	32° 43.2340'S	57° 16.1265'E	8	-	-	Transit to core site
12/12/11	346	11.44	32° 43.351'S	57° 15.004'E	8	-	-	Arrive core site
12/12/11	346	11.44	32° 43.351'S	57° 15.004'E	8	14	Megacore	Megacore in water
12/12/11	346	13.02	32° 43.351'S	57° 15.004'E	8	14	Megacore	Megacore at surface

12/12/11	346	13.05	32° 43.351'S	57° 15.004'E	8	14	Megacore	Megacore on deck – hove to
12/12/11	346	13.13	32° 43.353'S	57° 15.002'E	8	15	Megacore	Megacore in water
12/12/11	346	14.35	32° 43.353'S	57° 15.002'E	8	15	Megacore	Megacore at surface
12/12/11	346	14.35	32° 43.353'S	57° 15.002'E	8	15	Megacore	Megacore on deck – hove to
12/12/11	346	14.45	32° 43.35'S	57° 15.00'E	8	-	-	Transit to CTD site
12/12/11	346	15.40	32° 40.05'S	57° 19.66'E	8	-	-	At CTD site – hove to
12/12/11	346	15.48	32° 40.0571'S	57° 19.6625'E	8	16	CTD	CTD in water
12/12/11	346	17.59	32° 40.0571'S	57° 19.6625'E	8	16	CTD	CTD at surface
12/12/11	346	18.01	32° 40.0571'S	57° 19.6625'E	8	16	CTD	CTD on deck
12/12/11	346	18.01	32° 40.0571'S	57° 19.6625'E	8	-	-	Transit to CTD site
12/12/11	346	18.41	32° 41.4'S	57° 18.1'E	8	-	-	At CTD site – hove to
12/12/11	346	18.46	32° 41.3968'S	57° 18.1308'E	8	17	CTD	CTD in water
12/12/11	346	20.26	32° 41.3968'S	57° 18.1308'E	8	17	CTD	CTD at surface
12/12/11	346	20.32	32° 41.3968'S	57° 18.1308'E	8	17	CTD	CTD on deck
12/12/11	346	20.32	32° 41.3968'S	57° 18.1308'E	8	-	-	Transit to CTD site
12/12/11	346	21.08	32° 42.0'S	57° 17.3'E	8	-	-	Arrive CTD site
12/12/11	346	21.08	32° 42.008'S	57° 17.264'E	8	18	CTD	CTD in water
12/12/11	346	22.35	32° 42.008'S	57° 17.264'E	8	18	CTD	CTD at surface
12/12/11	346	22.37	32° 42.008'S	57° 17.264'E	8	18	CTD	CTD on deck
12/12/11	346	22.39	32° 42.008'S	57° 17.264'E	8	-	-	Transit to CTD site
12/12/11	346	23.09	32° 43.3'S	57° 17.3'E	8	-	-	Arrive CTD site – hove to
12/12/11	346	23.15	32° 43.2794'S	57° 15.8902'E	8	19	CTD	CTD in water
13/12/11	347	00.26	32° 43.2794'S	57° 15.8902'E	8	19	CTD	CTD at surface
13/12/11	347	00.27	32° 43.2794'S	57° 15.8902'E	8	19	CTD	CTD on deck
13/12/11	347	00.27	32° 43.2794'S	57° 15.8902'E	8	-	-	Downtime as azimuth thruster stuck
13/12/11	347	00.42	32° 43.28'S	57° 15.89'E	8	-	-	Transit to CTD site
13/12/11	347	01.05	32° 43.87'S	57° 15.21'E	8	-	-	Arrive CTD site
13/12/11	347	01.08	32° 43.8767'S	57° 15.2200'E	8	20	CTD	CTD in water
13/12/11	347	02.18	32° 43.8767'S	57° 15.2200'E	8	20	CTD	CTD at surface
13/12/11	347	02.19	32° 43.8767'S	57° 15.2200'E	8	20	CTD	CTD on deck
13/12/11	347	02.20	32° 43.8767'S	57° 15.2200'E	8	-	-	Transit to CTD site
13/12/11	347	02.45	32° 44.71'S	57° 14.10'E	8	-	-	Arrive CTD site – hove to
13/12/11	347	02.49	32° 44.729'S	57° 14.112'E	8	21	CTD	CTD in water
13/12/11	347	04.46	32° 44.729'S	57° 14.112'E	8	21	CTD	CTD at surface
13/12/11	347	04.47	32° 44.729'S	57° 14.112'E	8	21	CTD	CTD on deck
13/12/11	347	04.50	32° 44.729'S	57° 14.112'E	8	-	-	Transit to ROV site
13/12/11	347	05.30	32° 42.2'S	57° 18.0'E	8	-	-	At ROV site – hove to
13/12/11	347	05.50	32° 42.225'S	57° 18.020'E	8	22	ROV	ROV in water
13/12/11	347	15.33	32° 42.59'S	57° 17.01'E	8	22	ROV	ROV on surface
13/12/11	347	15.34	32° 42.59'S	57° 17.01'E	8	22	ROV	ROV on deck
13/12/11	347	15.34	32° 42.59'S	57° 17.01'E	8	-	-	Transit to net site
13/12/11	347	16.04	32° 42.1'S	57° 14.4'E	8	-	-	Arrive net site
13/12/11	347	16.05	32° 42.1904'S	57° 14.419'E	8	23	Ring net(small)	Net in water
13/12/11	347	16.58	32° 42.1904'S	57° 14.419'E	8	23	Ring net(small)	Net at 700m wire out
13/12/11	347	17.25	32° 42.1904'S	57° 14.419'E	8	23	Ring net(small)	Net at surface
13/12/11	347	17.25	32° 42.1904'S	57° 14.419'E	8	23	Ring net(small)	Net on deck – hove to
13/12/11	347	17.35	32° 42.1887'S	57° 14.42'E	8	24	Ring net (small)	Net in water
13/12/11	347	18.27	32° 42.1887'S	57° 14.42'E	8	24	Ring net (small)	Net at 700m wire out
13/12/11	347	18.55	32° 42.1887'S	57° 14.42'E	8	24	Ring net (small)	Net at surface
13/12/11	347	18.56	32° 42.1887'S	57° 14.42'E	8	24	Ring net (small)	Net on deck – hove to
13/12/11	347	19.00	32° 42.188'S	57° 14.423'E	8	25	Ring net (small)	Net in water
13/12/11	347	20.02	32° 42.188'S	57° 14.423'E	8	25	Ring net (small)	Net at surface
13/12/11	347	20.03	32° 42.188'S	57° 14.423'E	8	25	Ring net (small)	Net on deck – hove to
13/12/11	347	20.25	32° 42.1874'S	57° 14.425'E	8	26	Megacore	Core in water
13/12/11	347	22.39	32° 42.1874'S	57° 14.425'E	8	26	Megacore	Core at surface
13/12/11	347	22.40	32° 42.1874'S	57° 14.425'E	8	26	Megacore	Core on deck – hove to
13/12/11	347	22.52	32° 42.189'S	57° 14.423'E	8	27	Megacore	Core in water
14/12/11	348	00.58	32° 42.189'S	57° 14.423'E	8	27	Megacore	Core at surface
14/12/11	348	01.00	32° 42.189'S	57° 14.423'E	8	27	Megacore	Core on deck – hove to
14/12/11	348	01.19	32° 42.189'S	57° 14.424'E	8	28	Megacore	Core in water
14/12/11	348	03.25	32° 42.189'S	57° 14.424'E	8	28	Megacore	Core at surface
14/12/11	348	03.25	32° 42.189'S	57° 14.424'E	8	28	Megacore	Core on deck
14/12/11	348	03.25	32° 42.189'S	57° 14.424'E	8	-	-	Transit to ROV site
14/12/11	348	03.54	32° 42.85'S	57° 16.33'E	8	-	-	At ROV dive site – hove to
14/12/11	348	04.32	32° 42.860'S	57° 16.338'E	8	29	ROV	ROV in water
14/12/11	348	07.18	32° 42.860'S	57° 16.338'E	8	29	ROV	ROV at surface
14/12/11	348	07.20	32° 42.860'S	57° 16.338'E	8	29	ROV	ROV on deck
14/12/11	348	07.22	32° 42.860'S	57° 16.338'E	8	29	ROV	Transit to Port Elizabeth
15/12/11	349							Transit to Port Elizabeth
16/12/11	350							Transit to Port Elizabeth

17/12/11	351	Transit to Port Elizabeth
18/12/11	352	Transit to Port Elizabeth
19/12/11	353	Transit to Port Elizabeth
10/12/11	354	Transit to Port Elizabeth

4.1.2 Breakdown of activities during the cruise by time

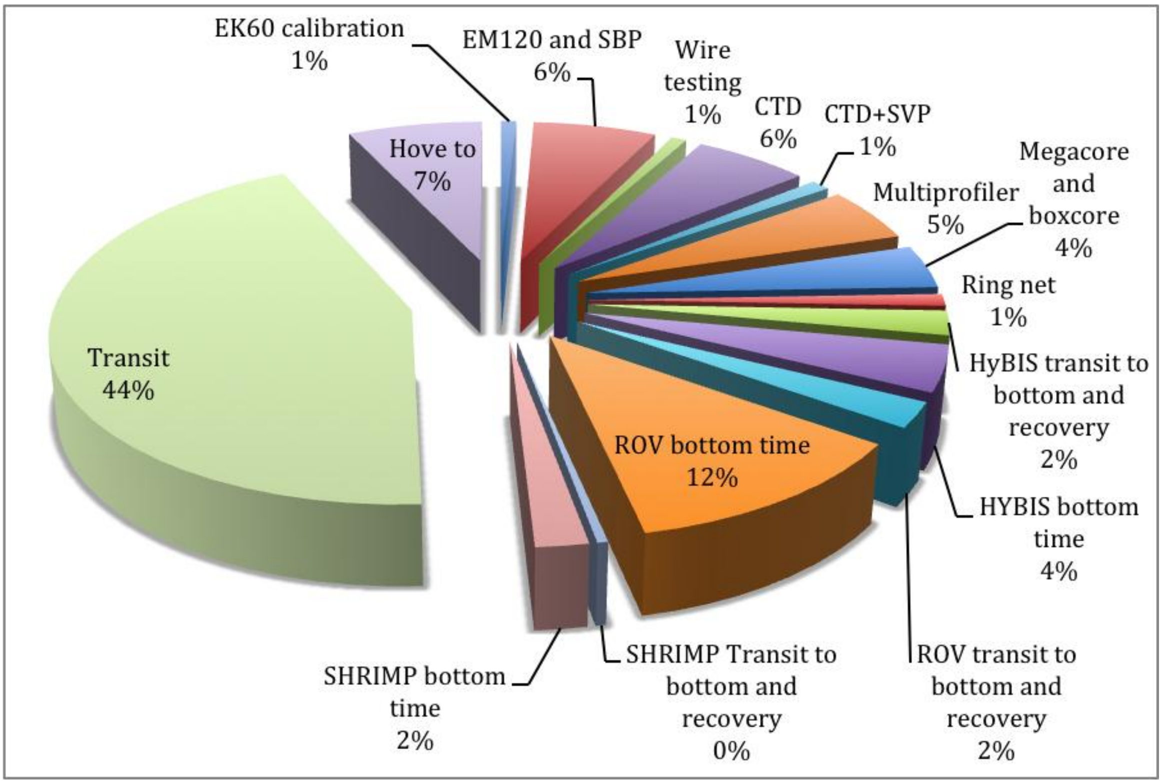

Figure 10. Breakdown of the use of time during cruise JC066

The breakdown of the use of time during cruise JC066 (Fig. 10) indicates that most time was actually spent in transit between sites or between working locations on seamounts. Time “hove to” includes periods of bad weather as well as periods when the vessel is awaiting sampling operations as equipment is prepared for deployment. Oceanographic studies took up ~11% of the time on the cruise, geophysical studies took up ~ 6% of the time. Deep submergence operations occupied most of the sampling time making a total of 20% of the cruise time.

Diving statistics are as follows:

	Total bottom time	Average dive length	Average bottom time
HYBIS	1.88 days	4.47 hours	3.01 hours
ROV	5.10 days	8.17 hours	6.45 hours
SHRIMP	0.88 days	5.09 hours	4.24 hours

Other types of sampling made up 5% of the cruise time (mainly megacore but also box core and nets). In total, specific scientific sampling or survey operations made up 42% of the cruise time. Other instruments were gathering data for the entire duration of the cruise including, for example, the Acoustic Doppler Current Profilers (ADCPs), constant measurements of the physical characteristics of surface seawater, meteorological measurements, the EM120 and SBP and the EK60.

4.2 Cruise track

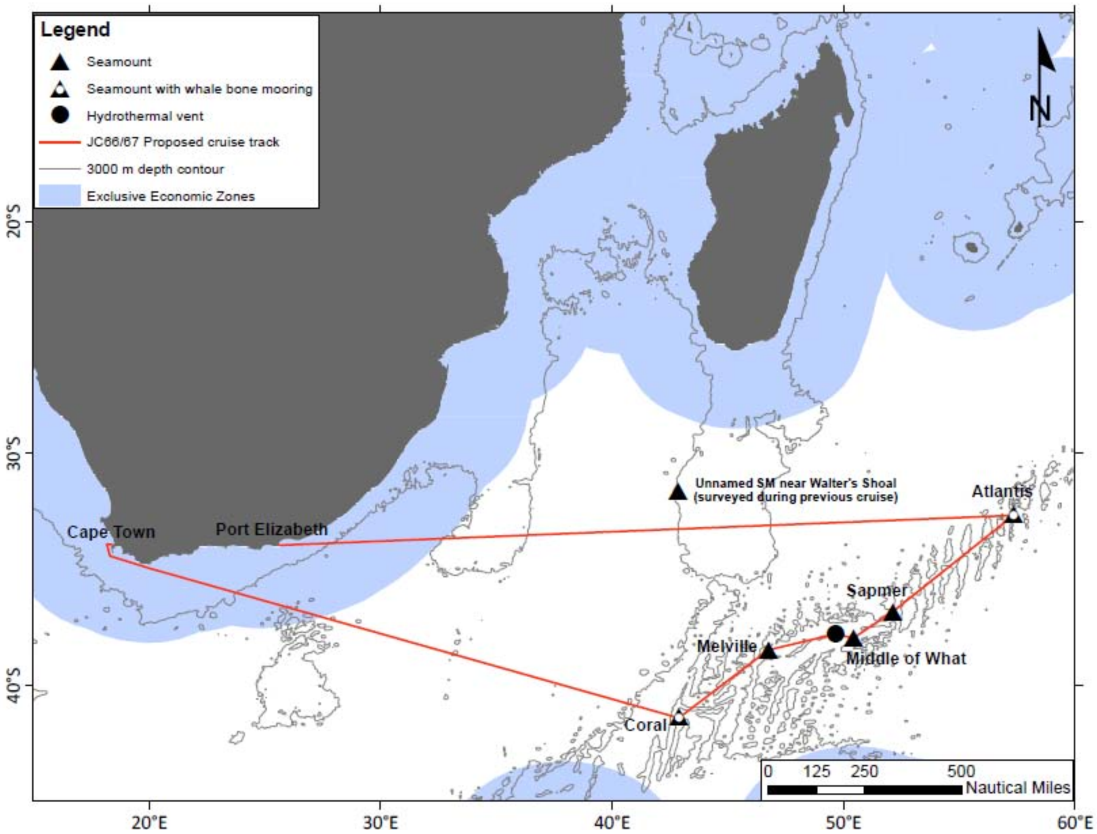

Figure 11. Cruise map highlighting locations of five seamounts visited on the RRS *James Cook* JC066 cruise. The five seamount sites were, from south to north, Coral Seamount, Melville Bank, Middle of What Seamount, Sapmer Bank and Atlantis Bank. The hydrothermal vent system studied during JC067 is indicated by the filled circle.

4.3 Weather conditions

Weather conditions for the duration of the cruise were very good for the South West Indian Ocean. Losses of science time were fairly minimal as a result of strong winds and heavy seas. In general, wind speeds were <10m s-1 with high winds only three or four times and these for fairly short durations.

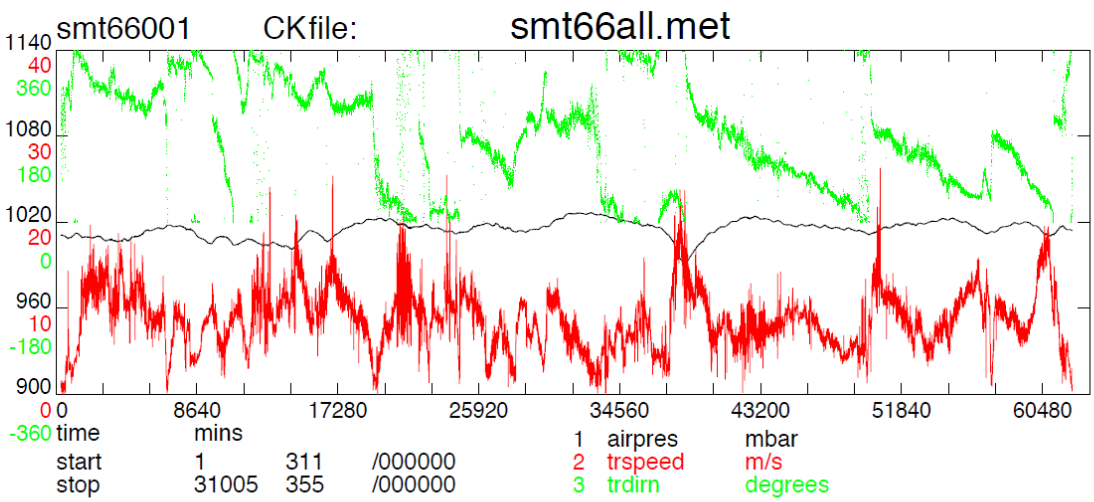

Figure 12. Graph of wind speed, wind direction and atmospheric pressure through the cruise.

5 Initial Scientific Reports

5.1 Geophysics cruise report

5.1.1 Objectives

The aim of the marine geophysics work was to study the characteristics of mid-ocean ridge seamounts on an ultra-slow spreading ridge (~16mm/yr). The principle objectives include:

(1) To undertake detailed bathymetric surveys of the seamounts in order to study growth and decay processes including eruptions and landslides.
(2) Gravity surveys to characterise flexure of the crust due to loading by the volcanic mass.
(3) Sub-bottom profiling to quantify sediment cover.

Previous bathymetry collected by a Simrad EM710 multibeam echosounder aboard the *Fritjof Nansen* in 2009 was available for comparison.

5.1.2 Swath Bathymetry

5.1.2.1 Survey planning

Surveys were planed based on previous 2009 data, from which expected swath widths were calculated and sufficient overlap allowed for. Across track coverage is around 2.5 times the water depth; the minimum depth ranged from 140m (Melville) to 960m (Middle of What). Figure 13 shows a typical survey pattern.

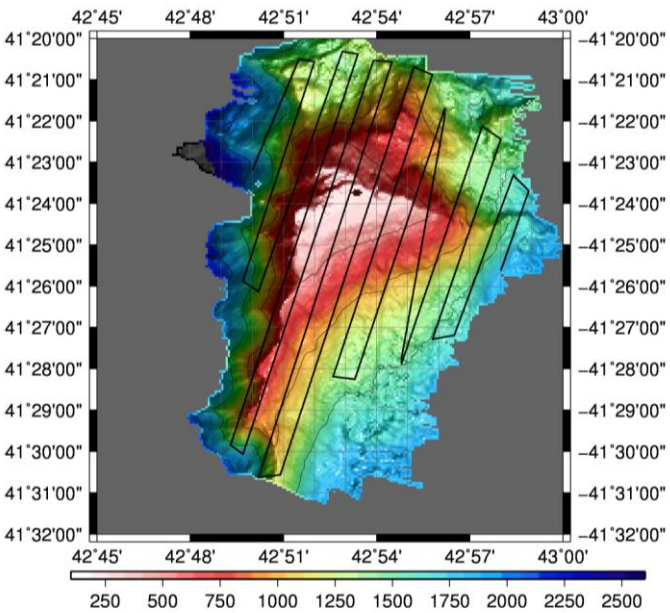

Figure 13 – Coral seamount bathymetry with cruise tracks

For Melville seamount survey (Station 5, Event 2) bad weathered necessitated additional lines to be added to the survey during acquisition.

5.1.2.2 Acquisition

Data was collected using the hull mounted Kongsberg-Simrad EM120 multibeam echo sounder which produces 191 beams per ping. This was monitored during acquisition using SIS software (Fig. 14)

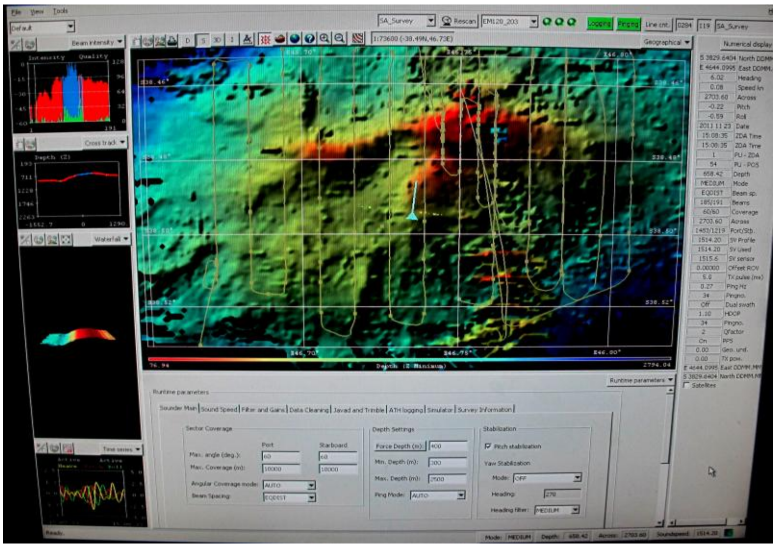

Figure 14. Screenshot of SIS software system during the Melville Bank

Following collection of raw data, editing was undertaken in both MB-system and Caris software to remove bad pings (outside of background levels) from the data. These were then gridded up using GMT software (Wessel and Smith, 1991) to produce contoured maps.

5.1.3 Bathymetry of the seamounts

5.1.3.1 Coral Seamount

This and subsequent surveys filled in gaps in the 2009 data (Fig. 15) as well as providing a time series allowing study of mass wasting and eruption process over short timescales. These will be analysed through difference maps with negative areas inferring landslides and positive areas inferring volcanic eruptions or tectonic inflation. Coral seamount shows little evidence of recent large-scale landsliding with no clear headscars or debris chutes. The triangular summit shape possibly originated as axial volcanic rifts with landsliding between, now covered by pelagic sediment. The main ridge is elongated N-S parallel to the adjacent fracture zone. The perpendicular ridge trends east from the summit and has broad and rugged unfailed slopes.

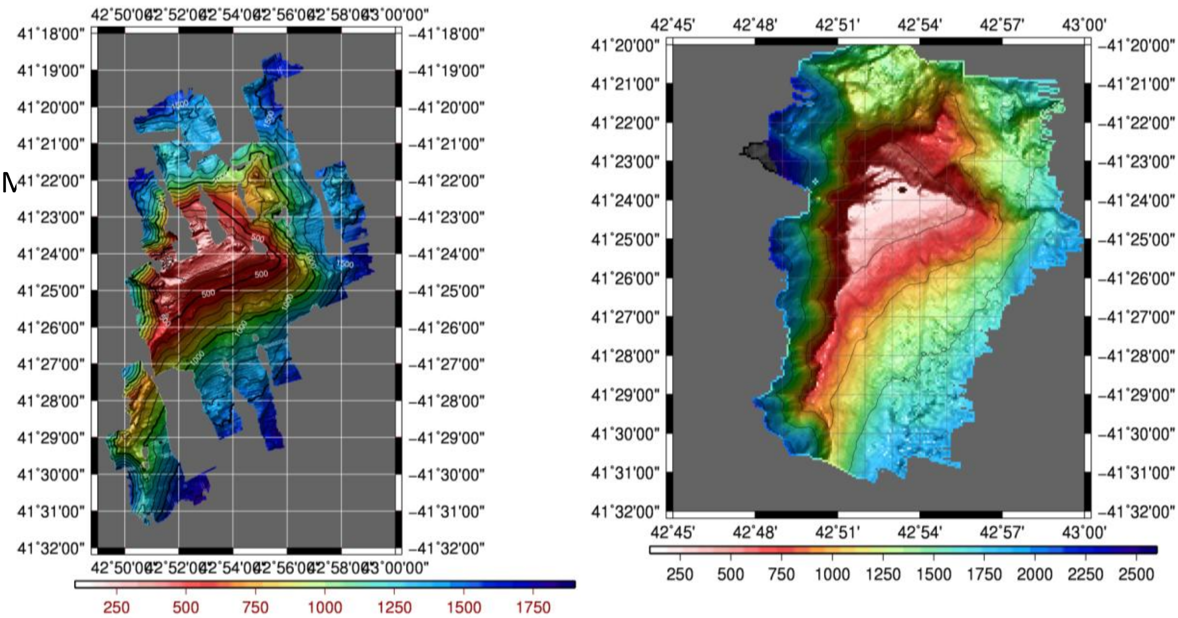

Figure 15. Comparison of 2009 and 2011 data for Coral Seamount

5.1.3.2 Melville Bank

In contrast to Coral Seamount, Melville Bank shows recent mass wasting; in particular there is a large landslide on the SW side forming a clear headscar, chute and debris deposit. The landslide was channelled between the E-W trending axial ridge and a large slump to the south. The landslide profile shows a steep profile; traditionally these show exponential forms, $(y = ae^{-bx}) + c$,with coefficients between 0.05 and 0.15.

Melville Bank shows an axial morphology with the longest axis trending 090° (E-W) showing no relationship with the NNE-SSW fracture zone located 20km to the West (Fig. 16). This axial morphology is enhanced by mass wasting between the ridges.

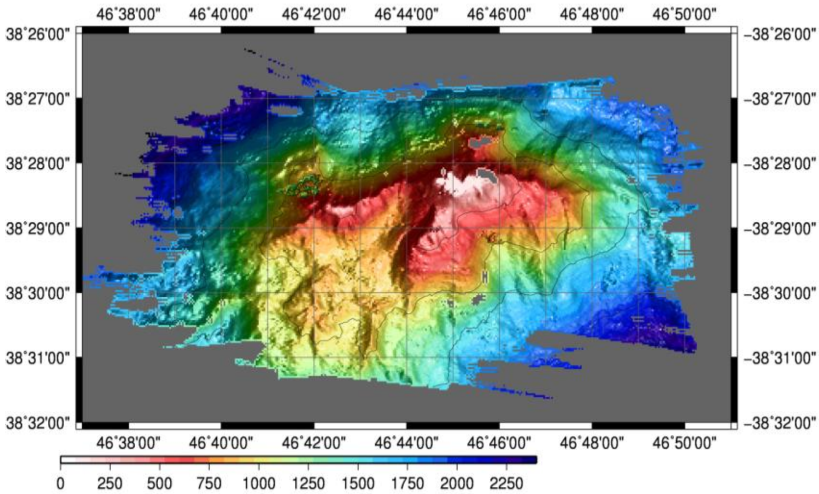

Figure 16. Bathymetry of Melville Bank from current cruise (2011) data

5.1.3.3 Middle of What Seamount

Middle of What seamount is much smaller both in height and aerial extent, suggesting either lower magmatic supply or younger age, the latter supported by its location close to the ridge axis. Clean, unfailed cones indicates recent active magmatism although there is no age constraint.

Middle of What has a more rounded geometry with no axial ridges but is cut by three 090° (E-W) trending faults (Fig. 17). These faults are perpendicular to the oblique spreading direction (N-S) of the ridge and so are likely accommodating extension.

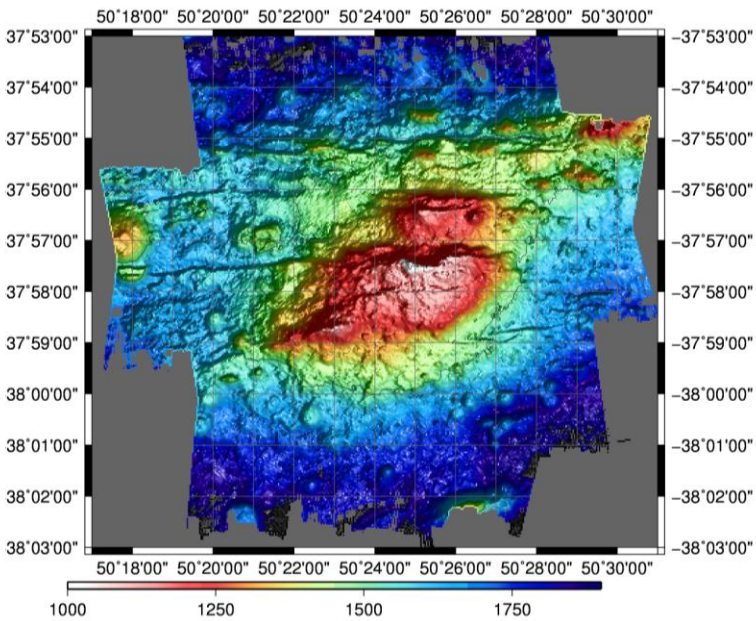

Figure 17. Bathymetry of Middle of What Seamount from current cruise (2011) data

5.1.3.4 Sapmer Seamount

Sapmer seamount has a very irregular, rough bathymetry (Fig. 18). A steep ridge extends NE-SW with more irregular ridges running perpendicular to this trending SE. These ridges possibly originated as volcanic rifts or were created by mass wasting between features. Several large landslides will be compared to the large landslides on Melville Bank to judge similarity of mass wasting processes on the different seamounts.

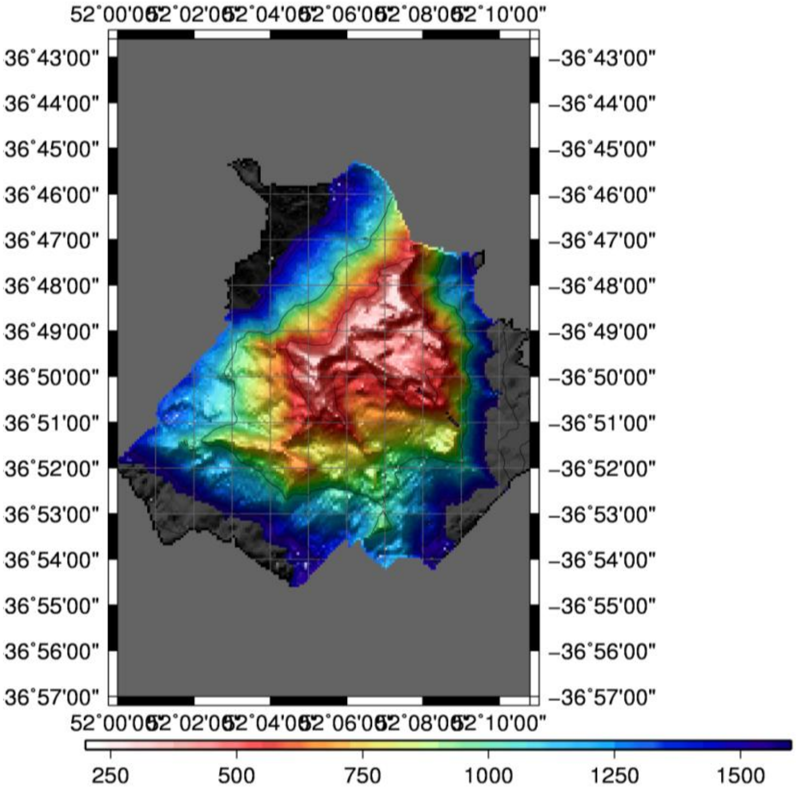

Figure 18. Bathymetry of Sapmer seamount from current cruise (2011) data

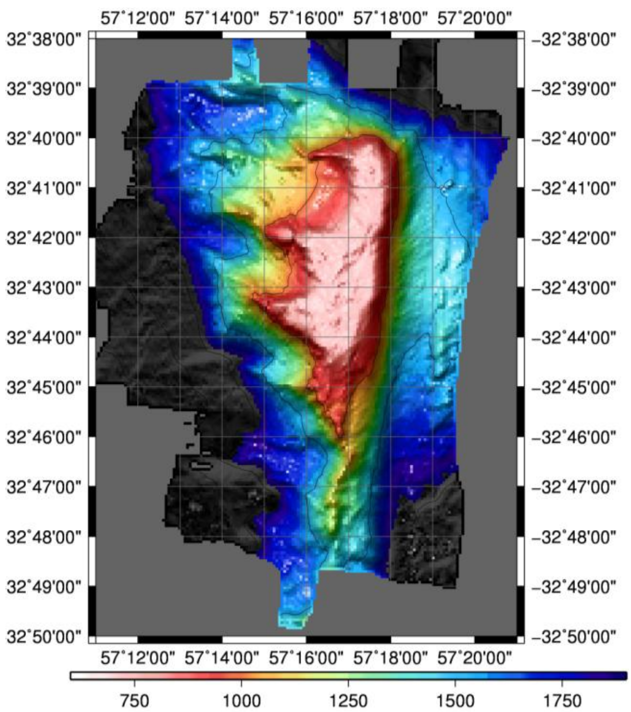

Figure 19. Bathymetry of Atlantis Bank from current cruise (2011) data

5.1.3.5 Atlantis Bank

Atlantis Bank (Fig. 19) is an oceanic core complex which has been exhumed from oceanic crust due to fault action. In the past it rose above sea level as evidenced by the limestones and beachrock found near the summit. Atlantis shows evidence of large-scale mass wasting on the west face with multiple landslides overlapping each other to the north. These landslides may be triggered by movement on the faults exhuming the bank. The top of Atlantis bank is flattened off, most likely due to wave action when it emerged as an island before sinking again. Since a large part of Atlantis Bank is composed of different material than the other seamounts, due to the different origins, it will may provide insight into the influence of composition on landsliding. Atlantis Bank is strongly elongated N-S parallel to the exhumation faults and adjacent fracture zone.

5.1.3 Gravity

An NMFSS Lacoste & Romberg Air-Sea gravimeter (number S84) was used to record the relative gravity throughout the cruise (Fig. 20). This instrument was in continuous operation throughout the cruise. The gravimeter has a calibrated range of 12,000 mGal and is sensitive to ±0.1 mGal. To correct for instrument drift over the duration of the cruise and convert relative to absolute measurements, the gravimeter was tied to absolute gravity reference stations in Cape Town and Port Elizabeth. The drift per month will be calculated to ensure this is within the manufacturer’s specifications.

Although the meter’s logging system will automatically calculate the filtered gravity from the spring tension on the beam, and correct it for Eotvos using input navigational data, during the cruise the Lacoste-Romberg QC gravity in counter units will be independently processed with the underway navigation and bathymetry and satellite-derived gravity data and converted to a free-air gravity anomaly for purposes of quality control. In the processing, a low-pass filter of variable width (200-2000 sec) and a delay of 180 sec will be used. Large fluctuations in the Eotvos correction are caused by changes in the speed and heading of the vessel. The free-air anomalies will be recovered from the processed data and compared with bathymetry and satellite-derived gravity data.

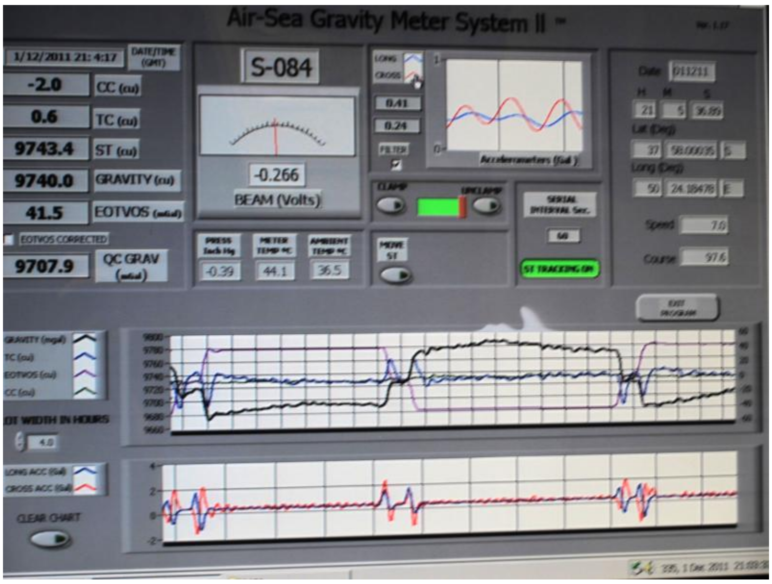

Figure 20. Screenshot of the gravimeter console. The black line represents corrected gravity values, while the purple line shows the EOTVOS correction. These are fluctuating periodically as the ship completes a swath survey passing over the seamount in different directions.

Figure 21 shows the regional gravity into which this high resolution data will be incorporated to provide influence to the tectonics of the ridge. Free-air anomaly profiles across each of the seamounts will be used to estimate elastic thickness and flexure of the crust providing an age constraint.

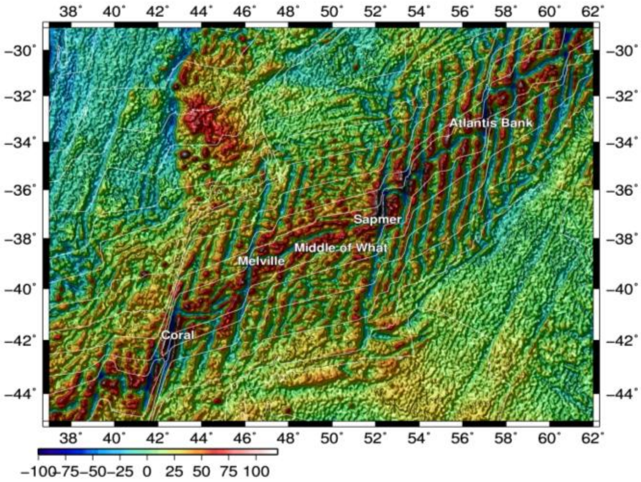

Figure 21. Regional free air anomalies derived from satellite altimetry. N-S fracture zones marked by a gravity low are N-S illustrating the highly oblique spreading direction. Seamounts along the walls of the median valley exhibit gravity highs due to the mass excess.

5.1.4 Sub-bottom Profiler

The sub-bottom profiler (SBP) struggled to attain any penetration on the seamounts due to steep slopes and a general lack of thick sediment cover. This is consistent with the young age of the seamounts. No numerical data was acquired since steep slopes prevented the return beams reaching the ship.

5.1.5 Conclusions

Overall the seamounts along this ultra-slow spreading ridge show a wide variety of mass wasting and magmatic behaviour. The geometries of the seamounts appear to be highly influenced by tectonics in particular the N-S trending fracture zones. The different seamounts will hopefully provide insight into the different stages through the evolution of these seamounts.

5.2 RRS James Cook cruise JC066 Physical Oceanography

5.2.1 Introduction

Surveys conducted in 2009 on the RV *Dr Fridjtof Nansen* cruise 09410 made observations of a variety of physical processes operating at seamounts in the SW Indian Ocean. In particular, there were strong tides, internal waves and propagation of energy through the water column above seamounts with evidence of mixing and modification of water masses at depths throughout the water column. RRS *James Cook* cruise 066 provided the opportunity to attempt to quantify the mixing, although due to the priorities of the cruise, the amount of work that could be done was fairly limited.

With the limited time available, the objectives for cruise 066 were:

1. To make microstructure measurements over a tidal cycle at 5 seamounts.
2. To make full depth CTD and LADCP measurements to provide large scale density structure and watermass structure.
3. To make acoustic Doppler current meter measurements of the tides and currents associated with each seamount.

Objective 1 was achieved for four seamounts (Coral, Melville, Sapmer and Atlantis) by making upper ocean (300m) turbulence measurements over a 13-hour period (approximately a tidal cycle). However, the summit of Middle of What is about 1000 m and with the topography affecting mainly the bottom 500 m of the water column, a full depth, 13-hour, CTD+LADCP yoyo was worked instead.

Objective 2 was achieved with short CTD transects across each seamount consisting of 6 or 7 CTD with LADCP profiles.

The plan for Objective 3 was to have an upward looking ADCP positioned on the seabed for the duration of each seamount survey. It was anticipated that the instrument would be deployed and recovered by the *Kiel* 6000 ROV. Unfortunately, due to time and weather constraints this was not achieved. Vessel-mounted ADCP measurements were made throughout the cruise and it is hoped that these will provide some information about the currents and tides.

5.2.2 Turbulence measurements

During RRS *James Cook* cruise 066 the microstructure profiler MSS90L serial number 50 was used to make microstructure turbulence measurements in the upper 300 m of the ocean. In addition, the profiler makes simultaneous precise and high resolution measurements of physical properties of the water column. Information about the equipment and methods needed for turbulence measurements were gathered from previous cruise reports: RRS *James Cook* cruise 29, RRS *Discovery* cruises 369, 321 and 306. Much of the information reported here is gleaned from those reports.

Measurements were made at 4 seamounts (Table 1) and over a 13-hour period to ensure that any changes or processes associated with the tidal cycle were captured. Previous experience in analysing the turbulence probe data suggests that it is important to average over 5-10 profiles to obtain robust estimates of turbulence (turbulence tends to be log-normally distributed). However, taking a full 13 hours of measurements shows how the turbulence develops and the water mass structure and movement with which the turbulence is associated.

Table 1. MSS90L events.

Station	Event	Start			End			Latitude	Longitude	Depth	No of
		jday	date	time	jday	date	time	°S	°E	m	profiles
Coral	4 /10	318	14Nov	18:39	319	15Nov	07:36	41 25.329	42 50.751	784	52
Melville	5 /10	326	22Nov	17:03	327	23Nov	05:06	38 28.257	46 43.920	521	55
Sapmer	7 /2	339	05Dec	13:51	340	06Dec	03:02	36 50.616	52 08.455	513	47
Atlantis	8 /6	344	10Dec	13:36	345	11Dec	03:02	32 42.712	57 16.331	742	53

5.2.2.1 Profiler description

The MSS90L profiler is produced by Sea and Sun Technology GmbH in cooperation with ISW Wassermesstechnik. The profiler consists of a cylindrical titanium housing, 1250 mm length and 90 mm diameter. The housing is water tight to 5MPa (500 m depth). Weights and buoyancy rings can be added to the top and bottom of the probe respectively to tune the sinking velocity by altering the buoyancy. For this cruise, the profiler was equipped with 2 velocity microstructure shear sensors (serial numbers 098 and 099), a microstructure temperature sensor, standard CTD sensors, a fluorometer, vibration control sensor and two component tilt sensors (details in Table 2). The sampling rate for all sensors is 1024 Hz with 16-bit resolution. All sensors are mounted at the measuring head of the profiler. The shear sensors are positioned at the tip of a slim shaft about 150 m in front of the CTD sensors. Data are transferred from the profiler by electrical cable to an onboard unit that pipes the data to a laptop PC.

Table 2. MSS90L sensors.

Sensor	Descriptions	Range	Accuracy	Resolution	Type	Calibration date
Count	Record counter	-			-	13.05.2011
NTCHP	Temperature	-2 to +30°C	±0.02°C	500 µK linear	NTCH FP07	13.05.2011
Pressure	Pressure	50 dbar	±0.1% fs	0.002 % fs	PA7-50	12.05.2011
SHE1	Shear 1	0 to 6 s^{-1}	-	~ 10-3 s^{-1}	098 PNS	13.05.2011
Temp	Temperature	-2 to +30°C	±0.01°C	0.0005 °C	PT100	12.05.2011
SHE2	Shear 2	-			0099 PNS	13.05.2011
Cond	Conductivity	0 to 6 mS/cm	0.005 mS/cm		0.0001 mS cm-1	small
	13.05.2011					
ACC	Acceleration	-1 to +1 m/s^2	0.02 m/s^2	0.005 m/s^2	s/n 8026	29.04.2011
NTC	Temperature	°C			NTC FP07	13.05.2011
ACCx	Acceleration in X	g			ADXL203	29.04.2011
ACCy	Acceleration in Y	g			ADXL203	29.04.2011
Chl_A	Chlorophyll A	µg/l			Cyclops 7 s/n 2101848	29.04.2011

Shear sensor calibration information were provided by ISW Wassermesstechnik together with the vibration control sensor and tilt sensor calibrations. All were carried out using special equipment for each sensor. CTD sensor calibration information was provided by Sea and Sun Technology GmbH using standard calibration equipment and procedures for CTDs. Coefficients to convert voltages into scientific values are listed in Table 3.

Table 3. MSS90L sensor coefficients.

	A(0)	A(1)	A(2)	A(3)	A(4)	A(5)
Count	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
NTCHP	-9.86705E-04	7.87983E-04	-5.19891E-05	1.71744E-06	0.00000E+00	0.00000E+00
Pressure	-2.56906E+01	8.96001E-03	5.05514E-10	-1.78035E-14	0.00000E+00	0.00000E+00
SHE1	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
	Sensitivity		b(0) = 1.314E-2		b(1) = 2.627E-2	
Temp	-2.66014E+00	5.99424E-04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
SHE2	0.00000E+00	1.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
	Sensitivity		b(0) = 1.247E-2		b(1) = 2.494E-2	
Cond	-2.10064E-01	9.92301E-04	-6.14395E-12	3.12017E-16	0.00000E+00	0.00000E+00
ACC	-1.18237E+01	3.61722E-04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
NTC	5.07766E-04	3.68218E-04	-1.24800E-05	4.70817E-07	0.00000E+00	0.00000E+00
ACCx	-1.12558E+00	3.41524E-05	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
ACCy	-1.12436E+00	3.42877E-05	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
Chl_A	-9.92032E-02	9.58597E-05	0.00000E+00	0.00000E+00	-1.30000E-01	1.00000E+01

5.2.2.3 Installation and operation

The profiler is operated via a winch, SWM1000, which was mounted on the port stern quarter of the vessel. Both the winch and the winch controller were bolted to the bulwark. The power cable for the winch and the data cable connecting the profiler to the PC were run along the port side of the vessel and into the deck laboratory through the bosuns locker. Except in bad weather, the winch was left on the bulwark where the connectors, in addition to blanking plugs, were protected by plastic sheeting. The probe and controller were stored in the hangar. During storms, the winch was also removed to the hangar.

There are two issues with deployment: Cable should always be fed out sufficiently quickly to ensure that at least two loops are always visible in the top few metres of the water. The cable has a tendency to catch occasionally, possibly because of salt crystals, and can tangle because of twists. Therefore, it is necessary to keep a hand between the spooling out cable (without touching it to ensure there are no vibrations that could be recorded as turbulence) and the drum to catch and throw off any loops that might catch. The other issue is to ensure that the cable streams clear of the ship. In the weak currents off Atlantis the probe drifted under the vessel and the ship turned across the cable, trapping it beneath the hull. The profiler was eventually recovered from the opposite side of the ship.

The profiler was previously used on *Discovery* cruise 369 and the configuration and setup were the same for this cruise. The profiler had a sinking velocity of approximately 0.7 m/s. During the first two sessions at Coral and Melville, the ship was able to balance the current against its speed to maintain a steady geographical location for the duration of the 13-hour deployment. At the third site, Sapmer, the current was too weak and the ship had to steam at 0.2-0.3 knots to stream the cable, which meant relocating to the geographical position approximately every 2 hours. An added complication was the presence of a Japanese fishing vessel that was trawling over the same spur of the seamount, at times it was not possible to return to the same location. At the fourth site, Atlantis, the current was very weak leading to problems trailing the cable.

Profiler deployment was undertaken by two people on the after deck and one in the lab. Those on the after deck were able to manage cable spooling problems, which besides the occasional snarl, included bluebottles (baby man-of-war jellyfish that cause extremely painful stings) and albatross. Bluebottles were found on the cable at Sapmer and Atlantis and care had to be taken to ensure the operators were not hurt. Albatross picked up the cable only once at Coral. Snarls in the cable were, on the whole, cleared without affecting the free fall of the probe. In general there was between 20-40 m of slack cable in the water.

Raw data from the profiler were transmitted by RS485 data link to the interface unit of the measuring system and from there by USB to the logging PC. Data were displayed and logged using the SDA 180 software package. Raw data were stored in the proprietary MRD binary format. No further processing was undertaken on the logging PC. Details of each profile including start and stop time, position, water depth and maximum depth of profile were logged manually.

One thing not made clear in previous cruise reports is the set-up for the SST SDA software. The package works on the principal of 'projects', where details of probes and sensors are contained in the project file (suffix PRJ), cruise and file information are stored in the header (suffix HDR) and sensor coefficients are stored in the configuration file (suffix CFG). It is essential to have the coefficients correctly entered because they are added to the header of each file as the data are logged. The raw data file are stored as binary and the first step of any subsequent processing is to convert (or import) the data into ascii and apply the coefficients. It is not clear that there is any way of correcting the data should the wrong coefficients be stored in the file header. The project files already existed for the MSS90L serial 50 probe as they had been created for *Discovery* cruise 369. The data collected for this cruise, JC66, effectively formed an extension to that project.

The raw binary data files (suffix MRD) were transferred to a Samsung netbook for processing after the failure of the dedicated Dell PC. Processing took place using the MSS Pro software version 1.05 (2010). However, processing steps did not exactly follow previous processing paths because it proved impossible to read a file once the 'cutgraf' utility had been used. Files had to be processed with surface and hauling 'bad data' at the beginning and end, and this needs to be investigated post cruise. Trying to transfer the data off the logging PC tended to cause the logging to crash, therefore the velocity or fall rate was not, in general, checked before profiling took place. For the same reason, no checks were made on the state of the shear probes.

Data were processed in three steps.

1. *Convert+shear* - converted the data from binary to ascii format at 1024 Hz, which vastly inflates the files (15-20MB to ~120-150MB). Data were converted from raw volts to scientific units and velocity and shear were calculated. The results were output to files with the prefix 'sh' (shear).
2. *Espilon+thorpe* - calculated turbulent dissipation rates and thorpe scales, and output data to files prefixed 'ep' (epsilon).
3. *Eddy* - calculated turbulent diffusivities and output results to files prefixed 'kd'.

Data were divided into two directories, rawdata contained the original binary files and processdata contained all subsequent output. During batch operations data were written to the eponymously named 'tob' file for each module. Using the Samsung netbook, it took approximately 10 minutes to run *convert+shear* on each profile. *Epsilon+thorpe* was slightly faster at 7-8 minutes per profile. This reduced the data so the final batch job, *eddy*, was very quick. The utilities datgraf and spectrum were used to visually inspect the data during processing, while tsgraf was used to produce pseudo contour plots of the data once processing was complete. During processing the Chl_A values appear to have been corrupted. This will be investigated post cruise, as the values looked reasonable during logging.

5.2.3 CTD measurements

At each seamount a single full depth CTD with SVP (sound velocity profile) was worked prior to any other activity, to provide accurate speed of sound in water for the acoustic instruments. During each seamount station a short CTD transect, consisting of 6 or 7 stations, was worked across the seamount. In addition, a 13-hour full depth (1000 m) CTD yoyo at Middle of What collected 13 profiles. Thus, a total of 51 CTD stations were worked (Table 4).

A downward looking 300 kHz RDI workhorse ADCP on the CTD frame provided current data for each profile, including the yoyo. These will be processed post-cruise using the Visbeck v10 software.

CTD stations were sampled for bacteria and POC, macro nutrients, dissolved oxygen and salinity. A total of 217 nutrient samples were frozen immediately after collection and will be analysed for nitrate+nitrite, phosphate and silicate on return to Southampton. Dissolved oxygen (230) and salinity (89) samples were collected to calibrate the CTD sensors.

Table 4. CTD station listing.

Stn no	event no	cast no	jday	date yymmdd	time start	time down	time end	latitude °S	longitude °E	depth m	altim m
Test											
1		001	311	111107	1410	1420	1427	33 53.77	18 14.67	93	12
Coral Seamount											
4	1	002	316	111112	0401	0438	0531	41 20.84	42 55.52	1327	7
4	23	003	321	111117	1839	1933	2106	41 21.23	42 50.30	1988	10
4	24	004	321	111117	2245	2311	2335	41 23.50	42 51.26		-
4	25	005	322	111118	0121	0208	0304	41 23.50	42 51.26	955	11
4	26	006	322	111118	0411	0431	0453	41 24.28	42 51.67	183	9
4	27	007	322	111118	0550	0624	0655	41 25.71	42 52.51	580	14
4	28	008	322	111118	0742	0830	0921	41 27.09	42 53.08	1198	11
4	29	009	322	111118	1025	1111	1210	41 29.13	42 54.01	1598	7
Melville Bank											
5	1	010	325	111121	1021	1105	1201	38 30.50	46 40.33	1340	11
5	3	011	326	111122	0332	0437	0541	38 31.56	46 45.74	1960	12
5	4	012	326	111122	0624	0702	0745	38 30.17	46 45.32	1195	11
5	5	013	326	111122	0834	0900	0929	38 29.23	46 44.98	550	8
5	6	014	326	111122	1010	1038	1103	38 28.68	46 44.75	390	13
5	7	015	326	111122	1144	1155	1202	38 28.29	46 44.67	120	15
5	8	016	326	111122	1236	1315	1350	38 27.83	46 44.42	1035	15
5	9	017	326	111122	1426	1528	1622	38 26.81	46 44.01	1978	11
James Cook cruise 67 Dragon Vent Site											
1		018	331	111127	0100	0203	0316	37 47.02	49 38.94	2753	14
Middle of What Seamount											
Yoyo											
6		019	333	111130		0549		37 57.42	50 24.83	986	9
6		020	333	111130		0708		37 57.42	50 24.83	1180	8
6		021	333	111130		0813		37 57.42	50 24.83	1180	8
6		022	333	111130		0921		37 57.42	50 24.83	1180	5
6		023	333	111130		1027		37 57.42	50 24.83	1180	3
6		024	333	111130		1126		37 57.42	50 24.83	1180	10
6		025	333	111130		1229		37 57.42	50 24.83	1180	8
6		026	333	111130		1326		37 57.42	50 24.83	1180	11
6		027	333	111130		1422		37 57.42	50 24.83	1180	9
6		028	333	111130		1515		37 57.42	50 24.83	1180	11
6		029	333	111130		1609		37 57.42	50 24.83	1180	10
6		030	333	111130		1711		37 57.42	50 24.83	1180	10
6		031	333	111130		1807		37 57.42	50 24.83	1180	9
Transect											
6	14	032	338	111204	1058	1203	1252	37 56.77	50 22.16	1477	14
6	15	033	338	111204	1407	1510	1607	37 56.96	50 23.92	1378	9
6	16	034	338	111204	1705	1809	1850	37 57.84	50 25.28	1078	9
6	17	035	338	111204	1952	2105	2159	37 58.43	50 25.87	1186	11
6	18	036	339	111205	2259	0016	0046	37 59.06	50 26.17	1450	9
6	19	037	339	111205	0148	0239	0323	38 0.09	50 27.57	1815	10

Sapmer Seamount										
7	1	038	339	111205	1144	1224	1251	36 50.99	52 9.40	1340	13
7	4	039	340	111206	1707	1804	1901	36 52.18	52 10.42	2202	11
7	5	040	340	111206	1944	2031	2108	36 51.23	52 9.13	1023	12
7	6	041	340	111206	2200	2231	2253	36 49.63	52 7.24	446	11
7	7	042	340	111206	2325	2348	0007	36 48.96	52 6.39	340	15
7	8	043	341	111207	0049	0118	0152	36 48.16	52 5.37	997	9
7	9	044	341	111207	0232	0320	0417	36 46.63	52 3.46	2040	10
Atlantis Bank											
8	1	045	346	111208	2254	2359	0046	32 48.54	57 18.28	2020	10
8	17	046	346	111212	1549	1652	1805	32 40.06	57 19.67	1667	11
8	18	047	346	111212	1847	1933	2032	32 41.40	57 18.13	952	8
8	19	048	346	111212	2108	2153	2235	32 42.01	57 17.26	713	11
8	20	049	346	111212	2316	2357	0025	32 43.28	57 15.89	730	10
8	21	050	347	111213	0108	0141	0218	32 43.88	57 15.22	1220	8
8	22	051	347	111213	0249	0343	0446	32 44.72	57 14.11	2115	8

5.2.3.1 CTD data processing

Data processing consisted of two stages. The SBE SeaSoft package was used for the initial stages following a BODC approved setup. Data were then transferred to pstar for processing using standard NOC scripts.

SBE CTD processing for British Oceanographic Data Centre
SBE SeaSoft processing consisted of:
datcnv – to convert data from raw engineering units to scientific units, including applying a hysteresis correction to oxygen.
filter – a low pass filter of pressure to remove spikes.
alignctd – to shift the oxygen sensor relative to the pressure sensor to compensate for the delayed response of the oxygen sensor. A lag of +8 seconds was applied.
celltm - to compensate for the thermal 'inertia' in the conductivity cell by using the temperature variable to adjust conductivity values. (The thermal anomaly, alpha, and thermal anomaly time constant, beta, were set to the SeaBird recommended values of 0.03 and 1/7 respectively.
derive – to recalculate salinity and generate oxygen and density values.
strip – to remove surplus variables.

At this point data were transferred to the pstar system for processing, however, two additional files were created for BODC:
loopedit - to remove effects of heave on the profiles and
binavg – to average the data reducing them from 24Hz to 2Hz.

Pstar CTD processing
Each CTD was processed in five steps:
ctd0 – converts the .cnv file from ascii to pstar binary format, extracting latitude and longitude, water depth and ancillary information from the cnv file for the pstar header. Data were maintained at 24Hz.
ctd1 – removes any spikes from the variables (pmdian), then averages to 1Hz (pavrge), absent data values in pressure were interpolated (pintrp), salinity and potential temperature were calculated for both sets of sensors and density (sigma0 and sigma2) were calculated for the main sensors (peos83). A 10 second file for calibration purposes was also created (pavrge).
ctd2 – crops the start and end of the file, following manual inspection to identify the first and last good data cycles (pcopya). It also extracts the downcast and averages it to 2db (pavrge).
bot0 – converted the btl file average for information at the time each Niskin bottle was fired.
sam0 – created additional variables for samples (botsal, botoxy, no2+3, po4 and sio3).

Some positional information was inaccurate, therefore positions were extracted from the posmv (master navigation) file at the time of the deepest point of each CTD profile and entered into the header (Table 4).

Sample data (dissolved oxygen and salinity) were extracted from excel spreadsheets and pasted into the sample/bottle files by pattern matching on profile number and niskin bottle number.

5.2.3.2 Salinity calibration

Salinity samples were analysed using a Guildline Autosal 8400B with IAPSO standard seawater batch number P151. 89 samples were analysed, one of which was a duplicate. The remaining 88 samples were compared with CTD salinity and conductivity data. The two conductivity sensors were very close to the absolute values so only a minor correction was necessary, especially for the primary sensor on the fin (conductivity2). Very few samples were collected in deep water, therefore, the regression was weighted towards shallow depths. To avoid skewing the deep data, the samples were rigorously culled.

conductivity = 2.340551587E-03 + 0.999966945 * cond (n=69, r^2 = 0.9999)
conductivity2 = 8.827701580E-04 + 0.999976957 * cond2 (n=68, r^2 = 0.9999)

Prior to calibration the mean difference between bottle and sensor values was 0.0022 ±0.0026 for the secondary sensor and 0.0008 ±0.0034 for the primary (fin) sensor. After calibration the mean residual was 0.0009 ±0.0026 for the secondary sensor and 0.0008 ±0.0034 for the primary sensor.

5.2.3.3 Dissolved oxygen calibration

Comparison of oxygen sample values with CTD sensor values showed a small correction to be necessary for the oxygen sensor. A linear regression was sufficient. Discarding outliers left 180 data points, giving:

Oxygen (ml/l) = 1.11266259 * ctdO – 0.392558161
n=180 r^2 = 0.99027

Prior to calibration, the mean difference between dissolved and sensor oxygen was 0.1377 with standard deviation ±0.0738. After calibration the difference was zero with standard deviation ±0.0516 (Fig. 22). However, the residuals in the bottom water increased, which needs to be investigated.

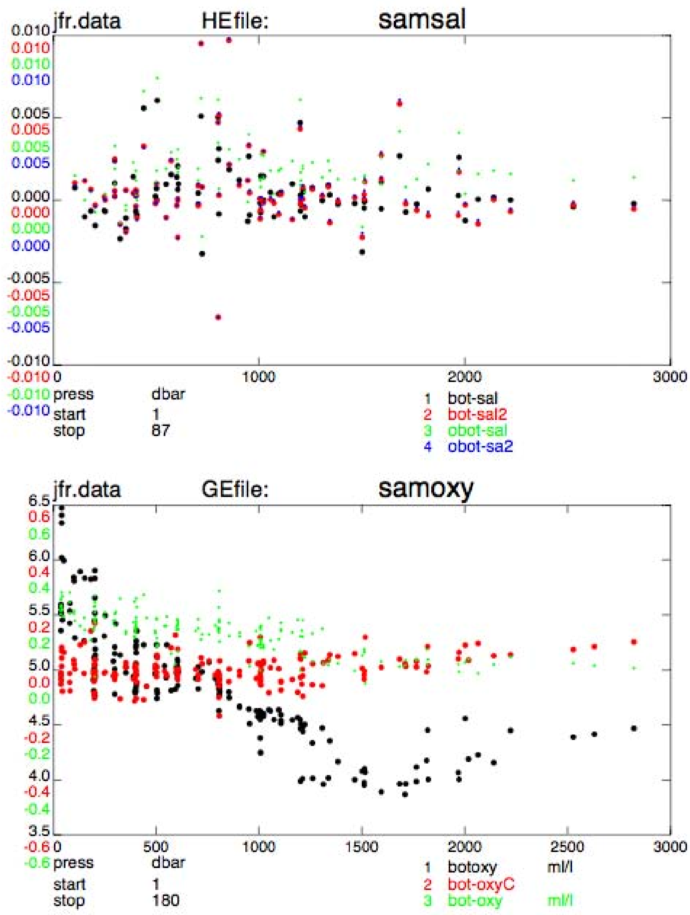

Figure 22. Salinity and oxygen calibration. Large (black and red) dots indicate calibrated residuals, small (green and blue) dots indicate pre-calibration residuals. Oxygen samples (large black dots) are included in the oxygen plot.

5.2.3.4 Dissolved oxygen sampling

A total of 230 samples were drawn from 28 CTD casts (not all casts were sampled, eg. SVP and yoyo profiles). Samples were always drawn first from the Niskin bottles. Sample depths were selected by reference to the CTD traces to identify maxima and minima in oxygen concentration or where oxygen gradients were weak or absent.

Water was drawn from the Niskin bottles through tubing into 100 ml calibrated clear glass bottles. Bubble free water was allowed to overflow the bottle to approximately twice the bottle volume. Temperature of the sample was measured prior to fixing. Samples were fixed immediately by adding 1 ml each of first manganous chloride and then alkaline iodide solution (sodium hydroxide – sodium iodide). The reagents were dispensed with variable quantity bottle top pipettes. Samples were shaken vigorously before being allowed to settle. The time before titration varied, but was generally about 12 hours. Samples were shaken again about half an hour before titration.

Before titration, samples were acidified using 1 ml of 12M sulphuric acid to dissolve the precipitate. Oxygen concentrations were determined using a semi-automated Winkler titration system. The titration endpoint was measured by a Metrohm 794 Basic Titrino with magnetic stirrer using amperometric end point detection. The volume of sodium thiosulphate dispensed was entered into an excel spreadsheet to calculate the concentration of dissolved oxygen.

Sodium thiosulphate solution was prepared at the beginning of the cruise by dissolving 25 g sodium thiosulphate in 1 litre of MilliQ water. Sodium thiosulphate was standardised at the beginning of each analysis session. Standardisation was done with a commercially prepared 0.01N potassium iodate solution (Ocean Scientific International Laboratories). Volumes of iodate solution were hand pipetted, however the 1 ml pipette proved unreliable so a 250µl pipette had to be used. There was more variability in blanks and standards than might be expected and eventually a cruise average blank (0.0010) and standard (0.5070) were used to calculate oxygen values.

Forty-eight of the 230 samples were duplicates. Excluding 4 extreme outliers, the mean difference in duplicates was 0.17 µmol/l with standard deviation ±1.26 (n=44). Two of the remaining 182 samples were outliers and excluded from the CTD sensor calibration.

5.2.4 Vessel-mounted ADCP and ship's navigation

The RRS *James Cook* carries two RDI acoustic Doppler current profilers (ADCP), one 75kHz and one 150kHz frequency, on the port keel. It should be possible to process the data from these during the cruise on a daily basis, but a number of problems were encountered during the cruise such that this did not happen.

Initially there was a problem connecting the unix workstation 'orthus' to the local network. After misleading suggestions that the ethernet card was u/s, it proved to be because the ethernet card was disabled. The workstation had come from RRS *Discovery*, where it was working perfectly, and it is not clear why the ethernet card was disabled. Having started mobilising on Nov 6th in expectation that everything would be up and running for departure on Nov 7th, this problem was not resolved until 10th Nov, long after calibrations should have been completed and routine processing underway.

Further problems were then encountered in accessing the ship's data. Eventually these were partially resolved by mounting the rvs raw_data area directly on to orthus (10th Nov). However, without the RVS software to read the RVS binary format data streams, it was not possible to access the data. Eventually copies of the software were provided on 15th Nov (now over a week after sailing). Meanwhile, access to the two ADCP instruments was provided by setting up very limited ftp access for pstar to the two ADCP PCs (11th Nov).

Once access to the data was available, it was clear that the navigation information on RSS *James Cook* is greatly complicated by the plethora of instruments that may, or may not, be working and the complete dearth of information about these systems. After several times of asking it was not until 7th Dec that some information was obtained about the ship's navigation systems in the form of past cruise reports.

On *Discovery*, the Ashtech ADU5 is used to correct the gyro heading for ship's attitude and the product 'bestnav' is used for ship's position, speed, heading and distance run. 'bestnav' is derived from GPS data, supplemented during drop outs by secondary GPS and dead reckoning and should be, as its name suggests, the best possible, and master, position information for the ship. On the *James Cook*, the Ashtech is not functioning correctly. It has an offset of about 10m position and failed to register good heading data. The primary position and attitude instrument is the Applanix PosMV, but this contains gaps and drop-outs. There appears to be no master position information for the ship. Gaps in the PosMV data will need in-filling using the other GPS systems, but could not be done at sea because of lack of time and personnel.

By the time the different navigational data streams and instruments had been investigated and their performance checked, there was insufficient time to adapt the processing scripts or to complete the data processing.

Data from the beginning of the cruise, during passage across the continental shelf, were inspected and used for a first attempt at calibration of the misalignment angles of the two instruments. Bottom tracking data from the 150kHz was significantly poorer quality than that from the 75kHz despite the water depth being 200m or shallower. This is reflected in the smaller number of data points available and the larger standard deviation of the results.

75kHz

misalignment angle,	phi = 9.214	±0.2508	
scaling factor	A = 1.0052	±0.0032	N = 289 points

150kHz

misalignment angle, phi = 0.466 ±0.8345

scaling factor	A = 1.0048	±0.0110	N = 161 points

It is hoped that good bottom tracking data will be obtained on the shelf during passage back to South Africa that can be used for calibration purposes and that time can be found post cruise to process all the data.

5.2.5 Recommendation

A full description of the ship's fitted systems should be freely available to all scientists joining the ship, together with information about how to access them and how the data are stored. This should include sensor specification, calibration information, known problems, recommendations, etc.

5.3 Microbiology

Marine microbes are the most numerous group of organisms on the planet. As a consequence of the huge diversity of this group, marine microbes are the major players in virtually all geochemical reactions occurring in the oceans (Kirchman, 2008). Microorganisms in the ocean include bacteria, archaea, fungi and protists. Abundances of fungi are very low in pelagic marine habitats (Kirchman, 2008) and archaeal abundances are generally only a fraction of bacterial abundances in surface waters (Schattenhofer *et al.*, 2009). On the other hand, bacteria are a very abundant group of marine microorganisms in these habitats and are ecologically very important.

Bacterioplankton in oceanic environments plays a significant role in the flux of organic matter and global nutrient cycling, but have thus far been poorly explored (Rappe *et al*. 2000; Arrigo, 2005). In marine biology, the research of marine phytoplankton biomass and composition has been crucial in understanding the dynamics of marine ecosystems. To increase knowledge about foodwebs in marine ecosystems it is critical to undertake research of the lower levels of the ecosystem.

In the present cruise five different samples of microbial communities will be collected:
-Free-living microbes
-Microbes associated with particles
-Microbes in sediments
-Flow cytometry samples, for total count of microbes and viruses
-POC

Free-living and particle-associated microorganisms

Setup of filtration system and pump (note):
Always start with the pump when assembling the filtration system. Plug the pump in and turn it on to see, which port is the inlet port (in this case, the right side port). Attach one end of the tube to the outlet port on the pump and one end into the VAC port on the carboy. Take the other tube and put one end to the MANIF. port on the carboy and the other end on the filtration system itself. To easily get the tubes onto the portholes put them in hot water.

Collection of samples:
1. Before collecting water the filtering system was rinsed (thoroughly rinsed with Milli Q water and subsequently washed with the sampling water) and new filters were placed into a suitable container. A pre-filter (47mm diameter, 3µm pore size) was used with a subsequent filter of 0.2µm pore size. The 0.2µm filter was placed on the iron “filter” first and then the 3.0µm filter.
Care was taken not to touch the filters with fingers and sterile gloves were worn.

2. When the filtration system was set up, water was poured from the niskin bottle into each of the filtration systems. If the filter became saturated, filtering was stopped and note taken of the quantity of water filtered. This was repeated until the filters were saturated. Note was taken of how much water was filtrated through each system.

3. After filtration, the two filters were placed in separate cryovials and store at -80°C until analysed. Cryovials were labelled appropriately with filter pore-size, where and when the sample was taken, quantity of water filtered as well as other relevant comments.

Flow Cytometry:
Samples were fixed and stored at -80°C prior to being analysed. Glutaraldehyde will lead to slightly higher cell loss than pure formaldehyde, but is clearly preferable to fixation with poor formaldehyde, which leads to a lot of background noise (cell debris, small particles), making flow cytometric analysis impossible.

Fixation Procedure:
1. Add glutaraldehyde ~250µl from a 20% stock solution for a 1.0% final concentration or a mixture of formaldehyde and glutaraldehyde (1% and 0.05%, respectively) into cryovials.
2. Collect ~4500µl of seawater in a 5 ml cryovial.
3. Mix by vortexing rapidly but gently.
4. Incubate for at least 15 minutes at room temperature.
5. Samples should then be stored at -80°C, as storage at -20°C beyond 1 week will result in rapid sample degradation.

Where possible two samples were collected at each sampling point (station).

POC sampling:
1. For POC samples, 1 litre of seawater was filtered through a pre-combusted 0.7µm filter.
2. When filtering was finished, the filter was placed on the tin foil it was packed and put in the oven at 55°C until dry (~10-15 mins).
3. Samples were frozen at -20°C in a cryovial.

Care was taken never to contaminate the sample with carbon. Gloves were always used and the filter or the inside of the tin foil were not touched.

Sediment samples:
~1 g of material for DNA/RNA extraction was collected. Samples were placed into cryotubes and several replicates taken to address the spatial heterogeneity within the sediments. The samples were frozen at -80°C.

If possible, animals were collected at different sites for symbiotic microbes. These were placed into sterile zip-lock bags and frozen at -80°C. Scrapings from microbial mats were also collected.

5.4 JC066 Net Sampling

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5.4.1 Summary

Plankton sampling using nets took place at four stations (Coral, Melville, Middle-of-What and Atlantis) during JC066. As the A-frame was occupied by the ROV deployment system, a rectangular trawl like the RMT 1+8 could not be used and a ring net with a 2 m opening diameter and 4 mm mesh size was thus designed and constructed specifically for this cruise. This net was deployed using the trawling wire, routed through the ship's main crane. Deployment depth was recorded with a data recorder mounted on the net mouth. This net sampled macrozooplankton and mikronecton and gave very good results in terms of keeping fragile gelatinous animals intact. The entire net assembly was lost after four deployments on 2/12/2011. A second ring net was deployed only at Atlantis Bank and had a mesh size of 250 µm with an opening diameter of 1 m. Samples from this second net have yet to be analysed, catches were predominantly composed of mesozooplankton. Results from all net samples will be used to supplement data on pelagic communities collected on RV *Dr. Fridtjof Nansen* cruise 2009-410 (a previous pelagic sampling campaign on the same seamounts) and to ground truth data collected from the EK60 fisheries echosounder.

5.4.2 Materials and Methods

5.4.2.1 Rigging of large ring net

The large ring net had a 2 m diameter frame constructed from marine grade stainless steel hollow profile (Physics Department Workshop, University of Oxford, Oxford, UK). The conical net bag (EFE and GB Nets, Lostwithiel, UK) had a 208 cm diameter collar and was 600 cm long. It was made from 4 mm black mesh material in four sections with reinforcing nylon tape on double sewn French hems. Mouth and cod end collar were made from double layers of industrial nylon fabric. The cod end was made from 110 mm PVC tubing with a screw cap on the bottom. A blank screw cap was used on all deployments to keep the cod end from draining and preserve fragile specimens.

The net was rigged for oblique towing, as illustrated in Figures 23 and 24. The towing wire was weighted down with a 180 kg iron weight. The three-point bridle of the net was then connected to the towing wire via a plastic coated spacer wire. The spacer wire was used to avoid the weight obscuring the net mouth during towing. All rigging components except for a stainless steel swivel and the stainless steel D-shackles on the net frame were provided by NMF-SS (Southampton, UK).

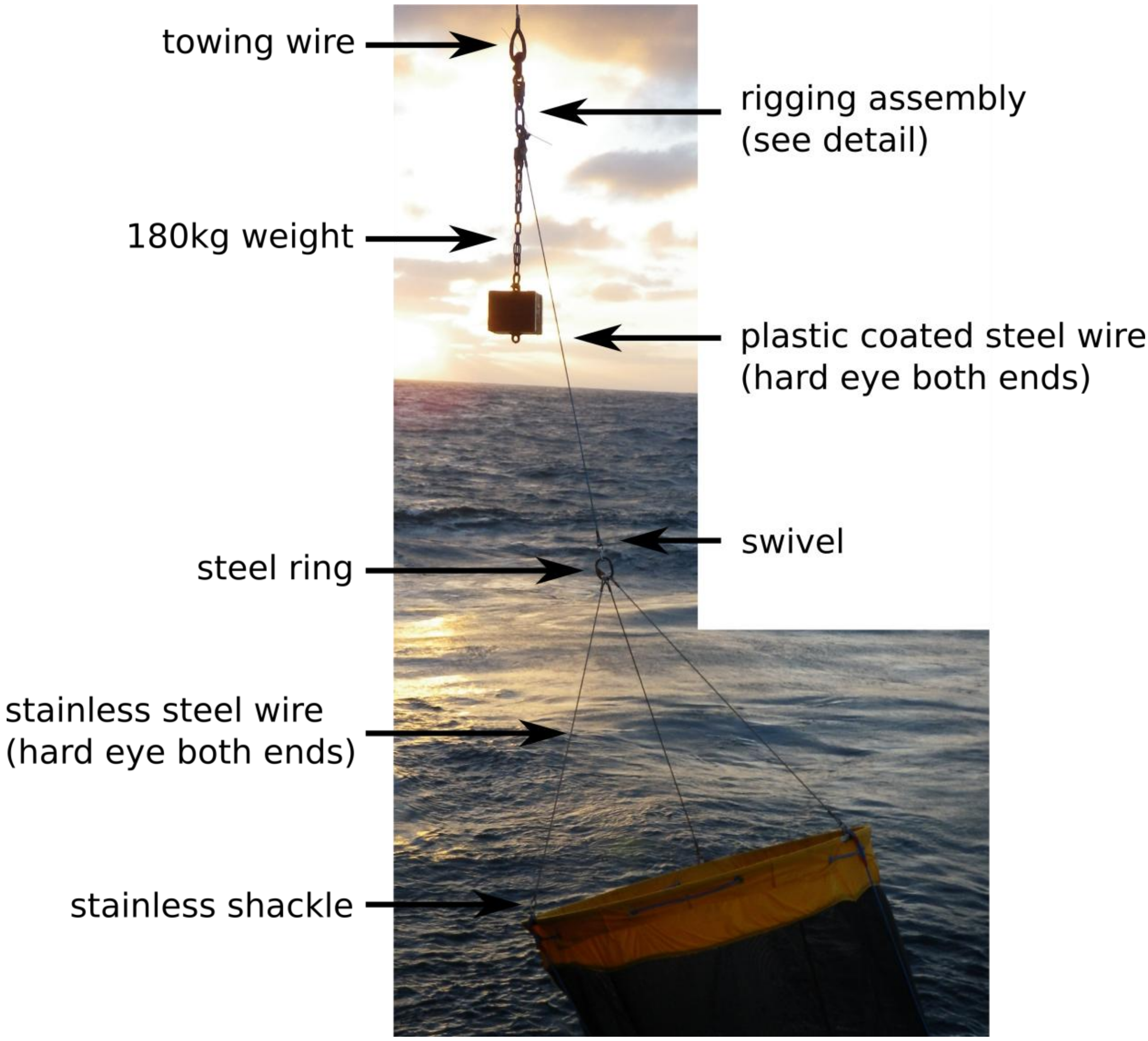

Figure 23. Bridle assembly for oblique towing of the large ring net.

5.4.2.2 Deployment and recovery of large ring net

The large ring net was deployed on the trawling wire routed through the ship's main crane. Details of times and locations of each of the eight deployments are given in Tables 5 and 6. All nets were deployed in the hours of darkness as the deep scattering layer would be at its most shallow at this time. The net was towed into the current at approximately 1.5 ms^{-1} relative to the water, whilst ensuring that it was kept well out from the starboard side at all times. The starboard propeller was isolated during all deployments. Wire was paid out at no more than 40 m/min, the net was then towed for 10 minutes at maximum wire out and heaved at 30 m/min.

For deployment all net components were assembled on deck. The net assembly was then hoisted with one person securing the cod end and one person securing the net ring using one of the cod end ropes. On recovery, the net was brought alongside and the upper section was hosed down with seawater. The net assembly was brought on deck with one person holding the cod end upright. The weight was removed and the whole net was hoisted up again until the cod end was above the deck, being secured by 2-3 people using the cod end lines. The lower section of the net was then hosed down and the cod end emptied into a

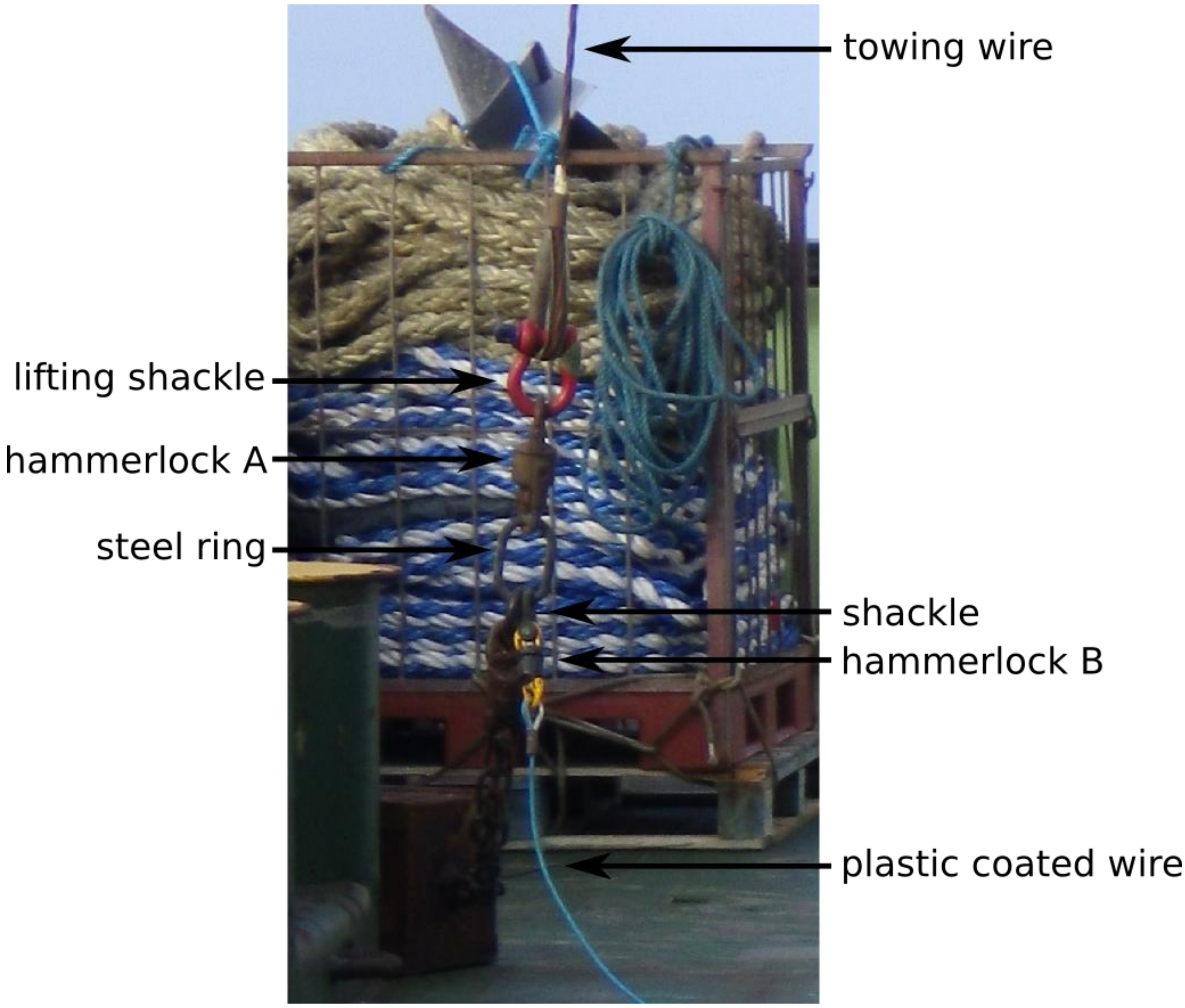

Figure 24. Detail of rigging assembly of the large ring net.

25l bucket.

5.4.2.3 Data Recorder

Deployment depth and temperature at the deployment depth were monitored using a G5 data recorder (Cefas Technology Ltd, Lowestoft, UK; Serial No. A08223) rated to 2000 m and set to log temperature and depth at 30-second intervals. The recorded data was downloaded from the tag after each deployment.

5.4.2.4. Small ring net

The small ring net consisted of a 1 m iron frame and a 3 m long mesh bag made out of 250 µm nylon mesh. The net was rigged with a three-point steel wire bridle and attached to the coring wire via two shackles and a hammerlock swivel (Fig. 25). A 60 kg weight was attached to the net frame using a three-point bridle made of polypropylene rope. The net was deployed vertically using the coring winch on the starboard parallelogram and the second net (Fig. 25A) performed vertical hauls at a speed of 35 m/min.

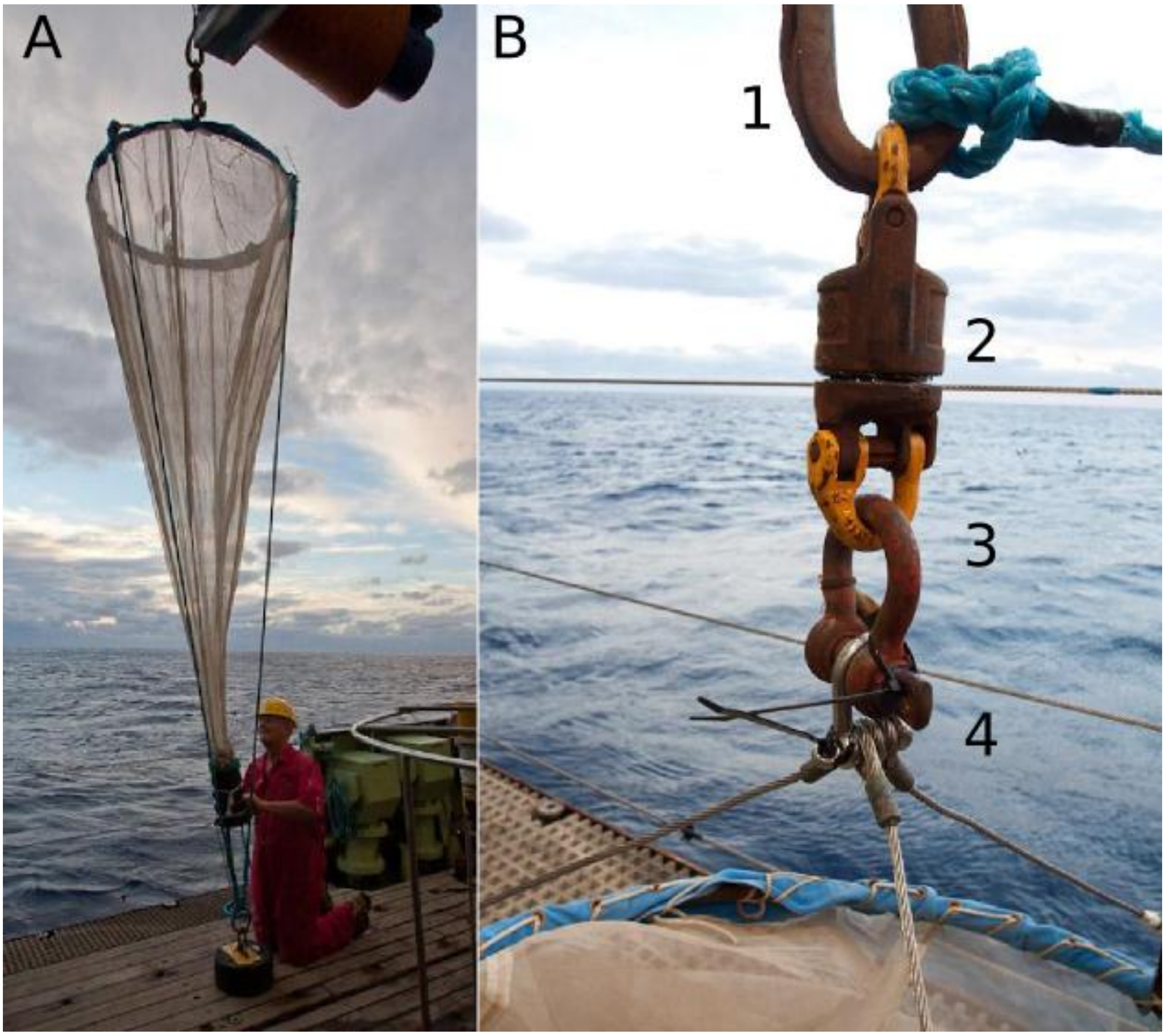

Figure 25. (A) Small ring net rigging overview. (B) Detail of connection between the towing wire (1) and the three-point bridle (4) using a hammerlock swivel (2) and a lifting shackle (3).

5.4.2.5 Sample sorting and preservation

All samples were immediately transferred to the controlled temperature room for processing and sorted at 4°C ambient temperature. For the large ring net gelatinous organisms were preserved in 4% buffered formalin and fish, crustaceans and other invertebrates were preserved in ethanol or formaldehyde, as appropriate. Large chaetognaths were preserved individually in RNALater and then frozen for genomic analyses. For the small ring net the whole cod-end was bulk fixed in 4% buffered formalin after removing large chaetognaths for preservation in RNALater.

Table 5. Deployment details of the 2 m ring net (4 mm mesh size) at three stations (Coral, Melville, Middle-of-What) along the Southwest Indian Ocean Ridge utilising the ship's main crane and trawling wire on the starboard side of the RRS *James Cook.*

Julian Day	Net No.	Station	Event	Latitude	Longitude	Time in water (GMT)	Time on deck (GMT)	Max wire out (m)	Max depth (m)
317	1	4	5	41° 22.632 S	42° 48.844 E	17:16	19:18	1500	1458
323	2	4	34	41° 22.303 S	42° 52.504 E	14:42	16:00	750	399
328	3	5	15	38° 30.252 S	46° 43.419 E	16:23	16:42	108	84
328	4	5	16	38° 32.489 S	46° 43.124 E	17:28	19:11	900	405
336	5	6	8	37° 56.109 S	50° 26.639 E	16:52	Net lost	1000	N/A

Table 6. Deployment details of the 1 m ring net hauls (250 um mesh size) at one station 'Atlantis' utilising the coring winch off the starboard side of the RRS *James Cook*.

Julian Day	Net No.	Station	Event	Latitude	Longitude	Time off deck (GMT)	Time on deck (GMT)	Max wire out (m)	Max depth (m)
347	6	8	23	32° 42.191 S	57° 14.419 E	16:05	17:25	750	692
347	7	8	24	32° 42.189 S	57° 14.422 E	17:35	18:55	750	684
347	8	8	25	32° 42.188 S	57° 14.423 E	19:00	20:00	400	395

5.4.3 Results

The large net predominantly sampled macrozooplankton and micronekton (size range 0.5 cm-5 cm), but also some very large nektonic specimens, e.g. a 20 cm long *Bathylagus* specimen. The quality of the specimens was very high; most animals were still alive when brought on deck and net damage, even to gelatinous taxa, was very limited compared to the large trawls employed on *Nansen* cruise 2009-410. The small ring net predominantly caught mesozooplankton smaller than 1 cm.

Sample sizes were small and probably insufficient for quantitative analysis. However, the high quality of specimens will be of great value for taxonomic studies.

5.4.4 Net loss incident

The large ring net was lost on 2/12/2011 during heaving with about 200 m of wire out. The loss is most likely due to a failure of the plastic coated spacer wire. The towing wire was recovered with all rigging components missing except for the weight and hammerlock B (see Fig. 23).

At 18:06 GMT the winch system recorded a sudden drop in tension on the wire. No unusually large spikes were recorded during the entire deployment, in fact the maximum recorded tension during this deployment was lower than in previous deployments and well below the 4 tonne breaking strength of the spacer wire (Fig. 26).

The material loss of the net, net frame, rigging components and the data recorder is in excess of £2000 GBP.

5.4.5 Conclusions and Recommendations

Despite the gear loss this cruise demonstrated the feasibility of conducting mesopelagic work using the ships main crane. The main limitation in using the net was the absence of a real-time depth monitoring mechanism. The use of the waterfall system for this purpose was discouraged at the pre-cruise meeting as this system is apparently not properly working and we strongly recommend the installation of a working pinger system for this purpose.

For a rebuild of the large ring net we recommend a slightly longer cod end (50-75 cm), so it can be rigged with a lower centre of gravity; this would prevent the cod end inverting during recovery.

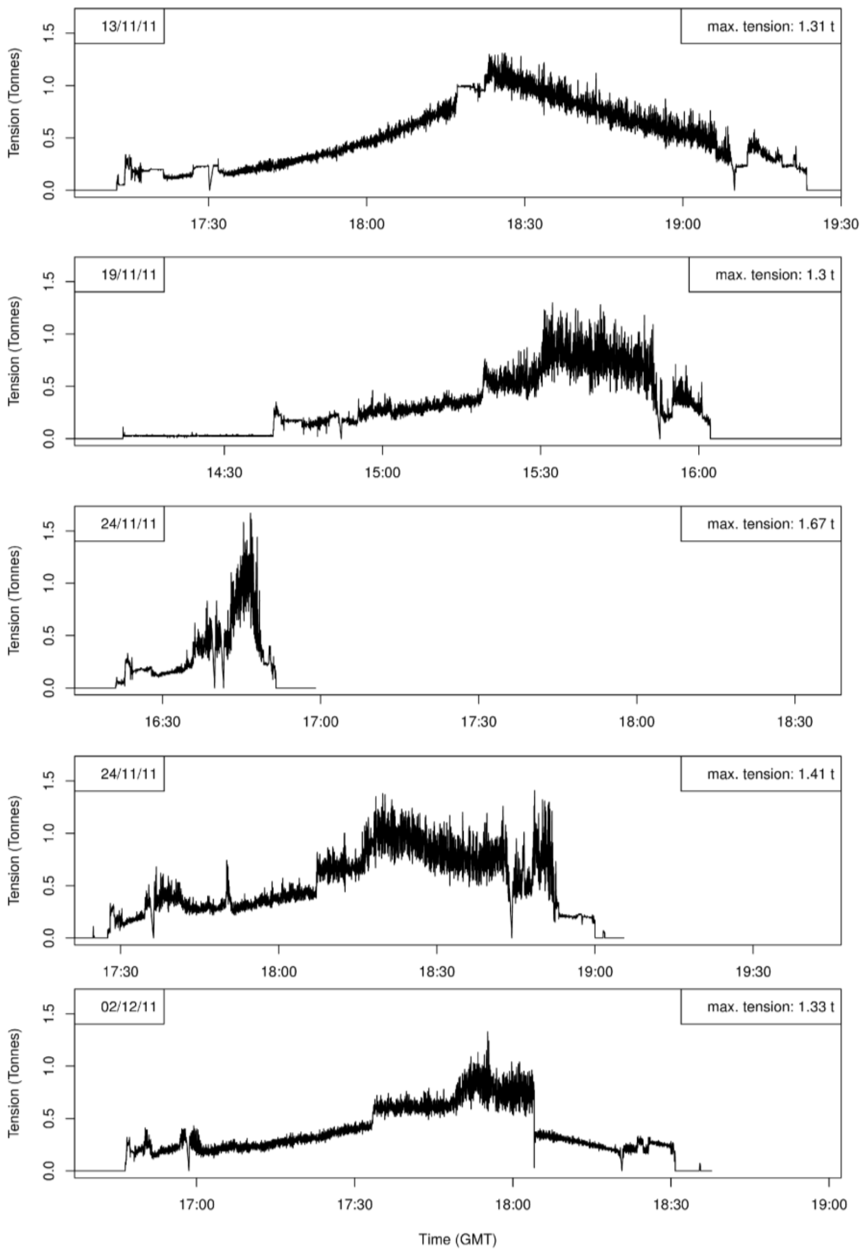

Figure 26. Records of wire tension during deployments of large ring nets. Note the sudden drop in tension in the last panel at approximately 18.06 GMT.

5.5 Acoustic surveys of deep-scattering layers and their interactions with seamounts

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5.5.1 Summary

Acoustic samples of the pelagic realm were opportunistically collected during large parts of the cruise using an EK60 scientific echosounder (Simrad, Norway). Calibration of the EK60 was carried out shortly after departing from Cape Town harbour on 7/11/2011 (33° 53.712' S, 18° 14.712' E). A tungsten carbide sphere was successfully deployed and positioned under the vessel's five permanently installed transducers (18, 38, 70, 120 and 200 kHz). The software programs LOBE and Echoview were used to process the transducers' calibration parameters. Adequate calibration results were obtained for all transducers except the 70kHz device, which may require servicing. As this is the second calibration exercise conducted by our research group that highlights problems with one of the transducers, we strongly recommend regular calibrations of the EK60 by NMF to ensure it is fully functional for scientific work.

The collected data is of acceptable quality considering the data was collected concurrently with geophysical and oceanographical sounders, and with a retracted drop keel. The data will be used to validate models of basin scale scattering layer distribution and scattering layer-seamount interactions developed from dedicated fisheries acoustics surveys during *RV Dr. Fridtjof Nansen* Cruise 2009-410. A post-cruise calibration will be attempted in Algoa Bay on 20/12/2011.

5.5.2 Introduction

Oceanic sound scattering layers and their vertical migrations have been observed since the invention of echosounders in the early 20th century. They are composed of zooplankton and micronekton, and several key processes driving their formation and vertical movements are thought to be understood rather well (Angel, 1985). Nevertheless, many aspects of the biology of scattering layers remain to be explained.

Given the vast expanse of the mid-ocean ridge system, surprisingly little research has been conducted on the effects of these topographic features on pelagic scattering layers. In the only available large-scale study, Opdal *et al*. (2008) described scattering layers along the Mid-Atlantic Ridge and possible topographical, hydrographical and biological processes shaping them. Unfortunately, their analysis was largely descriptive, as there is a general lack of quantitative metrics for scattering layer data.

No research has been conducted on the large scale distribution of scattering layers in the Indian Ocean or along SWIOR and this gap is currently being adressed using data from a recent pelagic survey of the area (Rogers *et al*. 2009; P. Boersch-Supan, unpublished data) using multifrequency data. An understanding of the influence on scattering layers by the regional oceanography and the ridge as a whole is also important to understanding the small-scale interactions around seamounts.

This small-scale (<500m horizontally, <10m vertically) bio-physical coupling in the immediate vicinity of seamounts is likely to be a crucial link for energy flux into seamount ecosystems. A substantial proportion of zooplankton and mikronekton biomass migrates daily between the surface and deeper layers. Shallow topography can block the descent of these animals, exposing them to predators and/or concentrating them on the summits and flanks of submarine banks and seamounts. This mechanism has been described as "topographic blockage"(Isaacs and Schwartzlose, 1965) and is likely to be of great importance for both mobile (Fock *et al*., 2002; Genin *et al*., 1988) and sessile seamount residents like corals (Genin *et al*., 1986).

Topographic blockage has been observed with sonar technology at seamounts in the Pacific (Genin, 2004; Isaacs and Schwartzlose, 1965) and the Indian Ocean (P. Boersch-Supan, unpublished data) and corroborated by gut content analyses of resident fish predators (Fock *et al*., 2002; Genin *et al*., 1988). Predation furthermore led to a depletion of the scattering layer and thus an increased plankton patchiness downstream of the seamount in several cases (Genin *et al*., 1994; Haury *et al*., 2000). As a result of allochthonous trophic subsidies, that is the influx of prey biomass that is not derived from local primary production, biomass of predators may be elevated in the vicinity of seamounts compared to adjacent deep waters. Demersal predators may further exploit a "feed-rest benefit" on seamounts by using quiescent shelters on the mounts in between feeding intervals, while currents and/or vertical migration cycles replenish their prey (Genin, 2004). Acoustic sampling has also provided some evidence that micronekton behaviour might be responsible for population retention on seamounts (Wilson and Boehlert, 2004).

The topographic blockage hypothesis has recently been challenged by Hirch and Christiansen (2010) on the basis of stomach contents and trophic markers. They concluded that lateral advection of non-migrating organisms may be the more likely mechanism of energy input for predators. Their analysis, however, was largely limited to small fish species, which are unlikely to be able to prey on migrating mikronekton. Commercially targeted seamount fishes are likely to exhibit different prey choices and topographic blockage may be of great importance to them; e.g. *Beryx splendens* has been shown to feed primarily on migrating micronekton such as sergestid prawns and myctophids (Horn *et al*., 2010) as well as cephalopods (P. Boersch-Supan, unpublished data).

As McClain (2007) has stressed, a quantitative and process-oriented approach is necessary for the understanding of seamount ecosystem function and to enable the conservation and management of these ecosystems. Pelagic processes at seamounts are poorly understood, and our current researchs aims to address these knowledge gaps in a quantitative and statistically rigorous way.

5.5.3 Calibration Procedure

Calibration of the five permanently installed EK60 echosounders on the drop keel of the RRS *James Cook* was carried out shortly after departing Cape Town harbour (33° 53.712 S, 18° 14.712 E) from 16:00 GMT to 23:00 GMT. Weather conditions remained good throughout. The drop keel was not deployed as we would not be deploying it during data acquisition. All other echosounders, including the bridge echosounder were turned off for the duration of the calibration.

The procedure followed the recommendations of Foote *et al*. (1987) and vessel specific recommendations (Martin Cox, Cruise Report for JC037 and personal communications): Three monofilament lines attached to electronic winches and fishing poles were set up (one on the port life boat station, one each on the starboard side, forward of the life boat station and on the starboard deck opposite the hangar door). Whilst the ship was drifting, a weighted rope was dropped over the bow and pulled under the hull. The port side line was attached to it, pulled through to the starboard side and all three lines were connect to each other and the calibration sphere on the starboard side. Once the port line was secured the ship kept on station (JC066 station 2) with dynamic positioning utilising the tunnel thrusters only - the azimuth thruster was kept retracted at all times during the calibration procedure. Positioning the sphere level with the drop keel on the starboard side before submerging it greatly helped positioning the sphere into the echosounder beam. This was achieved accurately because a person stood directly above this position (aft side of starboard lifeboat) and communicated effectively to the two starboard winch handlers. 35 full rotations (by hand) were paid out of each unclutched starboard winch followed by 15 full rotations pulled in from the port side winch. This was sufficient to hold the sphere in the beam of the 18 kHz transducer and in an optimal position relative to the near field ranges (Table 7); finer adjustments were made from the main laboratory using the electronic winch system.

The CTD profile from the nearby station 1 (33° 53.774 S, 18° 14.679 E) was used to calculate sound velocity and this was entered into MATLAB code supplied by supplied by Dr David Demer (Advanced Survey

Technology Division, Southwest Fisheries Science Center, USA) to calculate the theoretical TS values of the sphere for each frequency.

Table 7. The frequency, physical diameter and corresponding near field range of each transducer. Optimum distance from the transducer outside of the near field range estimated from $R_{opt} = 2d^2 f_0 / c$. *d* is the diameter of the transducer face, *f* is the echosounder frequency and *c* is the sound speed (1427.5 ms^{-1}).

Frequency (kHz)	Diameter (m)	Near field range (m)
18	0.625	9.85
38	0.48	12.27
70	0.28	7.69
120	0.18	5.45
200	0.12	4.04

LOBE software (included within the ER60 software) is used for calibration. Data were replayed using LOBE and post-processed using Echoview to obtain calibration parameter estimates.

5.5.4 Calibration Results

The theoretical TS values are shown in Table 8.

Table 8. Theoretical target strength of the tungsten carbide sphere at each frequency (sound speed of 1427.5 ms^{-1}). Calculated using MATLAB code supplied by Dr David Demer.

Frequency (kHz)	Target Strength (dB m^2)
18	-43.3
38	-41.8
70	-40.2
120	-40.3
200	-39.2

Calibration parameter estimates (from LOBE and Echoview) are given in Table 9. The calibration was interrupted at times by Cape fur seals diving underneath the vessel, blowing bubbles and – in one instance – dislocating the sphere.

Table 9. Calibration parameter estimates for the RRS *James Cook* EK60 system determined by post-processing the calibration exercise from Cape Town bay.

Frequency (kHz)	18	38	70	120	200
Calibration Sphere Range (m)	29.1	28.6	28.4	28.7	28.2
Gain (dB)	23.22	23.87	21.8	26.16	24.86
s_A correction (dB)	-1.19	-0.6	0	-0.63	-0.38
2-way beam angle (dB re 1 steradian)	-17.3	-21	-16.8	-20.9	-20.9
Angle sensitivity Along (deg)	13.9	21.9	13	23	23
Athwart (deg)	13.9	21.9	13	23	23
Angle offset Along (deg)	-0.07	-0.3	0	0.07	0.21
Athwart (deg)	0.06	-0.6	0	0.1	0.24
3 dB beam width Along (deg)	11.21	7.06	11	6.64	6.7
Athwart (deg)	11.26	7.22	11	6.65	6.73
Power (W)	2000	2000	800	1000	1000
Pulse duration (µs)	1024	1024	1024	1024	1024
Alpha (dB/km)	2.2	8.5	22.2	41	60.7
Bandwidth (kHz)	1.57	2.43	2.86	3.03	3.09
Serial numbers Transducer	2067	30637	130	345	313
GPT	102-203321	102-202585	102-202586	102-202587	102-202588

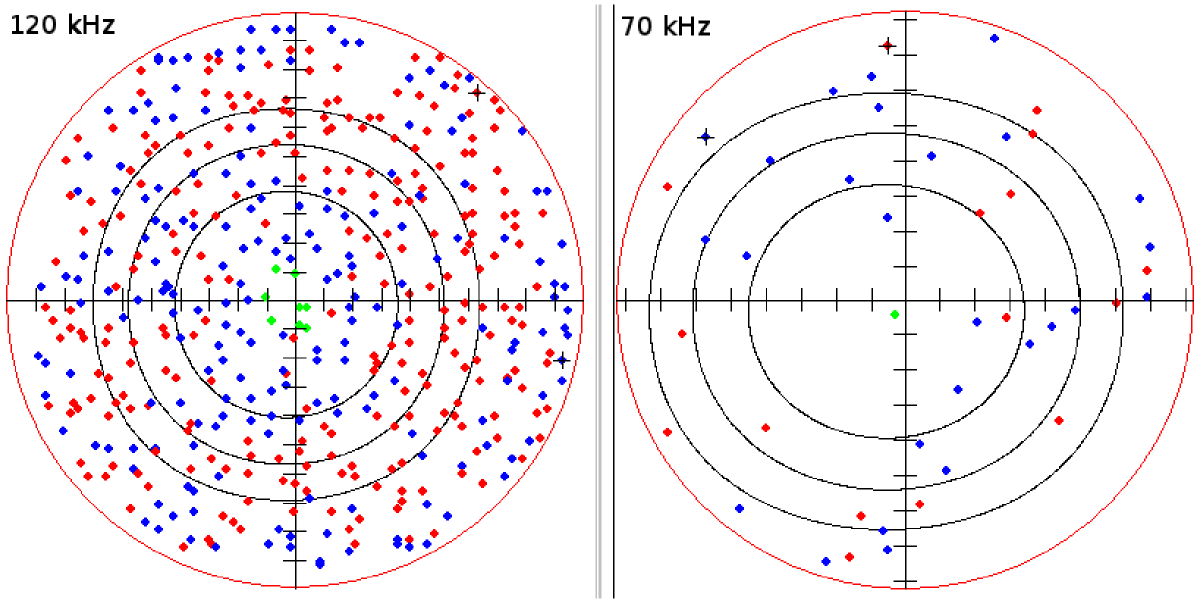

Figure 27. Single target detections of the 120 kHz transducer (left) and the 70 kHz transducer (right) during calibration of the EK60 echosounders on the RRS James Cook. This comparative example (the remaining three transducers were similar to the 120 kHz) shows there are significantly fewer single target detections on the 70 kHz than the other transducers.

5.5.5 Discussion

LOBE software (included within the ER60 software) is used for calibration and because it visualises in real-time which part of the beam sector is mapped using the calibration sphere. It is critical that this real time information is visible for each transducer. However, only one transducer (in this case the 18 kHz) could be viewed concurrently, therefore, we could only be sure that one transducer had both a sufficient spread of single target detections throughout the beam as well as a large number of on-axis hits which are required for an especially robust calibration. The suboptimal mapping of some of the transducers lead to relatively large error margins on the parameter estimates. Nonetheless, the calibration results provide useful parameter estimates.

5.5.5.1 70kHz transducer anomaly

A potential and as yet unknown problem with the 70 kHz is flagged – it received significantly fewer single target detections relative to the other transducers – Figure 27 shows the number of hits received compared to the 120 kHz. Also, the power setting was limited to 800 W, where it had been 1000 W during JC037. This requires further investigation.

5.5.5.2 Support of EK60 Calibrations by NMF-SS staff

While the support we received from the ships officers, crew and SST during the calibration exercise was first rate, it has to be pointed out, that the whole calibration procedure was based on the protocol of a previous calibration performed by the St Andrews Pelagic Ecology Research Group. To our knowledge there exists no NMF operating procedure for EK60 calibrations, nor are technicians or crew trained to conduct these independently. Both the calibration during JC037 and this cruise have highlighted problems with the 70 kHz transducer that were unknown to NMF. We therefore strongly recommend that crew and technicians receive adequate training to conduct EK60 calibrations and that NMF-SS calibrates the sounders at least once a year during a trials cruise. This is not to replace calibrations immediately before and/or after EK60 surveys but to ensure the system is fully functional.

5.5.6 Data Collection

EK60 data was collected throughout most of the cruise usually when other sounders (ADCPs, EM120, SBP, EA600) were running. To ensure minimal interference to oceanographical and geophysical data the EK60 was set to a low ping interval (37 s) for most of the survey, some higher resolution data was collected on a number of occasions at a ping interval of 4 s.

The data quality was variable, ranging from poor in rough sea conditions and/or during intensive thruster use to adequate in good conditions and during transit. Interference from other sounders was apparent throughout the cruise. Acoustical interference was investigated and it was found that interference-free EK60 data can only be collected when all other echosounders on the vessel are turned off.

Post processing will follow the recommendations of Korneliussen *et al*. (2008) and established PERG in-house procedures.

5.6 Deep-Submergence Surveys and Sampling

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5.6.1 Introduction

Seamounts represent extremely rugged seabed topography and although most of the studies undertaken on them have used dredges or robust trawl systems, visual survey offers a more effective way of observing ecosystems *in situ*. This is especially the case for extreme topography such as fresh lavas or vertical cliffs which form highly rugged rocky terrains. Given that seamounts host vulnerable marine ecosystems (VMEs), such cold-water coral reefs and gardens, they are also sensitive to collateral damage that can arise from over-the-side towed sampling systems, in the same way as commercial bottom trawl systems can impact sessile benthic communities. Much of the visual survey work undertaken on seamounts to date has been done using towed camera systems, although both Remotely Operated Vehicles and submersibles (Human Occupied Vehicles or HOVs) have been used. The often inclement weather of the South West Indian Ocean Ridge, and its extreme remoteness, mean that it is preferable to use towed cameras or ROVs for survey purposes. These also have the advantage of having lengthy bottom times – enabling scientists to take maximum advantage of favourable weather conditions when they occur.

Work originally planned for the Southwest Indian Ocean benthic seamount project included seabed surveys of seamounts (maximum of 8 transects per seamount) using video and stills images. The main tool for achieving these surveys was proposed as an ROV. Tools for sampling the fauna included the vehicle manipulators (megafauna), manipulator tools (e.g. suction samplers) and also using mini-box corers (macrofauna and meiofauna). These were to be supplemented using surface-deployed megacorers and boxcorers where suitable sediment occurred and research trawls in areas where VMEs were not observed. These operations were originally planned for 24-hour ROV operations. However, following the accident on RRS *James Cook* cruise JC055, the *Isis* ROV for which the cruise was originally planned was partially destroyed. A replacement ROV, the *Kiel* 6000, was found for JC066, however, this ROV only operates 12 hours per day. Thus, two supplementary towed camera systems were brought along for the cruise: HYBIS and SHRIMP (Seabed High Resolution Imaging System). All of these deep-submergence platforms have different strengths and weaknesses and all were used during the present cruise.

5.6.2 General survey protocols

5.6.2.1 ROV video surveys

Surveys were planned using detailed geophysical maps and then plotted using GIS to give a series of waypoints for the dive. Dives were all planned going from deep to shallow. For the purposes of surveys of benthic communities we introduced a system of staggered transects where the general direction of a transect was vertical from shallow to deep but at given depth intervals the ROV did a 200m horizontal transect to analyse the spatial variation of communities. The vertical intervals were determined by the different vertical elevations of the seamounts and particularly the summit depths compared to each other. Also, depth intervals were chosen to be comparable with previous seamount work by project scientists. These depths were as follows:

400m	Depth found below summit of Coral Seamount and SAPMER Bank
700m	Depth of summit of Atlantis Bank
1,000m	Depth of summit of Middle of What Seamount
1,300m	Comparable to sampling sites in Atlantic, also found on all seamounts

Surveys were semi-randomly selected to cover different aspects of each seamount and to target geophysical features of contrasting or similar characteristics.

During dives the HD video camera was run continuously and HD video data saved on a remote computer system with drives located in the main laboratory / plot of the vessel. The ROV, where possible was run at 1m above the seabed at approximately 0.2kts, although often the nature of the seabed topography or slope made this difficult and often the vehicle was between 1 and 2m above the seabed. This was particularly the case when the vehicle was running horizontally along isobaths on extreme slopes. Slopes of 45^o or even vertical slopes were encountered frequently on the South West Indian Ocean Ridge. For these surveys, the HD camera was configured to view horizontally forwards and slightly down from the vehicle. Because of the configuration of the vehicle tool trays and porch it was necessary to zoom the camera in to lose the edges of tool drawers on the port side of the ROV. Three parallel lasers, 0.1 m apart, were mounted parallel to the focal axis of the camera forming a triangle of points to provide scale in images. As long as the vehicle was sufficiently close to the seabed the lasers were visible as three bright red points just right of centre of the visual field of the camera. However, if the vehicle rose >2m from the seabed both the lasers would become obscured and it became difficult to identify megafauna, especially smaller animals, on the seabed. The *Kiel* 6000 ROV system also deployed a variety of other cameras that were controlled by the pilot and co-pilot of the ROV and were particularly useful for identifying fish in the far-field of the ROV or potential items for sampling (see ROV report for details of ROV cameras).

The stills camera on the *Kiel* ROV 6000 was not suitable for taking photographs while the vehicle was moving so we used this tool for taking images of important or spectacular megafauna both for identification purposes and for public communications. The camera had a very limited depth of field which made obtaining clear images difficult, although spectacular images were obtainable (Fig. 28).

Figure 28. *Lepidion* sp. on a steep seamount slope. Photographed using the Kiel stills camera system.

5.6.2.2 ROV sampling of fauna

The *Kiel* 6000 had two manipulator arms, a 3-function Rigmaster and a 5-function Orion manipulator. The Rigmaster was not useful for taking samples and was used twice during the cruise for recovery of moorings. For this purpose it had a blade fitted to the claw for cutting rope. The Orion manipulator was the main tool for biological sampling (see Fig. 29). This manipulator could be used for manually picking or pulling sessile fauna from the seabed and was even used on several occasions to sample mobile fauna such as decapod crustaceans. However, the arm was a fairly coarse tool and often samples such as stony corals were crushed or simply could not be picked up.

Two other manual tools were employed for sampling megafauna or coral framework. These were nets mounted on T-bars and a scraper tool, also mounted on a T-bar with wire mesh for a “net” on one side. These tools were particularly useful for sampling corals and smaller mobile epifauna such as crabs and squat lobsters.

In addition *Kiel* was equipped with a suction sampler and this was also particularly useful for sampling mobile invertebrates such as squat lobsters and large pycnogonids and for lifting larger animals into the bioboxes (see Fig. 30). However, this system was quite unreliable and often failed after a few uses during a dive. Most of these problems arose from a poorly marinised pumping system and from failure of seals.

Finally, the vehicle was equipped with two sets of sample compartments, a port and two starboard lidded bioboxes and port open bioboxes, one of which housed 16 cores for taking sediment samples (see sediment section). Cores were used with limited success during the cruise because of difficulty in placing the core tubes back in their quivers but also because of the very loose and unconsolidated nature of the sediment encountered on most of the seamounts.

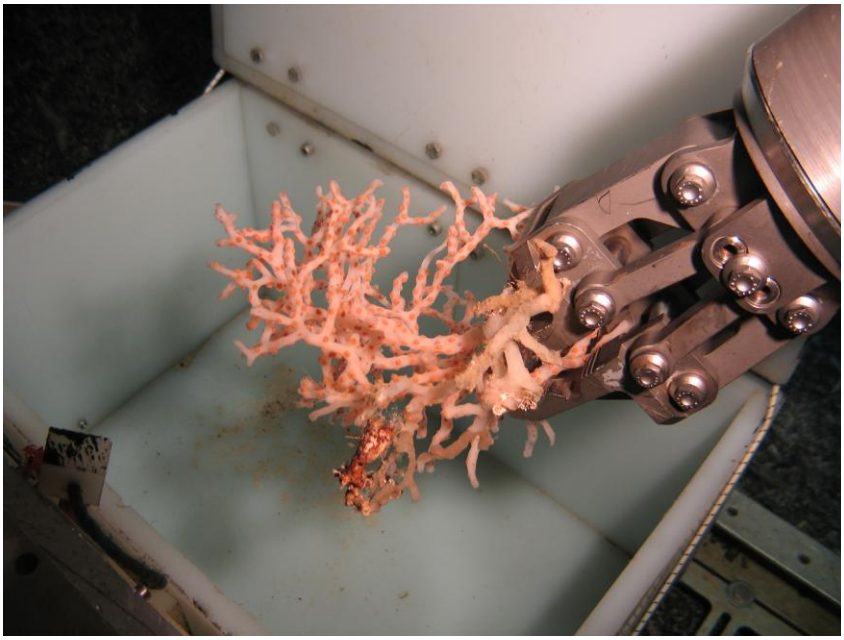

Figure 29. Orion arm being used to place sponge / zoanthid colony into port lidded-biobox.

Figure 30. Large echinoid being sampled with suction sampler.

During ROV sampling it was particularly important to try and keep track of what samples were taken where. This was achieved by assigning scientists to note down whenever samples were take, to identify where they were placed on the ROV specimen storage system using a sheet (see Appendix) and to take photographs from the video display screen of each sample as it was placed in the storage boxes and assign each a serial number (Fig. 31).

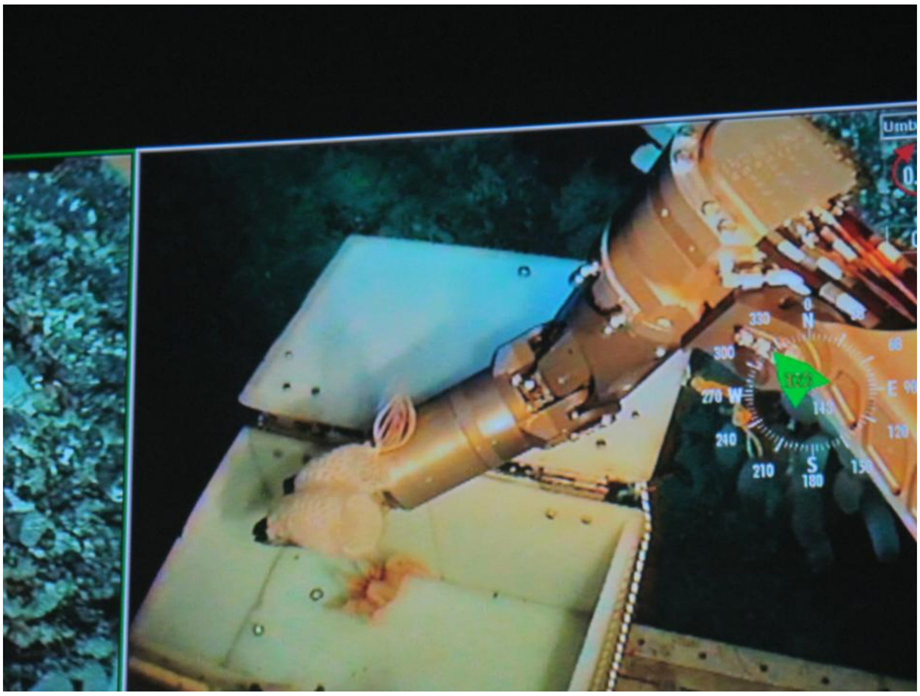

Figure 31. Example of video screen shot for subsequently identifying a specimens sampling location and its location in the ROV bioboxes.

5.6.2.3 SHRIMP towed camera system

SHRIMP was used for several dives during the JC066 cruise. This vehicle has a number of downward and forward-looking cameras and is also equipped with lasers for scaling of images. The vehicle is usually towed from deep to shallow along a transect and we employed it much as we did the ROV for survey dives. The main difference is in the quality of the images as generally SHRIMP cannot fly as close to the seafloor as the ROV, and is also subject to significant heave from the vessel, especially if there is any form of swell on the sea surface. SHRIMP also lacks any form of thrusters system so, unlike HYBIS, it cannot be manoeuvred while close to the seabed. This gives HYBIS a significant advantage over the SHRIMP system in extreme topography.

5.6.2.4 HYBIS

HYBIS is a video-grab system with two small thrusters, downward and forward pan and tilt cameras and an optional manipulator. The platform is flown from shallow to deep and its ability to change it's orientation underwater is extremely useful in extreme topography. The vehicle is limited particularly by the amount of lighting it carries, the quality of images and the lack of laser scaling. It was found to be particularly useful for the survey of underwater cliffs on seamounts (especially Melville Bank) and extreme sloping topography (such as on Middle of What Seamount). It was also found to be a very useful vehicle for surveying in strong currents, especially around Middle of What Seamount where very strong currents made ROV operations difficult. In general, the vehicle was flown above the seabed but as close as was feasible given the weather conditions, and it's orientation changed frequently to view the seabed and associated communities. The vehicle was used to recover sediment but this was of limited use as a biological sample because of washing during recovery. This was however useful in the determination of sites for coring.

5.6.3 Results

5.6.3.1 Summary of the video surveys on each seamount

5.6.3.1.1 Coral Seamount

The northeast corner of Coral Seamount was found to have extensive beds of sub-fossil barnacle scutes at a depth of ~ 1300m. Moving along the vertical transect on the NE slope steep exposed bedrock provided hard substrata for primnoid octocorals and sponges (generally under overhangs). This gave way to a large area of dead coral framework (*Solenosmilia variabilis, Desmophyllum dianthus*) at 700-800m depth. No live scleractinian coral was initially located, however, further towards the summit of a pinnacle on the NE face of the seamount patches of live *Solenosmilia variabilis* and *Caryophyllia antarctica* c.f. solitary corals were recorded and collected. There were also extensive areas of growth of zoanthid anemones. The framework was highly cryptic and provided habitat for a wide range of invertebrates, particularly squat lobsters and also octopi.

Progressing towards the seamount summit clear zonation of epifauna was seen from 700m to 400m depths, passing through hermit crab dominated sediment draped rock followed by a zone of gastropod molluscs (the source of the hermit crab domiciles). This progressed to a zone of calcareous polychaetes worm tubes. The summit was an unusual landscape of sponges and scleractinian thickets over a small boulder and sand substrate. Across much of this area zooanthids carpeted every free space. Tube worms were common and sea stars and brittlestars were seen regularly.

The southeastern slope of the seamount was generally covered with fairly course sediment with rocky outcroppings giving away to coral rubble nearer the summit. Pennatulids were observed on this slope along with a species of crab whose carapace is completely cloaked in a large colonial zoanthid. Octocoral gardens were present near the summit.

The western slope of the seamount was extremely steep, giving away to very broken and near vertical cliffs with a distinctive community of brachiopods, sponges, octocorals and black corals. On the lower parts of this slope a 6-gilled deep-water shark was observed.

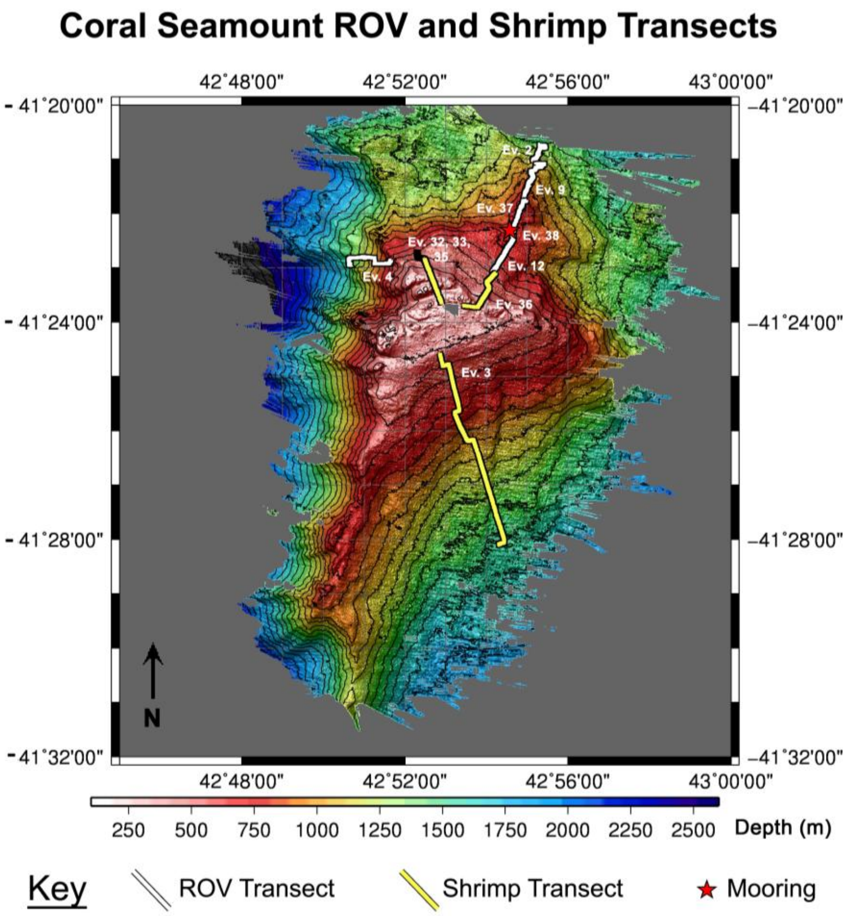

Figure 32. Bathymetric map of Coral Seamount showing location of ROV and SHRIMP transects as well as the site where the whalebone and wood mooring was located.

ROV work was stopped on at least 4 occasions due to the discovery of fishing line. On one of these incidents the gear was confirmed as a gill net. It looked very new with no overgrowth on the ropes (unlike the whale bone mooring which in 2 years had become furry with growth). The net was filled with corals and coral framework. And the area around it was cleared of live corals and sponges. This sighting was of great concern as the seamount has been placed under a voluntary closure to fishing by the deep-sea trawling industry. It would appear to confirm rumours of gill net fishing in the region, probably targeted at deep-sea sharks. Patagonian toothfish, *Dissostichus eleginoides*, were sighted a few times on this seamount, although the fish fauna was dominated by rat-tails (*Coryphaenoides* spp.) and *Lepidion* sp. A single orange roughy, *Hoplostethus atlanticus*, was also sighted.

5.6.3.1.2 Melville Bank

ROV operations commenced on the southwest face of Melville Bank at 900m. A barren plain of broken coral fragments and sediment was located. White stylasterids of a uniform size were observed commonly on larger cobbles and boulders. By far the most common megafauna were lobsters from the genus *Projasus*. Eels, pancake urchins, pencil urchins (Cidaridae), and Hexactinellida were also frequently seen in footage. This gave away to steeper rocky terrain forming a steeply sloping boulder face that formed a habitat where large octocorals and sponges were found; this is likely because this area is less vulnerable to trawling although it is notable that a buried trawl cable was encountered on this slope.

The north face of the seamount presented some very extreme topography. A sub-pinnacle summit to the west of the main summit area was found to be very heavily impacted by trawlers with trawl scars and lost fishing gear scattered all over the area. To the north there was a sheer cliff face comprising bare rock with almost nothing growing on it. Nearer the base, coral and sponges were encountered. Entire tows of plastic lobster pots were encountered, suspended down the cliff face, along with other types of fishing gear. A dive up the north face of the main summit area revealed sheer basalt rock face formed of fresh lavas and what appeared to be columnar pillar basalts. Extensive growths of octocorals and sponge were located in this area with some spectacular underwater scenery. Cardinal fish were also encountered on some of the steepest slopes. No dead scleractinian framework was seen with the majority of rubble being stylasterid. Small live stylasterids were common, sponges were rarer than in previous areas, fields of yellow Acanthogorgiidae, and some pinnate Primnoidae. The summit varied but for the most part was formed by deeply cut rock outcroppings covered with a different community of solitary corals (*Ballanophyllia*), fine black corals (Antipatheria), white and pink zoanthids, and colourful sponges. Wreckfish, jacks and tropical reef-associated fish were encountered in this area as well as some large sharks. A monofilament gill net was also found wrapped into a bundle on the summit with a dead crab in it. Just below the summit large lobsters of the genus *Jasus* were encountered, possibly the target of the pot fishery indicated by lost fishing gear.

A dive down the eastern face of the seamount with HYBIS revealed large numbers of lobsters (*Projasus*), many hiding in what may have previously been lava tubes. The deep slopes of the southern part of the seamount were dominated by octocorals, large stalked sponges and branching treelike sponges colonized by zoanthids.

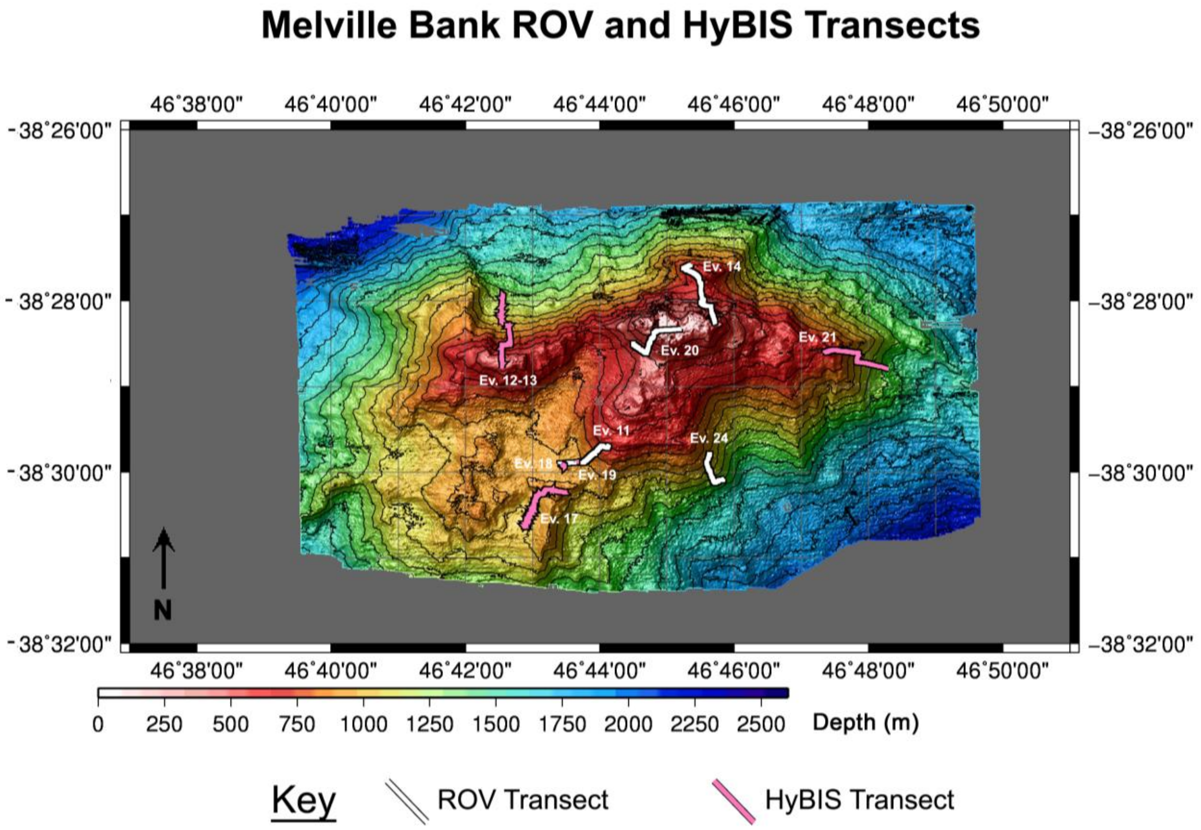

Figure 33. Bathymetric map of Melville Bank showing ROV and HYBIS transects.

5.6.3.1.3. Middle of What Seamount

The whole of the Middle of What Seamount was subject to extremely strong current flows, probably associated with the edge of a large meander or ring attached or closely associated to the sub-tropical and sub-Antarctic frontal system. The main summit of Middle of What Seamount comprised of coral rubble with some patches of low-lying coral framework, most of which was dead. Although no fishing gear was encountered it is likely this area had been impacted by fishing. An area in the NE of the seamount where a sharp and very steep volcanic cone arises is covered in dense and broken coral framework, most of which is dead, but like parts of Coral Seamount, colonized by a rich fauna of octocorals and sponges as well as *Projasus* and squat lobsters. Likewise, steep rocky terrain on the southwestern side of the seamount was also colonized by a variety of corals. The seamount was particularly notable for a very high density of small lantern sharks (*Etmopterus* spp), as well as oreos (Oreosomatidae), orange roughy and a sighting of a *Muraenolepis* species.

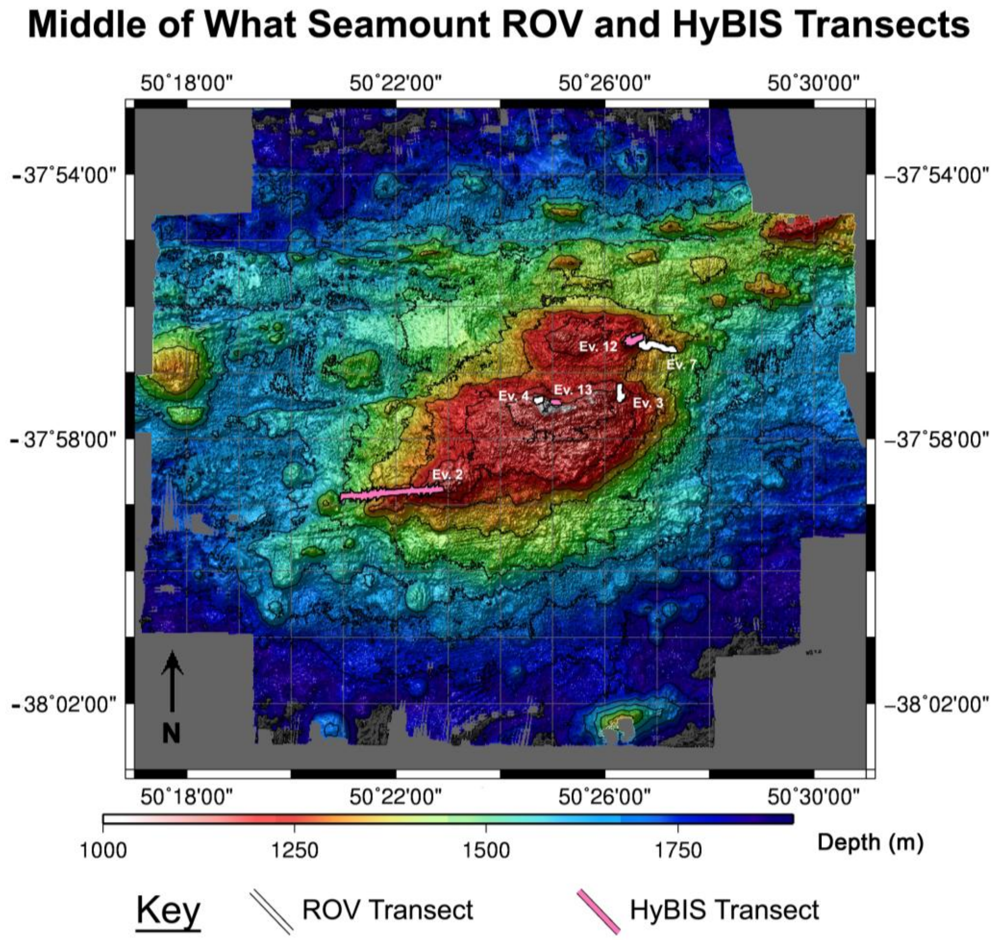

Figure 34. Bathymetric map of Middle of What Seamount showing ROV and HYBIS transects

5.6.3.1.4 Sapmer Bank

The beginning of the only ROV dive undertaken at Sapmer started at 700m (on the descent a few sharks were passed) with a few hundred metres of demolished coral reef with many areas trawled so hard the bare carbonate base was exposed. In shallower water, shallow sediment on the seabed clearly showed evidence of trawling in the form of long parallel scars on the seabed clearly visible on the forward-looking sonar of the ROV. The influence of fishing not only manifested itself in the physical destruction seen but also in human litter as well as lost fishing gear, including a large section of gillnet (likely fishing for shark) found amongst rocks.

Animal life from 700-500m was sparse with a scattering of seapens and octocorals. From 500m depth upwards the density of octocorals, black corals and fish (stargazers were relatively common as were rockfish and wreckfish) increased but were found in patches. Much of the coral growth was on exposed carbonate probably making it secondary growth post-fishing. From 400-300m there were intermittently dense thickets of live *Madrepora oculata* (the first live colonies seen on any seamount so far); these thickets were often near or attached to *Solenosimilia variabilis,* which was common. These hard framework-building corals were part of the large coral gardens seen across the upper slope where a diversity of primnoids, black corals, and other octocorals were also seen. *Goniocorella dumosa* was common across the summit (200m) as were thickets of *Stenocyathus vermiformis* and many octocorals. One example of the free-living solitary coral family of Fungiidae was also collected. A few large lobsters (*Jasus* sp.) and large crabs were seen and one unusual galatheid.

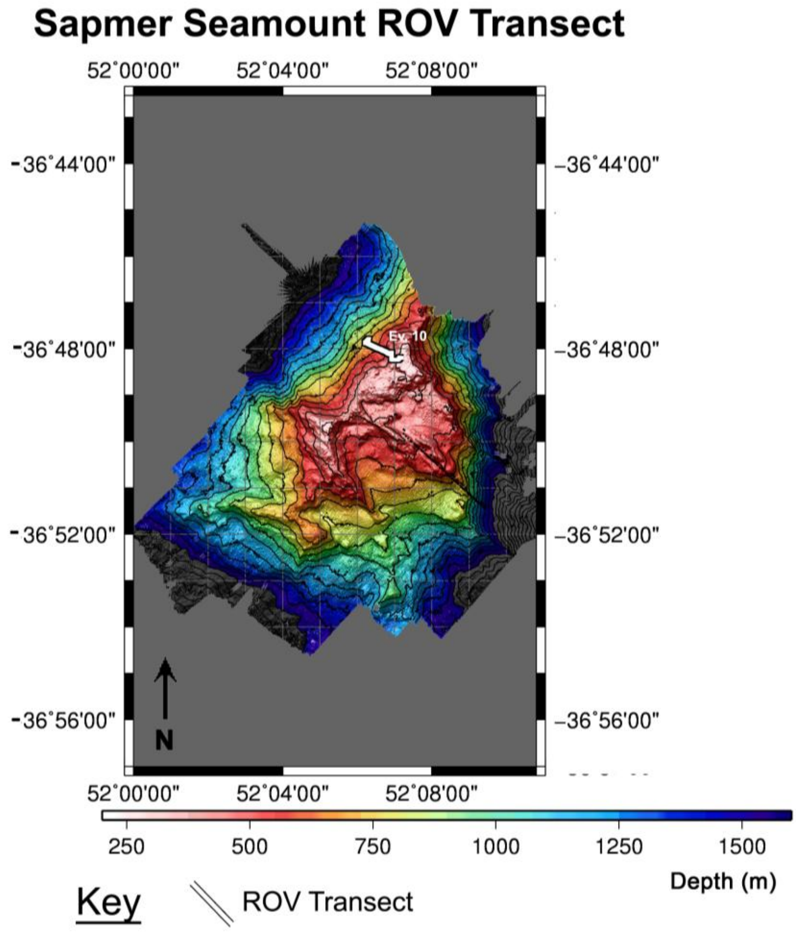

Figure 35. Bathymetric map of Sapmer Bank showing the single ROV track.

5.6.3.1.5 Atlantis Bank

Atlantis Bank was also a seamount showing marked contrasts between areas. The summit is generally a flat pavement of carbonate thinly draped in sediment with steep outcrops of bedrock. The flat areas are dominated by soft echinoids, small pink echinoids and cidarid echinoids. There are also small solitary Scleractinia and hermit crabs. The rock outcrops are colonized by large stylasterids, octocorals and scleractinians, including *Madrepora oculata*. The stylasterids in particular are often colonized by clumps of *Dermechinus horridus* (a sea urchin), the spines of which form red mats around the bases of the rock outcroppings. These are mixed with coral rubble and form a rich habitat for other species such as ceriantheid anemones. The most notable component of the fish fauna are armourhead, *Pseudopentaceros richardsoni*, and a smallish, fast-moving shark.

The western side of the seamount is characterized by two spurs between which are large mass-wasting features. The northernmost mass wasting feature was investigated using HYBIS and comprised of carbonates overlain by thin sheet basalts in the upper areas. Remarkably, these slopes were almost completely barren with just the odd echinoid and crinoids present. Further down the slope, at depths of ~900m, sediment was present but was furrowed with multiple parallel and criss-crossing trawl plough marks at such a high density that they resembled a ploughed field. This likely explained the lack of fauna further up the slope where trawl marks were barely visible because of the hard substrata. The spurs comprise steep slopes and cliffs colonized in areas by dense communities of anemones, giant sponges and huge octocoral trees of the genus *Paragorgia.* These areas were obviously too rugged to fish and were likely to be less impacted. The only lost fishing gear found was a single trawl cable on the seamount summit.

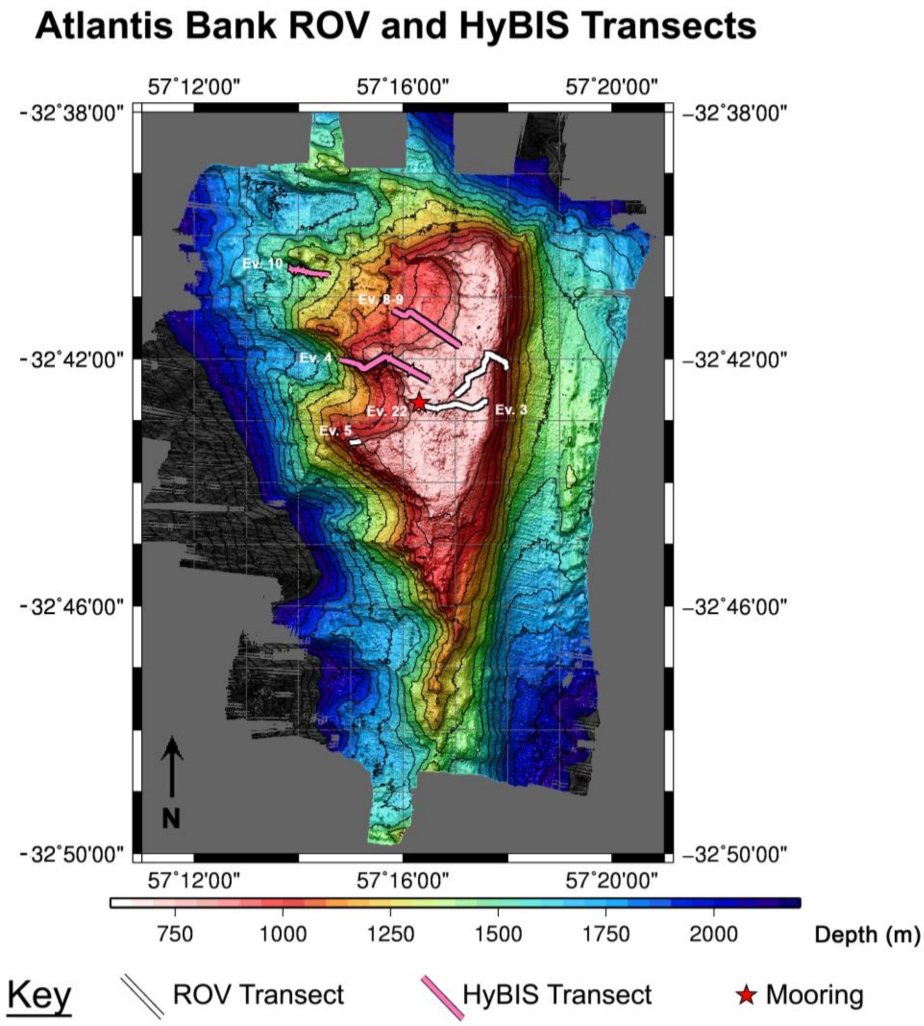

Figure 36. Bathymetric map of Atlantis Bank showing ROV and HYBIS dives

5.6.3.2 Overview of specimens collected on JC066

1709 samples were preserved throughout JC066, although, as some samples were batch preserved in their dozens to hundreds, this is a minimum value. Samples collected ranged across 15 phyla (Annelida, Arthropoda, Brachiopoda, Bryozoa, Chaetognatha, Chordata, Cnidaria, Echinodermata, Mollusca, Nemertea, Platyhelminthes, Porifera, Sipuncula, Tunicata, see Fig. 37). As Cnidaria were the most frequently seen taxa on benthic ROV surveys it is unsurprising that sampling was biased towards this group (although jellyfish did make up a portion of pelagic surveys). Many of the samples and phyla below were associated with the corals and sponges collected (see section on coral associates). The Chordata and Chaetognatha samples were collected from pelagic surveys rather than benthic, where the majority of remaining samples were collected (see section on net sampling for details of pelagic catches).

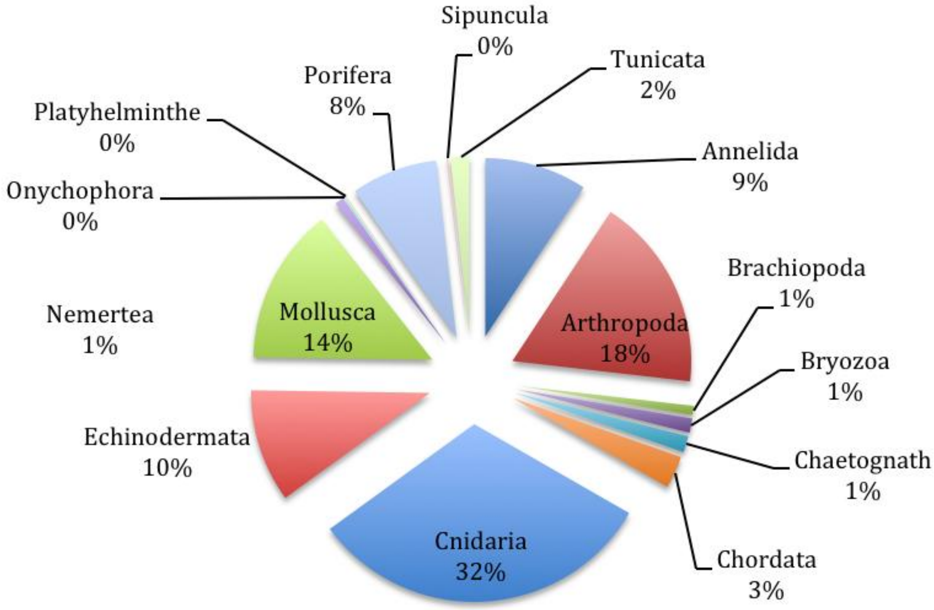

Figure 37. Piechart showing sample breakdown by phyla

5.6.3.2.1 Some taxonomic specifics

Within Annelida 97% of specimens were polychaetes. Polychaetes were often found across the surfaces of sponges and within the branches of corals. A few unusual specimens were specifically associated with holothurians and octocorals of the Primnoidae family; others created their own worm tunnels or even created tunnels through coral colonies (such as those found in stylasterids).

Arthropoda are a very diverse group whose higher taxonomy is uncertain. Specimens collected were from a range of orders and subclasses within Arthropoda (see Fig. 38). The most abundant were isopods and decapods. Isopods were again very commonly associated with a few species of corals, octocorals specifically. Within Decapoda, the most commonly seen specimens were galatheid crabs; these crabs were often found defending their space in live fan octocorals, sponges and hard coral framework. Some of the more unusual arthropods seen were sea spiders (Pycnogonida).

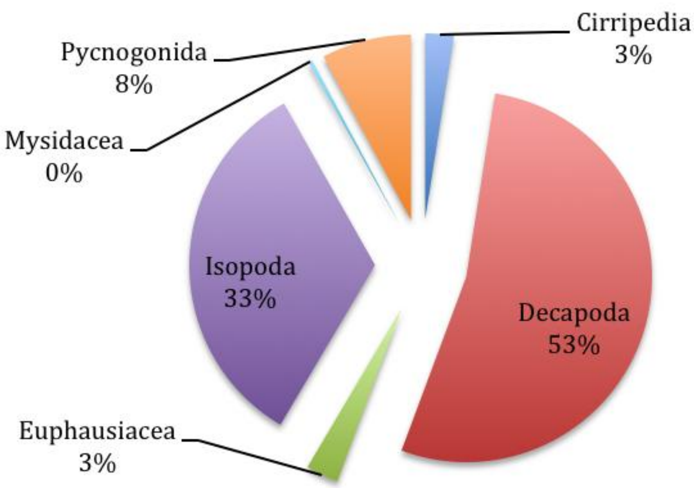

Figure 38. Piechart of specimen breakdown within Arthropoda.

Cnidaria were the most frequently seen and sampled megafauna. Within Cnidaria, Scleractinia (hard corals) and Octocorallia were sampled more frequently than other subclasses (Fig. 39). Primary identifications indicated 5 species of framework building Scleractinia were seen across these seamounts. Within Octocorallia at least twenty species were collected, most within the Primnoidae family, and

Acanthgorgiidae was seen on most seamounts as well. Actiniaria included a few interesting species of four-lobed fly trap anemones. Net sampling collected an array of Scyphozoa species. Zoantharia were often found carpeting seamount areas and many different species were collected. One particular zoanthid appears to have a close association with a Hexactinellida sponge species.

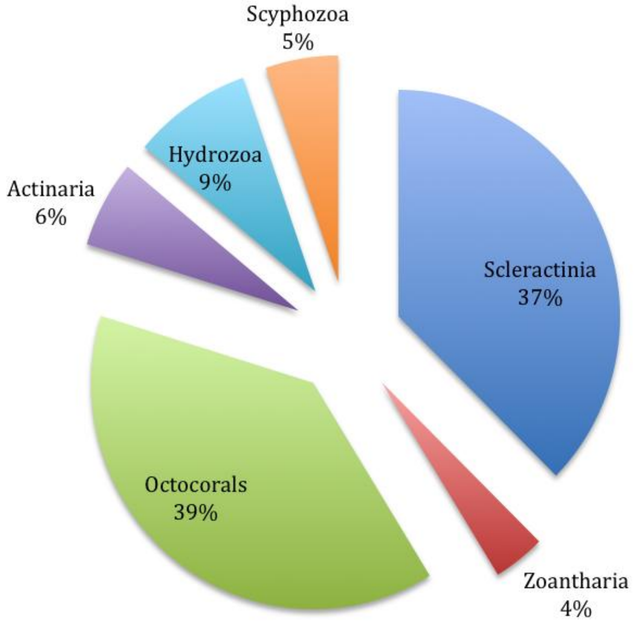

Figure 39. Piechart showing breakdown of Cnidaria specimens.

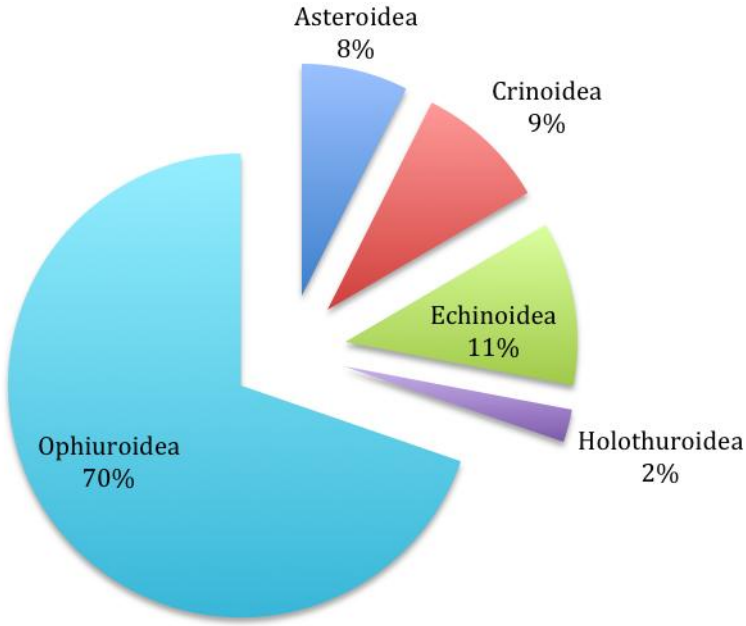

Figure 40. Piechart showing breakdown of Echinodermata specimens collected.

Specimens of Echinodermata were dominated by brittlestars (Ophiuroidea, see Fig. 40) whose body size ranged from the minute (5mm from arm tip to arm tip) to the large, 45cm wide, (basketstars - *Gorgonocephalus* sp.). Delicate sea urchins (Echinoidea) were seen in their highest numbers on Atlantis Bank and, although difficult to sample, a number of well preserved specimens were collected (see Fig. 30). Some of the more unusual Echinodermata included stalked sea lilies (Crinoidea), a few large holothurians (sea cucumbers, see Fig. 41) with commensal scale worms, and one armoured sea cucumber.

Figure 41. Armoured sea cucumber.

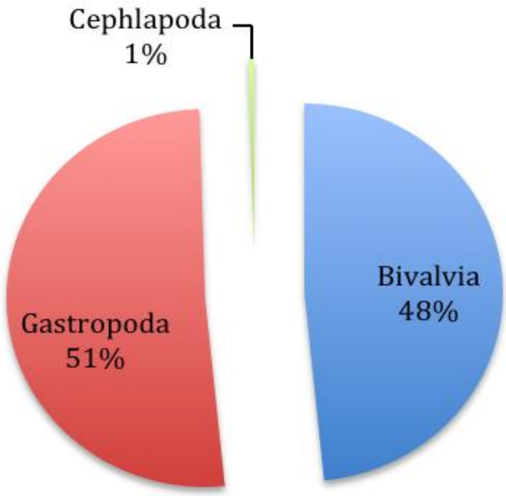

Figure 42. Piechart showing breakdown of Mollusca specimens collected.

There were approximately the same number of bivalves and gastropods collected (Fig. 42). Most of the bivalves were collected from whalebone specimens whereas gastropods were a relatively common occurrence within coral framework and other substrata. The single cephlapod was collected in the pelagic net surveys.

Although sponges were frequently seen in ROV footage and surveys, they were often large specimens and were thus not often collected. Those collected were of a range of shapes and sizes: cups, whips, stalked, and massive sponges. One of the most unusual associations seen were of a white barrel glass sponge that had two glass shrimp inhabitants, a male and a female, living permanently locked within it's walls (Figs. 53, 54).

Some of the rarer specimens included a few sipunculids, some nemerteans (although many more will likely be found with the closer inspections to be undertaken in the coming months), unusual stalked colonies of tunicates, and one platyhelminth.

5.6.3.2.2 Associated projects

As scientific research collections and studies in the Indian Ocean are very rare, in addition to the projects described within this report, collections were made for a number of other projects:

Sponges – Dr Kate Hendry, Woods Hole Oceanographic Institution, USA

"Silicon (Si) is an essential nutrient for photosynthetic diatoms, which play a key role in the cycling of carbon. In the modern surface ocean, biological formation of amorphous silica (biogenic opal) by diatoms is the dominant process that removes dissolved Si (silicic acid, or Si(OH)4) from seawater. Diatom blooms rely on upwelling sources of Si(OH)4 because efficient utilisation strips almost all of the Si from surface waters. Ocean circulation and variations in algal populations result in distinct Si(OH)4 concentrations in different deep water masses. The intermediate waters that form in the Southern Ocean and spread throughout most of the ocean, for example, are characterized by low Si(OH)4, relative to other nutrients. An understanding of past Si(OH)4 is required to reconstruct the supply of nutrients from the Southern Ocean through time.

I have developed a robust new proxy for the Si(OH)4 concentration of seawater using Si isotopes (d30Si) in deep-sea sponge spicules, based largely on samples collected from two cruises in the Southern Ocean (Hendry *et al*,. 2010, 2011). I have also added samples from the North Atlantic and North Pacific to the calibration, which show that the Si(OH)4-d30Si relationship appears to be global (Hendry & Robinson, in prep). Here, I propose to add sponge samples from the Indian Ocean, as no sponge silicon isotope measurements have yet been carried out in this region."

Fossil corals – Dr Tina van de Flierdt – Imperial College London, UK

Fossil coral were collected to support ongoing historical climate change studies.

Ophiuroids - Dr Tim O'Hara, Victoria Museum, Australia

Brittles stars (Ophiuroidea) were collected to expand global phylogenetic studies into the Indian Ocean.

Crinoidea – Dr Marc Eléaume, Dr Nadia Ameziane, Dr Marc– Museum National d'Histoire Naturelle, Paris.

Crinoids are well represented and abundant around Antarctica with around 50 known species. For the last 5 years, species of crinoids have been sequenced only to find that many species are in fact complexes of cryptic entities. Expanding collection and phylogenetic studies into the Indian Ocean is important to look at linkages between these regions.

Chateognaths – Prof. Peter Holland, University of Oxford

These will be used in studies of HOX-gene clusters in the phylum Chaetognatha.

5.6.3.2.2. Report on the Pycnogonida from the Southwest Indian Ocean Ridge

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5.6.3.2.2.1 Introduction

This report is based on collections made during Voyages JC066 and JC067 of the RSS *James Cook* utilizing the IMF-GEOMAR owned ROV *Kiel 6000* and the tethered video sediment-grab platform, HYBIS. The report is the first account of pycnogonids collected from the Southwest Indian Ocean Ridge.

The twenty-two specimens collected from the seamounts are provisionally assigned to seven genera and five families. Twelve species are recognized. Nine species of pycnogonid were collected from the 'Coral' Seamount of which six were on and about the whalebone deployment. Only one specimen (*Pantopipetta* sp. nov.) however was actually on experimental material (mango wood). Species in this genus are morphologically adapted to feeding on bryozoans and thecae hydroids. As the specimen was removed from wood in the CT room after removal of the net it is most likely it was dislodged from its host substrate. The remaining specimens were either recovered from the net, the mooring rope, or from the surrounding sediments. A particular association with either the whalebone or wood is considered unlikely. Further specimens were collected from sediment on the 'Middle of What' (MoW) seamount (3 species) and from the Atlantis seamount (one species). Only one species was recorded from more than one seamount (Coral and MoW). It is reasonable to assume that this species and probably others should at least be also found on the intervening Melville seamount, however, all of these seamounts are so adversely affected by trawling that it would now be difficult to identify connections and relationships between them.

The two large specimens collected at the Atlantis seamount are provisionally assigned to *Colossendeis melanocholicus* Stock, 1975. These specimens agree with the general habitus of that species, in particular the extremely long proboscis (almost three times the trunk length) but differ in several respects, the significance of which may best be resolved by molecular means. Should these specimens prove to be *C. melanocholicus* then these records fill a gap between two divergent collection locations; the Caribbean and eastern Tasmania. Predation by pycnogonids on sea anemones is not new however this is the first record of *Colossendeis* feeding on 4-lobed anemones. Several other specimens of *Colossendeis* and possibly *Bathypallenopsis* were sighted during HYBIS transects but not collected.

Specimens were also sighted at hydrothermal vent sites 2 and 3 but were not collected. These specimens were likely to be species of *Sericosura*. They were active and primarily associated with mussels (*Bathymodiolis*) and peltospiroid gastropods. Few specimens were observed in the open. Post-larval pycnogonids are known to parasitize soft-bodied invertebrates including gastropods and bivalves in which case possible associations amongst the vent fauna is worthy of investigation.

Specimens will be lodged in the Natural History Museum, London, following formal identification.

5.6.3.2.2.2 Identifications

Colossendeidae Hoek, 1881

Colossendeis Jarzynsky, 1870

Colossendeis macerrima Wilson, 1881
Material examined: Coral seamount, stn.4.9, 41˚ 21.32.996 S, 42˚ .55.03294 E, specimen JCO66- 578, on dead coral rubble, 863 m depth, 14/11/11 (NHM) 1 specimen.
This species has a wide-spread distribution and has been recorded previously from nearby South African waters. Its occurrence here is not unexpected.

Colossendeis cf *melanocholicus*?
Material examined: Atlantis seamount, 32˚ 43 20S, 57˚ 145 39E. Specimens JC066-3846, JC066-3847 Event 8.5 depth about 850 m, 10/12/2011 2 specimens. (Parent No. 2615).

Remarks: Specimens were observed on a cliff face feeding on pink, four-lobed anemones and on the open sea bed but with no apparent associations. The same species of anemone was however common in the area. Despite the accumulation of abundant records of male *Colossendeis*, specimens have never been recorded carrying eggs. The presence of an intermediate host is therefore likely. Up to sixty- seven juvenile of *Ammothella biunguiculata* are recorded from the gastrovascular cavity of anemones from the shallow waters of Japan (Miyazaki, 2002; Hong & Kim, 1987) and the possibility of *Colossendeis* using these anemones in a similar manner is worthy of investigation. Observations of pycnogonids feeding on sea anemones are not new, however deep-sea records are rare. A species of *Colossendeis* has been recorded feeding on 'Pom Pom' anemones on the Davidson Seamount, but this is the first record of a *Colossendeis* species feeding on these four-lobed anemones.

The leg span of largest specimen collected is 54 cm.

Hedgpethia Turpaeva, 1973

Hedgpethia sp.
Material examined: Coral seamount, 41˚ 21 46.04S, 42˚ 5454.4E. 687m. 20/11/11, specimen JC066-3109, 1 specimen.
Coral seamount, 41˚ 2231S, 42˚ 5457E. Specimen JC066-873. 732m. 20/11/11 (NHM). 1 specimen.
Middle of What seamount, 37˚ 56.795S, 50˚ 27240E, Specimen number JC066-3522, 1414 m, 2/12/2011, On dead coral in association with yellow an orange *Parazooanthus*. (NHM) 1 specimen.

Ammotheidae Dohrn, 1881

Tanystylum sp 'A'
Material examined: Coral seamount, 41˚ 2231S, 54˚ 57E, specimen JC066-871, on hydroids from whale bone rope, 732 m, 20/11/11, 1 specimen. Coral seamount, 41˚ 223138S, 42˚ 54574E, specimen JC066-884 732m. 20/11/11 2 juv, 1 adult. Middle of What seamount, 41˚ 2220S, 37˚ 4254E, specimen JC066-3521, 745m. On dead coral in association with yellow and orange parazooanthids, 2/12/2011, (NHM) 3 specimens. (Possibly many others present amongst the coral).

Tanystylum sp 'B'
Material examined: Coral seamount. 41˚ 2237S, 54˚.6067E Stn 4.12, specimen JC066-1068, 745m. 16/11/11, 1 specimen.

Sericosura?
Material examined: Coral seamount, 41˚ 22313S, 42˚ 5457E, Specimen JC 066-3440. 732m. 20/11/11. 1 specimen, juvenile female. Recovered from net containing Mango wood.
Remarks: This sub-adult female specimen is similar to *S. mitrata* known from S.W Africa & Antarctica. Species diagnostic characters are based on mature males and single females are difficult to determine. This genus has hitherto been associated with hydrothermal vents and cold seeps.

Nymphonidae Wilson, 1878
Nymphon J.C. Fabricius, 1798
Nymphon sp.' A'.
Material examined: Coral seamount, 41˚ 22313S, 42˚ 5457E. Specimen JC 066-3087. 732m. 20/11/11 1 specimen. Recovered from whale bone net.

Nymphon sp 'B' .
Material examined: Coral seamount, 41˚ 22313S, 42˚ 54575E. Specimen JC 066-908. On net containing Mango wood, 20/11/11, 700m depth. 1 specimen.

Nymphon sp 'C'
Material examined: Middle of What seamount, 37˚ 57 915S, 50˚ 24426E, amongst sediment, specimen JC066-3398, 1/12/11. 1100 m, 1 specimen.
Specimen JC066-3538 Middle of What seamount. 37˚ 56795S, 50˚ 27240E, 2/12/2011. Amongst sortings, 1 specimen.

Nymphon sp 'D'
Material examined: Middle of What seamount, 37˚ 57 915S, 50˚ 24426E, amongst sediment sample, specimen JC066-3415, 1/12/11, 1100 m, 1 specimen.

Austrodecidae Stock, 1954

Austrodecus sp.
Material examined: Coral seamount, 41˚ 22313S, 42˚ 54575E, on Mango wood, specimen JC 066-891. 732m. 20/11/11. 1 specimen.

Pycnogonidae
Pycnogonum sp. Brunnich, 1764
Material examined: Coral seamount, 41˚ 21 46S, 42˚ 54 53 E, amongst sortings, specimen JC066-3447, 20/11/2011. 702 m, 1 specimen.

5.7 Epifauna associations on corals and sponges

Dr Natalia Serpetti, Mr Peter Lamont and Mr Adam Chivers, Scottish Association for Marine Science
Dr Tim Ferrero and Dr Lucy Woodall, Natural History Museum

These studies have been proposed by the Natural History Museum (NHM) and the Scottish Association for Marine Science (SAMS) as an alternative project due to the unsuccessful attempt to collect quantitative cores for macrofauna and meiofauna analysis. Single corals, coral framework and rubble, and sediment scoops have been collected to study epifauna and within-tube fauna leaving in the biocenosis.

5.7.1 Material and methods

5.7.1.1 Coral framework

Coral framework and rubble have been collected with the ROV using 3 different scoop-nets of 500 µm, 1000 µm and ~2 cm mesh. When coral framework and rubbles were found, 2-3 scoops were collected and stored in the same biobox. Occasionally coarse sediment was also collected with the 500 µm mesh scoop-net. On board the samples were quickly moved in a constant temperature environment (CT lab) for processing. Larger megafauna and macrofauna have been picked off the framework (e.g. decapods, corals, anemones, polychaetes, isopod, amphipod, brittle stars and molluscs) and preserved in different ways for different taxa/class. The framework has been then preserved in different ways: in DESS for meiofauna genetic and in formalin for taxonomic identification.

At Middle of What (MoW) seamount, during two different ROV dives, coral framework and rubble were been collected for a better qualitative study (e.g. number of species per weight unit of coral framework) where most of the epifauna have been kept and preserved with the framework/rubble (only decapods and ophiuroids being removed). Part of the framework/rubble collected at these stations was also preserved in 100% ethanol for macrofauna DNA analysis.

5.7.1.2 Epifauna associations on single sponges and corals

On each ROV dive single corals (octocorals, primnoids, black coral) and glass sponges were collected with the manipulator arm. When possible, same coral species/families were stored in the same biobox to avoid cross contamination. Obvious epifauna species were picked off and separately preserved recording the parent barcode of the coral they belong to. Polychaetes were preserved in ethanol 100% and formalin for DNA and taxonomic analysis, respectively, and amphipods and isopods in ethanol 70% for taxonomic analysis. When a high density of small epifauna species was present (e.g. tanaids and sabellid polychaetes on octocorals) one part of the coral with epifauna was preserved in formalin, ethanol 100%, and DESS for further extraction and counting of species of macro- and meiofauna.

5.7.2 Preliminary results

5.7.2.1 Coral framework and rubble epifauna

All further analysis of macrofauna and meiofauna samples will be undertaken following the cruise at the designated research centre, SAMS and NHM.

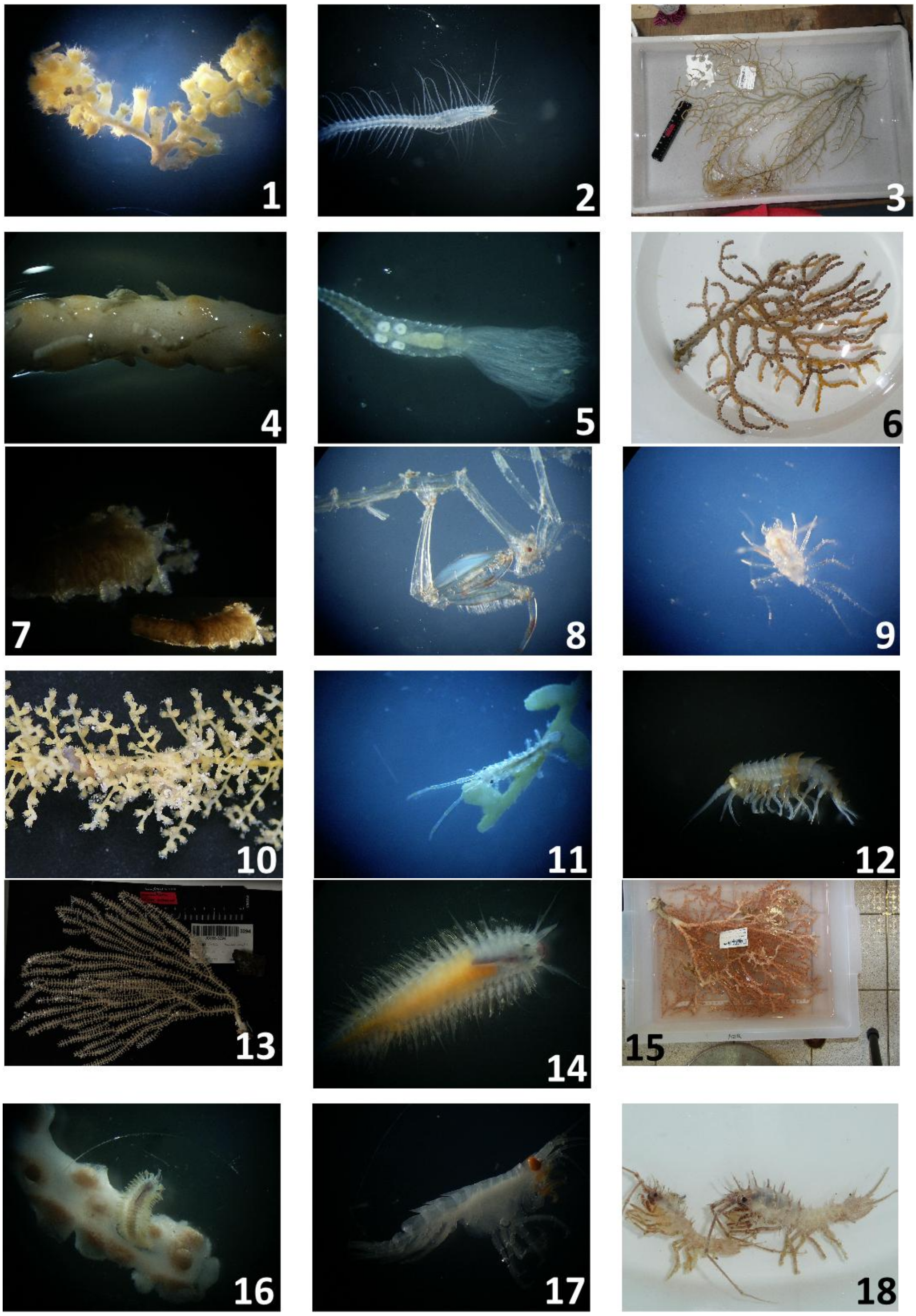
Table 10. The coral framework samples collected and the range of depth suitable for a comparison across the seamounts.

Coral	Melville bank	MoW	Sapmer	Atlantis bank
1300m		1200-1300m		
1100m		1000m		900-1000m
	750m		670m	700m

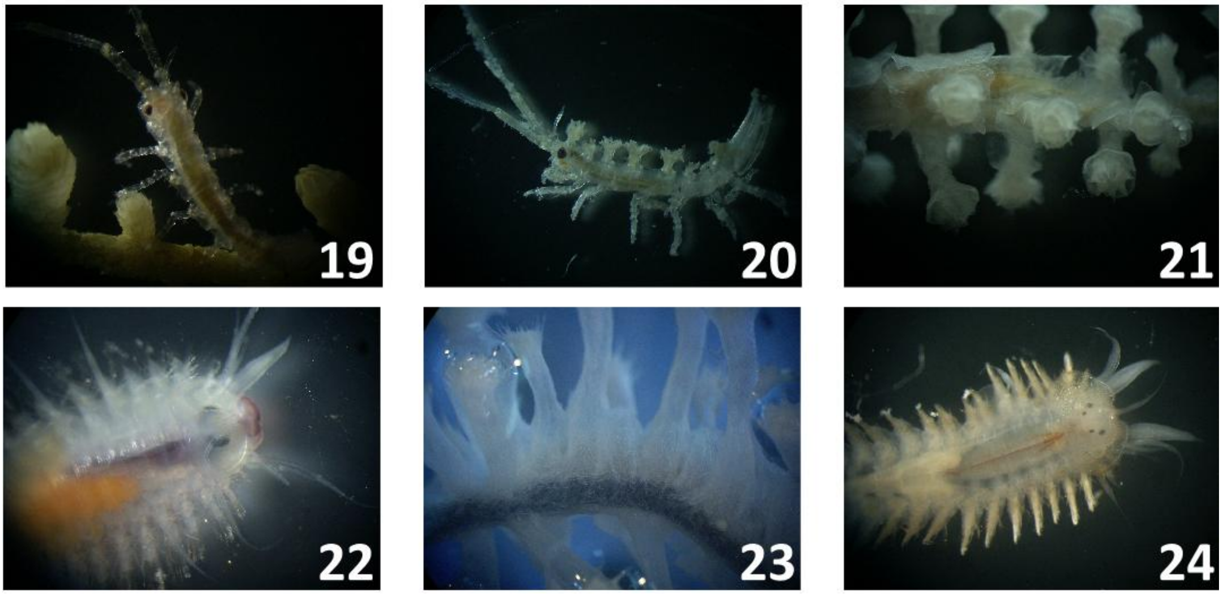
5.7.2.2 Epifauna of single sponges and corals

Interesting epifauna associations have been found in several single corals and in one glass sponge:

- Coral Acanthogogiidae (1) with syllids (2) and polynoid polychaetes
- Octocoral (3) with sabellids polychetes (4, 5)
- Fan octocoral (6) with tanaids (7), caprellids (8), isopods “long legged” (9) and nemertines
- Primnoid with polychates (10), Arcrurid isopods (11) and amphipods (12)
- Primnoid *Candidella* sp. (13) with polynoid polychaete (14)
- Glass sponge (15) with polynoid polychaetes (16) and amphipods (17)



Different epifauna species of arcrurid isopods with extraordinary structures were found across the sampled seamounts (18, 19 and 20). Particularly interesting is the specimen found in Atlantis Bank with "coral polyps" on the dorsal side (20).



Two different species of polynoids polychaetes were found on Primnoidae and Acanthogogiidae corals. It will be particularly interesting to investigate these associations and to analyse polychaete tube composition and construction methods.

5.7.3 Future analysis and comments

Most of the samples collected in this study are qualitative. One of the main aspects is to investigate the number of species and their dependency with depth ranges and variations along the productivity-disturbance gradient across the SWIOR.

A comparison between coral framework and sediment communities can be useful to evaluate the effect of the substrate complexity (habitat heterogeneity) on associated fauna diversity.

It is likely that new species have been collected so taxonomic identification of specimens will be a key focus.

For further macrofauna and meiofauna sample collection, ethanol of each coral collected should be sieved on 45 µm mesh aperture sieve and the material retained and sent to NHM and/or SAMS. All further analysis of macrofauna and meiofauna samples will be undertaken following the cruise at the designated research centre, SAMS and NHM, respectively.

5.8 Sediment Infauna

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5.8.1 Introduction

Personnel: Dr Tim Ferrero and Dr Lucy Woodall (Natural History Museum, London - NHM), Mr Peter Lamont, Dr Natalia Serpetti and Mr Adam Chivers (Scottish Association for Marine Science - SAMS).

Two teams of cruise participants conducted studies focused on sediment infauna comprising the macrofauna (animals generally < 4 mm and > 1 mm: SAMS) and meiofauna (animals generally < 1 mm and > 45 µm: NHM), principally the free-living nematode component.

The primary objective at the outset was to compare the species assemblages of meiofauna (particularly nematodes) and macrofauna (particularly polychaetes) from sediment cores taken across the five seamounts. A series of target depths were identifed (1500, 1000, 700, 400 and 200m), which could be sampled either during ROV dives or by mega/box corer following identification of suitable sediments during ROV operations or HyBIS/SHRIMP deployments (Table 11).

Analysis of previous bathymetric data showed that the five seamounts ranged in summit height from less than 200 m to approximately 900 m water depth. The series of depths chosen to target for sampling would enable comparisons to be made at least the two deepest depth zones across the five seamounts, with the 700 m depth covering four of the five and the full geographic range (Table 11).

Table 11. Showing the number of sampling depth levels present on each of the five seamounts (light green squares) illustrating the planned sampling campaign and the statistical comparisons that could be made.

	CORAL	MELVILLE BANKS	MIDDLE of WHAT	SAPMER	ATLANTIS
Summit depth (m)	c. 200	c. 100	c. 990	c. 400	c. 700
Summit (assuming depth independece)	[green]	[green]	[green]	[green]	[green]
200m	[green]	[green]	[grey]	[grey]	[grey]
400m	[green]	[green]	[grey]	[green]	[grey]
700m	[green]	[green]	[grey]	[green]	[green]
1000 m	[green]	[green]	[green]	[green]	[green]
1500 m	[green]	[green]	[green]	[green]	[green]

This sampling scheme would be repeated over a series of transects up each seamount. Sample replication would be achieved, therefore, on a range of nested scales at each sampling location, depth/transect and seamount. The proposed sampling designed was aimed at answering our principal questions, related to the determination of diversity, endemicity and/or geographic range of infaunal species across the SWIOR seamount system. Fully executed, the proposed design would also enable testing of hypotheses relating to the effects of depth and of seamount aspect, in relation to currents and tidal flows. These results could then be related to studies of other taxa and on other seamount systems, and more broadly to questions of dispersal and speciation.

5.8.2 Materials and Methods

5.8.2.1 HyBIS

HyBIS is equipped with a large grab through which a vertical real-time B&W camera can see the surface on which the grab is about to rest. HyBIS can thus be precisely directed to sample any bottom feature of interest. In addition, the grab is operated hydraulically and can be released a number of times, providing the chance to discard a sample should the first not be successful. Grab samples were scooped out with trowels into a plastic tub. Some subsamples were taken for microbiology, sediment grain size and meiofauna.

5.8.2.2 Box Corer (SBC)

The vessel was supplied with a stainless steel USNEL pattern boxcorer capable of obtaining a quantitative sample of seabed of 0.5 x 0.5 m. Seabed approach veering rates varied up to 30 m min^{-1}.

5.8.2.3 Megacorer

The NOC Megacorer was fitted with 100 mm internal diameter acrylic core tubes and capable of being mounted with up to twelve core tubes. During JC066 it was normally fitted with four core tubes, a few times with two tubes and once with six in an effort to penetrate the dense, usually coarse grained, stiff sediment. Seabed approach veering rates varied from 10 m min^{-1} at first to 27 m min^{-1}. On the summit of Middle of What seamount a strong SSW to NNE current made deployment of coring gear difficult and the technique of drifting the ship down-current onto the target location using a USBL beacon attached to the gear, bottoming the gear, and stopping the ship at the same time was tried with mixed success.

Megacores destined for meiofaunal analysis were immediately transferred to a core extruder. The top water was siphoned or syringed off through a 45 µm mesh aperture sieve (subsequently added to the sample containing the surface layer of sediment). The core was then measured and photographed prior to sectioning. If possible, the core was sectioned at 1 cm depth, but if the surface was excessively uneven or embedded hard substrate made this impossible without the section becoming disrupted and inaccurate, the core was then sectioned at 5 cm depth. Any sediment deeper than 5 cm remaining in the core was sectioned at 5 cm intervals and preserved as for macrofauna samples (SAMS). Macrofauna in the 0-5 meiofauna horizons is to be passed to SAMS. The section for meiofaunal analysis was further sub-cored with a ROV push core (see below) to achieve comparable data.

For macrofauna the cores were temporarily stored in the Controlled Environment Laboratory (CEL) then sectioned in 5 cm horizons and fixed with 4% formaldehyde solution before transferral to alcohol after a minimum of one day in the fixative. Macrofauna sediments were washed on a 250 µm sieve and the washings collected for meiofauna screening on 45 µm sieve by NHM.

5.8.2.4 ROV coring

ROV cores were taken with corers of the push core type, perspex, with an internal diameter of 74 mm and a total length of 30 cm (Figure 43 A). The top of the core was closed with an insert fitted with an 'o'-ring and secured by a large jubilee clip. Vent holes in the top of the insert were sealed with a circular silicone flap valve (Figure 43 B) allowing water to escape during core penetration and sealing on withdrawal. The insert also bore a numbered block on a rotating and slightly flexible mount which was grasped by the starboard manipulator (Orion) during deployment.

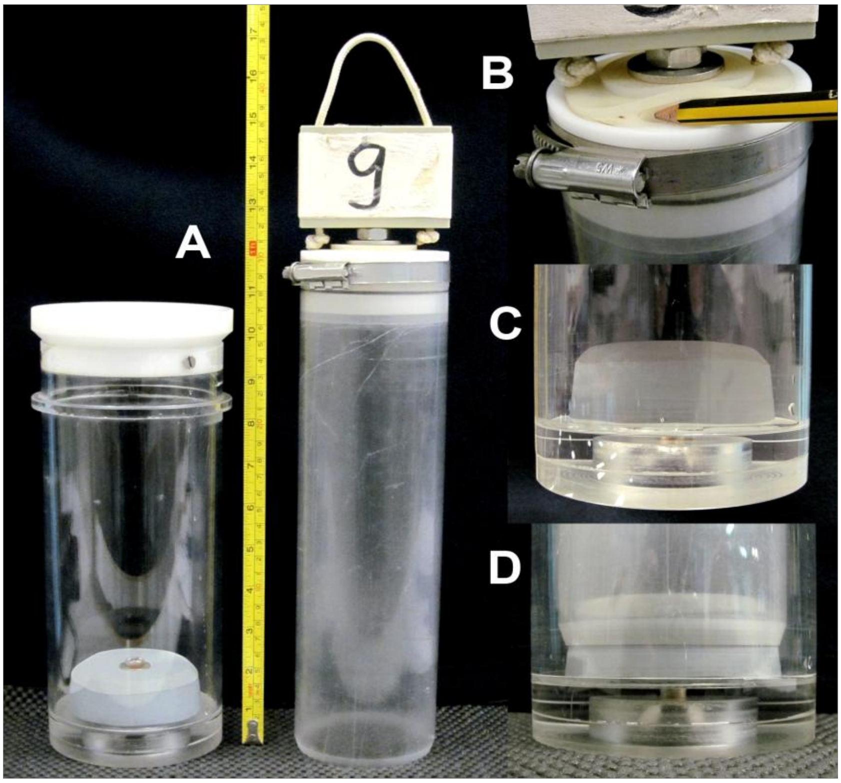

Figure 43. Design of the *Kiel* 6000 Push Core system. A: Complete system showing quiver on the left and core on the right, B: Detail of top insert showing silicone flap valve, C: Detail of base of quiver showing fixed sealing bung, D: Detail of push core seated on sealing bung.

The cores were deployed from a 4 x 4 rack of 16 core quivers located in the forward section of the port aft unlidded biobox on the *Kiel* 6000. When sampling, cores were removed from the quiver, inserted into the sediment and withdrawn bearing a core of variable length. The core was then replaced into the quiver and pressed down on to a captive, shaped bung secured to the bottom of the quiver. In this way, the base of the core was sealed (Fig. 43 C,D).

When the ROV returned on deck, the quivers were removed from the rack complete with cores and taken to the Controlled Environment Laboratory (CEL) maintained at 4ºC. Cores were released from the quiver by unscrewing a wing nut securing the bung to the base and the top insert was removed by removal of the jubilee clip. The cores were promptly transferred on to an extruder for sectioning.

5.8.3 Sample preservation

All samples destined for macrofauna analysis were fixed in 4% formaldehyde in buffered filtered (20 µm) seawater followed, after approximately 48 hrs, by sieving on a 250 µm mesh aperture sieve and transferral to 70% ethanol.

Samples destined for meiofauna analysis were fixed in either 4% formaldehyde in borax buffered, filtered (20 µm) tap water for morphological analysis, or in DESS (Seutin *et al.*, 1991) for DNA analysis. In the case of ROV cores, the first sample obtained from a location was fixed in DESS, the second in formaldehyde and then for subsequent cores, the preservation method was alternated. In the case of megacores, the first (inner) subcore was fixed in DESS and the remaining outer core in formaldehyde. For the next core obtained from the same location, the ROV subcore was fixed in formaldehyde and the outer core in DESS. For subsequent cores, the fixation method was alternated.

For both megacore and ROV push cores, very short cores, or cores which were clearly internally disrupted such that the contents of the top 5 cm could not realistically be assumed to actually represent the top 5 cm of the seabed sediment, were not sectioned but simply removed from the core tube and treated as a qualitative sediment sample. In the case of ROV push cores, sediment not sealed within the core tube, but which had been contained by the outer quiver, was also collected and treated as a quantitative sediment sample.

All further analyses of meiofauna and macrofauna samples will be undertaken by NHM and SAMS, respectively, following the cruise.

5.8.4 Results

5.8.4.1 Conventional Gear Deployments

Altogether 20 megacore deployments, 6 boxcores and 7 HyBIS grabs were recovered with sediment from four of the five seamounts visited Table 12.

Table 12. Summary of conventional coring gear deployments and results.

	Deployments	Good	Poor	Failed	Tubes
Megacorer	20	14	11	49	74
Boxcorer	7	0	6	1	n/a
Hybis	7	0	7	n/a	n/a

Seabed approach veering rates varied from 10 m min^{-1} at first to 27 m min^{-1}. Five deployments on the 12th of December (station 8 events 11 to 15) were carried out in marginal sea states for coring when the ship heave rate was peaking at 60 m min^{-1} explaining the lack of successful cores recovered (1 out of 16 tubes deployed).

Coral framework sediment was successfully cored (station 4, events 19, 20) showing that there was sufficient capability in the gear to cut through coral stems when sediment depth and consistency permitted. In addition to the general coring problems, the winch motor bearing began to malfunction and after attention with more lubrication, veering and hauling speeds had to be restricted to around 35 m min^{-1} which significantly lengthened deployment times (normal veering and hauling rates are of the order of 55 to 60 m min^{-1}).

From 20 megacore deployments (72 tubes) a total of only 14 reliable quantitative sediment samples were obtained for macrofauna and 16 samples for meiofauna.

The technique of drifting the gear down-current onto the target location depended on the gear being firmly anchored in the sediment as the ship stopped, since the current then came to bear creating drag on the cable, now stationary in the water column. Some damage to the megacorer resulted on one occasion (station 6 event 10) indicating it was probably dragged across the bottom.

The USNEL boxcorer was deployed 8 times returning 6 samples. All these were shallow and washed out with the overlying water draining past the box bottom due to coarse material trapped between box and spade. This gear normally can be expected to penetrate but in many cases either the sediment depths were shallow or the consistency seemed to be significantly more dense a short distance (> c 10 cm) beneath the surface. When extracting the gear from the seabed, haul rates tended to be about 10 m/min and it may be that in such sediments this may not allow time for the boxcorer spade to dig as fully as possible before the gear lifts off the bottom (haul rate must be added to the peak heave rate for actual possible extraction rate). It may also be that the boxcorer was not completely filled with lead shot in the central column, as overall weight undoubtedly aids penetration.

With the difficulties presented by coring, the generally dense, coarse grained and shallow sediments, it was hoped the HyBIS grab might return useful qualitative samples, especially for macrofauna. From 15 HyBIS dives, 7 grab sediment samples were retained. However, the HyBIS grab is designed primarily to collect rock samples and the covering plates do not seal it effectively. During recovery the onboard camera showed considerable water movement which efficiently suspended the sediment within the grab. This effect very probably winnows out lighter fauna and no macrofauna were observed in the washed Hybis samples apart from a small 2 cm long, urchin and a 3 cm sponge. Subsamples and washing waters from the Hybis sediments, examined for meiofauna, were found to be almost devoid of animals (see below 'meiofauna').

5.8.4.2 ROV Coring Deployments

Following the early ROV dives and unsuccessful corer deployments, it became clear that the proposed sampling design could not be achieved and that the objectives would have to be modified to adapt to the number and nature of samples likely to be obtained.

Sediments encountered were generally shallow, overlying either solid basaltic rock or hard carbonate pavement. They were also relatively coarse grained, un-cohesive and displayed notable thixotropy. Combined with this, slower than expected progress along identified ROV transects limited both sampling time, depth range covered, and the discovery of suitable locations for coring. Together, these properties presented a severe impediment to successful sampling by the ROV coring gear.

Where quantitative cores could be obtained, there was generally either a surface layer of coral fragments or other biological shell material (often also buried throughout the sediment). This made sectioning cores at 1 cm impossible in all but one case and therefore it was decided to standardise on cores sectioned at 5 cm depth. However, sediments deep enough to achieve reasonable core penetration were often associated with areas covered with coral debris, perhaps indicating that in such areas, the sediment is protected from erosion or suspension by this surface material. Figure 44 shows a group of ROV cores sampled from Middle of What (ROV Dive 12) and illustrates the type of cores obtained. The one good core, at the front, is relatively deep and has a thin layer of dead coral framework over the surface that did not unduly impede sectioning at 5 cm. However, the other cores visible were more typical of the most frequently obtained samples. In these cores, either penetration was impeded or a substantial portion of the core was lost on recovery, resulting in only a small amount of material being sealed within the core. Sediment would often begin to winnow from the base of the core tube shortly after withdrawal, followed by sediment pouring from the tube; this was exacerbated by any shaking or erratic movements of the manipulator arm.

Figure 44. An example of a good, quantitative ROV push core (front) with two examples of poor cores, suitable only for use as qualitative samples, on either side.

The replacement of cores into the core quivers represented a key factor impacting the final quality of cores retrieved. The nature of the sediment itself meant that as the manipulator arm moved the core over the quiver aperture, some sediment was often pouring out into the quiver prior to insertion. Any additional manipulator movements at this time tended to exacerbate this problem. An attempt to minimise this loss of sample was made by transporting the core from the coring location and positioning it over the quiver orifice at an angle of 45º, or greater, to the vertical. However, the relatively high lip of the unlidded port biobox around the core frame, impeded the ability of the manipulator to position the open end of the core very close to the quiver aperture and this often lead to further sediment loss. Much of this sediment did fall into the designated quiver and could be used as qualitative sample material, but analysis of the video footage also indicated significant winnowing of the sediment in the often high current velocities and it must be assumed that many meiofaunal (and macrofaunal) organisms were lost through this process.

5.8.4.3 Samples obtained

Macrofauna

A summary of SAMS macrofauna samples is listed in Table 13 and full details in Appendix 5.8.7.1. Very few macrofauna are normally observed onboard and only become evident when processing samples subsequently under binocular microscope onshore. Those large enough to be observed onboard are usually picked off into a vial and enclosed with the rest of the sample and thus fixed separately to avoid later damage. A few are photographed onboard to record *in-vivo* appearance and colour (see "Epifauna Associations on Corals and Sponges" section).

Table 13. Summary of number of macrofauna samples obtained.

	Depth	Quantitative	Qualitative
Coral	700	1 MGC	2 SBC
	950	1 MGC	1 SBC; 1 poor ROV biobox
	1050		1 SBC; 1 MGC; 2 ROV net
	1300		4 ROV net
	1400		1 SBC
Melville bank	750		3 ROV net
	1365	6 MGC	1 MGC; 1 poor HyBIS
	1500		3 poor HyBIS
Middle of What	1000	4 MGC	1 MGC; 1 ROV puc; 4 ROV net
	1200		3 ROV net
	1300		2 ROV net
	1500		1 poor SBC; 1 poor HyBIS
Sapmer	700		1 ROV net
Atlantis bank	700		1 poor HyBIS; 2 ROV net; 6 poor ROV chamber
	900	1 MGC	1 ROV net, 2 poor ROV biobox; 1 poor ROV chamber
	1000		1 ROV net
	1600	4 MGC; 2 poor MGC	2 MGC, 1 poor HyBIS; 2 poor ROV biobox

Meiofauna

Table 14 summarises the numbers of core samples obtained for meiofauna studies and full details are shown in Appendix 5.8.7.2. It is clear from these results that the number of quantitative samples obtained was very low (16) and that statistical analyses of species abundance data would be constrained. A larger number (43) of qualitative samples was obtained. If these are shown to be relatively unbiased (i.e. the occurence and relative abundance of species is similar to that found in quantitative samples) then there is greater scope for statistical analysis of relative abundances and measures of diversity. As core numbers obtained was low, a number of megacores were shared with SAMS workers such that the 0 - 5 section was fixed in formaldehyde and then sieved over a 250 µm mesh aperture sieve. All the sieveings were collected and then sieved on a 45 µm mesh aperture sieve to collect meiofauna. The aim is to attempt to reconstruct a meiofauna sample by combining the fauna from the < 250 µm sievings with larger meiofauna retained on the 250 µm sieve. However, this approach is not yet tested and these megacore samples are currently listed as quantitative samples.

As well as core samples, qualitative samples taken from HyBIS grab samples are listed. However, inspection of video recordings and of the material retained in the grab indicated that very significant winnowing of the sediment takes place both during sampling and particularly during recovery, which would have a serious negative impact on the number of meiofauna retained. In fact, one of these samples was processed following fixation according to a standard meiofaunal elutriation technique (10 x 30 second elutriations over a 45 µm sieve). The extract obtained was examined under a stereomicroscope and no nematodes were observed. This is an extremely unusual result most likely indicating severe degaradation of the grab sample during recovery.

Table 14. Number of meiofauna qualitative and quantitative samples obtained at each seamount station and depth. *Shared Megacore samples treated as qualitative until analysed. ** USBL ceased functioning - approximate depth.

Station number	Depth (m)	Target Depth	Qualitative samples	Shared Megacores*	Quantitative samples	Hybis Grab samples
5	100	200	-		-	1
4	700	700	5		4	-
4	600	700	1		-	-
7	600	700	2		-	-
8	700	700	11		-	1
4	1100	1000	1		1	-
4	1000	1000	3	1	1	-
5	900	1000	2		1	1
6	1000	1000	3		1	-
8	1100	1000	3		-	-
8	900	1000	3	1	1	1**
4	1400	1500	2		-	-
5	1300	1500	-		2	1
6	1500	1500	-	3	2	-
6	1300	1500	1		-	1
8	1600	1500	-	1	3	-
TOTALS			**37**	**6**	**16**	**5**

Table 15 shows a schematic representation of the samples obtained in relation to the original sampling strategy (see Table 11).

It is clear that, for the shallow sampling depths (200 and 400 m), very few seamounts were successfully sampled. More samples were successfully recovered from the deeper sampling depths (700, 1000 and 1500 m) with most samples obtained from four of the five seamounts at 1000 m. Fewer samples were obtained at 1500 m, but four seamounts were represented in the samples whereas only three were successfully sampled at the 700m depth. If the summit of a seamount is treated as a distinct habitat, independent of depth, then three seamount summits were also sampled: however, this assumption is untested.

Table 15. Summary of seamount locations and depth where qualitative or quantitative meiofauna core samples were obtained. The summits of the seamounts are also treated as depth-independent sampling locations.

	CORAL (St 4)		**MELVILLE BANKS (St 5)**		**MIDDLE of WHAT (St 6)**		**SAPMER (St 7)**		**ATLANTIS (St 8)**	
Summit depth (m)	c. 200		c100		c. 990		c. 400		c. 700	
Qualitative/Quantitative Samples obtained	Qual	Quant	Qual	Quant	Qual	Quant	Qual	Quant	Qual	Quant
Summit (assuming depth independence)	N	N	Y	N	Y	Y	N	N	Y	N
200m	N	N	Y	N						
400m	N	N	N	N			N	N		
700m	Y	Y	N	N			Y	Y	Y	N
1000 m	Y	Y	Y	Y	Y	Y	N	N	Y	Y

5.8.4.4 Revision of Objectives

As sediment sampling proceeded at the first two seamounts, the low number of samples being successfully recovered from coring gear led to a revision of objectives for both the meiofauna and macrofauna studies.

It was decided to continue with sediment sampling, but with the understanding that analytical objectives would have to be based on more faunistic data. The qualitative samples obtained would allow for analysis of relative species abundance and diversity, which could be supported by the lower number of quantitative samples. Questions relating to biogeographic parameters - species occurrence and range would receive greater emphasis and were ideal topics for molecular analyses of species turnover and potential cryptic speciation.

As quantitative cores were proving difficult to obtain, a modified ROV push core sampling strategy was introduced whereby sediments were initially sampled in the standard manner by inserting and withdrawing the core along a vertical axis. If this was unsuccessful, then the next step was to insert the core vertically but to try to withdraw the core at an angle in an attempt to limit sediment loss from the bottom of the core. If this too failed, then the core was used horizontally to obtain a qualitative "scoop" sample.

A number of additional sampling strategies were also introduced or, if they had already been occurring opportunistically, were formally incorporated. At a number of locations, patches of dead coral framework were encountered and it was decided to sample this framework specifically to analyse associated macrofauna and meiofauna (See "Epifauna Associations on Corals and Sponges" section for details). This study was also extended to include macro- and meiofaunal epifauna of some of the larger coral/soft coral species collected.

All water, sediments, and biological materials retained in the *Kiel* 6000's four bioboxes were collected from the outset by NHM staff and initial observations of live extracts showed that some nematodes were being collected by this method. This material could be used as a source of qualitative material and specimens both from sediments sampled along with other biological samples and also of species epizoic on larger organisms. As our objectives were reviewed, it was therefore decided to keep more detailed record of the contents of all bioboxes in case analysis of the nematode fauna could be associated with the presence or absence of certain sample materials. As megafauna samples were removed from the ROV's bioboxes and taken to the CEL, they were placed, often individually, in buckets of cooled seawater and remained there until being processed. In addition to the biobox water, this bucket water was often sieved for meiofauna, which may be related to the individual specimen(s) of megafauna in the bucket. The collection of biobox and other meiofauna sieves comprised a significant faunal collection of over 200 individual samples which may be regarded purely as an archival specimen bank, but which may also provide data that could be analysed statistically in relation to patterns of species range and association. This material also contained a number of specimens of macrofaunal taxa that may enhance the SAMS data set. Towards this end, some materials were also preserved in ethanol, as well as DESS and formaldehyde, such that macrofaunal taxa not suitable for DESS preservation (specifically polchaetes) could also be included in any subsequent molecular studies.

As bioboxes and potentially other sample types are exposed to the possibility of contamination from organisms in the water column, CTD water was collected from a full range of depths at Stations 6 and 8. These samples will be used to exclude pelagic meiofauna from the other samples collected.

5.8.5 Discussion

Difficulties in obtaining good quality ROV or megacorer cores seriously impacted on the success of the sampling campaign in terms of meeting our original objectives. The very low number of cores suitable for quantitative analysis will enable only a limited number of our initial questions to be tested statistacally using species abundance data. It is more likely that analyses of relative abundance data and diversity measures from qualitative samples will provide more informative results. Despite the difficulties encountered, specifically we will still be able to address the following questions:

8 What species are found on the five seamounts; are they the same or different?
9 Are there differences in species range?
10 Are there differences in species diversity between seamounts and between the deeper depth ranges?
11 Is there evidence of species isolation or cryptic species?

These questions may also be applied to the data obtained from the epifauna study and from our collection of biobox and specimen bucket sievings.

Further sampling would be required using equipment which can more reliably obtain quantitative samples in order to fully achieve the initial objectives.

For the meiofauna, future studies should include deployment of the multicorer as the smaller core tube diameter should result in a higher ratio of internal friction and reduced intra-core turbulence and washout. The multicorer is a long-proven, reliable, seabed sediment sampler capable of working in sea states beyond the capability of the megacorer. In the case of ROV deployments, the smaller diameter cores repeatedly withdrew successfully from the sediment, but the material was subsequently lost from the bottom owing to rapid slumping of the sediment or by the movements of the manipulator arm during transfer to the quiver, resulting in the sediment in the core being agitated and fluidising. It is clear that a ROV deployed push core could achieve a higher success rate if the sampling gear were modified such that the base of the core could be sealed more rapidly than appears to be possible at present. A core catcher based on internal, flexible plastic "fingers" was tested but with only limited success as the fingers projected too far up inside the corer - often further than the coreable sediment depth - and were rather too inflexible to be fully displaced by the sediments during coring, thus causing internal disruption.

A mini box corer was carried on board but could not be deployed owing to ROV-specific operational constraints. However, it is possible that such a sampler could be deployed successfully in future and achieve good results. Although not fully operational on this cruise, it is also possible that the HyBIS manipulator arm system on its alternative base, may also have been able to obtain better samples than the grab system during HyBIS deployments.

5.8.6 Reference

Seutin, G., White, B.N., Boag, B.T. 1991. Preservation of avian blood and tissue samples for DNA analyses. *Canadian Journal of Zoology* **69**: 82-90.

5.8.7 Appendices

Appendix 5.8.7.1 Details of macrofauna samples (SAMS), some to be further screened for meiofauna.

Seamount	Depth	Station Event	Gear	Sediment	SAMS no.	NHM bar code
Coral	1050	4_8	MGC	sand with pebbles	1635	164
	950	4_19	MGC	coral on sand	1644#1	155
		4_19	MGC	coral on sand	1644#1	156
	730	4_20	MGC	coral on sand	1645#1	160
		4_20	MGC	coral on sand	1645#1	161
	1050	4_13	SBC	sand with pebbles	1637	166
	700	4_15	SBC	sand with pebbles	1638	167
	1330	4_16	SBC	Barnacle shell	1641	140
		4_16	SBC	Sand	1641	139
	950	4_17	SBC	coral framework	1642	163
		4_17	SBC	Sand	1642	162
		4_17	SBC	Coral framework and sand	1642	152
	950	4_18	SBC	Coral rubble	1643	137
		4_18	SBC	Sand	1643	138

Seamount	Depth	Station Event	Gear	Sediment	SAMS no.	NHM bar code
	1300	4_2	ROV net	Framework residue	1634/1	67
	1300	4_2	ROV net	Framework residue	1634/2	565
	1300	4_2	ROV net	Framework residue	1634/3	67
	1300	4_2	ROV net	Framework residue	1634/4	???
	1100	4_9	ROV net	Coral framework	1636	1049
	1100	4_9	ROV net	Coral framework	1636	1050
		4_9	ROV_biobox	Coral framework from large glass sponge, K9	1636/1	143
	730	4_12	ROV_PUC	coral on sand	1639	168
	730	4_12	ROV_PUC	coral on sand	1640	169
	740	4_37	ROV_PUC	sand	1646	136
Seamount	**Depth**	**Station Event**	**Gear**	**Sediment**	**SAMS no.**	**NHM bar code**
Melville bank	1365	5_22	MGC	sand	1652#1	141
		5_22	MGC	sand	1652#1	142
		5_22	MGC	sand	1652#2	144
		5_22	MGC	sand	1652#3	145
		5_22	MGC	sand	1652#3	146
		5_22	MGC	sand	1652#4	147
	1365	5_23	MGC	sand	1653#1	148
		5_23	MGC	sand	1653#2	149
		5_23	MGC	sand	1653#3	622
		5_23	MGC	sand	1653#3	623
	1365	5_13	HYBIS	Sand	1648	3315
	985	5_17	HYBIS	Coral rubble	1649	3313
	905	5_18	HYBIS	Coral rubble and pebbles	1650	2715
	909	5_19	HYBIS	Pebbles	1651	635
		5_11	ROV net	Coral framework	1646/1	1238
		5_11	ROV net	Coral framework	1646/1	1239
	750	5_11	ROV net	Sand	1647	3143
	1500	5_17	HYBIS	medium-coarse sand	1649	624
	1500	5_17	HYBIS	medium-coarse sand	1649	625
	1500	5_18	HYBIS	medium-coarse sand	1650	2716
	1500	5_19	HYBIS	Medium-coarse sand	1651	626
	1500	5_19	HYBIS	Medium-coarse sand	1651	3314
Seamount	**Depth**	**Station Event**	**Gear**	**Sediment**	**SAMS no.**	**NHM bar code**
Middle of	1500	6_2	HYBIS	Sand	1654	637
What	1500	6_2	HYBIS	Barnacle shell	1654	638
	1003	6_10	MGC	coral rubble and sand	1661#1	3576
		6_10		coral rubble and sand	1661#1	3578
		6_10	MGC	coral rubble and sand	1661#2	569
		6_10		coral rubble and sand	1661#2	3594
		6_10		coral rubble and sand	1661#2	3593
		6_10		coral rubble and sand	1661#3	3580

		6_10		coral rubble and sand	1661#3	3581
	1003	6_11	MGC	coral rubble and sand	1662/1	575
		6_11	MGC	coral rubble and sand	1662/1	3592
		6_11	MGC	coral rubble and sand	1662#2	3590
		6_11	MGC	coral rubble and sand	1662#2	3589
	1474	6_9	SBC	Barnacle shell	1660	572
		6_9	SBC	Sand	1660	571
	1003	6_4	ROV_PUC	coral rubble and sand	1655	3583
	1003	6_4	ROV net	coral framework	1656	2740
		6_4	ROV net	coral framework	1656	2742
	1008	6_4	ROV net	coral rubble and sand	1657	2743
		6_4	ROV net	coral rubble and sand	1657	2744
	1178	6_7	ROV net	coral framework	1658	2755
		6_7	ROV net	coral framework	1658	2756
		6_7	ROV net	Primnoid	1658/1	3312
	1306	6_7	ROV net	coral framework and sand	1659	2759
		6_7	ROV net	coral framework and sand	1659	3595
		6_7	ROV arm	Rock	1659/1	Rock 7

Seamount	Depth	Station Event	Gear	Sediment	SAMS no.	NHM bar code
Sapmer	668	7_10	ROV net	Coarse sand and shell fragments	1664	419
		7_10		Rock	1664/1	3628

Seamount	Depth	Station Event	Gear	Sediment	SAMS no.	NHM bar code
Atlantis bank		8_9	MGC	Medium-coarse sand	1669	4102
	1585	8_26	MGC	Medium-coarse sand	1671#1	4218
		8_26	MGC	Medium-coarse sand	1671#1	4177
		8_26	MGC	Medium-coarse sand	1671#2	4178
		8_26	MGC	Medium-coarse sand	1671#2	4179
		8_26	MGC	Medium-coarse sand	1671#2	4180
	1585	8_27	MGC	Medium-coarse sand	1672#1	4186
		8_27	MGC	Medium-coarse sand	1672#1	4187
		8_27	MGC	Medium-coarse sand	1672#1	4188
		8_27	MGC	Medium-coarse sand	1672#2	4189
		8_27	MGC	Medium-coarse sand	1672#2	4190
		8_27	MGC	Medium-coarse sand	1672#3	4191
		8_27	MGC	Medium-coarse sand	1672#3	4192
		8_27	MGC	Medium-coarse sand	1672#4	4193
		8_27	MGC	Medium-coarse sand	1672#4	4194
	1585	8_28	MGC	Medium-coarse sand	1673#1	4196
	1585	8_4	HYBIS	Medium sand	1666	420
	1000	8_22	ROV net	Medium-coarse sand	1670	4270
		8_22	ROV net	Medium-coarse sand	1670	4271

749	8_3	ROV net	Coral framework	1665	3679
	8_3	ROV net	Medium-coarse sand with urchin spines	1665	3680
714	8_3	ROV net	Coarse sand	1665/1	430
728	8_3	ROV_chamber	Coarse sand	1665/2	3673
726	8_3	ROV_chamber	coral rubble	1665/3	3674
703	8_3	ROV_chamber	red spine coral rubble	1665/4	3675
732	8_3	ROV_chamber	Coarse sand	1665/5	3676
733	8_3	ROV_chamber	Coarse sand	1665/6	3677
742	8_3	ROV_chamber	red spine coral rubble	1665/7	3678
870	8_5	ROV net	Coral rubble	1667	3725
		ROV net	Sand	1667	3726
923	8_5	ROV_chamber	Coral framework	1667/1	3722
870	8_5	ROV_PUC	Coral framework	1667/4	
828-994	8_5	ROV_biobox	Coral framework	1667/2	3700
828-995	8_5	ROV_biobox	Coral framework	1667/3	3723
723	8_8	HYBIS	Medium-coarse sand	1668	421

Appendix 5.8.7.2 Details of meiofauna core samples (NHM) and summary details of samples based on biobox, specimen bucket and other sieveings.

Date/Seamount	Sampling Event	Description	Depth	Barcode
Coral				
12/11/11	St 4 Ev 02 ROV	Core 39 – qualitative	1400	71
12/11/11	St 4 Ev 02 ROV	3 biobox, bucket and other samples	1200-1400	
13/11/11	St 4 Ev 04 ROV	5 biobox, bucket and other samples	800-1300	
14/11/11	St 4 Ev 08 MEGA	Megacore 0-5cm horizon	1060	734
14/11/11	St 4 Ev 08 MEGA	1 other, sievings from SAMS (45-250um)	1060	735
14/11/11	St 4 Ev 09 ROV	Core 38 – qualitative	1000	967
14/11/11	St 4 Ev 09 ROV	Core 39 – qualitative	1000	96611
14/11/11	St 4 Ev 09 ROV	Core 43 – 0-5cm horizon	1000	9693
14/11/11	St 4 Ev 09 ROV	Core 6 – qualitative	1000	970
14/11/11	St 4 Ev 09 ROV	3 biobox, bucket and other samples	900-1000	
16/11/11	St 4 Ev 12 ROV	Core 34 – qualitative	700	598
16/11/11	St 4 Ev 12 ROV	Core 37 - 0-5cm horizon	700	73211
16/11/11	St 4 Ev 12 ROV	Core 38 - 0-5cm horizon	700	60211
16/11/11	St 4 Ev 12 ROV	Core 44 – qualitative	700	730
16/11/11	St 4 Ev 12 ROV	6 biobox, bucket and other samples	500-700	
16/11/11	St 4 Ev 13 BOX	Qualitative scoop	1000	729
16/11/11	St 4 Ev 13 BOX	1 other sample, sievings from SAMS (45-250um)	1000	28211
16/11/11	St 4 Ev 15 BOX	Qualitative scoop	600	723
16/11/11	St 4 Ev 15 BOX	1 other sample, sievings from SAMS (45-250um)	600	26651
16/11/11	St 4 Ev 16 BOX	Qualitative scoop	1400	724
16/11/11	St 4 Ev 16 BOX	1 other sample, sievings from SAMS (45-250um)	1400	31451
16/11/11	St 4 Ev 17 BOX	1 other sample, sievings from SAMS (45-250um)	900	28201
16/11/11	St 4 Ev 18 BOX	Qualitative scoop	900	733
16/11/11	St 4 Ev 18 BOX	1 other sample, sievings from SAMS (45-250um)	900	31441
17/11/11	St 4 Ev 20 MEGA	Qualitative core	700	418
17/11/11	St 4 Ev 21 MEGA	Qualitative core	700	609
20/11/11	St 4 Ev 37 ROV	Core 34 – qualitative	700	613
20/11/11	St 4 Ev 37 ROV	Core 37 – 0-5cm horizon	700	2667
20/11/11	St 4 Ev 37 ROV	Core 38 – 0-5cm horizon	700	26681
20/11/11	St 4 Ev 37 ROV	6 biobox, bucket and other samples	700	
20/11/11	St 4 Ev 38 ROV	8 biobox, bucket and other samples	700	

Date/Seamount	Sampling Event	Description	Depth	Barcode
Melville				
23/11/11	St 5 Ev 11 ROV	Core 18 - 0-5cm horizon	900	26831
23/11/11	St 5 Ev 11 ROV	Core 34 – qualitative	900	26841
23/11/11	St 5 Ev 11 ROV	Core 38 - 0-5cm horizon	900	2680
23/11/11	St 5 Ev 11 ROV	Core 38 - 5-10cm horizon	900	2681
23/11/11	St 5 Ev 11 ROV	Core 38 - 10-15.5cm horizon	900	2682
23/11/11	St 5 Ev 11 ROV	Core 39 - 0-5cm horizon	900	2679
23/11/11	St 5 Ev 11 ROV	5 biobox, bucket and other samples	600-900	
24/11/11	St 5 Ev 13 HYBIS	Qualitative scoop	1300	2688
24/11/11	St 5 Ev 14 ROV	3 biobox, bucket and other samples	?????	
25/11/11	St 5 Ev 17 HYBIS	Qualitative scoop	1000	2696
25/11/11	St 5 Ev 18 HYBIS	Qualitative scoop	900	2697
25/11/11	St 5 Ev 20 ROV	7 biobox, bucket and other samples	100-400	

26/11/11	St 5 Ev 21 HYBIS	Sediment and sievings concentrate from grab	1450	2693
26/11/11	St 5 Ev 22 MEGA	Core 0-1cm horizon	1300	2694
26/11/11	St 5 Ev 22 MEGA	Core 1-5cm horizon	1300	2695
26/11/11	St 5 Ev 22 MEGA	1 other sample, sievings from SAMS (45-250um)	1300	2731
26/11/11	St 5 Ev 23 MEGA	Core 0-5cm horizon	1300	27021
26/11/11	St 5 Ev 24 ROV	6 biobox, bucket and other samples	900 - 1200	

Date/Seamount	Sampling Event	Description	Depth	Barcode
Middle of What				
30/11/11	St 6 Ev 01 CTD	Water sample	01/05/00	2732
01/12/11	St 6 Ev 02 HYBIS	Quantitative scoop	1300	2747
01/12/11	St 6 Ev 02 HYBIS	1 other sample, sievings from SAMS (45-250um)	1300	2747
01/12/11	St 6 Ev 04 ROV	Core 18 – qualitative	1010	2736
01/12/11	St 6 Ev 04 ROV	Core 31 – qualitative	1010	2735
01/12/11	St 6 Ev 04 ROV	Core 34 - 0-5cm horizon	1010	2738
01/12/11	St 6 Ev 04 ROV	Core 38 – qualitative	1010	2737
01/12/11	St 6 Ev 04 ROV	5 biobox, bucket and other samples	1000	
02/12/11	St 6 Ev 07 ROV	Core 34 – qualitiative	1300	27511
02/12/11	St 6 Ev 07 ROV	10 biobox, bucket and other samples	1100-1300	
02/12/11	St 6 Ev 09 BOX	1 other sample, sievings from SAMS (45-250um)	1474	57311
03/12/11	St 6 Ev 10 MEGA	Core 0-5cm horizon	1500	27651
03/12/11	St 6 Ev 10 MEGA	2 other samples, sievings from SAMS (45-250um)	1500	
03/12/11	St 6 Ev 11 MEGA	Core 0-5cm horizon	1500	2767
03/12/11	St 6 Ev 11 MEGA	1 other sample, sievings from SAMS (45-250um)	1500	

Date/Seamount	Sampling Event	Description	Depth	Barcode
Sapmer				
07/12/11	St 7 Ev 10 ROV	Core 34 – qualitative	615	2775
07/12/11	St 7 Ev 10 ROV	Core 37 – qualitative	615	2764
07/12/11	St 7 Ev 10 ROV	14 biobox, bucket and other samples	290-670	

Date/Seamount	Sampling Event	Description	Depth	Barcode
Altantis Bank				
08/12/11	St 8 Ev 01 CTD	Water sieved from 4-400m	01/05/00	3630
09/12/11	St 8 Ev 03 ROV	Core 32 – qualitative	704	2787
09/12/11	St 8 Ev 03 ROV	Core 37 – qualitative	740	2784
09/12/11	St 8 Ev 03 ROV	Core 41 – qualitative	740	2786
09/12/11	St 8 Ev 03 ROV	Core 45 – qualitative	740	2789
09/12/11	St 8 Ev 03 ROV	Core 5 – qualitative	714	2788
09/12/11	St 8 Ev 03 ROV	Core 6 – qualitative	740	2785
09/12/11	St 8 Ev 03 ROV	13 biobox, bucket or other samples	700-800	
10/12/11	St 8 Ev 04 Hybis	Qualitative scoop	1000	2872
10/12/11	St 8 Ev 04 Hybis	1 other sample, sievings from SAMS (45-250um)		
10/12/11	St 8 Ev 05 ROV	Core 30 - 0-5cm horizon	900	4085
10/12/11	St 8 Ev 05 ROV	Core 41 – qualitative	1100	4081
10/12/11	St 8 Ev 05 ROV	Core 43 – qualitative	1100	4084
10/12/11	St 8 Ev 05 ROV	Core 45 – qualitative	900	4083
10/12/11	St 8 Ev 05 ROV	Core 6 – qualitative	1100	4088
10/12/11	St 8 Ev 05 ROV	8 biobox, bucket and other samples	800-1100	
11/12/11	St 8 Ev 08 HYBIS	Qualitative scoop	700	4094
11/12/11	St 8 Ev 08 HYBIS	1 other sample, sievings from SAMS (45-250um)		
12/12/11	St 8 Ev 12 MEGA	Qualitative core	900	4097

12/12/11	St 8 Ev 12 MEGA	Qualitative core	900	4098
12/12/11	St 8 Ev 12 MEGA	1 other sample, sievings from SAMS (45-250um)		
13/12/11	St 8 Ev 22 ROV	Core 18 – qualitative	745	4112
13/12/11	St 8 Ev 22 ROV	Core 34 – qualitative	745	4116
13/12/11	St 8 Ev 22 ROV	Core 42 – qualitative	744	4118
13/12/11	St 8 Ev 22 ROV	Core 43 – qualitative	744	4114
13/12/11	St 8 Ev 22 ROV	Core 44 – qualitative	744	4121
13/12/11	St 8 Ev 22 ROV	14 biobox, bucket and other samples	700-900	
13/12/11	St 8 Ev 26 MEGA	Core 0-5cm horizon	1500	4132
14/12/11	St 8 Ev 27 MEGA	Core 0-5cm horizon	1500	4137
14/12/11	St 8 Ev 28 MEGA	Core 0-5cm horizon	1500	4140
14/12/11	St 8 Ev 28 MEGA	Core - below 5cm	1500	4147
14/12/11	St 8 Ev 28 MEGA	2 other samples, sievings from SAMS (45-250um)	1500	
14/12/11	St 8 Ev 29 ROV	9 biobox, bucket and other samples	700	

5.9 Southwest Indian Ocean whalebone and wood fall moorings

5.9.1 Mooring details

Two moorings containing whalebone and wood material were successfully deployed on the first *Nansen* cruise on Coral Seamount, to the far south of the area studied, and Atlantis Bank, to the far north. These whalebones were collected opportunistically over several years prior to the cruise by Dr Kirsty Kemp (Institute of Zoology, London), Dr Thomas Dahlgren (Goteborg University, Sweden) and Dr Adrian Glover (Natural History Museum, London). Details are as follows:
- Three ribs from a juvenile male Humpback whale (*Megaptera novaeangliae*), found stranded near the Dartford Bridge, London, UK, on 12/09/09.
- Two ribs from a juvenile female Northern bottlenose whale (*Hyperoodon ampullatus*), found stranded at Bournemouth, UK, on 21/09/09.
- One scapula and 3 vertebrae from a juvenile Minke whale (*Balaenoptera acutorostrata*), found stranded on Veddö Island, Sweden, in December 2006.
- Half a vertebra from a Sperm whale (*Physeter macrocephalus*), found stranded on Veddö Island, Sweden, in December 2006.

The Institute of Zoology is licensed to possess and transport these specimens under Annex B of the Conservation Regulations 1994 issued by The Wildlife Licensing Unit, Natural England.

Logs of mango wood were collected from a local source in the departure port in Reunion. They came from a recently cut tree and remained moist from lying in a damp garden for approximately two weeks after cutting.

The moorings were thoroughly described in the Nansen cruise report and a summary in presented here. The basic mooring is comprised of a large ballast (150kg concrete-filled tires in this case), connected to a 15m double mooring line with a 20mm rope. This rope is the weak point in the mooring but is necessary as the ROV will cut the mooring at this point during recovery. The double mooring line is in turn shackeled to a string of 8 floats (Figure 45). A Sonardyne Transponder Type 7832 was fitted to the mooring rope.

All bones were individually drilled and fitted with loops of 8mm polypropylene line. They were then sewed into course net bags with the loops of polypropylene line protruding through the mesh. These lines were spliced onto a single lifting ring that in turn is connected directly to the ballast (not to the mooring line) by a single 14mm polypropylene line. A separate parcel was prepared in the same way for wood.

5.9.2 Recovery

Having successfully followed the beacon signal and located both moorings on exploratory dives, dedicated mooring recovery dives were undertaken. As suggested in the *Nansen* cruise report the packages were filmed in detail prior to any disturbance of the site by the ROV. The bone and wood packages were then recovered by cutting the individual 14mm polypropylene lines which attach them directly to the ballast. The packages were stored in the tray areas. It was not possible to retrieve the mooring package, however, the ballast was retrieved by cutting the rope below the SS swivel (Fig. 45).

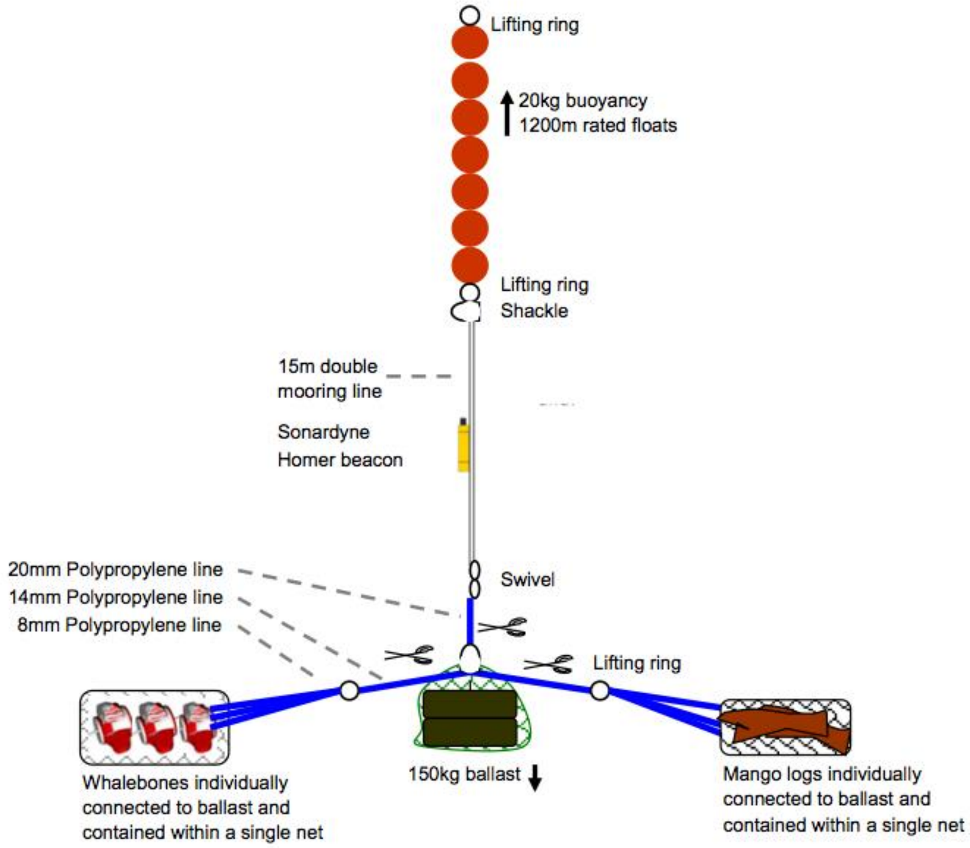

Figure 45. Mooring schematic. The scissor symbol designates where the ROV should cut during recovery.

Mesh bags were opened on deck so whalebones and wood fall could be placed into pre-chilled seawater and taken into the 4°C cold room for examination. All bones and wood were closely examined under a microscope and animals removed and preserved. Bones were preserved in both 70% ethanol and 4% formalin. Wood was too large to preserve whole was frozen after examination. Washings of the water both whalebones and wood were sitting in was sieved and preserved in 100% ethanol and 4% formalin for future examination of meiofauna.

5.9.3 Results

5.9.3.1 Coral seamount

Whalebones on Coral seamount were infested with bivalves (Fig. 46). Less obvious animals included some small polychaetes and even one unusual and minute anemone.

The wood at Coral was still very solid, although on close inspection the telltale holes of *Xylophaga* were found, as were some live specimens.

Animals found in and around the area included sea urchins, galatheid crabs, and hydroids on the mooring ropes.

Figure 46. Close up of whalebone with bivalves.

5.9.3.2 Atlantis

In exact contrast to Coral the whalebones at Atlantis appeared relatively untouched with fewer bivalves in comparison to Coral (although one bone showed evidence of a recent infestation of juvenile bivalves) and few other animals. The wood however was completely consumed; its insides practically minced and soft to the touch. Shells of *Xylophaga* were found throughout the wood (Fig. 47A) as were live specimens. On the exterior of both bone and wood many gastropods were found feeding (Fig. 47B).

A B

Figure 47. A. Interior of wood, eaten throughout. B. Gastropod found feeding on bone and wood.

In the area of the meshbags, many pencil urchins, brittlestars, and galatheids were found. Within the mesh, galatheids, a spider crab, and a crinoid were sampled, amongst others.

5.10 Public Communications - Photography

JC066 Cruise Report – Photography. David Shale

My aim for this cruise, as in recent expeditions, has been to provide a link between the HD video captured on the seafloor and the preserved and archived specimens.

This is important as the video does provide a detailed *in vivo* record of the species collected and the other nearby and associated fauna. Once the specimens have been collected the main priority is to preserve and barcode the material before it deteriorates. This is the key, because whenever samples are preserved for later examination, whatever the method of preservation, they all change; transparent animals become opaque, soft tissue becomes hard, colours change and animals contract.

I have been given first access to all material and I consider this a privilege, but it is also important from a specimen point of view. As soon as samples are in the cold room I select those I consider most vulnerable or important and transfer them to cold-water aquaria for photography. My tanks are small so I can photograph material up to a maximum size of 20cm in length; more than that it has to be a part-animal. But my interest is in macro-photography, so minimum size is not a problem.

I hope my photographs provide a permanent record and a valuable and additional resource to the other data collected on this cruise.

Figure 48. 1.5cm 'ghost lobster' found amongst coral rubble.

I have been intrigued by how much "associated fauna" there has been, particularly with the corals. Once I have specimens in my tanks I have the ability to scan and magnify my subjects and have been amazed by the variety of commensal fauna and how cryptic much of it is. Examples of this are the arcturid isopod and many polychaetes which are found on many of the corals.


Figure 49. Arcturid isopod

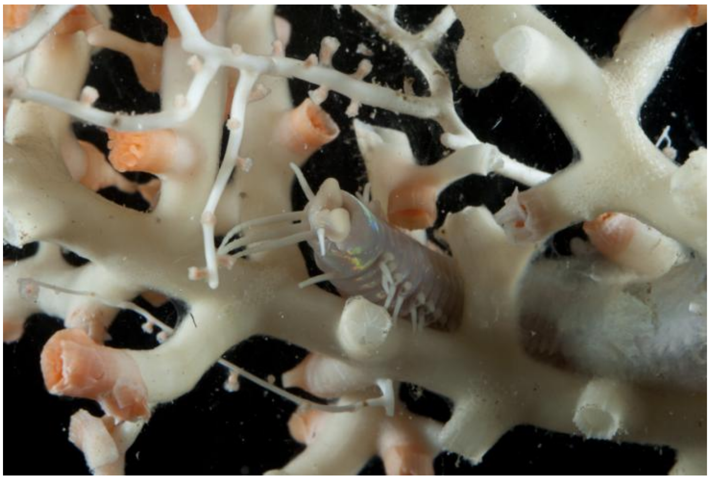
Figure 50. Polychaete in coral

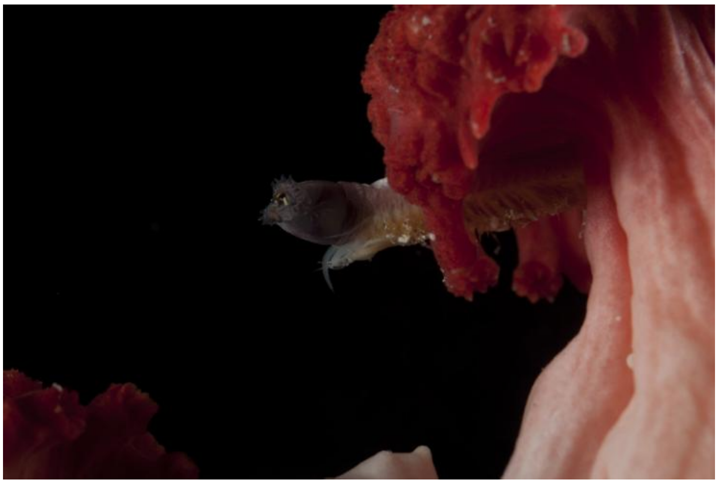
Figure 51. Polychaete and *Anthomastus*

Figure 52. Primnoid octocoral with polychaete tubes.

This specimen intrigued me (Fig. 52); it is of a primnoid coral with polychaetes which have aligned themselves to the rachis and have wrapped the coral scales around themselves. They are almost invisible and certainly protected.

But, I have to admit, that the animals which elicited the most interest were the glass sponges. Having reluctantly requested the collection of a small specimen during the dive because I know that size can be deceptive underwater and often those that arrive in the ‘bio-boxes’ are just too large to photograph. We collected 4, of which two were damaged but two were intact. The amazing part was that they contained “imprisoned” glass shrimps. Each sponge had a male and a female shrimp (Figs. 53, 54) and the females were carrying eggs. How do they get inside? How are only one of each sex selected? What do they feed on? What is the relationship with the sponge and what benefit if anything is there to the sponge?


Figure 53. Male and female glass shrimp


Figure 54. Female glass shrimp inside sponge.

5.11 Communications and public outreach activities

Aurelie Spadone, International Union for Conservation of Nature, Gland, Switzerland

5.11.1 Introduction

The main communication effort was done through daily posts on the expedition blog [www.seamountsexpedition.blogspot.com].

The second major activity was a weekly diary on the BBC Nature website with a wide public outreach which resulted in peaks in audience on the blog.

IUCN did a press release just before the cruise that resulted in good media coverage.

A young public outreach activity has been attempted with regular email exchange with a science schoolteacher in La Tour-de-Peilz, Switzerland.

5.11.2 Expedition blog

Daily blog posts relating the major science events during the course of the expedition were displayed on the following website address: http://www.seamountsexpedition.blogspot.com (see Fig. 55)

The blog was set up shortly before the cruise, in October 2011, as a continuation of the 2009 cruise blog (www.seamounts2009.blogspot.com from Sarah Gotheil's participation to the R/V Fritjof Nansen Cruise 410 in the southwest Indian Ocean in Nov-Dec 2009).

The blog contains additional pages notably a page with participant pictures, names and affiliations. In total 45 daily blog posts have been displayed on it.

Total of Pageviews*
15,039

*reporting period 25 Oct -16 Dec 2011; statistics provided by Google Blogspot.

The total number of pageviews reached 15,039 (as of 16 December) which corresponds to a mean of over 350 pageviews per day for the duration of the expedition. Note: each page contained 4 day blog posts. The peaks of traffic after each BBC Nature diary entry were up to 540 pageviews per day.

The audience was distributed among different countries (in order of importance): U.K., Switzerland, United States, Italy, Germany, France, Australia, Sweden, Denmark, Canada and others.
The main traffic sources for these pageviews were identified through a number of referring sites:
www.iucn.org (homepage + project webpage + Global Marine & Polar Programme webpage)
www.seamountsexpedition.blogspot.com (direct address)
www.facebook.com (IUCN put the address of the blog link on their Facebook page)
www.bbc.co.uk
www.google.co.uk
www.google.com
And others.

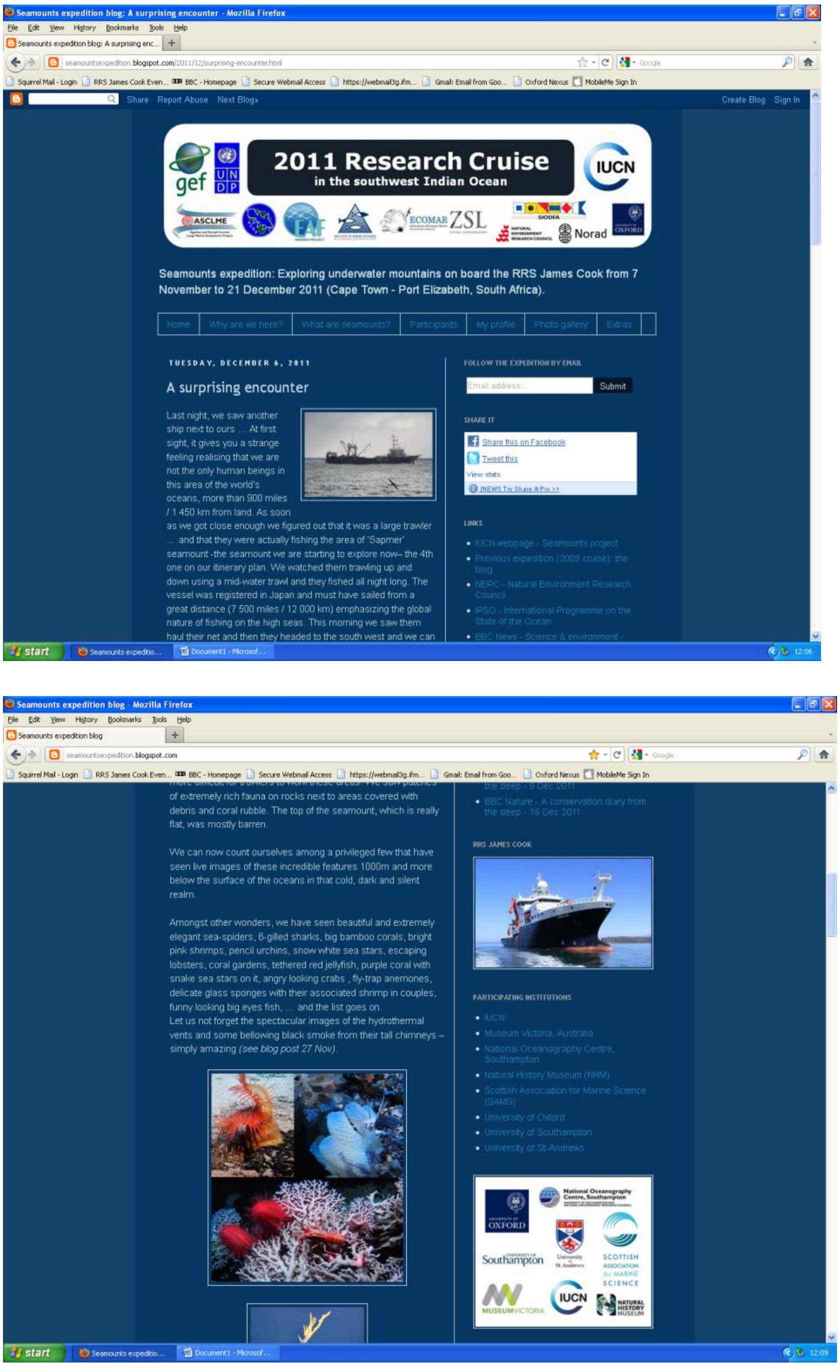

Figure 55. Screenshots of the expedition blog.

5.11.3 Media coverage

5.11.3.1 In the news

IUCN Global Communications Unit did a press release shortly before the cruise. It resulted in the following media coverage:

An article on BBC News - Science & Environment website 'Mission to scale the deep mountains' was written by Jenifer Carpenter and published on the 7 November (first day of the cruise).
http://www.bbc.co.uk/news/science-environment-15593602

Total of Pageviews*
113,152

*reporting period 6 Nov -13 Dec 2011; statistics provided by BBC (bbc-explorer)

Indian Ocean Exploration: Scientists Set out to Search 'Virtually Unknown Water', Huffington Post
http://www.huffingtonpost.com/2011/11/07/scientists-to-explore-indian-ocean_n_1079872.html

Interview with Carl Gustaf Lundin (head of IUCN Global Marine & Polar Programme), Al-Jazeera

Journey to the bottom of the sea, Times of Malta
http://www.timesofmalta.com/articles/view/20111109/world/Journey-to-the-bottom-of-the-sea.392980

Scientists Begin Exploring Indian Ocean's Depths, ABC News

Scientists to explore Indian Ocean's depths, Washington Times
http://www.washingtontimes.com/news/2011/nov/7/scientists-to-explore-indian-oceans-depths/

Expedition to underwater mountains, The Press Association

The International Union For the Conservation of Nature Plans Expedition To Underwater Mountains, Huffington Post
http://www.huffingtonpost.co.uk/2011/11/07/underwater-mountain-expedition_n_1079106.html

5.11.3.2 On the Internet

IUCN website promoted the expedition blog during the whole cruise (on its homepage http://www.iucn.org). There have been 1,519 pageviews overall for the pages related to the cruise or the project (from 7 November to 12 December).

IPSO (International Programme on the State of the Ocean) website has been updated regularly by Alex Rogers during the cruise with a total of 4 posts on the 'blogs' webpage.
http://www.stateoftheocean.org

Sommerville College promoted the cruise and the blog on their website http://www.some.ox.ac.uk
Invisible Dust website put text online on the 22 November
http://invisibledust.com/alex-rogers-voyage-set-off/

Scottish Association of Marine Science (SAMS) website (http://www.smi.ac.uk) published information about the expedition on their news webpage (home-> news room).
Museum Victoria (Australia) published a blog post by David Staples on 25 November on their MV Blog (http://museumvictoria.com.au).

5.11.3.3 BBC Nature weekly diary

The website BBC Nature published a total of five entries of 'Seamounts and coral: A Conservation Diary from the deep' by Aurélie Spadone (IUCN) on each Friday of the expedition (18 Nov, 25 Nov, 2 Dec, 9 Dec and 16 Dec). They advertised it on their homepage (see Fig. 56).

Links to the diary entries:

http://www.bbc.co.uk/nature/15772693	(18 Nov)
http://www.bbc.co.uk/nature/15872414	(25 Nov)
http://www.bbc.co.uk/nature/159919999	(2 Dec)
http://www.bbc.co.uk/nature/160763877	(9 Dec)
http://www.bbc.co.uk/nature/16197761	(16 Dec)

Diary entry	Total of Pageviews*
18 Nov	19,072
25 Nov	11,456
2 Dec	31,360
9 Dec	14,400
16 Dec	-
TOTAL (4 of 5)	76,288

*reporting period 6 Nov – 13 Dec 2011; statistics provided by BBC (bbc-explorer)

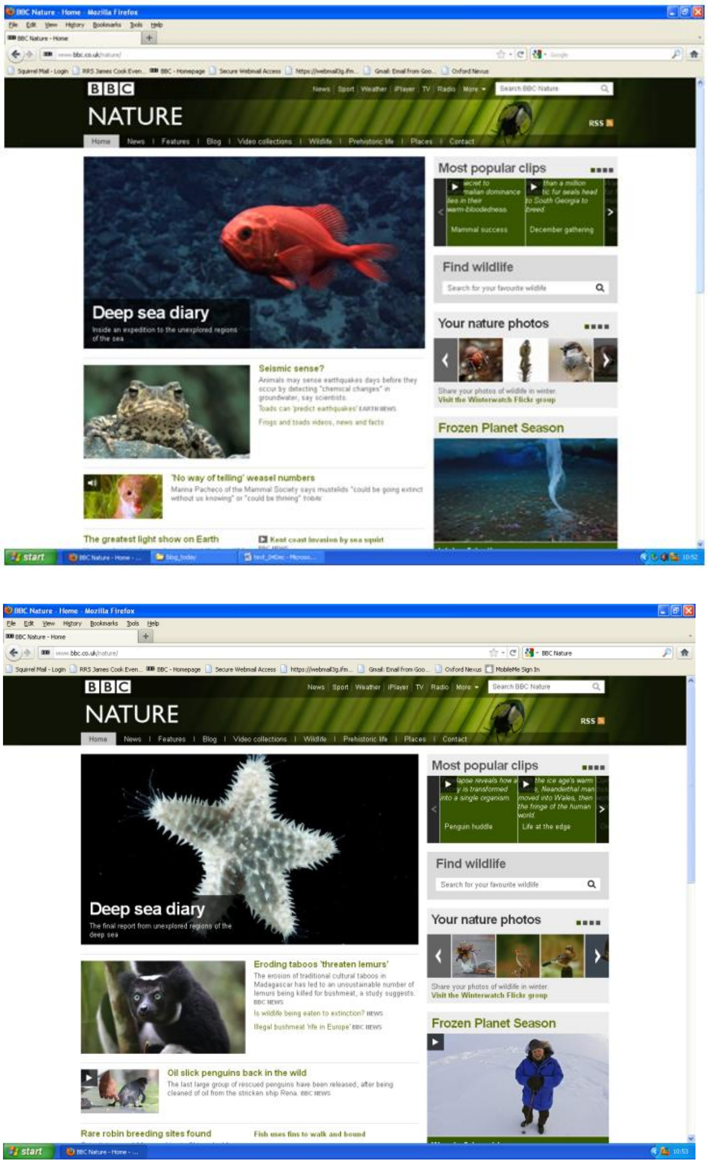

Figure 56. Screenshots of the BBC Nature website featuring this expedition

5.11.4 Outreach to younger audiences

A class of the 14-15 year old school pupils have been following the expedition via the blog. A visit is planned to the school (Collège des Mousquetaires, La Tour-de-Peilz, Switzerland) in January 2012 in order to gather their impression, answer their questions, raise their awareness of deep-sea biodiversity, threats on marine environment, etc.

5.12 Contacts

Aurélie Spadone from IUCN participated in the expedition and was responsible for writing the blog and the BBC Nature diary entries. She will be the person visiting the class in Switzerland as well.

Contact information:
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aurelie.spadone@iucn.org

The following persons can also be contacted if needed:

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brian.thomson@iucn.org
ewa.magiera@iucn.org
&
Olivia Meylan and James Oliver, Global Marine and Polar Programme, IUCN World Headquarters (see address above).
olivia.meylan@iucn.org
james.oliver@iucn.org

6 Equipment performance and technical information

6.1 General ship's systems, data logging and storage

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6.1.1 Overview

JC066/JC067 were both highly rewarding and demanding cruises.

I would like to thank Alex Rogers and the JC066/67 scientific party and wish them all the best in the long process of data analysis and interpretation.

This report section covers the period of JC066/67 as well as highlighting some of the changes made to systems during the passage down to Cape Town from Santa Cruz de Tenerife which had a direct impact on operations during this cruise.

I wish you all a safe journey home.

ave atque vale

L. Rolley

6.1.2 Data Deliverable Confirmation

All paths are from root directory of the data deliverables disk

Principle Scientist JC066 – Alex Rogers

Disk Serial No .... Signature ....

Principle Scientist JC067 – Jon Copley

Disk Serial No 13791105132908K Signature ....

Science System's Technician (Leighton Rolley)

Disk Serial No .... Signature ....

BODC (British Oceanographic Data Collection Centre)

Disk Serial No .... Signature ....

South African Authorities (As per Diplomatic Clearance Requirements)

Disk Serial No .... Signature ....

DATA RESTRICTIONS: Data on Olex should not be made available for download to either olex or other scientific cruises for a period of 2 YEARS

ALL DATA WILL BE ARCHIVED ONBOARD THE VESSEL FOR A PERIOD OF 6 MONTHS. THE SCIENTIFIC PARTY SHOULD VERIFY THE COMPLETENESS OF THEIR DATASET PRIOR TO JUNE 2012. AFTER THIS DATE THE DATA WILL BE REMOVED

6.1.3 Julian Day's for cruise JC066/67

*Events and Record's refer to the Event Logger

Day x of JC066	JDAY	Date	Weekday	Events*	Records*
Day 1	11311	07/11/2011	Mon	32	118612
Day 2	11312	08/11/2011	Tue	58	88155
Day 3	11313	09/11/2011	Wed	58	93316
Day 4	11314	10/11/2011	Thu	47	121550
Day 5	11315	11/11/2011	Fri	41	113381
Day 6	11316	12/11/2011	Sat	461	121264
Day 7	11317	13/11/2011	Sun	1337	120993
Day 8	11318	14/11/2011	Mon	1002	121294
Day 9	11319	15/11/2011	Tue	93	122094
Day 10	11320	16/11/2011	Wed	727	121655
Day 11	11321	17/11/2011	Thu	16	117469
Day 12	11322	18/11/2011	Fri	230	118929
Day 13	11323	19/11/2011	Sat	880	119658
Day 14	11324	20/11/2011	Sun	853	120364
Day 15	11325	21/11/2011	Mon	52	112293
Day 16	11326	22/11/2011	Tue	36	68556
Day 17	11327	23/11/2011	Wed	1143	120287
Day 18	11328	24/11/2011	Thu	1336	121077
Day 19	11329	25/11/2011	Fri	1338	120947
Day 20	11330	26/11/2011	Sat	858	121324
Day 21	11331	27/11/2011	Sun	428	121576
Day 22	11332	28/11/2011	Mon	353	121454
Day 23	11333	29/11/2011	Tue	303	121380
Day 24	11334	30/11/2011	Wed	545	120780
Day 25	11335	01/12/2011	Thu	942	121162
Day 26	11336	02/12/2011	Fri	749	118654
Day 27	11337	03/12/2011	Sat	353	121486
Day 28	11338	04/12/2011	Sun	13	121387
Day 29	11339	05/12/2011	Mon	10	120672
Day 30	11340	06/12/2011	Tue	54	121103
Day 31	11341	07/12/2011	Wed	780	103423

Day 32	11342	08/12/2011	Thu	2	120653
Day 33	11343	09/12/2011	Fri	1175	121090
Day 34	11344	10/12/2011	Sat	467	121048
Day 35	11345	11/12/2011	Sun	342	121119
Day 36	11346	12/12/2011	Mon	72	121207
Day 37	11347	13/12/2011	Tue	401	46526
Day 38	11348	14/12/2011	Wed	0	Pages
Day 39	11349	15/12/2011	Thu	0	Pages
Day 40	11350	16/12/2011	Fri	0	Pages
Day 41	11351	17/12/2011	Sat	0	Pages
Day 42	11352	18/12/2011	Sun	0	Pages
Day 43	11353	19/12/2011	Mon	0	Pages
Day 44	11354	20/12/2011	Tue	0	Pages

6.1.4 Data Logging Systems

The RRS James Cook currently has three methods of data logging.

- TECHSAS which produces NetCDF Files (Ship's Main Data Logger)
- Level-C which stores data in stream
- Event Logger a experimental database system.

6.1.4.1 TECHSAS

The Ifremer TECHSAS system is the primary data logger for all navigation, surfmet and winch data.

The TECHSAS software is installed on an industrial based system with a high level of redundancy. The operating system is Red Hat Enterprise Linux Edition Release 3.3. The system itself logs data on to a RAID 0 disk mirror and also logs to the backup logger. The TECHSAS interface displays the status of all incoming data streams and provides alerts if the incoming data is lost. The ability exists to broadcast live data across the network via NMEA.

The storage method used for data storage is NetCDF (binary which is a self describing file and is OS independent) and also pseudo-NMEA (ASCII). The NetCDF data files are currently automatically parsed through an application in order to convert them to RVS Format for data processing.

6.1.4.1.1 Data Deliverables

The TECHSAS data logging system was used to record data from the following instruments:

Module	Sensor	File Suffix	Notes
Applanix_GPS	Applanix POSMV	position-Applanix_GPS_JC1.gps	Applanix Position – Primary Science GPS
POSMV_TSS_JC1	Applanix POSMV	shipattitude-Applanix_TSS_JC1.att	Applanix Motion Data – Primary Science GPS
JCwinch	Clam	CLAM-CLAM_JC1.CLAM	Winch Data
POSMV Gyro JC1	Applanix POSMV		Applanix Heading – Primary Science GPS
EA600 JC1	EA600	EA600-EA600_JC.gps	EA600 Single beam Depth
SurfmetV2	Surfmet	Surf-JC-SM_JC1.SURFMETv2	Meteorological Data
Fusion USBL	Ranger USBL	Position-usbl_JC1.gps	ROV/Beacon Position
Chernikeif Log	Chernikief	EMLog-log_chf_JC1.EMLog	EM Log (Science)
Skipper Log	Skipper Log	VDVHW_log_skip_JC1.log	EM Log (Bridge)
Airsea II	Gravity Meter	AirseaII-S84_JC1.AirSeaII	LaCoste Gravity Meter
ADU5 PASHR POS	Ashtech ADu5 Position	PASHRPOS-ADU5POS_JC1.gps	
ADU5 GPPAT	Ashtech ADu5 Position	GPAT-GPAT_JC1.gyr	
DPS116 JC1	Seatex DPS116	position-DPS-116_JC1.gps	Bridge Nav GPS
SHIPS GYRO	Ships GyroCompass	gyro-GYRO1_JC1.gyr	Ships Gyrocompass
Seapath_200_JC1	Seapath 200	position-seapath200_JC1.gps	Backup Science/Nav GPS
Seapath_200AT_JC1	Seapath 200	shipattitude-seapath200AT_JC1.att	Backup Science/Nav GPS
SBE45_JC1	Seabird Thermosalinigraph	SBE45-SEB45_JC1.TSG	Thermosalinigraph
EM120 JC1	Em120 multibeam	sb_depth-EM120_JC1.depth	EM120 Centre Beam Depth value
CNAV 3050	CNAV GPS	Cnav-CNAV.GPS	DGPS

These data files can be located in the following folder:

\Ship_Systems\TECHSAS

6.1.4.2 LEVEL-C

6.1.4.2.1 Overview

The level-c system logs data broadcast from TECHSAS to “streams”. This data can be queried and analysed using a number of in-house developed tools

6.1.4.2.2 Stream Description

Each of the data streams populated by the Level-C are listed here along with the individual variables:

Stream	Description	Corresponding TECHSAS Module
winch	Clam winch data	JCwinch

cabltype	Cable Type
tension	Tension (Tonnes)
cableout	Cable Out (meters)
rate	Cable Rate (Positive out, negative haul in)
btension	Back Tension
angle	Angle – not implemented

- **adu5pat** ADU5 attitude data ADU5 GPPAT

measureT	Measure Time
lat	Latitude
lon	Longitude
alt	Altitude
heading	Heading (degrees)
pitch	Pitch (Degrees)
roll	Roll (Degrees)
mrms	
brms	

- **adu5pos** ADU5 position Data ADU5 PASHR POS

lat	Latitude
lon	Longitude
alt	Altitude
cmg	Course Made Good
smg	Speed Made Good
vvel	Vertical Acceleration/ Velocity (?)
pdop	Precision Dilution of Precision
hdop	Horizontal Dilution of Precision
vdop	Vertical Dilution of Precision
tdop	Total Dilution of Precision

- **dps116** DPS116 position Data DPS116 GPS

lat	Latitude
lon	Longitude
alt	Altitude
prec	Precision
mode	Mode
cmg	Course Made Good
smg	Speed Made Good

- **ea600m** EA600 Depth Data EA600 JC1

depth Depth (Meters)

- **em120cb** EM120 Multi-beam EM120 JC1

depth Depth (Meters)

- **gps_cnav** CNAV GPS Position CNAV 3050

lat	Latitude
lon	Longitude
smg	Speed Made Good
cmg	Course Made Good
prec	Precision
pdop	Precision Dilution of Precision
measureT	Measure Time

- **gravity** Gravity Meter AirSeaII JC1

grav_av
springt
xcup
beam
vc
al
ax
ve
ax2
pro_wind xac2
lac2
xac
lac
eotcor

lat	Latitude
lon	Longitude
heading	Heading
vel	

- **gyro_s** Ship's Gyrocompass Ships Gyro

heading Vessel heading (degrees)

- **gyropmv** POSMV Gyrocompass POSMV GYRO JC1

heading Vessel heading (degrees)

- **log_chf** Chernikief Log Chernikeef Log JC1

speedfa	Speed Fore/Aft
speedps	Speed Port/Starboard

- **log_skip** Skipper Log Skipper Log JC1

heading	Heading (Degrees)
headMag	Magnetic Heading
speed	Speed Kts
speedKPH	Speed

- **posmvpos** POSMV Position Applanix GPS JC1

measureT Measure Time

lat	Latitude
lon	Longitude
alt	Altitude (m)
prec	Precision
mode	Operational Mode
cmg	Course Made Good
smg	Speed Made Good

- **posmvtss** POSMV TSS (Motion Data) POSMV TSS JC1

heading	Heading (degrees)
roll	Roll (Degrees)
pitch	Pitch (Degrees)
heave	Heave (Degrees)
acc_roll	
acc_ptch	
acc_hdg	

- **sb-att** Seapath 200 Attitude (Motion) Seapath200AT JC1

heading	Heading (Degrees)
roll	Roll (Degrees)
pitch	Pitch (Degrees)
heave	Heave (Degrees)
accroll	
accpitch	
acchdg	

- **sb-pos** Seapath 200 position Seapath200 JC!

Lat	Latitude
lon	longitude

- **sbe45** Seabird 45 Thermosalinigraph SBE45 JC1

temp_h	Housing Temperature (Celsius)
cond	Conductivity
salin	Salinity (PSU)
sndspeed	Sounds Speed (M/S)
temp_r	Remote Temperature (Hull Inlet)

- **smartsv** Smartsv (NOT IN USE)

soundv	Sound Velocity M/S

- **surfmet** Surfmet Meteorological Data Surfmet V2 JC1

temp_h	Housing Temperature (Celsius)
temp_r	Remote Temperature (Hull Inlet)
cond	Conductivity
fluo	Flurometer (raw)
trans	Transmissometer (raw)
press	Air Pressure (mbar)

ppar	Port Photosynthetically Active Radiation
spar	Starboard Photosynthetically Active Radiation
speed	Windspeed m/s
direct	Direction (degrees)
airtemp	Air Temperature (Degrees Celsius)
humidity	Humidity %
ptir	Port
stir	

- **usblpos** USBL ROV/Beacon tracking Fusion USBL JC1

measureT	Measure Time
lat	Latitude
lon	Longitude
alt	Altitude (m)
prec	Precision
mode	Mode
cmg	Course Made Good (degrees)
smg	Speed Made Good (degrees)

- **relmov** Relative Motion

vn
ve
pfa
pps
pgyro

- **bestnav** Best Navigation File

lat
lon
vn
ve
cmg
smg
dist_run
heading

- **bestdrf**

vn
ve
kvn
kve

- **pro_wind** Processed Windspeeds

abswspd
abswdir

- **prodep** Processed Depths

unctdepth
cordepth
cartarea

6.4.2.2.1 Data Deliverables

These streams are located in:

\ShipSystems\Level-C\

6.1.4.3 EVENT LOGGER

6.1.4.3.1 Overview

The Event logger is still a developmental system that has been progressively evolved over over the last 11 months to meet scientific needs. The main role of the Event Logger is to logged events that occur on-board the vessel against real-time data collected from the various sensors at the time an event is created. Four event logging methods have been developed:

6.1.4.3.1.1 Current Event (http://192.168.62.58/EventAdd.asp)

Used to log an event "as it happens" when the user submits the event it is logged against data captured from the various vessel sensors.

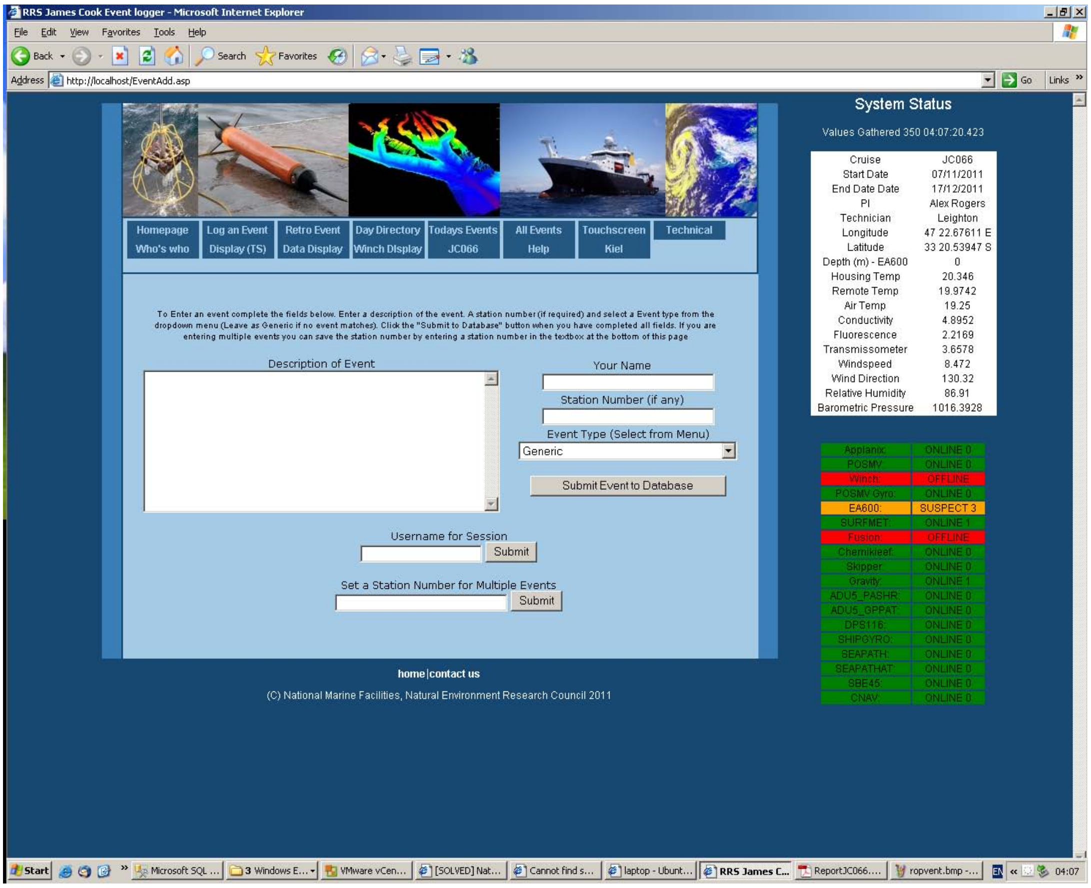


Figure 57. Event logger page – general events

6.1.4.3.1.2 ROV Events (http://192.168.62.58/eventaddrov2.asp)

A specific report type has been developed for ROV Operations.

During the start of JC066 we were logging biological sightings using a paper-based system but this turned out to be very time consuming. In response to this a new form based on experience with ISIS/Hallin/Kiel

ROV was developed that permitted quick entry of ROV events thus allowing the scientists more time looking at the screen than the logger.

This method of logging worked well and hopefully in the future we will use this method of logging for ISIS ROV operations.

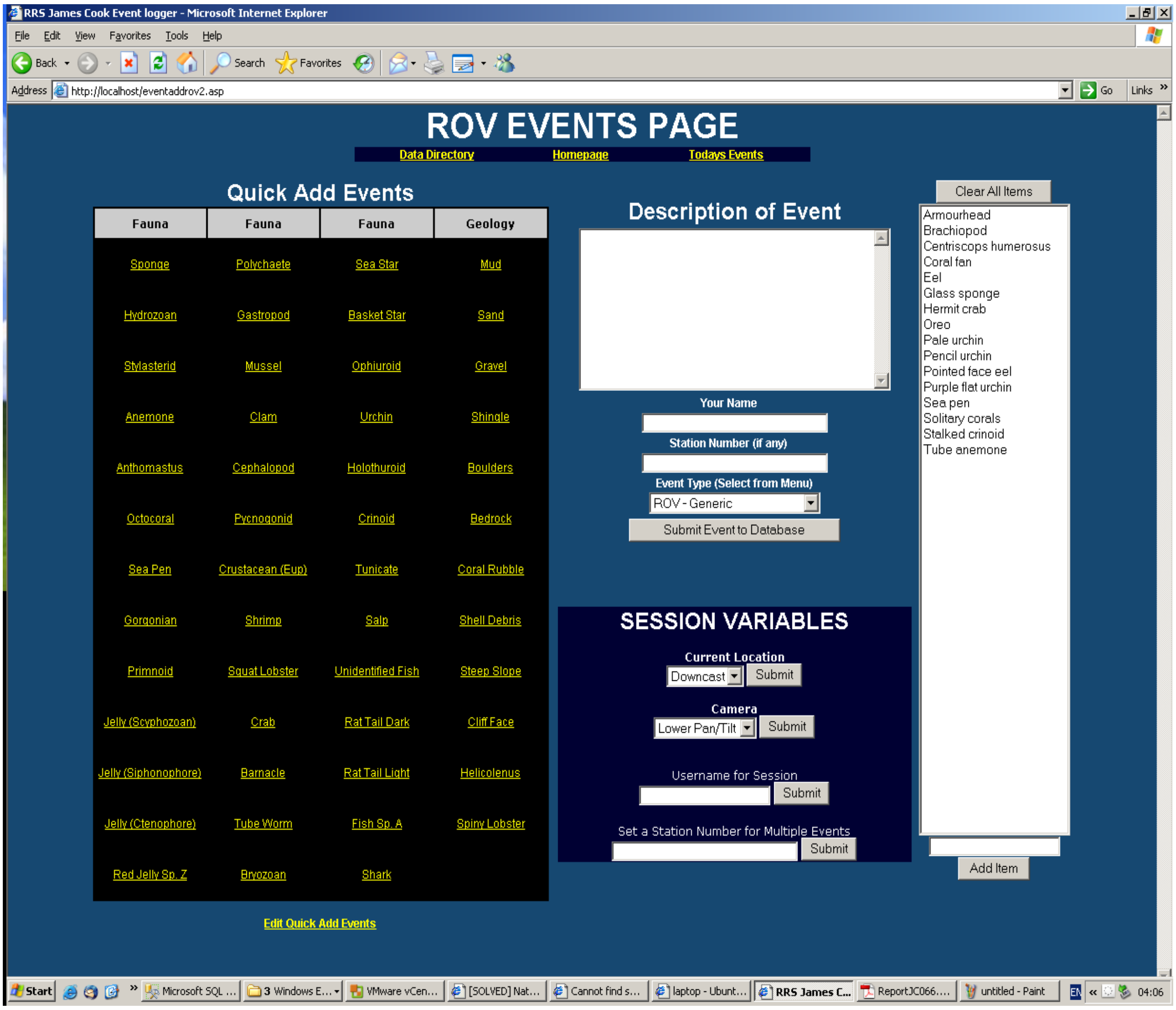


Figure 58. ROV Event Adding Page.

6.1.4.3.1.3 Retro Events

It is not always possible to log events when they occur. The Retro event page allows the user to add events after they happened by selecting the date and time an event occurred.

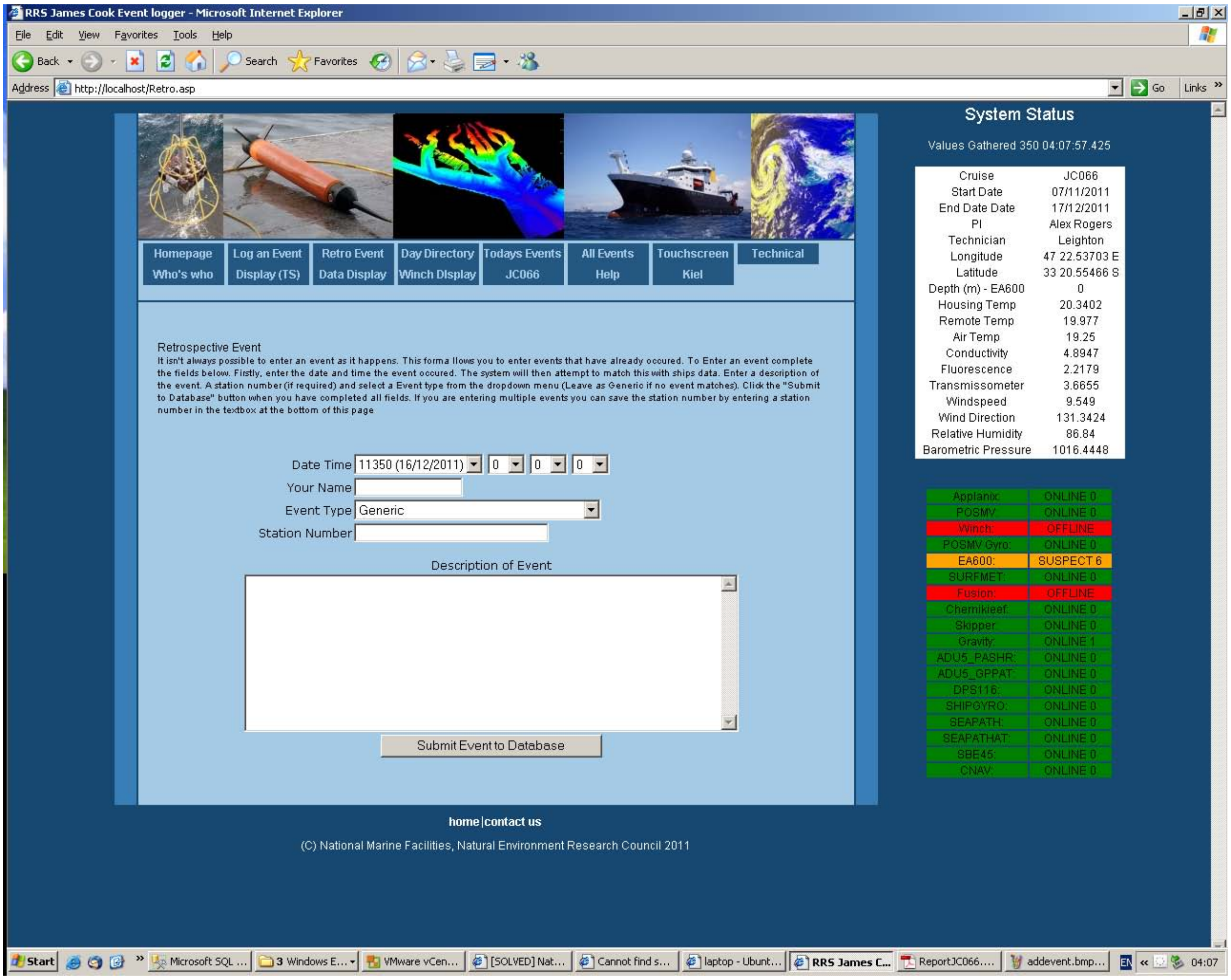


Figure 59. Retro Adding Event Adding Form.

6.1.4.4 Touch screen

Still in its infancy, the touch-screen interface allows the quick adding of events by simply clicking a button on the screen. The interface for this system has been designed to display on the HP touch screen PC's dotted around the vessel.

In a secondary role the Event Logger records all sensor data at a rate of 0.5hz (changeable).

This enables us to build a dataset for each day with roughly 0.5 second resolution

This data from each sensor is logged every 0.5 second into an SQL database and can be queried using SQL (Structured Query language). The EventLoggerServer (192.168.62.57) has a VB6 on the desktop that is used to capture data broadcast by TECHSAS using UDP protocol.

This data broadcast by TECHSAS is analysed and then stored in a temporary database on the Event Logger Server (192.168.62.57) before being archive to the main database/web interface machine (192.168.62.58) every minute.

This method of data handling is far more effective than archiving data every half second across the network and drastically reduces overheads. Splitting the two tables also removes the problems associated with performance when a user is executing an intensive query whilst the capture program is also attempting to commit data every second to the DB.

The user interacts with the database via a Intranet based website hosted on the waterfall PC (192.168.62.58). The website allows the generation of reports, graphs and events with a few simple clicks.

Additional cruise specific reports can be generated by querying the database directly using SQL although caution is advised, especially is using an UPDATE or DELETE keyword.

6.1.4.5 Validation of Data

A number of additional functions are used to determine the quality of data logged in the event logger.

TECHSAS simply logs the raw data sent from each sensors with no data analysis. It will log wrong data if it is sent to it and will not necessarily alarm or raise a warning.

The Event logger application adds an additional layer of data analysis to check the received values are accurate and within permissible ranges. These checks include:

Message Data Age and Status

The age of each message is logged so we know how long since the last message was received.

For operations such as USBL tracking this is useful. If we searched the Fusion stream on the Level-C for a position at say 11314 11:23:24 it may not have a position at this exact time and return no value.

The Event logger will highlight that the last recorded position of the beacon was X/Y and this position was recorded X Seconds ago. It will list the last value up until a maximum defined range – after which the value will become invalid e.g. 10 seconds

The status of the data is “weighted” Based on the age of the message.

For example a position fix from a USBL beacon would be valid for a few seconds when you consider the perceived error in the position fix is probably 10m in 1500m of water. So we could give a status value to the data based on:

e.g	0-2 Seconds	= GOOD
	>2 – 5	= OK
	>5 – 7	= SUSPECT
	>7-20	= BAD
	>20	= OFFLINE

e.g

Data Age	Latitude	Status
0	59 67.0000	Good
1	59 67.0000	Good
2	59 67.0000	OK
3	59 67.0000	OK
4	59 67.0000	OK
5	59 67.0000	OK
6	59 67.0000	SUSPECT
7	59 67.0000	SUSPECT
8	59 67.0000	BAD
9	59 67.0000	BAD

10	59 67.0000	BAD
...20	59 67.0000	OFFLINE

This weighting based on data age can be applied to any of the messages received by the datalogger.

In addition to the overall message status each variable within the message is also analysed to determine how good the data is.

There are a number of tests that determine the validity of each sensor value.

Maximum Change

The maximum change in values from one reading to another. This is used to identify spiking in data. If we see a sudden 4 degree change in Sea Surface Temperature we can flag this as BAD.

e.g.

Time	Sea Surface	Status
12:21:20	19.900	GOOD
12:21:21	19.912	GOOD
12:21:22	19.984	GOOD
12:21:23	19.989	GOOD
12:21:24	23.422	BAD

Must Change

Using the “Must change” option, a set period is defined in which the value must change e.g. windspeed should change even just a fraction over a 5 second period.

If the value doesn’t change, e.g. the sensor is frozen or not receiving data, we flag this as SUSPECT or BAD e.g. Sea Surface Temperature changes every second even if it is just 0.001 of a value. We could set the change period of 3 seconds during which the sea surface value should change.

Time	Sea Surface	Since Change	Status
12:21:20	19.900	0	GOOD
12:21:21	19.000	1	GOOD
12:21:22	19.000	2	BAD
12:21:23	19.000	3	BAD
12:21:24	19.000	4	BAD

Sensor Range (Min/Max Value)

The operational range of the sensor as defined by the manufactures documentation. A value should never be out of this range if it is we have a problem and the data is flagged as BAD.

Perceived Operational Range (Valid Min/Valid Max)

Whilst a sea water temperature sensor may have an operational range of -5 to +40 it is unlikely we will experience this range in everyday operations.

The event logger allows “gate” the values we would class as valid based on our experiences. So we may define a perceived operational range of 0 to +25.

Using this method we would flag anything within this range as good (as long as it didn't change too rapidly or not at all). Any values outside of this range but within the manufacturers specified range would be treated as SUSPECT and anything outside the manufacturers range would be treated as

BAD.

6.1.4.6 Daily Data Table (tblSensorDataYYDDD)

Each Day a table is automatically created by the event logger and populated with the days data.

These tables are name tblSensorDataYYDDD

e.g.

tblSensorData11340

These tables contain a comprehensive selection of variables:

Fieldname	Description
RecordNum	The unique Record Number
Cruise	The Cruise which this data belongs to
JDAY	The current JDAY in format YYDDD
DateTime	The Current Date Time in DD/MM/YYYY HHLMM:SS
Hour	The Current Hour 0-23
Minute	The Current Minute 0-60
Second	The Current Second 0-60
Month	The Current month 1-12
Day	The Current Day 1-31
Year	Current Year YYYY
EA600_Time_UDP	The current UDP time of the EA600 Data
EA600_Lat_Value_UDP	Latitude
EA600_Lat_NS_UDP	N/S
EA600_Lon_Value_UDP	Longitude
EA600_Lon_EW_UDP]	E/W
EA600_GPS_Quality_UDP	Quality of GPS (POSMV)
EA600_No_Sats_UDP	Number of Satellites
EA600_HDOP_UDP	The Horizontal Dilution of precision
EA600_Altitude_UDP	The Altitude of GPS fiz
EA600_ReferenceStn_UDP	The current reference station for DGPS fixes
EA600_HDT_Heading	Vessel Heading
EM120_SS_SST	Em120 Sound Speed at transducer
EM120_SS_SSA	Em120 Sounds Speed Average
EM120_SS_SSB	Em120 Sound speed at Bottom
ApplanixDate	Applanix Date
ApplanixTime	Applanix Time
ApplanixHDOP	Applanix Horizontal Dilution of Precision
ApplanixHDOP_Status	The status for this field based on Max/Min Change and validity of

	logged value
ApplanixVDOP	Applanix Vertical Dilution of Precision
ApplanixVDOP_Status	The status for this field based on Max/Min Change and validity of logged value
ApplanixPDOP	Applanix Precision dilution of precision
ApplanixPDOP_Status	The status for this field based on Max/Min Change and validity of logged value
ApplanixMeasureTime	Applanix Measure Time Value
ApplanixEW	Applanix East/Wet (E/W)
Applanix_Lat_Degrees	Applanix Latitude Degrees
Applanix_Lat_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
Applanix_Lat_Minutes	Applanix Latitude Minutes
Applanix_Lat_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
ApplanixNS	Applanix N/S (North/South)
Applanix_Lon_Degrees	Applanix Longitude Degrees
Applanix_Lon_Degrees_Statua	The status for this field based on Max/Min Change and validity of logged value
Applanix_Lon_Minutes	Applanix longitude Minutes
Applanix_Lon_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
Applanix_Altitude	Applanix Altitude in Meters
Applanix_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value
Applanix_Precision	Applanix Precision
Applanix_Precision_Status	The status for this field based on Max/Min Change and validity of logged value
Applanix_Logging	Applanix logging Status
POSMV_Date	POSMV Date
POSMV_Time	POSMV Time
POSMV_Heading	POSM Heading (Degrees)
POSMV_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
POSMV_Roll	POSMV Roll (Degrees)
POSMV_Roll_Status	The status for this field based on Max/Min Change and validity of logged value
POSMV_Pitch	POSMV pitch (Degrees)
POSMV_Pitch_Status	The status for this field based on Max/Min Change and validity of logged value
POSMV_Heave	POSMV Heave Degrees

POSMV_Heave_Status	The status for this field based on Max/Min Change and validity of logged value
POSMV_Logging	POSMV Logging Status
POSMV_GYRO_Date	POSMV Gyro Date
POSMV_GYRO_Time	POSMV Gyro Time
POSMV_GYRO_Heading	POSMV Gyro Heading (Degrees)
POSMV_GYRO_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Date	ADU5 GPPAT Date
ADU5_GPPAT_Time	ADU5 GPPAT Time
ADU5_GPPAT_Lat_NS	ADU5 Latitude N/S
ADU5_GPPAT_Lat_Degree	ADU5 Latitude Degrees
ADU5_GPPAT_Lat_Degree_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Lat_Min	ADU5 GPPAT latitude Minutes
ADU5_GPPAT_Lat_Min_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Lon_EW	ADU5 GPPAt longitude E/W
ADU5_GPPAT_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Pitch	
ADU5_GPPAT_Pitch_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Roll	
ADU5_GPPAT_Roll_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_Heave	
ADU5_GPPAT_Heave_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_PRMS	
ADU5_GPPAT_PRMS_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_GPPAT_BRMS	
ADU5_GPPAT_BRMS_Status	The status for this field based on Max/Min Change and validity of logged value
SHIPGYRO_Date	
SHIPGYRO_Time	
SHIPGYRO_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
SHIPGYRO_Heading	
SEAPATHAT_Date	

SEAPATHAT_time	
SEAPATHAT_Heading	
SEAPATHAT_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATHAT_Roll	
SEAPATHAT_Roll_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATHAT_Pitch	
SEAPATHAT_Pitch_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATHAT_Heave_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATHAT_Heave	
SKIPPER_Date	
SKIPPER_Time	
WINCH_Date	
WINCH_Time	
WINCH_CableType	
WINCH_CableTension	
WINCH_CableTension_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_CableOut	
WINCH_CableOut_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_Heave	
WINCH_Heave_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_WireRate	
WINCH_WireRate_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_Pitch	
WINCH_Pitch_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_BackTension	
WINCH_BackTension_Status	The status for this field based on Max/Min Change and validity of logged value
EA600_Date	
EA600_Time	
EA600_Feet	
EA600_Feet_Status	The status for this field based on Max/Min Change and validity of logged value

EA600_Meters	
EA600_Meters_Status	The status for this field based on Max/Min Change and validity of logged value
EA600_Fathom	
EA600_Fathom_Status	The status for this field based on Max/Min Change and validity of logged value
SBE45_Date	
SBE45_Time	
SBE45_Htemp	
SBE45_Htemp_Status	The status for this field based on Max/Min Change and validity of logged value
SBE45_Conductivity	
SBE45_Conductivity_Status	The status for this field based on Max/Min Change and validity of logged value
SBE45_Salinity	
SBE45_Salinity_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Date	
DPS116_Time	
DPS116_VisibleSats	
DPS116_VisibleSats_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_UsedSats	
DPS116_UsedSats_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_HDOP	
DPS116_HDOP_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_VDOP	
DPS116_VDOP_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_PDOP	
DPS116_PDOP_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_MeasureTime	
DPS116_NSt	
DPS116_Lat_Degrees	
DPS116_Lat_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Lat_Minutes	
DPS116_Lat_Minutes_Status	The status for this field based on Max/Min Change and validity of

	logged value
DPS116_EW	
DPS116_Lon_Degrees	
DPS116_Lon_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Lon_Minutes	
DPS116_Lon_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Altitude	
DPS116_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Precision	
DPS116_Precision_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_GroundCourse	
DPS116_GroundCourse_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_groundSpeed	
DPS116_groundSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_SurfaceSpeed	
DPS116_SurfaceSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_SurfaceCourse	
DPS116_SurfaceCourse_Status	The status for this field based on Max/Min Change and validity of logged value
DPS116_Heading	
DPS116_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_Date	
SURFMET_Time	
SURFMET_htemp	
SURFMET_htemp_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_temp_m	
SURFMET_temp_m_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_Conductivity	
SURFMET_Conductivity_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_Fluorescence	

SURFMET_Fluorescence_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_Trans	
SURFMET_Trans_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_WindSpeed	
SURFMET_WindSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_WindDirection	
SURFMET_WindDirection_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_AirTemperature	
SURFMET_AirTemperature_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_RelativeHumidity	
SURFMET_RelativeHumidity_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_BarametricPressure	
SURFMET_BarametricPressure_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_SPAR	
SURFMET_SPAR_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_PPAR	
SURFMET_PPAR_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_PTIR	
SURFMET_PTIR_Status	The status for this field based on Max/Min Change and validity of logged value
SURFMET_STIR	
SURFMET_STIR_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_Date	
CNAV_Time	
CNAV_VisibleSV	
CNAV_VisibleSV_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_UsedSV	
CNAV_UsedSV_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_HDOP	

CNAV_HDOP_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_VDOP	
CNAV_VDOP_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_PDOP	
CNAV_PDOP_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_MeasureTime	
CNAV_NS]	
CNAV_Lon_Degrees	
CNAV_Lon_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_Lon_Minutes	
CNAV_Lon_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_EW	
CNAV_Lat_Degrees	
CNAV_Lat_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_LatMins	
CNAV_LatMins_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_Altitude	
CNAV_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_Precision	
CNAV_Precision_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_GroundCourse	
CNAV_GroundCourse_Status	The status for this field based on Max/Min Change and validity of logged value
CNAV_GroundSpeed	
CNAV_GroundSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_Date	
ADU5_PASHR_Time	
ADU5_PASHR_svc	
ADU5_PASHR_svc_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_MeasureTime	

ADU5_PASHR_NS	
ADU5_PASHR_Lon_Degree	
ADU5_PASHR_Lon_Degree_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_Lon_Minute	
ADU5_PASHR_Lon_Minute_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_EW	
ADU5_PASHR_Lat_Degree	
ADU5_PASHR_Lat_Degree_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_Lat_Minute	
ADU5_PASHR_Lat_Minute_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_Altitude	
ADU5_PASHR_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_CMG	
ADU5_PASHR_CMG_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_SMG	
ADU5_PASHR_SMG_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_VerticalVelocity	
ADU5_PASHR_VerticalVelocity_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_PDOP	
ADU5_PASHR_PDOP_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_HDOP	
ADU5_PASHR_HDOP_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_VDOP	
ADU5_PASHR_VDOP_Status	The status for this field based on Max/Min Change and validity of logged value
ADU5_PASHR_TDOP	
ADU5_PASHR_TDOP_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Date	
SEAPATH_Time	
SEAPATH_VisibleSV	

SEAPATH_VisibleSV_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_HDOP	
SEAPATH_HDOP_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_VDOP	
SEAPATH_VDOP_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_PDOP	
SEAPATH_PDOP_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_MeasureTime	
SEAPATH_NS	
SEAPATH_Lat_Degrees	
SEAPATH_Lat_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Lat_Minutes	
SEAPATH_Lat_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_EW	
SEAPATH_Lon_Degrees	
SEAPATH_Lon_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Lon_Minutes	
SEAPATH_Lon_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Altitude	
SEAPATH_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Precision	
SEAPATH_Precision_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_GroundCourse	
SEAPATH_GroundCourse_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_GroundSpeed	
SEAPATH_GroundSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_SurfaceSpeed	
SEAPATH_SurfaceSpeed_Status	The status for this field based on Max/Min Change and validity of logged value

SEAPATH_SurfaceCourse	
SEAPATH_SurfaceCourse_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_Heading	
SEAPATH_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_Date	
FUSION_Time	
FUSION_VisibleSV	
FUSION_VisibleSV_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_UsedSV	
FUSION_UsedSV_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_HDOP	
FUSION_HDOP_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_VDOP	
FUSION_VDOP_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_PDOP	
FUSION_PDOP_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_MeasureTime	
FUSION_NS	
FUSION_Lat_Degrees	
FUSION_Lat_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_Lat_Minutes	
FUSION_Lat_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_EW	
FUSION_Lon_Degrees	
FUSION_Lon_Degrees_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_Lon_Minutes	
FUSION_Lon_Minutes_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_Altitude	
FUSION_Altitude_Status	The status for this field based on Max/Min Change and validity of logged value

FUSION_Precision	
FUSION_Precision_Status	The status for this field based on Max/Min Change and validity of logged value
FUSION_GroundCourse	
FUSION_GroundCourse_Status	The status for this field based on Max/Min Change and validity of logged value
CHERNIKEEF_Date	
GRAVITY_Date	
GRAVITY_Time	
GRAVITY_grav_av	
GRAVITY_grav_av_Status	The status for this field based on Max/Min Change and validity of logged value
GRAVITY_springt	
GRAVITY_springt_Status	The status for this field based on Max/Min Change and validity of logged value
GRAVITY_beam	
GRAVITY_beam_Status	The status for this field based on Max/Min Change and validity of logged value
GRAVITY_Longitude	
GRAVITY_Longitude_Status	The status for this field based on Max/Min Change and validity of logged value
GRAVITY_Latitude	
GRAVITY_Latitude_Status	The status for this field based on Max/Min Change and validity of logged value
GRAVITY_Heading	
GRAVITY_Heading_Status	The status for this field based on Max/Min Change and validity of logged value
CHERNIKEEF_SpeedFA	
CHERNIKEEF_SpeedFA_Status	The status for this field based on Max/Min Change and validity of logged value
CHERNIKEEF_PS	
CHERNIKEEF_PS_Status	The status for this field based on Max/Min Change and validity of logged value
WINCH_Angle	
WINCH_Angle_Status	The status for this field based on Max/Min Change and validity of logged value
SBE45_SoundSpeed	
SBE45_SoundSpeed_Status	The status for this field based on Max/Min Change and validity of logged value
SBE45_Rtemp	
SBE45_Rtemp_Status	The status for this field based on Max/Min Change and validity of

	logged value
SBE45_SpeedKPH	
SBE45_SpeedKPH_Status	The status for this field based on Max/Min Change and validity of logged value
SEAPATH_UsedSV	
SEAPATH_UsedSV_Status	The status for this field based on Max/Min Change and validity of logged value
EK60_Time	
EK60_Lat	
EK60_NS	
EK60_Lon	
EK60_EW	
APPLANIX	Applanix
APPLANIX_AGE	Applanix Message Age in Seconds
POSMV	POSMV Message Status
POSMV_AGE	POSMV Message Age in Seconds
WINCH	WINCH Message Status
WINCH_AGE	Winch Message Age in Seconds
POSMV_GYRO	POSMV Gyro Message Status
POSMV_GYRO_AGE	POSMV Gyro Message Age in Seconds
EA600	EA600 Message Status
EA600_AGE	EA600 Message Age in Seconds
SURFMET	Surfmet Message Status
SURFMET_AGE	Surfmet Message Age in Seconds
FUSION	Fusion Message Status
FUSION_AGE	Fusion Message Age in Seconds
CHERNIKEEF	Chernikeef Message Status
CHERNIKEEF_AGE	Chernikeef Message Age in Seconds
SKIPPER	Skipper Message Status
SKIPPER_AGE	Skipper Log Message Age in Seconds
GRAVITY	Gravity Message Status
GRAVITY_Age	Gravity Message Age in Seconds
ADU5_PASHR	ADU5 PASHR Message Status
ADU5_PASHR_AGE	ADU5 PASHR Message Age in Seconds
ADU5_GPPAT	ADU5 GPPA Message Status
ADU5_GPPAT_AGE	ADU% GPPAT Message Age in Seconds
DPS116	DPS116 Message Status
DPS116_AGE	DPS116 Message Age in Seconds

SHIPGYRO	SHIPGYRO Message Status
SHIPGYRO_AGE	SHIPGYRO Message Age in Seconds
SEAPATHAT	Seapath Message Status
SEAPATHAT_AGE	SEAPATHAT Message Age in Seconds
SBE45	SBE45 Message Status
SBE45_AGE	SEB45 Message Age in Seconds
SYS18	SYS18 Message Status
SYS18_AGE	SYS18 Message Age in Seconds
CNAV	CNAV Message Status
CNAV_AGE	CNAV Message Age in Seconds
EM120_1	
EM120_1_AGE	
EM120_2	
EM120_2_AGE	
EM120_3	
EM120_3_AGE	
EK60	
EK60_AGE	

6.1.4.7 User Events Table (tblUserEvents)

When the user creates an event using the web interface is is logged to the table tbluserevents.

The logged event is linked to the corresponding data table containing all the data for this exact time via the "Data_Table" field. The "DataRecordLink" field specifies which unique entry in the table this event refers to.

Field	Description
UniqueID	The unique ID given to this event
DateTime	The Date Time this event was created in format DD/MM/YYYY HH:MM:SS
JDAY	The Jday on which this event was created DDD
JDAY_Full	The Jday this event was created in format YYDDD
Hour	The hour when this event was created 0-23
Minute	The minute when this event was created 0-59
Second	The second when this event was created 0-59
Day	The Day when this event was created 1-31
Month	The month when this event was created 1-12
Year	The year when this event was crated e,g, 2011
Description	The actual event description e.g. "ROV in water"
StationNumber	The station number eg.g. JC066-001
Type	The type of event – Biology, Equipment Recovery etc
IP	The IP address of the machine that created the event – no implemented yet

Username	The user who created the event
DataTable	The Data Table which contains the full list of sensor values e.g. tblSensorData11340 that were logged when this event was created
DataRecordLink	The UniqueID of the entry in the above table when this event was created
Lat	The latitude of this event (use to quickly get lat without linking tables)
Lon	The longitude of this event (use to quickly get lon without linking tables)
Depth	The Depth of this event (use to quickly get depth without linking tables)
Heading	The Heading of this event (use to quickly get heading without linking tables)
SOG	The Speed over Ground of this event (use to quickly get SOG without linking tables)
SampleOrLine	
ROVDiveLoc	The location during a ROV dive (ROV Ops only) – Downcast, Seabed, Upcast
Camera	The camera on which the sighting occurred (ROV Ops only)

ROV/USBL EVENT LOG

Station Number Report JC066-008 Event 22

Report Generated : 16/12/2011 04:18:25

Date Time	Event Type	USBL	DBT	Loc.	Camera	Ship Lat	Ship Lon	USBL Lat	USBL Lon	Fix Age	Ship SOG	Heading
347 - 13/12/2011 15:34:07	RECOVER - ROV	-5.7m	1767.12 m			32 42.59476S	57 17.0198E	32 42.53822 S	57 16.98292 E	-100	0.69 kts	154.11 °
ROV on deck												
347 - 13/12/2011 15:33:20	ROV - Generic	-5.7m	1862.74 m	Seabed	HD	32 42.59535 S	57 17.02101 E	32 42.53822 S	57 16.98292 E	-100	0.94 kts	154.76 °
ROV out of water.												
347 - 13/12/2011 15:31:29	ROV - Generic	-5.7m	2363.35 m	Seabed	HD	32 42.59718 S	57 17.02207 E	32 42.53822 S	57 16.98292 E	-100	0.74 kts	154.01 °
ROV on surface.												
347 - 13/12/2011 15:07:44	ROV - Generic	-715m	720.04 m	Seabed	HD	32 42.59767 S	57 17.01943 E	32 42.57559 S	57 17.01691 E	2	0.94 kts	156.15 °
ROV ascend, recovery begins. End of transect.												
347 - 13/12/2011 15:07:21	ROV - Generic	-718.4m	722.92 m	Seabed	Upper/Lower HD	32 42.59682 S	57 17.01972 E	32 42.57466 S	57 17.01331 E	2	0.88 kts	155.38 °
shark												
347 - 13/12/2011 15:07:16	Biology Observation	-718.4m	722.92 m	Seabed	HD	32 42.59682 S	57 17.01972 E	32 42.57466 S	57 17.01331 E	2	0.88 kts	155.38 °
Shark												
347 - 13/12/2011 15:06:47	Biology Observation	-718.6m	722.02 m	Seabed	HD	32 42.59619 S	57 17.02038 E	32 42.57352 S	57 17.01487 E	4	1.13 kts	155.8 °
Spiny Lobster												
347 - 13/12/2011 15:06:19	Biology Observation	-719.3m	722 m	Seabed	Upper/Lower HD	32 42.59516 S	57 17.02179 E	32 42.57156 S	57 17.01578 E	0	1.07 kts	154.85 °
Stylasterid												
347 - 13/12/2011 15:06:15	ROV - Generic	-719.3m	722 m	Seabed	HD	32 42.59516 S	57 17.02179 E	32 42.57156 S	57 17.01578 E	0	1.07 kts	154.85 °
Centriscops humerosus												
347 - 13/12/2011 15:06:14	ROV - Generic	-719.3m	722 m	Seabed	Upper/Lower HD	32 42.59516 S	57 17.02179 E	32 42.57156 S	57 17.01578 E	0	1.07 kts	154.85 °
white coral												
347 - 13/12/2011 15:05:31	ROV - Generic	-720m	719.6 m	Seabed	Upper/Lower HD	32 42.59551 S	57 17.02326 E	32 42.57207 S	57 17.01568 E	4	0.09 kts	154.58 °
yellow coral												
347 - 13/12/2011 15:05:31	ROV - Generic	-720m	719.6 m	Seabed	Upper/Lower HD	32 42.59551 S	57 17.02326 E	32 42.57207 S	57 17.01568 E	4	0.09 kts	154.58 °
347 - 13/12/2011 15:05:22	ROV - Generic	-720.7m	721.6 m	Seabed	HD	32 42.59574 S	57 17.02388 E	32 42.57268 S	57 17.01683 E	4	1.08 kts	154.04 °
Various coral fans, 1 horridus urchin.												
347 - 13/12/2011 15:05:16	Biology Observation	-720.7m	721.6 m	Seabed	Upper/Lower HD	32 42.59574 S	57 17.02388 E	32 42.57268 S	57 17.01683 E	4	1.08 kts	154.04 °
Urchin												
347 - 13/12/2011 15:05:10	ROV - Generic	-720.7m	721.6 m	Seabed	HD	32 42.59574 S	57 17.02388 E	32 42.57268 S	57 17.01683 E	4	1.08 kts	154.04 °
Glass sponge												
347 - 13/12/2011 15:04:16	ROV - Generic	-724.2m	500.18 m	Seabed	Upper/Lower HD	32 42.59645 S	57 17.02179 E	32 42.57216 S	57 17.02002 E	1	0.62 kts	154.76 °
shark												

Figure 60. USBL Report showing ship GPS and USBL Beacon position.

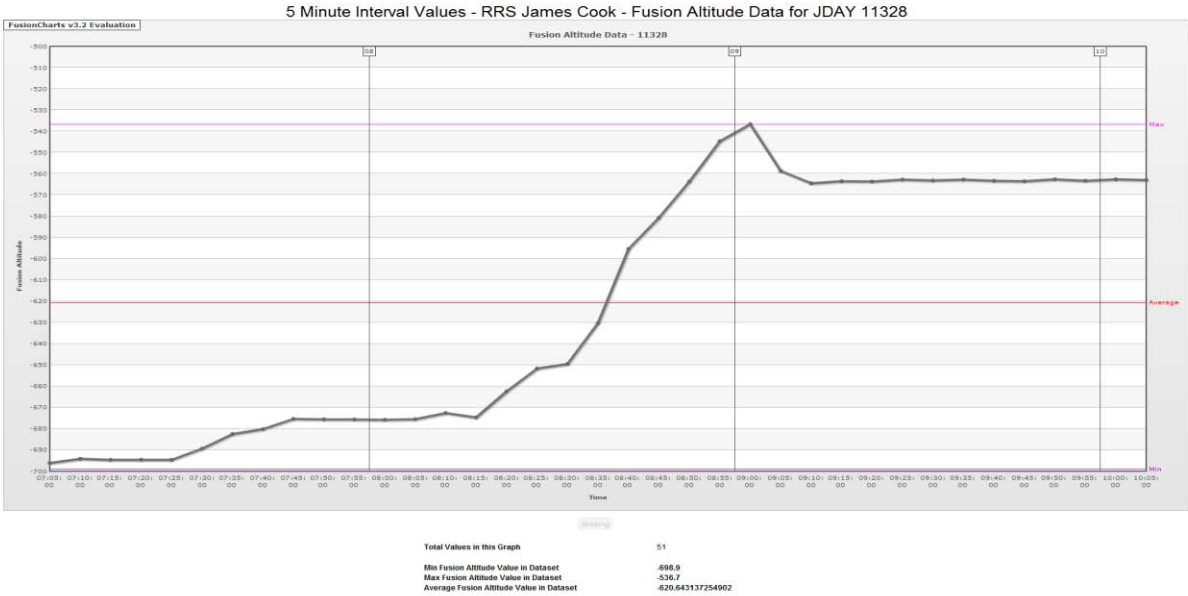


Figure 61. An Altitude plot for the USBL showing the height of the beacon during a dive.

EVENT LOG

347 - 13/12/2011 22:52:25

Event Unique ID:	131220112252258	Created By:	ac	JDAY:	347

Description of Logged Event

Event Type: DEPLOY - Mega Core
Description: MGC deployment 2, 4 core tubes attached

Primary Science GPS

HDOP	1.1
Time	40890.953058
Lat DD MM.MM	32 42.18873 S
Lat DD.DDD	32.70315
Lon DD MM.MM	57 14.42356 E
Lon DD.DDD	57.24039
Altitude	8.19
Precision	2
Roll	-1.08
Pitch	-0.38
Heave	-0.49
Heading	137.86

Ship Gyro

Heading	138.33°

ADU5

Latitude	32 42.19332 S
Longitude	57 14.41996 E

DPS116

Latitude	32 42.18796 S
Longitude	57 14.42166 E
Ground Speed	0.87kts

Seapath 200

Latitude	32 42.18821 S
Longitude	57 14.42326 E

CNAV

Latitude	32 42.18757 S
Longitude	57 14.42234 E
Ground Speed	0.74kts

Meteorological

Lab Temp	19.8689 °C
Sea Surface	19.6582 °C
Conductivity	4.8406
Fluorometer	0.7745
Transmissometer	3.7221
Pressure	1018.738
PPAR	0.6
SPAR	-0.2
Wind Speed	5.585m/s 10.86kts/s
Wind Direction	355.3056°
Air Temperature	16.5°C
Humidity	57.27
PTIR	-0.8
STIR	-1.2

Seabird 45

Htemp	19.869
Conductivity	4.84058
Salinity	35.5108
Sound Speed	1521.096
RTemp	19.6577

Gravity

Gravity	9409.75
Spring tension	9405.97
Beam	-235819.17
Longitude	57.240391
Latitude	-32.703147
Heading	137.7

Winch

Cable Type	3.000000
Cable Tension	
Cable Out	-7.2
Winch Heave	
Winch Wire Rate	0
Winch Pitch	
Back Tension	0.83

Chernikeef

Fwd/Aft kts	0.64
Fwd/Aft m/s	0.33 kts
Port/Stbd kts	0.3
Port/Stbd m/s	0.15 kts

....

....

....

....

Figure 62. Paper based print out.

Date and Time	Event Added By	Event Type	Latitude	Longitude	Depth	SOG	Station No	Unique ID	Data Table
13/12/2011 22:40:31	ac	RECOVER - Mega Core	32 42.18717S	57 14.42329E	1484.75m	0.89	JC066-008 Event 26	1312201122403113	tblSensorData11347

2 good cores recovered, 25cm+ each

Export as TXT Export as CSV Export as XML User Report Station Report Printer Friendly Version

Figure 63. Examples of on screen event report.

RRS James Cook Events Report

Homepage

11347

Return To Top

Index Page for Graphing and Report Generation for this date

22:00:00

Date and Time	Event Added By	Event Type	Latitude	Longitude	Depth	SOG	Station No	Unique ID	Data Table
13/12/2011 22:52:25	ac	DEPLOY - Mega Core	32 42.18873S	57 14.42356E	1488.93m	0.87	JC066-008 Event 27	131220112252258	tblSensorData11347

MGC deployment 2, 4 core tubes attached

Export as TXT Export as CSV Export as XML User Report Station Report Printer Friendly Version

Date and Time	Event Added By	Event Type	Latitude	Longitude	Depth	SOG	Station No	Unique ID	Data Table
13/12/2011 22:40:31	ac	RECOVER - Mega Core	32 42.18717S	57 14.42329E	1484.75m	0.89	JC066-008 Event 26	1312201122403113	tblSensorData11347

2 good cores recovered, 25cm+ each

Export as TXT Export as CSV Export as XML User Report Station Report Printer Friendly Version

20:00:00

Date and Time	Event Added By	Event Type	Latitude	Longitude	Depth	SOG	Station No	Unique ID	Data Table
13/12/2011 20:20:26	ac	DEPLOY - Mega Core	32 42.18824 S	57 14.42433 E	1505.68m	0.86	JC066-008 Event 26	131220112020253	tblSensorData11347

mgc 1st deployment

Export as TXT Export as CSV Export as XML User Report Station Report Printer Friendly Version

Figure 64. Further examples of on-screen event log.

6.1.5 GPS

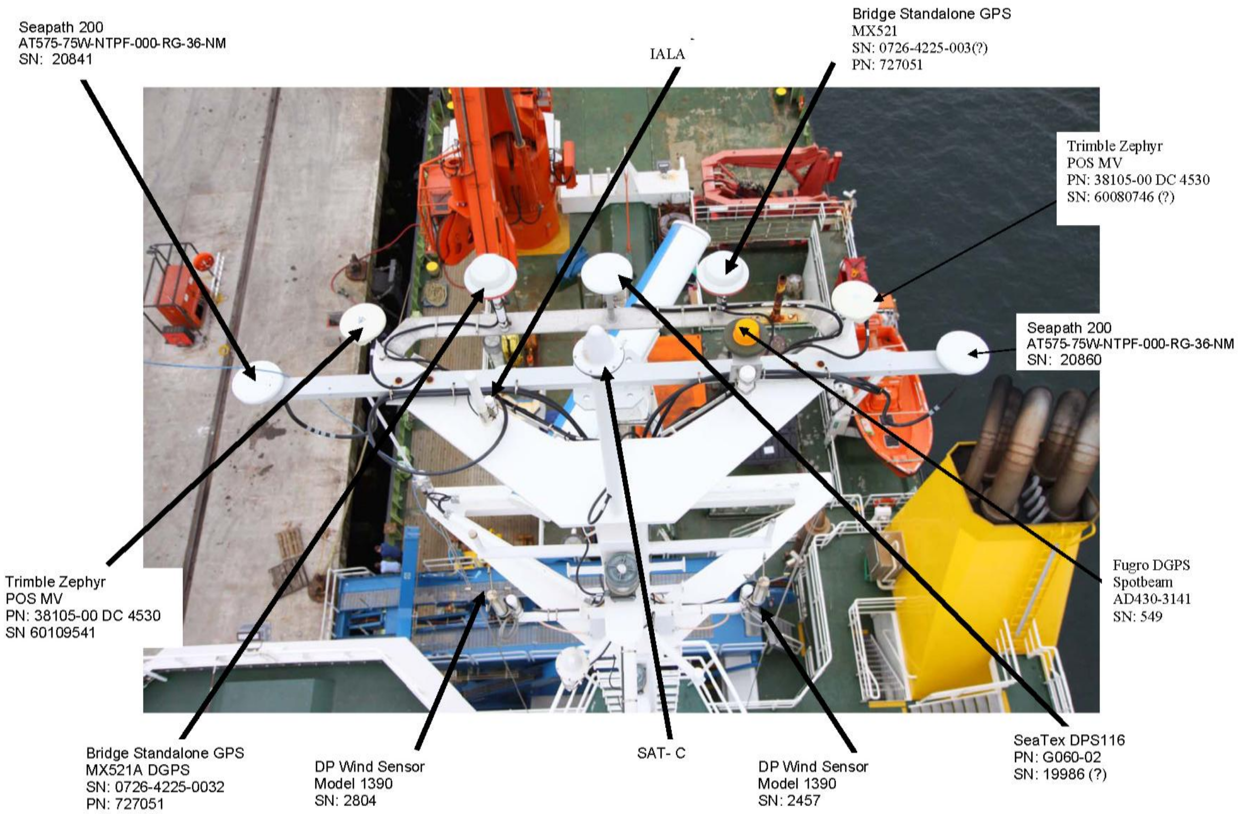


Figure 65. Pre 2011 set-up. The only difference is the Spotbeam has now been replaced by the CNAV antenna which occupy s the same position.

All systems preformed well for the entire duration of JC066. A few problems were encountered on the transit down from Cape Verde due to increased Solar Activity. This was dealt with in MCA flash sent to the vessel detailing DP and GPS problems off the coast of Africa.

6.1.5.1 DPS116 – Bridge Navigation (GPS 1)

6.1.5.1.1 Overview

The DPS116 is primarily used for bridge navigation and is GPS1 on the DP console. This system does not contain any X,Y,Z offsets and the position logged in techs as is the position of the antenna. The DP Desk has offsets that are applied to the GPS output for navigation. The DPS116 is used to supply the USBL system with a position as Fusion cannot work with systems referenced from a CRP.

6.1.5.1.2 Data Deliverables

The DPS116 data is included in the TECHSAS NetCDF files (See above documentation). The DPS116 data is included in the DPS116 rvs stream (see documentation above). The DPS116 data is included in the Event Logger (see above documentation).

6.1.5.1.3 System Specification

A copy of the DPS116 System Specification is included in:
/Documentation/DPS116

6.1.5.1.4 Problems

During the transit down from Cape Verde and during the first part of JC066 we experienced a number of high noise errors associated with the DPS116. During these periods the system weighting of GPS inputs would result in GPS2 being selected for navigation (Seapath 200). Vessel navigation was at no point impaired.

HDOP

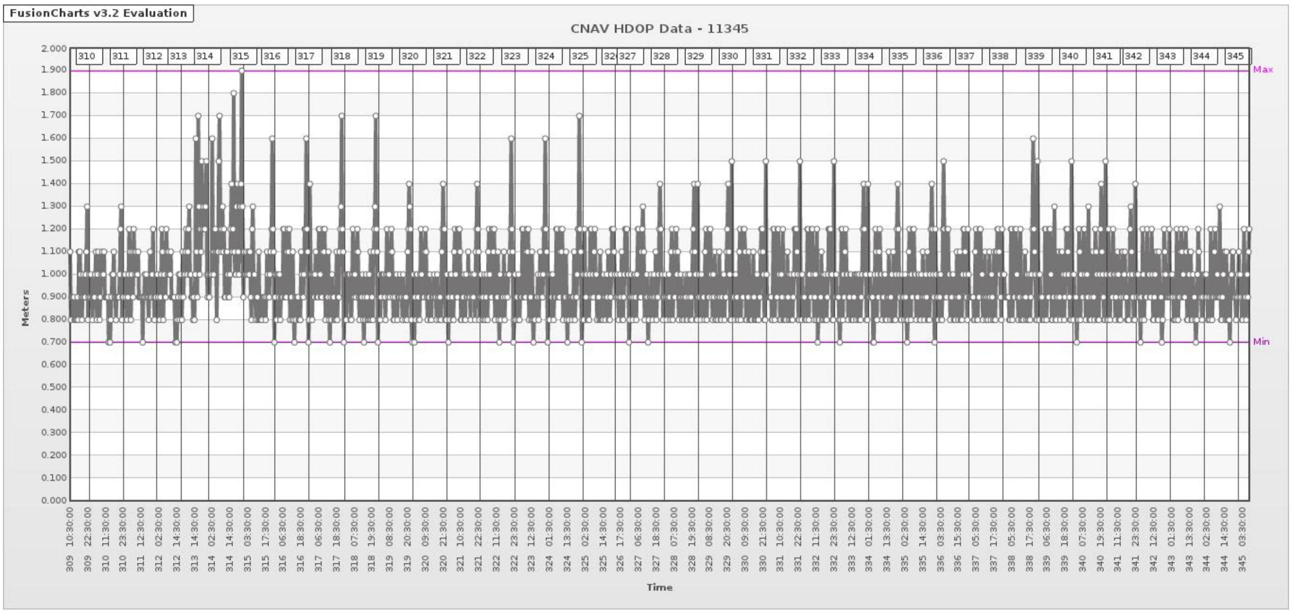


Figure 66. Despite "High Noise" errors on the DP system the actual HDOP values for the DPS116 were very good for the duration of the cruise.

6.1.5.2 POSMV – primary Science GPS

6.1.5.2.1 Overview

The POSMV is the Primary Science GPS. It sends positions to the EM120, SBP120, EM710, EA600, EK60, ADCP's and Gravity Meter. The POSMV position is referenced to the vessel CRP (0,0,0) and all positions are from this location and not the antenna.

6.1.5.2.2 System Specification

A copy of the POSMV System Specification is included in:

/Documentation/POSMV/

6.1.5.2.3 Data Deliverables

The POSMV data is included in the TECHSAS NetCDF files (See above documentation). The POSMV data is included in the POSMV rvs stream (see documentation above). The POSMV data is included in the Event Logger (see above documentation).

6.1.5.3 ADU5 – Standalone GPS

6.1.5.3.1 Overview

The ADU5 is a standalone GPS system that is neither referenced or used by any of the science systems.

Figure 67. The ADU5 is the 4 antennas in the left of the image.

<u>This is not our primary GPS as per RRS Discovery</u>

When plotted alongside data acquired from POSMV/DPS116/Seapath 200 and CNAV an offset of roughly 10m will be visible as this system is positioned above the starboard bridge wing and not on the vessels mast.

6.1.5.3.2 System Specification

A copy of the ADU5 System Specification is included in:

/Documentation/ADu5/

6.1.5.3.3 Data Deliverables

The ADU5 data is included in the TECHSAS NetCDF files (See above documentation). The ADU5 data is included in the ADU5 rvs stream (see documentation above). The ADU5 data is included in the Event Logger (see above documentation).

HDOP

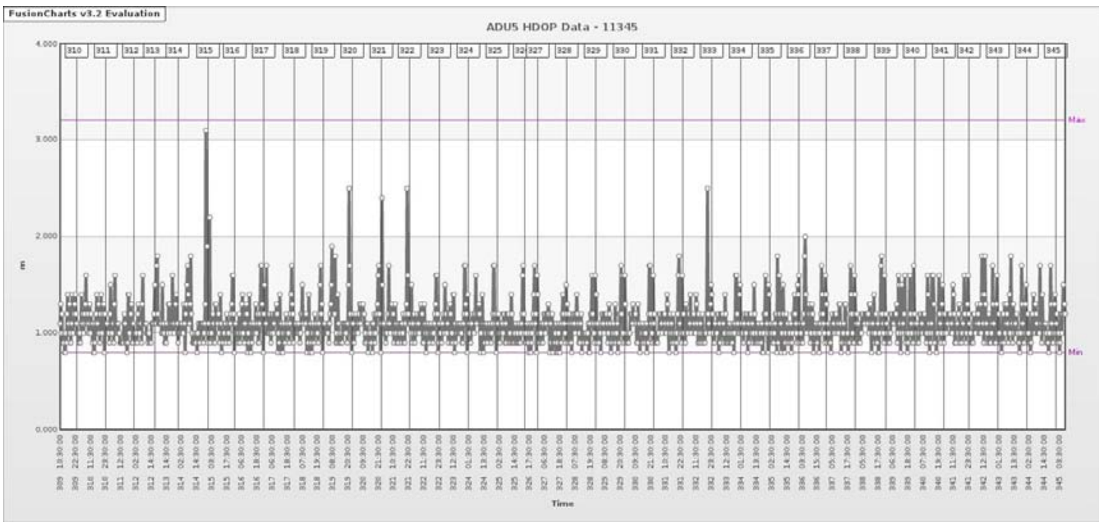


Figure 67. With the exception of the evening of 11314 all HDOP's were < 3m.

6.1.5.4 CNAV – DGPS Corrections

The CNAV system is used to distribute high accuracy DGPS corrections to the Seapath 200, DPS116 and POSMV. The CNAV is also a standalone GPS receiver.

6.1.5.4.1 System Specification

A copy of the CNAV System Specification is included in:

/Documentation/CNAV/

The CNAV is installed on the main mast in the position previously occupied by the seastar (Fig. 68).

Figure 68. Image of CNAV antenna.

6.1.5.4.2 Data Deliverables

The CNAV data is included in the TECHSAS NetCDF files (See above documentation). The CNAV data is included in the CNAV rvs stream (see documentation above). The CNAV data is included in the Event Logger (see above documentation).

HDOP

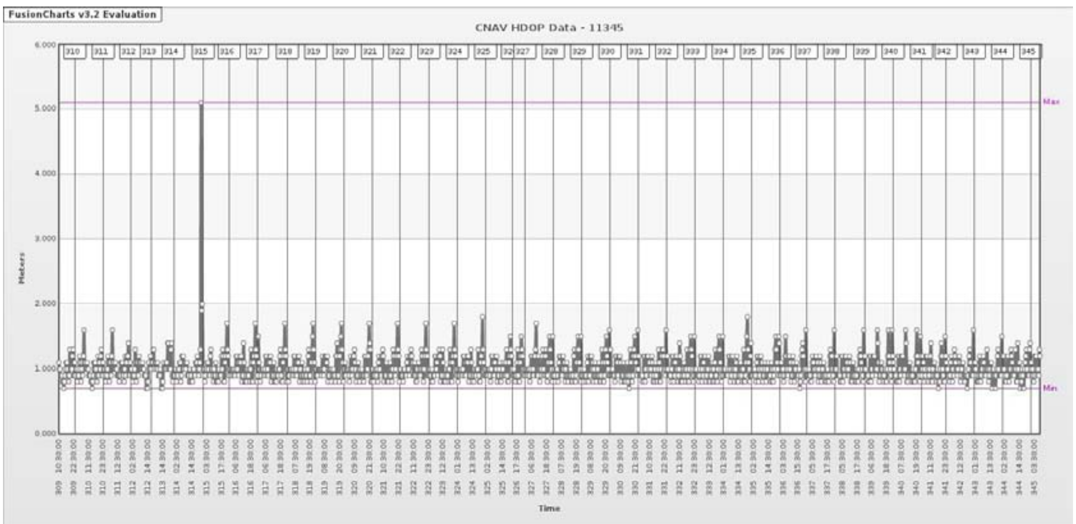


Figure 69. CNAV HDOP plot showing only one instance of high HDOP during the evening of 11314.

6.1.5.5 Seapath 200 – Secondary Nav/Science GPS

6.1.5.5.1 Overview

The Seapath 200 is a backup GPS system for both science and navigation. The seapath 200 is GPS feed 2 to the bridge DP console. The DP console analyses the DPS116 and Seapath 200 inputs and uses the most accurate based on a number of variables. The Sepath 200 can also be used by the EM120, SBP120 and Em710 in the event of a POSMV failure.

6.1.5.5.2 System Specification

A copy of the SP200 System Specification is included in:
/Documentation/SP200/

6.1.5.5.3 Time Display Issue

The time display shown on the Seapath 200 is 15 seconds out from all other GPS units and NTP clock enabled PC's.

6.1.5.5.4 Reduced Heading

On three occasions during JC066 the Heading status value went from NORMAL to REDUCED. No further details available

6.1.5.5.5 Data Deliverables

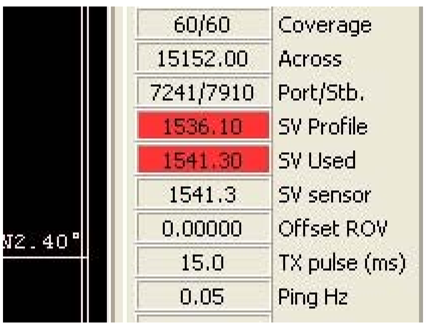
The SP200 data is included in the TECHSAS NetCDF files (See above documentation). The SP200 data is included in the SP200 rvs stream (see documentation above). The SP200 data is included in the Event Logger (see above documentation).

6.1.6 Acoustic Systems

6.1.6.1 Sound Velocity profiles

SVP were taken at each survey sites in accordance with UKHO requirements for SVP's to be obtained when the vessel has transited more than 30km or when a change of more than 0.5 degrees has been encountered. During the surveys the water temperature was monitored using the Surfmet system to check the validity of profiles for the entire survey area. No surveys required multiple SVP's.

6.1.6.1.1. Sound Speed Alarm SIS



During transits the SVP values in SIS would go red to indicate that the SVP is no longer valid based on data acquired from the hull mounted SVP.

If the SVP sensors and the current profile differ substantially then SIS alarms indicating that sufficient sound speed changes have occurred to warrant a new SVP

6.1.6.1.2 SVP particulars

All SVP profiles were obtained using this probe

Manufacturer: Valeport
Serial No: 22356
Inventory Number: 250002729

Calibration File:

\Sound_Velocity_Profiles\CalibrationSheets\

Operational Configuration of SVP

2hz Sample Rate
Continous Sampling

Profile Processing

The SVP profile is downloaded using Datalog Express

Once downloaded it is processed using the built-in SVP Editor available in Kongsberg's SIS software.

Profiles downloaded from our Valeport SVP are in ".000" format which is included as part of the data deliverables

The .000 can be found in the folder

\Ship_Systems\Sound_Velocity_Profiles\[SVP FOLDER]\Raw\

The raw file contains the following values (Date, Time, Sound Speed, Temperature)

21/11/2011 11:12:47.000	1491.415	1099.571	5.907
21/11/2011 11:12:48.000	1491.418	1099.571	5.910
21/11/2011 11:12:48.500	1491.410	1099.571	5.910

Prior to use by the EM120,EM710 and EA600 the SVP must be changed into an .asvp format which just includes just depth and sound speed.:

(SoundVelocity 1.0 0 199712302359 0.0 0.0 -1 0 0 KM_DEFAULT E 0376)
0 1514.164
5.285 1514.164
13 1514.256
15.143 1514.279
31.143 1514.264
56.714 1514.44
59.857 1514.319
60.571 1514.297

To create a profile for the USBL we must manually edit the files in Excel. The format for the USBL SVP is:

JC066-001
7/8/2002
12:30:0 0

SVP Valeport
SVP1

0.571	1499.249
1.285	1499.141
1.571	1499.109
2.143	1499.104
2.857	1499.088
2.571	1499.087
2.571	1499.1
2.285	1499.161

The SVP Processing method used during this cruise was:

- Removal of up-cast data
- Check profile (Sort Depths)
- Extend Profile down to full ocean depth
- Thin profile (SIS Only uses 500 values in its SVP profile)
- Load data into system
- Check Profile is Loaded
- Compare with Previous SVP
- Create USBL file in excel

A copy of on-board SVP processing methods are included in:

\Ship_Systems\Documentation\SVP process

When loaded into the EM120/EM710 the following files are generated by SIS

These can be found in

\Ship_Systems\Sound_Velocity_Profiles\[SVP FOLDER]\Multibeam\

[PROFILE]_salinity_03500_12kHz
[PROFILE]_salinity_03500_32kHz
[PROFILE]_salinity_03500_60kHz
[PROFILE]_salinity_03500_70kHz
[PROFILE]_salinity_03500_80kHz
[PROFILE]_salinity_03500_90kHz
[PROFILE]_salinity_03500_95kHz
[PROFILE]_salinity_03500_100kHz
[PROFILE]_salinity_03500_200kHz
[PROFILE]_salinity_03500_300kHz
[PROFILE]_salinity_350.temp
[PROFILE].temp

6.1.6.2 Synchronisation Issues

A number of potential conflicts were investigated regarding the various acoustics systems interfering with each other. Due to the multidisciplinary nature of this cruise we had a number of different groups utilising the various acoustic systems each with different requirements that, in some instances, conflicted with one-another:

Lilly Muller: EM120/EM710/SBP120

Philipp Boersch-Supan / Clare Webster: EK60

Jane Read: ADCP75/ADCP150Khz

This presented various challenges arising from how each system was used and resulted in the following operational methods being adopted for the duration of the cruise.

Fisheries

- For specific fisheries surveys, the EK60 would operated with no additional systems pinging
- During ROV ascent/Descent the EK60 would operate at a 4 Second Ping rate
- During any other operations the ping rate of the EK60 would be reduced to once every 37 seconds

ADCP's

- A compromise was obtained whereby the EK60 team would reduce ping rate to 37 seconds during general operations to reduce interference with ADCP data.

Geo Science

- EK60 reduced to sampling at 37 second intervals during EM120 Surveys.
- In earlier surveys (Coral/Melville) the EK60 pinging was turned off during swath surveys

Triggering and Synchronisation

EK60	- Internal triggering when pinging at 37 Second
EM120	- Internal pinging when conducting survey as this permitted a higher ping rate
EM710	- External trigger
EA600	- External trigger

6.1.6.3 Em120 – Deep Water Multibeam

6.1.6.3.1 Overview

The EM120 preformed very well during JC066/67. During the JC065 the system was examined and modified by a Kongsberg Field Engineer in response to ongoing banding issues that have been present for the last 4 years. A number of major changes were made to the system and during JC066 we saw no banding issues in the raw data.

6.1.6.3.2 System Specification

A copy of the EM120 System Specification is included in:
/Documentation/EM120/

6.1.6.3.3 Data Deliverables

Configuration File:	\Ship_System\Acoustics\EM-120\Configuration
BIST File:	\Ship_System\Acoustics\EM-120\BIST
RAW EM120 data is located in:	\Ship_System\Acoustics\EM-120\
Line Data is Located in:	\Ship_System\Acoustics\EM-120\Line Info\
Grid Data is Located In	\Ship_System\Acoustics\EM-120\Grids\

Screen shots \Ship_System\Acoustics\EM-120\Screenshots

6.1.6.3.4 Calibration

No dedicated calibration was preformed during this cruise. However, each of the surveys incorporated a number of tie-in lines designed to assist in processing the data and helping with the generation of calibration values. At Coral Sea Mount additional swath lines were executed to ensure that sufficient data was available for post-processing calibration. However, the produced data quality during JC066/67 was exceptionally good and no evidence of calibration issues were visible in the raw and processed data – it is some of the best data I have seen from this system.

6.1.6.3.5 EM120 Anti-Fouling

Divers who attended the vessel in Santa Cruz, Tennerife photographed the transducers. Unfortunately the paint job applied during the 2011 refit has started to peel and by the time the vessel has completed its 14kt transit to Cape Town the transducers will probably be clean of paint. However, this has absolutely no affect on the performance of the transducers

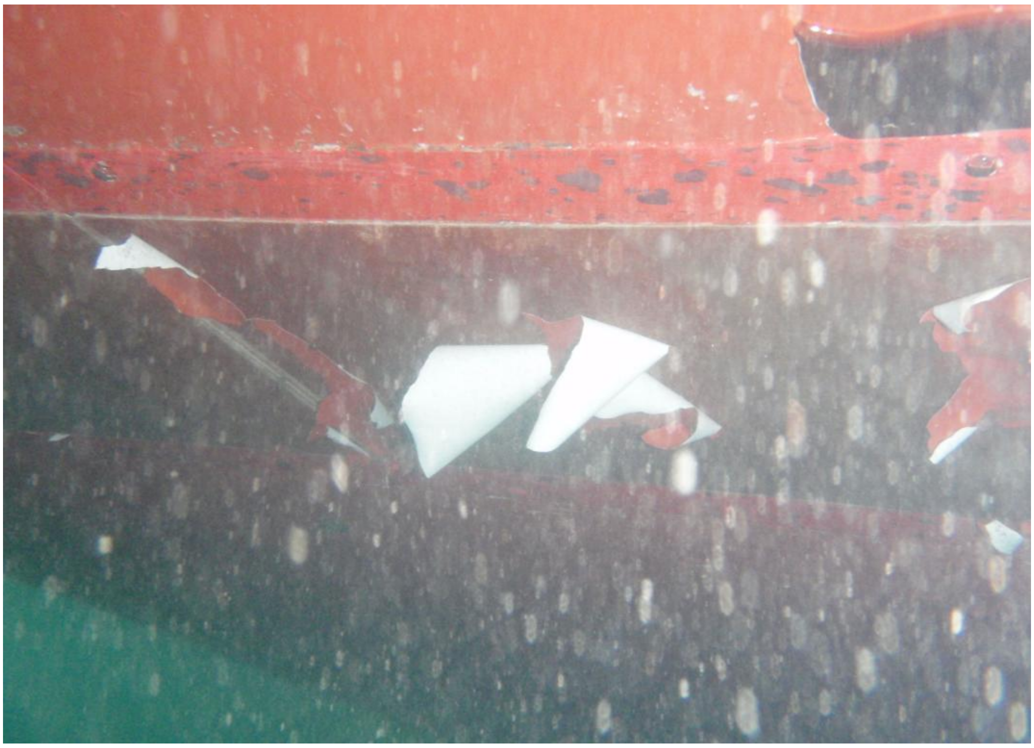


Figure 70. Paint peeling on EM120 transducers.

6.1.6.3.6 SWATH – Bridge Operations

Bridge-Lab communications were very good for the duration of the cruise. Particular effort was made by the bridge team to ensure adequate “run in” and trials were made with both automatic and manual turning. The Master has made a number of refinements to automated turns at the end of lines and this will be included in his handover note.

I would like to thank the bridge team for their assistance during these surveys which went a long way to ensuring the exceptionally good data quality that was obtained.

6.1.6.3.7 Weather Conditions/Current

Generally weather conditions were favourable for the majority of EM120 surveys.

At Melville we encountered strong surface currents and higher sea states which required the vessel to crab at a slight angle to the swath line in order to hold course. This resulted in some “blank” areas which were filled during additional operations.

At Atlantis bank our first attempted at swath encountered degraded data quality due to pitching of the vessel and the steepness of the terrain we were mapping. The first attempt was aborted.

The bridge team was very helpful in monitoring the prevailing weather conditions and adequate data were supplied allowing us to plan the survey with greater understanding of current and future weather conditions.

6.1.6.3.8 System Performance Issues

A few minor issues were encountered with the system when swathing in access of 10kts. The most commonly encountered issue was “blank” areas in the data. I believe these artefacts are caused by aeration under the hull. When a blank area occured the size of the “dead” data would increase in an almost linear fashion until the pinging was either restarted or the software resolved the problem. This occured a number of times during the surveys and was solved using the restart method described above. Once restarted the system continued to obtain data.

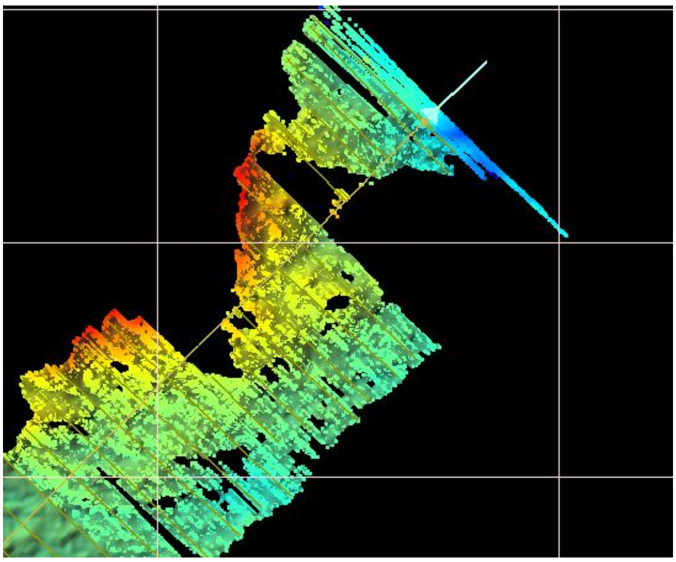


Figure 71. Bad swath. This bad data has been fixed by stop/starting the pinging.

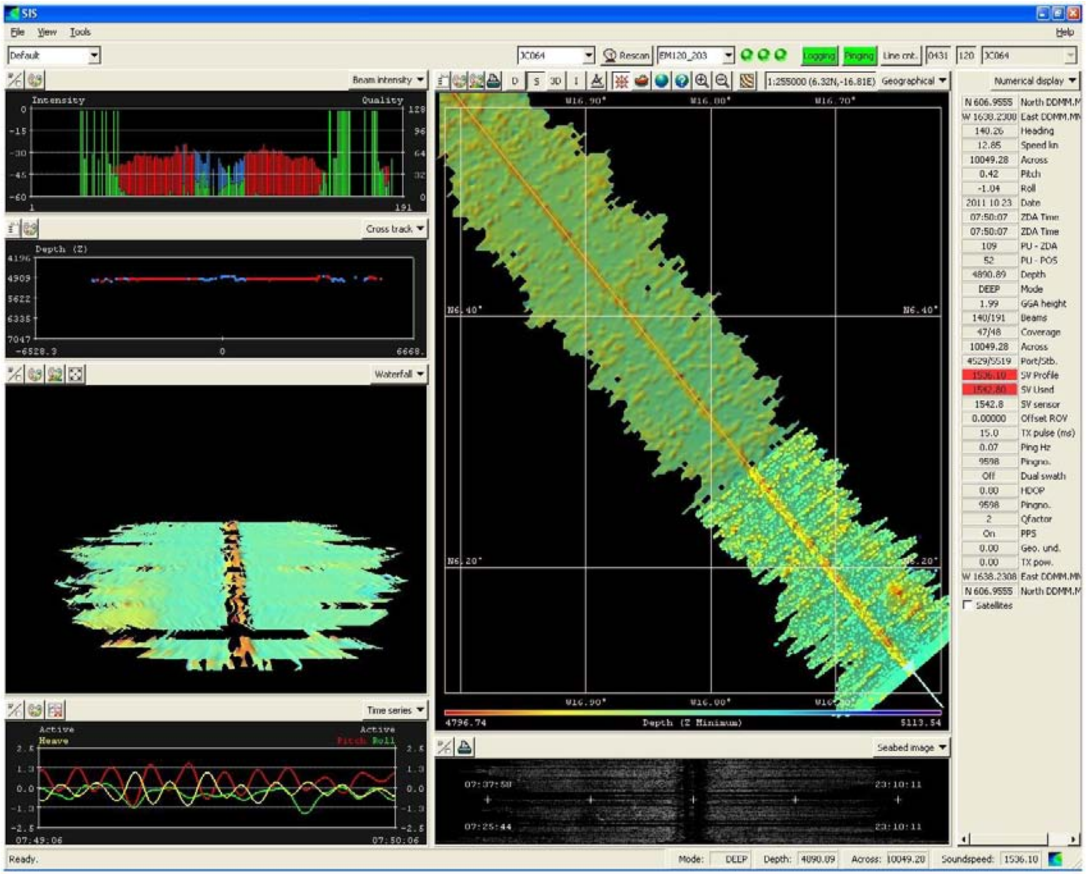


Figure 72. On one occasion during the cruise a problem occurred where no centre beam data was displayed in SIS. Stopping and restarting SIS solved this issue. During this stage we did not have an accurate sound speed profile.

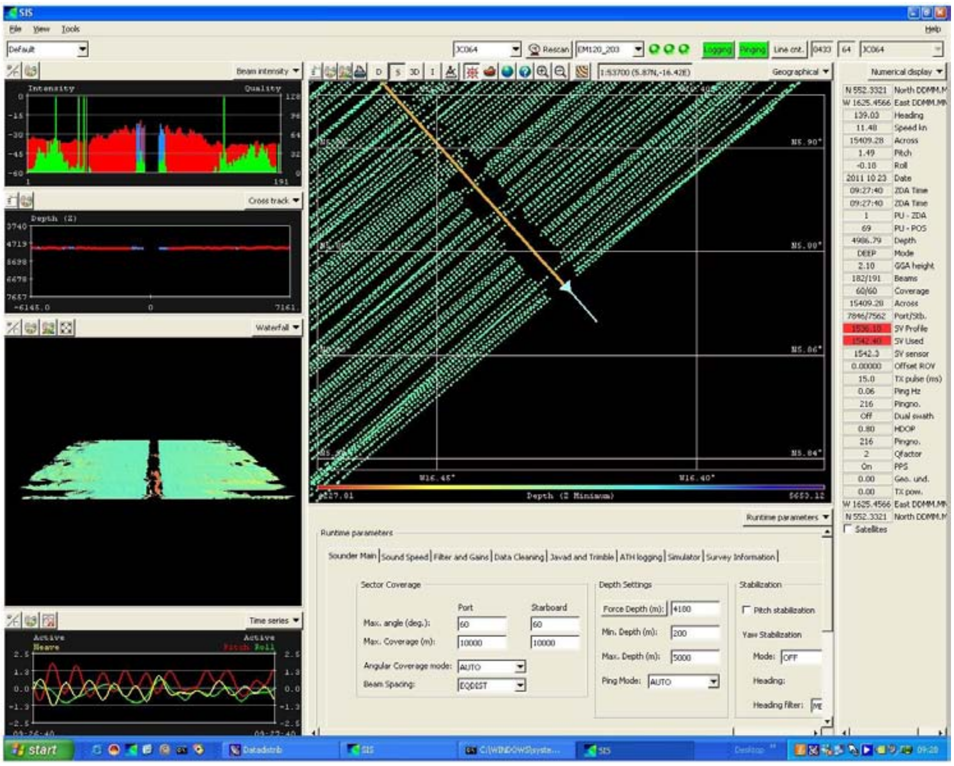


Figure 73. A similar issue occurred with a visible raised area below the vessel. As with the “no data” problem described above, this was solved restarting SIS.

6.1.6.3.9 Transit Data Collection

Data acquired during transit was exceptionally good and constitutes some of the best data I have seen from this system. The sea state was very good during the transits and the vessel was also operating trimmed down at the bow. In addition the vessel was transiting at high speed 10-14kts which I am informed is the design speed for the bow and may further emphasise why the data was this good.

6.1.6.3.10 Logging and Survey Management

Good watch keeping and survey practices were used throughout each of the surveys. During each survey the line counter was increased at the start of a swath line and again at the end of the swath line. To ensure the survey was split into manageable chunks. Each increment of the line counter was recorded and resulted in an accurate log of swath operations. Data acquired in turns was not processed unless it revealed features out of the main swath survey areas.

6.1.6.3.11 Time management during surveying

Future consideration should be given to the possibility of an additional computing technician during cruises where large surveys over 16 hours are included.

6.1.6.3.12 Line File and Survey Information

Line Data files have been included with the end of cruise deliverables:

\Ship_System\Acoustics\EM-120\Line Info\

These files contain useful data on each of the lines generated during this cruise and can be used to cross-reference data logged in the event logger.

```
StartTime 20111103 40717130
StopTime  20111103 40729130
FirstPing  1  LastPing 1 NoPings 1
MinDepth  5883 MaxDepth 6044 AvgDepth 5990
NoBeams  16  NoValid 16
TotalCoverage 0.00 AverageSwath 1265.92
MaxAcross  658  MinAcross -607
#Statistical info for positions
StartTime 20111103 40717130
StopTime  20111103 40729130
NoPos  13
TotalDist  101
AvgSpeed  8.47  AvgTime 0.00
LineHeading  308.38
FirstLat  -599947830 FirstLong 145447505
LastLat   -599956966 LastLong  145451623
MinLat    -599956966 MinLong   145447505
MaxLat    -599947830 MaxLong   145451623
```

6.1.6.3.13 Planned Swath Survey

During JC066 we conducted around 70 hours of dedicated surveying:

Coral Seamount

Station :	JC66-004-011
Date:	11311
Survey Duration:	08:00 – 01:09 – 17 hours

Melville Bank

Station: JC66-005-002
Date: 11319
Survey Duration: 12:23 – 02:30 – 14 hours

Middle of What Seamount

Station: JC066-006-005
Date: 11322
Survey Duration: 16:00 – 04:00* Estimate – 12 hours

Sapmer Seamount

Station: JC066-007-011
Date: 11341
Survey Duration: 03:43 – 15:00 - 12.5 hours

Atlantis Bank

Station:
Date:
Survey Duration: 18 hours

6.1.6.4 SBP120

6.1.6.4.1 Overview

Sub bottom profilers work on the same principle as simple echosounders, but use much lower frequency acoustic energy. The acoustic pulses penetrate below the seabed and into the sediment. Returning echoes from sub bottom features such as geological stratas or buried material create a trace on the screen in the main lab. JC066 was the first attempt to use this system on Sea Mounts. We have had great success from this system in the North Atlantic and in abysaal or flat areas.

Whilst good data was gathered in and around Canyons this method of surveying is usually thwarted by rugged terrain or seabed compositions of gravel/boulders/rock.

6.1.6.4.2 System Specification

A copy of the EM710 System Specification is included in:
/Documentation/

6.1.6.4.3 Data Quality

We found that whilst operating on or in the vicinity of the seamounts the SBP120 performance was degraded by the very steep and irregular terrain as would be expected from such a system.

We were only able to obtain a small amount of penetration on some of the seamounts. Generally this showed a shallow amount of service with some strong reflectors. Attempts to core these areas were not very fruitful and generally resulted in a handful of sediment with dead coral. Having spoken to one of the scientists we believe that coral in the sediment may also be "breaking" up the sound before hitting the solid bedrock.

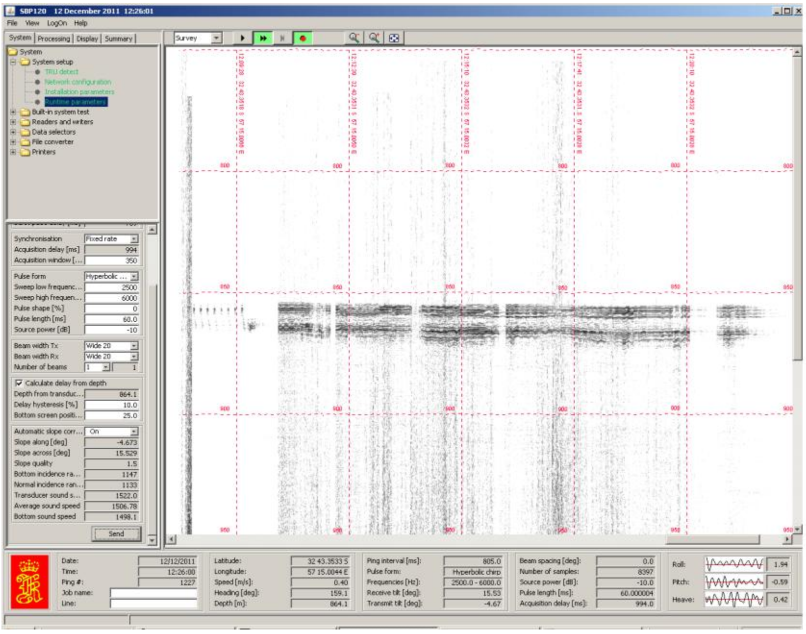


Figure 74. SBP profile from seamount showing minimal penetration of seabed.

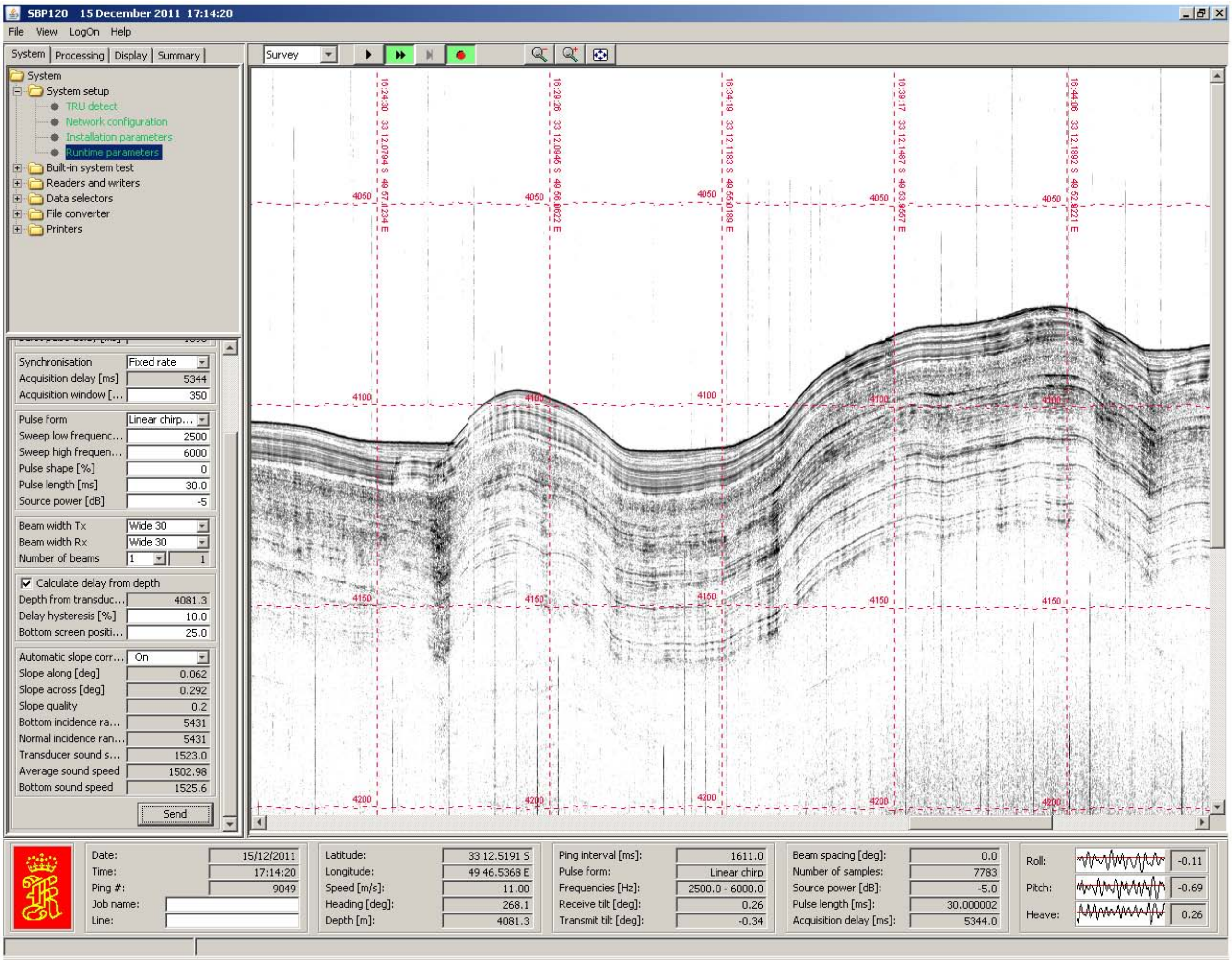


Figure 75. SBP Penetration off the sea mounts and during transit were greatly improved.

6.1.6.4.4 Card Problems

A recurrence of the 2010 card issue on the SBP120 was witnessed. The Online Monitor routinely showed a read light for Card 8 although the channels remained OK.

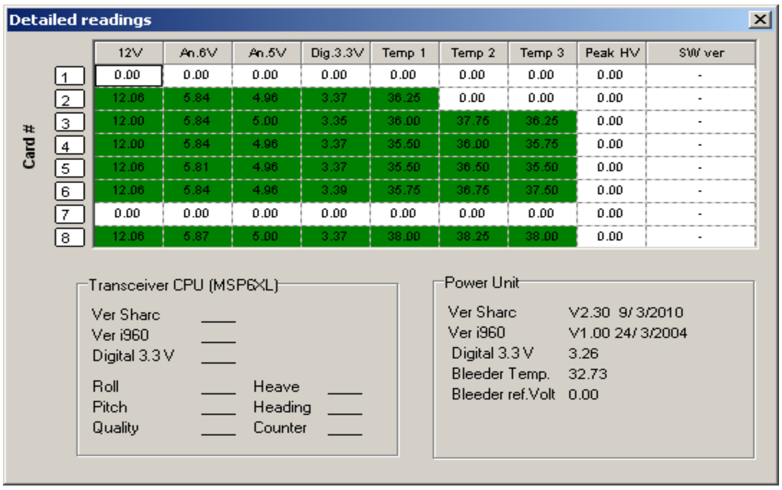


Figure 76. Display showing occurrence of card problem.

6.1.6.5 EM710

6.1.6.5.1 Overview

For the majority of JC066/67 the minimum depth was at the operational extremities of the EM710 or the terrain changed so quickly that surveying with the EM710 would have been confined to very small areas at the top of the seamounts. The Norwegian vessel that acquired SWATH for portions of these seamounts used a modified Em710 that was capable of operating down to around 1500m. This system was mounted on the vessels drop keel similar to the James Cook's. The James Cook's EM710 transducer is mounted on the port drop keel with the ADCP75/150khz transducers. The two ADCP's were calibrated in the hull flush configuration and we were asked not to alter the port keel for the duration of the cruise.

Where we encountered depths shallow enough to use the EM710 at the Melville Seamount, the sea state was upwards of 6/7 and causing issues with the data quality of the Em120 and severely hampering EM710 data acquisition in the hull flush configuration. If we had been able to extend the keel we would have been able to get better data quality.

No usable data was acquired during this cruise

6.1.6.5.2 System Specification

A copy of the EM710 System Specification is included in:
/Documentation/

6.1.6.6 Multi-beam Data Processing and Charting

6.1.6.6.1 Olex

6.1.6.6.1.1 3d Mapping

Our version of Olex has a license to enable 3 dimensionally plotting the ROV/Beacon position on acquired. This setup was very useful when surveying on the seamounts.

A Serial NMEA output has been setup from the USBL to Olex system

Protocol: PSIMSSB
Port: NCU Port 5B
Baud: 9600 8-N-1

6.1.6.6.1.2 Data Cleaning

Once multibeam data has been acquired using Olex it is necessary to clean the data and remove spikes. This is preformed using the "Remove Suspicious Depths" option and can take a long time depending on the size of the survey area.

6.1.6.6.1.3 Olex and Data Telegrams from the EM120

Even when the EM120 is NOT logging the data telegram is still sent to the olex system. This presents some issues:

1. Logging data in waters where we have no permission to log. Maintenance of the EM120 or just pinging for depth whilst steaming will still result in data being sent and logged to the olex system. You must turn off the multi-beam "calculate" option if you do not wish to log data.

2. Once we had surveyed a sea mount we turned off the calculate multi-beam option whilst still using the EM120 centre beam to give us an accurate depth. Where the multibeam processing option was accidentally left on and Olex processed depths for the vessel whilst on station we ended up with a lot of spikes and bad data.

6.1.6.6.1.4 Data Download Restrictions

THE PI HAS REQUESTED THAT DATA ACQUIRED FROM THIS CRUISE AND STORED IN OLEX IS NOT MADE AVAILABLE FOR DOWNLOAD TO ANY OTHE SCIENTIFIC PARTY FOR THE NEXT 3 YEARS AS MULTIBEAM OF THE SEAMOUNTS FORMS PART OF A PARTICPANTS MASTERS

6.1.6.6.2 Caris

6.1.6.6.2.1 Overview

The SST processed the swath data acquired during the EM120 surveys using HIPS and SIPS version 7,0,1,0 Service Pack 1. Data quality was very good and required only standard cleaning. A number of A0 charts were produced for ROV dive planning.

6.1.6.6.2.2 Data Deliverables

The following projects were created and can be found on the end of cruise deliverables:

Coral Seamount Processing

Processing Time:	6 hours
Folder:	\Ship_Systems\Acoustics\EM-120\Processed\Coral
Project:	\Ship_Systems\Acoustics\EM-120\Processed\Coral\Project\
Field Sheets:	\Ship_Systems\Acoustics\EM-120\Processed\Coral\FieldSheet
Session Files:	\Ship_Systems\Acoustics\EM-120\Processed\Coral\Session\

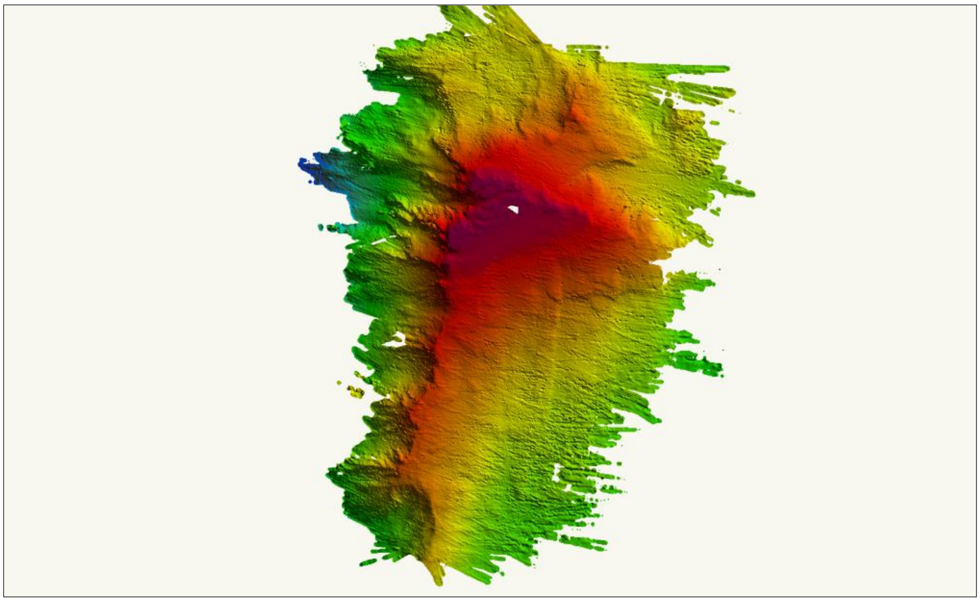


Figure 77. Coral seamount geophysical map created in Caris (L. Rolley).

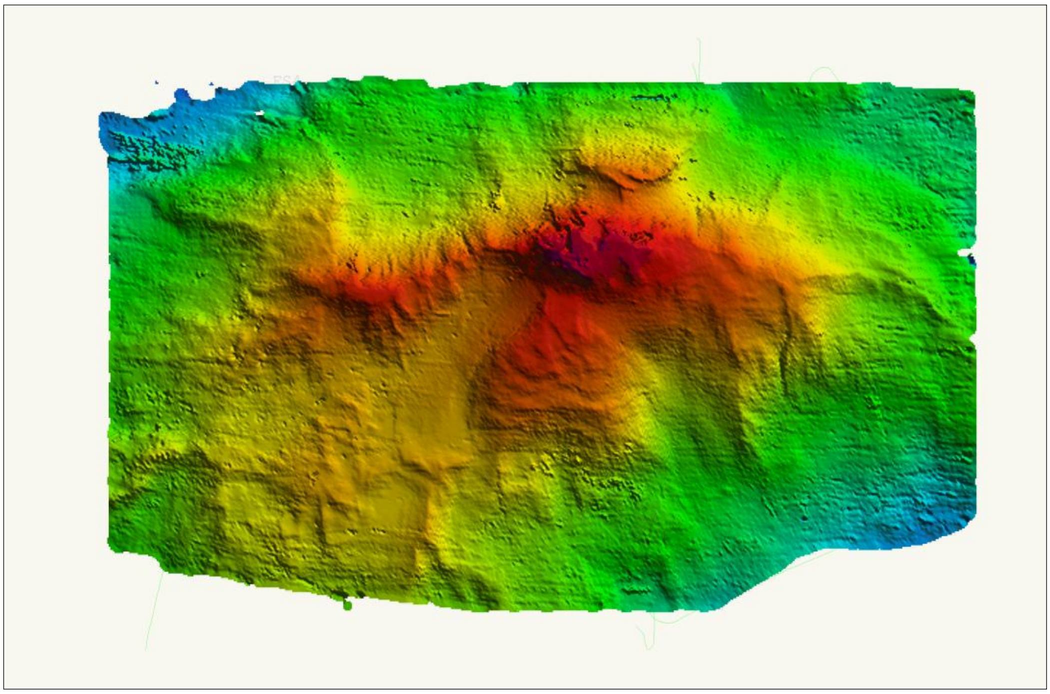


Figure 78. Melville Bank geophysical map created using Caris (L Rolley).

Melville Seamount Data Processing

Processing Time:	5 hours
Folder:	\Ship_Systems\Acoustics\EM-120\Processed\Melville
Project:	\Ship_Systems\Acoustics\EM-120\Processed\
Field Sheets:	\Ship_Systems\Acoustics\EM-120\Processed\Fieldsheets
Session Files:	\Ship_Systems\Acoustics\EM-120\Processed\Session

Middle of What Seamount Data Processing

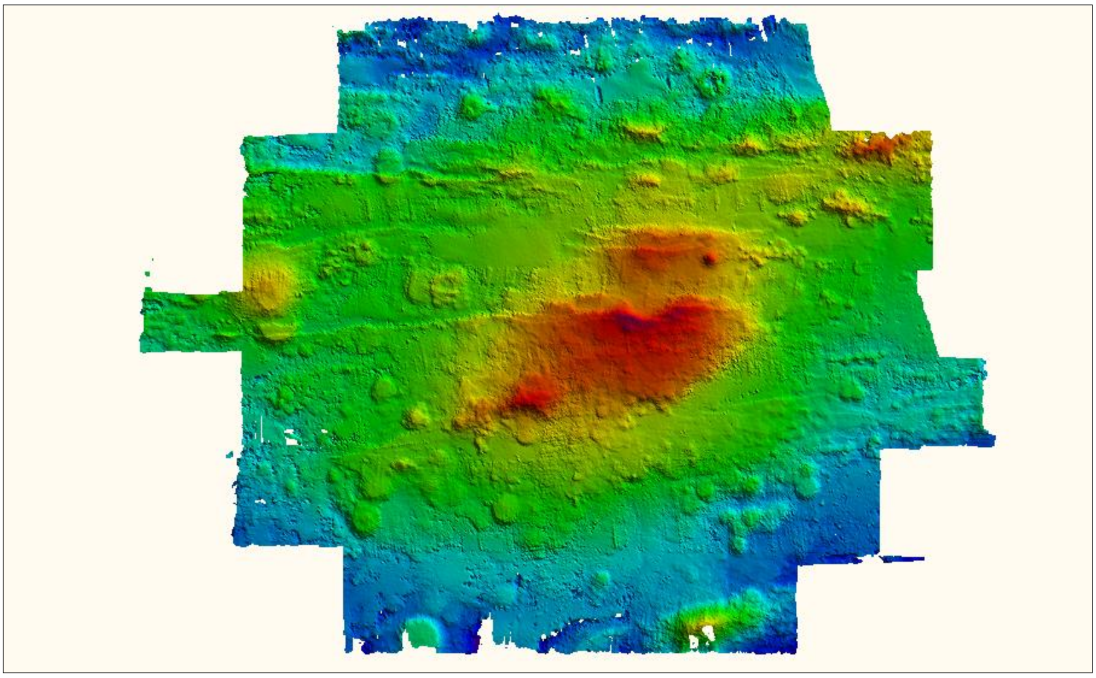


Figure 79. Middle of What Seamount geophysical map created using Caris (L Rolley).

Processing Time:	3 hours
Folder:	\Ship_Systems\Acoustics\EM-120\Processed\middleofwhat
Project:	\Ship_Systems\Acoustics\EM-120\Processed\middleofwhat\Project
Field Sheets:	\Ship_Systems\Acoustics\EM-120\Processed\middleofwhat\Fieldshets
Session Files:	\Ship_Systems\Acoustics\EM-120\Processed\middleofwhat\Session

Sapmer Seamount Data Processing

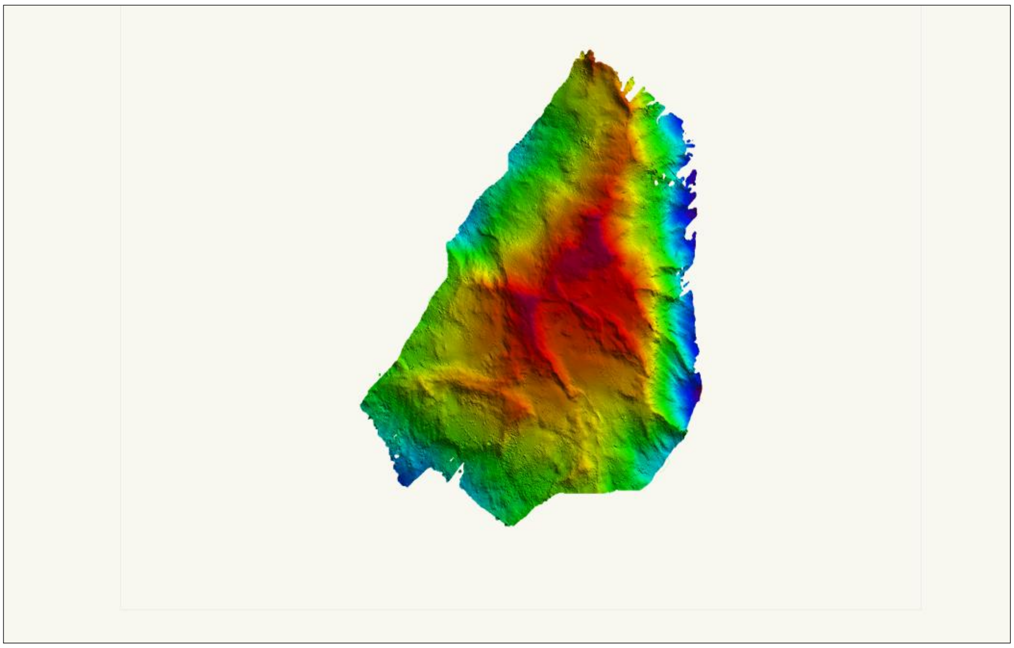


Figure 80. Sapmer Bank geophysical map created using Caris (L Rolley).

Processing Time:	4 hours
Folder:	\Ship_Systems\Acoustics\EM-120\Processed\Sapmer
Project:	\Ship_Systems\Acoustics\EM-120\Processed\Sapmer\Project\
Field Sheets:	\Ship_Systems\Acoustics\EM-120\Processed\Sapmer\Fieldsheets\
Session Files:	\Ship_Systems\Acoustics\EM-120\Processed\Sapmer\Session\

Atlantis Bank Data Processing

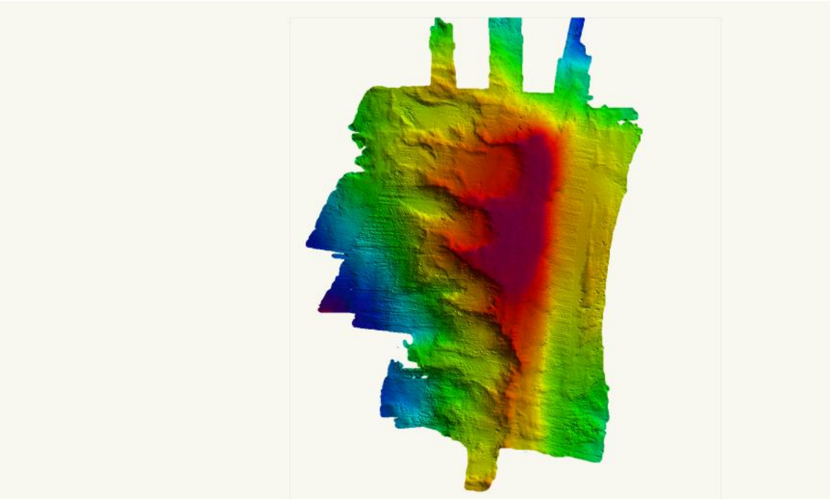


Figure 81. Atlantis Bank geophysical map created using Caris (L Rolley).

Processing Time:	4 hours
Folder:	\Ship_Systems\Acoustics\EM-120\Processed\Atlantis
Project:	\Ship_Systems\Acoustics\EM-120\Processed\Atlantis\Project\
Field Sheets:	\Ship_Systems\Acoustics\EM-120\Processed\Atlantis\Fieldsheets
Session Files:	\Ship_Systems\Acoustics\EM-120\Processed\Atlantis\Session\

Crashes

Hips and Sips Crashed periodically during data processing. The most common time for crashed occurred if the *3d view* was opened whilst the *subset editor* was also open. In this instance a runtime error was generated and the program needed to be restarted.

Vessel Configuration File

The vessel configuration file used to process the swath data is included on the cruise disk. If this file is used in future processing please be aware that zero offsets are used as the x,y,z offsets for GPS and transducer locations are set-up in the system and do not need to be re-entered in Caris.

Folder: \Ship_Systems\Acoustics\EM-120\Processed\Vessel Config\

3d Videos

A number of bathymetry "Fly Throughs" were generated using Caris

These are included in the folder:

\Ship_Systems\Acoustics\EM-120\Fly Throughs\

Files

Middleofwhat.avi
Melville.avi
sampervideo1.avi
sampervideo2.avi
atlantis1.avi

atlantis2.avi

6.1.6.6.3 QlandKarte

6.1.6.6.3.1 Overview

QlandKarte GT: 1.2.2
QT Library: 4.7.4

Tests were made with various software to plot the events logged in the event logger onto the multibeam data acquired from the EM120

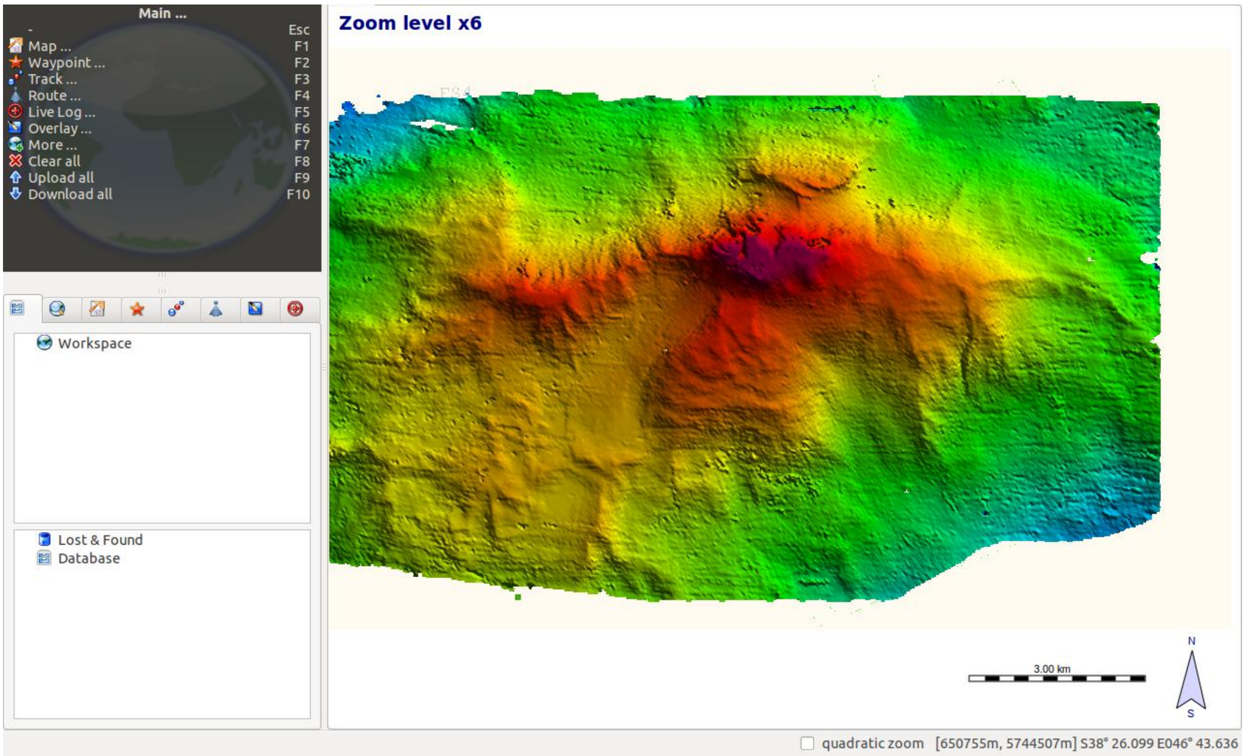


Figure 82. QlandKarte showing swath acquired at Melville.

Caris does not incorporate an easy mechanism for adding way-points to multi-beam data even using its export tools and data presentation packages such as Plot. GeoTiff's were produced for each of the survey locations and loaded into QlandKarte (available free under Ubuntu).

Load Map > Select Map

Once imported way points, routes and measurements could be simply added by the user. Using this software we were able to plot HYBIS/ROV Dives on the SWATH.

Waypoint > Add Waypoint

An export page was created on the Event logger that allowed USBL positions for each day to be exported into QlandKarte using the GPX format

More Data is available in GPX format here:

http://www.topografix.com/gpx.asp

The experimental script to produce these reports is:

c:/inetpub/wwwroot/ListShortx.asp

The script was modified depending on the requirements and is only at the experimental stage.

The File Format produced by this report and supportable by QlandKart is the GPS format, which can also be created in notepad:

Waypoints:

```
<wpt lon="49.64905167" lat="-37.78430176">
 <time>2011-12-04T17:23:49Z</time>
 <name> 2 small old extinct chimneys with coral(?) on them</name>
 <sym>Pin, Blue</sym>
</wpt>
```

Track plot:

```
<name>HYBIS Dive 3</name>
<extensions>
        <gpxx:TrackExtension>
        <gpxx:DisplayColor>DarkBlue</gpxx:DisplayColor>
       </gpxx:TrackExtension>
</extensions>
<trkseg>
       <trkpt lon="49.64848" lat="-37.78422">
       <time>27/11/2011 04:55:00</time>
       </trkpt>
       <trkpt lon="49.64853" lat="-37.78416">
       <time>27/11/2011 04:57:00</time>
       </trkpt>
       <trkpt lon="49.64856" lat="-37.78412">
       <time>27/11/2011 04:58:00</time>
       </trkpt>
       <trkpt lon="49.64862" lat="-37.78409">
       <time>27/11/2011 04:59:00</time>
       </trkpt>
       <trkpt lon="49.64868" lat="-37.7841">
       <time>27/11/2011 05:00:00</time>
       </trkpt>
       <trkpt lon="49.64873" lat="-37.78411">
       <time>27/11/2011 05:01:00</time>
       </trkpt>
</trkseg>
```

I would recommend installing QlandKarte on a spare Linux system and using it display data from the swath and plot data. Qlankarte also has the ability to take a NMEA input so that the ship's or ROV's position can be plotted on the swath.

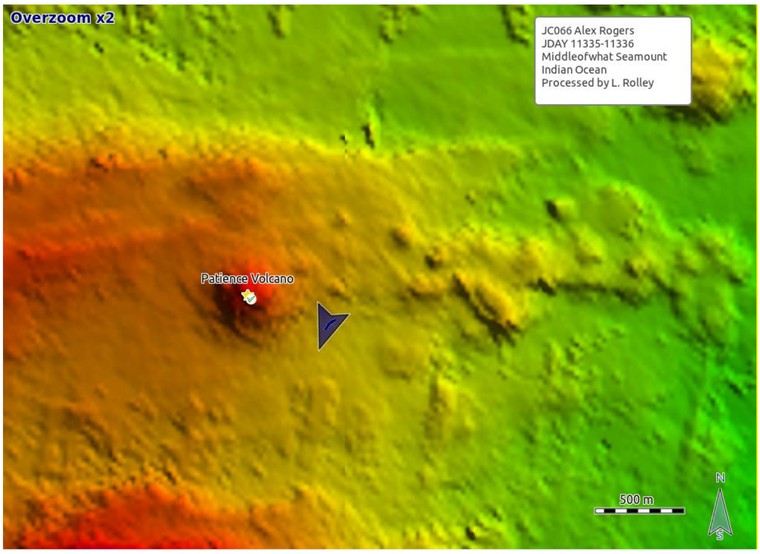


Figure 83. This image shows a waypoint added to the swath indicating Figure XX "Patience volcano". The blue arrow indicates the ships position obtained from an NMEA feed from the Splitter in the main lab. Top right shows a text box label. Bottom left is a scale bar and North direction indicator.

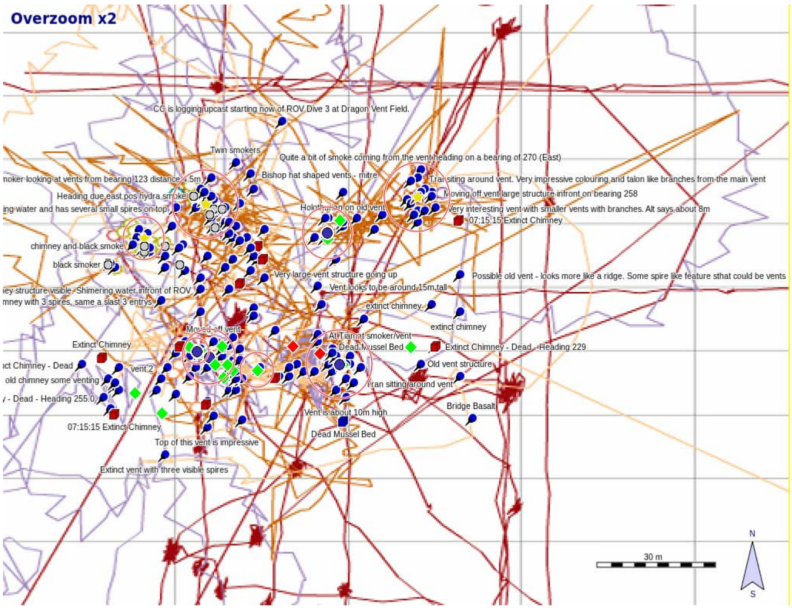


Figure 84. Example of a chart produced using the events logged in the event logger and then overlaid on the a track plot for the USBL/Ship position to show the position of vents and features during JC067.

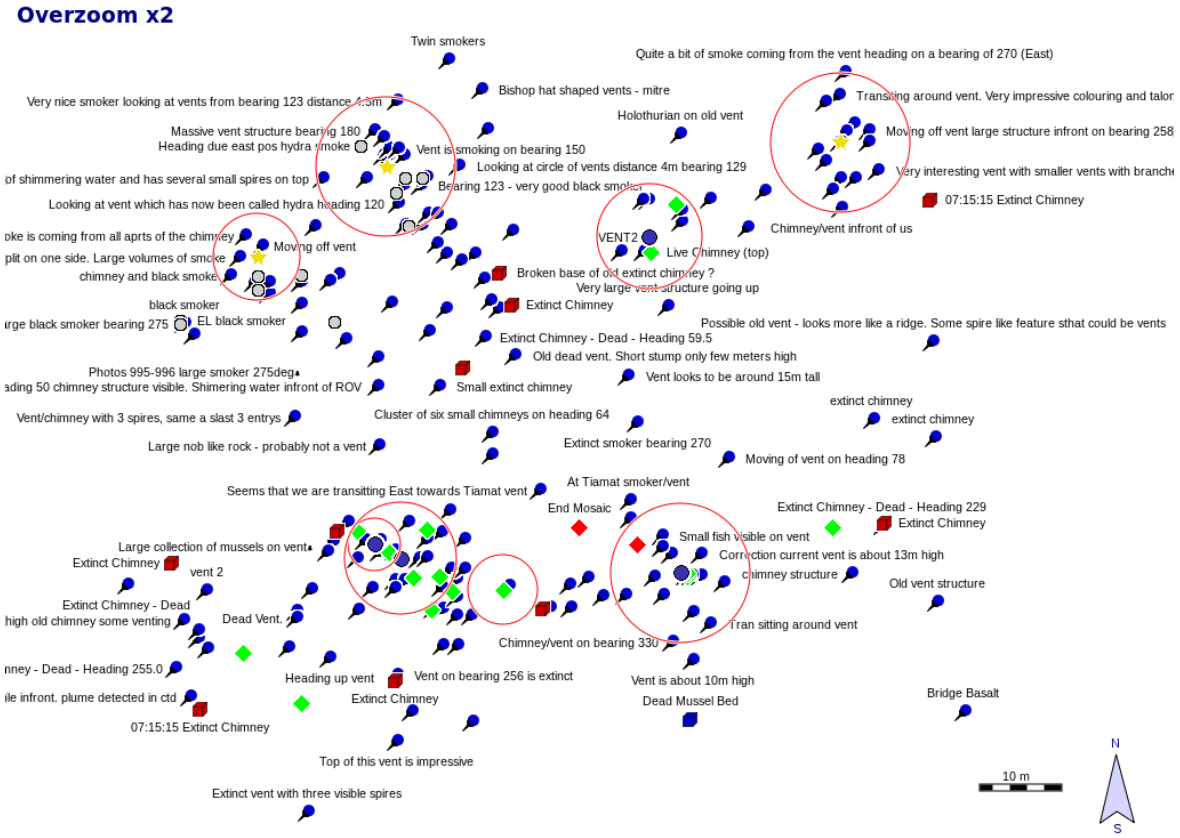


Figure 85. Mapping of vents during JC067.

This feature enabled us to accurately plot the vent field in JC067 and was very successful in the absence of a ROV mounted swath unit

6.1.6.7 EA600

6.1.6.7.1 Overview

The EA600 preformed within specification during the cruise. A number of issues were encountered when operating on some of the more complex seamount terrain. Multi-pathing of data resulted in no reasonable bottom locks especially on the steep slopes that were a common characteristic of the seamounts. On seamounts where the depth often changed drastically we were constantly adjusting power and gating ranges to ensure that we obtained the best bottom lock.

6.1.6.7.2 System Specification

A copy of the EA600 System Specification is included in:

\Documentation\EA600\

6.1.6.7.3 Data Logging

The EA600 is logged to the techsas and depth data can be found in netcdf files:

DATE RAGE-EA600-EA600_JC1.EA600

6.1.6.8 EK60

6.1.6.8.1 Overview

The EK60 was used throughout JC066/JC067 for fisheries applications

6.1.6.8.2 System Specification

A copy of the EK60 System Specification is included in:
/Documentation/EK60/

6.1.6.8.3 Calibration

Calibration of the EK60 was carried out shortly after departing from Cape Town harbour on the 7/11/11 (33° 53.71226 S, 18° 14.712 E). The tungsten carbide sphere was successfully deployed and positioned under the vessel's five permanently installed transducers (18, 38, 70, 120 and 200 kHz). The software programs LOBE and Echoview were used to process the transducers' calibration parameters.

6.1.6.8.3.1 Material and Methods

Calibration of the five permanently installed EK60 echosounders on the drop keel of the RRS James Cook was carried out shortly after departing Cape Town harbour (33° 53.712 S, 18° 14.712 E) from 16:00 GMT to 23:00 GMT. Weather conditions remained good throughout. Three monofilament lines attached to electronic winches and fishing poles were set up (one port, two starboard). Whilst the ship was drifting, a rope with the port side line attached was dropped over the bow in order to attach the calibration sphere to all three lines at the starboard side. Once the port line was secured the ship kept on station (JC066 station 2) with dynamic positioning utilising the tunnel thrusters only - the azimuth thruster was kept retracted at all times during this calibration procedure.

Positioning the sphere level with the drop keel on the starboard side prior to being lowered under the seawater surface was found to be critical in terms of efficiency. This was achieved accurately because a person stood directly above this position (aft side of starboard lifeboat) and communicated effectively to the two starboard winch handlers. 35 full rotations (by hand) were paid out of each starboard winch followed by 15 full rotations pulled in from the port side winch. This was sufficient to hold the sphere in the beam of the 18 kHz transducer and in an optimal position relative to the near field ranges (Table 16); finer adjustments were made from the main laboratory using the electronic winch system. The CTD profile from the nearby station 1 (33° 53.774 S, 18° 14.679 E) was used to calculate sound velocity and this was entered into MATLAB code supplied by supplied by Dr David Demer (Advanced Survey Technology Division, Southwest Fisheries Science Center, USA) to calculate the theoretical TS values of the sphere for each frequency.

Table 16. The frequency, physical diameter and corresponding near field range of each transducer. Optimum distance from the transducer outside of the near field range estimated from Ropt = 2d2 f0 / c. d is the diameter of the transducer face, f is the echosounder frequency and c is the sound speed (1427.5 ms-1).

Frequency (kHz)	Diameter (m)	Near field range (m)
18	0.625	9.85
38	0.48	12.27
70	0.28	7.69
120	0.18	5.45
200	0.12	4.04

LOBE software (included within the ER60 software) is used for calibration. Data were replayed using LOBE and post-processed using Echoview to obtain calibration parameter estimates.

6.1.6.8.3.2 Calibration Results

The theoretical TS values are shown in Table 17.

Table 17. Theoretical target strength of the tungsten carbide sphere at each frequency (sound speed of 1427.5 ms^{-1}). Calculated using MATLAB code supplied by Dr David Demer.

Frequency (kHz)	Target Strength (dB m2)
18	-43.3
38	-41.8
70	-40.2
120	-40.3
200	-39.2

Calibration parameter estimates (from LOBE and Echoview) are given in Table 18.

Table 18. Calibration parameter estimates for the RRS James Cook EK60 system determined by post-processing the calibration exercise from Cape Town bay.

Frequency (kHz)	**18**	**38**	**70**	**120**	**200**
Calibration Sphere Range (m)	29.1	28.6	28.4	28.7	28.2
Gain (dB)	23.22	23.87	21.8	26.16	24.86
s_A correction (dB)	-1.19	-0.6	0	-0.63	-0.38
2-way beam angle (dB re 1 steradian)	-17.3	-21	-16.8	-20.9	-20.9
Angle sensitivity Along (deg)	13.9	21.9	13	23	23
Athwart (deg)	13.9	21.9	13	23	23
Angle offset Along (deg)	-0.07	-0.3	0	0.07	0.21
Athwart (deg)	0.06	-0.6	0	0.1	0.24
3 dB beam width Along (deg)	11.21	7.06	11	6.64	6.7
Athwart (deg)	11.26	7.22	11	6.65	6.73
Power (W)	2000	2000	800	1000	1000
Pulse duration (µs)	1024	1024	1024	1024	1024
Alpha (dB/km)	2.2	8.5	22.2	41	60.7
Bandwidth (kHz)	1.57	2.43	2.86	3.03	3.09
Serial numbers Transducer	2067	30637	130	345	313
GPT	102-203321	102-202585	102-202586	102-202587	102-202588

6.1.6.8.3.3 Discussion

LOBE software (included within the ER60 software) is used for calibration and because it shows which part of the beam the sphere has been detected in it is critical that this real time information is visible for each transducer. The major problem with this software on this system is that only one transducer (in this case the 18 kHz) could be viewed, therefore, we could only be sure that one transducer had both a sufficient spread of single target detections throughout the beam as well as on-axis hits which are required for an especially robust calibration. Without these data, what this calibration provides is still useful and accurate, but it could have been greatly improved.

A potential and as yet unknown problem with the 70 kHz is flagged – it received significantly fewer single target detections relative to the other transducers – figure 1 shows the number of hits received compared to the 120 kHz. Also, the power setting could not be increased from 800 W. This requires further investigation.

Note that the drop keel was not deployed as we would not be deploying it during data acquisition.

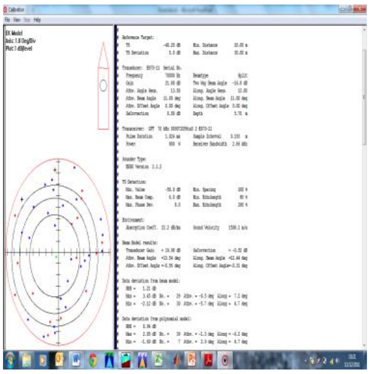
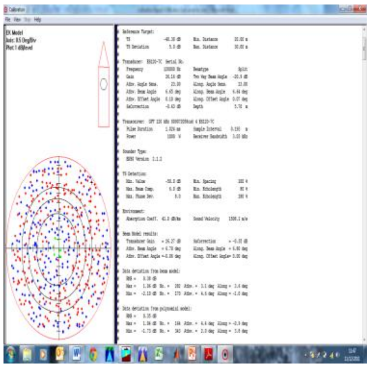
 

Figure 86. Single target detections of the 70 kHz transducer (left) and the 120 kHz transducer (right) from calibration of the EK60 echosounders on the RRS *James Cook*. This comparative example (the remaining three transducers were similar to the 120 kHz) shows there is significantly less single target detections on the 70 kHz than the other transducers.

6.1.6.8 USBL

6.1.6.8.1 Overview

The USBL worked well during this cruise and no major problems with tracking or beacons were encountered.

6.1.6.8.2 System Specification

A copy of the USBL System Specification is included in:
/Documentation/USBL/

6.1.6.8.3 USBL Spar Sticking

The Starboard USBL Spar encountered issues during a number of deployment/recoveries during JC066. Usually this problem centred around either the light indicating the pole was extended or retracted not activating thus leaving us unaware of the state of the spar. This required the intervention of engineering staff and usually resulted in around 10-15 minutes associated investigation and rectification time. Generally this was solved by repeated attempts to extended/retract the pole.

This fault should be investigated at the earliest opportunity as failure of this spar would have severe impact on future USBL operations.

6.1.6.8.4 Spin Test and Calibration

The PI was not informed of the requirement to preform a spin test to confirm the accuracy of the USBL systems calibration. The requirement to calibrate the system had been communicated a number of times internally within NMFS as the flotation collars and weights needed to be sourced. The last email covering "Calibration Requirements - Roger's Cruise" was sent with high priority 10 days before arriving in Cape Town.

The spin test started at 7:45 and finished at 8:25 GMT on JDAY 11316. The Spin test took 40 minutes but additional time was taken manoeuvring the ROV under the vessel due to problems with their compass that had an incorrect offset. As the spin test was preformed with the ROV on the seabed and the ship rotating around the wire the test could not be deemed entirely ideal.

Sonardyne highlight the test should be directly above the beacon and the vessel rotated around the pole. The spin test showed the beacon move roughly 10-15m during the test. The PI was happy with this degree of accuracy and no calibration exercise was planned.

The system should be considered accurate to around to 15m at 1500m when using a correct Sound Speed velocity profile. This is around 1% of depth accuracy as opposed to the 0.5% that Sonardyne quote. However, the accuracy during the cruise remained quite high and we were able to accurately find the whalebone moorings previously deploy and have a very high level of repeatability.

6.1.6.8.5 Rov Tracking operations

Originally it was planned to have an Avocent screen that could show the tracking status of the beacon in the ROV van and allow the *Kiel* team to “Turn on” tracking. However, as this idea was declined by the ROV team, and it fell on the technician to ensure that tracking was turned on each time the vehicle was deployed.

6.1.6.8.6 ROV Position and DP

The HPR418BCD stream to the bridge to display beacon positions on the DP console was critical on this cruise and made Ship-ROV operations considerably easier. It was worth its weight in gold during the “Dead Vehicle” recovery on 11345 and during operations at Melville seamount where sub-sea currents often pushed deployed packages more than 500m away from the ship

One issue that was identified was when a beacon was accidentally set as a reference beacon. The positions displayed in Fusion and on the DP were considerably different. This was due to the DP system expecting the reference beacon to be static and not move. Whilst the beacon sent back “Good positions” the DP continued to display the beacon in the original position it received a fix and did not update it. Where a beacon is mounted to a mobile package please ensure that the beacon does not have the reference option selected.

Figure 87. HPR positions displayed on the DP.

6.1.6.8.7 USBL Beacons

A large number of beacons were supplied during this cruise. These beacons are listed below

<u>NMFS Beacons:</u>

<u>Super Sub Mini (MF Directional)</u>
Inventory Number: 250000098
Serial Number: 18593-004
Address: 12

Operational Summary:

Super Sub Mini (MF Directional)
Inventory Number: 250000099
Serial Number: 18592-001
Address: 06

Wideband Super Sub Mini
Inventory Number:
Serial Number:
Address: 06

Deep Platforms Beacons:

Compatt 5 Kiel
Unit ID:
Serial Number:
Address: 110

Compatt 5 Shrimp
Unit ID: 001F70
Serial Number: 263694-001
Address: 210 B38

Compatt 5 Release
Unit ID: 0001AF
Serial Number: 218897-07
Address: 107 B07

Compatt 5 Release
Unit ID: 000198
Serial Number: 218897-04
Address: 104 B06

6.1.6.8.7.1 Mounting of Beacons on Equipment

CTD and Mega Corer

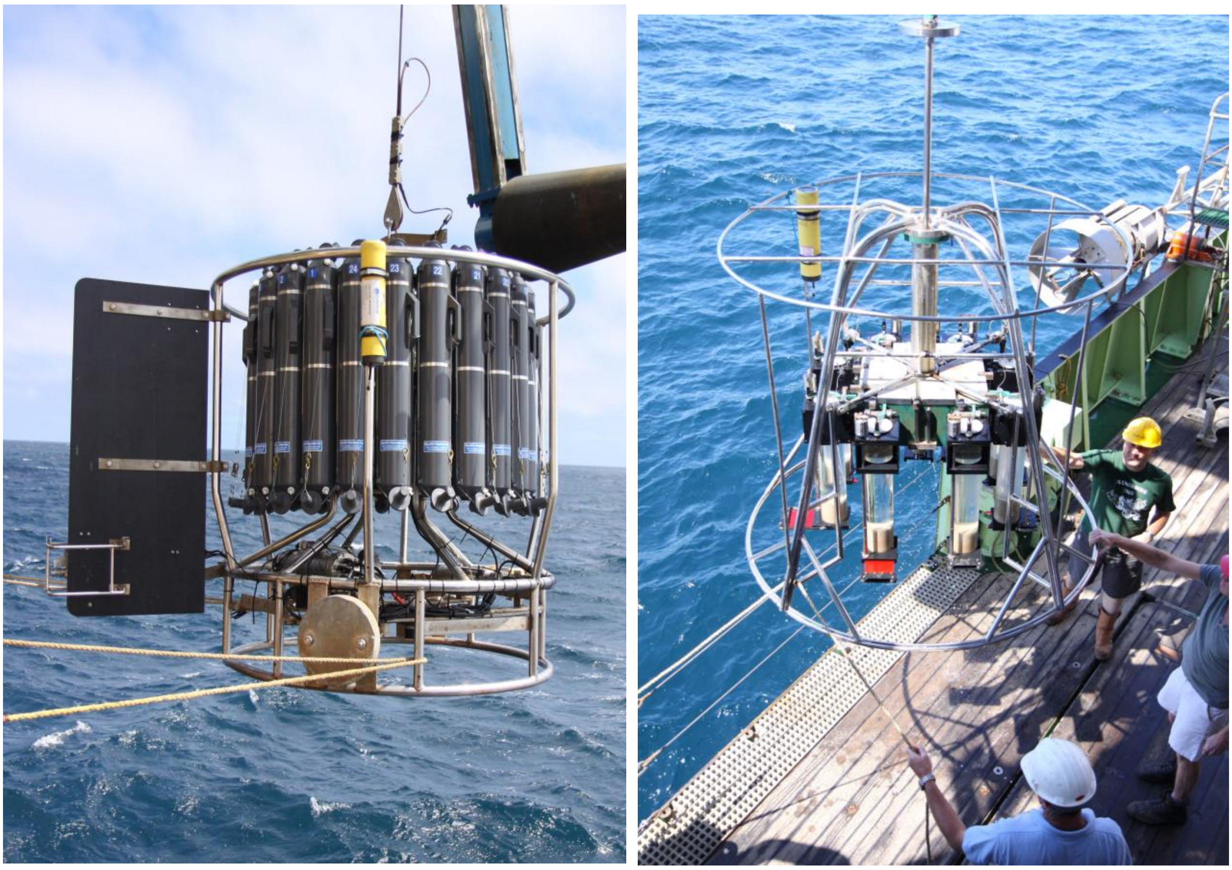


Figure 88. Photographs showing the mounting of USBL beacons on the CTD and Megacorer.


Figure 89. SHRIMP showing the mounting of the USBL system.


Figure 90. HYBIS showing the mounting of the USBL system.

6.1.6.8.7.2 Beacon Charging

Beacons were charged whenever not in use.

PLEASE BE AWARE THAT THE SUPER SUB MINI AND THE WIDEBAND MINI CHARGERS ARE NOT INTERCHANGEABLE AND SHOULD ONLY BE USED FOR THE CORREPSONDING BEACON

6.1.6.8.7.3. Problems During Operation – Jumps

During the first ROV dive and at Dragon vent site a jump of between 15 and 20m was witnessed by the ROV team. Plotting of data did not show any unusual activity and further investigation/monitoring of the system is required to identify any problems.

6.1.6.8.7.4 ROV Movement/USBL Conflict

During the initial dives the ROV team complained that the USBL was inaccurate and was moving in a different direction from which they were flying. Investigation of this problem identified that the ROV compass had a 25 degree offset value. This was corrected and tracking was found to be correct with no further problems.

6.1.6.8 ADCP 75Khz

6.1.6.8.1 Overview

The ADCP75Khz worked well throughout the cruise with no problems

6.1.6.8.2 System Specification

A copy of the ADCP 75 System Specification is included in:
/Documentation/ADCP75

6.1.6.8.3 Data Deliverables

ADCP 75Khz Data can be found in:
\Ship_Systems\Acoustics\ADCP75

6.1.6.9 ADCP 150Khz

6.1.6.9.1 Overview

The ADCP75Khz worked well throughout the cruise with no problems.

6.1.6.9.2 System Specification

A copy of the ADCP 150 System Specification is included in:
/Documentation/ADCP150

6.1.6.9.3 Data Deliverables

ADCP 150Khz Data can be found in:
\Ship_Systems\Acoustics\ADCP150

6.1.7 ROV – Ship Integrations

6.1.7.1 Video Wall

Figure 91. Photograph of the screen displays mounted in the Plot Room of RRS *James Cook* for live viewing of ROV operations.

ROV Video feeds in the main lab far exceeded the visibility of the operators in the van which was equipped with only small screens. We had a good set-up in the main lab which allowed considerable flexibility between the various operations: geo-sciences, swath and wire operations. A permanent and more practical video wall should be considered in a future refit and a similar set-up should be adopted for the new vessel.


Figure 92. Photograph showing the different screens in the Plot Room.

Configuration of the video screens was as follows:

Projector Screen

ROV Footage

LCD Screen

ROV footage – HDMI Input 4
Avocent input – HDMI Input 3
Hybis - Scart

HP Touchsmart

Avocent – HDMI Input

LCD 1

Avocent

LCD 2

Avocent

Video/BNC/FO

One of the main hurdles for distributing the video from the ROV van to the main lab was the lack of any suitable cabling.

The high def definition video feeds to the projector and recording deck had to be run using FO cables brought along by the ROV team

Running FO cable through the ship required some of the internal doors to remain open – which is not idea and also made damaging these expensive cables was a very real possibility.

6.1.7.1.1 Future considerations:

FO Link Deck/Main Lab/Hangar/bridge

A permanently installed FO link sould be considered either from the hangar to the main lab or a position on the back deck to the main lab. With more and more equipment utilising HD video this would be a good investment for the future. Chatting with STO he has said 5 FO cables would be ideal.

6.1.7.2 Kiel 6000 Ship Data String/USBL UDP broadcast

From Techsas:

The ROV team took the USBL Navigation data directly from TECHSAS's UDP broadcast:

Module: Fusion_USBL_JC1
Port: 19005

Event Logger Kiel Output

A specific string was developed for the Kiel ROV team so that they could receive a specific message structure.

The stream was produced developed as part of the Event Logger data capture application and I broadcast on the network via UDP.

Destination: 192.168.58.10
Port: 440
Rate 1.5Hz

Example Data Stream:

$SHIPDATA,JC066,Transit_to_Atlantis,32:44.09770,S,057:18.08516,E,021.45,0.000000,04.200,6.63,,,09/12/11,03:08:36.919,20.235800,35.49580,58.687200,11.237000,-02.35,-00.79,+00.32

$SHIPDATA

[0] $SHIPDATA
[1] Cruise (Mission)
[2] Dive/Event ID
[3] Lat
[4] NS
[5] Lon
[6] EW
[7] Heading
[8] Depth
[9] Course
[10] Speed
[11] Course Through Water
[12] Speed Through Water
[13] GPS Date
[14] GPS Time
[15] TSG Temperature
[16] TSG Salinity
[17] Wind Direction
[18] Wind Speed
[19] ETA Lat
[20] ETA N/S

[21] ETA lon
[22] ETA E/W

6.1.7.3 ROV Container Connection Overview

The following scientific connections were required to integrate the ROV van with the ship

Ethernet (Internet)
Ethernet (Phone)
Ethernet (Avocent TX)
BNC – Video Feed * Replaced by FO
Fibre Optic – Projector Main Lab
Fibre Optic – Recording Deck

6.1.7.3.1 Display of Ship Systems in the ROV Van

The ROV team was informed of the benefits of including an avocent receiver in their control van so that they could view and control many of the ship fitted science systems. However, they rejected this idea on grounds of space and the need to install an extra cat5 cable. My main concern was the *Kiel* Navigation software that took a NMEA feed from our USBL system. If the USBL failed to track the beacon or crashed the *Kiel* Navigation system would not highlight this and the last position would still display on their navigation system. If they were able to see the USBL system they would be able to see the quality of the fixes.

6.1.7.3.2 Broadcast of ROV Footage using Avocent

6.1.7.3.2.1 Kiel Navigation

An avocent TX unit was installed in *Kiel* van so we could broadcast the *Kiel* Navigation screen around the ship. However, the resolution of the *Kiel* Navigation screen was not compatible with any of the screens on-board and we had to install one of the touchscreen PC's at the plot that supported the broadcast resolution. Because of the resolution of the system we were unable to show the ROV Navigation software on the bridge. However, I believe this was beneficial as the Ranger USBL display to the bridge showed the ROV position and was significantly easier to understand than the Kiel nav Screen that was cluttered and deficient in some area.

6.1.7.3.2.2 ROV Video Wall broadcast

The video was broadcast from an Avocent TX unit in the main lab with a Dvi connection from a HD Link supplied by the Rov Team. This enabled the bridge team to see footage from the ROV when the vessel was sat on DP for a number of hours. However, we encountered a few issues. Where multiple avocent displays of different screen sizes were used to display this feed the screens would flicker occasionally. We limited the number of screens displaying the ROV feed to 4 and this solved the problem.

6.1.7.3.2.3 Kiel 6000 PC's

The Kiel ROV Had the following PC's Configured

kiel-telm	192.168.58.10
kiel-navpc	192.168.58.30
kiel-rov	192.168.58.20

6.1.7.3.2.4 Communications

Communications between the main lab and ROV container during the trials cruise was problematic. The walkie-talkies did not work well between the main lab and the van and anyone who wanted to contact the van had to leave the main lab so that the radios would work. The ROV team was not happy with science communications conducted via the phone, which they wanted open in the event of an emergency. This was after not wanting a phone installed in the van in the first place. The solution was to use two Linux Laptops configured with Empathy chat application.

*THE PASSWORD FOR RVS ACCOUNT WAS CHANGED FROM THE STANDARD RVS PASSWORD TO **PASSWORD***

Empathy allows chat over the local area network unlike many available chat applications that communicate via the internet. A laptop operating on the wireless network was used by the scientist at the plot viewing the video wall. The second small Splitter Eeepc was setup in the van to use the wireless network, which is available on the back deck. This setup worked intermittantly and was not an elegant solution and distracted scientists from looking at the video feeds. Because of the nature of the van and the large coil of wire, wifi drop-outs were more common and very frustrating. However, very few options were open to us as the ROV team did not want talking in the van so voice communication had to be ruled out.

6.1.7.3.2.5 Future Communications Consideration if operating with a third party ROV

The ISIS setup which is ultimately based on the Jason setup allows a much more meshed and interactive ROV-Science interface and permits much better reactive operation and utilisation of dive time.

- Clear comms

  Headsets enabling communications between van-main lab

  As used by scientists on French and Irish vessels

- No Comms

  One suggestion was to operate the ROV as if it was a manned submersible with two observers who have no communications with the lab.

  However, this distracted from the benefits of operating an ROV

- More Scientists in the van

  Not ideal

6.1.8 Power outages

During the cruise we experienced a number of issues with the power in the main lab

6.1.8.1 Clean Power Loss

Loss of clean power in the main lab occurred at the following times:

322 17:35:16 – 17:40:37
327 12:04:27 – 12:45:33

During these failures we were advised that too many devices were plugged into the clean supply and that scientific gear should be split evenly between the clean and dirty sockets.

6.1.8.2 Dirty Supply Power loss and Problems

6.1.8.2.1 Loss of Dirty Supply

After the failure of the clean supply the devices in the lab were subsequently split between clean/dirty.

In the following days we experienced a number of blackouts on the “dirty” supply ,which were attributed to “overloading”.

However, loss of power also occurred when only minimal devices were plugged into the dirty supply and eventually the breaker was changed and not furtehr problems were experienced.

Whilst the loss of the “dirty” power to the main lab did no affect the bulk of ship fitted system it did cause a number of issues with the scientific equipment which had been swapped to the “dirty” after the failure of the clean.

This included the recording deck for the ROV footage.

6.1.8.2.2 Labelling of “Dirty” Sockets

Labelling of sockets as dirty with red “dirty” labels has caused some confusion and the engineers are looking at removing this labelling as it suggests that the power status is not as good as the “clean” supply

Scientists unwillingness to plug equipment into a supply labelled dirty may have contributed to overloading the clean supply.

6.1.8.3 Corruption of ROV Footage

During the power failures the scientific part were recording ROV footage on video deck. When the power failed the current video file that was being written to disk became corrupted.

JC066: 1 Hour Data Loss due to corruption
JC067: 2 Hours Data Loss (Roughly 10% of the ROV footage acquired during JC067)

6.1.8.4 Loss of Data and Time

Ships systems were severely affected by the clean power failure. Data loss was incurred during the power loss included:

Science Systems in main Lab

- EM120 Multi-beam Echo-sounder

PC located in Main Lab.

- SBP120 Sub Bottom Profiler

Operator PC located in Main Lab.

- EK60 Fisheries Echosounder

No GPS Data and corruption of current file.

- Log_chf
- ADCP 75Khz
- ADCP150 Khz
- Waterfall PC (Event logger DB)
- Gravity Meter
- Clam – Winch System

PC Located in main lab.

- USBL Acoustic Log File

PC/NCU located in main rack.

- POSMV Data

NMEA Splitter for POSMV data located in Kongsberg Rack.

- Surfmet Data

PC located in Kongberg Rack.

- Level-C Streams

EM120/EM710 Files are saved in 120 minute chunks (unless manually changed). The SBP120 writes files in 50MB chunks which could be about 30 minutes of data. The ADCPs write daily files. Both files could be reduced in size to minimise the potential data loss. However, this is a careful balance and making thousand of files is not ideal when it comes to the processing stage. If an acoustic file was corrupted and data lost for this period we are looking at additional costs in fuel and time to retrace our steps and re-survey.

6.1.8.5 Systems Recovery

In a recent report for the engineering staff we highlighted that it would take between 20-30 minutes to return all systems to an operational state in the event of a clean shutdown and restart. In the case of an unscheduled shut-down, especially one during the early hours of the morning additional delays are incurred locating staff (Duty Engineer, ETO, SST), investigating the failure and subsequent restart of power. These additional considerations meant that downtime of the systems described below was around 30 minutes before normal operation was restored and operations could continue. Obviously uncontrolled shut-down of systems presents us with a number of serious data related issues as some of the systems are not "happy" when power is removed suddenly – these implications are discussed in the next section.

Using UPS for all the systems that require power and which would be affected by sudden power loss is probably not cost effective and spacing/ventilation would need to be considered. Where a system is identified as critical in the cruise agreement it may be worth having a UPS installed in the Kongsberg rack from which this system can draw power. To some extent this would safeguard data and allow the technician to cleanly shutdown the machine in the event of power loss and prevent corruption of data files.

6.1.8.5.1 Summary of System Reboot times

System	Restart Time	Notes
EM120	4:00	Reboot/Start Logging
EM710	3:00	Reboot/Start Logging
SBP120 BF	3:00	
SBP120 Opertator Station	4:00	
EA600	3:00	
SSU	1:00	
Surfmet	2:00	
Touchscreen Displays	10:00	
Clam	3:00	
USBL	3:00	
Splitter PC	5:00 – 7:00	
Avocent	10:00	When power is removed without warning the system takes significantly longer to reboot
Caris PC	2:00	
Terminal Room PC	2:00	

Internet PC Terminal	2:00	
Internet PC Darkroom	2:00	
XBT/SVP Machine	2:00	
ADCP75	6:00	The Dell Rack PC's sometimes react slower when rebooted after an unclean shutdown
ADCP150	6:00	The Dell Rack PC's sometimes react slower when rebooted after an unclean shutdown
Waterfall (Event Log DB)	4:00	The Dell Rack PC's sometimes react slower when rebooted after an unclean shutdown
Level-C	10:00	
PCO2	4:00	

6.1.8.6 Ship Systems affected by power loss

In the main lab the Winch System is probably the most critical system that was affected by power loss especially when equipment was in the water.

Ship systems that were affected by power loss included:

- CCTV monitors
- ODIM HMI
- Desktop Radio unit

During wire operations the loss of the wire logging system, winch GUI and CCTV screens is not ideal.

The ship should strongly consider purchasing a UPS for the winch machine and Clam.

From experience the remainder of the hardware for the winch system remains active when the power fails in the main lab and this would still permit safe operation.

> *During a future trials cruise it would be worth investigating how an active winch reacts if the power to the Gui is removed. I suspect the operator could simply hit the emergency stop button on the belly box until power is restored. However, retaining control of the system via the GUI may be desirable.*

UPS for ScienceBloom

> In discussion of the principle scientists I was asked if it was possible to supply a UPS for scientific use. A spare UPS has been configured to be used in conjunction with the scientific party's video recorder to safeguard the writing of HD footage from the ROV.
>
> However, one or more spare UPS's for transient NMF or scientific gear may be desirable although 99% of the time not required.
>
> *Whilst not related to NMFSS equipment I was also asked if the -80 freezer could also have a UPS. However, I suspect this fridge would stay cold for a long time.*

6.1.9 Meteorological Sensors (Surfmet)

6.1.9.1 Water Flow

Please be aware that when the taps adjacent to the tap supplying surfmet is used this can significantly affect the water flow through surfmet and where possible no additional equipment should use these taps.

6.1.9.2 Algal Bloom

During the steam down to the first worksite and whilst at Atlantis a build up of green growth was visible in the flow indicator. This is post likelly attributed to the fact that the CTD hangar door was open constantly and during these periods we experience higher levels of sunlight.

6.1.9.3 Water Bottles

6.1.9.3.1 Salinity

Date/Time	Bottle	Surfmet	Sbe 45
324 041132	643	34.4432	34.4432
324 160700	642	34.4439	34.440
325 065530	641	35.332	
326 142000	144		
327 071400	140		
328 093100	139		
330 110400	138		
330 150900	139 (?)		
331 040400	129		
333 084200	142		
335 150100	131		
336 143700	132		
338 100600	133		
341 053700	134		
344 083400	135		
345 102800	128		

6.1.9.4 Wind-speed Problems

On a number of occasions windspeed went to 50kts even though actual windpseed was nowhere near this value. I was unable to track down what was causing this issue – sensor or programming. It may be possible that this is caused by high levels of vibration through the pole especially during times of high thruster use.

6.1.9.5 Windspeed Shadowing

When conducting swath and running lines it is evident that the blocking of our wind speed sensor is quite significant and we should investigate the possibility of a second wind sonic sensor on the mast or at least get a feed from the ship's dp wind sensor – see image above. This became a problem when monitoring windspeed trends when the vessel was on certain headings.

Figure 93. Graph showing evidence of wind speed sensor blocking.

Figure 94. One possibility would be to use the two spare poles on the mast for science wind speed sensors. This would reduce shadowing by the vessel super structure and would offer additional readings to the wind sonic on the Met platform and Bridge DP system.

6.1.9.6 STIR Problem

Windsonic sensor Serial NO 994132 was identified as faulty and the data plotted above shows progressive issues over a week period. The sensor was changed on JDAY 339 with sensor 973134.

No further problems were identified.

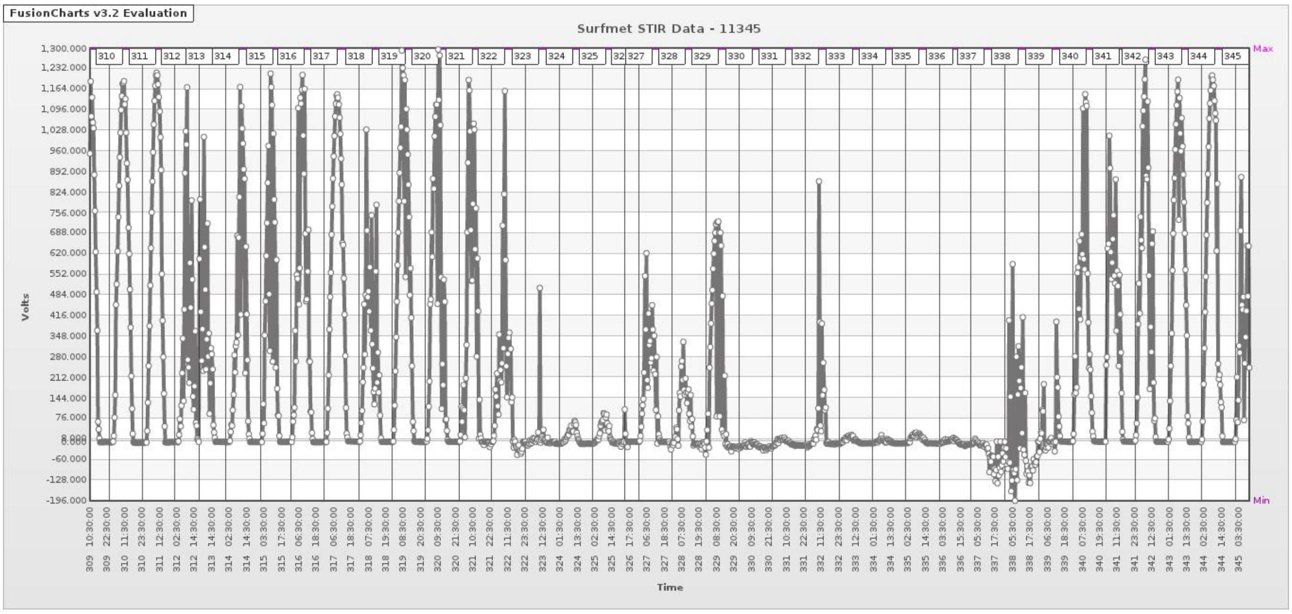


Figure 95. Graph showing issues with windsonic sensor.

6.1.10 Gravity Meter

A gravity base station tie in was completed in Cape Town. The nearest base station was located at the University of Cape Town.

Station: UCT NEW

Latitude: -33.57.30 Longitude: 18.27.39 Height: 109,76 m

Description: Brass stud with collar set in tiled floor on western side of the entrance foyer at the 2nd level of the Menzies Building, University of Cape Town. Inscribed on the collar: "Gravity Base Survey Dept."

IGSN71 Gravity: 979 616,80 mgal

Estimated Accuracy: 0,1 mgal

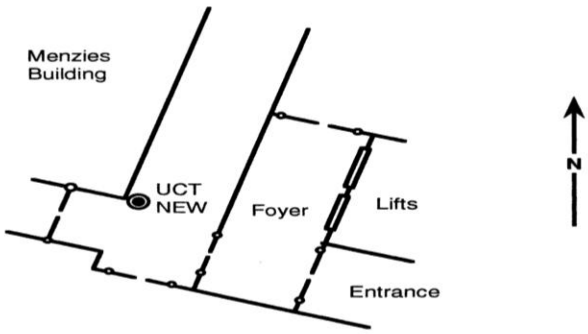


Figure 96. Map of location of Gravity base station in Cape Town.

Our contact was George Smith [George.Smith@uct.ac.za] who was contacted through the university website and arranged access to the university base station. We furnished George with some t-shirts and ship gifts as a thank you.

6.1.10.1 Changing Accelerometer – Delays

The encoder on the gravity meter installed on the vessel was identified as potentially faulty during the previous cruise. A replacement encoder was removed from gravity meter at NOC and shipped to the vessel.

This was replaced prior to leaving Cape Town and a period of data recorded alongside so that this could be used to verify against the base station calibration preformed the day before.

New Accelerometer

P/N	2224A0044
PO	7771
JO	010570/2

Old Accelerometer

P/N	2224A0044
PO	6022
JO	83813

6.1.11 Internet

6.1.11.1 PI's Review of internet facilities

During the Post Cruise Assessment the PI raised a number of issues regarding the internet on-board. The PI's main concern as the new set-up did not permit sufficient means of dealing with work back ashore. He highlighted most scientists had papers and other projects that they were involved in that needed better access to internet facilities. The PI admitted that the internet was good for his use as he has direct access to the internet but he believes it hampered many of the scientists.

The general consensus from both the crew and scientists was that the internet is slow, which it is.

The internet onboard the vessel is becoming a contentious issue that is requiring more and more of the SST's time both in dealing with individual complaints and trying to maximise what we get out of the system whilst remaining on friendly terms with everyone.

"I cannot go to the Engineers and ask for them to create an additional 20,000HP - neither can we just generate additional bandwidth"

I also think that the whole internet policy change has had a negative impact on crew-SST relations. I would like to highlight that the current setup onboard the vessel is optimum and NMFSS has invested considerable time and finance to ensure that we utilise the link as much as possible with many layers of technology to help streamline the link. These measures include:

- Web Cache

Ensuring commonly accessed pages such as the BBC aren't downloaded over the link but from a copy held on a local server each time someone attempts to access that page.

- AMS Mail Server

NERC's web-mail and the majority of other institutes email web access pages are very bandwidth heavy. The security protocols that enable secure email access are quite intense and accessing a web based interface over the link is painfully slow. There is nothing we can do about this problem.

- WSUS Server (Windows Update Server)

This server downloads windows updates once from which the other systems on-board can download the updates and install, thus minimising the number of machines attempting to get updates via the internet.
SquidGuard

General access is limited by White lists/Blacklists which permit certain websites to cabins but is also used to ban heavy bandwith websites such as youtube from the genral access PC's dotted around the ship.

- Exinda Bandwidth Monitoring

Vigor Firewall has some minor tools that can also limit website access etc.

- SST's Review of Internet onboard

The link is slow. There is no magical switch we can flip to make it faster. NMFSS has been exhaustive in its steps to maximise what it can get out of this link. We have hit a ceiling that is now dictated by the bandwidth of the system – SST's cannot magically create bandwidth. This is an issue for NERC to study the feasibility of.

6.1.11.2 Pre-Cruise Communication of Internet Limitations

The limits of this connection need to be specified in the cruise planning stage.

Publicising that the ship has internet is misleading.

"RRS James Cook has 24 hour access to the internet. Cabin connections are configured for direct access from your laptop. E-mail is then accessed through your regular e-mail provider (hotmail etc.)"

6.1.11.2.1 RSU Vessel Document published online

Everyone is now used to broadband technology and better and expect the same level of speed and data "on demand" as ashore. The severe limitations of this system need to be communicated as early as possible so we avoid irate scientists who complain that they cannot download large files (scientific papers) to review or another student missed out on a grant proposal because the internet was down. The internet has evolved a a rapid pace since this system was installed 6 years ago and both business and social activities that were previously achievable on this vessel are no longer feasible. Google show that "Average" websites have increased by 200KB in this time period and the top websites have increased by as much as 400KB. It is quite easy to say this should have dealt with before the scientists left – this isn't helpful for the SST's who have to deal with often frustrated or emotional people who in some cases see the SST as an obstruction to them having normal email access.

Most of our problems stem from not educating Scientists and Crew prior to joining. Anyone joining the vessel should be made aware of the following:

The internet service is on a ship and can be affected by:

Motion of the vessel

Direction of the vessel based on shielding form structures (mast/TV dome)

Failure of equipment and loss of service

Maintenance

Operation in high latitudes where service quality is degraded

Where Possible:

Scientists should ensure there computers are patched and anti- virus is up-to-date before joining

Any important or large documents are downloaded PRIOR to the cruise

Supplied with a copy of the NERC IT and e-communications policy

The usual complaints that I receive mainly from crew members (lots more agency staff these days) are "I was on a cargo ship/standby vessel which had internet which was faster than this. "

Usually the vessels in questions were operating in regions that had good satellite coverage and didn't need a large system such as the VSAT System which has to provide a worldwide service and there were significantly less than 50 people on-board these vessels. The ships from where these people came were usually commercial and the internet had a real-time financial impact on business operations which made upgrading to meet the evolving demands of the internet both cost effective and viable to stay ahead of the game.

Most experienced scientists who have served on other research vessel are aware that the facilities on-board this vessel are better than other research ships – many of which are still limited to only a few email transmissions a day such as the Sonne. The younger generation of scientists who have experience of high speed internet on their IPhones often expect the same from the ship's internet as they don't know any different. I have been on a number of research vessels operated by other nations and I believe the James Cook has one of the best and robust setups for a vessel of her size. Mistakes were made when the vessel was brought into service and allowing "unrestricted" access to both scientists and crew in their cabins. As the demand on this service has grown, the internet has evolved and NERC/NOCS presence and reliance on web based operations has ballooned. All these factors have ultimately resulted in changes to the system on-board and although this system coped reasonably well six years ago it is now severely restricted by today's scientific and personal demands which are often conflicting.

At the earliest possible stage the limitations and set-up of the internet onboard the RRS James Cook need to be communicated to the scientist at the pre-cruise planning stage

6.1.11.3 Shadowing by TV Dome in Cape Town

During the initial attempt to change over satellite in Cape Town we encountered problems due to the television dome blocking the VSAT's view of the satellite. Due to this blockage we were unable to complete the planned changes whilst alongside as originally planned.

6.1.11.4 Change over at sea

Figure 97. Polarisation was changed at sea.

The satellite change over occurred during the evening of November 6th. During the changeover I encountered a number of issues with the signal strength from our system and considerable tweaking was required using both the hand-held unit in the dome and on the modem in the BES. This should have been a two person job.

6.1.11.4 VSAT

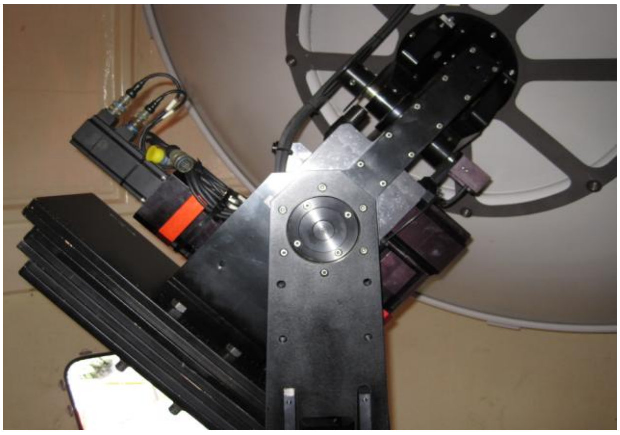


Figure 98. VSAT

A small pool of red gearbox oil was visible on the counter balance weights (Fig. 98) and periodic checks should be made to ensure this is not an escalating problem. We have seen a similar issue before which resulted in gearbox failure. It is also possible that the leaking oil was due to a change in temperature as the vessel headed north – this has also been seen on previous cruises when the vessel travels from a cold to hot climate.

6.1.11.5 System Setup

During this operation we had rolling work permit as we were required to turn on/off the VSAT frequently. I made around 25 trips up/down the mast. The NERA Fleet 77 phone was not acquiring satellites correctly during the changeover process and communications with Aberdeen and Germany were severely affected. As we were close to the African coast we were able to use the Master's mobile phone. However the signal was not great. The changeover took around 11 hours to complete.

6.1.11.6 Phone Issues

Since changing satellites we have had a number of issues with the phones. NESSCO are aware of this issue. The problem arises when the signal drops – either when the vessel turns or the antennas FOV are blocked or as a result of poor signal. If the duration of this blockage exceeds 30 seconds then it is highly likely that any “in use2 phone lines will “lock up”. To rectify this problem we have to contact NESSCO who in turn rectify the problem with 10-15 minutes of notification. The situation seemed to improve as we headed further North and very few problems were encountered around Atlantis bank.

6.1.11.7 Pool of Internet Enabled Addresses

The following addresses have been enabled for internet access in the squidguard.conf

192.168.70.10-192.168.70.24

Location of Internet Enabled PC's

Terminal Room	192.168.70.10	priv-termpc
Library	192.168.70.11	priv-conf1
Ship's Office	192.168.70.13	priv-master
Purser's Office	192.168.70.14	priv-purser
Principle Scientist	192.168.70.15	priv-pi
Darkroom	192.168.70.	
Conference Room	192.168.70.12	priv-conf2
Technicians Office	192.168.70.	
Engine Control Room	192.168.70.17	priv-chief

Additional Internet Enabled machines JC066

The Captain asked me to set-up communications for the ROV team so they could conduct operation critical tasks.

- Kiel 6000 laptop 192.168.70.20

An additional laptop belonging to one of the scientists was set-up for use around the Plot table so scientists could research what they saw with the ROV.

- Scientific laptop 192.168.70.21

Non Public Use PC's enabled for Internet Access

- Waterfall PC – for sending daily SAPI reports
- AMS – Enabled for Mail (Not sure this is needed)

Software installed of privilege machine

- Microsoft Office
- AVG
- Adobe Acrobat

Planned Maintenance

Weekly anti-virus update and scan
Remove junk files from desktop/downloads folder

6.1.11.7 Internet Policy Complaints

Two complaints from crew were received with regards to the new internet policy and dealt with by NMFSS. These complaints centred around personal email access.The PI will be including his own report on the internet setup. Additional "verbal" complaints were made to the SST.

6.1.11.8 AMS

No major problems occurred with the AMS system during this cruise and it required minimal attention. It was rebooted twice due to failure to obtain messages

6.1.11.9 Squid – Cache

The cache ran well with no problems.

6.1.11.10 SquidGuard – Access Management

The SquidGuard file was modified during the trials and JC066 to limit internet access to a number of machines.

File at the end of JC066

```
dbhome /usr/local/squidGuard/db
logdir /usr/local/squidGuard/logs

src privileged {
ip      192.168.70.10-192.168.70.24
ip      192.168.62.58
```

```
ip          192.168.62.16
}

src admingrp {
ip          192.168.62.32
}

dest admin {
 domainlist admin/domains
}


dest black {
 domainlist black/domains
}

dest white {
 domainlist testx/domains
}


acl {

 privileged {
 pass all
 }
admingrp {
 pass white admin !black none
            redirect http://192.168.62.58/blockedwebpage.htm
 }
 default {
            pass white !black none
            redirect http://192.168.62.58/blockedwebpage.htm
 }
}
```

White List Located in:

/usr/local/squidGuard/db /testx

6.1.11.10.1 JC066/67 White List Entries

The following websites were in the white list at the end of JC066. Only websites with a proven operational requirement were added to the list.

This is the list of website included in the white list at the end of JC066

bbc.co.uk	BBC Website
noc.soton.ac.uk	
nerc.ac.uk	
ams-host.cook.local	Mail Server
192.168.62.58	Event Logger
passageweather.com	weather charts
metoffice.gov.uk	weather charts
opc.ncep.noaa.gov	weather charts
nhc.noaa.gov	weather charts
sailwx.info	weather charts

magicseaweed.com	weather charts
meteo.fr	weather charts
xcweather.com	weather charts
deliaonline.com	Catering
wilhelmsen.com	Engineering
cromwell.co.uk	Engineering
cpc.co.uk	Engineering
armadamh.co.uk	Engineering
uk.rs-online.com	Engineering
farnell.com	Engineering
screwfix.com	Engineering
kongsberg.com	Engineering
brunvoll.no	Engineering
schneider-electric.com	Engineering
dft.gov.uk	Engineering
hoppe-bmt.de	Engineering
tycofireandsecurity.com	Engineering
odim.com	Engineering
rolls-royce.com	Engineering
seamountsexpedition.blogspot.com	JC066 Blog
ukho.gov.uk	Bridge
wetterzentrale.de	weather charts
ummuk.com	weather charts
weathersa.co.za	weather charts
mcga.gov.uk	Bridge
maib.gov.uk	Bridge
chartcoselect.com	Bridge
webmail3g.ifm-geomar.de	JC066 Kiel ROV Team

Black List located in:

/usr/local/squidGuard/db /black

Youtube
Iplayer

6.1.11.10.2 Access Denied Screen

An access denied page was created on 192.168.62.58 (Event logger Web Server – waterfall PC) and is located in the web server directory

c:\inetpub\wwwroot\blockedwebpage.htm

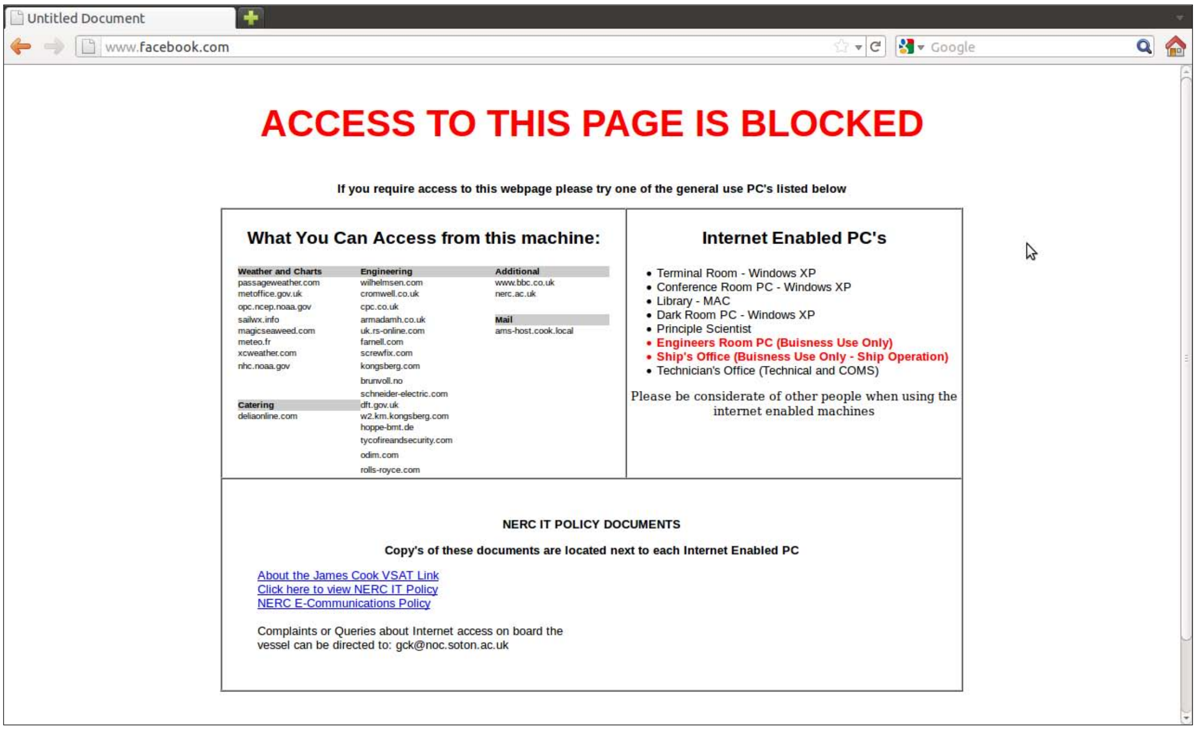


Figure 99. Access denied web page.

6.1.12 WAMOS

Vessel mobilisation occurred on the Saturday 5th November and the crane to fix the wave radar also arrived during this period. With the crane and container wagons on the quay wall there was not much space for manoeuvring and we had to schedule crane operations around the mobilisation of the vessel. Weather conditions were windy with occasional light drizzle. The first attempt at accessing the mast was thwarted by strong winds (16kts) and was aborted until wind-speed died down. The second revealed that the crane supplied by the agent was actually too short to reach the wave radar platform and further work was impossible. The engineer did attempt to access the radar via the rungs on the mast but deemed this method of servicing the radar to be unsafe.

A second attempt at accessing the radar occurred on Sunday 6th November. Windspeed was round 10kts and getting close to the radar was quite awkward. The scanner was opened and and the internal workings were covered in dust from the brushes which were installed during the 2011 refit. The encoder disk was cleaned but with much difficulty. The engineer noticed that there was no rubber cover on the motor assembly that permitted the build-up of dust in the housing – this is why we have had this reoccurring problem.

The engineer highlighted some points

- This is the fourth service engineer to deem to mast “unsafe”
- Maintenance of the radar is impossible without scaffolding
- Brushed will need to be changed ASAP
- Rubber cover needs to be fitted to the motor assembly

Figure 100. Access to the motor assembly is impossible with a man cage and access by an engineer on the mast is very difficult even with the new platform assembly.

Figure 101. This image shows how far from the actual mast the radar unit and motor assembly are located.

6.1.13 Additional Systems and information

6.1.13.1 Data Storage

6.1.13.1.1 Public Data Drive

Originally data was set-up in the folder

\\192.168.68.57\Public

However, two Macs could not see this share and as they were deemed critical to operations we switched to using the drobo.

6.1.13.1.2 Drobo

A copy of the Drobo data is located on the data deliverables disc:
\Drobo_Public_Share_Backup

6.1.13.2 PC's

Several PC's were rebuilt during the Passage down to Cape Town.

These machines are:

Ships Network	Kongsberg	Name
192.168.71.10	192.168.1.52	spare1.cook.local
192.168.71.11		spare2.cook.local
192.168.71.12		spare3.cook.local
192.168.71.13	192.168.1.50	spare4.cook.local
192.168.71.14		spare5.cook.local
192.168.71.15	192.168.1.51	spare6.cook.local
192.168.71.16		spare7.cook.local
192.168.71.17		spare8.cook.local
192.168.71.18		spare9.cook.local
192.168.71.19		spare10.cook.local

Figure 102. Set-up of computers in computing lab.

6.1.13.3 Kongsberg Network Setup

A number of machines were assigned “static” Ip addresses on the Kongsberg network.

These reservations were setup on the Kongsberg DHCP server and are as follows:

192.168.1.101	Olex	
192.168.1.53	RVSSpare2	
192.168.1.52	rvs-desktop	spare1.cook.local
192.168.1.51	rvs-testbed	spare6.cook.local
192.168.1.50	RVSSpare4	spare4.cook.local
192.168.1.13	XBTSVP	
192.168.1.11	Carus	
192.168.1.6	HWS10-305	
192.168.1.5	EA600	
192.168.1.4	SBP OP	

192.168.1.3	EM710
192.168.1.2	EM120
192.168.1.1	EK60

6.1.13.4 Time Server

The MMS3 time-server was configured to serve time requests to the Kongsberg Network on Lan port 2. The Time server's IP address on the kongsberg network is 192.168.1.49. The wiring for the Kongsberg Network/MMS Link is through the Fieldbus:

> MMS Lan 2 - > FB BES 008 → 008 Main Lab Patched through 031 to locker → Into Kongsberg Switch

The following systems have been set-up to synchronise with the Time Server

- EM710
- EM120
- Ek60
- EA600
- SBP120 OP

6.1.13.5 Kongsberg Server

The Kongsberg Server which is used to issue DHCP to the Kongsberg Server has also been given a static IP address on its second Ethernet card and is now connected to the ship's network (it only allocates IP's on the Kongsberg network).

192.168.62.37 kongsberg.cook.local

6.1.13.6 Scientists Computer Issues

6.1.13.6.1 Solaris Machine

A Solaris machine was found not to connect to the network. No lights were visible on the Network HDD. This was solved by re-initialising the card.

6.1.13.6.2 Laptop

One of the scientific party's laptops failed due to a HDD Failure. No remedial action was possible and a number of tests showed that the disk was faulty.

6.1.13.6.3 Portable HDD – ROV footage

One of the portable HDD's assigned for ROV Footage would not mount on the mac or other machines. Drive was deemed to be faulty.

6.1.13.6.4 Turbulence Probe Backup

A backup of the turbulence Probe PC was requested by one of the scientists and a complete clone of the system was made using clonezilla.

6.2 Deployment of ROV KIEL 6000 during expeditions JC066 in the south-western Indian Ocean

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[2] NOC, Southampton, UK

6.2.1 Introduction

During the Seamounts-Project Expedition JC066 onboard RRS *James Cook*, ROV KIEL 6000 was deployed for the first time from this British ship (Fig. 103).

Figure 103. Deployment of ROV KIEL 6000 from the stern gantry of RRS James Cook. ROV still on deck (left) and in the water released from its latch (right).
Photos: Aurélie Spadone,/ IUCN

ROV KIEL 6000 is a 6000 m rated deep diving platform, manufactured by Schilling Robotics LLC, Davis, USA. Its design is based on commercially available ROVs, but customized to our demands, e.g. being electrically driven and truly mobile. Until today, ROV KIEL 6000 has been operated from a variety of different research vessels (RV *Sonne*, N/O *l'Atalante*, RV *Maria S. Merian*, RV *Meteor*, RV *Celtic Explorer* and RV *Polarstern*) until today. As an electric work class ROV of the type QUEST, this is build No. 7. ROV KIEL 6000 is based at the Leibniz Institute for Marine Sciences IFM-GEOMAR in Kiel, Germany (GEOMAR/ Helmholtz Centre of Marine Research after 1st of January 2012).

During JC066, 18 scientific dives (Table 19) were accomplished. Maximum depth was 1505 m. Bottom time accumulated to approx. 114 hours (total dive time ca. 147 hours). Including this cruise, ROV KIEL 6000 has accomplished 150 dives during 12 scientific expeditions.

Table 19. ROV station list JC066.

Station No. JC066	Dive No.	Date	Location	Max. Depth (m)	Time Start (UTC)	At Bottom (UTC)	Off Bottom (UTC)	Time End (UTC)	ROV Bottom Time (h)
	129	06.11.2011	Harbour Test Cape Town						
4_2_ROV01	130	12.11.2011	Coral Seamount 1	1400	06:09	07:12	15:25	16:13	08:13
4_4_ROV02	131	13.11.2011	Coral Seamount 2	1500	05:30	06:40	15:16	16:15	08:36
4_9_ROV03	132	14.11.2011	Coral Seamount 3	1120	05:02	09:18	16:53	17:22	07:35
4_12_ROV04	133	16.11.2011	Coral Seamount 4	750	03:09	03:54	08:28	08:59	04:34
4_37_ROV05	134	20.11.2011	Coral Seamount 5	740	03:14	03:42	09:55	10:32	06:13
4_38_ROV06	135	20.11.2011	Coral Seamount Mooring Recovery	750	12:40	13:13	14:36	15:02	01:23
5_11_ROV07	136	23.11.2011	Melville Bank 1	925	07:02	07:47	15:26	16:20	07:39
5_14_ROV08	137	24.11.2011	Melville Bank 2	710	06:02	06:42	15:14	15:33	08:32

5_20_ROV09	138	25.11.2011	Melville Bank 3	390	07:40	08:35	15:31	15:43	06:56
5_24_ROV10	139	26.11.2011	Melville Bank 4	1320	06:37	07:33	13:07	13:43	05:34
6_3_ROV11	143	01.12.2011	Middle of What 1	1120	04:06	05:24	06:14	09:52	00:50
6_4_ROV12	144	01.12.2011	Middle of What 2	1010	11:18	12:51	14:43	15:18	01:52
6_7_ROV13	145	02.12.2011	Middle of What 3	1380	05:22	07:31	15:46	16:24	08:15
7_10_ROV14	146	07.12.2011	Sapmer Seamount	700	05:04	05:29	15:44	16:00	10:15
8_3_ROV15	147	09.12.2011	Atlantis Bank 1	700	04:40	05:05	15:45	16:13	10:40
8_5_ROV16	148	10.12.2011	Atlantis Bank 2	1110	04:02	04:33	11:14	12:35	06:41
8_22_ROV17	149	13.12.2011	Atlantis Bank 3	1020	05:59	06:29	15:07	15:34	08:38
8_29_ROV18	150	16.12.2011	Atlantis Bank Mooring Recovery	745	04:30	05:03	06:47	07:16	01:44
Total: 18 scientific dives									**114:10**

6.2.2 Sampling Setup and tasks during the Cruise

Configuration 1 (Figs 2a & b, 3 - 7): 16 Pushcores (Fig. 3), Slurp Gun with 8 containers, 2 - 3 Handnets (Fig.7), 3 lidded BioBoxes (NOC) (Figs 3 & 4), 1 Temperature Probe (NOC), 2 Lasersets (NOC) on horizontal/ slightly tilted HD Camera (Fig. 5) and Lower Pan&Tilt unit.

In addition, a scraper tool (Fig. 7), built on board, was employed. The (green) laserset on the lower pan & tilt unit as well as the temperature probe were omitted after dive 1.

Tasks carried out during this leg by ROV KIEL 6000 at the seafloor included survey, HD-video documentation and still photography along selected transects across five different seamounts (up-slope), sampling of sessile and mobile fauna using the ORION manipulator, nets, scraper or slurp gun as well as rock-sampling using the ORION. The fauna was usually stored in one of three lidded bioboxes, while rocks were placed in the open space of the aft portside drawer.

One special task was the location and recovery of two 2-year old moorings with bags attached, containing whalebones and mango logs. Recovery procedure for these moorings required that several buoyant polypropylene ropes had to be cut using a blade that was specially designed and mounted on the RIGMASTER manipulator jaw. The buoyant ropes posed a potential threat to the ROV thrusters, but the operation could be finished without any incidences. The blade was left on the ROV in case of entangling in fishing lines, which were observed throughout the study areas.

Fig. 2a: ROV KIEL 6000 with Configuration 1: port drawer with 16 pushcores and lidded biobox in front; starboard drawer with 2 lidded bioboxes.

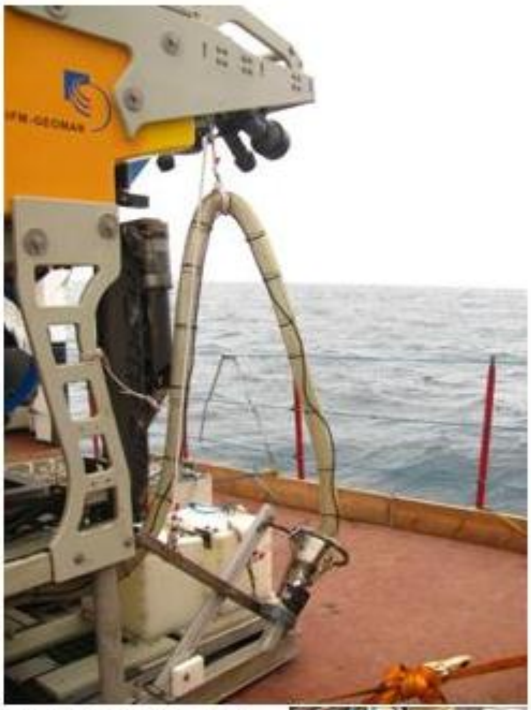

Fig. 2b: ROV KIEL 6000 with Configuration 1: slurp gun nozzle, with attached temperature probe (see right)

Fig. 3: Portside drawer with 16 pushcores and large lidded biobox in front

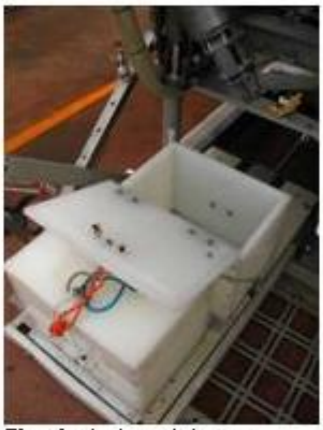

Fig. 4: starboard drawer with 2 lidded bioboxes

Fig. 5: Forward looking HD camera with laser array

Fig. 6: Handnet

Fig. 7: Scraper

Fig. 8: Blade on Rigmaster jaw

6.2.3 Issues during the cruise

One of the major issues during the present cruise was the presence of lost **fishing gear** at the sea floor, which we observed on most seamounts. The ROV itself got caught in floating lines several times. The most horrific sight was that of a lost massive gill net (Fig. 111), overgrown by hydrozoans and only thus visible.

Luckily, no serious problems arose from the entanglings. However, bottom time of several dives was considerably shortened as the ROV had be freed from lines. The special blade, used for recovering the moorings at Coral Seamount and Atlantis Bank, was left mounted henceforth.

Figure 111. Gill net observed on Sapmer Seamount

Another issue encountered was the presence of very **strong currents** from the south at Middle-of-What-Seamount throughout the entire water column, affecting the entire cable length, causing high dragging forces on the ROV. Even after repairing one thruster suspected to have caused the vehicle and its motion reference unit to behave erratically, it was not possible to get satisfactory video footage, as the ROV was ripped off the seafloor by the cable. Parking the vehicle for sampling had to be done at full thrust at cost of all other thrusters faulting under the high load one by one. Still, some samples could be retrieved.

Weather was mostly favourable for ROV operations. There were days, however, with no chance of deployment, as well as others 'beyond the edge' with 3-4 m waves and between 5 and 7 Bft and we had to decide not to deploy, because safe operations could not be guaranteed.

Manoeuverability of the ship was excellent thanks to its dynamic positioning system. As the ship could be moved in the range of metres into any required direction and at the desired speed, this helped in fulfilling our tasks at the seafloor as well as eased the procedures of launch and recovery even in rather adverse conditions, e.g. strong currents and high sea-state.

Ship's power supply differs to other ships ROV KIEL 6000 has been operated off. Instead of the more common 380 V, 415 V are fed into the system. In addition, voltage on one of three phases was significantly higher, causing problems in all subsequent rectified DC-systems. The winch's frequency converter was able to handle this by changing firmware parameters. This was not the case for the ROV converter, i.e. no adjustments were possible. The consequence was an un-balanced rectified DC supply for the vehicle, which may have caused 4 power breakdowns during start up as well as during shut down.

A **Dead Vehicle Recovery** became necessary when the vehicle died on dive 16. Investigations showed that the 48 V socket had burned out due to water ingress. The respective parts were exchanged after intense and careful fault finding procedures. Possibly, the incidence may have caused deeper-going problems to the system, indicated by erratic telemetric electronic behaviour during the last 2 dives.

The **slurp gun** was used for retrieving small mobile fauna, such as shrimps and other crustaceans, mollusks and also small corals. Larger individuals could also be captured by sucking them to the tube, and then let them drop them into one of the boxes (Fig. 112).

The pump motor was leaking and drawing seawater into the system. The issue was tackled, and with some care, the device could be used again. The filter at the outlet got clogged every now and then, reducing the suction pressure.

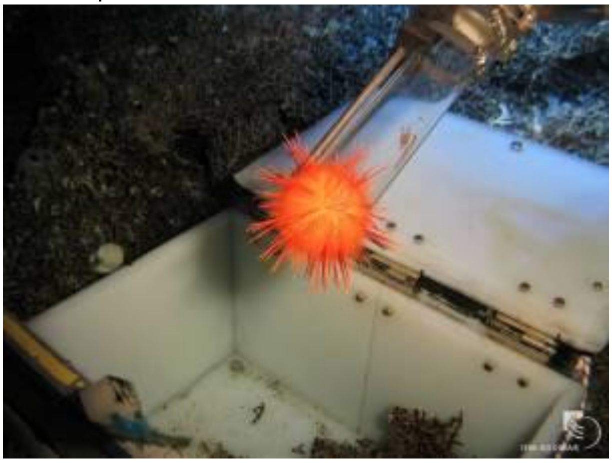

Figure 112. Sea urchin sampled by the slurp gun and about to be dropped into a biobox.

6.2.4 Detailed system description and notes

The vehicle is equipped with 7 electric thrusters. Power is supplied through a 19 mm diameter steel armoured umbilical with 4160VAC/460 Hz. The deep sea winch (manufactured by Hatlapa, Uetersen, Germany) takes up 6500 m of umbilical (NSW, Nordenham, Germany).

- Worked well during the cruise.

ROV KIEL 6000 is configured as a “free flyer” and thus does not require a tether management system (TMS). Two sets of floats (i.e. 3 and 9 floats, each with a buoyancy of 7kg) mounted onto the first 60-70 metres of the umbilical decouple the ROV from ship’s movements. Thus, the ROV is capable of making excursion of up to 200 metres away from the aft of the ship, before the ship needs to be re-positioned.

- Floats were mounted by German ROV team members, supported by the ship’s crew

KIEL 6000 is equipped with two manipulator arms. A seven-function position controlled manipulator ORION is used for dexterious operations, and a five-function rate controlled manipulator RIGMASTER performs more rugged tasks.

- Worked well

Further tools standardly installed on the vehicle include 7-8 cameras (for more details see ‘Video Setup, HDTV and archiving of video material‘ below), a depth sensor, a high resolution sonar system MS1000, a SBE 49 FastCAT and a compass.

- All worked well
- The compass was corrected for magnetic deviation

In addition, a motion reference unit (MRU) containing a fibre optic gyro is mounted. The MRU is used for controlling the vehicle’s balanced movements within the water column and at the bottom.

- Probably due to a malfunctioning thruster (see above), the MRU behaved erratic during the first dives. Repair of the thruster solved the problem.

An RDI Doppler velocity log (DVL) allows the small-scale positioning /displacement of the vehicle in the range of 10s of centimetres at the seafloor, which is especially important during crucial operations like mosaicking.

- Worked generally well during the cruise
- During dive 16, the DVL died on arrival at the bottom due to water ingress at the connector
- Cable and port were swapped

For general underwater navigation, a USBL-based IXSEA POSIDONIA™ system is installed on the ROV. As RRS James Cook is not equipped with POSIDONIA, during the present cruise, 2 mobile autonomous Sonardyne transponders (Fig. 11) were attached to the ROV for navigation. For more details on positioning and navigation see 'Telemetry and navigation' below.

- Navigation worked very well

A **tool sled** in the lower-most part of the vehicle is configured to take up the scientific payload. Located on the portside front of the tool sled is a sample tray that can be opened hydraulically and can be customized on demand using a modular set-up. On starboard front there is a drawer, likewise hydraulically driven, which can take up sample containers, probes or other scientific tools continuously mounted or used by the manipulator. Port aft and starboard aft are reserved for additional scientific payload which differ from mission to mission, e.g. the slurp gun carousel containing 8 containers, each with a volume of 2.5 litres.

6.2.5 Telemetry and navigation

Data transfer between the vehicle and the topside control van is managed by the digital telemetry system (DTS™) that consists of two surface and four sub-sea nodes, each representing a 16-port module. Each port may be individually configured for serial (SIM), video (VIM) or network (NIM) purposes. During the present cruise, for example, communication to the NERC temperature probe was realized via a SIM.

The topside telemetry logging system ROVMon which has been developed and customized to our needs in-house, collects incoming data from ROV, ship, winch, CTD and Sonardyne navigation. It distributes data to several subsystems like the navigation system, the video overlay and data display clients. The telemetry system can handle TCP/IP, UDP and serial connections. The data usually is transferred as NMEA strings; if other formats are transferred, these can be converted by specialized frontends. The configuration of data logging is declared in advance where protocols, devices (sensors) and exports are specified for the ship and the cruise. The whole data set is written each second in CSV (comma separated values) files. The telemetry system starts a new file after a given interval for security reasons.

The Sonardyne transponder information string is broadcasted by UDP datagrams to the ROVMon telemetry system. The date and the coordinates are converted for further use in the navigation system by a customized frontend.

For navigation and coordination with the ship during the dive we use the navigation software OFOP 3.2 (Ocean Floor Observation Protocol by SAMS, Texel, NL). Coordinates and heading data from the ship and the ROV are overlayed on a calibrated map.

This navigation screen has been provided to the bridge and to the mainlab.

Figure 113. Sonardyne transponders mounted on light rack of the ROV, the smaller one served as a back-up.

6.2.6 Scientific data management

The navigation software OFOP in addition includes a protocol function for the scientists to describe the dive and actions like sampling and taking pictures with coordinates and timestamps. After each dive, the scientific protocol is converted into an Excel file to provide it to the scientists. The telemetry files are packed and copied onto the server for public access and post-processing.

- During one dive, problems with OFOP occurred and no navigation data were distributed to the protocol PC, thus, while the single observations were recorded, no positions or ship's time was recorded. As all events were time-stamped by the computer itself, it was possible to manually identify the correct position for each event, and the protocol delivered is thus identical to all others.

6.2.7 Video Setup, HDTV and archiving of video material

Cameras standardly installed on the vehicle include an HDTV camera, two high-resolution colour zoom cameras (on pan&tilt units), one digital still camera as well as three black and white observation cameras. From Dive 14 onwards, an additional rear camera was installed. All colour cameras' footage is recorded on harddrives. The HDTV Camera (1080i) is recorded on demand using an Apple MacPro with a HD-Videocard (AJA KonaLHe) and Final Cut Pro 7.

The HD video is standardly recorded in DVCProHD (13.5 Mbytes/sec). Other formats like Apple ProRes or even uncompressed recording are possible. The video is first stored on the Macs internal RAID-System (1.5TB). After each dive it is copied to a second MacPro for postprocessing and downconverting using Telestream Episode software. All HD Videos are converted to SD resolution (DV) with an IFM-GEOMAR Logo imprint.

During the present cruise, HD footage was constantly recorded by the customers. When the main lab was faced with power cuts, the HD recording in the control van was started to cover the time period otherwise lost.

The pilots split screen as well as the HD screen were broadcasted to the mainlab and the bridge using SDI signals converted to fibre optics by Telecast Fibre Systems rattlers.

Both SD-Cameras are permanently recorded on an IBM-Z pro Computer in the control van using two Focus Capture Cards and Focus capture suite software. The Video is recorded in Mpeg2. The software automatically starts a new file every 20 minutes to generate smaller sized, thus user friendly files. The SD material contains an imprinted data overlay including date, time, depth, temperature and pan angle of the specific camera.

During the present cruise all material was provided additionally as original versions without any imprints.

All SD video files are uploaded on the fly into the Como ProxSys video asset management system. The ProxSys system is accessible via the ship's network using common web browsers like Internet Explorer or

Safari. The ProxSys server provides a structured overview of the complete video and data files for each dive of the cruise.

The Kongsberg Digital Still camera has a resolution of 5 MPixel, images are taken on demand. After each dive, all images are downloaded from the camera and logo, date and time are imprinted and images (originals and those with logos) are uploaded onto the ProxSys server subsequently.

Users can then preview and download videos, photos and protocol data.

At the home institute, the ROV KIEL6000 ProxSys system is synchronized with an onshore system of the IFM-GEOMAR. The onshore system contains all media- and data-material ever collected by ROV KIEL6000.

6.2.8 ROV based tools, installed on vehicle and/or handled by ROV KIEL 6000

Toolskid containing 2 hydraulically driven drawers in the front (IFM-GEOMAR)
2 pallets for customized configuration in the aft section of the ROV (IFM-GEOMAR)
CTD real-time probe (IFM-GEOMAR)
Pushcores, 6 or 16 in portside drawer (IFM-GEOMAR)
Hand-Nets (IFM-GEOMAR)
Slurpgun w/ 8 containers (IFM-GEOMAR)
Acoustic HOMER Beacon markers (IFM-GEOMAR)
Simple knife for manipulator operations (IFM-GEOMAR)
Blade mounted on RIGMASTER for cutting mooring ropes or fishing lines (IFM-GEOMAR)
Lasersets (1 green and 1 red) (NERC)
Scraper (NERC)
Lidded Bioboxes (NERC)
MegaCam (network based compression) (MPI) (not used)
Chisel (IFM-GEOMAR) (not used)
Round-lidded BioBox Barrels (IFM-GEOMAR) (not used)

The IFM-GEOMAR ROV Team consisted of 4 pilots/technicians, 2 technicians/trainee pilots (just joined the team) and was supported by 2 pilot/technicians from NOC during ROV operations.

We would like to thank the master Bill Richardson of RRS *James Cook* and his crew for professional handling of ship and equipment which added to the success of our missions.

Details on individual dives are given in the scientific chapters of this report.

For more information and details on ROV KIEL 6000, please visit www.geomar/kiel6000.

6.3 SHRIMP video sled

James Cooper

Figure 114. The SHRIMP video sled.

6.3.1 Instrumentation

Video/Data	:	*Focal 901* video/data multiplexer
Cameras	:	1 x *Insite Pacific* video camera (From Isis) on pan and tilt
		1 x *Bowtech* LC3 video camera (Rear facing at an angle)
		1 x *Imenco* combined video and digital stills camera with flash and internal light
		1 x *Mini Zeus* (From Isis) HD 1080i high definition camera, downward facing
Lights	:	1 x *Deep sea power and* light 400Watt HID lamps (downward)
	:	2 x 250W halogen lamps (downward)
	:	1 x 250W equivalent LED lamp on pan and tilt unit

Notes specific to JC066/67

1) The Imenco Stills camera was damaged on the second dive and was not operational for the remainder of the cruise.
2) 10cm scaling lasers where fitted mid-cruise and is visible on the HD video feed
3) Power supply noise was present, in particular on the forward-looking insite pacific camera. The best quality images where recorded on the HD system which was installed from salvaged Isis components.
4) Recording was realized using 3 x short play (1hr per disk) DVD recorders and a HD tape deck.

Table 20. Summary of dives for SHRIMP during JC066

Shrimp dive details for JC66, Station, event, date, start position, water depth at start (m), operation times and technical notes

Station	Event	Date	Start Position		Water Depth (m)	Operation Times (GMT)					Notes
			Latitude	Longitude		In Water	On Bottom	Start Recovery	Out of Water	On Deck	
4	3	12/11/2011	41 28.122 S	042 54.330 E	1494	17:30	18:20	04:01	04:22	04:24	SHRIMP Dive 1
4	32	18/11/2011	41 22.537 S	042 52.049 E	689	23:05	23:40	03:22	03:38	03:38	~01:50GMT lost winch power; had to reverse ship to bring SHRIMP safely into deep water while fault investigated. ~01:56GMT SHRIMP powered off, to allow manual investigation in winch room. ~02:33GMT SHRIMP dive resumed, winch fault rectified and vehicle powered up again. ~03:22GMT SHRIMP feed lost when ship rolled, recovering to deck. Dive End Position, 41 22.827S, 042 52.481E.
4	33	19/11/2011	41 22.838 S	042 52.473 E	373	05:50	06:14	07:19	07:30	07:33	Continued to finish up transect from SHRIMP Dive. ~06:33GMT -- Winch fault, had to reverse course to pull SHRIMP off seabed while fault rectified. 06:45GMT -- Winch fault rectified; transect resumed. 07:12GMT -- SHRIMP lost lights; intermittent HD video signal. 07:18GMT -- Started recovery to deck, from depth of ~300m.
4	35	19/11/2011	41 22.850 S	042 52.477 E	373	17:12	17:48	20:45	20:58	20:59	Depth is from ER60.
4	36	19/11/2011	41 23.094 S	042 54.229 E	514	21:47	22:14	02:01	02:16	02:17	Depth is from EA600. Left bottom to recover in time for early a.m. ROV dive and in order to transfer lasers back to ROV. Dive End Position, 41 23.694S, 42 53.411E.

Also SHRIMP dive for JC67.

6.4 HyBIS operations during JC66

Veit Huehnerbach, Marine Geosciences Group, National Oceanography Centre, Southampton, UK

6.4.1 The HyBIS vehicle

HyBIS is a simple, low-cost, multi-purpose, survey and sampling robotic underwater vehicle (RUV) with a depth capability of 6000m. It was designed and built in the UK by Hydro-Lek Ltd. in collaboration with the National Oceanography Centre, Southampton (NOC), back in 2008. Since then, the vehicle has had 3 successful trials cruises and completed 5 scientific expeditions, from the Arctic to the Tropics.

The vehicle has a modular design that make its very versatile, with the top module being a command and power system that comprises power management, cameras, lights, hydraulics, thrusters and telemetry. Telemetry is via a single-mode fibre optic link and provides 3 channels of real-time standard-definition colour video plus vehicle attitude data. Power is supplied through a single-phase 1500V ac, 8kVA umbilical and converted to 3-phase 120V on the vehicle by two silicon motor controllers, 240V ac for the lights, and 24 to 12 V dc for onboard instruments.

The easily changeable lower modules available at the moment include a clam-shell sampling grab, a 5-function manipulator-arm and tool sled, a winch with 600m rope for instrument recovery and an ocean bottom seismometer deployment module. The sampling module used during JC66 comprised a 0.5 cubic metre clam-shell grab with a pay-load capacity of 750kg and closure force of 4 tonnes.

Unlike a conventional ROV, HyBIS does not have any floatation or buoyancy, it is rather suspended by its umbilical cable directly from the ship which makes it slightly susceptible to ship roll and heave motion. On the positive side, the advantage of direct suspension is that HyBIS can recover or deploy a payload of up to 750kg.

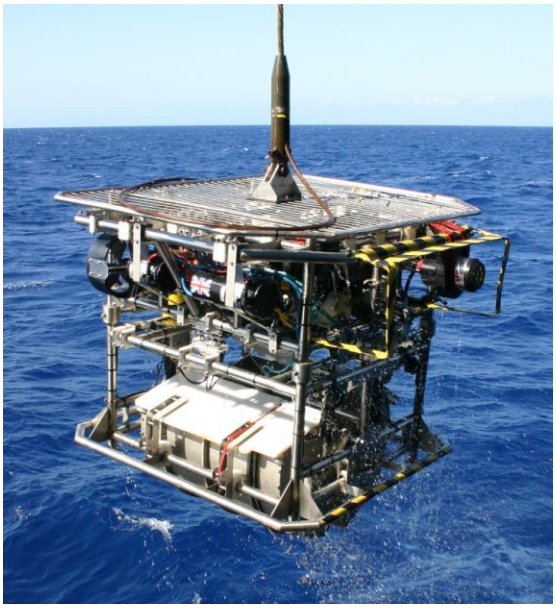

Figure 115. HyBIS vehicle with grab module.

6.4.2 Laboratory control unit setup

The top-side control centre was established in the main lab, on the starboard side, towards the aft and next to the high-voltage bulk-head connections. This minimised the length of trailing high-voltage leads across the lab. The vehicle's primary control box was supplemented with additional monitors and a relay of the USBL navigation screen. A video-extended Cat5 cable was used to relay the forward-looking camera's video stream to a 42-inch flat screen on the forward bulkhead of the main lab to enable group viewing. A dedicated GPS aerial was mounted on an out-rigger over the starboard side and provided a continuously recorded GPS string to the Garmin GPS navigation system in the control box. Winch controls were established adjacent to the vehicle pilot's position, allowing synchronisation between winch operator and pilot.

Video was recorded digitally as DV and AVI formats on 2Tb hard-discs. All three cameras (forward and downward SD and forward HD) were recorded continuously in standard definition. The forward-looking camera with vehicle attitude data overlain was also recorded on DVDs of about one hour length. Full HD video (1080i, PAL, 30fps, AVCHD format) was downloaded from the vehicle's HD camera after the dives at each of the 5 seamounts were completed and copied to another 2Tb hard drive provided. Back-ups of all dive data and videos were then made on regular intervals. All GPS navigation data were recorded on the top-side command unit and copied to a USB portable drive. Time codes were all set and synchronised to GMT.

Acoustic navigation was provided by the 'Sonardyne' USBL system on the RRS *James Cook* and a Super-sub mini transponder on the HyBIS vehicle. Tracking was generally good although transponder battery conditions deteriorated with time and the beacon was changed to a wideband beacon for the later part of the cruise. All available SBL navigation data were recorded by the Sea Systems computing representative onboard.

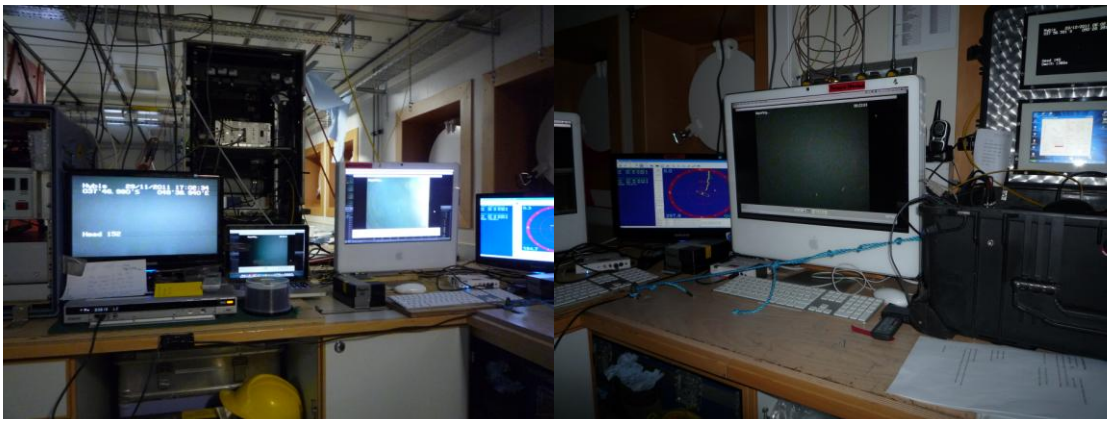

Figure 116 a-c, left to right, top to bottom: Lab setup showing video screen arrangements and main control box.

6.4.3 High-voltage power setup

Prior to the first deployment, a lockable enclosure had to be built in order to comply with UK high-voltage regulation. The 1500V HyBIS power supply, and also the SHRIMP power pack, was placed within the steel cage, inaccessible to the public. HV safe working procedures were put in place which meant that neither HyBIS nor SHRIMP were to be switched on prior to deployment and recovery. All procedures were communicated to and agreed with the crew. HV working permits were issued and signed off for each deployment. In addition, the lab entrance from the deck side was closed off after power up of the HV equipment to limited access to the area.

Figure 117. HV enclosure in the main lab.

6.4.4 Dive narrative and vehicle performance summary

18th November 2011, HyBIS Dive #68
Coral Seamount (41° 23.67S, 42° 52.90E), water depth ~215m
Aim: Video survey from the summit downslope on a northerly course.
SHRIMP was the first vehicle to be used for towed video surveying, therefore HyBIS could only be tested on a 220V deck power supply. These tests were all successful. The vehicle could not be tested on the HV deep-tow cable prior to the deployment. This dive had to be abandoned due to vehicle power problems. A plug of the forward light harness was damaged and seawater leaked inside which shortened out the power.

18th November 2011, HyBIS Dive #69
Coral Seamount (41° 23.66S, 42° 52.90E), water depth ~217m
Aim: Video survey from the summit downslope on a northerly course.
After solving the vehicle power issues HyBIS was redeployed. Unfortunately, now the forward-looking camera malfunctioned. The dive was cancelled immediately and the survey vehicle was changed to SHRIMP in order to keep the loss of survey time to a minimum. The forward-looking camera was successfully repaired during the SHRIMP video survey.

19th November 2011, HyBIS Dive #70
A full dip-test was carried out and all vehicle functions were tested successfully for about 20 minutes while the ship was briefly on station.

23rd November 2011, HyBIS Dive #71
Melville Seamount (38° 46.47S, 46° 42.30E), water depth ~410m
Aim: Video survey along the Northern face of the summit.
The vehicle surveyed along the steep cliff face of the Western part of the summit. After about 3 hours into the dive the starboard thruster failed but video surveying continued. Only when the port thruster failed two hours later the decision was taken to recover the vehicle and inspect the cause – after taking a sediment grab sample. A power cycle solved the problem and the vehicle was re-deployed 15 minutes later to continue the video transect.

24th November 2011, HyBIS Dive #72
Melville Seamount (38° 28.26S, 46° 42.50E), water depth ~1035m
Aim: continue video transect of Dive 71.

24th November 2011, HyBIS Dive #73
Melville Seamount (38° 30.13S, 46° 43.25E), water depth ~851m
Aim: Conduct a short video survey and take a grab sample.
The sediment sample was successfully taken at 993m depth at 38° 30.37S and 46° 42.53E, after about 4 hours of video survey.

25th November 2011, HyBIS Dive #74
Melville Seamount (38° 29.90S, 46° 43.39E), water depth ~910m
Aim: Conduct a short video survey and take a grab sample.
The second grab sample of the night was taken at 906m depth. The position was 38° 29.55S and 46° 43.26E.

25th November 2011, HyBIS Dive #75
Melville Seamount (38° 29.86S, 46° 43.57E), water depth ~920m
Aim: Conduct a short video survey and take a grab sample.
Another sediment sample was collected at 38° 29.53S, 46° 43.40E, at 907m depth. After taking the sample, HyBIS returned to the surface.

25th November 2011, HyBIS Dive #76
Melville Seamount (38° 28.60S, 46° 47.32E), water depth ~682m
Aim: Video survey along transect and take a grab sample.
This dive completed the HyBIS work on Melville Seamount, a sediment grab sample was also taken. Two hours before the end of the dive, the USBL communication between the ship and HyBIS was lost due to low battery power of the beacon.

30th November 2011, HyBIS Dive #81
Middle of What Seamount (37° 58.73S, 50° 22.85E), water depth ~1031m
Aim: Video survey downslope the SW flank of the seamount and grab sample
A strong current parallel to a cliff face was encountered during the dive.

3rd December 2011, HyBIS Dive #82
Middle of What Seamount (37° 56.60S, 50° 26.41E), water depth ~1149m
Aim: Video survey from the top of a small volcanic cone downslope, North of Middle of What Seamount
Strong currents around the summit made surveying challenging during this day-dive but still a big success because the Kiel ROV was unable to dive in these conditions. Oil compression bags were filled and access air bled prior to deployment.

3rd December 2011, HyBIS Dive #83
Middle of What Seamount (37° 57.53S, 50° 25.10E), water depth ~980m
Aim: Video survey along the top of the summit, from East to West

On this dive, along the steep cliff face of the seamount, many overhanging terraces were encountered. Strong currents made it impossible to drive the vehicle around; even the vessel had difficulties maintaining position. Deteriorating weather conditions resulted in the vehicle drifting too far to the North, away from the summit. It was decided to haul in the vehicle to mid-water (800m), while repositioning the ship to the South. Upon payout toward the seabed, the Master cancelled the continuation of the dive as storm force winds made it impossible to keep the vessel on site.

9th December 2011, HyBIS Dive #84
Atlantis Seamount (32° 42.32S, 57° 16.48E), water depth ~703m
Aim: Video survey toward SW, down a landslide headwall
About two hours before the end, the USBL powered down again, hence no vehicle positions are available, but HyBIS was close to the ship during the entire dive. At the end of the dive, a grab sample was taken successfully. Upon recovery it was noted that corals from overhangs along the dive had been caught in the vehicle frame and top cage; these samples were preserved by the biologists.

11th December 2011, HyBIS Dive #85
Atlantis Seamount (32° 41.84S, 57° 17.19E), water depth ~745m
Aim: Video survey along a transect to the West, then to SW, and grab sampling
As soon as HyBIS reached the seabed, the dive plan was slightly changed. Instead of the video survey, it was decided to take a sediment sample with the grab. This was successfully carried out at 32° 41.51S and 57° 17.11E in a water depth of 730m. The vehicle was immediately recovered, then redeployed for the survey.

11th December 2011, HyBIS Dive #86
Atlantis Seamount (32° 41.84S, 57° 17.19E), water depth ~745m
Aim: Video survey along a transect to the West, then to SW, take another grab sample
For this dive the USBL beacon had been changed from a super-sub mini model to a wideband one. Adverse weather conditions (strong winds and high sea swell) forced the bridge to call off the dive, but a second sediment sample was collected at 32° 41.13S and 57° 49.29E. HyBIS needed a power cycle prior to taking the grab sample as both thrusters tripped out.

11th December 2011, HyBIS Dive #87
Atlantis Seamount (32° 40.54S, 57° 13.87E), water depth ~1527m
Aim: Continuation of video survey of dive #86 but in opposite direction (upslope)
Vessel roll and heave of up to 3m made this dive challenging. The survey ended in front of a high cliff face. While hauling in, the winch cable and the vehicle got caught briefly under an overhang which resulted in minor structural damage to HyBIS. On top of the overhang was a terrace with a large abundance of coral and other biota.

6.4.5 Summary

With almost 90 hours of dive time, HyBIS became an integral and important part of the science activity during the two cruises (JC66/67), due to the time-limited ROV work of the *Kiel* 6000 system. HyBIS operated on four seamounts of the Southwest Indian Ocean Ridge system that were investigated during the cruise and did particularly well video surveying down and along the vertical cliffs. It also proved to be a very useful platform in the high current environment around the 'Middle of What' Seamount where the ROV was unable to conduct survey work. In addition, it collected 9 grab samples of predominantly sandy material, which proved to be too difficult to be sampled with conventional coring techniques.

Small technical glitches of a broken video camera and light harness failure were sorted out without major delay to the science program. Thruster failure (mainly of the port thruster) occurred on several dives. This malfunction had only very limited impact on the survey activities of JC66/67. Nevertheless, the limited manoeuvrability during some cliff profile surveying caused minor structural damage to the vehicle which is very much limited to the top cage and part of the lifting gear when the vehicle got once briefly trapped under an overhang.

HyBIS received great support from James Cooper, John Wynar and Russel Locke during this trip. The NMF-techs helped out in several ways, from watch keeping and small vehicle maintenance to junction box change over et cetera; hence the HyBIS success is very much a team effort.

Table 21. Summary of HYBIS dives on JC066.

Station/Event No.	HyBIS Dive No.	Date & Time Deployed	Date & Time Recovered	Notes
JC66-4-30	68	18 Nov – 1623	18 Nov – 1826	Video survey on Coral Seamount. Dive abandoned due to vehicle power problems and camera malfunction.
JC66-4-31	69	18 Nov – 1954	18 Nov – 2035	Video survey on Coral Seamount. Dive abandoned due to camera malfunction.
No station/Event number	70	19 Nov - afternoon	19 Nov – afternoon	20 mins test dive at 10m depth.
JC66-5-12	71	23 Nov – 1706	23 Nov – 2350	Video survey on Melville Seamount. Dive abandoned due to thruster malfunction. Grab sample taken.
JC66-5-13	72	24 Nov – 0007	24 Nov – 0431	Cont. video survey of dive 71 (Melville Seamount). Grab sample taken.
JC66-5-17	73	24 Nov – 1959	25 Nov – 0204	Short video survey on Melville Seamount. Grab sample taken.
JC66-5-18	74	25 Nov – 0247	25 Nov – 0445	Short video survey on Melville Seamount. Grab sample taken.
JC66-5-19	75	25 Nov – 0514	25 Nov – 0653	Short video survey on Melville Seamount. Grab sample taken.
JC66-5-21	76	25 Nov – 1622	26 Nov - 0020	Video survey on Melville Seamount. Grab sample taken. USBL signal lost for part of the survey (low battery power).
HyBIS Dives 77-80	were	part of	JC67	(See separate cruise report)!
JC66-6-2-	81	30 Nov – 1945	1 Dec – 0258	Video survey on Middle of What Seamount. Grab sample taken.
JC66-6-12	82	3 Dec – 0524	3 Dec – 0853	Video survey on Middle of What Seamount.
JC66-6-13	83	3 Dec – 0940	3 Dec – 1235	Video survey along central ridge on Middle of What Seamount. Dive cut short (adverse weather conditions).
JC66-8-4	84	9 Dec – 1647	10 Dec – 0259	Video survey along SW transect of Atlantis Seamount. Grab sample taken. USBL signal lost for part of the survey (low battery power).
JC66-8-8	85	11 Dec – 1300	11 Dec – 1420	Grab sample taken prior to start of video survey in Western part of Atlantis Seamount.
JC66-8-9	86	11 Dec - 1428	11 Dec – 2050	Video survey in Western part of Atlantis Seamount. Grab sample taken. Dive cut short (adverse weather conditions).
JC66-8-10	87	11 Dec - 2206	12 Dec – 0255	Continuation of dive 86, but in opposite direction (upslope) due to adverse weather.

6.5 JC66/67 National Marine Facilities – Sea Systems Support

6.5.1 Introduction

The NMFSS technical team provided 24-hour operations support throughout the cruise. Day work was targeted at ROV operations due to a ~12hr *Kiel* ROV defined operation limit and at night with a combination of CTD, Microstructure profiler, Hybis, SHRIMP, coring and nets, and geophysics surveys. A watch system was implemented in agreement with the chief scientists that maximised programme flexibility with respect to technical expertise and hours of rest in the event the ROV was inoperable due to weather or technical downtime.

A couple of health & safety issues during the cruise required addressing – a High Voltage (HV) safety cage was constructed to surround the HV components in the main lab for Hybis and SHRIMP operations with production of procedural documents including winch room access generated. Notification for aft deck red zone working with stern rails removed the requirement for life jackets and harnesses and the use of electrical insulating gloves when non-isolated HV equipment and cables were handled.

6.5.2 NMFSS Enhancements to ROV Kiel 6000

At pre-cruise meetings it was identified that a number of enhancements to the ROV system were required to meet the scientific requirements. From the outcome of a meeting in Kiel a list of actions was generated below.

From a selection of the *Isis* ROV equipment prepare

- 4 x Titanium Major fluid samplers
- Inductively coupled temperature probes in support of the Major samplers
- Manufacture an adaptor for the Orion manipulator to mount a hydraulic trigger ram for activation of the Major samplers
- T-handle Vent Funnel
- T- handle Box cores 2 x small, 2 x Large
- Interface Temperature probe
- Sample boxes – a selection to fit and compatible with the Kiel tool sled 400mm height limit
- Scoops / nets
- Laser scalars
- USBL Navigation beacon
- Video data recording solution
- ADCP ROV deployed lander

All equipment above fitted with a 12mm T- Handle required manufacture and replacement with 20mm handles to fit the Kiel Orion manipulator grip.

6.5.3 Video Recording / Display

A requirement to provide continuous HD Video recording during dives, not provided by the *Kiel* system, offered the opportunity to advance the *Isis* HDV tape recorders to a hard disk solution. This provided superior quality video recording with Apple ProRes 422 (1.5 TB / 24 hrs.) compared with HDV (270GB / 24 Hrs.) in tape format. Benefits resulting with ease of video management and significant cost reduction in consumables.

The equipment was setup in the main lab for scientific operation - an Apple IMac computer, AJA KiPro recorder with 500GB disk caddies and 6TB Western Digital Mybooks for archiving master and backup copies. As a fall back in the event of equipment failure suitable HDV tape quantities were available to cover the cruise requirements. The *Isis* HDV tape recorders shared between SHRIMP operations. It is noted that scientists found the Proxsys network software used by *Kiel* to be a good solution for access to server stored media files.

The *Kiel* single control container, which allows a maximum of 2 scientists during dives, required a remote display setup in the main lab for the benefit of other scientist participation. To achieve this, a dual single mode fibre cable was installed, channelled through the Bosun store, deck lab and through the forward door to the corridor. From here the cable was inserted into the existing conduit and fed into the main lab via the pass through next to the winch room hatch. The obvious alternative route through the ship's coaxial junction boxes was initially attempted but the degradation in signal prevented this despite insertion of repeater amplifiers.

2 off HD-SDI channels fed both HD camera and multi-windowed display from the ROV control container, HD to the video recorder with pass through to a local, component input HD 32" TV and via an HDMI extender over CAT5 cable to the scientific plot table TV display. The multi-windowed display utilised a *Kiel* HDMI projector and fold down screen.

Chief scientist Alex Rogers was provided with 2 x 6TB + 1 x 2TB WD MyBook master data disks for JC66 with backup equivalents shipped in NMFSS equipment container.

6.5.4 Temperature Probe

The thermocouple probe and electronics bottle were mounted on the ROV for the duration of the cruise, primarily required for JC67. A pressure-balanced oil filled (PBOF) lead linked the serial and 24V power lines via a Schilling connector adaptor bottle to the ROV Node. Software to display temperatures was installed on the *Kiel* system computer. The cable from the bottle to the thermocouple lance was routed along the outside of the suction sampler hose, to provide good cable management, with the thermocouple strapped to the sample pipe. During one dive the pipe broke whilst sampling, dragging the probe on the seabed. On recovery the probe was replaced due to a fault.

6.5.5 Lasers

Two sets of 3 lasers were mounted on equilateral 10cm spacing brackets. One set of red lasers strapped to the HD camera housing and the other set of green lasers strapped to the upper pan & tilt camera housing; these were used for object scaling purposes. 24V power was supplied from the ROV via Schilling connector adaptor bottles to the two harnesses. The green lasers were used mainly in mid-water benefitting from their superior visibility. During the cruise the alignment accuracy of the lasers were checked and adjusted in the lab. It was found that the internal laser modules were not in alignment with their housings. This will be followed up with the company on return.

6.5.6 Sample Boxes & Tooling

At the start of the cruise, scientists were shown the variety of sampling equipment to establish dive setup permutations. The port drawer had a large fixed box used regularly for stowage of push cores with space behind for lose items. Attached to the front of the box attached a lidded sample box. This sample box had to be sacrificed if Box core's or Niskin bottles were required. The starboard drawer had two smaller sample boxes attached but had to be sacrificed if a high-resolution megacam was required. A selection of scoops / nets were fixed to the porch.

6.5.7 Acoustic Navigation

A Sonardyne Wide-band Compatt midi and supersub mini (backup) were mounted to the ROV light bar for monitoring with the shipboard Ranger software on all dives. It was decided to set the beacons in a self-contained transponder mode to avoid additional power and trigger interfacing complexity with the ROV system for responder mode.

Communication problems identified during the JC65T trials cruise, when the ROV was near the seabed, were easily rectified on the cruise by surrounding the Compatt transducer cage with rubber sheet. It is thought that the noise spectrum generated by the ROV components were reflected from the seabed generating a high ambient noise condition for the beacon.

An opportunity was provided during the first ROV dive to check the acoustic calibration accuracy by conducting a ship 180-degree spin test with the ROV sitting on the seabed i.e. a fixed beacon position. The result indicated an acceptable accuracy for the water depth.

6.5.8 Acoustic Doppler Current Profiler (ADCP)

A solution for seabed ROV positioning of a frame mounted ADCP unit was available but not used.

6.5.9 Major Samplers

A solution for vent fluid sampling was available but not required.

6.5.10 Adjustments

It should be recognised that attempts were made to improve push core sampling in fine sediment with fabrication of makeshift core catcher devices and additional scoop fabrication for collection of coral fragments.

6.5.11 ROV Observations

It was clearly demonstrated that operational weather windows are reduced when stern working. The ideology of utilising the ship A-frame and potentially ship winches having benefits with reduced equipment shipping and mobilisation issues does not outweigh the overall efficiency benefit to science of a simple ship side deployed method, a solution that requires 4 ROV team and 2 crew for deployment and recovery. Stern deployment requires all hands (8 team members) on deck with significant increased risk to equipment and personnel.

Comparing watch patterns it is inefficient within a 24/7 ship operations environment to make available a major ROV facility for only 12 hrs a day. The knock on affect is any maintenance procedures or equipment changes impact significantly on routine daily operations and flexibility in deployment and recovery times is lost. It should be recognised to achieve 24/7 coverage requires at least 2 competent persons with pilot and manipulator skills and broad knowledge across the watch for maintenance and dive turn around. This approach allows for introduction of at least one trainee per watch not 4 winch drivers as per this cruise. The single control van accommodating 2 operators and 2 scientists is very limiting. In the case above, training of people is far more accomplished with the inclusion of a 3rd operator. This position should have included responsibility for winch control removing the deck setup requirement of remote display, deckchairs and canopy. Routine inspection rounds with CCTV monitoring of winch and wire runs would be safe & adequate.

6.5.12 ROV Vehicle Setup

6.5.12.1 Tool draws & Porch

The *Kiel* 2 front extendable / retractable drawer approach with an HD camera centralised low down within the tool skid greatly reduces the sampling device configuration flexibility. With the HD camera raised above the tool sled the full utilisation of space is achieved without obscuring the HD camera viewport. I struggle to see the true benefit of having 2 drawers whereas I believe one full width drawer would provide more stowage flexibility. There are additional benefits when operating close to a cliff face / slope in that when the vehicle is pushed in to the face for stability the vehicle maybe pushed back with uniform extension of the drawer providing clearer space with which to use the manipulators. I witnessed on a number of occasions difficulty during these operations with only the space clearance the porch provides. With more drawer space sample boxes and tooling can be optimally setup to reduce tool selection and routine housekeeping overhead when sampling with the manipulators.

6.5.12.2 Manipulators

The *Kiel* system is equipped with a dextrous proportional controlled starboard mounted 7 function Schilling Orion and port mounted Rigmaster. The rate controlled Rigmaster was only in action during the release of the 2 whale bone moorings. I would recommend the installation of a 2nd Orion to replace the Rigmaster to aid sampling processes. This would maintain the servicing knowledge and spares compatibility.

6.5.12.3 Lighting

The lighting requirements were adequate for the cruise but as HD video benefits from high illumination and for redundancy purposes I would add another HMI or LED equivalent circuit for forward or downward illumination when video mosaicing. In addition a lighting circuit to support rear camera viewing is recommended.

6.5.12.4 Kongsberg Digital Still Camera

Problems associated with the Kongsberg digital still camera in focussing ability during ROV movement require the camera to be inspected and serviced by Kongsberg. I used the same camera model during JC60 earlier in the year without problems. An associated strobe would be beneficial.

6.5.12.5 MegaCam

This large camera to provide high resolution, forward looking digital still images was not used. To mount on the ROV would require removal of the 2 starboard sample boxes. Effort should be focussed in upgrading the Kongsberg still camera.

6.5.12.6 Slurp Gun / Sample Carousel

The Slurp hydraulic pump routinely caused the most problems during the cruise. The pump design is not ideally suited for these operations with the bearing needing regular servicing due to failure of the mechanical seal. Water was regularly sucked into the hydraulic oil during operations requiring maintenance after each dive. It is recommended to source a more robust pump to replace it. I will forward information to the *Kiel* team about the *Isis* pump on my return.

6.5.12.7 Winch

The direct pull electric winch worked very well. The scrolling was accurate and being electric was very quiet in operation. A good design all housed in a container.

6.5.12.8 Electrics

2 pre-installed electrical junction boxes in the hangar provided power for the winch and Control / workshop containers.

6.6 Mechanical/Coring Report

Neil Sloan

6.6.1 Coring

Scientific coring requirements were met during the cruise with a combination of Box and Mega core devices. A multicore was also made available but was not used. The sediment consistency found during the cruise made coring with these devices difficult. The combination of fine sandy / coral / stony / thin sediment throughout the seamount worksites combined with at times high currents and seas prevented good penetration and capture of cores. Coring events detailed in table below show that in spite of these conditions a number of successful samples were obtained.

During these coring events some damage was sustained to both corers.

Box core

- No mechanical issues.
- Bent core box
- Please see core table for data.

Mega Core

- 7 Tubes broken.
- 1 Bottom closer shaft bent.
- 1 Broken bottom catcher.
- 2 Shutter closing spring broken.
- Please see core table for data.

Multicore

- Unused

JC066 Core Details							
Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E6		Mega Core		Core	41' 28.09 S	42' 24.14 E	1505
MWO	Pull out (T)	Rig					
1515	2.05	4 tubes. No sample					
Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E7		Mega Core		Core	41' 28.09 S	42' 24.14 E	1505
MWO	Pull out (T)	Rig					
1515	2.3	4 tubes. No sample					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E8		Mega Core		Core	41'26.37 S	42' 53.71 E	1061
MWO	Pull out (T)	Rig					
1069	2.37	4 tubes. 2 samples. Course sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E13		Box Core		Core	41'26.37 S	42' 53.71 E	1061
MWO	Pull out (T)	Rig					
1067	1.39	standard bucket. Course sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E14		Box Core		Core	41' 25.29 S	42' 53.12 E	576

MWO	Pull out (T)	Rig
584	1.22	standard bucket. Did not trigger

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E15		Box Core		Core	41' 25.27 S	42' 55.12 E	576
MWO	Pull out (T)	Rig					
586	1.51	standard bucket. 1/2 full sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E16		Box Core		Core	41' 20.73 S	42' 55.38 E	1403
MWO	Pull out (T)	Rig					
1413	2.36	standard bucket. 1/2 full sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E17		Box Core		Core	41' 21.35 S	42' 55.10 E	950
MWO	Pull out (T)	Rig					
960	1.85	standard bucket. 1/2 full sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E18		Box Core		Core	41' 21.35 S	42' 55.10 E	950
MWO	Pull out (T)	Rig					
960	1.89	standard bucket. 1/4 full sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E18		Mega Core		Core	41' 21.35 S	42' 55.10 E	954
MWO	Pull out (T)	Rig					
962	1.61	4 tubes. 2 samples.1 full - 1 1/2 full Course sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E19		Mega Core		Core	41' 22.35 S	42' 54.61 E	740
MWO	Pull out (T)	Rig					
748	1.43	4 tubes. No sample. 1 slider broken					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E20		Mega Core		Core	41' 22.35 S	42' 54.61 E	740
MWO	Pull out (T)	Rig					
750	1.48	4 tubes. 2 samples.1 full. Course sand/stones. 1 broken tube.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S4 E21		Mega Core		Core	41' 22.98 S	42' 54.23 E	568
MWO	Pull out (T)	Rig					
578	1.28						

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S5 E22		Mega Core		Core	38' 27.74 S	46' 42.59 E	1382
MWO	Pull out (T)	Rig					
1392	2.28	4 tubes. 4 full. Sand/stone					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S5 E23		Mega Core		Core	38' 27.74 S	46' 42.59 E	1384
MWO	Pull out (T)	Rig					
1394	1.96	4 tubes. 3 full. 1 tube broken. Sand/stones/coral					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S6 E6		Mega Core		Core	37' 57.43 S	50' 24.73 E	1010
MWO	Pull out (T)	Rig					
1020	1.7	4 tubes. No sample. 1 tube broken.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S6 E9		Box Core		Core	37' 59.65 S	50' 20.67 E	1537
MWO	Pull out (T)	Rig					
1547	2.17	standard bucket. 1/4 full sand/stones					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S6 E10		Mega Core		Core	37' 57.92 S	50' 24.51 E	1121
MWO	Pull out (T)	Rig					
1129	1.77	4 tubes. 3 full. 1 tube and stem broken.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S6 E11		Mega Core		Core	37' 57.92 S	50' 24.51 E	1100
MWO	Pull out (T)	Rig					
1108	1.66	6 tubes. 2 1/4 full. Sand coral.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E11		Mega Core		Core	32' 43.32 S	57' 15.02 E	859
MWO	Pull out (T)	Rig					
869	1.59	4 tubes. No sample.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E12		Mega Core		Core	32' 43.32 S	57' 15.02 E	860
MWO	Pull out (T)	Rig					
868	1.73	4 tubes. 3 1/4 full. Sand/coral.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E13		Mega Core		Core	32' 41.23 S	57' 16.12 E	983
MWO	Pull out (T)	Rig					
991	1.88	4 tubes. No samples					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E14		Mega Core		Core	32' 43.35 S	57' 14.99 E	876
MWO	Pull out (T)	Rig					
882	1.71	2 tubes. 1 1/4 full. Sand/coral					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E15		Mega Core		Core	32' 43.35 S	57' 14.99 E	876
MWO	Pull out (T)	Rig					
884	1.69	4 tubes. No samples.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E16		Mega Core		Core	32' 42.18 S	57' 14.42 E	1582
MWO	Pull out (T)	Rig					
1592	2,04	2 tubes. 2 full. Sand/stone.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8		Mega Core		Core	32' 42.18 S	57' 14.42 E	1582
MWO	Pull out (T)	Rig					
1590	2.16	4 tubes. 4 1/2 full. Sand/coral/pebbles.					

Core stn	Date	Type	Weight (T)	Wire	Lat	Long	Depth (m)
S8 E18		Mega Core		Core	32' 42.18 S	57' 14.42 E	1580
MWO	Pull out (T)	Rig					
1590	2.13	4 tubes. 2 1/4 full. Sand/coral.					

6.6.2 Super Crane

The starboard mounted deck crane was used for regular movement of mid-ship equipment.
Notification of:

- Slew Lever on valve block sticking.
- Grease nipple on slew has been pulled out which has also pulled out heli- coil.
- Paint on jib extensions starting to flake.

6.6.3 Lebus 5T GP Winch

This winch was mounted middle of aft deck for retention of ROV Snubber frame during recovery and deployment and operated without problems.

6.6.4 Milli-pore

No problems.

6.6.5 Fume Hoods

Bottle mounts were manufactured onboard and fixed within the fume hood to aid scientific dispensing.
The following chemical was used in chemistry lab fume hood for 6 days:

- Glutaraldehyde 20%

The following chemical was used in wet lab fume hood for the entire trip:

- Ethanol 70%
- Formalin 4%

6.6.6 Laminar Flows

No problems.

6.6.7 Additional Work

High Voltage Safety Cage construction for Hybis and SHRIMP operations.
ROV Tooling, Slurp gun motor, Sample box repair.

6.6.8 Lost equipment Report

6.6.8.1 Oxford supplied Ring Net

The Bongo net comprises a steel ring frame of diameter 2 meters with attached 6 meter long 4 mm mesh net. A bridle for towing was supplied by NMFSS. The net was deployed over the starboard side using the ship trawl wire routed through the Main crane block During the 5th operation the net became detached from the 8mm plastic coated steel pennant wire linking the net bridle to the hammer lock swivel. On recovery only the swivel, hammer lock and 180Kg depressor weight returned.

The Ring net operating depth was 500m we achieved this by paying out 1000m of trawl wire and towing the net at 2.5 knots. Once at operating depth the net was towed for 10min. Net deployment speed was 20m/min and recovery speed was 30m/min.

It is our assumption that the pennant line failed. Please see winch graph and net picture in Section 5.

6.7 NMFSS Sensors and Moorings CTD Report

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6.7.1 CTD System Configuration

The initial sensor configuration was as follows:

Sea-Bird 9*plus* underwater unit, s/n: 09P-0943
Frequency 0 - Sea-Bird 3 Premium temperature sensor, s/n: 03P- 2674
Frequency 1 - Sea-Bird 4 conductivity sensor, s/n: 04C-2231
Frequency 2 - Digiquartz temperature compensated pressure sensor, s/n: 110557
Frequency 3 - Sea-Bird 3 Premium temperature sensor, s/n: 03P - 4872
Frequency 4 - Sea-Bird 4 conductivity sensor, s/n: 04C-3258
V0 - Sea-Bird 43 dissolved oxygen sensor, s/n: 43-0862
V2 - Benthos PSA-916T 7Hz altimeter, s/n: 41302
V3 – WETLabs turbidity sensor, s/n: BBRTD-759R
V4 – Seatech Light Scatter Sensor s/n:339
V5 – Chelsea Aquatracka MKIII fluorometer, s/n: 88-2960-163
V6 - Free
V7 – Chelsea Alphatracka MKII transmissometer, s/n: 161047

Ancillary instruments & components:

Sea-Bird 11*plus* deck unit, s/n: 11P-24680-0587
Sea-Bird 24-position Carousel, s/n: 32-60380-0805
24 x Ocean Test Equipment 10L water samplers, s/n: 1A through 24A

6.7.2 CTD Operations

There were 51 individual CTD casts were made. Log sheets were scanned and included with the data from this cruise.

The pressure sensor was located 30cm below the bottom and approximately 75cm below the centre of the 10L water sampling bottles.

The configuration file used was JC066_7_NMEA.xmlcon (see Appendix 1) from cast 1 to 10 inclusive. Due to the replacement of the transmissometer (see below), configuration file JC066_7_NMEA_a.xmlcon was used from cast 11 onwards.

6.7.3 Sensor Failures

Transmissometer s/n: 161048 was used from cast 11 onwards in an attempt to remove the hysteresis that s/n: 161047 exhibited at depth. The fluorometer cable was cleaned at the same time and later replaced.

6.7.4 Data Processing

CTD cast data was post-processed according to guidelines established with BODC (ref. Moncoiffe 7th July 2010). After plotting oxygen against pressure using Seaplot an oxygen advance of 8 seconds was chosen.

WildEdit was not used during processing, it being deemed unnecessary. LoopEdit was employed during processing but saved as a separate file and no further processing carried out on those files.

No bottle file exists for CTD 4 since no water samplers were closed on that cast due to a winch failure. Similarly, no bottle files exist for casts 19 to 30 inclusive because no water samplers were tripped. Due to a period of poor weather during casts 32 to 36 inclusive, water samplers were tripped "on the fly" but processed as above. Casts 19 to 31 inclusive were part of a full water column "Yo-yo" CTD cast.

6.7.5 Salinity measurement

A Guildline Autosal 8400B salinometer, s/n: 68426, was used for salinity measurements. A total of 88 salinity samples were taken during the cruise for CTD analysis. The salinometer was sited in the Chemistry Lab, with the bath temperature set at 24°C, the ambient temperature being approximately 23°C. A bespoke program written in Labview called "Autosal" was used as the data recording program for salinity values, and results were plotted via an Excel spreadsheet (see JC066-67_SAL).

The results indicated that the secondary conductivity sensor, before corrections were applied, more accurately measured the salinity profile. This should indeed be the case as it was mounted on the CTD vane in more open water.

6.7.6 TRDI LADCP Configuration

The TRDI WHM 300kHz LADCP (s/n: 4275) was deployed in a downward-looking orientation on the CTD frame. Battery voltage could be monitored as the cable was not diode protected. The instrument was configured to ping at intervals of one second, use 16 bins, a blanking distance of 5m and a depth cell size of 10m thus yielding a range of approximately 165m in ideal conditions. The ambiguity velocity was set to 250 cms^{-1} and pings per ensemble to 1.

Built-in pre-deployment tests *(PA, PC2 and PT200)* were run before each cast, and then the following command file sent *(F2)*:

Master command file (WHM_JC66.txt)

```
PS0
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0011101
WM15
WW1
WD111100000
WF0500
WN016
WP00001
WS1000
WV250
SM1
SA001
SW05000
TE00:00:01.00
```

TP00:00.00
CK
CS

6.7.6.1 Deployment Comments

Each deployment BBtalk terminal session was logged to a file (*F3)* of the form: *JC66_XX.txt*, where *XX* is the first CTD cast number at the start of the deployment. Hence during yo-yo's there could be many CTD files but only one LADCP file. Downloaded data files were re-named to be of the form: *JC66_XXm.000*.

The real-time clock of the LADCP was checked prior to deployment *(TS?)* and re-synchronised with the ship's GPS clock if it was more than a few seconds in error. The time difference was written on the log sheet.

Paper log sheets were used for all casts, the LADCP file number being defined by the CTD cast number.

6.7.7 APPENDIX 1

Initially, the config file used was the following:

Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\JC066_67\JC066_7_NMEA.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Surface PAR voltage added : No
Scan time added : No

1) Frequency 0, Temperature

Serial number : 03P-2674
Calibrated on : 13 April 2011
G : 4.35675162e-003
H : 6.42193937e-004
I : 2.34494364e-005
J : 2.29940020e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2231
Calibrated on : 12 April 2011
G : -1.07697431e+001
H : 1.69453083e+000

I : -2.49118239e-003
J : 2.97276980e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 110557
Calibrated on : 26 April 2009
C1 : -6.010548e+004
C2 : -1.565601e+000
C3 : 1.823090e-002
D1 : 2.668300e-002
D2 : 0.000000e+000
T1 : 3.020528e+001
T2 : -6.718318e-004
T3 : 4.457980e-006
T4 : 1.203850e-009
T5 : 0.000000e+000
Slope : 0.99994000
Offset : -1.08250
AD590M : 1.280700e-002
AD590B : -9.299644e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4872
Calibrated on : 19 April 2011
G : 4.34380421e-003
H : 6.38106056e-004
I : 2.07199354e-005
J : 1.68084099e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-3258
Calibrated on : 12 April 2011
G : -1.06523753e+001
H : 1.35929693e+000
I : 4.08972236e-004
J : 4.40882550e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

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

Serial number : 43-0862
Calibrated on : 10 March 2009
Equation : Sea-Bird
Soc : 4.36200e-001
Offset : -4.99200e-001
A : -1.09340e-003
B : 9.78700e-005
C : -2.32650e-006
E : 3.60000e-002
Tau20 : 1.37000e+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 : 41302
Calibrated on : 20 April 2007
Scale factor : 15.000
Offset : 0.000

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

Serial number : BBRTD-759R
Calibrated on : 18 May 2010
ScaleFactor : 0.003130
DarkVoltage : 0.048000

10) A/D voltage 4, Free

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

Serial number : 88-2960-163
Calibrated on : 11 February 2010
VB : 0.044200
V1 : 2.046800
Vacetone : 0.201400
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

12) A/D voltage 6, Free

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/WET Lab CStar

Serial number : 161047
Calibrated on : 18 March 2008
M : 23.7757
B : -0.4636

Path length : 0.250

After changing the transmissometer, the config file used was as follows:

Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\JC066_67\JC066_7_NMEA_a.xmlcon

and changed to:

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/WET Lab CStar

Serial number : 161048
Calibrated on : 28 May 2008
M : 24.5574
B : -0.4420
Path length : 0.250

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