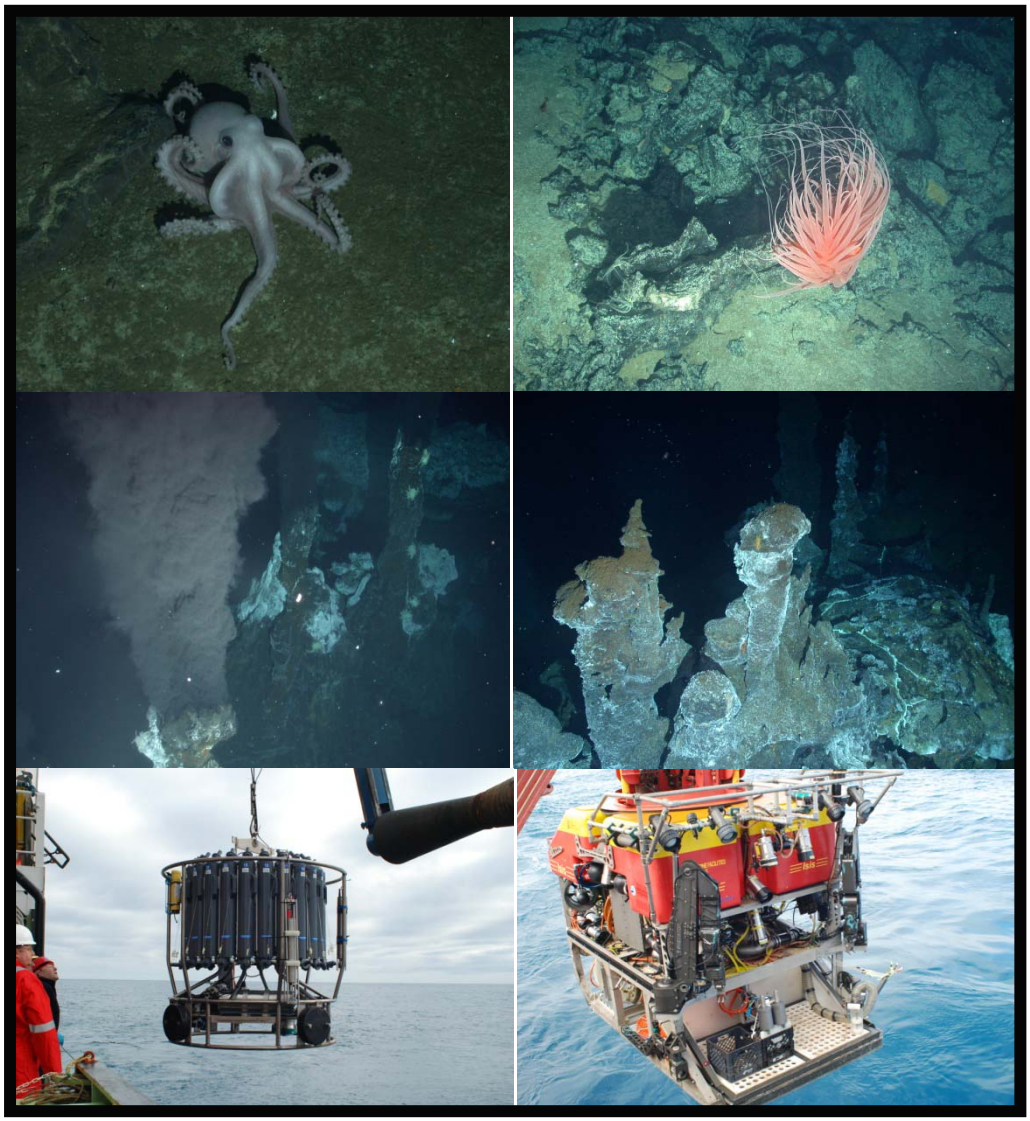
Chemosynthetic Ecosystems of the Southern Ocean (CHESSO)

RRS James Cook Cruise 42



Cruise Report

Edited by Dr Alex David Rogers

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1.0 Summary

The following report comprises an account of the work carried out on RRS *James Cook* Cruise JC42. This cruise was a follow-up to RRS *James Clark Ross* Cruise JR 224 on which seeps and hydrothermal vent sites were located using CTD casts and vents filmed using a towed camera system, SHRIMP. The cruise was aimed at investigating chemosynthetic environments in the Atlantic sector of the Southern Ocean, including a putative methane-seep off South Georgia, deep-sea hydrothermal vents on the East Scotia Ridge, a putative hydrothermal vent site in McIntosh Crater, and a putative seep site at Douglas Strait. The main sampling equipment for these investigations included CTDs and the ROV *Isis*. These cruises represent the first and second cruises of the Chemosynthetic Ecosystems of the Southern Ocean (CHESSO), funded by the Natural Environment Research Council.

The methane-seep at South Georgia was not located. Deep-sea hydrothermal vents on E2 and E9 Segments of the East Scotia Ridge were relocated, surveyed and sampled for biology, chemistry and geology using the ROV *Isis*. Extensive hydrothermal vent-endemic biological communities were found at these vents. High temperature vent fluids were sampled (temperature >350^{o}C) and vent plumes surveyed and sampled using CTD casts and in-situ water sampling using ROV niskin bottles. At McIntosh Crater a large area of seeps and warm vents were located, partially hosted in sediment and partially in basalt. Vent/seep-endemic biological communities were located at these sites and differed from those at E2 and E9. Biological, chemical and geological samples were taken and the sites of venting surveyed. In addition, a whale skeleton, probably of a humpback whale (*Megaptera novaeangliae*), was located and a whale-fall community, including the siboglinid worm *Osedax*, documented and sampled. Because of the novel nature of this new site it was decided to abandon plans to survey Douglas Strait. Overall, the cruise was the first to document and sample live organisms from hydrothermal vent and seep communities in the Southern Ocean and Antarctica (south of latitude 60^{o}S).

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Second Officer	Malcolm
Third Officer	Vanessa Laidlow
Purser	Paul Lucas
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Second Engineer	John Hagan
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ETO	Alan
Deck Engineer	Viv Wythe
Bosun (CPO-D)	Kevin Luckhurst
CPO-S	Steven Smith
POD	Iain Thompson
A/B	John Dale
A/B	Steven Gallagher
A/B	Nathaniel Gregory
A/B	Robert Spencer
ERPO	Emlyn Williams
Head Chef	Darren Caines
Chef	Dean Hope
Steward	Peter Robinson
Catering Assistant	Brian Conteh

Figure 2.1. JC42 Science/ROV Team/Chief Engineer Photograph

3.0 Cruise Science

3.1 Introduction

In the 1970s it was recognised that measurements of heat flow from young oceanic crust fit thermal models of cooling of the lithosphere very poorly. This suggested that heat may be being lost through convective hydrothermal processes as well as conductive heating (Tyler *et al*., 2003; Van Dover, 2003). It was the search for convective hydrothermal fluids that first revealed the spectacular biological communities around hydrothermal vents at the Galapagos Rift in the East Pacific in 1977. It quickly became apparent that the communities at vents were driven by chemical energy through bacterial-mediated chemosynthesis, with larger organisms either grazing bacteria or harbouring chemosymbionts in their tissues. Hydrogen sulphide was the main source of energy for the microorganisms at hydrothermal vents, but other sources of energy were also utilised, including methane. This changed the perception that all biological productivity was reliant on photosynthesis, changed ideas about the early stages of life on Earth and opened the possibility for life in places previously thought to be azoic, including layers of basalt within the Earth's crust and even elsewhere in the solar system and beyond. In the early 1980s another type of chemosynthetic environment, cold seeps, were discovered at the base of the western Florida escarpment where methane rich fluids escaped from the sea floor. Hydrogen sulphide was also present at these sites through sulphate reduction using methane by bacteria.

Research on the vent biota has focused on chemosynthesis, the chemosynthetic basis of food webs at hydrothermal vents and physiological adaptations to an environment hostile to most forms of life because of high temperatures and the presence of toxins such as hydrogen sulphide. However, hydrothermal vent communities have also provided useful models for studying dispersal, evolution and biogeography in the deep ocean. Hydrothermal vent taxa are notable for their remarkable levels of endemism with 82% of species only occurring at vents (McArthur & Tunnicliffe, 1998). High levels of endemism have also been observed at cold seeps although in general the fauna is less well known and understood than at hydrothermal vents (Sibuet and Olu, 1998). It was thought that the high endemism at chemosynthetic

communities, especially at the genus and family level, reflected an ancient origin for many of the groups of fauna (Campbell, 2006). However, palaeontological studies have revealed that Palaeozoic chemosynthetic taxa became extinct and vent and seep taxa are largely Cenozoic and Mesozoic in origin, a finding supported by molecular phylogenetic studies (Little & Vrijenhoek, 2003; Kiel & Little, 2006; Campbell, 2006). There is speculation that this later origin of vent fauna reflected a susceptibility to past climate change events leading to widespread oceanic anoxia/dysoxia, particularly at the end of the Cretaceous (Little & Vrijenhoek, 2003). Such a hypothesis is not thought to be correct for seep fauna which show origins in the Cretaceous or Jurassic (Kiel & Little, 2006), although it should be noted that the species richness of seep faunas declines with increasing depth (Sibuet & Olu, 1998) perhaps suggesting a refugia from deep-ocean anoxia for these organisms in shallow water.

Amongst extant hydrothermal communities it has been recognised that regional faunas are distinct. The Galapagos Rift fauna was dominated by giant tubeworms (*Riftia pachyptila*), clams (*Calyptogena magnifica*), mussels (*Bathymodiolus thermophilus*) and a number of other gastropods and polychaetes (Tyler *et al*., 2003). Further discoveries of vents at 21^{o}N and 13^{o}N, on the East Pacific Rise, revealed a similar fauna to that of the Galapagos Rift with the addition of the pompey worms (Alvinellidae) on high temperature chimneys at these sites. Further discoveries in the Gulf of California and the Guaymas Basin also revealed a similar fauna, although the latter was a sediment-hosted vent site with significant differences in fauna resulting from a different environmental setting (Tyler *et al*., 2003). Together, it became apparent that the vents of the East Pacific Rise and Galapagos Rift formed a single biogeographic province.

The discovery of hydrothermal vents in the Northeast Pacific in 1981 revealed a fauna related to the East Pacific Rise at the generic and family level but with different species. For example, vestimentiferan tube worms were present but instead of *Riftia pachyptila*, the species *Ridgeia piscesae*, *Tevnia jerichonana* and *Oasisia alvinae* occurred (Tyler *et al*, 2003; see Tunnicliffe *et al*., 1998 for review). Until 30MA these two ridge systems were thought to be continuous and were isolated when the North American Plate overrode the mid-ocean ridge (Bachraty *et al*., 2009). Following the

separation of the two ridge systems the fauna diverged sufficiently to form two separate biogeographic provinces although taxa remain closely related. As further hydrothermal vent systems were discovered, with more distinctive faunas, other biogeographic provinces were proposed. The first global biogeographic model for hydrothermal vents was proposed by Tunnicliffe (1997) on the basis of faunal similarity and geological history. This classification included seven provinces: Atlantic, Japan-Mariana basins, West-Pacific, Northeast Pacific, Northern East Pacific Rise, Galapagos and Southern East Pacific Rise. Mironov (1998) reduced these to four provinces on the basis of analyses of both hydrothermal vent and non-vent fauna. Tunnicliffe *et al*. (1998) revised her scheme to include consideration of cold-seep communities and identified five provinces: Northeast Pacific, West-Pacific, Mid-Atlantic Ridge, Southern East Pacific Rise, Southwest Pacific from the Fiji basin. New discoveries of vent fields in the Indian Ocean led to the identification of six vent provinces by Van Dover *et al*. (2002): East Pacific Rise, Northeast Pacific, Western Pacific Back-Arc Spreading Centres, Azores, Mid-Atlantic Ridge and Central Indian Ocean. Tyler and Young (2003) recognised nine biogeographic provinces including: East Pacific Rise, North- east Pacific, Mid-Atlantic Ridge, Western Pacific, the Western Pacific Back-Arc Basins, Loihi Seamount, Indian Ocean, and two potential new provinces (but unexplored), including the East Scotia Ridge and Arctic.

Vent exploration in recent years has led to the accumulation of more detailed knowledge of the presence of species at different sites around the world. This has enabled multivariate approaches to be used in analyses of the likely relationships between different vent sites and the likely routes of dispersion / colonisation taken in different parts of the world. Using such approaches, Bachraty *et al*. (2009) have analysed data on the distribution of 592 species from 63 vent fields and have identified 6 putative biogeographical provinces: the northern East Pacific Rise, the southern East Pacific Rise, the Northeast Pacific, the Northwest Pacific the Southwest Pacific, including the central Indian Ocean and the Mid-Atlantic Ridge. This study also suggested that the East Pacific Rise may have played a central role as a centre of speciation and dispersal for deep-sea hydrothermal vents. This study bares similarities to previous biogeographic hypotheses regarding vents but shows some important differences in the identification of the southern East Pacific Rise as a separate province in itself, the unification of the Atlantic hydrothermal vents sites into a single

province and the unification of the southwestern Pacific and Indian Ocean vent communities.

Connections between the biogeographic provinces identified over the last 10 years are consistent with dispersal of taxa along mid-ocean ridge systems, with vicariance events being related to severance of ridges through subduction or other processes (e.g. Tunnicliffe & Fowler, 1996). This is also consistent with gene-flow studies that have demonstrated significant relationships between measures of genetic differentiation (F_{ST}) and whether populations are present on the same ridge segment, are separated by transform faults or are present on different ridges (Creasey & Rogers, 1999). However, the biogeographic patterns exhibited by hydrothermal vent communities may also be influenced by larval dispersal on deep-ocean currents with or without the aid of stepping stones provided by other chemosynthetic ecosystems such as cold seeps and whale falls (Van Dover *et al*., 2002; Bachraty *et al*., 2009). Examples of where such dispersal routes may have been important include the dispersal routes between the eastern Pacific and Mid-Atlantic Ridge, and the eastern Pacific, South Atlantic and Indian Ocean (Van Dover *et al*., 2002; Bachraty *et al*., 2009). Understanding of such dispersal routes, however, is severely hampered by a lack of exploration of hydrothermal vents at high latitudes, such as along the East Scotia Ridge, South Atlantic, South Pacific and Southern Indian Ocean (Tunnicliffe & Fowler, 1996; Van Dover *et al*., 2002; Tyler & Young, 2003; Bachraty *et al*., 2009). Knowledge of the vent fauna of these areas are also critical to a full understanding of the biogeography of vent ecosystems.

3.2 The CHESS Programme and CHESSO Project

The Census of Marine Life's (CoML) programme Chemosynthetic Ecosystem Studies (CHESS) was developed with the specific aim of improving the knowledge of the biogeography of chemosynthetic ecosystems such as hydrothermal vents (Tyler *et al*., 2003). One of the specific aims of the CHESS project was to address the alternative hypotheses:

The vent fauna of the East Scotia Arc is influenced by its tectonic attachment to the Atlantic. Or alternatively, hydrographic inputs from the Pacific have the most profound effect on the species composition of Scotia Arc vents, with larvae from the southern EPR flowing through the Drake Passage, borne by the southernmost limb of the Antarctic Circumpolar Current (Tyler *et al*., 2003).

A field project in the Southern Ocean aimed at detecting and exploring vent and seep ecosystems to specifically address the hypotheses above was proposed as a Consortium bid to the Natural Environment Research Council (NERC): Chemosynthetic Ecosystems of the Southern Ocean (CHESSO). Past work on vent ecosystems has demonstrated clearly that the biota present at a particular vent site does not only reflect processes of dispersal and colonization over different spatial and temporal scales but also the physical environment of a particular site. For example, the biota of the Guaymas Basin hydrothermal vents was significantly different to that of the East Pacific Rise because the former was sediment hosted. Thus CHESSO was developed as a multidisciplinary programme aimed at not only characterising the fauna present at chemosynthetic ecosystems in the Southern Ocean but also the physical environment of the vent or seep sites and the ecology of the communities present. Exploration of chemosynthetic ecosystems at high latitudes offers the possibility of solving many questions related to biogeography at a range of scales from single species and groups of animals (e.g. barnacles; Desbruyères *et al*., 2006) to entire communities (the province scale; e.g. Bacraty *et al*., 2009).

The CHESSO project initially aimed to target several different areas within the Atlantic sector of the Southern Ocean. These included two segments of the East Scotia Ridge where hydrothermal plumes had previously been detected using TOBI, a plume sensor string and CTD profiling to detect particles and the presence of high concentrations of manganese in the water column (German *et al*., 2000). They also included a putative mud volcano located just to the east of the southern South Sandwich Islands and an area of potential methane seepage off southern South Georgia where methane hydrates had been previously recovered during a trawl survey. The other main area of work proposed for the CHESSO project was in the Bransfield Strait and north of King George Island off the Antarctic Peninsula. Here venting has been detected on a shallow sunken crater and north of Middle Sister, a

volcanic ridge on the Hook Ridge (Klinkhammer *et al*., 2001). Hot sediments overlain by a silaceous crust and a section of chimney have been recovered from the sunken crater suggesting the presence of a venting site with a covering of sediment (Klinkhammer *et al*., 2001).

The specific objectives of the CHESSO programme were to:

1. Locate individual vent and cold seep sites using *BRIDGET* and CTD Yo-Yos, and to use the sampling/deployment capabilities of ROV *Isis* to investigate these sites in detail (see subsequent objectives 2 to 6)
2. To sample and analyse focussed and diffuse vent fluid compositions (temperature, pH, sulphide and methane concentrations) to evaluate the contribution of the reduced chemicals supplied to the overall energy budget within the chemosynthetic food-web, and to ascertain if there are any systematic differences in the different chemosynthetically-driven ecosystems.
3. To sample the vent and seep sites for metazoan organisms, and for micro-organisms.
4. To compare the biota of the examined vent and seep sites, using both morphology and molecular techniques, and determine their place in the global biogeographic context for both hydrothermal vent and cold-seeps.
5. To determine whether the fauna of any or all the four study sites are inter-related due to migration along the seafloor (eg via volcanic or tectonic links) or by hydrographic controls.
6. To elucidate food-web structures using state of the art techniques of stable isotope and lipid analyses, and to compare these chemosynthetic-community types and locations both within the chosen region and outside it.

Much of the previous exploration of hydrothermal vent and seep ecosystems had been undertaken with Human Occupied Vehicles (HOVs) such as the submersibles Alvin, Mir I and Mir II and Nautile. However, operating such vehicles in the harsh environment of the Antarctic was always considered as high risk and some authors have considered exploration of vents at high latitudes unlikely (e.g. MacPherson *et al*., 2005). Remotely operated vehicles (ROV) offer a safer alternative to explore chemosynthetic ecosystems in extreme environments as well as giving more

flexibility in terms of diving time. Thus CHESSO aimed to deploy the ROV *Isis* to explore any chemosynthetic ecosystems detected during the project in situ. This vehicle is capable of diving to 6,500m depth, undertaking surveys using high definition cameras or SWATH, collecting samples and placing experiments on the seabed.

3.3 *James Clark Ross* 224 and *James Cook* 42

The first cruise of the CHESSO project, JCR224 established the presence of high levels of methane on the southern South Georgia shelf, consistent with a hydrocarbon seep or methane hydrate site, and confirmed the presence of hydrothermal plumes above the East Scotia Ridge. Towed camera surveys using the vehicle SHRIMP identified two hydrothermal vent sites, one on the E2 and one on the E9 segment of the East Scotia Ridge. SHRIMP was also used to survey the "mud volcano" east of the South Sandwich Islands but this was found to be a rock feature on the seabed. Geophysical survey of the Kemp Seamount area to the west of the southern South Sandwich Islands detected a submarine crater. This was associated with hydrothermal plumes and bacterial mats were detected on a subcone lying within the main crater. Because this site was located in a back-arc setting rather than on a spreading ridge this offered the prospect of a geochemical setting quite different to those of the vents at E2 and E9 (Van Dover, 2003). Finally, Douglas Strait, lying between Thule and Cook Island were also investigated using SHRIMP and CTDs and was found to present a sediment covered seabed with elevated levels of methane.

The objectives of JC42 were as follows:

(i) Investigate the southern South Georgia site to locate the presence of hydrocarbon seep or exposed methane hydrates. To document any such sites using video and stills and sample the fauna for taxonomic, phylogenetic, reproduction and food web studies using the ROV Isis. To simultaneously document the geological features of any site and sample fluids and sediments for geochemical analyses.

(ii) To relocate and document hydrothermal vents at E2 and E9 using video and stills and sample the fauna for taxonomic, phylogenetic, reproduction and food web studies using the ROV Isis both on and off the vent sites. To simultaneously document the geological features of the E2 and E9 vent sites and sample fluids and sediments for geochemical analyses.

(iii) To investigate the newly discovered McIntosh Crater using CTD casts to attempt to resolve individual hydrothermal plumes and to survey the crater floor for hydrothermal sites. To document any such sites using video and stills and sample the fauna for taxonomic, phylogenetic, reproduction and food web studies using the ROV Isis. To simultaneously document the geological features of any site and sample fluids and sediments for geochemical analyses.

(iv) To return to Douglas Strait and undertake coring studies to study the sediment geochemistry of the caldera. To undertake ROV dives to detect areas of hydrothermal venting or diffuse flow and sample them for fauna and geochemistry as at previous sites. This area was considered as low priority because it was felt that there was little evidence of significant hydrothermal flow at the site.

In this report we present details of the work undertaken during cruise JC42 including details of the equipment deployed, geophysical surveys undertaken, samples collected and measurements made.

4.0 Overview of RRS James Cook Cruise 42

4.1 Timetable of Events

Date (Julian Day)	Time (GMT)	Station	Operation	Position	Activity
7	23.00	N/A	N/A	52°50.3'S 70°35.8'W	Leave Punta Arenas
8	09.00	N/A	N/A	52°46.0'S 67°48.9'W	Steaming
9	09.00	N/A	N/A	53°07.6'S 60°38.6'W	Steaming
10	04.01	N/A	N/A	53°15.86'S 54°41.29'W	Ship's clock advanced one hour
10	10.22	1	N/A	53°15.98'S 53°13.01'W	Arrive Station 1
10	10.26	1	1	53°15.98'S 53°13.01'W	CTD in water
10	11.30	1	1	53°15.98'S 53°13.01'W	CTD at maximum depth
10	12.11	1	1	53°15.98'S 53°13.01'W	CTD on deck
10	12.34	1	2	53°15.98'S 53°13.01'W	ROV Dive 124 Start
10	16.45	1	2	53°15.98'S 53°13.013'W	ROV Dive 124 Leave seabed
10	19.37	1	2	53°15.98'S	ROV Dive

				53°13.01’W	124 on deck
10	20.00	N/A	N/A	53°15.9’S 53°11.8’W	Resume transit
11	09.00	N/A	N/A	53°29.5’S 49°36.4’W	Steaming
11	14.44	N/A	N/A	53°35.45’S 48°01.94’W	Stop for USBL test
11	17.24	N/A	N/A	53°33.97’S 48°04.05’W	USBL test complete, resume transit
12	09.00	N/A	N/A	53°53.7’S 43°40.0’W	Steaming
13	03.33	2	N/A	54°09.52’S 37°56.02’W	Arrive St.2 USBL test
13	04.26	2	N/A	54°09.52’S 37°56.02’W	USBL onboard
13	04.39	2	N/A	54°09.29’S 37°55.89’W	EK60 survey
13	05.02	2	N/A	54°09.41’S 37°59.60’W	End of EK60 line
13	05.07	2	N/A	54°09.368’S 38°00.548’W	Relocating “plume”
13	10.30	2	1	54°09.45’S 37°58.55’W	Deploy CTD
13	10.35	2	1	54°09.45’S 37°58.55’W	CTD back on deck – wire problem

13	10.39	2	1	54°09.45’S 37°58.55’W	Redeploy CTD
13	10.58	2	1	54°09.45’S 37°58.55’W	CTD at max. depth (250m)
13	11.13	2	1	54°09.45’S 37°58.55’W	CTD on deck
13	11.45	2	2	54°09.45’S 37°58.55’W	Deploy gravity corer
13	12.00	2	2	54°09.45’S 37°58.55’W	Gravity corer at bottom
13	12.08	2	2	54°09.45’S 37°58.55’W	Corer on deck
13	12.22	2	3	54°09.45’S 37°58.55’W	Deploy gravity corer
13	12.34	2	3	54°09.45’S 37°58.55’W	Gravity corer at bottom
13	12.41	2	3	54°09.45’S 37°58.55’W	Gravity corer on deck
14	00.18	2	4	54°09.482’S 37°56.072’W	ROV dive 125 start
14	00.39	2	4	54°09.482’S 37°56.072’W	ROV on seabed
14	10.29	2	4	54°09.452’S 37°58.552’W	ROV leaves seabed
14	10.58	2	4	54°09.452’S 37°58.552’W	ROV on deck

14	11.20	2	N/A	54°09.46’S 37°58.54’W	Commence transit to St.3
15	09.05	N/A	N/A	55°33.1’S 33°26.5’W	Steaming
15	21.00	3	1	56°02.0’S 30°47.4’W	Deploy CTD
15	22.43	3	1	56°02.0’S 30°47.4’W	CTD 20m off bottom
15	22.50	3	1	56°02.0’S 30°47.4’W	CTD on way up
16	00.02	3	1	56°05.30’S 30°19.12’W	CTD on deck
16	00.35	3	2	56°05.326’S 30°19.094’W	ROV Dive 126 start
16	02.37	3	2	56°05.327’S 30°19.119’W	ROV on seabed
16	07.15	3	2	56°05.37’S 30°19.08’W	ROV leaves seabed
16	09.30	3	2	56°05.29’S 30°19.11’W	ROV on deck
16	11.01	3	3	56°05.31’S 30°19.12’W	SAPs deployed
16	17.30	3	3	56°05.31’S 30°19.12’W	SAPS on deck
17	08.14	3	4	56°05.326’S 30°19.156’W	ROV Dive 127 start

17	09.54	3	4	56°05.37’S 30°19.07’W	ROV on seabed (PA)
17	18.27	3	4	56°05.27’S 30°19.09’W	ROV on deck
17	20.26	3	5	56°05.258’S 30°19.226’W	ROV Dive 128 start
17	22.06	3	5	56°05.26’S 30°19.23’W	ROV on seabed
18	13.45	3	5	56°05.32’S 30°18.98’W	ROV on deck
18	15.40	3	6	56°05.41’S 30°19.25’W	CTD in water
18	17.22	3	6	56°05.330’S 30°19.100’W	CTD at 2,605m depth
18	17.23	3	6	56°05.330’S 30°19.100’W	Commence hauling CTD
18	20.22	3	6	56°05.32’S 30°19.14’W	CTD on deck
18	20.55	3	7	56°05.325’S 30°19.155’W	ROV Dive 129 start
18	22.33	3	7	56°05.32’S 30°19.155’W	ROV on seabed (PA)
19	06.07	3	7	56°05.322’S 30°19.103’W	ROV leaves seabed
19	07.52	3	7	56°05.34’S 30°19.11’W	ROV on deck

19	08.37	3	8	56°05.32’S 30°19.10’W	CTD + SAPS in water
19	10.05	3	8	56°05.34’S 30°19.12’W	2,602m wire out
19	13.40	3	8	56°05.34’S 30°19.12’W	Commence hauling CTD
19	14.58	3	8	56°05.35’S 30°19.13’W	CTD on deck
19	16.49	3	9	56°05.387’S 30°19.151’W	ROV Dive 130 start
19	18.19	3	9	56°05.36’S 30°19.09’W	ROV approaching seabed
20	08.01	3	9	56°05.325’S 30°19.089’W	ROV leaves seabed
20	10.33	3	9	56°05.32’S 30°18.87’W	ROV on deck
20	11.36	3	10	56°05.368’S 30°19.105’W	Commence mooring deployment
20	15.37	3	10	56°05.35’S 30°19.11’W	Release mooring
20	18.03	3	11	56°05.367’S 30°19.064’W	ROV Dive 131 start
20	19.45	3	11	56°05.36’S 30°19.09’W	ROV on seabed (PA)
21	02.42	3	11	56°05.382’S 30°19.073’W	ROV leaves seabed

21	05.57	3	11	56°05.40’S 30°19.00’W	ROV on deck
21	13.59	3	10	56°05.44’S 30°19.31’W	SAPS mooring released
21	15.20	3	10	56°05.32’S 30°19.14’W	All mooring gear retrieved
21	18.00	3	N/A	56°05.36’S 30°19.23’W	Streaming ROV wire
21	20.16	3	N/A	56°05.35’S 30°19.13’W	ROV wire onboard
21	20.40	3	12	56°05.35’S 30°19.13’W	Deploy CTD
22	00.53	3	12	56°05.35’S 30°19.13’W	CTD on deck
22	03.36	3	13	56°05.356’S 30°19.130’W	ROV Dive 132 start
22	05.23	3	13	56°05.336S 30°19.064’W	ROV on seabed
22	22.23	3	13	56°05.307’S 30°19.080’W	ROV leaves seabed
23	00.18	3	13	56°05.32’S 30°19.07’W	ROV on deck (PA)
23	00.45	3	14	56°05.319’S 30°19.08’W	CTD in water
23	02.10	3	14	56°05.319’S 30°19.080’W	CTD at 2,575m

23	06.46	3	14	56°05.256’S 30°19.190’W	Hauling CTD
23	08.51	3	15	56°05.384’S 30°19.111’W	ROV Dive 133 start
23	10.44	3	15	56°05.384’S 30°19.111’W	ROV on seabed (PA)
23	19.04	3	15	56°05.033’S 30°19.034’W	ROV leaves seabed
23	20.50	3	15	56°05.334’S 30°19.079’W	ROV on deck
23	21.27	3	16	56°05.320’S 30°18.884’W	CTD in water
23	22.34	3	16	56°05.320’S 30°18.884’W	CTD on deck
23	23.32	3	17	56°05.320’S 30°19.080’W	SAPS deployed
24	02.01	3	17	56°05.35’S 30°19.09’W	SAPS on deck
24	02.36	3	18	56°05.358’S 30°19.092’W	ROV Dive 134 start
24	04.16	3	18	56°05.34’S 30°19.06’W	ROV on seabed
24	16.42	3	18	56°05.287’S 30°19.138’W	ROV leaves seabed
24	18.55	3	18	56°05.34’S 30°19.126’W	ROV on deck

24	22.52	3	19	56°05.306’S 30°19.125’W	ROV Dive 135 start
25	00.36	3	19	56°05.297’S 30°19.132’W	ROV at seabed
25	09.51	3	19	56°05.305’S 30°19.112’W	ROV leaves seabed
25	11.45	3	19	56°05.313’S 30°19.129’W	ROV on deck
25	15.11	3	20	56°05.31’S 30°19.13’W	SAPs deployed
25	17.12	3	20	56°05.29’S 30°19.17’W	Hauling SAPS
25	17.50	3	20	56°05.36’S 30°19.22’W	SAPs on deck
25	22.38	3	21	56°05.365’S 30°19.069’W	ROV Dive 136 starts
26	00.39	3	21	56°05.362’S 30°19.131’W	ROV on seabed (PA)
26	01.24	3	21	56°05.341’S 30°19.179’W	ROV leaves seabed
26	03.26	3	21	56°05.35’S 30°19.16’W	ROV on deck
26	03.36	3	N/A	56°05.41’S 30°19.11’W	Commence transit to St.4
26	09.00	N/A	N/A	56°38.5’S 30°16.3’W	Steaming

27	06.04	4	N/A	60°02.50’S 29°58.99’W	Arrive St.4
27	06.17	4	1	60°02.49’S 29°58.99’W	CTD in water
27	07.20	4	1	60°02.49’S 29°58.99’W	CTD at 2,380m
27	08.37	4	1	60°02.49’S 29°58.98’W	CTD on deck
27	09.17	4	2	60°02.505’S 29°58.994’W	ROV Dive 137 start
27	09.37	4	2	60°02.50’S 29°59.00’W	ROV dive aborted
27	10.36	4	2	60°02.50’S 29°59.00’W	ROV on deck
27	11.23	4	3	60°02.503’S 29°58.993’W	ROV Dive 138 start
27	12.58	4	3	60°02.507’S 29°58.993’W	ROV at seabed
28	06.07	4	3	60°02.849’S 29°58.696’W	ROV leaves seabed
28	07.58	4	3	60°02.83’S 29°58.70’W	ROV on deck
28	08.44	4	4	60°02.58’S 29°58.92’W	CTD in water
28	10.55	4	4	60°02.58’S 29°58.92’W	CTD on deck

28	13.24	4	5	60°02.520’S 29°58.951’W	ROV Dive 139 start
28	14.51	4	5	60°02.51’S 29°58.95’W	ROV on seabed
29	04.39	4	5	60°02.738’S 29°58.773’W	ROV leaves seabed
29	06.16	4	5	60°02.75’S 29°58.70’W	ROV on deck
29	07.04	4	6	60°02.726’S 29°58.783’W	CTD deployed
29	08.00	4	6	60°02.72’S 29°58.78’W	CTD at 2,350m depth
29	10.55	4	6	60°03.14’S 29°57.97’W	Hauling CTD
29	11.43	4	6	60°03.14’S 29°57.97’W	CTD on deck (PA)
29	12.26	4	7	60°02.930’S 29°58.401’W	ROV Dive 140 start
29	14.01	4	7	60°02.898’S 29°58.361’S	ROV at seabed
30	11.50	4	7	60°02.70’S 29°58.63’W	ROV leaves seabed
30	13.30	4	7	60°02.55’S 29°58.52’W	ROV on deck
30	16.33	4	8	60°02.763’S 29°58.704’W	ROV Dive 141 start

30	18.00	4	8	60°02.83’S 29°58.73’W	ROV on seabed
30	22.22	4	8	60°02.786’S 29°58.703’W	ROV leaves seabed
31	00.05	4	8	60°02.83’S 29°58.72’W	ROV on deck
31	00.46	4	9	60°02.570’S 29°58.918’W	CTD & SAPs deployed
31	03.00	4	9	60°02.57’S 29°58.91’W	CTD at 2,245m depth
31	05.20	4	9	60°02.57’S 29°58.91’W	Hauling CTD
31	06.25	4	9	60°02.57’S 29°58.91’W	CTD on deck
32	17.24	4	10	60°02.794’S 29°58.706’W	ROV Dive 142 start
32	18.43	4	10	60°02.80’S 29°58.70’W	ROV on seabed
33	06.52	4	10	60°02.48’S 29°58.89’W	ROV leaves seabed
33	08.57	4	10	60°02.59’S 29°58.91’W	ROV on deck
33	09.26	4	11	60°02.56’S 29°58.91’W	CTD deployed
33	10.33	4	11	60°02.585’S 29°58.915’W	CTD stopped

33	10.58	4	11	60°02.585’S 29°58.915’W	CTD hauling
33	11.56	4	11	60°02.585’S 29°58.915’W	CTD on deck
33	12.38	4	12	60°02.808’S 29°58.646’W	ROV Dive 143 start
33	12.54	4	12	60°02.808’S 29°58.646’W	ROV dive aborted
33	14.45	4	13	60°02.819’S 29°58.673’W	ROV Dive 144 start
33	16.29	4	13	60°02.824’S 29°58.74’W	ROV on bottom
33	22.54	4	13	60°02.842’S 29°58.744’W	ROV leaves seabed
34	00.36	4	13	60°02.82’S 29°58.73’W	ROV on deck
34	11.46	4	14	60°02.80’S 29°58.70’W	CTD deployed
34	12.43	4	14	60°02.80’S 29°58.69’W	CTD at 2,350m start hauling
34	14.00	4	14	60°02.79’S 29°58.71’W	CTD over Ivory Tower plume
34	13.49	4	14	60°02.794’S 29°58.709’W	Haul CTD to 2,100m
34	13.54	4	14	60°02.794’S 29°58.709’W	Veer CTD to 2,350m

34	16.06	4	14	60°02.794’S 29°58.709’W	Haul CTD to 2,200m
34	16.32	4	14	60°02.801’S 29°58.695’W	Veer CTD to 2,300m
34	16.36	4	14	60°02.801’S 29°58.695’W	Haul CTD to 2,100m
34	16.44	4	14	60°02.801’S 29°58.695’W	Veer CTD to 2,200m
34	17.05	4	14	60°02.80’S 29°58.59’W	Veer CTD to 2,350m
34	17.15	4	14	60°02.80’S 29°58.58’W	Hauling CTD
34	17.42	4	14	60°02.80’S 29°58.58’W	CTD on deck
35	00.00	4	15	60°02.793’S 29°58.827’W	ROV Dive 145 start
35	01.15	4	15	60°02.578’S 29°58.785’W	ROV on seabed
35	05.59	4	15	60°02.568’S 29°58.900’W	ROV leaves seabed
35	07.33	4	15	60°02.54’S 29°58.91’W	ROV on deck
35	10.14	4	16	60°02.495’S 29°58.863’W	ROV Dive 146 start
35	11.45	4	16	60°02.48’S 29°58.89’W	ROV on seabed (PA)

35	13.13	4	16	60°02.566’S 29°58.884’W	ROV leaves seabed
35	14.46	4	16	60°02.62’S 29°58.89’W	ROV on deck
35	15.01	4	17	60°02.56’S 29°58.89’W	CTD in water
35	16.06	4	17	60°02.563’S 29°58.895’W	CTD at 2,390m hauling
35	17.18	4	17	60°02.563’S 29°58.895’W	CTD on deck
35	17.35	4	N/A	60°02.191’S 29°48.60’W	Transit to St.5
35	23.57	5	1	59°40.67’S 28°23.69’W	CTD deployed
36	00.22	5	1	59°40.70’S 28°23.74’W	CTD at 700m commence To-Yo
36	07.57	5	1	59°41.56’S 28°25.08’W	Hauling CTD
36	08.20	5	1	59°41.56’S 28°25.08’W	CTD on deck
36	09.10	5	2	59°41.08’S 28°22.63’W	CTD deployed
36	09.50	5	2	59°41.08’S 28°22.63’W	CTD at 1,125m, commence To-Yo
36	15.40	5	2	59°41.571’S	CTD at

				28°23.673’W	1,100m start hauling
36	16.15	5	2	59°41.480’S 28°23.506’W	CTD on deck
36	16.55	5	3	59°41.457’S 28°21.155’W	CTD deployed
36	18.03	5	3	59°41.504’S 28°21.208’W	CTD at 1,100m commence To-Yo
36	20.12	5	3	59°41.74’S 28°21.46’W	Hauling CTD
36	20.50	5	3	59°41.74’S 28°21.45’W	CTD on deck
36	21.14	5	4	59°41.747’S 28°21.460’W	ROV Dive 147 start
36	22.07	5	4	59°41.89’S 28°21.55’W	ROV on seabed
37	23.46	5	4	59°41.680’S 28°21.094’W	ROV leaves seabed
38	00.50	5	4	59°41.66’S 28°21.12’W	ROV on deck
38	01.20	5	N/A	59°41.65’S 28°20.98’W	Sub-bottom profiler transect started
38	02.24	5	N/A	59°41.143’S 28°21.554’W	Sub-bottom profiler survey complete

38	03.13	5	5	59°41.896’S 28°19.854’W	Gravity core deployed
38	03.50	5	5	59°41.896’S 28°19.856’W	Gravity core at seabed, 1,583m wire
38	05.17	5	5	59°41.896’S 28°19.855’W	Gravity corer on deck
38	04.32	5	6	59°41.896’S 28°19.855’W	Gravity core deployed
38	05.01	5	6	59°41.896’S 28°19.855’W	Gravity core at seabed, 1,607m wire
38	05.27	5	6	59°41.896’S 28°19.855’W	Gravity core on deck
38	06.31	5	7	59°41.734’S 28°21.937’W	ROV Dive 148 start
38	07.50	5	7	59°41.681’S 28°21.452’W	ROV on seabed
39	06.15	5	7	59°41.671’S 28°21.089’W	ROV leaves seabed
39	07.25	5	7	59°41.680’S 28°21.102’W	ROV on deck
39	07.55	5	8	59°42.24’S 28°21.94’W	Mooring deployment
39	12.34	5	9	59°41.674’S 28°21.030’W	ROV Dive 149 start
39	13.36	5	9	59°41.67’S 28°21.07’W	ROV on seabed

40	03.33	5	9	59°41.698’S 28°20.976’W	ROV leaves seabed
40	04.36	5	9	59°41.67’S 28°20.93’W	ROV on deck
40	05.19	5	10	59°41.680’S 28°21.083’W	CTD deployed
40	06.22	5	10	59°41.680’S 28°21.083’W	CTD at 1,417m SAPs pumping
40	07.45	5	10	59°41.680’S 28°21.083’W	CTD hauling
40	08.45	5	10	59°41.68’S 28°21.08’W	CTD on deck
40	09.09	5	11	59°41.722’S 28°21.108’W	ROV Dive 150 start
40	10.05	5	11	59°41.789’S 28°21.061’W	ROV on seabed
40	22.21	5	11	59°41.693’S 28°20.961’W	ROV leaves seabed
40	23.21	5	11	59°41.68’S 28°20.96’W	ROV on deck
41	00.00	5	12	59°41.65’S 28°21.15’W	Deploy gravity core
41	01.12	5	12	59°41.65’S 28°21.15’W	Gravity core on deck
41	01.30	5	13	59°41.64’S 28°21.14’W	Deploy gravity core

41	01.59	5	13	59°41.64’S 28°21.14’W	Gravity core on deck
41	02.58	5	14	59°41.705’S 28°21.033’W	Deploy gravity core
41	03.24	5	14	59°41.705’S 28°21.034’W	Gravity core at seabed, 1,433m
41	03.46	5	14	59°41.699’S 28°21.035’W	Gravity core on deck
41	04.50	5	15	59°42.026’S 28°21.161’W	ROV Dive 151 start
41	05.53	5	15	59°42.012’S 28°21.163’W	ROV at seabed (PA)
41	17.58	5	15	59°41.687’S 28°20.998’W	ROV leaves seabed
41	19.03	5	15	59°41.686’S 28°20.954’W	ROV on deck
41	19.32	5	16	59°41.67’S 28°21.09’W	CTD deployed
41	20.17	5	16	59°41.67’S 28°21.09’W	CTD at 1,360m
41	20.30	5	16	59°41.67’S 28°21.09’W	CTD hauling from 1,355 to surface
41	21.04	5	16	59°41.67’S 28°21.08’W	CTD on deck
41	21.55	5	17	59°41.995’S 28°20.952’W	ROV Dive 152 start

41	22.55	5	17	59°42.02’S 28°20.96’W	ROV at seabed
42	11.04	5	17	59°41.607’S 28°21.137’W	ROV leaves seabed
42	12.02	5	17	59°41.57’S 28°21.18’W	ROV on deck
42	12.31	5	18	59°42.33’S 28°21.99’W	Current mooring released
42	12.50	5	18	59°42.35’S 28°22.33’W	Mooring at surface
42	13.13	5	18	59°42.34’S 28°22.01’W	Mooring on deck
42	14.07	5	19	59°41.671’S 28°21.030’W	ROV Dive 153 start
42	15.05	5	19	59°41.673’S 28°21.033’W	ROV at seabed
42	22.30	5	19	59°41.697’S 28°20.974’W	ROV lost power, retrieved from seabed
43	02.34	5	19	59°41.76’S 28°20.51’W	ROV on deck
43	03.27	5	20	59°41.69’S 28°20.95’W	CTD deployed
43	04.19	5	20	59°41.6968’S 28°20.9542’W	CTD at 1,396m start to haul
43	04.50	5	20	59°41.6967’S	CTD hauled to 1,032m

				28°20.9542’W	for SAPS
43	04.59	5	20	59°41.697’S 28°20.956’W	CTD veered to 1,052m
43	07.00	5	20	59°41.697’S 28°20.956’W	CTD veered
43	07.09	5	20	59°41.697’S 28°20.956’W	CTD at 1,390m
43	07.25	5	20	59°41.697’S 28°20.956’W	CTD hauling at 1,061m
43	08.10	5	20	59°41.697’S 28°20.956’W	CTD on deck
43	08.39	5	21	59°41.696’S 28°21.003’W	ROV Dive 154 start
43	09.35	5	21	59°41.69’S 28°20.99’W	ROV at seabed (PA)
43	11.53	5	21	59°41.585’S 28°21.163’W	ROV leaves seabed
43	13.00	5	21	59°41.59’S 28°21.08’W	ROV on deck
43	13.06	5	N/A	59°41.697’S 28°20.956’W	Commence transit to St.6
44	09.00	N/A	N/A	58°12.8’S 31°01.3’W	Steaming
45	09.00	N/A	N/A	56°03.0’S 36°28.3’W	Steaming
46	09.15	N/A	N/A	54°42.7’S	Steaming

				41°49.3’W	
47	09.00	N/A	N/A	51°56.6’S	Steaming
				44°29.5’W	
48	09.00	N/A	N/A	48°18.8’S	Steaming
				47°00.4’W	
49	09.15	N/A	N/A	44°29.3’S	Steaming
				50°01.4’W	
50	09.00	N/A	N/A	40°47.1’S	Steaming
				51°12.0’W	
50	11.31	6	1	40°33.22’S	CTD Deployed
				51°24.64’W	
50	12.15	6	1	40°33.28’S	CTD stopped
				51°24.64’W	
50	13.25	6	1	40°33.38’S	CTD on deck
				51°24.63’W	
50	13.42	6	N/A	40°32.9’S	Resume transit
				51°25.1’W	
End of Science					

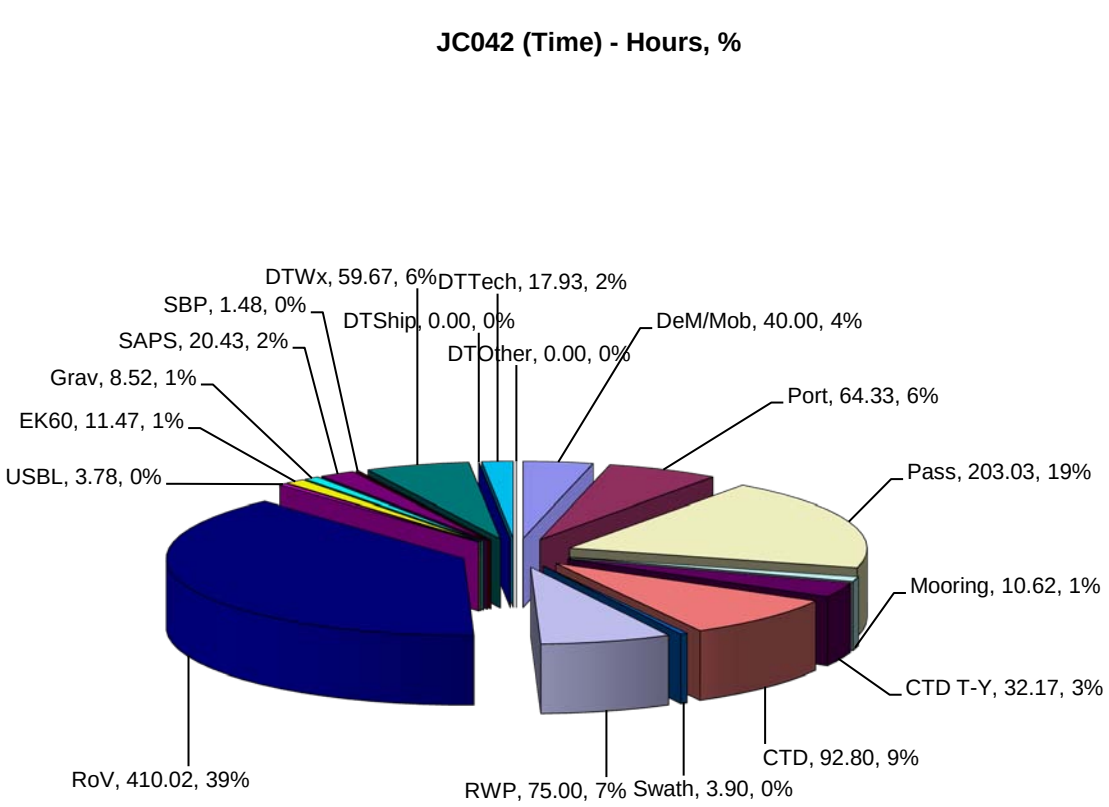


Figure 4.1. Breakdown of time used during Cruise JC42 up to 14th February. Abbreviations as follows: RoV = ROV dive time; USBL = testing of ultra-short baseline navigation system; EK60 = EK60 survey time; Grav = Gravity coring; SAPS = time for Stand-Alone Pumping System sampling; SBP = time for survey using sub-bottom profiler; DTWx = down-time weather; DTShip = down-time due to ship technical problems; DTTech = down-time due to other technical issues; DTOther = down time for other issues; DeM/Mob = Demobilisation / mobilisation time; Port = time in port; Pass = passage time; Mooring = time for deploying and retrieval of moorings; CTD T-Y = time for CTD tow-yos; CTD = time for CTDs; SWATH = time for SWATH surveys; RWP = Re-positioning, waiting, preparation. All data and pie chart by Peter Sarjeant.

4.2. JC042 cruise track

Alistair Graham

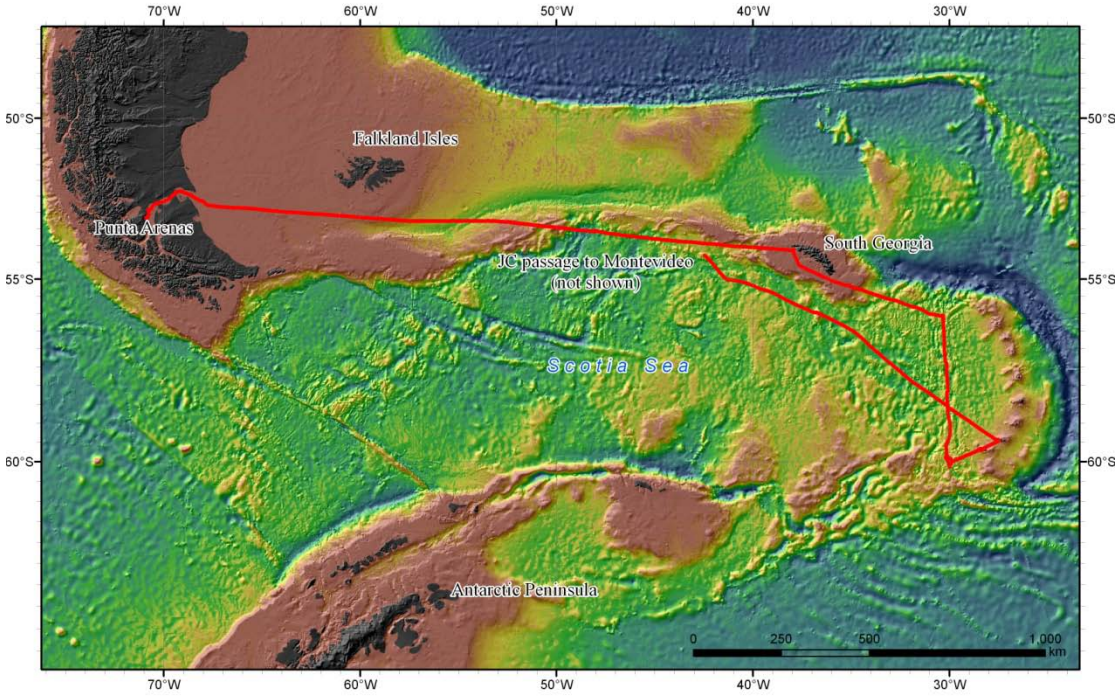


Figure 4.2. Ship track for cruise JC042, January-February 2010 (red line). The ship track shown runs from Julian Day (JD) 4 until JD 46; return passage to Montevideo is not illustrated. Bathymetry data taken from Smith and Sandwell, version 11, 1-minute global topographic grid. Hot colours represent shallow bathymetry, cold colours deep. Mercator projection (WGS84) with a standard parallel at 60° S.

4.3 Weather conditions and ice

Conditions during the cruise were relatively good. Low pressure systems tended to develop west of Drake Passage or between the Falkland Islands and Patagonia and then track east. The path of depressions was generally past South Georgia and the northern South Sandwich Islands and weather conditions were generally calmer in the southern South Sandwich Islands around E9 and the McIntosh Crater. A single storm in South Georgia where wind speeds were at hurricane force caused a temporary halt in work and a later, less severe storm, on the East Scotia Ridge caused minor delays.

Throughout the cruise the programme UGRIB (grid in binary) was used as the main tool for weather forecasts. This programme provides gridded meteorological data over five days for any location globally. The programme is downloaded from http://www.grib.us/Home.aspx and registration is free.

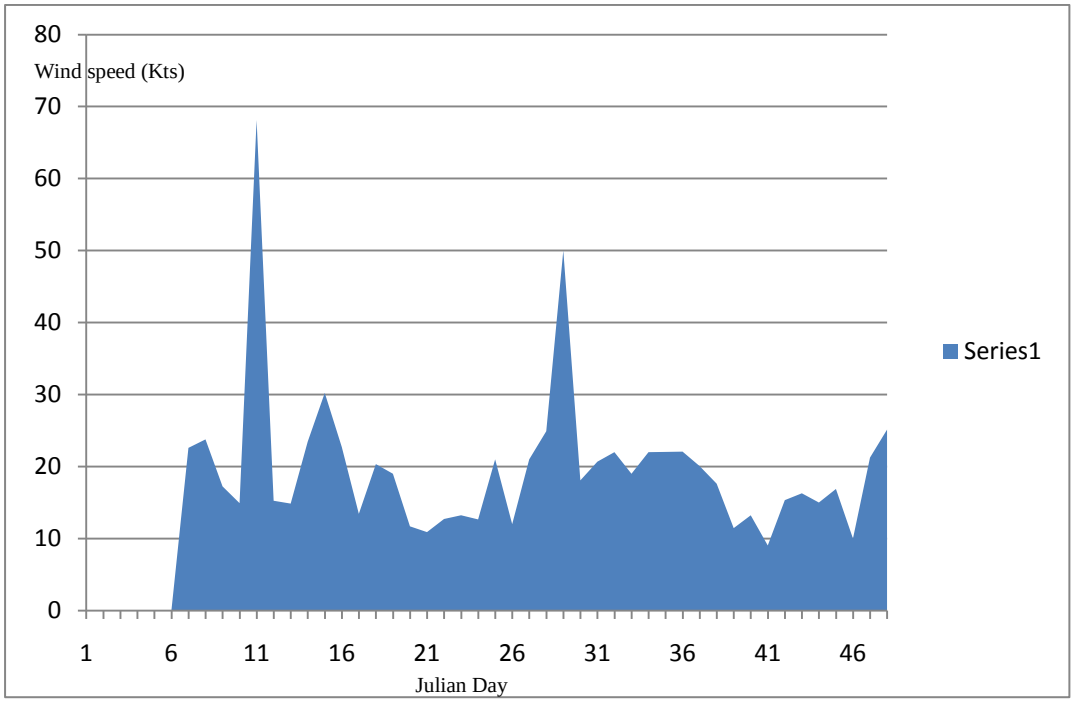


Figure 4.3. Maximum wind speed for each day of the working period of the cruise.

Ice conditions throughout the cruise were generally good with a variety of icebergs encountered while working on the East Scotia Ridge. Further south ice remained locked in the western Weddell Sea and the eastern side of the Antarctic Peninsula for the duration of the cruise. No delays were caused directly by ice and ROV operations were unaffected during the cruise. However, during the hours of darkness, or in foggy conditions while in transit, the presence of ice caused the ship to maintain a low speed.

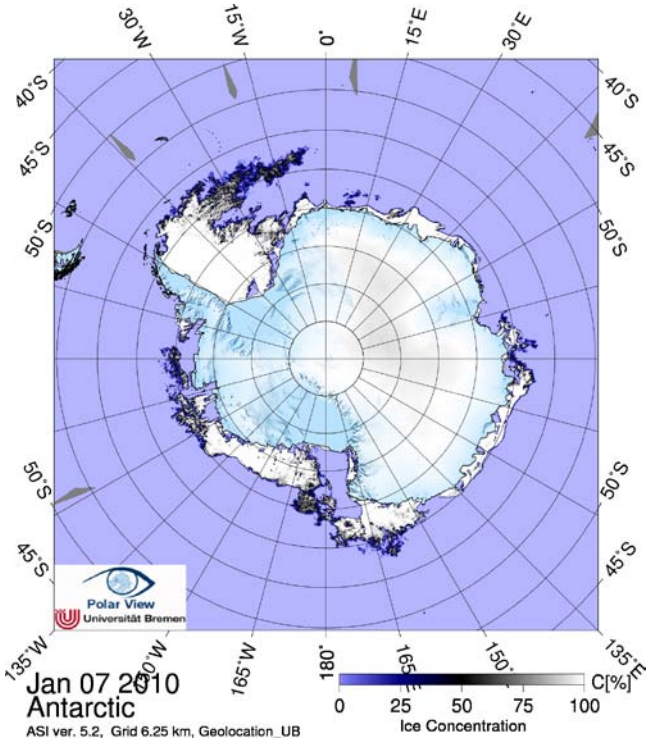


Figure 4.4. Sea ice conditions on the 7th January, 2010. Ice maps showed little change throughout the duration of the cruise. Data from the University of Bremen daily updated AMSR-E Sea Ice Maps (Spreen *et al*., 2008).

5.0 Initial Scientific Reports

5.1. Geophysics

Ali Graham, Veerle Huvenne

5.1.1. Objectives

The principle objectives of marine geophysical work on cruise JC042 were: (1) to provide detailed characterisation of the bathymetry and geology of previously identified hydrothermal vent sites on the East Scotia Ridge; (2) to use these data to identify new, prospective chimney and vent-field targets, and (3) to provide a context for biological and geochemical sampling of the sea bed, conducted using the ROV ISIS.

Two modes of geophysics data acquisition were carried out during the cruise: (1) ship-based geophysical survey and (2) ROV geophysical survey. Shipborne geophysical data collection consisted of sea-floor mapping using a hull-mounted Kongsberg-Simrad EM120 multibeam echo sounder, and sub-bottom profiling using a hull-mounted parametric echo sounder. ROV geophysics data collection consisted of high-resolution sea-floor mapping using the ISIS Simrad SM2000 multibeam echo sounder. Few shipborne surveys were carried out during cruise operations. Therefore, for the purposes of this report, we focus on ROV geophysical data only (although see sections 7.2-7.4 for information on ship-based surveys).

The main sites in which multibeam data were collected comprised (in operational order): (i) a potential cold seep site where elemental sulphur had been discovered in past BAS trawls, south of Bird Island on the South Georgia shelf, (ii) Segments E2 and E9 of the East Scotia Ridge where visual observations of black and white smokers, abundant hydrothermal activity, chemosynthetic biological communities, and axial magma chambers had previously been identified, (iii) a submarine caldera west of the Kemp Seamount, on the southern tip of the South Sandwich arc, where a towed underwater camera system had previously identified possible hydrothermal vent activity (Figure 5.1).

Existing bathymetry in these areas was poorly defined prior to 2009. However, new regional bathymetry data of the key sites were collected on the first ChEsSO consortium cruise (JR224), 12 months earlier. On JR224, these data were used to identify small-scale geological structures from which sites of likely sea-floor venting could be further investigated. For JC042, they provided a useful back-drop on which to plan and carry out further exploratory ROV dives, and ROV swath bathymetry surveys.

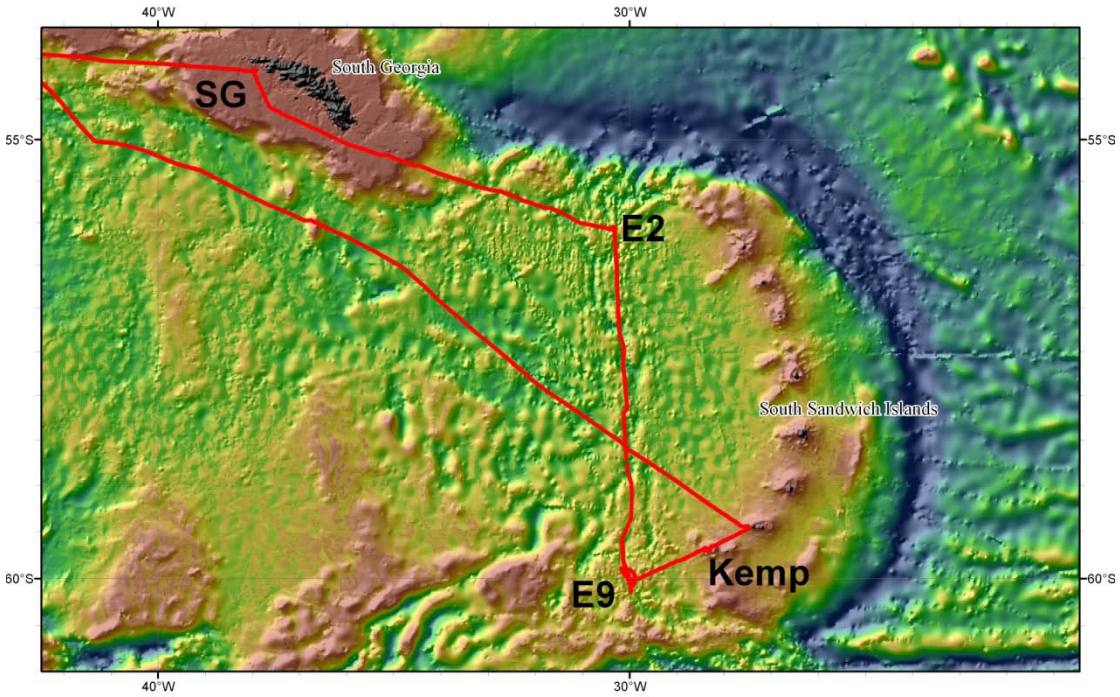


Figure 5.1. Location map of the East Scotia Ridge and surrounding region. The four sites where ISIS ROV operations were carried out are labelled. Red line shows ship track from cruise JC042. Bathymetry from Smith and Sandwell, version 11, 1-minute global topographic grid. Hot colours represent shallow bathymetry, cold colours deep. Mercator projection (WGS84).

5.1.2. ISIS ROV multibeam echo sounder surveys: work at sea, and preliminary results

ISIS multibeam swath bathymetry surveys were conducted at each of the four target locations shown in Figure 5.1 where blocks of the seafloor, normally involving

multiple overlapping swaths, were mapped out. Summary maps illustrate the preliminary processed swath grids, together with observational waypoints (markers for vents, chimneys, areas of diffuse flow etc.) for the E2 (Figure 5.2), E9 (Figure 5.3) and Kemp/Macintosh crater (Figure 5.4) working sites.

5.1.3. Swath bathymetry maps and observational waypoints

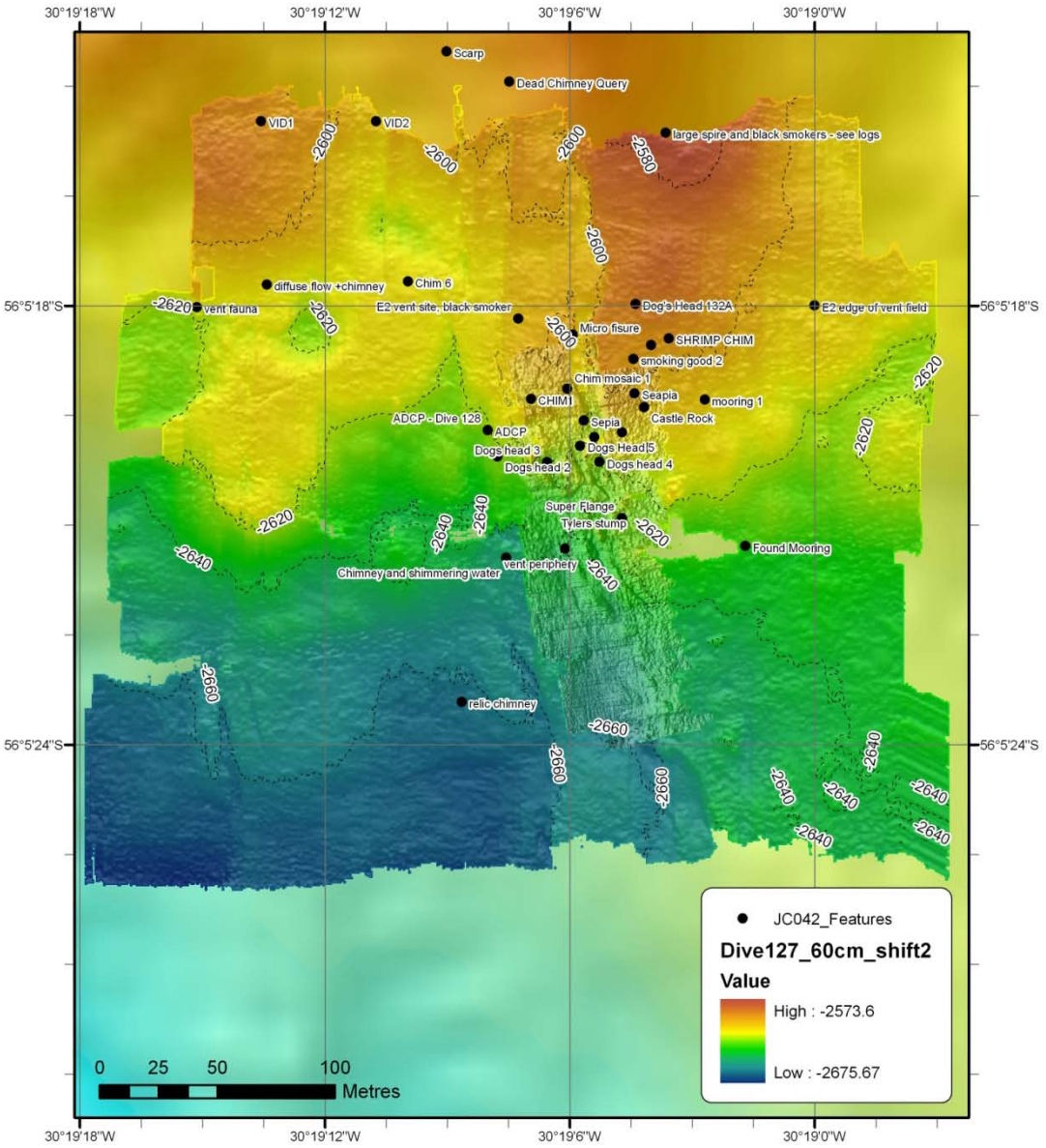


Figure 5.2. JC042 ISIS ROV swath bathymetry grid for the 'Mermaid's Purse', E2 segment, on the East Scotia Ridge. Data were acquired during ISIS dives 126 to 135. Main grid is rendered at a 60-cm grid-cell size, overlain by a smaller, higher-resolution 25-cm grid in the Dog's Head area. Mercator projection, with a standard parallel at 56° S. Waypoints shown as black dots. N.B. Due to navigational problems at the E2 site, ALL data come with a severe health warning. See VH or AG for queries.

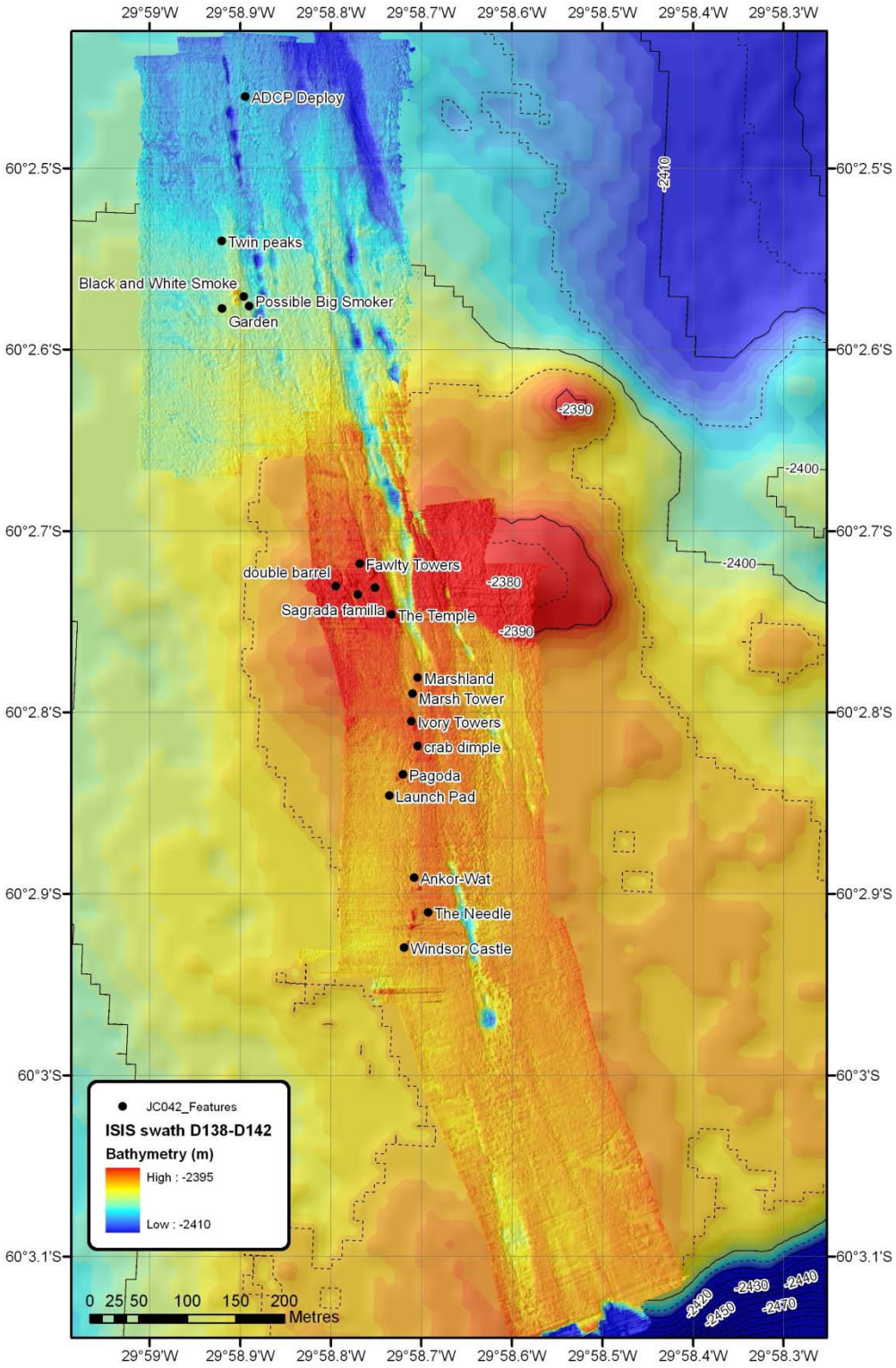


Figure 5.3. JC042 ISIS ROV swath bathymetry grid for the 'Devil's Punchbowl', E9 segment, on the East Scotia Ridge. Data were acquired during ISIS dives 138 to 142. Main grid is rendered at a 40-cm grid-cell size. Mercator projection, with a standard parallel at 60° S. Waypoints shown as black dots.

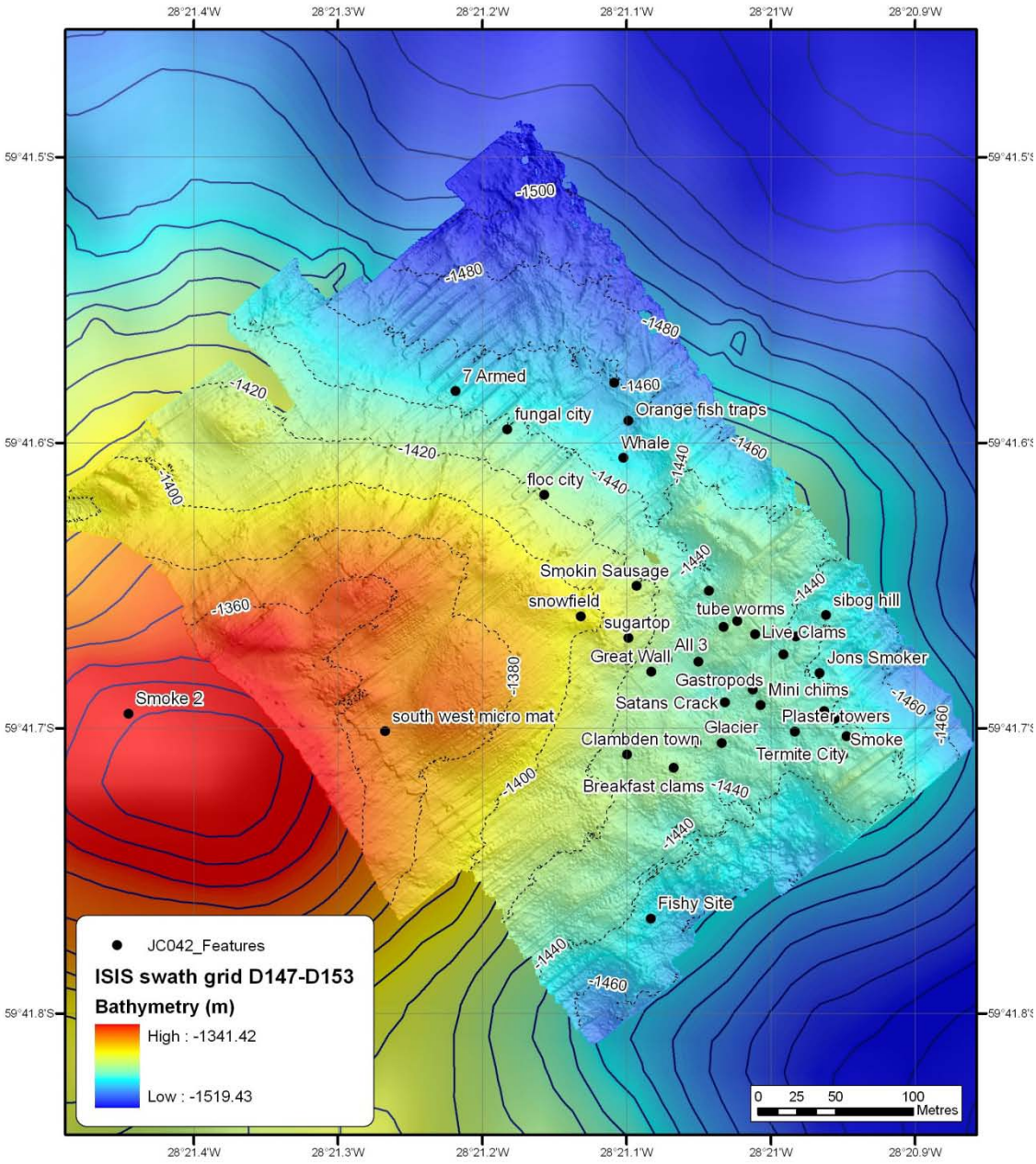


Figure 5.4. JC042 ISIS ROV swath bathymetry grid across the sub-cone in the 'Mackintosh Crater', west of Kemp Seamount, on the South Sandwich volcanic arc. Data were acquired during ISIS dives 147 to 153. Main grid is rendered at a 40-cm grid-cell size. Mercator projection, with a standard parallel at 60° S. Waypoints shown as black dots.

In total, 36 hours 48 minutes of swath survey were carried out, collecting approximately 27.2 line-kilometres of high-resolution bathymetric data (Table 1). Further details of swath bathymetry data collection and processing can be found in Section 6 of this report.

Table 5.1. Overview of ROV-based multibeam bathymetry data collection

Sample number	Site	JDay (Start)	Start Date	Start Time GMT	Start Lat	Start Long	Start depth	End Date	End Time GMT	End Lat	End Long	End depth	Time (hours, mins)	nr of lines	line spacing (m)	height above seabed (m)	pixel size final grid (m)	navi-gation used for proces-sing	sound velocity (m/s)	Comments
JC42-2-004-01/ISIS125-SW01	South Georgia	14	14/01/2010	07:01	-54.157	-37.992	262	14/01/2010	09:33:00	-54.157	-37.972	241	2 32	5	N.A.	20/40	0.2/0.4	usbl	1456.4	Swath survey for tests, 5 lines
JC42-3-002-02/ISIS126-SW01	E2	16	16/01/2010	06:39:00	-56.090	-30.322	2643	16/01/2010	07:15:00	-56.090	-30.317	2643	0 36	1	40	20	0.6	dopp.	1494	One line of swath data, sound velocity: 1494m/s
JC42-3-004-01/ISIS127-SW01	E2	17	17/01/2010	10:02:00	-56.089	-30.318	2619	17/01/2010	15:55:00	-56.089	-30.319	2620	5 53	10	40	20	0.6	dopp.	1494	continuation of survey, 8 more lines plus 2 calibration lines, usbl switched from D116 to POSMV after line 6
JC42-3-005-02/ISIS128-SW01	E2	18	18/01/2010	10:41:00	-56.089	-30.320	2591	18/01/2010	11:04:00	-56.089	-30.317	2602	0 23	1	40	20	0.6	dopp.	1494	single line to correct navigation offset.
JC42-3-019-13/ISIS135-SW01	E2	25	25/01/2010	02:12:00	-56.089	-30.319	2627	25/01/2010	06:09:00	-56.089	-30.318	2619	3 57	6	40/20	20/10	0.6/0.25	dopp.	1494	3 lines at 20 m off bottom, 0.3 kn; 3 lines at 10m, 0.2kn for high-res DTM of chimneys
JC42-4-003-02/ISIS138-SW01	E9	27	27/01/2010	19:04:00	-60.041	-29.983	2387	27/01/2010	23:23:00	-60.043	-29.148	2380	4 19	7	40	20	0.4	dopp.	1494	5 lines plus 2 calibration lines over E9
JC42-4-005-xx/ISIS139-SW01	E9	29	29/01/2010	00:46:00	-60.041	-29.979	2397	29/01/2010	04:29:00	-60.045	-29.979	2378	3 43	4	40	20	0.4	dopp.	1494	3 lines addition to previous survey, 4th line recorded during fast transit to possible chimney (up to 0.7kn, marginal quality)
JC42-4-007-29/ISIS140-SW01	E9	30	30/01/2010	06:20:00	-60.044	-29.980	2426	30/01/2010	09:18:00	-60.045	-29.977	2362	2 58	3	40	20	0.4	dopp.	1494	Addition to previous 2 surveys. line 1 aborted due to navigation problems, restarted as line 2
JC42-4-010-120/ISIS142-SW01	E9	32	01/02/2010	22:22:00	-60.049	-29.979	2377	02/02/2010	01:50:00	-60.049	-29.976	2377	3 28	4	40	20	0.4	dopp.	1494	swath survey of stretch towards crater
JC42-5-004-19/ISIS147-SW01	Kemp Seamount caldera	37	06/02/2010	12:43:00	-59.692	-28.353	1491	06/02/2010	20:23:00	-59.694	-28.350	1406	7 40	11	40	20	0.4	dopp.	1494	major irregularities with usbl navigation on lines 5-6. 2 calibration lines (9 & 11)
JC42-5-010-26/ISIS150-SW01	Kemp Seamount caldera	40	09/02/2010	10:21:00	-59.696	-28.351	1439	09/02/2010	11:07:00	-59.693	-28.357	1400	0 46	1	40	20	0.4	dopp.	1494	one line to fill the gap
JC42-5-017-1/ISIS153-SW01	Kemp Seamount caldera	42	11/02/2010	19:45:00	-59.696	-28.351	1431	11/02/2010	20:18:00	-59.694	-28.354	1339	0 33	2	40	20	0.4	dopp.	1494	last line to fill gaps. Started in wrong location, hence line1 aborted and restarted as line 2

5.1.3. Preliminary observations: geology

Preliminary observations of the geology of each site, based on new high-resolution swath bathymetry surveys, and ISIS sea-floor observations, are as follows:

South Georgia trial site

- Flat sea floor reflects muddy substrate, infilling cross-shelf trough.
- No evidence for hydrothermal activity or methane seepage on the swath bathymetry with an absence of sea-floor mounds, chimneys or pockmarks.
- Subtle iceberg ploughmarks cross-cut the sea bed, with amplitudes of only 0.5-2 metres.

E2 segment (Figure 5.2)

- Prominent north-south structural fabric to the sea floor defining a series of stair-cased, terraced features which are divided by west-facing scarps.
- Major steep-sided fissure runs north-south through the centre of the site. Filled in places by lobes of pillow basalts.
- Main vents located at the intersection between this main fissure and a west-east striking fault or scarp, consistent with the expected location of active venting on back-arc spreading ridges.
- Relict (extinct) and actively-venting chimneys are resolvable on the swath grids, clustered in a band running approximately NW-SE.
- Numerous volcanic cones and small volcanic craters apparent around the vent field.

E9 segment (Figure 5.3)

- Ridge axis is heavily crevassed and fissured, with numerous collapse features and broken pillow lava ridges.
- Major fissures run NNW-SSE through the site, breaking up an otherwise flat and unvaried terrain.
- Highs in the centre of the study site are possibly dead magma domes; no activity around these sites.

- Most active venting appears to lie along one of the smaller fissures, west of a main N-S trending feature.
- Diffuse flow and black smokers line the feature intermittently, but activity becomes reduced and dies away farther south, towards the ‘punchbowl’ itself.
- Chimneys, both relict and active, are prominent on the map.

Macintosh Crater, west of Kemp Seamount (Figure 5.4)

- Site is the sub-cone (a submarine volcano) at the base of the western flank of the large Macintosh crater.
- Most prominent sea floor feature is a concentric ridge that runs through a large part of the study area, towards the base of the volcano.
- White smokers and dead chimneys are found along this ridge although poorly imaged in the sea-floor bathymetry.
- Northern slopes of the cone have features oriented down-slope; perhaps originating from lava flows, or later mass movement events.
- The middle to upper flanks of the cone exhibit widespread diffuse flow.

5.2 Water column studies

Douglas Connelly, Rachael James, Katrin Zwirglmaier, Darryl Green, Jeff Hawkes and Belinda Alker

5.2.1 Introduction

Following the success of finding 2 vent sites in 2009 the work on this cruise was aimed at investigating in more detail the water chemistry associated with the black smoker vents identified at E2, the continued search for smoker vents at E9, a more thorough investigation of the South Georgia suspected gas hydrate site and an attempt to locate any hydrothermal activity in the new crater. In summary the location of black smokers on both E2 and E9 resulted in an excellent opportunity to obtain a complete suite of water column samples using CTD system, and hot vent fluids using titanium samplers and near-field samples using mini-niskin bottles mounted onto the ROV. The discovery of the extremely unusual system in the new crater spurred further investigation and opens the door to further in-depth study in coming years.

On this cruise we had a complete compliment of geochemists, biologists and geophysicists. This truly multidisciplinary approach is essential for the study of these complex systems. The water column study of the chemistry will be led by NOCS using samples collected on this cruise. Rachael James is a leading expert in vent fluid chemistry, and will focus on chemistry of the hydrothermal fluids collected from the vents. Douglas Connelly along with his student Jeff Hawkes will focus on the water column chemistry to decipher the processes that occur once the vent fluids are entrained in the seawater. Jeff will focus specifically on the cycling of organic matter in the vicinity of vents, an increasingly important area of study in geochemistry. Katrin Zwirglmaier with David Pearce will focus primarily on the microbial populations at the vent sites. This combination of expertise represents an unparalleled opportunity for the efficient exploitation of the samples collected during the cruise, to address some of the most complex and difficult questions associated with the chemistry of hydrothermal vents.

5.2.2. CTD deployments

A full list of the CTD operation locations can be seen in Appendix A1.
A full list of samples collected can be seen in Appendix A4.

The majority of the water samples collected were done using a Seabird CTD. The CTD system used is a Seabird +911 on a titanium frame with up to 24 externally sprung Niskin bottles. This is a clean system, specifically designed for the sampling of waters with low levels of trace metals and nutrients. The bottles are Teflon lined, with Teflon taps and non-metallic parts, any metallic components are titanium or high quality stainless steel.
The first operation (CTD 01) was carried out to collect seawater at 1000m in the Falklands Trough, this was basically a system check to determine any issues with bottles and the CTD electronics before use for the main science programme. It was noted that there was a problem with the firing mechanism on the rosette for bottle 22, this bottle was not used in subsequent sampling.

The first scientific samples of the cruise were taken on the 13th of January over a site to the south west of South Georgia. This area was originally investigated during the cruise aboard the RRS *James Clark Ross* last year. It is an area where a suspected sample of gas hydrate was dredged on a previous trawling cruise. The CTD samples collected all had elevated dissolved methane (see section below on methodologies), these samples guided an ROV deployment. There was no evidence from the ROV of hydrate deposits so we left this location.

We then proceeded south to segment E2 on the East Scotia Ridge. Our first CTD station, CTD 03, was a reoccupation of a station CTD 181 sampled above the E2 hydrothermal site discovered last year. The plume was strong and distinct, it was sampled at 4 depths through the plume and the remaining bottles were fired at 1000m. A series of CTD casts with and without SAPS (Stand alone pumps), see section below, samples were collected. In total 6 CTD's were sampled at this area (CTD 03-06), with CTD 05, 06 and 08 being for microbiology alone, and two down plume studies (CTD 04 and 07).

We left E2 and proceeded directly to segment E9, arriving in the 27th of January. We immediately deployed CTD 09, over the area where in 2009 we had found the diffuse vent site. At E9 we deployed a mixture of different CTD casts for various studies. There were 2 separate full deployments for microbiological sampling, these were sub-sampled from one niskin to provide supporting geochemical data. A series of in plume studies were performed for Jeff and in total we did full water column surveys using the CTD over the Black and White smoker and the Ivory Tower vents. The science behind these in-depth studies was to

link in with the samples we had collected for vent fluids and the mini-niskin samples over these sites using the ROV.

We left the E9 segment and proceeded to the McIntosh Caldera, arriving on the 4th of February. We immediately deployed the CTD and did a series of 3 Tow-Yos over the area at the edge of the crater, in the western part of the crater and immediately over the raised body in the crater. All of these, while showing occasional departures from background LSS, did not definitively locate a plume. After discovery by the ROV we then targeted the Great Wall diffuse flow area with a CTD combined with a SAPS (CTD 101), followed by a dedicated CTD for microbiology (CTD 102). We completed the work at this site with an in-depth plume study over the Winter Palace vent field, combined with a 2 hour SAPS (CTD 103).
We then left the area to return to Montevideo.

Falklands Trough			
CTD 01	53°15.85	53°13.98	10/1/10
South Georgia			
CTD 02	54°09.45	37°58.54	13/1/10
E2			
CTD 03	56°05.303	30°19.129	15/1/10
CTD 04	56°05.324	30°19.074	18/1/10
CTD 05	56°05.325	30°19.10	19/1/10
CTD 06	56°05.356	30°19.129	21/1/10
CTD 07	56°05.315	30°19.09	23/1/10
CTD 08	50°05.33	30°18.90	23/1/10
E9			
CTD 09	60° 02.513	29°58.991	27/1/10
CTD 10	60°02.593	28°58.921	28/1/10
CTD 11	60°02.732	28°58.794	29/1/10
CTD 12	60°02.571	29°58.92	31/1/10
CTD 13	60°02.567	29°58.912	2/2/10

CTD 14	60°02.905	29°58.895	3/2/10
CTD 15	60° 02.563	29°58.894	4/2/10
McIntosh Caldera			
CTD 16-100	59°40.675	28°23.696	4-5/2/10
CTD 101	59°41.867	28°21.096	9/2/10
CTD 102	59°41.667	28°21.095	10/2/10
CTD 103	59°41.693	28°20.942	12/2/10

Table 5.2. Summary of CTD casts (for bottle depths and preliminary methane data see Appendix A1)

5.2.3. Water Analyses

5.2.3.1 Biogeochemical samples

A number of samples were taken as part of the thesis work of Jeff Hawkes, a summary is presented here, full details can be found in Appendix A4. These samples, collected and preserved on board will be returned for further analysis at NOCS.

The CTD Carousel Niskin and ROV mini-Niskin bottles were sampled for (in order):

1. Methane (125ml, poisoned with HgCl for analysis at the NOC, Southampton)
2. Dissolved inorganic carbon (DIC) (250ml, poisoned with HgCl for analysis at the NOC)
3. Total dissolved organic carbon (tDOC) (20ml, filtered through 0.2m filter and acidified with HCl for analysis at the NOC)
4. Trace metals (filtered through 0.2m filter into an 500ml acid cleaned Teflon bottle, analysis at NOC)
5. Metal speciation (filtered through 0.2m filter into duplicate 250ml bottles and frozen for analysis at NOC)
6. Siderophores - remaining volume for Mini-Niskins, usually 10L for large Niskins - filtered and sucked through an Isolute ENV+ column (frozen) for characteristion at NOC
7. The Filters were all washed for salts with pH8 MilliQ water and stored frozen for analysis at NOC)

	CTD Cast	Firing Depths	Methane	DIC	DOC	CSV	Trace metals	Isolute columns	Filters
S. Georgia	02	4	12						
	03	5	6	8	5	10	5	9	10
	04	5	15	7	5	10	5	4	10
	05	1	3	1	1		1		1
E2	06	2	3	1	1	2	1	1	2
	07	4	12	4	4	8	4	4	8
	08			1	1		1 (unfiltered)		
	10	2	4	1	2	4	2	8	8
	12	1	2	1	2		1	1	1
E9	13	1	3	2	1	2	1	1	2
	14	4	12	4	4	6	3	4	6
	15	6	12	12	6	12	6	6	12
	101	3	9	3	3	6	3	3	6
MC	102	1	3	1	1	1	1		
	103	5	15	4	5	5	5	5	8
			111	**50**	**41**	**66**	**38**	**46**	**74**

Table 5.3. The number of samples collected at the 4 stations (S. Georgia, E2, E9 and the McIntosh Caldera), total = 426.

5.2.3.2 Methane analysis

The first samples to be drawn from the Niskin bottles were for methane. These samples were collected in 100 ml glass vials, capped with a rubber stopper and crimped with an aluminium seal to ensure no loss of the water or gas occurred. The samples were taken to the laboratory where 20ml of UHP nitrogen was added and the bottles were left to equilibrate as they warmed to room temperature. A sample of the headspace gas was taken for each vial and analysed using a 7850 Agilent Gas Chromatograph. We had two 7850 systems on board, the first combines an FID (Flame ionisation detector) for C1-C6 detection with a HID (Hydrogen ionisation detector) for the determination of hydrogen. The second system has an FID with built in methaniser for the determination of carbon dioxide in addition to methane. From the beginning of the cruise the HID did not function, towards the end of the cruise the methaniser

malfunctioned. The result of this was that the last CTDs at the New Crater were not analysed on board. The samples were poisoned with 20 µl of mercuric chloride and stored.
The analysis of the vent fluids was also performed on board. 20 ml of fluid was collected into a headspace vial and 5 ml of UHP nitrogen added. The analysis was performed as per the water samples.

5.2.4. Microbiology

5.2.4.1 Objectives
Hydrothermal vents and cold seeps provide a wide range of habitats for micororganisms and the diversity of prokaryote communities can vary from one or two species in the case of endo- or episymbionts to diverse communities of Archaea and bacteria. In general, biotopes that show extremes of temperature, pH and other physical and chemical parameters have a lower diversity of species but higher relative abundance of Archaea than Eubacteria. Organisms may be attached to substrata, form microbial mats, live as endo- or episymbionts, or occur as free cells in venting fluids and sediment. An important component of the microbial studies will be aimed at elucidating the diversity of a variety of biotopes in vents and seeps and comparing this diversity to that known from comparable environments in the Pacific and Atlantic Oceans. This will include studies on both prokaryote and eukaryote microbial communities as well as bacteriophage.

Elucidation of the microbial taxa that inhabit Southern Ocean chemosynthetic environments will help to determine what elements of primary production and carbon cycling are present and in which biotopes or habitats they are occurring. This will be directly linked to biomarker and isotope studies (Chris Sweeting/Will Reid, Newcastle) and to the physical and geochemical background in which samples are taken (Doug Connelly/Darryl Green/Rachel James/ Alfred Aquilina, NOC; Chris German, WHOI).

Hydrothermal vent environments are not limited to the immediate area of the active vent fields. The smoke from the vent chimneys rises up and forms buoyant plumes in the water column, which can contain microbial cells numbers up to 100x higher than the surrounding seawater. The aim of the CTD-based water column studies is to compare the microbial abundance and diversity within the plume both with samples from above the plume as well as samples from the vent fluid and immediate vicinity of the vent chimney (see 5.3.4.)

5.4.2.2. Work at sea

Sampling

Samples were taken with a CTD with 24 10L Niskin bottles. The sample volume varied between 10-200L (see samples list, Appendix). Bottles were fired either within the buoyant plume or above the plume (= negative control). The water was drained from the Niskin bottles into 50L plastic barrels that had been rinsed with MQ water. The samples were stored in the CTD hangar (ambient temperature <10°C) until processing.

Processing of samples

Water samples were processed for 5 different types of analysis: 1. Flow cytometry, 2. Fluorescence in situ hybridisation (FISH) filters, 3. FISH unfiltered, 4. phage counts and 5. DNA extraction. Sample types 1-4 were processed immediately after the CTD came on deck, processing for DNA extraction, especially for volumes >100L, took up to 48h.

1. Flow cytometry

1ml sample was transferred to an Eppendorf tube and fixed with 0.5% glutaraldehyde. Samples (in triplicate) were stored at -80°C.

2. FISH filters

50ml sample was filtered onto a 0.2µm 25mm diameter black polycarbonate filter using a glass filtration unit and a hand pump. Filters were air-dried and then fixed in 4% paraformaldehyde for 1-6h at 4°C. After that, filters were briefly dipped in MQ water and then dehydrated in 50, 80 and 100% ethanol for 3min each. Filters were air-dried and stored at -80°C. For each sample 10 filters were used.

3. FISH samples, unfiltered

In addition to the FISH filters, unfiltered water samples (30ml in universals) were stored at -80C for FISH analysis, one set (triplicate) fixed with 0.5% glutaraldehyde, a second set untreated.

4. Phage counts

30ml sample (in universals) was stored at 4°C for phage counts, one set (duplicate) unfiltered, the second set after filtration through 0.2µm.

5. DNA extraction

The entire remaining sample volume (between 9.5 – 200L, depending on sample), was filtered for DNA extraction. Filtration was done with a peristaltic pump (Millipore masterflex) using 6mm silicone tubing (Millipore). Water was size fractionated using a 3µm (membrane filter, Millipore) and 0.2µm (cellulose nitrate, Whatman) 47mm diameter filter and 2 stainless steel inline filtration units. Filters had to be changed after ca 10-40L, depending on the concentration of microbial cells at the sampling site. Filters were stored at -80°C.

Sample list

Samples for microbiology were taken from CTDs 1,2,3,4,5,6,8,9,10,12,13,101 and 102.
See Appendix A5 for full list of samples, including sampling locations and sample volumes.

5.4.2.3. Preliminary results and further analysis

All analysis will be done back at BAS, Cambridge. The main focus will be on the DNA samples, i.e. pyrosequencing of 16S/18S rDNA PCR products to determine bacterial, archaeal and eukaryotic diversity, potentially metagenomic sequencing to determine functional capacities of the microbial population, as well as FISH analysis to complement and confirm the sequence data.

5.2.5 Stand Alone Pumps (SAPS)

SAPS are designed to allow the high volume sampling of particles from the water column. On this cruise we used 293 mm Nuclepore filters with a nominal pore size of 1µm. The SAPS are designed to be mounted on either a line or modified to fit directly onto a CTD frame. Where we employed the pumps onto the CTD frame 4 niskin bottles had to be removed resulting in a total potential cast of 20 bottles. In general deployment on the frame was preferred as it allows a sampling of the water at the correct depth and time for the particle collection to occur. We performed SAPS deployments on the CTD frame 4 times at E2, twice at E9 and once in the McIntosh caldera. In addition to these frame deployments we did a CTD on a wire at E2 for microbiology/background particles, we also attempted to deploy a mooring with 2 SAPS and a current meter. This was lowered to the seafloor at E2 and was to be moved into an optimal position for plume sampling using the ROV. Unfortunately this wrapped around the ROV and resulted in many hours of lost time, and was not attempted again.

5.3 Geochemistry

5.3.1 Objectives

The overarching objective of geochemical studies on samples collected during JC42 is to define the chemical environment at the different chemosynthetically-driven ecosystems south of the Polar Front. To this end, we have collected a suite of (i) focussed and diffuse vent fluids, (ii) fluid samples from above sites of active venting, (iii) rock samples and (iv) sediment cores, from each of the sampling localities. Full details of all of the samples collected, together with a description of processing techniques and any on-board analyses are provided in Sections 5.3.1 to 5.3.3. Many of these samples were also sub-sampled for microbiological studies; details of this work can be found in Section 5.4.3.

5.3.2 Fluid Sampling

A suite of focussed and diffuse vent fluids, together with samples of the buoyant plume, was taken at each of the three localities (E2, E9 and Macintosh Caldera), with the aim of characterising the geochemical conditions that sustain their chemosynthetic communities. Excellent sample coverage was obtained at all sites; all in all, 63 focused and diffuse vent fluids (sampled via Ti samplers) and 75 samples from the buoyant plume (sampled via Niskin bottles located on the ROV) were collected.

5.3.2.1 Titanium samplers

The sampling and chemical analysis of focussed and diffuse vent fluids is a key objective of this consortium project, and is essential to evaluate the contribution of reduced chemicals to the overall energy budget within the chemosynthetic food-web, and to ascertain if there are any systematic differences between the different chemosynthetically-driven ecosystems. Collection of these samples was achieved using titanium (Ti) samplers, equipped with an ICL high-temperature sensor to ensure the collection of high quality samples. In the case of diffuse flow, or for sampling of friable chimney structures, the Ti samplers were used in conjunction with a specially-constructed Ti diffuse sampler (Fig. 5.3.1.1.1), which was used to prevent entrainment of surrounding seawater in to the path of the fluid during sampling. This system was used as an alternative to the *Isosampler* system discussed in the proposal.

A total of 11 focussed and 6 diffuse fluid samples were collected at Site E2. At E9, the total was 12 focussed and 8 diffuse samples; 24 samples were collected from Kemp Caldera. A

summary of the samples collected, together with the ICL temperature reading, is given in Table 5.4.

Location/ Dive No.	Sample number	Description	ICL Temp* (°C)
E2			
130	B2-05 & B2-08	Black smoker fluid, Dog's Head	323
130	Y2-01 & Y2-04	Black smoker fluid, Sepia	351
132	B1-02 & B1-03	Black smoker fluid, from 'beehive' structure at Sepia	313
132	Y1-07	Black smoker fluid, Dog's Head	351
133	Y2-01 & Y2-04	Diffuse fluid, area dominated by anenomes	3.5
133	B2-05 & B2-08	Diffuse fluid, area dominated by galatheids ('Crab City')	19.9
134	B1-02 & B1-03	Diffuse fluids, area dominated by barnacles	8.1
135	Y2-01 & Y2-04	Black smoker fluid, Sepia	352.6
135	B2-05 & B2-08	Black smoker fluid, Sepia	346.6
E9			
140	B2-05 & B2-08	Diffuse fluid, area dominated by galatheids	11.1
140	Y2-01 & Y2-04	Black smoker fluid, Black & White	380.2
141	B1-02 & B1-03	Diffuse fluid, area dominated by (female) galatheids	5.0
141	Y1-06 & Y1-07	Diffuse fluid, little fauna observable	19.9
142	B2-05 & B2-08	Black smoker fluid, Ivory Tower	347.7
142	Y2-01 & Y2-04	Black smoker fluid, Black & White	382.8
144	Y1-06 & Y1-07	Black smoker fluid, Pagoda	350.8
144	B1-02 & B1-03	Black smoker fluid, Launch Pad	350.7
145	Y2-01 & Y2-04	Diffuse fluid	n/a
145	Y1-06 & Y1-07	Black smoker fluid, Black & White	372
McIntosh Caldera			
147	Y1-06 & Y1-07	Diffuse fluid, Great Wall	n/a
147	Y2-01 & Y2-04	Diffuse fluid, Great Wall	21.1
149	B2-05 & B2-08	White smoker fluid, Winter Palace area	39.0 (212)
149	B1-02 & B1-03	White smoker fluid, Winter Palace area	(179)
150	Y2-01 & Y2-04	White smoker fluid, Winter Palace area	18.1 (124)
150	Y1-06 & Y1-07	White smoker fluid, Winter Palace area	14.8
151	B1-02 & B1-03	White smoker fluid, Winter Palace area	115.2
151	B2-05 & B2-08	White smoker fluid, Winter Palace area	65.5
152	Y1-06 & Y1-07	White smoker fluid, Winter Palace area	27.7
152	Y2-01 & Y2-04	White smoker fluid, Winter Palace area	23.4
153	B1-02 & B1-03	White smoker fluid, Winter Palace area	25.1
153	B2-05 & B2-08	White smoker fluid, Winter Palace area	90.5

Table 5.4 Summary of fluid samples collected by Ti samplers on JC42. *Temperature is maximum temperature of fluid recorded during sampling. Figure in brackets is the maximum temperature recorded *prior* to sampling via the diffuse flow sampler at Kemp Caldera (see text for more details). For sample locations, see Figures 5.2-5.4.

Sample collection: The Ti samplers were cleaned thoroughly before deployment using a solvent flux remover and rinsed with Milli-Q water. All Ti-Ti surfaces were lubricated with FluoroLube. Sample bottles were deployed in pairs, although each bottle had its own nozzle for insertion into the vent orifice (or diffuse flow sampler). Each pair of Ti samplers was coupled to an ICL high- temperature sensor that was located at the tip of the sample nozzles. Pins for firing the bottles were set at a distance of 22-31 mm above the top of the Ti sampler; however, when the pins were set high (31 mm) it proved difficult to couple the ICL temperature probe (for this reason, no temperature was recorded for some samples). The optimal setting for the pins was found to be ~27 mm.

For optimal sampling of focussed flow, the orifice was usually widened by breaking off a small piece with the arm of the ROV. The nozzles of the Ti samplers were then inserted into the orifice and the ram was slowly lowered until a reading was obtained on the ICL sensor. Once the temperature reading was considered to be steady, the ram was lowered in full to allow the sample to enter the bottle. The Ti sampler was kept in the path of the fluid for ~5 minutes after the springs had fully sprung, to give the sample time to cool and contract. The ram was then withdrawn and the Ti sampler returned to the ROV basket. On occasion, one of the bottles in the pair did not fire; if this occurred then the first bottle was allowed to fill, the ram withdrawn to seal the bottle and the second bottle was then fired separately. Firing of the bottles was successful on all occasions except one; on return to the surface it was found that the sample nozzles were blocked by chimney material.

For optimal sampling of diffuse flow, the diffuse flow sampler was placed over the area to be sampled, and allowed to equilibrate until fluid was observed to be flowing out of the sampler. The nozzles of the Ti samplers were then inserted into the diffuse flow sampler and the ram was slowly lowered until a reading was obtained on the ICL sensor. Once the temperature reading was considered to be steady, sampling proceeded in the same way as for a focussed fluid. The diffuse flow sampler was also used on occasion to assist sampling of white smoker fluids in Kemp Caldera. These fluids were emanating from small cracks in extremely friable 'beehive'-type structures. On a number of occasions, these structures collapsed when attempts were made to widen the orifice, so after minor excavation the diffuse flow sampler was then held gently over the excavated area, and sampling proceeded as soon as fluid was seen flowing out of the sampler. Nevertheless, the temperature of the fluid flowing from the diffuse

flow sampler was generally lower than that recorded by direct insertion of the nozzle into the structure, suggesting that this procedure resulted in entrainment of ambient seawater.

Where possible, the fluid samples were always taken towards the end of the dive, to minimise the loss of gases and precipitation of minerals.

Figure 5.5. Sampling of diffuse fluid using the diffuse flow sampler. The sampler, constructed of Ti, is placed over the area of diffuse flow and a good seal is obtained via careful positioning of the weighted 'skirt' (constructed from a fire blanket). In order to take a sample of the diffuse fluid, the nozzle of the Ti sampler is then inserted into the throat of the diffuse flow sampler. The photograph shown here was taken in the vicinity of the Great Wall at Macintosh Caldera. Note that the 'wall' consists of white and yellow mineral precipitates.

Shipboard processing and analysis: As soon as the samplers returned to the surface, they were rinsed in Milli-Q water and the fluid was withdrawn. Separate sub-samples were collected for (i) refractive index, (ii) alkalinity, (iii) dissolved inorganic carbon and carbon isotopes, (iv) pH, (v) gases (including CH_4, CO_2 and H_2), (vi) anions and silica, (vii) nutrients, (viii) dissolved organic carbon, (ix) O and H isotopes, and (x) bacteria, in that order. The remainder of the sample was emptied into an acid-cleaned 1-L HDPE bottle for analysis of all other constituents, including cations and the transition metals. Any 'dregs' remaining in the bottle were washed in to an acid-clean 30ml HDPE bottle with Milli-Q water.

Analysis of 'time-critical' parameters (e.g. pH), and key indicators of sample quality (e.g. Cl), was carried out onboard. The analysis of other constituents will be carried out back in the laboratory. The treatment applied to each of the sub-samples is summarised in Table 5.5.

Description	Volume/ ml	Onboard processing
Refractive index	Few drops	Measured onboard using refractometer. Calibrated vs IAPSO.
Alkalinity	25	Sampled to exclude air. Analysed onboard using Gran titration method. Standardised vs IAPSO.
DIC	25	Sampled to exclude air. Diluted with Milli-Q water to give a total volume of 250ml and poisoned with mercuric chloride for analysis back onshore.
pH	13	Analysed onboard using a pH electrode. Electrode calibrated using pH 2, 4, 6.8 and 9 buffer solutions.
Gases	20	Sample drawn into a headspace vial and crimped shut to exclude air. Some samples analysed for CO_2 and CH_4 onboard by GC; remainder preserved by poisoning with mercuric chloride for analysis back onshore. Samples analysed onboard calibrated against BOC gas standards.
Hydrogen sulphide	2×6	Sampled to exclude air. One sample analysed onboard using iodimetric titration method. Other sample preserved for analysis back onshore using zinc acetate/gelatine solution.
Anions & silica	~2	Sample diluted with Milli-Q water and analysed onboard by ion chromatography for Cl, Br and SO_4. Standards include pre-weighed individual salts, plus IAPSO. Remainder of diluted sample will be used to determine the concentration of other constituents back onshore.
Nutrients	~25	Sample bubbled with N_2 to displace H_2S, then frozen for analysis back onshore.
DOC	20	Sample filtered through 0.2 μm filter and preserved for analysis back onshore by acidifying with HCl.
O and H isotopes	1.6	Sampled to exclude air. Sample refrigerated for analysis back onshore.
Bacteriology	30	Sample immediately frozen at -80°C for analysis back onshore.
Bulk sample	Remainder	Sample acidified with HNO_3 for analysis back onshore.

Table 5.5. Onboard sub-sampling and processing of Ti sample fluids.

Preliminary Results: A full calibration of the data collected onboard, as well as the majority of the chemical analyses, will be carried out back in the laboratory onshore. Nevertheless, our initial data would indicate that sampling was extremely successful, and the samples are extremely interesting. Analyses of dissolved sulphate suggest that 'black smoker' samples consist of up to 97% of the hydrothermal endmember (i.e <3% seawater was entrained during the sampling process). This is a fantastic result that will allow us to specify the chemical

composition of the endmember fluid with certainty. There are clear differences in the chemistry of black smoker fluids from sites E2 and E9. Samples from E2 have concentrations of dissolved chloride [Cl^-] that are similar to seawater, while levels of chloride in black smoker fluids from site E9 have very low [Cl^-]; as much as 80% less than 'normal' seawater in this area. Meanwhile, fluids emanating from white smokers at the Macintosh Caldera are characterised by extremely high levels of hydrogen sulphide- as much as 40 mM.

5.3.2.2 In-situ Niskins

In order to assess microbial diversity and to understand the chemical transformations that take place as focused and diffuse fluids enter the overlying water column and mix with ambient seawater, a series of water samples were taken a few meters above the vent sites using 1.2-L Niskin bottles located towards the rear of the ROV. The bottles (5 in total) were fired on all of the vent fluid sampling dives, and 75 samples were collected from above all 3 sites. A summary of the samples collected is given in Table 5.6.

Samples will be used for both chemical and microbiological studies back onshore; no analyses were conducted onboard. Samples for chemical studies were combined, and sub-sampled and processed as described in Table 5.7. Processing of microbial samples is described in Section 5.3.4.

Location/ Dive No.	Sample bottle	Description	Sample type
E2			
130	red, green	Buoyant plume, Dog's Head	Chemistry*
130	white, brown, yellow	Buoyant plume, Sepia	Chemistry*
132	red, green	Buoyant plume, Sepia	Chemistry
132	white, brown, yellow	Buoyant plume, Dog's Head	Chemistry
133	All	Area of diffuse flow, 'Crab City'	
134	All	Buoyant plume, Sepia	
135	All	Buoyant plume, Sepia	
E9			
140	All	Buoyant plume, Black & White	
141	All	Area of diffuse flow, Marsh Tower	
142	All	Buoyant plume, Ivory Tower	
144	All	Buoyant plume, Launch Pad	
145	All	Buoyant plume, Black & White	
McIntosh Caldera			

147	All	Area of diffuse flow, Great Wall	
149	All	Buoyant plume, Winter Palace area	
150	All	Buoyant plume, Winter Palace area	
151	All	Buoyant plume, Winter Palace area	
152	All	Area of diffuse flow, Great Wall	

Table 5.6. Summary of fluid samples collected by ROV-mounted Niskin bottles on JC42.

Description	Volume/ ml	Onboard processing
Gases (CH_4)	125	Sampled to exclude air. Most samples poisoned with mercuric chloride for analysis back onshore; a few samples analysed onboard by GC.
DIC	250	Sampled to exclude air and poisoned with mercuric chloride for analysis back onshore.
DOC	20	Sample filtered through 0.2 μm filter and preserved for analysis back onshore by acidifying with HCl.
Trace metals	500	Sample filtered through 0.2 μm filter and stored in an acid-cleaned HDPE bottle. Sample preserved for analysis back onshore by acidifying with HNO_3.
Metal speciation	2 × 250	Sample filtered through 0.2 μm filter stored in an acid-cleaned HDPE bottle. Sample preserved by freezing for analysis back onshore.
Siderophores	Remainder	Sample filtered through 0.2 μm filter and passed through a column packed with Isolute ENV+ resin. The column was then frozen for analysis back onshore.
Plume particulate material	Filters	0.2 μm filters were washed to remove sea salt with Milli-Q water adjusted to pH8, and frozen for analysis back onshore.

Table 5.7. Onboard sub-sampling and processing of Niskin bottle samples for chemical studies.

5.3.3 Sulfide Sampling

Christopher German

5.3.3.1 Overview

Altogether, fourteen sulfide samples were collected at the three hydrothermal sites investigated during the JC042 Cruise – at the E2 and E9 segments of the East Scotia Ridge and from the Macintosh caldera, at the southernmost limit of the South Sandwich Arc. At all three study sites it was decided to focus exclusively on sampling sulfide samples from sites of active fluid flow and this is reflected in the list of samples taken (Table *CRG1*) which are matched with complementary fluid samples collected from the same sites (see section 5.3.1).

5.3.3.2. Sampling & Handling Protocols

All samples were treated following protocols advised by Dr.Meg Tivey (WHOI):-

When sampling, temperatures in and around the chimney structures were documented as thoroughly as possible, using the temperature lance as well as the ICL temperature sensors mounted on the Ti major-pair fluid sampler. Ideally, samples were taken that were of the order 20cm tall. Although subsamples were routinely taken for microbiology (and to a lesser extent for bio-film studies – see Table *CRG1*) the chimney samples were not placed in bio-boxes to keep at close to ambient temperatures. Rather, the cool surface temperatures at all three study locations were considered sufficient to protect against warming of samples prior to recovery in-board from the ROV.

Once on deck the following procedures were followed:-

a) Each sample was carried into the laboratory immediately upon recovery, wearing latex gloves to guard against microbial contamination. This handling procedure was continued until all sub-sampling for microbiological and bio-film analyses had been completed.
b) Photographs were taken of the intact sample, together with sample number and a 30cm ruler to provide scale as soon as possible after recovery.
c) Microbiological samples (and bio-film samples) were then removed – either as fragments that had broken from the main sample during recovery in the ROV basket or using a hammer and chisel to separate fragments from the main chimney sample. Photo-documentation was used to record removal of these samples so that they can be oriented back to the original samples in post-cruise laboratory work-ups.
d) All microbiological samples (to be analysed at BAS) and one subset of bio-film samples (to be analysed at NOC) were then bagged and frozen at -80°C.
e) A further two sets of bio-film samples, when taken, were preserved as follows: one set was dried in ethanol, and the other was kept moist and refrigerated at 4°C.
f) The remaining samples were then photographed and their dimensions noted (height, breadth, depth) as well as the sizes of any conduits present, evidence for layering from exterior to interior).
g) Samples were then air-dried thoroughly (~24-96h depending on sample size)
h) Once dry, each sample was placed in a labeled plastic zip-lock sample bag with a second hand-written label placed inside the bag. Samples were then stored, bubble-wrapped at room

temperature ready for transfer to shore with the exception of elemental sample S9 which was refrigerated to guard against deliquescence.

Preliminary Observations: A listing of all samples collected, together with details of their sample collection sites, corresponding vent-fluid samples and sample sizes is presented in Table 5.8. In summary, four different types of samples were collected across the three study areas.

ID	Dive (Evt)	JDay	Time (z)	Lat (S)	Long (W)	Depth (m)	Fluid ID	Tmax°C	µbio	biofilm	size (cm)
S1	130 (09)	019	23:36	56° 05.313'	30° 19.102'	2603	130-Blue2	323	√	x	24x25x15
S2	130 (14)	020	07:26	56° 05.324'	30° 19.090'	2616	130-Yellow2 (135-Yellow2 (135-Blue2)	351 352.7)	√	x	A: 12x B: 10x C: 8x4x2
S3	132 (11)	022	21:37	56° 05.306'	30° 19.078'	2603	132-Yellow1	351	√	√	40x26x22
S4	140 (19)	030	11:11	60° 02.568'	29° 58.892'	2395	140-Yellow2	380.1	x	x	T1: 25x24x15 T2: 15x9x8 A:17x15x13 B: 13x10x14 C: 27x8x18 D: 26x10x26
S5	142 (09)	033	04:01	60° 02.815'	29° 58.712'	2394	142-Blue2	347.7	x	x	40x18x25
S6	144 (14)	033	21:03	60° 02.842'	29° 58.725'	2395	144-Yellow1	350.7	x	x	11x10x5
S7	144 (16)	033	21:50	60° 02.839'	29° 58.735'	2394	144-Blue 1	350.7	√	x	A: 17x12x5 B: 11x7x4.5
S8	145 (21)	035	05:49	60° 02.570'	29° 58.901'	2395	145-Yellow1	372	√	x	A: 12x12x9 B: 8x4x5
S9	147 (15)	037	23:09	59° 41.678'	28° 21.098'	1422	147-Yellow2	20.3	√	√	8x6x7
S10	149 (19-)	040	02:03	59° 41.684'	28° 20.959'	1436	149-Blue2	92	√	x	11x10(dia)
S11	149 (22)	040	02:54	59° 41.689'	28° 20.964'	1434	149-Blue1	179	√	√	60x30 (dia)
S12	150 (21)	040	22:13	59° 41.693'	28° 20.959'	1436	150-Blue1	14.8	√	x	N/A
S13	152 (59)	042	09:05	59° 41.695'	28° 20.966'	1436	152-Yellow2	184	√	√	A: 10x8 (dia) B: 7x9x2 C: 4x8x3.5 D: 6x5x3.5
S14	152 (60)	042	09:35	59° 41.689'	28° 20.965'	1436	152-Yellow1	36	√	√	15x10 (dia)

Table 5.8. Summary of Hydrothermal Sulfide Samples Collected on JC 042 (Jan-Feb 2010)

5.3.3.3 Preliminary Observations

A listing of all samples collected, together with details of their sample collection sites, corresponding vent-fluid samples and sample sizes is presented in Table CRG1. In summary, four different types of samples were collected across the three study areas.

E2 Segment

Three samples were collected from this first study area. Samples S1 and S3 were collected from two separate orifices at the Dog's Head site that were each sampled for vent-fluid chemistry on the same *Isis* dive as the sulfide sample was taken. S2 was taken from the Sepia vent on *Isis* dive 130 but fluid sampling on that dive was only partly successful. Fluid samples that were closer to end-member were collected on subsequent *Isis* dive 135. All three samples returned consolidated chimney samples that showed clear zonation from interior to exterior with inner surfaces lined with a coarse yellow-gold mineral indicative of chalcopyrite (Fig.5.6).

Figure 5.6. hydrothermal chimney samples S1, S2 and S3 from the E2 segment, East Scotia Ridge

E9 Segment

Five samples were collected from the E9 segment. Two of these samples (S4, S8) were collected from adjacent orifices at the Black and White vent, collected on *Isis* dives 140 and 145. Three other samples (S5, S6, S7) were collected – one sample each – from the three other sites that were identified as sites of active high-temperature venting in the E9 segment: Ivory Tower, Pagoda and Launch Pad

respectively. The samples collected fell into two distinct types. Samples S5 and S6 appeared rather similar to those collected from the E2 segment in that both of these samples were highly consolidated, showed significant zonation from exterior to interior and were lined with an extensive and coarse-grained yellow-gold mineral indicative of chalcopyrite (Fig.5.7).

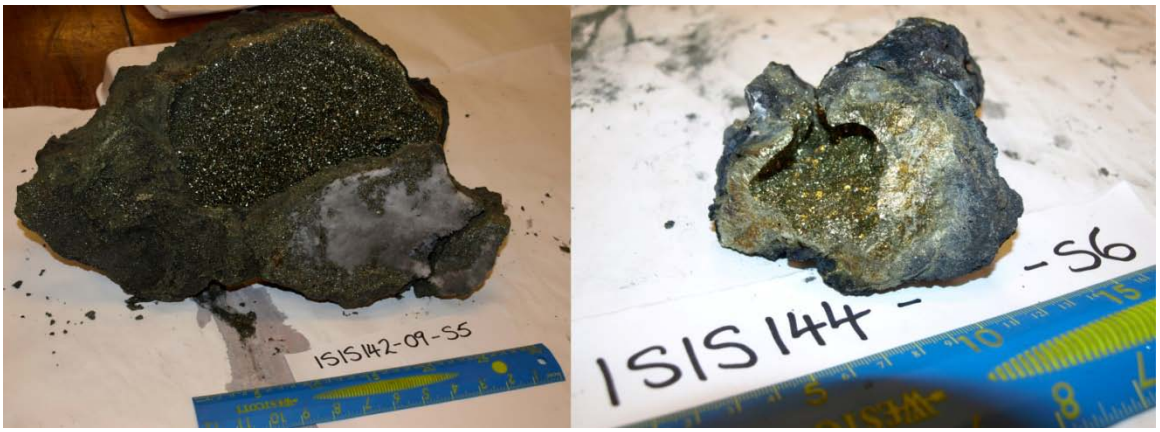


Figure 5.7. Consolidate samples S5 and S6 from the E9 segment, East Scotia Ridge

The other three samples, by contrast, were quite distinct. All three samples were much more friable and dominated by a dark grey to black, opaque mineral (possibly Cu-rich supergene minerals chalcocite and/or digenite) with only a very thin lining to any conduits of a green-yellow metal sulfide (presumed to be chalcopyrite). Another important feature of these samples was the abundance of a white crystalline but fibrous-textured mineral that was found pervasively both within the walls of these chimneys but also lining some portions of conduits, indicative of seawater ingress into the upflow pipes of these chimney structures (Fig.5.8).

Figure 5.8. More friable samples S4, S7 and S8 from the E9 segment, East Scotia Ridge

McIntosh crater

The samples collected at the McIntosh crater site, at the southern end of the South Sandwich Islands arc, were of two distinct types, each quite distinct from any of the samples collected from vent-sites on the East Scotia Ridge. Sample S9 was collected from a site of low temperature diffuse venting associated with a feature named "The Great Wall" that appears to be composed entirely of elemental sulfur (Fig.S4). One other sample of this low temperature material was attempted using a canvas scoop-bag manipulated by *Isis* via a T-handle (S12) but only an unconsolidated sulfur-gravel was obtained. The other samples collected from McIntosh crater (S10, S11, S13 & S14) were all rather similar to one another and collected from different white-smoker structures within the "Winter Palace" area. Samples S10, S13 and S14 were relatively small samples and, of these, S13 and S14 retained internal conduit structures (Fig.S4). All of the Winter Palace samples were characterized by an outer red-brown oxidized coating which was typically ~30% covered with small, yellow and often plastic-textured spherules clearly indicative of liquid sulfur. It would appear that the same spherules were also apparent, pervasively, throughout these chimneys based on their abundance on surfaces freshly exposed during sampling. Conduits within these samples were either small and rare or absent. Rather, what was apparent was a minor amount of a platy/fibrous white crystalline mineral (presumed anhydrite) interspersed among a more massive purple-brown mineral that gave off an iridescent sheen under reflected light – potentially indicative of "peacock ore" formed from tarnishing of the Cu-Fe sulfide mineral bornite (Fig.5.9).

Figure 5.9. Hydrothermal deposits collected from the McIntosh crater. Clockwise from top left: elemental sulfur sample (S9) from Great Wall diffuse venting site; high-temperature (>150°C) sulfide deposits S10, S13, S14 and S11, all collected from the Winter Palace area, with oxidized exteriors, evidence for liquid sulfur droplets, pervasive anhydrite and (inset to S11) “peacock ore”.

5.3.3.4 Summary and Future Work Plans

A suite of 14 hydrothermal samples have been collected from the E2 and E9 segments, East Scotia Ridge and the Macintosh crater. At the end of the cruise the samples were returned to NOCS for work up as a planned joint collaboration between UK researchers (lead ChEsSO Co-PI: Dr. R.Mills, NOCS) and those at WHOI (lead NSF Co-PI, Dr C.German). In addition to the complementary fluid studies that will be essential to this collaboration (Dr.R.James, NOCS), a majority of the sulfide samples were sub-sampled for microbiology studies (Dr.D.Pearce, BAS) and a significant sub-set were also sampled for bio-film research (Dr.D.Connelly, NOCS).

5.3.4 Sediment Sampling

A total of 36 gravity cores and push cores, as well as one sediment scoop sample, were taken on JC 42. Samples were recovered from 3 of the 4 sites, (a) South Georgia, (b) the E9 segment of the East Scotia Ridge, and (c) the Macintosh Caldera (Table 5.3.3.1). No sediment was recovered from the E2 segment of the East Scotia Ridge. The recovered sediment cores will be subject to geochemical and lipid analysis, in order to: (a) investigate and constrain the chemical parameters which regulate the chemosynthetic ecosystems, and (b) investigate elemental cycling, in hydrothermal vent settings along the East Scotia Ridge, Antarctica.

Shipboard processing: At all sites, the sedimentary layer was generally thin (<15 cm, but often much less than that). Cores taken from South Georgia and the base of 'Toxic Castle' within the Macintosh Caldera were the most successful (ca. 20 cm long) (e.g. Figure 5.10.). Sediments recovered from the E9 and Caldera sites generally consisted of coarse, sand-like sediment that did not core successfully. In such cases, it was not possible to retrieve any cores, and occasionally the material was lost during extrusion in the nitrogen glove bag. Table 5.3.3.1 is a complete list of the push cores and gravity cores taken and extruded at each station: South Georgia, E2 (no cores collected due to a lack of sediment), E9 and the Macintosh Caldera.

Gravity cores (> 1 m) were split using a circular saw and nylon wire, and sub-sampled under a nitrogen atmosphere at 4 ºC. One half of the core was archived at -20ºC. Push cores and short gravity cores (< 50 cm) were extruded and sampled at 2 cm intervals inside a glove bag under a nitrogen atmosphere and at 4ºC.

Interstitial water collected following centrifugation (10,000 rpm, 4 ºC, 20 min) was filtered using a cellulose nitrate membrane (0.2 μm pore size) and collected in a plastic syringe. The pore water volume extracted varied between ca. 10 and 15 ml. This was split into two aliquots: (a) ca. 2 ml was transferred into an acid-cleaned 8-ml LDPE bottle, and (b) the remaining volume was transferred into a 20-ml plastic vial. The first aliquot was acidified with nitric acid and stored at 4ºC pending analysis of major cations by ICP-AES and ICP-MS (as described below). The second aliquot was sub-sampled further as described in Tables 5.9.a,b.

Table 5.9. Details of gravity core and push cores collected during cruise JC42.

(a) Gravity cores

Sample	Julian Day	Site	Core Length (m)	Core Sections
JC042-02-02	13	South Georgia	Failed	
JC042-02-03	13	South Georgia	2.02	4
JC042-05-05a	38	Macintosh Caldera	Failed	
JC042-05-05b	38	Macintosh Caldera	0.2	1
JC042-05-11a	41	Macintosh Caldera	Failed	
JC042-05-11b	41	Macintosh Caldera	Failed	
JC042-05-12	41	Macintosh Caldera	Failed	

(b) Push cores and sediment scoop samples. ‘Intact sediment’ has been frozen for processing back onshore. Geochemistry cores have been centrifuged to separate porefluids from the solid phase.

ISIS Dive	JD	Locality	Core Number	Core Length (m)	Shipboard Processing
South Georgia					
125	14		PUC 1	0.25	Used for O_2 / pH probe analysis
E9					
142	32		PUC 1	0.12	Core extruded - Geochemistry
142	32		PUC 2	0.07-0.1	Core collapsed during extrusion
142	32		PUC 3	0.02	Core extruded - ‘intact sediment’
142	32		SCOOP		
144	33	Marsh Land	PUC 1	0.10	Core extruded - Geochemistry
144	33	Marsh Land	PUC 2	0.00	Failed
144	33	Pagoda	PUC 3	0.10	Core extruded - 'intact sediment'
144	33	Pagoda	PUC 4	0.05	Core extruded - Geochemistry
145	35	North of Black & White	PUC 1	0.07	Core extruded - 'intact sediment'
145	35	North of Black & White	PUC 2	0.10	Core extruded - Geochemistry
145	35	Diffuse flow	PUC 3	0.03	Core extruded - 'intact sediment'
145	35	Diffuse flow	PUC 4	0.06	Core extruded - Geochemistry
147	37	Live clam bed	PUC 1	0.13	Core extruded - Geochemistry
147	37	Live clam bed	PUC 2	0.15	Core collapsed during extrusion

147	37	Snowfield	PUC 3	0.03	Core extruded - Geochemistry
147	37	Snowfield	PUC 4	0.00	Failed
McIntosh Caldera					
149	39	Clam field, Glacier	PUC 1	0.13	Core extruded - Geochemistry
149	39	Clam field, Glacier	PUC 2	0.25	Core extruded - 'intact sediment'
149	39	Tubeworm field	PUC 3	0.10	Core extruded - 'intact sediment'
149	39	Tubeworm field	PUC 4	0.25	Core extruded - Geochemistry
150	40	Top of Glacier	PUC 1	0.13	Core extruded - 'intact sediment'
150	40	Top of Glacier	PUC 2	0.11	Core extruded - Geochemistry
150	40	Toxic Castle	PUC 3	0.11	Core extruded - Geochemistry
150	40	Base of Toxic Castle	PUC 4	0.08	Core extruded - 'intact sediment'
151	41	Whale fall	PUC 1	0.10	Core extruded - 'intact sediment'
151	41	Whale fall	PUC 2	0.06	Core extruded - Geochemistry
151	41	Winter Palace	PUC 3	0.06	Core extruded - 'intact sediment'
151	41	Winter Palace	PUC 4	0.05	Core collapsed during extrusion
152	42	Live clam field, Glacier	PUC 1	0.12	Core extruded - Geochemistry
152	42	Live clam field, Glacier	PUC 2	0.13	Core extruded - 'intact sediment'
152	42	White ash site, Glacier	PUC 3	0.07	Core extruded - Geochemistry
152	42	White ash site, Glacier	PUC 4	0.05-0.1	Core collapsed during extrusion
153	42	Whale fall	PUC 1	0.10	Core extruded - 'intact sediment'
153	42	Whale fall	PUC 2	0.14	Core extruded - Geochemistry
153	42	Toxic Castle	PUC 3	0.03	Core collapsed during extrusion
153	42	Toxic Castle	PUC 4	0.18	Core extruded - 'intact sediment'

Figure 5.10. Push core collected from a field of live clams within the Macintosh Caldera. The core consists of fine ash-like sediment, which overlies a layer of lighter, silty material. The bottom layer has a dark colouration and smells of hydrogen sulfide. A pale-coloured bacterial mat, extending over 2 cm depth, was present between the layers of 'ash' and sulfidic mud.

Shipboard analyses: Interstitial water samples were analysed for total alkalinity, ammonia and major anions according to standard methods (Table 5.10). Alkalinity was measured by titrating against standard hydrochloric acid solution as soon as possible after sample collection using the Bruyevich method (Rogachev et al., 1996). The method was calibrated against International Association of the Physical Sciences of the Oceans (IAPSO) seawater standards. Concentrations of anions (Cl^-, Br^- and SO_4^{2-}) were determined by ion chromatography; samples were run at 1:200 dilution. Ammonia was determined by colourimetry according to the method of Solorzano (1969).

Parameter	**Treatment**	**Method**
Methane	Fix with NaOH	Gas chromatography
Total alkalinity	None	Titration
Ammonia	None	Colourimetry
Major anions	Dilute to 1:200	Ion chromatography

Table 5.10. Methods for on-board analyses of sediment core samples

On-shore analyses: Treated aliquots of pore fluid were stored for subsequent analysis at the home laboratory (Table 5.11). Additionally, the residual sediment samples will be shipped frozen (-20ºC) to the NOCS, where a range of mineralogical (XRD and XRF) and geochemical (total acid digestions and sequential dissolutions) methods will be used to determine the solid-phase composition. Total carbon, sulphur and nitrogen contents, as well as the inorganic carbon content, will be determined using an elemental analyser. Stable carbon and sulphur isotope ratios (in DIC and sulfides, respectively) will be determined using isotope ratio mass spectrometry.

From each sampling site, a second sister push core was collected (whenever possible; Table 5.9); this was extruded and sampled at 2 cm intervals. The sediment sections will be shipped frozen and used to determine the distribution and carbon isotope signature of microbial biomarkers in these settings.

Table 5.11. Methods for on-shore analyses

Parameter	**Treatment**	**Method**
Hydrogen sulphide	Fix with zinc acetate	Colourimetry
Major cations	Acidify with nitric acid	ICP-AES and ICP-MS
Remaining nutrients	Freeze at -20ºC	Colourimetry
DIC and $\delta^{13}C_{DIC}$	Poison with mercuric chloride	TBD
$\delta^{34}S$	Poison with mercuric chloride	Isotope ratio MS

5.3.5. Microbiology sampling

5.3.5.1. Objectives

Hydrothermal vents and cold seeps provide a wide range of habitats for micororganisms and the diversity of prokaryote communities can vary from one or two species in the case of endo- or episymbionts to diverse communities of Archaea and bacteria. In general, biotopes that show extremes of temperature, pH and other physical and chemical parameters have a lower diversity of species but higher relative abundance of Archaea than Eubacteria. Organisms may be attached to substrata, form microbial mats, live as endo- or episymbionts, or occur as free cells in venting fluids

and sediment. An important component of the microbial studies will be aimed at elucidating the diversity of a variety of biotopes in vents and seeps and comparing this diversity to that known from comparable environments in the Pacific and Atlantic Oceans. This will include studies on both prokaryote and eukaryote microbial communities as well as bacteriophage.

Elucidation of the microbial taxa that inhabit Southern Ocean chemosynthetic environments will help to determine what elements of primary production and carbon cycling are present and in which biotopes or habitats they are occurring. This will be directly linked to biomarker and isotope studies (Chris Sweeting/Will Reid, Newcastle) and to the physical and geochemical background in which samples are taken (Doug Connelly/Darryl Green/Rachel James/ Alfred Aquilina, NOC; Chris German, WHOI).

5.3.5.2. Work at sea

Sampling

Using the ROV, different types of samples were obtained for microbial analysis of various habitats: High temperature vent fluids and diffuse flow samples were obtained using titanium syringes. Plume samples from within the smoke directly above the smoker chimneys were sampled with 1.2L Niskin bottles. ISIS' robotic arms were used to obtain fragments from several vent chimneys. Sediment samples were obtained with either push cores (ROV) or gravity cores. All samples for microbiology work were subsamples from the respective geology (Chris German) and chemistry (Doug Connelly, Rachel James, Alfred Aquilina) samples. For details of sampling procedure and equipment see previous sections.

Processing of samples

All samples were frozen immediately at -80°C.

Sample list

See appendix for full list of samples, including location and sample volume.

5.3.5.3. Preliminary results

Initial basic analysis of the samples under the microscope using a DNA stain

(DAPI/SYBR green) showed extremely high numbers (no exact cell counts were done) of prokaryotic cells in the plume samples from the Niskin bottles, about 10x less cells in the diffuse flow samples and very few cells in the high temperature vent fluid samples. Chimney samples were found to be covered in clusters of bacteria.
A detailed analysis of the microbial communities, focussing on 16S/18S rDNA sequence analysis and FISH will be carried out back at BAS.

5.4. Videographic surveys

Jon Copley, Leigh Marsh

5.4.1. Introduction

Deep-sea chemosynthetic habitats typically exhibit remarkable spatial variation in faunal distribution, which reflects heterogeneity in physico-chemical conditions and biological interactions. To investigate and quantify this ecological feature for the first time at deep-sea chemosynthetic habitats of the Southern Ocean, we undertook high-resolution videographic surveys at the E2 and E9 segment vent sites of the East Scotia Ridge, and at the volcanically-hosted seep and whale skeleton in the caldera adjacent to Kemp seamount.

5.4.2 Survey methods

Two equipment arrangements were used to conduct videographic surveys during *Isis* ROV dives. "Horizontal" surveys (surveys of horizontal substratum) were undertaken using a downward-looking Atlas 3-chip CCD video camera. The camera housing was mounted to view the seafloor through an aperture cut in the port forward corner of the ROV tool tray. A downward-facing HMI light was similarly mounted through the starboard forward corner of the tool tray. Two parallel lasers, 0.1 m apart, were mounted parallel to the focal axis of the camera to provide scale in images. Footage from the downward-looking Atlas camera was recorded to DVCAM tapes and DVD in the ROV control van. Controls for the Atlas camera (iris, zoom, focus, colour balance) were adjusted from the ROV control van to obtain the clearest possible images for faunal identification.

Horizontal surveys were run with the ROV at a target altitude of 3.5 m above the seabed for optimal lighting, although adjustment of altitude was often required by pilots to navigate seafloor topography. The horizontal videographic surveys were run at two different scales:

(1) "transects" consisting of long (25-250 m) lines to investigate wider faunal zonation around chemosynthetic sources. Camera zoom was set in "transect" surveys to achieve image frames approximately 1.5 m wide. Zoom was adjusted manually as required during transects over undulating

topography to maintain this approximate image width. Navigation using Doppler log was generally preferred during video transect lines, even over longer distances, given variation in USBL fixes generated by shipboard GPS.

(2) "mosaics" consisting of grids of shorter lines (5-25m) to produce overlapping video images to enable complete faunal mapping of an area of seafloor in detail. Mosaics were undertaken using closed-control of the ROV to maintain constant vehicle heading, and Doppler lock to enable movements of the vehicle over precise distances relative to the seafloor. Camera zoom was set in "mosaic" surveys to achieve image frames approximately 1 m wide, with no adjustments during surveys, as images will be mosaiced together between overlapping survey lines for analysis.

"Vertical" videographic surveys (surveys of vertical substrata such as vent chimneys) were undertaken using the high-definition pilot pan-and-tilt (HDI-PPT) camera of the Isis ROV. For these surveys, this camera was configured to view horizontally forwards from the vehicle, so that its focal axis was perpendicular to vertical substratum surfaces. Two parallel lasers, 0.1 m apart, were mounted parallel to the focal axis of the camera to provide scale in images.

Vertical surveys were undertaken using closed-control of the ROV to maintain constant vehicle heading, and Doppler lock to enable movements of the vehicle over precise distances relative to the seafloor. These features enabled the ROV to undertake vertical lines up and down chimneys, offset by fixed horizontal distances to obtain overlapping video images of the structure from a particular heading. Distance from the vehicle to the structure was kept constant, so that survey lines lay on a flat vertical plane a fixed distance from the structure being surveyed. Camera zoom was set in vertical surveys to achieve image frames approximately 1 m wide, with no adjustments during lines, as images will be mosaiced together from overlapping lines for analysis.

As only one pair of functioning lasers were available, horizontal and vertical surveys were undertaken on separate ROV dives. Videographic surveys conducted during *Isis* dives are summarised in the Table below.

Three horizontal transect surveys were carried out at the E2 vent field, each consisting of between five and twenty 20-25 m survey lines offset by 1 to 2 m. Three horizontal mosaics surveys were carried out at E2: two (at different zoom settings to experiment with the camera) 5 m x 5m grids at Anemone Field, and another 5 m by 5 m grid south of Dog's Head, at the NE corner of the transect survey in the same area. Vertical mosaics were undertaken of the Dog's Head structure from south, SE and NW.

At E9, two horizontal mosaic surveys were undertaken at Twin Peaks (one with overlapping lines 25 m in length, covering the eastern edge of the faunal aggregations; and one with overlapping lines 15 m in length, covering the western edge of the faunal aggregations). Horizontal mosaic surveys were also undertaken at the Garden site (with overlapping lines 20 m in length) and at the NW corner of the Black & White chimney structure (with overlapping lines 10 m in length). Vertical mosaics at E9 covered the Black & White chimney structure from two different views (west and east sides), the Carwash structure from three different views, and all four cardinal direction sides of the Ivory Tower structure.

At the Caldera site, six horizontal transect lines (250 m in length) were undertaken over the E / SE / S slope of the volcanic knoll. Four horizontal mosaics were undertaken to characterise the different faunal assemblages present in chemosynthetic habitats: clam beds, anemones with gastropods, pycnogonids, and sibloglinids.

Despite variation in USBL fixes arising from the ship's GPS, the *Isis* ROV achieved very high precision in relative navigation, undertaking movements as small as 0.05 m relative to the seafloor during adjustments of position for survey lines. Overall, 34 videographic surveys were undertaken during the cruise (9 horizontal transect surveys; 13 horizontal mosaic surveys; 12 vertical mosaic surveys), recording a total of 30 hours 24 minutes of footage for analysis. Surveys will be analysed to elucidate faunal microdistribution patterns as follows:

(1) horizontal transects will be analysed to determine wider-field faunal zonation at sites, including ranges of occurrence and abundances of different species where possible;

(2) horizontal mosaics will be analysed to characterise different faunal assemblages within sites (for example, anemone beds at E2; stalked barnacle, gastropod and galatheid aggregations at E9; clam beds on sedimented seafloor at the Caldera; anemone and gastropods on rock at the Caldera). Analysis will include quantification of faunal abundances, and where preserved specimens allow for wet weight determination and morphometrics, estimates of biomass from videographic data;

(3) vertical mosaics will be analysed to quantify distribution patterns on chimneys in relation to distances from actively vent sources, and determine scales of heterogeneity in assemblage composition for comparison with that found at vents in other biogeographic provinces. Geometric solids will be used to approximate areas of structure surfaces in quantitative analyses, as used previously in videographic analysis of chimney fauna at other vent sites.

Table 5.12. JC 42 videographic surveys undertaken to investigate faunal microdistribution

Site	ISIS Dive	Horizontal or Vertical	Camera	Location	Number	Start time (GMT)	End time (GMT)
E2	129	Horizontal	ATLAS 3 Chip	Anemone Field and environs	Transect 1	23:24	00:34
E2	129	Horizontal	ATLAS 3 Chip	Anemone Field (wide)	Mosaic 1	00:51	00:58
E2	129	Horizontal	ATLAS 3 Chip	Anemone Field (zoom)	Mosaic 2	01:01	01:09
E2	129	Horizontal	ATLAS 3 Chip	SE of Dog's Head	Transect 2	03:48	04:36
E2	129	Horizontal	ATLAS 3 Chip	SE of Dog's Head	Transect 3	04:43	05:07
E2	129	Horizontal	ATLAS 3 Chip	SE of Dog's Head	Mosaic 3	05:14	05:29
E2	132	Vertical	PPT-HDI	Dog's Head chimney, SW face	Mosaic 1	05:52	07:38
E2	132	Vertical	PPT-HDI	Dog's Head, NE face	Mosaic 2	12:35	13:55
E2	132	Vertical	PPT-HDI	Dog's Head, South face	Mosaic 3	17:14	18:30
E9	139	Horizontal	ATLAS 3 Chip	Twin Peaks	Mosaic 1	16:28	19:57
E9	139	Horizontal	ATLAS 3 Chip	Twin Peaks	Mosaic 2	20:09	21:22
E9	139	Horizontal	ATLAS 3 Chip	Garden	Mosaic 3	21:50	22:59
E9	139	Horizontal	ATLAS 3 Chip	NW corner of Black & White	Mosaic 4	23:01	00:08
E9	140	Vertical	PPT-HDI	Black and White, West face	Mosaic 1	18:07	19:03
E9	140	Vertical	PPT-HDI	Black and White, East face	Mosaic 2	19:25	19:50
E9	140	Vertical	PPT-HDI	Carwash HDG 161°	Mosaic 3	20:25	21:07
E9	140	Vertical	PPT-HDI	Carwash HDG 128°	Mosaic 4	21:12	21:56

E9	140	Vertical	PPT-HDI	Carwash HDG 340°	Mosaic 5	22:21	22:56
E9	142	Vertical	PPT-HDI	Ivory Tower, west face	Mosaic 1	19:39	19:56
E9	142	Vertical	PPT-HDI	Ivory Tower, east face	Mosaic 2	20:06	20:40
E9	142	Vertical	PPT-HDI	Ivory Tower, south face	Mosaic 3	20:48	21:10
E9	142	Vertical	PPT-HDI	Ivory Tower, north face	Mosaic 4	21:17	21:43
Caldera	148	Horizontal	ATLAS 3 Chip	250 m E-W line, eastern slope of knoll	Transect 1	10:38	12:06
Caldera	148	Horizontal	ATLAS 3 Chip	250 m E-W line, eastern slope of knoll	Transect 2	12:38	14:01
Caldera	148	Horizontal	ATLAS 3 Chip	250 m SE-NW line, eastern slope of knoll	Transect 3	14:29	15:20
Caldera	148	Horizontal	ATLAS 3 Chip	250 m E-W line, SE slope of knoll	Transect 4	19:58	21:00
Caldera	148	Horizontal	ATLAS 3 Chip	250 m S-N line, SE slope of knoll	Transect 5	21:24	22:24
Caldera	148	Horizontal	ATLAS 3 Chip	250 m S-N line, southern slope of knoll	Transect 6	22:57	23:57
Caldera	148	Horizontal	ATLAS 3 Chip	Ash Field	Mosaic 1	01:04	01:25
Caldera	148	Horizontal	ATLAS 3 Chip	Gastropods and anemones, north of Great Wall	Mosaic 2	02:19	02:54
Caldera	148	Horizontal	ATLAS 3 Chip	Tubeworm Field	Mosaic 3	03:12	04:00
Caldera	148	Horizontal	ATLAS 3 Chip	Clams at Glacier	Mosaic 4	04:11	04:31
Caldera	148	Horizontal	ATLAS 3 Chip	Whale Fall	Mosaic 1	16:10	17:28
Caldera	148	Horizontal	ATLAS 3 Chip	Whale Fall	Mosaic 2	17:36	18:15

5.5. Sampling of megafauna and macrofauna

Katrin Linse, Nicolai Roterman, Sven Thatje, Jon Copley, Leigh Marsh, Jon Dinley, Chris Sweeting, Will Reid, Andy Clarke, Alex Rogers

5.5.1. Objectives

One of the main objectives for the second CHESSO cruise to the East Scotia Ridge is to sample the vent megafauna and macrofauna for later taxonomic (morphological and molecular), biogeographic, phylogenetic and ecological studies. Eight different groups (A-I) have an interest in the macrofauna collected for different research projects. Their aims and sample requirements are listed below:

A. Morphological and molecular taxonomy (Alex Rogers, Katrin Linse, Nicolai Roterman):

Specimens of **all collected species** fixed in ethanol and formaldehyde for taxonomic and phylogenetic identification.

Minimum requirements:	5 specimens (3 in ethanol, 2 in formaldehyde)
Medium requirements:	10 specimens (5 in ethanol, 5 in formaldehyde)
Maximum requirements:	> 10 specimens (max 30 in ethanol, all others in formaldehyde)

B. Foodweb analysis – stable isotopes (Chris Sweeting, Will Reid):

Specimens of **all collected species** fixed in ethanol and formaldehyde for taxonomic and phylogenetic identification.

Minimum requirements:	5 specimens (2-5 g tissue)
Medium requirements:	10 specimens
Maximum requirements:	~ 15 specimens for intra-population studies

C. Population genetics (Alex Rogers, Katrin Linse, Nicolai Roterman):

Specimens and/ or tissue of **3-6 collected, dominant and abundant species** fixed in ethanol and formaldehyde for population genetics. If species are too large for entire animal fixation in ethanol, tissue samples will be fixed in ethanol and the specimens in formaldehyde. At minimum 10 specimens will be kept as voucher material.

Target taxa: galatheid crabs, scalpellomorph barnales, gastropods, bivalves, polychaetes)

Minimum requirements: 30 specimens

Medium requirements: 50 specimens

Maximum requirements: > 100 specimens

Specimen samples were shared with groups D. and E.

D. Population reproduction (Jon Copley, Leigh Marsh):

Gonads/reproductive organs of **3-6 collected, dominant and abundant species** fixed in formaldehyde for reproduction studies.

Target taxa: galatheid crabs, scalpellomorph barnales, gastropods, bivalves, polychaetes)

Minimum requirements: 30 specimens (females)

Medium requirements: 50 specimens (females)

Maximum requirements: > 100 specimens (males & females)

Specimen samples were shared with groups D. and E.

E. Population stable isotopes (Chris Sweeting, Will Reid):

Tissue of **3-6 collected, dominant and abundant species** fixed or frozen for population stable isotope studies. If possible, separate tissue analysis in size classes.

Target taxa: galatheid crabs, scalpellomorph barnales, gastropods, bivalves, polychaetes)

Minimum requirements: 30 specimens

Medium requirements: 50 specimens

Maximum requirements: > 100 specimens

Specimen samples were shared with groups C. and D.

F. Pressure physiology (Sven Thatje):

Specimens of **1-2 collected, dominant and abundant species** first live for pressure experiments, later frozen.

Target taxa: galatheid crabs, gastropods, bivalves, polychaetes)

Minimum requirements: 30 specimens

Maximum requirements: 50 specimens

Total requirements (all sites): 160 specimens

G. Heavy metal analysis (Andy Clarke):

Specimens of **2-3 collected, dominant and abundant species** for heavy metal analysis.

Target taxa: galatheid crabs, gastropods, bivalves, polychaetes)

Minimum requirements: 20 specimens

Medium requirements: 30 specimens

Maximum requirements: 50 specimens

H. Polychaete Histology (Jon Dinley):

Specimens of **polychaete species** for microscopy.

Minimum requirements: 5 specimens

Medium requirements: 10 specimens

Maximum requirements: 20 specimens

5.5.2. Work at sea

For the sample distribution after ISIS dives a sample protocol was set up (Table 5.13) that was followed from dive 125 to dive 154.

Priority	Minimum/few sampled specimens	Medium/more sampled specimens	Maximum/many sampled specimens
1.	5 specimens per abundant species for taxonomy		
2.	20 specimens for live experiments		
3.	5 specimens per species (of all) for taxonomy		
4.	5 specimens per species (of all) for stable isotopes		
5.	5 specimens per polychaete species for histology		
6.	30 specimens for population studies		
7.	20 specimens for heavy metal studies		
8.		5 specimens per species (of all) for	

		taxonomy	
9.	15 specimens for selected species for symbiosis fixation (liquid nitrogen, RNA later, glutaldehyd)		
10.		15 specimens for live experiments	
11.		5 specimens per species (of all) for stable isotopes	
12.		30 specimens for population studies	
13.		20 specimens for heavy metal studies	
14.		5 specimens per polychaete species for histology	
15.			10 specimens per species (of all) for taxonomy
16.			15 specimens for live experiments
17.			5 specimens per species (of all) for stable isotopes
18.			30 specimens for population studies
19.			10 specimens for heavy metal studies
20.			5 specimens per polychaete species for histology

Table 5.13. Protocol of sample distribution after ISIS dives

If more specimens were collected, these were be fixed in formaldehyde or frozen, potentially tissue samples taken of individuals for genetic analysis.

Of the population study specimens, the first 10 were frozen as genetic voucher material, the next 30 used for tissue specific stable isotopes within size classes and the further ones frozen as genetic voucher material.

During JC42 three areas were visited for *Isis* dives: the Falkland Through - for an *Isis* test dive during which one sea urchin, one crinoid and one lobster were collected, the South Georgia shelf, off King Haakon Bay, the East Scotia Ridge with its segments E2, E9, and the arc volcanic crater next to Kemp seamount. As the work at sea focussed on the East Scotia Ridge, only the megafauna and macrofauna collected at these sites is considered in the following. A complete sample/station list can be found in Appendix A4.

In total more than 12,500 specimens of more than 100 species were collected at E2, E9 and in the crater (Table 5.14). E2 and E9 are characterised as hot vent habitats while in the crater a warm seep community was discovered.

PHYLUM/CLASS	ORDER	GENUS	SPECIES	E2	E9	Crater
Porifera						
Demospongiea	Poecilosclerida	Carnivourus sponge	branched	15		
Demospongiea	Poecilosclerida	Carnivourus sponge	radial		10	
Demospongiea		sponge	soft			13
Cnidaria						
Anthozoa		anemone	red, corn on cob		1	1
Anthozoa		anemone	white	7		
Anthozoa		anemone	big		6	
Anthozoa		anemone	white-red	188	6	
Anthozoa		anemone	large, dark red			44
Anthozoa		Umbellula	sp			1
Hydrozoa		Hydrozoa	feather-like			1
Octocorallia		big fat	beige	1		
Octocorallia		stick	white		4	
Octocorallia	Alcyonacea	Alcyonacea	purple			2
Octocorallia		soft corals	feathered			5
Mollusca						
Bivalvia		Thyasira	sp big			6
Bivalvia	Veneroida	Calyptogena	sp			366

Gastropoda		"Littorinid"-type	orange	1608	401	
Gastropoda	Muricoidea	"Pareuthria"-like	smooth, orange	6		
Gastropoda	Lepetodriloidea	limpet-like	brown-green	266	2200	
Gastropoda	Trochoidea	Trochid	brown, big	439	1200	
Gastropoda	Vetigastropoda	Pyropelta	medium			900
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 2 raised			400
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 3 sulphur			85
Gastropoda	Vetigastropoda	Gastropod	beige			1dead
Cephalopoda		squid	sp			3
Annelida						
Polychaeta	Errantia	polychaete	Nereis-type		1	
Polychaeta	Errantia	Polynoid	white		2	
Polychaeta	Errantia	Polynoid	sp 1	1		
Polychaeta	Errantia	Polynoid	glossy pink		16	
Polychaeta		Ophilia-type	pink, smellie			2
Polychaeta		Osedax	sp			14
Polychaeta	Errantia	polychaet	sp			1
Polychaeta	Errantia	polychaetes	small, brown			416
Polychaeta		polychaetes	bamboo			1
Polychaeta		polychaetes	spp			many
Polychaeta		polychaetes	spp			10
Polychaeta	Errantia	Polynoid	big			1
Polychaeta		Polynoid	sp			2
Polychaeta	Errantia	polynoid	dark puple			1
Polychaeta		tube worm	brown			3
Polychaeta		Tubes	thin			many
Polychaeta	Sedentaria	Polychaet	white, small	200		
Polychaeta	Sedentaria	Polychaet	green		6	
Polychaeta	Sedentaria	Polychaet	tentacles	3		
Sipunculida						
Sipunculida			sipunculid	small		1

Nemertea						
Nemertea		nemertean	pink	2		
Crustacea						
Ostracoda		Big carapace	white, smooth	2		
Ostracoda		Ostracod	sp 2		1	
Copepoda?	Harpacticoida?		small	1	5	
Malacostraca	Amphipoda	apmphipod	spp		many	many
Malacostraca	Amphipoda	Lysianassidae	spp large			75
Malacostraca	Amphipoda	Amphipod	large white			many
Malacostraca	Amphipoda	Amphipod	spp mixed			many
Malacostraca	Amphipoda	Gammarid	white, pink eyes		159	
Malacostraca	Isopoda	Isopoda	sp. 1	1	1	
Malacostraca	Isopoda	isopod	sp. 2		9	
Malacostraca	Isopoda	Isopoda	sp. 3		1	
Malacostraca	Isopoda	isopod	sp. 4			314
Malacostraca	Isopoda	isopod	sp 5			5
Malacostraca	Isopoda	Natatolana	sp			1
Malacostraca	Isopoda	isopods	spp			3
Malacostraca	Isopoda	isopod	spikey			1
Malacostraca	Isopoda	isopod	large			1
Malacostraca	Decapoda	Galatheid	sp. 1	360	336	
Malacostraca	Decapoda	shrimp Lebeus-type	sp. 1	3	2	
Malacostraca	Decapoda	shrimp Lebeus-type	sp. 2			7
Malacostraca	Decapoda	Nematocarcinus	sp		43	28
Cirripedia	Scalpellomorpha	stalked barnacle	light	209	>500	3
Cirripedia	Scalpellomorpha	stalked barnacle	smooth		>300	
Malacostraca	Tanaideacea	Tanaidacea	white, slender	1		
Echinodermata						
Brisingida	Brising	Freyella	sp. Pink	4	5	3
Asteroidea		5-armed seastar	cussion		1	
Asteroidea		7-armed seastar	pink	2	19	4

Asteroidea	5-armed starfish	big centre		1	
Asteroidea	5-armed starfish	normal		1	
Asteroidea	Cushion star	big, orange			5
Asteroidea	starfish	white, hard			1
Echinoidea	Sterechinus	sp		1	6
Echinoidea	Cidaroid	white			1
Crinoidea	Promatochrinus	sp			1
Holothuroidea		spp		3	
Holothuroidea		white, solid		4	
Holothuroidea	Psolus	pink			6
Holothuroidea	Bathypoltes?	pinkish			2
Holothuroidea	holothurian	dark purple spots			3
Ophiuroidea	Ophiuroid	white-ish			105
Ophiuroidea	Ophiuroid	pink, feathered arms			1
Ophiuroidea	Odontaster?			6	
Ophiuroidea	Ophiuroid	sp 1		9	
Chelicerata					
Pycnogonida	Colossendeis-type	bulbious trunk	2	2	
Pycnogonida	Pycnogonid	dark, medium	2	2	
Pycnogonida	Colossendeis-type	thin trunk	1	3	
Pycnogonida	Pycnogonid	small		17	
Pycnogonida	Pycnogonid	white, dactylus swollen	1		
Pycnogonida	Pycnogonid	white, medium	33	93	
Pycnogonida	Pycnogonid	pale			66
Pycnogonida	Pycnogonid	spp			850
Pycnogonida	Pycnogonid	white, thin legs			10
Chordata					
Ascidiacea	Ascidian	white			2
Ascidiacea	Synascidian	white, on rock			2
Vertebrata					
Pisces	Zoacid???			9	

Pisces	Macrourid	sp	1
Pisces	Notolepis	annulata	3

Table 5.14. Species and specimen numbers per sample area

5.6. Sampling for microbiology

5.6.1. Objectives

Hydrothermal vents and cold seeps provide a wide range of habitats for micororganisms and the diversity of prokaryote communities can vary from one or two species in the case of endo- or episymbionts to diverse communities of Archaea and bacteria. In general, biotopes that show extremes of temperature, pH and other physical and chemical parameters have a lower diversity of species but higher relative abundance of Archaea than Eubacteria. Organisms may be attached to substrata, form microbial mats, live as endo- or episymbionts, or occur as free cells in venting fluids and sediment. An important component of the microbial studies will be aimed at elucidating the diversity of a variety of biotopes in vents and seeps and comparing this diversity to that known from comparable environments in the Pacific and Atlantic Oceans. This will include studies on both prokaryote and eukaryote microbial communities.

Elucidation of the microbial taxa that inhabit Southern Ocean chemosynthetic environments will help to determine what elements of primary production and carbon cycling are present and in which biotopes or habitats they are occurring. This will be directly linked to biomarker and isotope studies (Chris Sweeting/Will Reid, Newcastle) and to the physical and geochemical background in which samples are taken (Doug Connelly/ Darryl Green/ Rachel James/ Alfred Aquilina, NOC; Chris German, WHOI).

5.6.2. Work at sea

Sampling

Samples were taken with the suction sampler of the ROV. Fauna for microbiological studies on epi-/endosymbionts was sampled from sites E2, E9 and Kemp Caldera. Samples from site E2 included galatheids, stalked barnacles, anemones and gastropods, from site E9 galatheids, stalked barnacles, anemones, gastropods and limpets and from the Kemp Caldera 2 types of clams.

Processing of samples

Three different methods were used for sample preservation, depending on the

intended further use of the sample. Refer to the sample list (Appendix 5) for preservation method of each individual sample.

1. Freezing without fixation

Samples intended for DNA extraction were frozen at -80°C without any fixation.

2. Paraformaldehyde fixation

Samples intended for microtome sectioning followed by FISH were fixed in 4% PFA overnight at 4°C. They were then washed 3 times in MQ water for 10-15min and stored in 70% Ethanol/PBS at -80°C.

3. Ethanol fixation

Samples were placed in 96% ethanol and stored at -80°C.

Ethanol fixation was used as an alternative for PFA fixation. Samples preserved in this way can be used for both microtome sectioning and DNA extraction.

Sample list

See appendix for full list of samples, including location, number of specimen and method of preservation.

5.6.3. Preliminary results and further analysis

All analysis will be carried out at BAS, Cambridge. Analysis will focus on identifying potential epi- and endosymbionts in various tissues, including gills of galatheids, gastropods and clams, cirri of the barnacles and carapace hair of the galatheids. This will be done by DNA extraction and sequencing as well as FISH on microtome sections of the respective tissues.

5.7. Food webs and trophic structure of East Scotia Sea chemosynthetic environments.

Christopher Sweeting & William Reid

5.7.1. Objectives

Deep sea chemosynthetic systems represent oases of high relative productivity. Production in these systems is based on free living and symbiotic chemosynthetic bacteria that enhance photosynthetic production from surface waters to create high but localised abundances of marine life. Outside of these areas the deep sea is sustained solely by new and recycled photosynthetic material leading to low organism density. To a variable degree chemosynthetic production may be exported via mobile consumers to surrounding non-vent areas enhancing communities over a wider area. However, the relative importance of chemosynthetic vs. photosynthetic production and its flow through associated food webs is variable with consumer group, locations and habitat and significant sources of production that may further explain the numerous trophic levels observed in other chemosynthetic habitats remains to be identified.

The aim of this work is "*to elucidate food-web structures… and to compare these chemosynthetic-community types and locations both within the chosen region and outside it*" (Proposal objective 6). Based on the success of this second cruise (JC042) in the programme, the overarching objective can be refined and broken down as follows:

i) to describe the sources of production sustaining communities
ii) identify production transfer through the local food chains within the community
iii) define the trophic roles within and among constituent species
iv) assess if chemosynthetic production is exported to surrounding communities
v) compare and contrast

The work will be undertaken using the combined power of triple stable isotope ($^{12}C/^{13}C$,$^{14}N/^{15}N$,$^{32}S/^{34}S$) analyses and investigation of hopanoid biomarkers for bacterial symbionts. This will allow characterisation of the importance of different sources of production and in turn allow their flow to be traced through the food web.

5.7.2 Work at Sea

Sediment samples, invertebrates and fish tissue were collected by the deep submergence vehicle *Isis* using a range of interchangeable gears including suction sampler, scoop, flocculent and sediment nets and the vehicles manipulators. (Figure 5.11a-f). Additional samples of mobile epifauna were obtained from 3 different types of fish trap (Figure 5.12 a-c) deployed and retrieved by *Isis* and by opportunistic sampling of pelagic organisms obtained from cooling seawater intake screens of *RRS James Cook.*

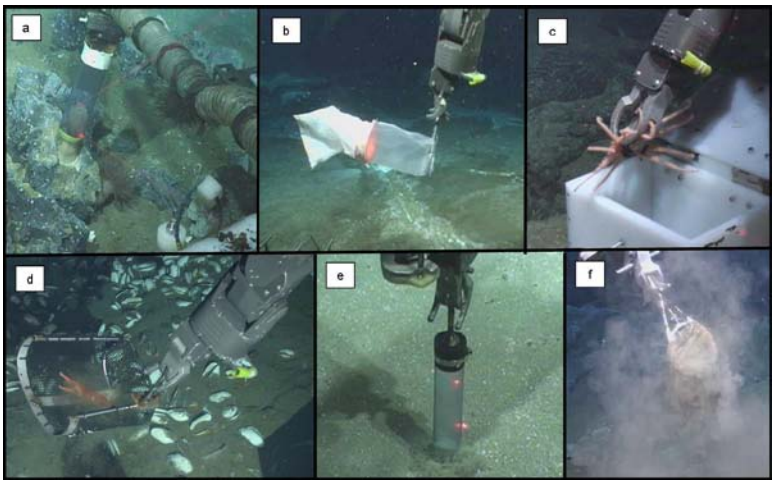


Figure 5.11. Sampling tools utilised on *Isis*; a) suction sampler b) flocculant net c) manipulator d) scoop e) push core f) net

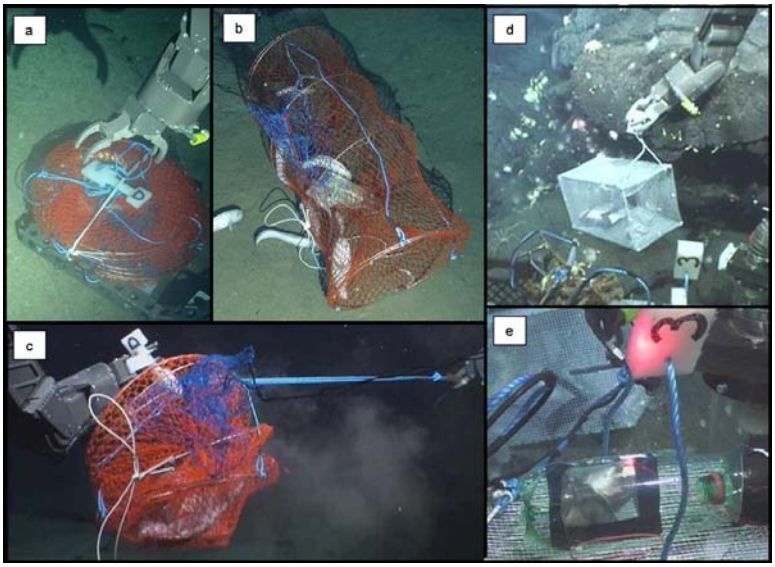


Figure 5.12. Collapsible (a-c), cage d) traps 1/3 of which also included amphipod traps e) deployed by *Isis* over the course of the sampling programme

Organisms were sorted to the lowest taxonomic level. After the removal of specimen for taxonomy individuals were selected for isotope analyses. 2-5g of tissue was then removed from each specimen. Where individuals were too small, whole specimen was taken and for very small organisms a number of individuals were pooled to obtain sufficient tissue for analysis. For abundant species a series of different tissues were dissected to examine tissue specific variation in stable isotopes. 1-2cm^3 of sediment was extracted from cores across a range of core depths and from surface scoops. All samples were then frozen to -80^{o}C.

In excess of 800 samples were collected for stable isotope and hapanoid analyses over the course of JC042. Samples from E2 were obtained on *Isis* dives 130, 132-135; those from E9 were obtained on dives 140-142, 144-145; and for the Kemp Seamount Caldera samples were collected on dives 147, 149-153. A summary of the number of individuals by site and analysis is provided in table 5.15.

5.7.3 Preliminary Results

No isotope or hapanoid results are available at this time. The processing and analyses required in both techniques are vulnerable to movement and changes in temperature

and humidity and are thus not amenable to ship bourn determination. It is expected that initial results will be available within five months of sample return to the UK.

Table 5.15. Collated sample list by location.

		E2	E9	Kemp
Crustacean	Galatheids	69	45	
	stalked barnacle	34	60	
	Nematacarcinus spp.		10	7
	Amphipod sp A			5
	Amphipod sp B			5
	Amphipod spp			3
Mollusca	Trochidae	51	175	
	Lepetodriloidea	11	9	15
	"Pareuthria"-like	1		
	"Meteuthria"-type		2	
	Calyptogena sp A?			44
	Calyptogena sp B?			36
	Cephalopod			1
Cnidaria	Anemone	27	4	32
	Octocoral			4
Arthropoda	Pycnogonid, small	20	21	
	Pycnogonid, bulbous	1	3	
	Pycnogonid, thin		6	
	Pycnogonid			60
Porifera	Carnivourus sponge	10		
	Demospongiea			6
Asteroidea	7-armed seastar	1	10	
	Cushion stat			7
	Brisingidae	3	3	3
	Ophiuroid		13	6
Holothuria	Sp A		1	
	Sp B		4	2

	Sp C			3
	Psolus spp.			3
Polychaeta	Bamboo worm			1
	Terebellomorph			1
Fish	Zoarchid?		8	
	Notolepis annualata			3
	Macrourid			1
Other	Floccuent	3	1	
	Galathaid bacterial scrapings	5	5	
	Matt		2	

5.8. Population Genetics

5.8.1. Objectives

Deep-sea hydrothermal vents are potentially ephemeral sites as changes in the flow of hydrothermal fluids may mean that active sites can become inactive over short periods of time. Longevity of vent fields reflects, to some extent the underlying geology of the Earth's crust with fast-spreading ridges showing a rapid turnover of sites of venting compared to intermediate or slow-spreading ridges. As a result of "turnover" of sites of active hydrothermal venting, estimating the connectivity of populations of hydrothermal vent-endemic organisms is important in understanding population dynamics and evolution at vents. As with hydrothermal vents, other chemosynthetic communities, such as hydrocarbon seeps, and whale and wood falls, are also discontinuous habitats and similar evolutionary pressures influence dispersal and recruitment of species that are endemic to them. At larger temporal scales there is evidence of exchange of fauna between different chemosynthetic environments.

The aim of the population genetics sampling, by estimating the level of gene flow within a species or morphotype between chemosynthetic sites, was to assess the degree of isolation of the communities at different sites along the East Scotia Ridge and the surrounding region. These data, in concert with phylogenetic analyses and the study of reproductive biology will help to elucidate species richness, aspects of faunal life history and their influence on realised dispersal of taxa. A broad aim of the research is to address the question of whether or not there is an Antarctic chemosynthetic 'province of fauna' and to provide insights into the evolutionary history of the chemosynthetic fauna in the Southern Ocean as well adjacent oceans.

5.8.2. Specimen Collection

Sufficient numbers of key species (50 – 100 individuals per morphotype) were collected from different locations within and between the different sites for population genetic analyses. In particular it appeared that E2 and E9 vent sites shared the same or similar morphotypes of galatheid crabs, stalked barnacles and red/brown gastropods. It is possible that the limpets (Lepetodrilidae) found on the gastropods and crabs were

also the same species between the sites. Although large numbers of the small anemone were sampled at E2 (> 150), no similar morphotype was found at E9. The McIntosh caldera knoll presented an entirely different megafaunal assemblage more reminiscent of seep fauna and dominated by two morphotypes of vesicomyid clams. Along with these, large anemones and a limpet-like gastropod were also sampled for population genetics. There were no apparent chemosynthetic-dependent species shared between the caldera and the Scotia ridge, however the population genetics data gleaned will be useful if more seeps are found nearby or in the Bransfield Strait in the future.

Both at the Scotia ridge and at the McIntosh caldera subcone some dominant fauna were in sufficient abundance to allow for large numbers (> 50) to be sampled from different sub-communities, such as the crabs, barnacles, gastropods and vesicomyid clams. This will allow the analysis of *within* site gene flow as well.

Serendipitously, samples were also collected from decomposing whalebones discovered on the caldera knoll and tissue from *Osedax* worms were collected from four of the bones.

5.8.3. Tissue Extraction

Except for the smallest animals collected, such as the lepetodrillid limpets, the littorinids, the pycnogonids and isopods, which were fixed whole, muscular tissue was excised by scalpel and stored in 7ml cryotube vials of 96% ethanol. In the case of the galatheids, tissue was extracted from the 2nd and 3rd pereopods on both sides of the animal, and for the large gastropods, tissue was removed from the foot. The barnacles were extracted whole from their rostra and the stalk and plates retained for reproductive studies or frozen. In the case of the anemones, both large and small, tissue from the pedal disc was fixed.

5.8.4. DNA Extraction

DNA was extracted onboard the James Cook with DNeasy Tissue Extraction Kits (Qiagen, Crawley, West Sussex, United Kingdom) in batches of 18 according to the manufacturer's instructions. Table 5.16 below lists the DNA extractions that have been completed at sea thus far.

Dive No.	Area	ID	Phylum	Class	Order	Family	Genus	Common Name	Quantity	DNA
130	E2	F-013	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	75	18
130	E2	F-061	Mollusca	Gastropoda	Lepetodriloidea		limpet-like		10	
130	E2	F-086	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid		19	
132	E2	F-034	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	2	
132	E2	F-038	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	6	
132	E2	F-040	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	14	
132	E2	F-021	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Brown Snail	3	
132	E2	F-031	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Brown Snail	5	
132	E2	F-025	Mollusca	Gastropoda			"Littorinid"-type	Tiny gastropod	8	
132	E2	F-052	Mollusca	Gastropoda			"Littorinid"-type	Tiny gastropod	5	
132	E2	F-057	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	Lepetodrillus	1	
132	E2	F-058	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	Lepetodrillus	5	
132	E2	F-128	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	Lepetodrillus	50	
132	E2	F-029	Mollusca	Gastropoda	Lepetodriloidea		limpet-like		26	
133	E2	F-142	Cnidaria	Anthozoa			anemone	Small Anemone	65	
133	E2	F-123	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacl	Stalked Barnacle A	48	18
133	E2	F-101	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacl	Stalked Barnacle A	43	
133	E2	F-166	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacl	Stalked Barnacle A	11	
133	E2	F-166G	Mollusca	Gastropoda			"Littorinid"-type	Tiny gastropod	18	18
133	E2	F-132	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Brown Snail	37	
134	E2	F-227	Cnidaria	Anthozoa			anemone	Small Anemone	47	18
134	E2	F-221	Cnidaria	Anthozoa			anemone	Small Anemone	34	
134	E2	F-142	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Gastropods	118	
135	E2	F-210	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	62	
140	E9	F-302	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacl	Stalked Barnacle B	117	18
140	E9	F-269	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Brown Snail	130	
140	E9	F-245	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	100	
140	E9	F-280	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	Lepetodrillus	> 100	
141	E9	F-325	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	Brown Snail	149	18
141	E9	F-469	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacl	Stalked Barnacle A	150	
142	E9	F-461	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	19	
144	E9	F-438	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	Squat Lobster	100	18
144	E9	F-438L	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	Lepetodrillus	> 250	18
148	McInt	F-571O	Polychaeta				Osedax	Osedax	10	
148	McInt	F-549O	Polychaeta				Osedax	Osedax	51	18
149	McInt	F-677	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta		100	
149	McInt	F-691	Arthropoda	Pycnogonida			Pycnogonid		150	
149	McInt	F-615	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	Calyptogena A	34	17
149	McInt	F-619	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	Calyptogena B	11	
149	McInt	F-631	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	Calyptogena A	5	
150	McInt	F-658	Cnidaria				anemone	Large Anemone	12	
150	McInt	F-728	Arthropoda	Pycnogonida			Pycnogonid	Pycnogonids	52	
150	McInt	F-665	Arthropoda	Pycnogonida			Pycnogonid		80	
150	McInt	F-711	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta		138	
151	McInt	F-703	Cnidaria				anemone	Large Anemone	25	
151	McInt	F-800	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	Calyptogena B	62	
151	McInt	F-772	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	Calyptogena A	75	

Table 5.16. Summary of fauna collected for study of population genetics and DNA extractions to date.

5.9. DNA extraction of macrobenthic fauna for phylogenetics

Katrin Linse

5.9.1. Objectives

One of the main objectives for the second CHESSO cruise to the East Scotia Ridge is to sample the vent and neighbouring non-vent macrofauna organisms for later taxonomic (morphological and molecular) and phylogenetic characterisation. For this purpose DNA of selected specimens from each represented morphospecies at each site will be extracted at sea and their COI, 28S and 18S genes sequenced to analyse their phylogenetic position within their clades and to confirm their species status by comparing barcode sequences. The molecular identification will be done in parallel with the morphological ones. While the population genetic part of ChEsSO will analyse the phylogenetic and population genetic relationships of the abundant taxa, this study will analyse the less abundant and rare species.

5.9.2. Work at sea

Genomic DNA was isolated from tissue sample selected specimen, using different tissues depending on the taxon (crustacean, pycnogonid: legs, gastropod, anemone: foot). DNA was extracted with the DNeasy Tissue Extraction Kit (Qiagen, Crawley, West Sussex, United Kingdom) as directed by the manufacturer.

In total 12 DNA extractions comprising 286 benthic invertebrates have been carried out on board (Table 5.17).

Table 5.17. Sample and specimen numbers of the extracted taxa

PHYLUM/CLASS	ORDER	GENUS	SPECIES	SAMPLE_ID	DNA spec	Station
Porifera						
Demospongiea	Poecilosclerida	Carnivourus sponge	branched	JC42-F-135	3	E2
Demospongiea	Poecilosclerida	Carnivourus sponge	branched	JC42-F-121	1	E2
Demospongiea	Poecilosclerida	Abyssocladia-type	radiating	JC42-F-427	2	E9
Demospongiea		sponge	soft	JC42-F-605	2	Crater
Cnidaria						
Anthozoa		anemone	white	JC42-F-080	1	E2

Anthozoa		anemone	white	JC42-F-095	1	E2
Anthozoa		anemone	white-red	JC42-F-204	1	E2
Anthozoa		anemone	white-red	JC42-F-286	1	E2
Anthozoa		anemone	white-red	JC42-F-113	2	E2
Anthozoa		anemone	white-red	JC42-F-134	2	E2
Anthozoa		anemone	white-red	JC42-F-221	2	E2
Anthozoa		anemone	white-red	JC42-F-320	3	E9
Anthozoa		anemone	large, dark red	JC42-F-676	5	Crater
Hydrozoa		Hydrozoa	feather-like	JC42-F-796	1	Crater
Octocorallia		stick	white	JC42-F-349	1	E9
Octocorallia		big fat	beige	JC42-F-410	1	E9
Octocorallia	Alcyonacea	Alcyonacea	purple	JC42-F-740	1	Crater
Octocorallia	Alcyonacea	Alcyonacea	purple	JC42-F-716	1	Crater
Mollusca						
Bivalvia		Thyasira	sp big	JC42-F-609	1	Crater
Bivalvia		Thyasira	sp big	JC42-F-777	1	Crater
Bivalvia	Veneroida	Calyptogena	sp	JC42-F-644	3	Crater
Bivalvia	Veneroida	Calyptogena	sp	JC42-F-649	3	Crater
Bivalvia	Veneroida	Calyptogena	sp	JC42-F-730	3	Crater
Chephalopoda		squid	red	JC42-F-589	1	Crater
Gastropoda		"Littorinid"-type	orange	JC42-F-271	4	
Gastropoda		"Littorinid"-type	orange	JC42-F-130	5	E2
Gastropoda		"Littorinid"-type	orange	JC42-F-241	5	E2
Gastropoda		"Littorinid"-type	orange	JC42-F-292	5	E2
Gastropoda	Vetigastropoda	"Meteuthria"-type	orange, spirals	JC42-F-502	3	E9
Gastropoda	Vetigastropoda	"Meteuthria"-type	orange, spirals	JC42-F-326	5	E9
Gastropoda		Clione	sp	JC42-F-414	4	E9
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 2 raised	JC42-F-636	3	Crater
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 2 raised	JC42-F-606	5	Crater
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 3 sulphur	JC42-F-541	3	Crater
Gastropoda	Vetigastropoda	Lepetodrillus	sp. 3 sulphur	JC42-F-655	5	Crater
Gastropoda	Vetigastropoda	limpet-like	brown-green	JC42-F-223	3	E2
Gastropoda	Vetigastropoda	limpet-like	brown-green	JC42-F-272	5	E2
Gastropoda	Vetigastropoda	limpet-like	brown-green	JC42-F-324	5	E9
Gastropoda	Vetigastropoda	limpet-like	brown-green	JC42-F-503	5	E9
Gastropoda	Vetigastropoda	Pyropelta	medium	JC42-F-552	3	Crater
Gastropoda	Vetigastropoda	Pyropelta	medium	JC42-F-661	5	Crater
Gastropoda	Trochoidea	Trochid	white, small	JC42-F-240	5	E2
Gastropoda	Trochoidea	Trochid	white	JC42-F-507	1	E9
Gastropoda	Trochoidea	Trochid	brown, big	JC42-F-242	2	E2
Gastropoda	Trochoidea	Trochid	brown, big	JC42-F-360	2	E9
Gastropoda	Trochoidea	Trochid	brown, small	JC42-F-077	3	E2
Gastropoda	Trochoidea	Trochid	brown, big	JC42-F-016	5	E2
Gastropoda	Trochoidea	Trochid	brown, big	JC42-F-246	1	E2

Gastropoda	Trochoidea	Trochid	brown, big	JC42-F-265	5	E9
Annelida						
Polychaeta		Osedax	sp	JC42-F-624	1	Crater
Polychaeta	Errantia	Polynoid	glossy pink	JC42-F-342	1	E9
Polychaeta	Errantia	Polynoid	big	JC42-F-749	1	Crater
Polychaeta	Errantia	polynoid	dark puple	JC42-F-774	1	Crater
Polychaeta	Errantia	Polynoid	sp 1	JC42-F-163	2	E2
Polychaeta		Siboglinidae	thin	JC42-F-591	3	Crater
Polychaeta		Siboglinidae	spp	JC42-F-645	3	Crater
Polychaeta		Siboglinidae	spp	JC42-F-795	3	Crater
Polychaeta		tube worm	sp	JC42-F-650	1	Crater
Crustacea						
Malacostraca	Amphipoda	Gammarid	white, pink eyes	JC42-F-262	2	E2
Malacostraca	Amphipoda	Gammarid	white, pink eyes	JC42-F-126	3	E2
Malacostraca	Amphipoda	Gammarid	white, pink eyes	JC42-F-504	5	E9
Malacostraca	Amphipoda	Lysianassidae	spp	JC42-F-603	5	Crater
Malacostraca	Decapoda	Anomura larvae	white, eyeless	JC42-F-005	1	E2
Malacostraca	Decapoda	Anomura larvae	white, eyeless	JC42-F-036	1	E2
Malacostraca	Decapoda	Galatheid	sp. 1	JC42-F-215	1	E2
Malacostraca	Decapoda	Galatheid	sp. 1	JC42-F-022	2	E2
Malacostraca	Decapoda	Galatheid	sp. 1	JC42-F-423	3	E9
Malacostraca	Decapoda	Galatheid	sp. 1	JC42-F-304	4	E9
Malacostraca	Decapoda	Galatheid	sp. 1, larvae	JC42-F-519	5	E9
Malacostraca	Decapoda	Nematocarcinus	sp	JC42-F-307	1	E9
Malacostraca	Decapoda	Nematocarcinus	sp	JC42-F-314	2	E9
Malacostraca	Decapoda	shrimp Lebeus-type	sp. 1	JC42-F-131	1	E2
Malacostraca	Decapoda	shrimp Lebeus-type	white	JC42-F-309	1	E9
Malacostraca	Decapoda	shrimp Lebeus-type	sp 1	JC42-F-499	1	E9
Malacostraca	Decapoda	shrimp Lebeus-type	sp 1	JC42-F-236	2	E2
Malacostraca	Decapoda	shrimp Lebeus-type	sp 2	JC42-F-759	5	Crater
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-621	1	Crater
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-625	2	Crater
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-170	3	E2
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-284	3	E2
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-122	5	E2
Cirripedia	Scalpellomorpha	stalked barnacle	light	JC42-F-501	8	E9

Chelicerata						
Pycnogonida		Pycnogonid	white, medium dactylus	JC42-F-214	1	E2
Pycnogonida		Pycnogonid	swollen	JC42-F-100	1	E2
Pycnogonida		Pycnogonid	white, medium	JC42-F-152	2	E2
Pycnogonida		Pycnogonid	white, medium	JC42-F-202	2	E2
Pycnogonida		Colossendeis-type	bulbious trunk	JC42-F-206	2	E2
Pycnogonida		Colossendeis-type	thin trunk	JC42-F-211	2	E2
Pycnogonida		Colossendeis-type	bulbious trunk	JC42-F-220	2	E2
Pycnogonida		Pycnogonid	dark, medium	JC42-F-277	2	E2
Pycnogonida		Pycnogonid	small	JC42-F-477	3	E9
Pycnogonida		Pycnogonid	spp	JC42-F-642	3	Crater
Pycnogonida		Pycnogonid	white, thin legs	JC42-F-726	3	Crater
Pycnogonida		Pycnogonid	white, thin legs	JC42-F-760	3	Crater
Pycnogonida		Pycnogonid	pale	JC42-F-566	5	Crater
Echinodermata						
Asteroidea		5-armed seastar	cussion	JC42-F-472	1	E9
Asteroidea		5-armed starfish	big centre	JC42-F-339	1	E9
Asteroidea		5-armed starfish	normal	JC42-F-381	1	E9
Asteroidea		7-armed seastar	pink	JC42-F-219	2	E2
Asteroidea		7-armed seastar	pink	JC42-F-270	3	E9
Asteroidea		7-armed seastar	pink (8 arms)	JC42-F-697	1	Crater
Asteroidea		7-armed seastar	pink	JC42-F-755	1	Crater
Asteroidea		7-armed seastar	pink (8 arms)	JC42-F-754	2	Crater
Asteroidea		Cushion star	big, orange	JC42-F-572	2	Crater
Brisingida	Brisingid	Freyella	sp. Pink	JC42-F-406	3	E9
Brisingida	Brisingid	Freyella	sp. Pink	JC42-F-129	4	E2
Crinoidea				JC42-F-002	1	FT
Crinoidea		Promatochrinus	sp	JC42-F-717	1	Crater
Holothuroidea		Psolus	sp	JC42-F-751	3	Crater
Ophiuoidea		Odontaster?		JC42-F-462	2	E9
Chordata						
Ascidiacea		Ascidian	white	JC42-F-761	1	Crater

5.10. Sampling for reproductive and life-history biology studies

Jon Copley & Leigh Marsh

5.10.1. Introduction

In the three decades since the discovery of fauna associated with deep-sea chemosynthetic habitats, fewer than 70 vent, seep or whale-fall species have been the subject of studies focused primarily on reproductive or life history biology. Given the ephemeral and insular nature of deep-sea chemosynthetic habitats, however, life-history biology is likely to be a key factor for understanding patterns of gene flow and biogeography. The influence of heterogeneity in physico-chemical conditions on patterns of reproductive development is also poorly understood in chemosynthetic habitats, as are links between modes of larval development and seasonal reproductive patterns in vent and seep species, and the prevalence of synchrony of reproductive cycles in relation to fertilisation mechanisms. During Cruise JC42, we therefore collected and preserved specimens and material for investigation of reproductive and life-history biology.

5.10.2. Methods

The primary material collected for this work consists of gonadal tissue in specimens where muscle and other tissues were removed for studies of population genetics (described in section 5.4.4a) and isotope composition (described in section 5.4.3). This material, usually comprised of the remainder of the specimen once those studies had removed their tissues, was preserved in buffered 4% seawater formaldehyde solution. In addition, galatheid eggs / hatching larvae were frozen at -80ºC for future CN content analysis, to characterise likely mode of development. Galatheid eggs / hatching larvae were also preserved in phosphate-buffered formalin solution for electron microscopy study. Calyptogena shells from two locations at the Caldera site were also air-dried for investigation of microgrowth increment patterns.

Three types of analyses will be conducted using the material collected:

(1) Description of reproductive development in taxa, including determination of likely mode of larval development where possible, and elucidation of features such as female sperm storage and hermaphrodism. This work will be carried out through (i) histological study of gonadal tissue; (ii) measurements of maximum oocyte sizes from dissected oocytes; (iii) ultrastructural investigation of gonadal tissue and cells, through electron microscopy, where possible and appropriate; (iv) CN content and other analyses (e.g. glycogen content) of frozen tissues. Reproductive development will be examined in both males and females for gonochoric species. Samples of a total of 18 putative species were collected for descriptive reproductive studies.

(2) Determination of reproductive synchrony between individuals within samples, between samples from different locations within sites, and between sites where shared taxa and specimen numbers allow. These analyses will be conducted through determination of oocyte-size frequency distributions, using measurements of dissected oocytes.

(3) Determination of spatial variation in reproductive development, where samples of taxa from different locations within a site allow (Galatheids at E2 and E9; trochid gastrpods at E2 and E9; limpets at E2, E9, Caldera; stalked barnacles at E9; pyncogonids, anemones and *Calyptogena* at Caldera; amphipods, isopods, limpets and polychaetes on different whalebones).

(4) Sclerochronology of bivalve shells, using Mutvei's solution to determine variability in shell microgrowth increments. Comparison of microgrowth increment patterns in shells of specimens collected from two locations at the Caldera site may reveal records of disturbance events across the site, in addition to contributing to understanding of variability of microgrowth in seep environments.

Relevant results from (1) relating to modes of larval development should aid interpretation of levels of gene flow between populations at E2 and E9. Integration of results from (3) with information on the nutritional state of the same individuals from stable isotope analyses should further our understanding of the influence of physico-chemical heterogeneity on biological processes such as reproduction at vents and seeps.

Table 5.18 Sample list for reproductive and life-history biology studies

Sample ID	Taxon	Number of individuals	Specimen preservation	Collection location	Future analysis
JC42-F-0013	Galatheid eggs / hatching larvae	8 vials	Broods from 8 females frozen at -80ºC	E2	CN content
JC42-F-0013	Galatheid eggs / hatching larvae	8 vials	Broods from 8 females preserved for EM	E2	Electron microscopy
JC42-F-0329	Galatheid larvae	1 vial	Hatching eggs from 1 female frozen at -80ºC	E9	CN content
JC42-F-0013	Galatheids	75	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0021	Trochids	3	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0034	Galatheids	2	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0038	Galatheids	6	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0040	Galatheids	14	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0045	Limpet sp. 1	13	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0046	Limpet ?sp. 2	2	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0047	Limpet ?sp. 2	6	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0050	Limpet sp. 1	2	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0060	Limpet sp. 1	10	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0084	Trochids	19	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0150	Limpet sp. 1	20	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0185	Limpet sp. 1	6	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0196	Trochids	40	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0210	Galatheids	59	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0227	Actinaria sp. 1	46	4% buffered formaldehyde	E2	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0245	Galatheids	55	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0256	Limpet sp.	>100	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial

					variation in reproductive development
JC42-F-0290	Trochids	100	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0329	Galatheids	79	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0331	Trochids	~80	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0357	Ammotheids	35	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0365	?*Vulcanolepas* sp.	~100	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0380	Various gastropods	~80	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0408	Eolepadid sp. 2	~100	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0449	Galatheids	35	4% buffered formaldehyde	E9	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0531	Whale-fall Lysianassid	100	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0540	Whale-fall polychaetes	110	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0545	Whale-fall isopods	60	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0562	Whale-fall isopods	100	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0579	Whale-fall Lysianassid	100	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0600	Whale-fall Pyropeltids	57	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0611	Pycnogonid ?sp. 2	110	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0613	Pycnogonid ?sp. 2	70	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0615	*Calyptogena*	35	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0618	Whale-fall polychaetes	60	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0619	*Calyptogena*	11	Tissues preserved in 4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial

					variation in reproductive development
JC42-F-0647	Pyropeltids	80	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0658	Actinaria sp. 2	12	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0689	Pyropeltids.	51	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0703	Actinaria sp. 2	23	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0704	Pycnogonid ?sp. 2	52	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0771	Ophiuroids	75	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony
JC42-F-0772	*Calyptogena*	1	Dissected tissues in 4% buffered formaldehyde	Caldera	Descriptive reproductive biology
JC42-F-0794	Pyropeltids	145	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0800	*Calyptogena*	62	4% buffered formaldehyde	Caldera	Descriptive reproductive biology; determination of reproductive synchrony; determination of spatial variation in reproductive development
JC42-F-0737	*Calyptogena*	11	Shells air dried	Caldera	Sclerochronology
JC42-F-0800	*Calyptogena*	30	Shells air dried	Caldera	Sclerochronology

5.11. Metals analysis benthic invertebrates

Prof. Andrew Clark

5.11.1. Introduction and aims

In recent years a great deal of attention has been directed at the stoichiometry of the major elemental constituents of organisms, with most effort directed at understanding the behaviour of C, N and P. Much of the original work in this area has involved terrestrial and freshwater systems (Sterner & Elser, 2002), but recently attention has once again been directed at the ecological stoichiometry of marine systems, which is actually where the field originated (Redfield, 1934, 1958). Almost all of this work has centred on behaviour C, N and P, but recently this has been extended to the metallic elements that form a minor but often essential component of organisms (Karimi, 2006).

In marine organisms the stoichiometric behaviour of C, N and P differs between herbivores, omnivores and predators (Clarke, 2008), driven principally by the differing balance between protein, lipid and carbohydrate. The samples used in these analyses came from Rothera Station (Adelaide island, Marguerite Bay), and have been archived for further analysis. A specific aim of these further analyses has been to examine the stoichiometric behaviour of the suite of metals that are found as minor components in all organisms, and to compare the patterns between vent and non-vent organisms. The rationale for this comparison is to see whether the patterns differ between organisms from an environment where the input of metals to the seawater is high, and in proportions that may differ from those of normal seawater. The analyses will be undertaken using ICPMS, and the work will be collaborative between Andrew Clarke (BAS) and Chris German (WHOI).

5.11.2. Sampling

Samples taken on JC42 for these analyses were:

Unknown gastropod from vent chimneys at E2 (Dives 130 and 134)
Unknown gastropod from vent chimneys at E9 (Dive 140)
Unknown anemones from close to the vents at E2 (Dive 134)

Stalked barnacles from vent areas at E9 (Dive 140)

These have been carefully cleaned and deep-frozen for return to UK. In UK the samples will be dried, powdered and then shipped to WHOI for analysis. It is anticipated that at least one collaborative paper should result from these samples.

5.12. Behavioural and physiological response to hydrostatic pressure and temperature in a hydrothermal vent galatheid crab from the East Scotia Ridge, Antarctica

Sven Thatje

5.12.1. Summary

The study investigates the physiological tolerance of an undescribed galatheid squat lobster, common to the hydrothermal vent systems along the East Scotia Ridge, Antarctica, in response to hydrostatic pressure and temperature. This report summarizes the methods employed during JC42, and provides a brief outlook on the significance of this research.

5.12.2. Materials and Methods – work at sea

Sampling and Maintenance

Individuals of an undescribed galatheid squat lobster common to JC42 sites E2 and E9 were collected using the ROV Isis during January and February 2010. Animals were maintained in approximately 5 l tanks containing filtered seawater and aeration; water was partially changed once a day. The desired experimental temperature was maintained using Haake cooling incubators. No animal was used for an experiment more than once. To reduce handling stress, animal parameters (Carapace Length= CL, weight, sex) were obtained following each experiment and then each animal was fixed in 5% buffered formalin. Wet weight to the nearest 1/100 g will be determined back in the laboratories at NOCS. Animals of both sexes were used.

Respiration rates

Experiments were conducted using IPOCAMP^{TM} pressure system (Shillito *et al*., 2001). The seawater used as a medium for the respiration chambers (vials) was aerated for 30 minutes. The aeration system was removed 30 minutes before the start of each experiment to ensure that the water was fully oxygen saturated yet no longer contained air bubbles. An individual galatheid crab was placed inside a 50 ml transparent plastic vial which was then filled with the oxygen saturated, filtered

seawater and closed underwater to ensure that no air bubbles were trapped inside. The vial was placed inside IPOCAMP^{TM} previously acclimatized to the desired test temperature. When required, the IPOCAMP^{TM} was pressurized to the desired level. The increase in pressure was continuous and acute, taking 30 seconds or less. At the end of the experiment pressure was released instantaneously; duration of each experiment was temperature dependent, recognizing that the oxygen depletion of the medium by the crab should not drop below 60-70% oxygen saturation. The plastic vial was removed and inverted gently three times to ensure the oxygen content of the seawater was homogenously mixed. The lid was then removed carefully to ensure no water was spilt. Using the microoptode (Presens, Germany) and temperature sensor the oxygen percentage concentration and temperature were measured and recorded.

Standard Metabolic Rate

Oxygen was measured using a temperature controlled oxygen meter and microoptode (Microx TX 3, Presens, Germany). The microoptode was calibrated prior to use at the experimental temperature with 0 % oxygen saturation as a seawater solution oversaturated with sodium sulphite (Na_2SO_3) and 100 % oxygen saturation as fully aerated seawater that had been left to settle for 30 minutes. Oxygen measurements were temperature compensated using a temperature probe (PT 1000) positioned in close proximity (within mm) to the microoptode.

In order to measure the concentration of oxygen in the 100% oxygen saturated seawater prior to experimental use, the temperature and salinity of the seawater, were measured. The concentration of oxygen in 100% saturated seawater (µmol O_2 l^{-1}) was calculated using the equation from Benson and Krause (1984), which validates the effect of microbial respiration. To determine anomalies caused by minor differences in seawater and in the calibration of the microoptode, the end point percentage oxygen saturation of the control vial containing only seawater was subtracted from 100 %. A minimum of five replicates was conducted for each pressure at each temperature. For each test condition a control was run.

Heat shock experiments

Heat shock experiments were performed inside the pressurized incubator IPOCAMP^{TM} (Ravaux et al., 2003). The experiment was carried out at 24 MPa for the

hydrothermal vent squat lobsters in flow-through mode (20 liters h^{-1} flow rate). The temperature of the flowing seawater (filtered at 0.4 µm) is measured constantly, under pressure, in the inlet and outlet lines (± 1°C). Animals were maintained 2 hours at 5 ± 1°C, then the water temperature was ramped to 20, 30, 35 ± 1°C respectively, at a rate of 0.2°C/min (after Cottin *et al*., 2010). Squat lobsters were kept at this elevated water temperature for 5 hours, after which the temperature was reduced to 5°C, and maintained as such for 2 more hours, until the end of the experiments. Less than 10 min passed between the end of the experiments and the moment the last specimen was frozen at -80°C. Reference animals were maintained for the same duration as for the heating experiments (about 9 h) at a constant temperature of 5°C. Characterisation of HSP70 will be done back at NOCS and following established method (Cottin et al., 2010).

Behavioural Measurements

Behavioural measurements were taken using the IPOCAMP^{TM} pressure system (Shillito *et al*., 2001). The IPOCAMP^{TM} was set running for 1 hour prior to the start of each test to ensure that the saltwater inside was maintained at the desired test temperature (1, 10, 20 °C). Squat lobsters were randomly selected and placed inside the IPOCAMP^{TM} upon a tripod platform, which raised the position of the specimens inside the pressure chamber, allowing it to be viewed more clearly using an endoscope (see Ravaux et al., 2003). The IPOCAMP^{TM} was then set running at atmospheric pressure for 30 minutes to allow the crabs to acclimatize and recover from handling stress. The video recorder was then set to record and the pressure altered at 5 minutes intervals and 10 atm pressure steps, from 1 to 300 atm, and the same for depressurization. Repeats were conducted for each of the experimental temperatures. For the purpose of this study only the increase in pressure was analyzed for comparison with SMR.

The videos will be analyzed back at NOCS using the software package Ulead. Behaviours will be divided into two categories - states and events, depending on the relative length of time over which each behavioural incident occurred. Behaviours classed as states consist of an action or position, which occurs over a period greater than 10 seconds. Behaviours that are classed as events, consist of single specific

actions or movements, which are completed in less than 10 seconds. Appropriate classification of both states and events will have to be done at NOCS.

5.12.3 Outlook

The Southern Ocean is known for its depauperate decapod crustacean fauna, which has frequently been discussed as being both the result of ecological and physiological constraints (Thatje and Arntz, 2004). Hydrothermal vent systems in the Southern Ocean do not only appear isolated geographically but physiologically, which makes the question of dispersal of ontogenetic stages of any kind between sites pertinent. The study of the physiological scope of key organisms inhabiting these vents will provide us with a first idea of how genetic exchange is facilitated or constrained. Temperatures that are slightly colder in the Antarctic deep sea than in any other deep-sea environment, may exhibit physiologically significant barriers to dispersal mechanisms commonly employed by invertebrates elsewhere in the sea.

5.13. Vesicomyid shell dissolution experiment

Katrin Linse, Chris German, Chris Sweeting, Will Reid

5.13.1. Objectives

In the vicinity of the knoll within the crater near the Kemp seamount several large beds of large-sized living and dead vesicomyid bivalves were found. Vesicomyid bivalves are a consistent component of communities that live in reducing environments such as cold seeps at continental margins, hydrothermal vents along mid-ocean ridges, or associated with organic remains. Vesicomyids from sulphide-rich reducing environments are rather large, mostly several cm to 10s cm in size. Estimations of the actual number of vesicomyid subgenera and genera in the recent literature vary from 1 to 13 (Krylova & Sahling in press). Furthermore, molecular analysis does not support the monophyly of currently used generic names. This uncertainty is apparently the consequence of ambiguous generic diagnoses, which are probably the result of morphological convergence and the common occurrence of reduction in the hinge structures (Krylova & Sahling in press).

While members of the small sized subfamily Vesicomyinae, e.g. *Kelliella sirenkoi*/*Vesicomya atlantica* (see Linse 2004, Krylova & Sahling in press) are common on the Antarctic deeper shelf and deep-sea, representatives of the large-sized subfamily Plicardiinae have been collected in 2006 in the Larsen B area of the Western Antarctic Peninsula for the first time by Heilmeyer et al (2008). Our find of large sized vesicomyids is the second record for the Antarctic and the first for living material. The shell material collected at Larsen B is preliminary assigned to the *Archivescia*/*Akebiconcha* group (Sahling pers comm.) and by photo comparison resembles the shells collected in the crater (Fig. 5.13).

Figure 5.13. Left. Vesicomyid from Larsen B Right. Vesicomyid from crater knob

As large beds of dead shells were seen during *Isis* dives, while in general dead shell assemblages are rare in Antarctica in non-chemosynthetic communities, an experiment to study the dissolution of clam shells was set up.

5.13.2. Work at sea

Shells of 60 living clams collected at the sites “end of Glacier” and “Clam Road”, whose soft parts were used for reproduction, isotope and population genetic studies, were measured, cleaned, individually numbered and separated into left and right valve. The left valves were used for the dissolution experiment, the right valves were kept for comparisons and base line measurements. A set of 5 valves each was placed into an individually labelled metal mesh bag and then placed into a metal mesh cage (Fig. 5.14). A total of 4 bags were placed into each cage coming to a total of 20 valves per treatment (Table 5.19).

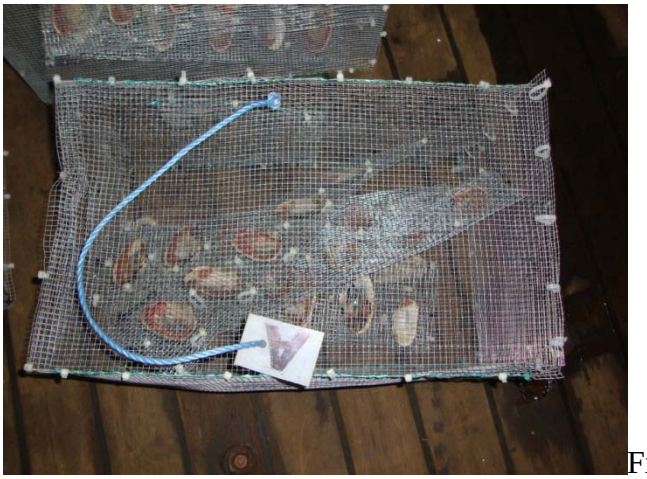


Figure 5.14. Clam cage with bags

Table 5.19. Clam shell numbers, measurements and treatments

Cage	Bag	Specimen no	shell length (mm)	shell height (mm)
A	2	JC42-F-744-5	79	43.3
A	2	JC42-F-772-17	100.9	57.5
A	2	JC42-F-772-18	97.9	55
A	2	JC42-F-772-19	96.9	53
A	2	JC42-F-772-21	104	56.1
A	5	JC42-F-772-11	104.4	54.2
A	5	JC42-F-772-14	109	59.9
A	5	JC42-F-772-28	102	52.2
A	5	JC42-F-772-29	100	51.4
A	5	JC42-F-772-38	95	54
A	8	JC42-F-772-10	105	52
A	8	JC42-F-772-13	99.4	56.9
A	8	JC42-F-772-15	107.8	57.9
A	8	JC42-F-772-16	105.4	52.5
A	8	JC42-F-772-34	103.7	49
A	11	JC42-F-772-3	96.1	52
A	11	JC42-F-772-4	102.8	53.3
A	11	JC42-F-772-6	99.3	51.4
A	11	JC42-F-772-7	100.9	52
A	11	JC42-F-772-8	101.4	51.5

B	1	JC42-F-744-1	65.7	36.3
B	1	JC42-F-782-2	104.1	57
B	1	JC42-F-782-4	82.7	50.4
B	1	JC42-F-772-24	106.9	57.7
B	1	JC42-F-772-32	98.5	52.2
B	4	JC42-F-744-3	78.4	43.7
B	4	JC42-F-744-4	68.6	37.4
B	4	JC42-F-772-22	112.9	58
B	4	JC42-F-772-40	93.4	46.2
B	4	JC42-F-781-1	100.7	49.9
B	7	JC42-F-744-2	60.5	35.4
B	7	JC42-F-782-5	85.3	47.7
B	7	JC42-F-772-31	105.7	54.5
B	7	JC42-F-772-33	105.6	54.5
B	7	JC42-F-772-39	100.5	53.2
B	10	JC42-F-772-26	98.4	55.8
B	10	JC42-F-772-27	96.2	53.5
B	10	JC42-F-772-30	98.5	54.3
B	10	JC42-F-772-35	105.4	54.3
B	10	JC42-F-772-37	100	49.1
C	3	JC42-F-772-2	101.1	53.7
C	3	JC42-F-631-3	106.8	60.1
C	3	JC42-F-669-1	81.8	45.2
C	3	JC42-F-772-9	104.6	55.1
C	3	JC42-F-782-3	85.6	47.9
C	6	JC42-F-615-105	105	56.8
C	6	JC42-F-631-2	105.2	55.9
C	6	JC42-F-772-1	99.1	57.6
C	6	JC42-F-772-12	105.6	59.1
C	6	JC42-F-772-20	96.4	47.1
C	9	JC42-F-615-107	83	43.7
C	9	JC42-F-615-112	98.4	51.5
C	9	JC42-F-615-116	97.6	55.2

C	9	JC42-F-615-117	99.7	51.9
C	9	JC42-F-615-132	104.5	56
C	12	JC42-F-615-113	104.2	51.4
C	12	JC42-F-615-114	97.9	53.2
C	12	JC42-F-615-122	102.6	55.3
C	12	JC42-F-615-124	91.2	48.7
C	12	JC42-F-615-131	105.1	52.1

The three cages were deployed on ISIS dive 154 at three different localities 1) at the living clam field “End of Glacier” – Cage “C”, 2) at the diffuse flow site without living clams “Great Wall” – Cage “A” and 3) off the seep site at “Orange fish traps” – Cage “B”.

The aim is to collected the traps during JC55 (ChEsSO III) and assess the shell dissolution.

5.14. Wood-fall experiment

Jon Copley

Wood falls are an insular and ephemeral organic resource in many areas of the deep sea, but not at high Southern Ocean latitudes. The latitudinal limits of larval distribution in species associated with deep-sea wood falls, such as *Xylophaga* spp., have yet to be determined. We therefore deployed wooden blocks as colonisation substrates during Isis dive #154 (12/02/10) at the Caldera site, 59ºS and 1400 m deep.

Two substrate units were constructed (shown below), each consisting of a pair of untreated pine blocks, measuring 0.5 m x 0.2 m x 0.05 m, attached by polypropylene lines through two drilled holes to an 8 kg metal weight, itself attached to a buoyant white plastic marker disk 0.3 m in diameter (marked “1” and “2”). These two substrate units were deployed together at the “Orange fish traps” WP location, within sight of the whale skeleton on the NE flank of the volcanic knoll. Recovery is anticipated during Research Cruise JC055 in January/February 2011.

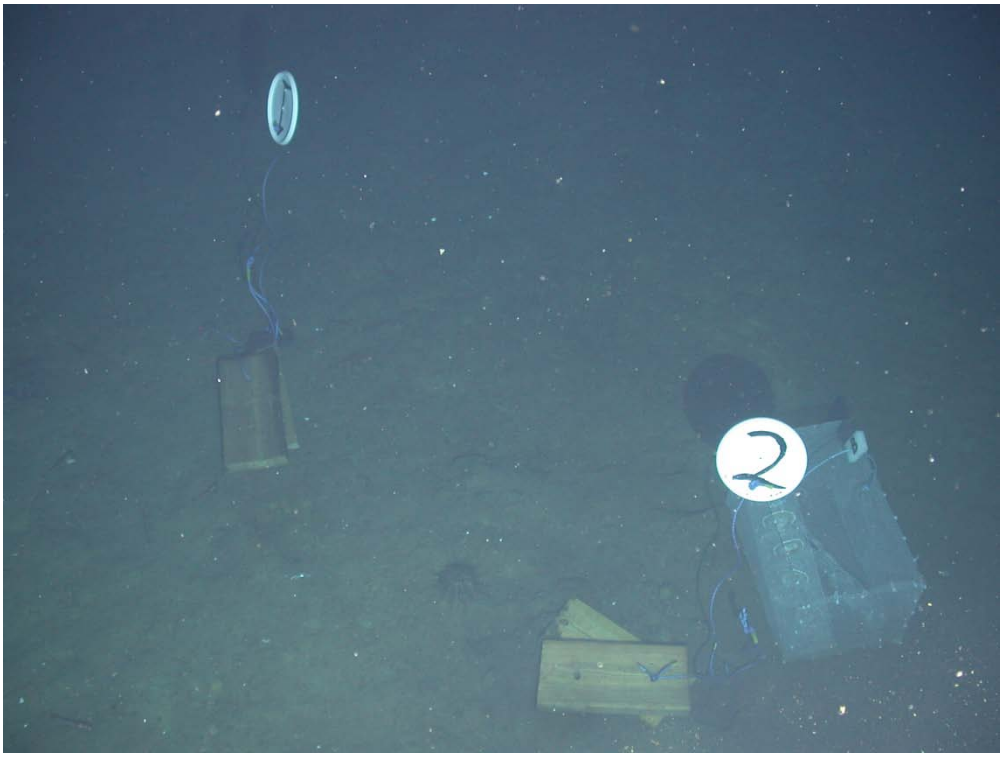


Figure 5.15. Scorpio digital still image of wood-fall substrate units emplaced on seafloor

6.0. Equipment performance

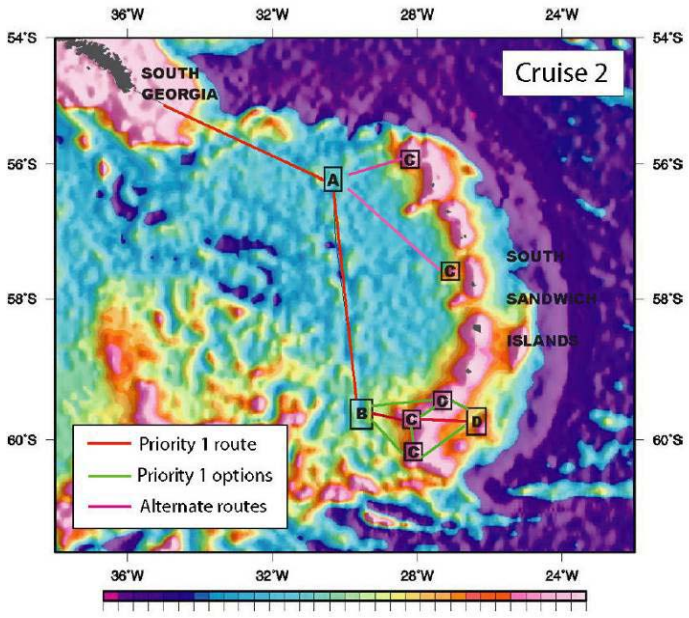
6.1 ROV Tech Report

David Turner

6.1.1 ROV Summary

Figure 6.1 ROV Isis

Cruise Dates:	7th Jan 2010 to 24th Feb 2010
Principal Scientist:	Alex Rogers (Paul Tyler)
ROV Operations Co-ordinator:	Dave Turner
Sea Systems Cruise Manager:	Leighton Rolley
NMFD ROV team:	Pete Mason James Cooper Dave Edge Robert Keogh Will Handley (contractor)
NMFD Techs:	Rhys Roberts Jez Evans Terry Edwards



NB: red track = preferred route; green track = optional alternates depending on results of cruise 1; pink track = extreme alternate if (very unlikely) ice-cover is so great as to preclude all work at 60°S.

Figure 6.2. Original Cruise Outline:

Isis Stats:

No. of dives	31 (dive no. 124 to dive no.154)
Total run time for (JC042) thrusters:	388.8 hrs
Total time at seabed or survey depth:	308 hrs
Isis ROV *total* run time:	2353.95 hrs
Max Depth and Dive Duration:	2675m and 14hrs
Max Dive Duration and Depth:	26.6 hrs and 1345m (dive 147)
Cruise Data Volume:	330GB +DVR 453GB = 783GB + Sonardyne Nav to be sorted
	4395 Scorpio images (4GB)
	SM2000 (12GB)
	Techas (1.27GB)
	CTD (1.3GB)
	Mybook Ser # WU2Q1008550
	Alex Rogers (PSO)
	Mybook Ser #WU2Q10100377

	Paul Tyler airfreight
	Mybook Ser #WU2Q10099877
	Leighton Rolley
	Mybook Ser #WU2Q10086302 (BODC)
	Mybook Ser# WU2Q10089704 (BODC)
Qty 184min DV Cam tapes:	250 Tapes
Qty HDV Cam Tapes:	500 Tapes
Qty DVDs:	600 DVD's

NB: A copy of the JC042 Isis Data will remain on the Isis RAID system for a period of one month commencing from the end date of the cruise after which it will be deleted.

6.1.2. Mobilisation:

Punta Arenas, Chile: 3rd Jan to 7th Jan 2010

The mobilisation of the system was very straight forward with no problems reported.

The umbilical termination was also made during this period, and was pull tested to 7,000kg.

6.1.3. De-Mobilisation

Montevideo, Uruguay : Feb 24th 2009

The majority of the system was stripped down during the 9 day steam back to Montevideo. With good weather we were able to remove the Isis ROV from the LARS enabling us to shut down the A-Frame and remove all hydraulic connections and power to the system. The major lifts to stow the vehicle, winch and storage drum into containers will take place alongside at Monte.

6.1.4. Isis Handling System:

6.1.4.1 Hydraulic Power Unit (HPU):

Worked well for the duration of the cruise. A new power indicator bulb was fitted

Future modifications/requirements:

- None

6.1.4.2 Storage Drum/ Traction Winch:

The Storage Drum worked well for the duration of the cruise. The umbilical had to be re-terminated twice during the cruise. The first time was after the several turns appeared in the wire during a recovery. Removing these turns, left the umbilical in a state not fit for purpose. The second time was after the umbilical got caught around a stand alone pump, on a mooring that the Isis vehicle was trying re-locate. 60m of cable was removed on each occasion. Due to this torsion build up in the umbilical, it was decided that a 'stream' vertically to a max depth available (2500m) would hopefully take out some of these turns. This was carried out after the second re-termination. As an added precaution the locking pins in the new termination design were removed, to allow some movement and eliminate any problem that it may be inducing. No further torsion problems were reported for the duration of the cruise. However, a couple of turns were found in the inner core when the termination was stripped at the end of the cruise. A further 80m of umbilical was removed at the end of the cruise. The storage drum chain drive was lubricated and tensioned at the end of the cruise.

The Traction winch worked well for the duration of the cruise. Scrolling followers were inspected at the end of the cruise and appear to be within there working tolerance.

Future modifications/recommendations/maintenance:

- The chain drive should be closely monitored as part of routine operational checks, maintenance intervals reduced, the chain and drive sprocket considered as a consumable item.

- A possible form of cooling the center of the storage drum (blowing in cool air), should be considered, as this might help with keeping cable temps manageable when the ROV is working at shallow depths.
- Prior to the termination being installed into *Isis*, the Umbilical must be streamed vertically to a max depth available. The new termination with the locking pins is to be used. Any signs of torsion building up during the cruise would indicate that a second stream may be necessary. A full ocean stream is probably necessary to help eliminate this problem.

6.1.4.3. Launch and Recovery System (LARS):

This worked well for the duration of the cruise, with only one minor problem noted. The fwd lower ram on the side of the A frame leaked quiet badly through its wiper seal. This was not something that would cause the ram to fail, but did mean some oil would spurt out each time the ram was operated. This is not something that can easily be repaired without moving the ROV from inside the A-frame, and would mean a fair bit of down time to science, and therefore was deemed usable for the rest of the duration, providing some oil spill mats were used to control the leak.

During the passage to Montevideo when the weather conditions improved, we were able to lift the ROV from the A-frame and position on the aft deck. This meant we were able to collapse the LARS and commence work on the ram. The wiper seal was replaced and the ram exercised to test for leaks.

The tugger assembly was also fully inspected; the small drive sprocket on the hydraulic motor has been measured so that a spare can be ordered.

Future modifications/recommendations/maintenance:

- Sort out DNV certification??
- Build and install a proper sprinkling system for the storage drum.
- Order replacement seals for LARS rams

- On return to NOC LARS rams to be removed, all seals replaced and generally serviced.
- Order Spare drive sprocket for hyd motor on rotating sheave assy.

6.1.4.4. CCTV

The CCTV system used for launch, recover and winch monitoring performed without problems. One camera providing a through A frame, a 2nd and 3rd providing storage and traction winch and a pan & tilt unit for following vehicle and floats when at the surface. The 4 cameras supplied rely on a 50Hz power signal so a separate power line is fed into the control van from the adjoining deck wet lab.

Future modifications/recommendations/maintenance:

- The original supplied Pan & Tilt assembly is an essential requirement so we should consider obtaining a spare motorised unit / controller.

6.1.5. ISIS External Equipment:

6.1.5.1 Elevator A (beacon address 107)

Requested and ready for use, however, were not used for the duration of the cruise. New recovery lines have been made incorporating the new pennant float.

Future modifications required:

- None

6.1.5.2. Elevator B (beacon address 105):

Requested and ready for use, however, were not used for the duration of the cruise. New recovery lines have been made incorporating the new pennant float.

Future modifications required:

- None

6.1.5.3. USBL & LBL Acoustic System (Sonardyne):

ISIS control room USBL suite (PC and NCU)

NCU

The ISIS NCU was seen to freeze on some occasions via the indication on the USBL PC. This is not due to the NCU itself but the COM port on the USBL PC. Turning off the USBL PC and removing power momentarily rectifies the problem and the NCU itself is fully functional. It should be noted that there is no spare NCU in the ISIS equipment suite.

Fusion USBL survey PC

During the first trial dive it was apparent that the Fusion Survey software installed on the USBL PC had suffered a serious malfunction. The hard disk drive with the Fusion instillation was replaced with its backup, but this still did not rectify the problem.
Tracking of ISIS, and subsequently a separate beacon on a test wire confirmed that the issue was with the top side system and not sub-sea hardware. Successful tracking in both ISIS Ranger and the vessels own Fusion suite further confirmed the problem being with the Fusion survey PC in the ISIS control room.

A new installation of Fusion USBL survey was performed on the control room PC and a new job file used, that was created on the ships USBL system. Tracking on the ISIS Fusion system was restored, however it became apparent that although the PORT POLE offsets where carried over from the new job file/re-installation process, the CORRECTIONS where not. These where added manually after issues with navigation accuracy where noticed.

Correspondence with Sonardyne Ltd concluded that the most probable cause of this issue was the corruption of the Fusion USBL survey software. A known issue where by it is impossible to start the Fusion USBL survey software was rectified by the

provision of two software batch file that would clean out dead processes from the PC. Both spare and primary hard disk drives are to be sent back to base for investigation.

There is a serious issue with the GPS systems aboard the ship. It would appear that the different systems are referenced to different points. Another issue would appear to be the differing sensitivities or something similar between the systems. An example being the ship would be on a straight course running on DP. The Sonardyne would show the ship deviate from this straight course then return to it again. The USBL vehicle would also deviate exactly the same as the ship. However the Doppler navigation on the ROV continued straight. This scenario proved almost conclusively that the POSMV satellite system that the Sonardyne system was using wandered off whilst the DP systems' gps appeared to keep a true course. This possible occurred at times of low satellite coverage.

Future modifications/recommendations/maintenance:

- The change over switch in the main lab needs to be replaced with a more reliable one. The two existing switched should be replaced by a single two way switch with break before make contacts of a robust construction. This new switch should allow the Lab NCU to connect to the normal head and the ROV NCU connect to the big head in one position and in the other position to connect the Lab NCU to the big head and the ROV NCU to the normal head.
- Investigate getting direct signals from the master unit(ships GPS, attitude, and heading)
- A master 'ISIS Job file' should be kept separate and used for subsequent cruises. The offsets AND corrections should be double checked at the start of each cruise against the hard copy in the Navigation Check List.
- Investigate the possibility of providing our own GPS system, separate from any vessel system should ISIS be deployed at these latitudes again.
- Investigate the purchase of a new bespoke USBL PC with serial COM port.
- The Fusion survey USB dongle key to be returned to base to allow continued investigation.

Homer

The Homer master transducer fitted to the ROV was found to be flooded after dive 146. It will be transported by air freight to Sonardyne UK Ltd for repair. All homer beacons remain in storage ready for use.

The connector on the homer frequently shows a slight ground fault. This disappears with cleaning the connector but reappears again after only a couple of dives.

Future modifications/recommendations/maintenance:

- Airfreight Homer master to UK and return to Sonardyne for repair.
- Have Sonardyne fit a MCIL 4 pin connector.
- Purchase MCIL tail and wire to Isis Junction box.

Compatt Beacons

One Compatt5 beacon was fitted on an elevator, it was not used and has been disabled for transport. Compatt beacon #210 was used on the ISIS vehicle after #110 failed to upload new firmware provided by Sonardyne Ltd. The #110 is not functioning and will be returned to Sonardyne for repair. Beacon #210 has been disconnected for transport/storage and the battery measured to be still at near full capacity. (BC=14, 14.0V)

Future modifications/recommendations/maintenance:

- Check and purchase batteries
- Purchase new anodes.
- Leave 2 x Compatt 5 Beacons onboard for JC044 (this has been agreed and will support Hybis for operations over 4000m)

6.1.5.4. Football Floats

During Dive 131 the ROV Umbilical got tangled into a mooring that it was trying to move. As a result of this 2 x footballs floats were released by the manipulator and lost.

Future modifications/recommendations/maintenance:

- Purchase 2 x Football Floats

6.1.5.5. Suction Sampler

The suction Sampler worked well for the duration of the cruise. All previous problems of the chambers not rotating and jamming have been illuminated. On a couple of occasions the 3" dia bore suction hose got blocked, but only because the sample taken was too large. The Suction nozzle took a couple of bad knocks, and the end tubes had to be replaced. A slight modification to this design to make a little more rugged, with the possible option to change the nozzle bore dia would improve things dramatically.

The hydraulic suction motor was stripped and flushed at the end of the cruise.

Future modifications/recommendations/maintenance:

- Airfreight the suction nozzle back to the UK for overhaul and modifications.
- Possible option of a single chamber option.

6.1.5.6. Push Cores

The push cores worked well for the duration of the cruise.

6.1.6. Isis ROV

6.1.6.1. Thrusters

The two vertical thrusters were stripped and serviced at the midpoint of the cruise. The new speedi sleeves that had been fitted prior to the cruise had shown signs of wear. However these had protected the shafts and were an improvement of the previous methods tried. There was some slight wear from there not being enough clearance on the end cap bore. This bore was machined to increase clearance. For the second half of the cruise a new set of gold speedi shafts were used.

These gold speedi sleeves proved to be a vast improvement over the others, showing little or no wear upon final inspection at the end of the cruise. All thrusters were stripped, machined and fitted with gold speedi sleeves at the end of the cruise.

Future modifications/improvements/maintenance:

- Purchase spare speedi sleeves.
- Replace used bearings and seals taken from the spares kit.

6.1.6.2. Thruster Controllers

There were several occasions where AC ground faults showed. In most cases this was resolved by servicing the connectors. However the stbd aft pod developed a sustained ground fault and when opened a small amount of water was present; a tea spoon full. There was no obvious sign as to where the water ingression occurred. Apparently WHOI experienced a similar problem and concluded that the ingression occurred via the connection leads within the connector. They subsequently replaced all of their power connectors on the thruster pods with the s/s version, which is the same as we are currently using. A full set of connectors has been ordered with the intension of replacing all connectors at a suitable time in the future.

After the problem with water ingression, the suspect pod was completely stripped down and re-built using a new centre casting and new power connectors. One of the

“power control bloks” showed discoloration on the brass base. This was replaced with a new blok. The pod was re-assembled using delrin spacers for the DG O’Brian connectors. The delrin will have to be replaced with a harder material in the future.

The new test box for testing the control blok’s and thrusters pods worked well and made these tasks much safer and easier.

The centre castings that were manufactured all appear to have defects in one of the o’ ring groves. The casting eventually used had the defect away from the o’ring contact surface.

Future modifications/improvements/maintenance:

- Before the vehicle is next used all power connectors must be fully serviced unless they have been replaced with new ones.
- At a convenient time all the Subcon power connectors should be replaced.
- All thruster pods should be removed and the seatings under the connectors checked. In cases where there are signs of corrosion, the O ring faces should be skimmed and re-anodised or new units used. Before re-assembly all connectors must have any sharp edges smoothed down; including the threads.
- A spacer made from Utlem 2300 should be installed under eack DGO connector. The spacers made from Delrin should be replaced with Ultem 2300 ones.
- Use Capital funds to carry out repair work, and or additionally look at manufacture of replacement and spare pods. Look at option of manufacturing centre section in titanium!!!. A batch of three? Were made but all had a scratch or anodizing defect close to or where the o’ring seats. The reason why should be discovered and addressed.
- When the pods are being re-built, the hydraulic pod should have a second power bloc installed within it.

6.1.6.3. Vehicle Main System Compensators

Initially the system compensator oil level would not sustain any real duration. After a couple of dives, and finding a couple of connectors that needed tightening, the system became more reliable increasing the dive times. This coupled with the oil temp stabling out, and any air entrapment being bled out, left the system with good oil capacity for the duration of the cruise, with no further problems.

The transformer HV compensator system performed well for the duration of the cruise. A couple of small leaks have been noted on the junction box that the umbilical connects into. These will addressed next time the junction box is opened up

Future modifications/improvements/maintenance:

- Sort out leak on HV umbilical connection junction box. One being where the F/O from the main pressure tube enters the box. This unfortunately in a Dorn fitting that has a split rubber inside. Secondly the two off hose barbs that connect the fibers from one side to the other

6.1.6.4. Tool Sled

Drawer

This worked well for the duration of the cruise.

Future modifications/improvements/maintenance:

- None

Swing Arms

This worked well for the duration of the cruise.

The hydraulic locking rams have been stripped and flushed as part of the post cruise maintenance.

Future modifications/improvements/maintenance:

- Bring out for next cruise the spare locking rams that have been ordered and now finally delivered to NOC

6.1.6.5. Hydraulic System

The hydraulic system worked well for the duration of the cruise. There was one incident whereby we were unable to obtain system pressure, preventing any use of the hydraulic functions. Upon inspection this was found to be the main system relief valve that appeared to have a small piece of plastic blocking one of the ports. This valve was replaced and no further problems were encountered.

The high pressure and return filters were changed periodically throughout the cruise and oil samples were taken at the end of every dive. The system did not take on any water.

Following our first oil filter change it was noted that we were loosing reservoir volume over the duration of a dive. This was monitored over several dives, checking for leaks after every recovery. The source of the leak was later determined to be with the wrist assembly of the manipulator arms, see below. Due to the complexity of this fault, and the fact that the oil levels were sufficient to sustain a dive it was not to be rectified until all the science dives had been completed.

At the end of the cruise all filters were changed again, and where possible rams and hoses flushed.

Future modifications/improvements/maintenance:

- Replace all filters that have been used.
- Replace system pressure relief valve.

6.1.6.6. Manipulators

Port Side

The port manipulator worked well for the duration of the cruise. Towards the last few dives when it was noted that the hydraulic reservoir was loosing fluid, it became apparent that the wrist assembly on this arm could be leaking slightly. This was not addressed until all the Dives had been completed. During the post cruise service of the vehicle the wrist assembly has been removed, stripped and serviced with new seals and o'rings.

Starboard Side

The starboard arm suffered from ground faults (GF) on a couple of occasions. This was finally rectified after both the shoulder and elbow rams had been replaced, along with all the connectors and pots associated with it. These were not all replaced at the same time, but on different occasion that the GF's occurred. The wrist assembly was also noted to have oil leakage towards the end of the cruise. During the post cruise service of the vehicle the wrist assembly has been removed, stripped and serviced with new seals and o-rings.

Future modifications/improvements/maintenance:

- Look at purchasing a spare mini master
- Mini master spares
- New ram cylinder + cap
- New tube assembly
- Replace all seals and o'rings used in servicing of the wrists.
- Penetrators + plugs + female plugs.
- Look at a switchable mini master arrangement.

6.1.6.7. Pan & Tilt Units

Worked fine.

Future modifications/improvements/maintenance:

- None

6.1.6.8. Doppler

The 300 kHz DVL did not work at the start of the cruise. It was opened and contained about a table spoon full of water. The water showed signs of corrosion along one side. This must have happened whilst the DVL was sat in a storage box between cruises. It would appear that the water must have ingressed during the last cruise and just sat on the transducers. The damage occurred once it was taken off and stored on its side. RDI have been contacted and a return number has been issued for us to send it back from Montevideo for assessment.

The 1200 kHz DVL operated well for the duration of the cruise.

Future modifications/improvements/maintenance:

- Arrangements are in place to return it to the manufacturers from Montevideo. A quote with delivery time has been received should the damaged unit be un-repairable. The quote was for $33,750 which includes a one off 10% discount with a 30 – 60 day delivery after receipt of order.

6.1.6.9. Cameras

3 Chip Atlas

The 3 chip broadcast quality camera was used during some dives mounted on the port side forward tool drawer looking downwards. The drawer grills were removed to provide a clear view while protecting the camera within the drawer. An additional HMI fitted to improve illumination for the High Definition cameras was removed from the light bar and mounted on the starboard side of the tool draw for seabed illumination. Control of this camera is through the Sony RMC remote made available to the watch scientist for optimising the image.

Pegasus Pilot

Replaced with HD pilot

Pegasus Science

The new Pegasus camera mounted on the starboard side of the science pan & tilt position suffered condensation with a water droplet forming in the viewport. This has occurred with a number of factory supplied cameras in the past and has been resolved by purging at NOC in an oven at 35 degs C for 4-5 hours. To remove and clean, the viewport has to be removed which highlighted a requirement for additional spare Kapton ring seals. These were requested from the manufacturer during the cruise. A NOC purged spare Pegasus camera was used for the remainder of the cruise without problems.

Future modifications/improvements/maintenance:

- This unit is to be returned to NOC and purged using suitable controlled environment.

Scorpio digital still with flash unit

This camera was mounted on the port side of the science pan& tilt with the strobe mounted centrally to the foam pack.

These units were returned to the manufacturer prior to the cruise for servicing and replacement of a strobe unit which failed on JC36. In addition to check operation of the TTL operation of strobe control implemented prior to JC36. Initially only one camera strobe pair would work on deck – later it was found that after swapping the cameras the strobe would activate only in the water. This requires further investigation however over 4000 images were downloaded during the cruise.

Future modifications/improvements/maintenance:

- This unit is to be returned to NOC and purged using suitable controlled environment. As per Science Pegasus.

High Definition Pilot and Fixed camera units

Two new high definition cameras (1080i) where used as the main vehicle camera system. One was fitted to the pilot pan and tilt unit and designated HD2 Pilot, the other fitted to the forward fixed mounting and designated HD1 Fixed. Both functioned well for the duration of the cruise however the strength of the fibre optic signal from each camera is of concern since loses in the overall fibre optic system (junction boxes, slip ring, cable and van interconnects) push the signal budget to its limit. (see details below)

Future modifications/improvements/maintenance:

- Contact Insite regarding the development of multiple to single fibre WDM (Wave division multiplexing) electronics tube that would allow multiple HD cameras on one fibre optic link.
- If no WDM option available in the immediate future, upgrade the current HD cameras to have the more powerful 0dbm transmitter.

High Definition video de-multiplexer and video distribution

Each high definition camera uses a surface HD/SDI de-multiplexer to convert the fibre optic signal to a HD/SDI (on a standard BNC). The BNC output is then fed into a HD/SDI to component video converter (for use on the main video monitors). A HD/SDI signal is also fed directly into the recording suite that consists of two Sony HVR 1500A recorders.

The optical signal levels on each HD/SDI de-multiplexer was noted to be on the borderline of the operational budget, approximately -15dbm to -20dbm. The optical loses were reduced by replacing the camera fibre/j-box link with oil filled Seacon connectors, effectively removing a fibre optic coupler. Further loses where reduced by running a direct fibre cable from the storage drum winch j-box to the control room HD/SDI de-multiplexer, effectively removing two further fibre coupling links.
The new Seacon fibre optic oil filled connectors worked well, although there is noticeable surface corrosion on the tails, possibly due to the corrosive nature of the dive sites. This corrosion should be monitored and spares purchased appropriately.

High Definition video tape recorder

Two HVR1500A units where used for recording the high definition video stream fed out from the HD/SDI to Component HD converter. The units performed without incident.

Future modifications/improvements/maintenance:

- As previously recommended a hard disk recording solution would overcome the mass tape and optical media requirements and would simplify watch keeping operations with HDV tape changes x4, DVCam x2 every 3 hours and DVD disks x4 every 2 hours. Costs would be reduced by a potential 75%. The regular need for DVD recording would effectively be removed as this is tended to be used for distribution of footage for those without tape replay facilities. An improvement of the current CCTV recorder to full frame rate would improve most DVD resolution review situations and post cruise environmental tape care would be eliminated. Time would also be saved by removing Non Linear editor ingests.

Mini Cams

Uplook , Drawer, LED Sampler/Gauges

A drawer camera installed was rarely used and would be best positioned on the light bar looking down at the tool drawer giving the pilot a permanent view of the front edge of the vehicle when the science P&T cameras are looking elsewhere.
The LED tooling camera monitoring the slurp carousel and gauges was provided with additional illumination – a 250W halogen was positioned there.

Future modifications/improvements/maintenance:

- A drawer camera installed was rarely used and would be best positioned on the light bar looking down at the tool drawer giving the pilot a permanent view of the front edge of the vehicle when the science P&T cameras are looking elsewhere.

Mercury (Aft Cam)

This is an excellent low light monochrome camera providing sharp pictures with minimal lighting and is well suited for vehicle rear view monitoring. No problems were encountered.

6.1.6.10. Lights

HMI, LED, quartz

The 4 HMI's performed flawlessly through out the cruise – the 4th unit installed for this cruise to provide additional illumination for the HD cameras was positioned on the tool drawer looking down in support of the Atlas camera when conducting seabed video transects. It was noted additional blanks are required for connectors when removed from vehicle.

The LED lamps provided excellent illumination as 40W replacements for the 250W halogens however some ground faults occurred located to some connector pin corrosion. The new lamps have a contact shoulder at the base of the pins unlike the quartz halogens.

Future modifications/improvements/maintenance:

- Bennix to clarify the situation with regards what would appear to be an incompatibility issue with the new LED lamp connector and their existing Halogen lamp.
- Spare cabling and replacement of existing cables

6.1.6.11. Lasers

The red paired laser modules spaced at 10cm and fixed to the fixed HD camera and Atlas, when seabed video mosaicing, housed in the WHOI tubes, worked well. However, they suffered a power cable / connector failure. To avoid opening and draining the junction box another cable was fabricated powered from the science bus port 6. The green laser units bought just before the cruise did not meet the advertised specifications and failed at low temperatures. In communications with the company they apologised for this and would work quickly on a solution – they came up with wrapping a filament heater within the module boosting the power consumption to 50W per laser module. The present power brick is 150W so should be capable of powering a scaling pair.

Future modifications/improvements/maintenance:

- The green lasers are to be returned to manufacture cruise for modification with the proviso of acceptance that the solution be demonstrated ok on the following cruise.
- SHRIMP lasers to be returned to NOC for overhaul.

6.1.6.12. Sonars

MS2000

This operated well for the duration of the cruise.

A temporary 24v / 24v isolating converter was used to drive the sonar head. This worked very well eliminating the interference that had plagued this system. The drawback with this converter is that it does not provide any GF monitoring. A suitable converter that will run off the DC bus and provide gf information should be sought to replace the original Vicor brick.

Future modifications/improvements/maintenance:

- Address temporary issue for permanent when time permits.

MS1000 Profile

Not used for the duration of the cruise.

MS1000 Imaging (Fwd)

This worked well for most of the cruise, however during the earlier dives which were deeper, the gain appeared to jump, producing spoke like orange fingers on the screen. Once operating at 2,300m it operated well.

6.1.6.13. Digiquartz Pressure Sensor

Worked well for the duration of the cruise.

6.1.6.14. CTD

The Idrinaut 320 Plus CTD was used on all dives mounted on the starboard side near the light bar, without problems. Data was recorded and displayed using the associated REDAS5 version 5.4 software. Version 5.43 was downloaded during the cruise for

assessment and future upgrade. This includes additional GPS position NMEA input Similarly there is a firmware upgrade for the CTD which will be performed at a later date.

6.1.6.15. WHOI Magnetometer

Not used for this cruise

6.1.6.16. Electrical Systems and Wiring

The repairs carried out to the boards within the telemetry tube worked well and the previous faults rectified.

6.1.6.17. Altimeter

Worked well for the duration of the cruise.

6.1.6.18. Novatech Radio/Strobe Beacons

Worked well for the duration of the cruise.

6.1.6.19. PRIZM –FO Comms

The PRIZM comms worked well for the duration of the cruise, however it took an unacceptably long time to start working when powered on. The symptoms appeared to be a temperature issue where it would start quickly after a long time in use yet could take up to 30 minutes to start when left powered down for a long period of time.
The tube was pulled and a power supply feed was found to be slightly low which tied up with the PRIZM log. It was 4.8V, it is now is 5.1 V. Unfortunately once the system was moved into the Science Container it has worked correctly and it is not possible to replicate the fault. It may or may not be this power supply issue. Further tests are ongoing.

6.1.6.20. Scientific Sensors

ICL Probe

The Inductively Coupled Temperature probes built at WHOI were used for the first time with the Isis vehicle. They provide a decoupled solution designed for operation with the titanium water samplers. Software developed by the Isis team operating on the Control Van Device Controller computer provided a clear indication of communication link status when coupled to within 1cm of the battery operated probe. Alignment of the 2 coils, one mounted on a hydraulic ram on the port manipulator and the other attached to the titanium sampler, required precision positioning achieved by rotation of the manipulator jaws. This could be improved by introducing a less critical alignment coupling technique and reduce the need for precise settings on the actuating trigger bolts. Communication and power was provided through Isis science bus port 7 configured for 12-15V and RS232 communications.

At the start of the cruise the probes which had previously been used and returned damaged required repair of the electronics bottle connector. This was implemented and tested ok – additional spares should be sought for this equipment namely thermocouple probes and cables etc. No calibration had been done and a technique is required to achieve this. The potential operational temperature range is estimated to be between -1^{o}C to 500^{o}C

Temperature Lance

To provide an additional high temperature measurement solution to the ICL probes a thermocouple wand monitoring system was completed at the start of the cruise. Utilising the same ICL thermocouple probe and redundant crossbow bottle housing modified with an additional bulkhead connector to house a Type J thermocouple sensing module with cold junction reference. Software developed by the Isis team operating on the Control Van device controller provided for a numeric and graphical temperature monitoring and data logging. To help protect and make rigid the thermocouple an Isis team designed slotted sleeve proved effective and prevented channelling of hot vent fluid up a potentially simple tube design and melting the electronic cabling.

The electronics bottle was mounted in the original crossbow position at the starboard rear end of the vehicle with a shielded 7 metre cable running along the length of the vehicle to the forward drawer where the probe fitted with T-handle and supported with a tube holster resided. The system worked well suffering a couple of failures due to cable damage. Additional manipulator grab points would be beneficial on the cable line to prevent damage when grabbing with manipulators. No calibration was made but results correlated reasonably well with the ICL probes.

6.1.7. *Isis* System Topside

6.1.7.1. Video Tilters

Worked well for the duration of the cruise.

6.1.7.2. Jetway

This operated well for the duration of the cruise, with the one exception when one of the smoothing capacitors on its output circuit failed. After looking at the circuit diagrams and taking into account the characteristics of the tow cable it was decided to proceed without replacing this capacitor for the one short remaining dive. The Jetway compartment air conditioning was re-routed to blow air directly into the Jetway power supply. This has made a big improvement to the operating temperature of power supply. A small opening was made in this trucking to blow cool air over the HV transformer.

Future modifications/improvements/maintenance:

- The output smoothing capacitors should be replaced with the upgrade suggested by the Jetway manufacturers. Relevant data sheets and instructions have been obtained and the replacement capacitors plus one spare have been ordered.
- Look into external cooling of the transformers (water cooled, etc)

- Sound insulation to be fitted to jetway door, so as to improve working conditions for the engineer.

6.1.7.3. Device Controller

This Windows XP computer provided for the control and monitoring of Cameras, Joysticks, ICL Probes and temperature lance. (Science Pegasus camera, Scorpio digital Still camera, 2 off ROS Pan & tilt units, Pilot joybox and Logitech wired and wireless joysticks.

As on the previous cruise the system became sluggish and non responsive over a period of time this required a quick restart of the software to clear. The exact cause has yet to be identified. It was identified however at the start of the cruise the computer had time consuming processes active periodically consuming all CPU time. This PC had been previously used for a number of differing applications so the hard disk was rebuilt to strip out redundant software which significantly improved the performance.

Future modifications/improvements/maintenance:

- A proposal for discussion was submitted to the Isis technical leader before the cruise to develop the system onto a deterministic real-time operating system together with associated ergonomic control boxes incorporating present and recent additional high definition controllers. To this aim during the cruise investigation of the default computer hardware was assessed. It would appear that the addition of a PCI network card can potentially transform the system to the benefits of real-time while retaining developed software.

6.1.7.4. Techsas PC

This operated well for the duration of the cruise.

The new logging process to read in and time stamp the swath mab data was implemented at the start of this cruise. It successfully logged the mab data during the various swath runs.

The system was powered down and re-started when the container power was changed. Upon starting up it would only broadcast nema data but no xml data. This was caused by the network sub mask being set to 255.255.0.0 instead of 255.255.255.0 once changed it worked well.

This Linux computer provides the major data logging tasks and also acts as an NTP server for time synchronisation for the other computers. This performed without problems with only file incrementing per dive requiring intervention.

6.1.7.5. Caraibes PCs

This setup worked well for the duration of the cruise.

The machine was set up as a windows xp machine with linux running in a virtual machine. A common or shared directory was setup between them so that flies could easily be transferred from one machine to the other.

The new file for swath data was operational for this cruise. It consisted of the existing .mab file but it was time-stamped and logged on the TECHSAS data logger. First impressions showed that this new file structure worked well, however time has not allowed a good comparison between the two file types to say which is better for post processing accuracy.

During the cruise a problem was found with the function Odicee.

6.1.7.6. Sumatra PC

This worked well for the duration of the cruise with the exception of a couple of points.

- When data from any of the inputs did not occur for a few minutes, the capture for that input stopped and could only be re-started by stopping and starting the acquisition.
- The swath data displayed only covered an area approximately 2/3 of the true coverage.
- Controlling the colour scaling of the swath data was not easy since the "stretched" option was not recommended for this purpose.

6.1.7.7. Event Logger PC

This Windows XP computer event logger provides the scientific electronic diary of Isis events. There were few issues with this occasionally having to restart the TomCat administrator server and remapping external drives to enable frame-grab logging. On one occasion though the system effectively froze. The fault was tracked to the system attempting to acquire a frame-grab from the remote Ethernet linked frame grabber whose power brick had failed – replacement of the power brick solved the problem.

6.1.7.8. SM2000 PC

This worked well for the duration of the cruise.

All the swath lines were conducted at an altitude of 20m,with a range setting of 50m and a ping rate of 500mS.

The data rate for this scenario was about 1.69 GB/h for the raw swath data, 3.5 MB/h for the swath .mab data and 3 MB/h for the relevant navigation, depth and attitude data to process the swath .mab files.

6.1.7.9. MS1000 PC

Operated well for the duration of the cruise.

6.1.7.10 Topside PC

This ran well for the duration of the cruise.
New reference points were entered twice during the cruise.

6.1.7.11. Videowall PC

This worked well for the duration of the cruise. The display showed a large video feed that could be switched by the scientists in the science container, a small video feed from a pre selected video source and an SDIV display showing the vehicle's latitude, Longitude, heading and depth.

Several requests were made to have the Sumatra screen incorporated in this display or else have it on a separate screen. This is valid request and should be looked into.

This is a new feature comprising two quad video capture boards. It was noticed that if two or more feeds on one board were displayed, the images started to flicker. This should be looked into though not critical at present.

6.1.7.12. DVLNAV PC

This worked well. However the virtual port software occasionally hung and had to be "repaired" to get the system operating again. This tended to occur infrequently; 5 times all cruise.

Two new reference points were added during the cruise.

The DVL offset was calibrated and adjusted during the cruise.

6.1.7.13. Minimac PC

Not used.

6.1.7.14. Pilot/Engineer PC

Worked well.

6.1.7.15. DVD / DV Cam Recording Setup

The existing DVCam decks performed without incident. However several of the DVD recorder units are coming to the end of their life and are currently unreliable, namely DVD3 and DVD4.

The 4 screen Numark rack mounted monitors are too small to follow the DVD menus when finalizing disks.

Future modifications/improvements/maintenance:

- Investigate the replacement of the DVD suite, possibly with recordable Blue-Ray devices.
- Investigate the replacement of the DVD suite, possibly with recordable Blue-Ray devices.

6.1.7.16. Minifilm Recording

Worked well. This was achived on the BODC computer which had two capture cards installed specifically for this task. The frame grabs were takes at 60 second intervals and written directly onto the RAID data base in the appropriate dive folders.

6.1.7.17. DVR

The DVR provides a 5 frame a second h.264 per channel record (DVD quality) of up to 8 video channels. During this cruise 4 channels were recorded per dive amassing 453GB of data. The time stamped record provides a quick reviewing solution either on or offline. The additional facility of web server provided a live bandwidth limited network feed to the ships network where access is through standard pc web browsers.

A feed was enabled on the Bridge next to the DP station but still a permanent computer / wiring has not been installed as recommended from previous cruises.

6.1.7.18. BODC video archiving PC

The BODC computer recorded the s-video signal from the Atlas 3 chip camera, whilst it was mounted vertically on the front of the tool tray. This captured video recorded each I frame in MPEG2 m2p format.

After the ATLAS camera was removed the BODC data came from the Pilot HD camera via the tape recorder where it was output in S video and connected directly into the capture card. The Pilot HD camera was used for most of the specialised scientific operations. It was the prime instrument for recording the vertical moasicing of cliffs and chimneys

All the capture, coding etc. is carried out on the special capture board making it immune to any computer processing issues.

An audio signal with date, time, Latitude, longitude, heading and depth were recorded to the left audio channel and a microphone for scientific annotations was recorded on the right audio channel.

Two “My Book” disc were used to record the data onto and were send back to NOC with the airfreight from Montevideo. The disc S/Ns are WU2Q10086302 & WU2Q10089704.

A programme running on this computer produced the audio signal with encoded data; time, latitude, longitude, heading and depth. This audio signal was distributed to all the video recorders on the left audio channel.

6.1.8. Isis Topside Technical Details

6.1.8.1. Ship Network Connection

Worked well.

6.1.8.2. Ship – ROV Patch Panel Connections

The two Juniper firewalls have been configured in the ROV control van to allow access to the ships NTP server and ships Techsas UDP broadcasts. Isis UDP broadcast traffic is blocked by the firewall so as not to clog up the ships network with ROV traffic.

A DHCP server was been setup for the ROV 192.168.40.0/24 network running as a service on the Apple X-Serve. Science back bench left CAT5 socket (ROV-D/01) now connects to the Ship network and the right hand CAT5 socket (ROV-D/03) connects to the ROV network.

Science access to the RAID server for JC42 is setup as follows:

Username science, password science gives read only access to IsisData/JC42
Username sciencerw, password fulladmin gives full access to IsisData/JC42

6.1.8.3. Fibre Optic Terminations

Worked well. Due to a low bandwidth budget for the HD cameras a deck lead was put in going directly from the storage drum junction box, to the rattlers of the HD system. Removing all the additional interconnects vastly improved the budget allowing the system to work faultlessly.

6.1.8.4. Apple X-Server / RAID-Server

Worked well.

6.1.8.5. Bender Ground Fault Unit – Isis

Checked for operation during the cruise and found to be operating satisfactorily.

6.1.8.6. Power Supplies

The power for the control room, science container and Jetway compartment used the 440V 60Hz clean supply via a 63A plug.

At the end of the cruise this 440V supply was replaced by connecting a 230V, 32A clean supply to the control container, a 230V, 32A clean supply to the science container and a 230V dirty supply to the Jetway compartment. Current measurements showed that the control container drew about 17A, the science container about 10A and the Jetway compartment about 30A (10A per A/C unit). Only two A/C units were run for this period limiting the current to 20A. These power sources were located on the port aft bulkhead in the deck lab.

For the next cruise the Control Container and Science Container should be connected up to the 230V supplies as above. The Jetway compartment should be ideally connected to the two 230V 32A supplies in the deck lab. These two connectors should be joined with a single 63 A cable running into the Jetway compartment. Note, A safety notice will have to be put in place to prevent disconnecting one connector whilst the other is still powered. The alternative method to power the Jetway compartment is the use the diry 415V 50Hz supply via the inbuilt transformer. The Chief engineer will confirm if the preferred option is acceptable.

The Jetway power supply and was powered from a separate 415V 50 Hz dirty supply.

During the next refit suitable power sourses will be available in the hangar area. A requirement was drawn up with the Chief Engineer to provide

- Two off 230V, 63A, 50Hz clean supplies
- One off 230V, 63A, 50Hz dirty supply.
- One off 415V, 50Hz, 110A dirty supply
- These will be located in the hangar close to the container opening on the port side.

Also there will be a 415V, 200A, 50Hz dirty supply on the aft. Stbd. side of the hangar. This will be provided with studs so that the two winch 100A cables can be wired in parallel.

When the containers return to NOC the bottom gooseneck should be replaced with two 63A 230V plugs. One for the clean supply feeding the Control and Science containers and the other for the dirty supply feeding the Jetway compartment.

6.1.8.6. Air Conditioning Units

During the mobilisation period the A/C unit that cools the Control room failed. This was replaced with the spare one and all three functioned well for the duration of the cruise.

According to the Chief Engineer these units are charged with a gas that is banned in Europe and could not be re-gassed aboard.

When the system is mobilised in St Johns an A/C engineer should be hired to service and re-gas these units; either as is or with a compatible one with the ship.

Upon return to NOC these units should receive a thorough service and be re-gassed with a gas that is compatible with that aboard the ships. It might be necessary to change the oil at the same time.

6.1.9. ISIS Dive Summary (hrs run)

Cruise	Dive no.	Dive Hrs	Depth (m)	Bottom Time (hrs)
JC042	124	7	2559	2.5
JC042	125	9.3	256	8
JC042	126	9	2653	5
JC042	127	10.2	2644	6.5
JC042	128	17.5	2675	14
JC042	129	11	2632	7.5
JC042	130	17	2666	15.5
JC042	131	12	2675	7.6
JC042	132	21	2618	17.3
JC042	133	11.6	2646	8.3
JC042	134	16.6	2642	12.5
JC042	135	12.7	2666	10.3
JC042	136	5	2656	1
JC042	137	1.5	219	0
JC042	138	20.5	2450	17.3
JC042	139	16.5	2400	13.5
JC042	140	25	2450	22
JC042	141	7.5	2396	4.3
JC042	142	12	2392	15.3
JC042	143	0.5	0	0
JC042	144	9.75	2389	6.3
JC042	145	7.5	2399	4.25
JC042	146	4.3	2400	1
JC042	147	26.5	1345	23.75
JC042	148	24.5	1482	23.3
JC042	149	15	1467	14

JC042	150	14	1436	12.5
JC042	151	14	1487	12
JC042	152	13.75	1472	12
JC042	153	12.5	1442	8
JC042	154	3.6	1501	2.5
Totals	**31 (dives)**	**388.8**	**2675**	**308**

6.1.10. Mooring Tangle Incident (20th Jan 2010) Dive 131:

Isis Dive 131 was intended to locate a 60m mooring, that had been specially designed to be moved by the ROV, and repositioned into a suitable position within a vent site.
The mooring was deployed without any complications, and was located with the ROV several hrs later. The original plan was to move this short mooring from the top and reposition. Unfortunately due to the visibility, the length of the mooring and the terrain it was decided that it may be best to move from the bottom, with the anchor weight.

A host of things were considered, such as wire angles, ROV umbilical, currents etc (tool box talk), which led to the ROV and ship being positioned accordingly. The removable of the sacrificial weight, the picking up of the mooring, and even the accurate positioning of the mooring went very well, and would not have been achievable from the top as originally planned.

Unfortunately, when a final inspection of the mooring was being made it was noted that the ROV umbilical had tangled around one of the Stand Alone Pumps (SAP) that made up the mooring string. To make matters worse it had wrapped itself behind one of the clamps on the pump, and two of the umbilical football floats were pulling the umbilical taught behind this clamp.

After several hrs of working with the manipulators we were able to untangle the ROV umbilical from this SAP and its clamp. To achieve this we had to release the two football floats, using the manipulators, so that we could generate enough slack to pull the umbilical free.

More wraps around the mooring were later found further up the string, of which we were able to unwind by flying the Isis ROV in the correct rotation. It is more than likely, based on the number turns (lots) that these had occurred whilst we were working on the entanglement with the SAP.

Once free the ROV was recovered in its usual manner, sustaining minor damage to the umbilical where the manipulator arms had worked to get free.

Due to the torsion issues we had been experiencing with the umbilical it is possible that the neutral buoyant part of the wire had a large sweeping turn in it, which would have put the umbilical around in-front of the vehicle, further up, rather than behind where we thought it should be during our mooring operation. It again is possible that it was this loop that for us unfortunately caught on the SAP

Upon recovery Isis was closely inspected for damage, but none was found.
80m of Umbilical was removed and a new termination was made.
Following this and due to the uncertainty of how the umbilical got tangled it was determined that streaming the umbilical vertically could only improve matters in removing any torsion built up in the cable.

No further moorings for ROV positioning were used for the duration of the cruise. Had their been a requirement, the mooring string would have only been 20 to 25m long, as originally planned, and would have been re-position from the top.

6.1.11. ROV multibeam system

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6.1.11.1. Standard settings

Localised and detailed bathymetry surveys were carried out with the Kongsberg SM2000 system mounted onto the ISIS ROV. This high-resolution multibeam system runs at a frequency of 200 kHz and has 128 beams, spaced with equal angles over a total of 120°. Surveys were generally carried out at 20 m above the seabed, at a speed of 0.3 to 0.4 kn. The survey height was limited by the capacity of the high-resolution Doppler navigation system

(max. 30 m height), after the lower resolution system was found defect at the start of the cruise. Swath width at 20 m altitude theoretically is 70 m, but line spacing was kept to a conservative 40 m, in order to obtain sufficient overlap (especially in very heterogeneous terrain and with noisy navigation) and data quality. In addition to these settings, one high-resolution survey was carried out during Dive135, where ISIS was kept 10 m off the seabed.

The swath system was used during 12 dives, building up 3 major grids and some extra datasets. A summary of the surveys is given in Table 5.1. The three major areas mapped were the three main study areas ‘E2’, ‘E9’ and ‘Kemp Seamount caldera’. In addition, some data was gathered at the dive site offshore South Georgia.

Data were recorded using the Kongsberg SM2000 software, at a rate of 2 Hz. Parameter settings were saved in a configuration file ‘Vents_20m’, involved an overall gain of 37.5%, and a TVG curve with parameters:

TVG Type = Custom
TVG A factor = 37 dB
TVG B factor = 76 dB/km
TVG C factor = -11 dB
TVG limit = 92.0 dB
TVG K factor = 120.0 mdB/degree

The general operational procedure during the swath surveys was to keep the SM2000 recording all the time (.raw files), but to export the data in different files for each line (.mab format). At the start of each line, the Doppler navigation was reset to the USBL location, the TECHSAS file number was changed and the export was started.

Processing was carried out within the IFREMER software suite ‘Caraibes’, which has been adapted on purpose to handle the ISIS SM2000 data. The processing steps included:
Tnmg77: importation of navigation, converting the TECHSAS .gps files (both USBL and Doppler) into CARAIBES .nvi files
ImpIsis: importation of immersion, converting the Techsas NetCDF file into ascii
Tms2000: conversion of bathymetry data into .mbb files, using a time offset of -1.32 s (although this may need re-assessment for different dives) between soundings (.mab files) and

vehicle attitude (Tss2-Octans1, NetCDF files). The following vehicle equipment offsets were used, in relation to a common reference point:

	X (m, + to starboard)	Y (m, + forward)	Z (m, + down)
Compatt USBL	-0.990	-0.380	-1.495
Depth sensor	0.574	-1.550	0.000
MRU (Octans)	0.000	-0.879	0.521
DVL	0.570	-2.900	0.120
MS2000	0.000	-2.580	0.000

Coratt: integration of immersion data with the .mbb file (using 'absolute value', 'from file'), converting it into .mbg

Genexy: integration of navigation (.nvi) with bathymetry data (.mbg)

Odicce: manual cleaning data files, removing outliers and noise. Due to a very high data quality, this step was minimal

Calbat: Pitch and roll offsets were checked with this routine, based on calibration data collected at each of the survey sites. It turned out that no pitch or roll corrections were necessary.

RegBat: rubber-sheeting of the different survey lines in order to obtain an internally consistent DTM. This processing step started from the Doppler-referenced data, but used the USBL navigation positions as guidance. Due to the problems with the different navigation systems, the data did need quite a lot of rubber-sheeting.

Mailla: gridding of the DTM, using a Mercator projection, using the 4 soundings closest to the grid point.

MntAsc: exportation of DTM to ArcGIS format (.flt file, plus .hdr file), ready for importation into the GIS

6.1.11.2. System performances

SM2000

The overall performance of the SM2000 multibeam system was very good throughout this cruise. The TVG settings were carefully chosen and gave optimal results. In addition, the ROV altimeter was switched off during the swath runs, which gave a much better data quality than obtained on previous cruises.

The only problem that still persists is the occurrence of across-track stripes throughout the data. These are caused by pitching of the vehicle during data collection. Although the vehicle attitude is recorded by the octans system and stored on the Techsas datalogger, correlating both datasets in time has proven problematic. So far the exact time offset between the two datasets has not been established yet, and it appears that this may differ between surveys. In addition, also the time between the depth data (immersion) and SM2000 recordings seems to be offset in certain cases (up to 20 s). Further tests and investigations will be necessary to establish these offsets.

Sumatra

During the surveys, the incoming data was broadcast in real-time to the tracking system 'Sumatra', to be displayed (in uncorrected form) on the interactive map. Sumatra is an extension of the ArcGIS software, developed by IFREMER, to provide real-time tracking of vessels and underwater vehicles The performance of the system was intermittent. Tracking the ROV and ship was generally OK throughout most of the dives, although the system had to be stopped and restarted each time the USBL navigation dropped out for more than about a minute. Occasionally, on long dives, the software would crash altogether, probably due to an overload of the computer memory. During swath surveys, it is possible to display the swath coverage on the map, but this seemed to fill up the memory very quickly (resulting in even more frequent system crashes). Moreover, the swath width displayed did often not correspond to the actual swath width obtained. This, combined with the memory overflow and the insecurity about the actual position of ISIS (see 'navigation') made that the swath display function of Sumatra was generally not used.

6.2. EM120 Multibeam echo sounder

Alistair Graham

EM120 data were acquired at each study site during the first ChEsSO consortium cruise (JR224) in 2009. As a result shipborne multibeam swath bathymetry were only collected during cruise JC042, where it was identified that further data would supplement this existing dataset. Logging was initiated on passage to South Georgia, east of Punta Arenas, but the system was operated on an *ad hoc* basis therein, and data collection was infrequent. However, two noteworthy periods of multibeam survey were undertaken during operations: the first, across the collapse crater at the E9 ridge segment; the second, over the sub-cone at

the base of the Macintosh crater, west of Kemp Seamount. Both multibeam surveys aimed to visualise any changes in sea-floor bathymetry since the last survey of the area, and thus establish whether the region is currently experiencing topographical changes due to active volcanism. The data will be processed and analysed post-cruise.

6.2.1 Standard settings

When operational, the EM120 was synchronised with the EA600 through the SSU with a calculated ping cycle based on the working water depth. The width of the swath was set to a level appropriate for the water depth and weather conditions. Beam angles were set as wide as possible for data acquisition, but were reduced if the outer beams became discordant or noisy, or if the EM120 had problems fixing the bottom. Minimum and maximum depths were set as appropriate for the regional bathymetry. Occasionally, the maximum depth was fixed near to the actual water depth in an attempt to stop the EM120 from picking spurious multiple seafloor reflectors. Sound velocity profiles were changed appropriate to the water structure of the survey area. Typical parameter settings for the EM120 workstation are listed in Appendix A3

6.2.2 Problems encountered

No problems were encountered. The EM120 system performed adequately at both the targeted survey areas, and during periods of underway acquisition. The data quality are noticeably variable from the *James Cook*, heavily dependent on the ship's heading, speed and sea-state, but the system itself performed without fault.

6.3 SBP120 sub-bottom profiler (AG)

The SBP120 was operated on an *ad hoc* basis, in-line with EM120 surveys, as outlined above. Only a single targeted sub-bottom survey was carried out during the cruise; as a pre-site survey to establish targets for gravity coring in the Mackintosh crater, west of Kemp crater.

6.3.1 Standard settings

Typical parameter settings on the control workstation are listed in Appendix A5. The SBP trigger was generally operated in a synchronized mode through the SSU. In most cases, the TOPAS system was operated using a chirp source, with a signal strength of no more than 80%. Automatic gain control (AGC) and a bandpass filter was used to improve imaging of the seafloor on the screen display. Data were written out to .raw and .jpg image files, but no hard (paper) copy of the data were made.

6.3.2 Problems encountered

No problems were encountered with the SBP. Indeed, the data quality was often superb in the deep ocean, providing acoustic penetration up to 100 m below the sea floor (see example below).

6.4 EA600 Echo Sounder

The Kongsberg EA600 12 kHz echo sounder is used for navigational purposes. Unlike onboard the *James Clark Ross*, where the EA600 runs in a 'passive' mode (taking its depth from the EM120's first return) the EA600 is routinely switched to an 'active' mode on the *JC*. The system ran without fault, although data quality often mirrored that of the EM120 (i.e. was highly variable).

6.5. Navigation

Alistair Graham, Veerle Huvenne, Leighton Rolley

Obtaining correct navigation for ISIS was a major challenge during JC042, due to a combination of factors: USBL calibration, DGPS performance and settings, and the location of the study sites compared to GPS base stations. As a result, the ISIS navigation and sample positions obtained throughout the cruise have to be treated with caution, especially for site E2.

6.5.1. DGPS

The ISIS position, through the USBL system (Ultra Short Base-Line), is derived from the ship's position. Hence, errors in the ship's position are propagated to the ROV navigation on the seabed.

The JC042 operations took place south of 55°S, where satellite visibility is often rather limited, or satellites do not appear very high above the horizon. In addition, the study sites were far away from DGPS base stations (the main station used during the cruise was located in Buenos Aires, >3500 km away). Satellites visible at those locations were not always the same as those picked up by the *James Cook* systems. As a result, the DGPS traditionally used for the ship's Dynamical Positioning and for the ISIS USBL calculations ('DPS116') dropped out repeatedly. During Dive127, at 14.15z, it was decided to switch over to the scientific DGPS, the 'POS-MV', which appeared to be more robust.

In addition, from that moment on, the systems were set to import differential calculations from several base stations rather than one. Unfortunately, it turned out that the POS-MV system only takes one base station into account at any one time. By comparing different DGPS tracks (towards the end of the cruise, Fig. 6.3), it appeared that the POS-MV 'wandered' repeatedly, especially when the satellite HDOP was high, probably due to the system switching between base stations. As a result, the ROV position also wandered on the seabed, resulting in errors of up to 40 m. The worst-affected dive appears to be Dive147.

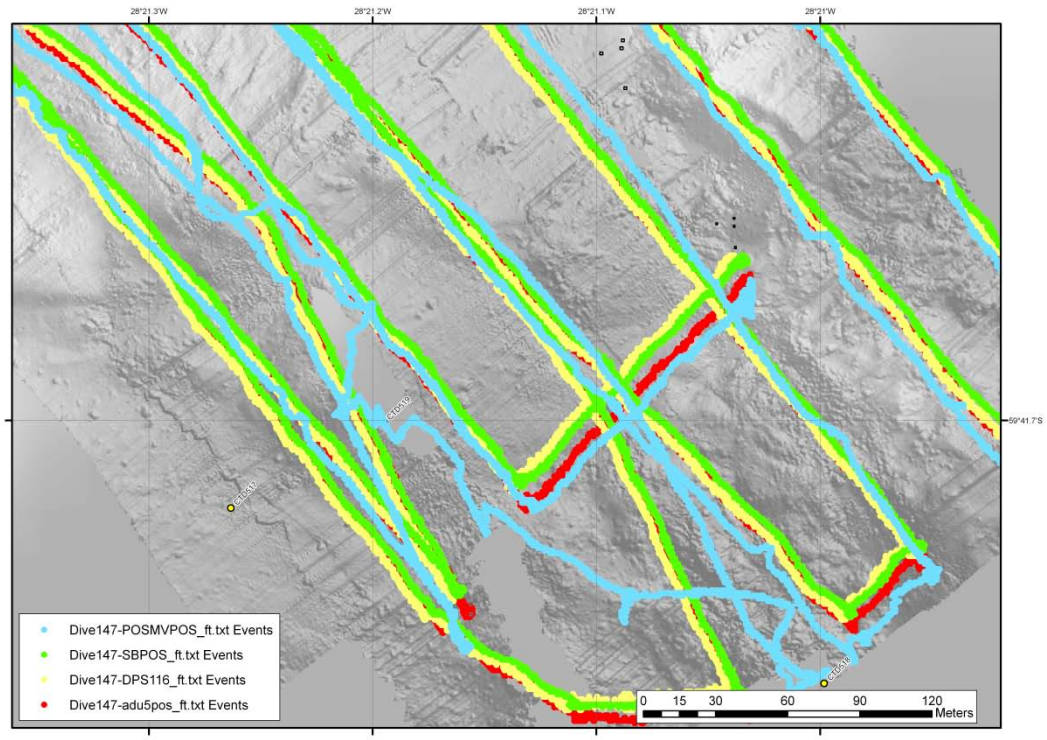


Figure 6.3 Comparison of ship's positions during Dive147, provided by different DGPS systems on board RRS James Cook. Note the diversions of the POS-MV (blue track).

6.5.2. USBL

A Sonardyne USBL system is used to measure the ROV position in relation to the ship, and to convert this information into absolute positions for ISIS (using the Fusion software). The ship sends out acoustic signals, to which the ROV responds. From the angle and distance of the echos, the position of the ROV can be calculated. However, during the dives over the Mermaid Purse site (‘E2’), it became apparent that the navigation regularly was offset by up to 115 m compared to previous visits to the same features. In particular, replicate multibeam bathymetry surveys provided evidence for these offsets.

As a result, it was decided to run a number of tests during the first dive at the ‘Devil’s Punchbowl’ site (‘E9’). With ISIS stationary on the seabed, the ship was rotated over 360 degrees in 4 quarters, both in a clockwise and anticlockwise direction. The apparent position of ISIS moved in a circle with diameter of 150 m (Fig.6.4).

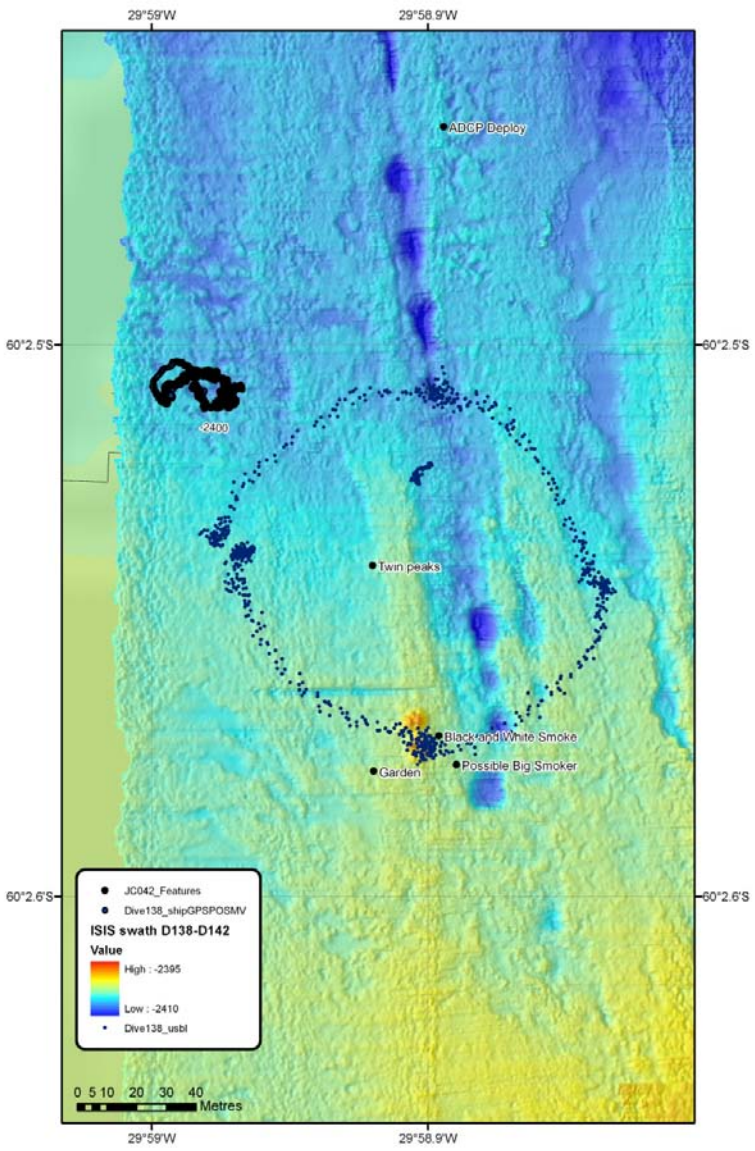


Fig. 6.4. Illustration of the navigation error during calibration tests at the start of Dive138: ISIS was stationary on the seabed while the ship's heading was turned over 360deg.

In order for the USBL system to measure the angles between ROV and ship correctly, and to convert the positions correctly to the coordinate framework of the ship, the (angular and lateral) offsets of the ship's transponder have to be known exactly. Unfortunately, due to initial problems with the USBL system at the beginning of the cruise, including a system reboot, the wrong calibration values were used for the first part of the cruise. RRS *James Cook* has two transponder 'heads' (standard head for shallow water work, 'Big Head' for deep-water work), and it appears that calibration values for the one were used with the other. This was corrected before the deployment of the ADCP during Dive138, and the positions of

ISIS during all subsequent dives should be within a precision of ~20m (except for the occasional problems with the POS-MV described above, which may have caused an additional 40m of error).

6.5.3. Doppler

In addition to the USBL navigation, the ROV ISIS also has a Doppler system, which works on the basis of dead-reckoning. Once the initial position of ISIS is determined on the seafloor, the system tracks the direction and speed of travel, and calculates the ROV position from that. Over the length of the track, the error on the position gradually increases, hence the Doppler position is regularly reset to the USBL position, when the latter receives a set of reliable fixes.

The ISIS team owns 2 Doppler systems for the ROV: one high-resolution system that works within 30 m of the seabed, and one lower-resolution system running up to 100 m altitude. Unfortunately the latter one was broken, so for the entire cruise the high-resolution system was used. This performed very well, and drift on the system was minimal.

6.6. CTD Operations

A total of 103 CTD casts were completed during the cruise. Casts 1 to 10 and 13, 14, 101, 102 and 103 were conventional profiling casts with water sampling, and casts 11 and 16 to100 were TOW-YO casts where multiple up and down casts were recorded in multiple *.hex files, each up and down cast recorded separately. The titanium CTD system was used throughout. 28 salinity samples were taken .

A single SAP was fitted to the CTD frame in place of bottles 7, 8, 9 and 10 using lashings to secure it in place, resting on a cross bar. (See SAP section for details).

6.6.1. 24-way Titanium CTD Frame

The titanium frame configuration was as follows:

• Sea-Bird 9/11 *plus* CTD system with fin-mounted secondary sensors
• Sea-Bird SBE-32 24 way rosette pylon on NMF 24 way frame
• 24 by 10L custom OTE external spring water samplers
• Sea-Bird SBE-43 oxygen Sensor
• Chelsea MKIII Aquatracka fluorometer
• Chelsea MKII Alphatracka 25cm path transmissometer
• Wetlabs BBRTD 660nm backscatter sensor
• NMF LADCP pressure-case battery pack
• RD Instruments Workhorse 300 KHz lowered ADCP (downward-looking master only configuration)
• Benthos PSA-916T 200kHz altimeter

For the 10l bottles, the pressure sensor was located 34cm below the bottom of the water samplers, and 121cm below the top of the water samplers. The 10l niskins are 87cm in height between end-cap seals.

• V0 --- SBE 43 Oxygen s/n 43-0862 (primary duct - 9+ mounted)
• V1 --- Unused – obsolete oxygen temperature

• V2 --- Chelsea MKIII Aquatracka Fluorometer s/n 09-7117-001
• V3 --- Benthos PSA-916T Altimeter s/n 41302
• V4 --- User supplier EH sensor
• V5 --- Seatech LSS
• V6 --- Wetlabs BBRTD backscatter s/n 182
• V7 --- Chelsea MKII Alphatracka 25cm path Transmissometer s/n 07-6075-001
Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\JC042\0758tita.con

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 : Yes

1) Frequency 0, Temperature

Serial number : 4380
Calibrated on : 11 September 2009
G : 4.37246986e-003
H : 6.55812162e-004
I : 2.43426096e-005
J : 2.00363188e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 2165
Calibrated on : 5 Oct 2009
G : -1.07901687e+001
H : 1.48369019e+000
I : -2.85077435e-003
J : 2.62590340e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 90074
Calibrated on : 17 Nov 2008
C1 : -6.571123e+004
C2 : 2.050504e-001
C3 : 1.612220e-002
D1 : 2.883800e-002
D2 : 0.000000e+000
T1 : 2.986693e+001
T2 : -2.678465e-004
T3 : 3.986390e-006
T4 : 7.472100e-010
T5 : 0.000000e+000
Slope : 0.99995000
Offset : -0.04600
AD590M : 1.283700e-002
AD590B : -8.642460e+000

4) Frequency 3, Temperature, 2

Serial number : 4592
Calibrated on : 09 May 2009
G : 4.38615149e-003
H : 6.40097973e-004
I : 2.17948389e-005
J : 1.88440815e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 2164
Calibrated on : 30 April 2009
G : -9.93396028e+000
H : 1.36974324e+000
I : -2.65227233e-003
J : 2.43844517e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

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

Serial number : 0709
Calibrated on : 28 May 2008
Equation : Sea-Bird
Soc : 4.29400e-001
Offset : -4.95700e-001
A : -1.33110e-003
B : 1.51160e-004
C : -3.22560e-006
E : 3.60000e-002

Tau20 : 1.58000e+000
D1 : 1.92630e-004
D2 : -4.64800e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 09-7117-001
Calibrated on : 10 June 2009
VB : 0.201500
V1 : 2.078500
Vacetone : 0.466900
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Altimeter

Serial number : 112522
Calibrated on : 20 April 2007
Scale factor : 15.000
Offset : 0.000

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, User Polynomial

Serial number : 182

Calibrated on : 20 June 2007

Sensor name : Wetlabs BBRTD

A0 : -0.00035320

A1 : 0.00301900

A2 : 0.00000000

A3 : 0.00000000

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : 161-2642-002

Calibrated on : 4 Sept 96

M : 21.2270

B : -0.4880

Path length : 0.250

The additional self-logging instruments were configured as follows:

• RDI Workhorse 300 KHz Lowered ADCP (down-looking master configuration) s/n 12920

The LADCP was powered by the NMF battery pack WH006T.

6.6.2. Deployment Comments

The system performed well with only minor issues. SBE32 sn 0346 position 22 has water ingress and ceased to work. Not user serviceable. Will be returned when a spare is available. A few 10litre TM bottles were found to leak during the cruise, these were serviced during the cruise. Bottle 4 had new O rings and small leak traced to lanyard mount screws. LSS 346 suffered from step change in the output and was replaced on 18th Jan. Used as an uncalibrated sensor. The LSS, BBRTD and transmissometer all displayed good correlation, the LSS having the high gain ability was very useful.

6.6.3. Salinometry

Two Guildline Autosal 8400B salinometers were available for use having serial numbers 65764 and 68426. Unit s/n 65764 was used for all samples with unit s/n 68426 being reserved as a spare. The work was carried out in the electronics workshop forward of main lab and I

believe this caused an anomaly in the sampling beyond sample 12. The correlation of primary and secondary sensor pairs was excellent, but drifted slightly after the tow – yo casts. There is no evidence that the tow – yo caused this.

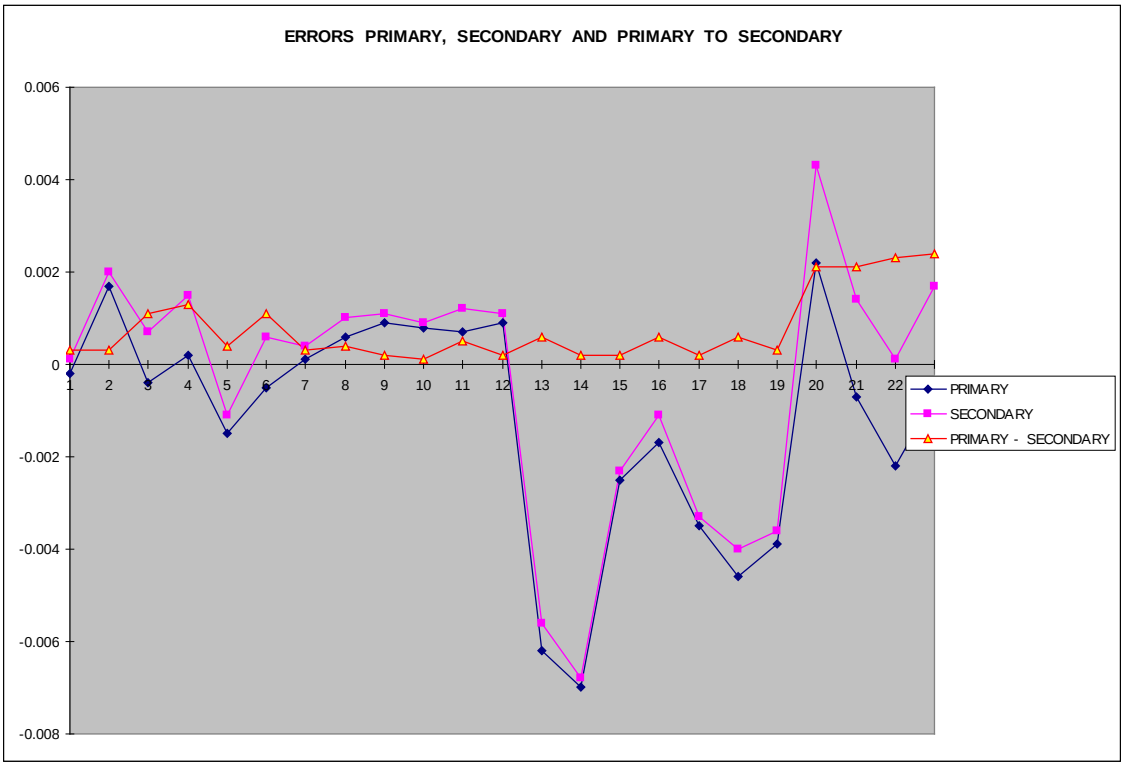


Figure 6.5. Salinometry errors.

Overall, the salinities achieved errors of -0.004 and -0.003 for primary and secondary pairs respectively.

6.6.4. RDI Workhorse LADCP Configuration

The Down looking LADCP was used throughout the cruise. A poor power connection caused a few casts to generate multiple files, but this was only noted on start ups and the main data files were unaffected.

No problems noted.

Downlooking Master
Workhorse 300 kHz
Aluminium Pressure Case
WHM_JC041.CMD

PS0
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0011111
TE00:00:01.00
TP00:01.00
WM15
LD111100000
LF0500
LN016
LP00001
LS1000
LV250
LJ1
LW1
LZ30,220
SM1
SA001
SW05000
CK
CS

6.6.5. Deployment Comments

The LADCP's were operated by NMF technicians. Prior to each deployment the BBtalk terminal session was logged to a file named with the format CTDxxx.txt for the down-looking master, where xxx was the CTD cast number.

Then the following commands were sent:

TS? – time set, offset from GPS clock noted and time reset if greater than a few seconds.
RS? – to check flashcard space and re ErAse if necessary
PA and PT200 – pre-deployment and built in self tests

About 10 minutes before the CTD was deployed the command files were sent and BBtalk file logging stopped. Deployment and end of pinging times were recorded on the rough log sheets.

After pinging was stopped, the number of deployments in the recorder was queried with RA? And the most recent file downloaded in the default RDI-xxx.000 name format (after changing baud rate to 115200 using CB811). The file was then renamed to the form CTDxxxm/s.000. All filenames were noted on the rough log sheets. The battery was fully charged at 58V until it was drawing 100mA between each cast.

6.7. SAPS Operations

SAPS were deployed in moored, wire and CTD mounted mode. A single SAP was deployed on CTD casts 4 (with one on wire using spare CTD termination clamps), 5, 6, 7. 12, 14, 101 and 103. Typical pumped volume was around 100l per hour, this was attributed to build up on the filters. Units tested on deck and at 1000m without filters pumped over 1000l per hour.

SAP 03-03 was damaged during the ROV tangle and the timer board removed and put in 02-02 which timer had intermittent failure in that it would not stop pumping. 03-03 also had a damaged impellor housing and ceramic bearing. All to be repaired at NOC. Parts are in the box, bagged up.

Mounting the SAP on CTD wire using the termination clamps worked well, but was a tricky process to carry out. Dan Comben to produce new simpler clamps of a similar design.

Note that upgraded timer boards with switched start mode would have been very useful.

6.8. Moorings Report

6.8.1 Mooring 1

2 moorings were deployed during the cruise and also 2 deployments of a Sentinel ADCP in a low drag frame. Mooring 1 was deployed as described below except that the ROV was able to move it with enough hold down weight so that the top buoyancy package did not have to be cut away. However, the length of the mooring and the terrain meant that it could not be moved from the top as originally planned.

Instead after due consideration of currents and risks, the mooring was moved from the bottom. This appeared to work until the ROV withdrew after positioning and it became apparent that the umbilical had snagged on the lower SAP, between the pressure case and the clamp bracket.

The snag was eventually removed and the ROV recovered.

- Mooring is deployed anchor first, Instruments and buoyancy put into line as per normal stopping off procedure.

- Mooring is lowered to seabed on trawl warp with acoustic release below 100kg weight

- USBL fitted to allow tracking (if needed)

- Acoustic release fired and trawl warp recovered with weight and release attached.

- ROV dives to inspect site. Depending on situation, the ROV will perform none or all of the adjustments / moves. The most likely scenario is that all adjustment will take place, so the procedure would be:

1. Cut away anchor 1
2. Move mooring to required site
3. Adjust instrument heights off seabed by cutting short section(s)

4. Release top buoyancy to increase hold down weight.

It will then be necessary to recovery the top buoyancy package consisting of billings float, 4 x 17” glass and tail with a small pellet.

Ascent rate expected to be 2 to 3 m/s, about 15to 20 minutes. The package is not expected to be significantly affected by currents. The remaining mooring will be released acoustically and recovered in the normal manner.

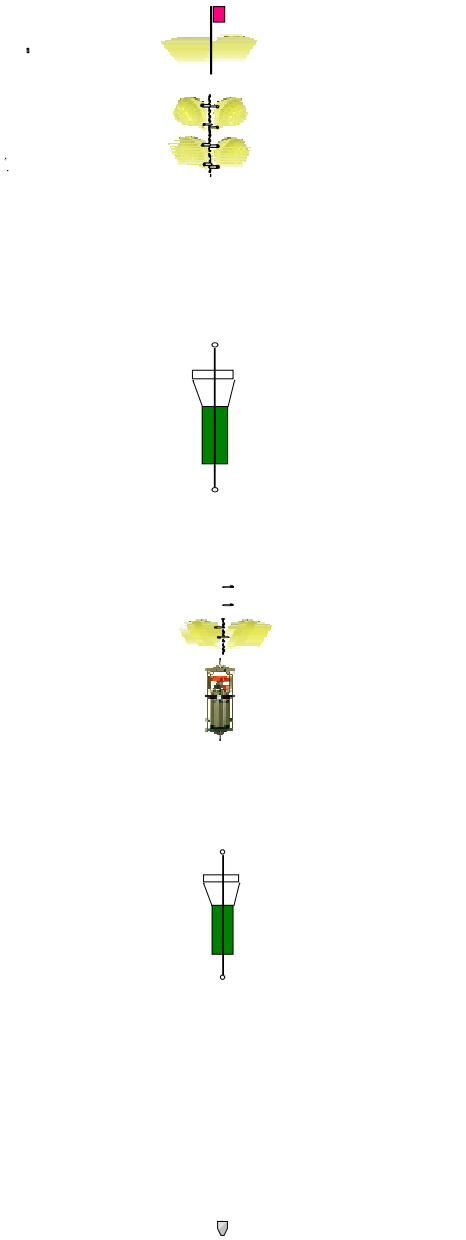


Figure 6.6. Mooring 1. SAPS Mooring Design.

Deployed anchor first. Started deployment at 1135, all outboard at 1235 GMT. Mooring dropped with top release 80 to 100m above seabed, bottom anchor 20-40 m above. Depth tracking is tricky due to confused terrain. Top release fired at 1556.
Positioned about 50m from intended drop zone. Mooring located using ROV sonar. Bottom anchor cut away successfully and mooring relocated to new position. Mooring was 51kg negative and ISIS handled it no problem.
Fouling occurred with SAP 03-03 and ROV umbilical. Cleared with minor damage to SAP.
SAP 03-02 intact, but failed to pump. Intermittent problem on timer board, replaced with one from 03-03.

Instruments

Release 1061 at bottom, ARM 18FE, REL 1855
SAP 03-02, 24 hrs delay, 2 hrs pump.
Seaguard CM sn 91, 1 min sampling allowing 35 days.
SAP 03-03, 24hr delay, 2 hr pumping
Novatech light X03-076

Release on cable 1064 ARM 183e, REL 1855, DIAG 1849.

Mooring recovered 21st Jan. Release fired successfully at 1359 after azi thruster turned off. Surface at 1430. Came up in a big tangle, possibly due to turns induced by ROV interference.

Data recovered from Seaguard.

SAP 03-03. Impellor housing broken. Timer card put into 03-02.
SAP 03-02. Timer does not switch off, also suspect starting issue.

6.8.2. Mooring 2

A single current meter mooring was deployed on the crater site, 8th Feb and recovered 11th Feb 2010. Data was recovered from the current meter.

Instruments
Release 1061 at bottom, ARM 18FE, REL 1855
Seaguard CM sn 91, 20 second sampling.
Novatech light X03-076

Figure 6.7. Mooring 2. Current meter mooring design.

6.9. Lander

The ROV deployed a lander at sites 3 and 4 containing a gimball mounted Sentinel ADCP. The set up was as follows:

CF11101

>EA0

>EB0

>ED0

>ES35

>EX11111

>EZ1111111

>WA50

>WB0

>WD111100000

>WF176

>WN30

>WP50

>WS500

>WV175

>TE00:05:00.00

>TP00:06.00

>CK

[Parameters saved as USER defaults]

>The command CS is not allowed in this command file. It has been ignored.

>The following commands are generated by this program:

>CF?

CF = 11101 ---------- Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)

>CF11101

>RN stn03

>cs

Sentinel recovered. BBTalk did not recognise the card and no data appeared to have been stored. Removed the flash cards and checked; one card showed data but wouldn't read. After a few attempts the data was recovered and initial checks look good. Redeployed with only 1 card installed. Station 4 used the same parameters. Data was downloaded using BBTalk. Data checked using WIN Adcp, initial checks look good, though only about 60m range.

6.10 Data-logging and other continuous data recording devices

6.10.1. 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.

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

1. Applanix POSMV System (Converted to RVS Format as posmvpos, posmvatt, posmvsat)
2. Applanix POSMV System Heading
3. Kongsberg Seatex DPS-116 (Converted to RVS Format as dps116p and dps116s)
4. Chernikeef EM speed log (converted to RVS format as log_chf)
5. Skipper EM Speed Log (converted to RVS Format as log_skip)
6. Ships Gyrocompass (converted to RVS format as gyronmea)
7. Simrad EA600 Precision Echo Sounder (Converted to RVS Format as ea600)
8. NMFD Surface-water and Meteorology instrument suite (Converted to RVS as sm_surf, sm_met and sm_light)
9. ASHTECH ADU-5 Altitude Detection Unit Converted to RVS Format as adu5pat and adu5pos)
10. NMFSS Cable Logging and Monitoring (Converted to RVS as winch)

During the cruise there were no issues with the logging systm.

6.10.2. Chernikeef EM log

The Chernikeef EM log is a 2-axis electromagnetic water speed log. It measures both longitudinal (forward-aft) and transverse (port – starboard) ships water speed.

The EMLog proved inaccurate during high speed runs.

6.10.3. Ship's Gyrocompass

The Gyronmea is a file that receives its data from the Ships gyro compass located in the Bridge Electronics Space. There are two such Gyros on the bridge and we are able to use either one of them as a source of heading. The selected Gyro is logged by the TECHSAS system and is used as part of the bestnav calculation.

6.10.4. Skipper Doppler Log

The Skipper Doppler log is the ship fitted speed indicator mainly used by the bridge.

The system is not reliable.

6.10.5. Surfmet System

This is the NMFD surface water and meteorology instrument suite. The surface water component consists of a flow through system with a pumped pickup at approx 5m depth. TSG flow is approx 18 litres per minute whilst fluoriometer and transmissometer flow is approx 1.5 l/min. Flow to instruments is degassed using a debubbler with 24 l/min inflow and 10/l min waste flow.

The meteorology component consists of a suite of sensors mounted on the foremast at a height of approx 16.4m above the waterline. Parameters measured are wind speed and direction, air temperature, humidity and atmospheric pressure. There is also a pair of optical sensors mounted on gimbals on each side of the ship. These measure total irradiance (TIR) and photo-synthetically active radiation (PAR). The Non Toxic system was enabled as soon as we were far enough away from land in order to protect the sea surface sensors from pollution which generally occurs close to land.

The system worked fine and was cleaned every two days during the cruise.

6.10.6. ADCP 150

Logging throughout cruise. No Problems

6.10.7. ADCP 75

Logging throughout cruise. No Problems

6.10.8. Gravity Meter

The gravity meter operated throughout the cruise although was not required by the scientific party. System checks were completed daily.

6.10.9. CASIX PCO2 System

This system is an autonomous pCO2 system developed by PML and Dartcom. I advise that you contact Nick Hardman-Muntford at PML for information. The system was run at the same time as the Surfmet system. The System was cleaned on a weekly basis in order to remove fouling from the system as per the manual.

6.11. Ship's Navigation Systems

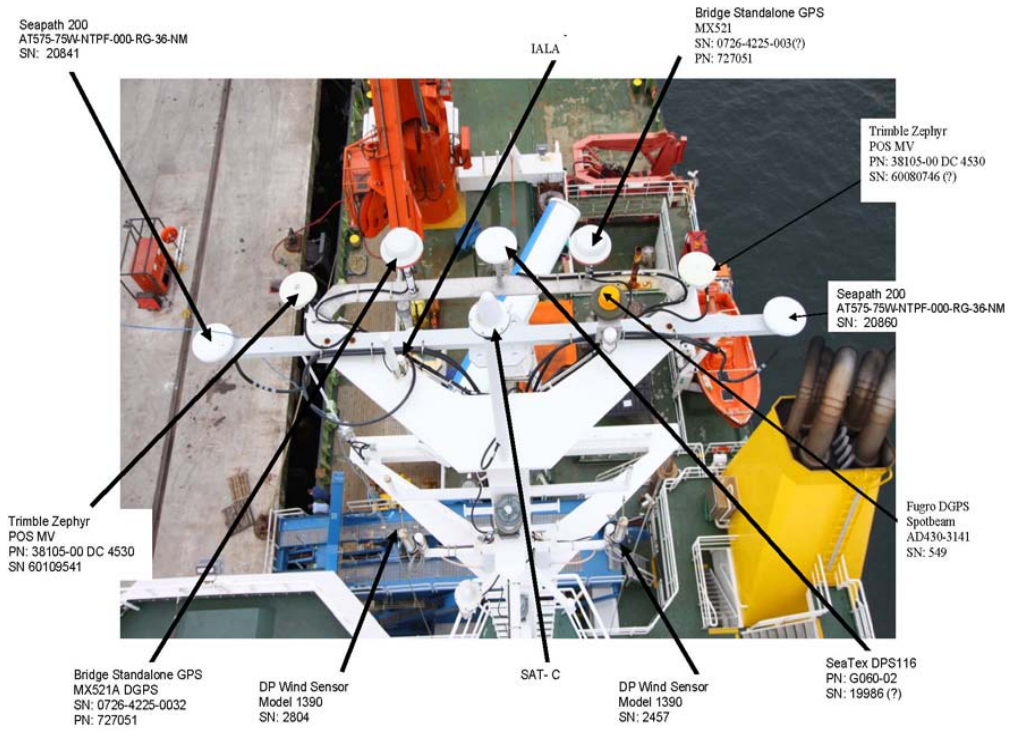


Figure 6.8 Picture of the antenna array on the bridge of the RRS *James Cook*

6.11.1. SeaTex DPS 116 DPS116

This DPS116 is a GPS system that was installed primarily to provide information for the ships DP system

We also receive an NMEA feed for ships use which we now receive an output from single GPGGA message which we record on the TECHSAS System.

The DPS 116 is located at the top of the ships Main mast.

6.11.2. Applanix POSMV System

The Ships primary GPS System for scientific data. The POSMV includes an intertial measurement unit capable of providing heading pitch and roll data to the bridge, logged by the techsas system and displayed in the main lab. The POSMV data is also used by the ADCP systems in order to account for ships motion.

The Applanix IMU is located at the ships centre point and is used as reference for all offsets for instruments on board the RRS James Cook The GPS antenna positions are held within the POSMV and the GPS position is corrected for the position of the MRU and so the GPS position that is recorded is the position of the MRU itself.

System Specifications

	Specification (With Differential Correction	During GPS Outages
Roll, Pitch Accuracy	0.02 º (1 sigma with GPS or DGPS	0.02 º
Heave Accuracy	5cm or 5% whichever is greater for periods of 20 seconds or less	5cm or 5% whichever is greater for wave periods of 20 seconds or less
Heading Accuracy	0.02 º with 2m antenna	Drift less than 1 º per

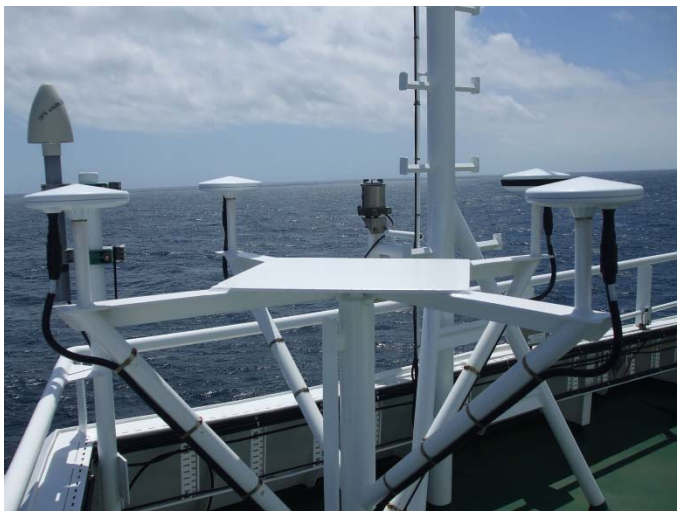
	baseline	hour (negligible for outages < 60 seconds)
Position Accuracy	0.5 – 2m (1 sigma) dependant on differential correction quality	Ddegredation 2.5m (1 sigma for outages < 30s) <6m (1 sigma for outages < 60s)
Velocity Accuracy	0.03 m/s horzontal	

6.11.3 ADU5

This is a four antenna GPS system that can produce attitude data from the relative positions of each antenna and is used to correct the VMADCP for ship motion. The antenna array is located on the port side of the ships monkey island.

The ADU-5 system worked reliably throughout the cruise.

The ADU-5 forms part of the bestnav system which is an assembly of multiple GPS signals including the gyronmea and emlog stream in order to calculate the best possible position, speed heading pitch and roll of the ship.



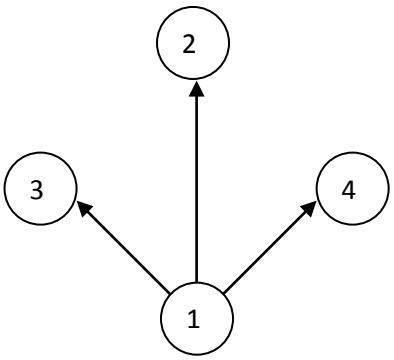


Figure 6.9. ADU5 Platform on the Starboard Side. Black surrounded Antenna indicates AFT. This is the primary antenna which sits behind all 3 other antennas.

ADU5 Offsets with reference to Antenna 1 (used internally by ADU5 for HPR Calculations

Vector	X(Right Positive)	Y(Forward Positive)	Z(Up Positive)
1-2	0.000	1.203	0.010
1-3	-0.599	0.600	0.010
1-4	0.597	0.598	0.012

Antenna Position on James Cook From MRU (0,0,0)

Antenna	X (Positive Starboard)	Y (Positive Forward)	Z (Positive Up)

6.11.4. Navigation problems

A number of problems relating to the ships navigational and scientific GPS were encountered during cruise JC042 and are discussed in this report. All problems related to the remoteness of the location and to the operation of the ship/science GPS units in a previously untested theatre. During processing of the GPS streams towards the end of the cruise it was noted that the POSMV wandered/was offset during science operations in comparison to the three other GPS systems fitted to the ship (ADU5, Seapath 200 and DPS116).

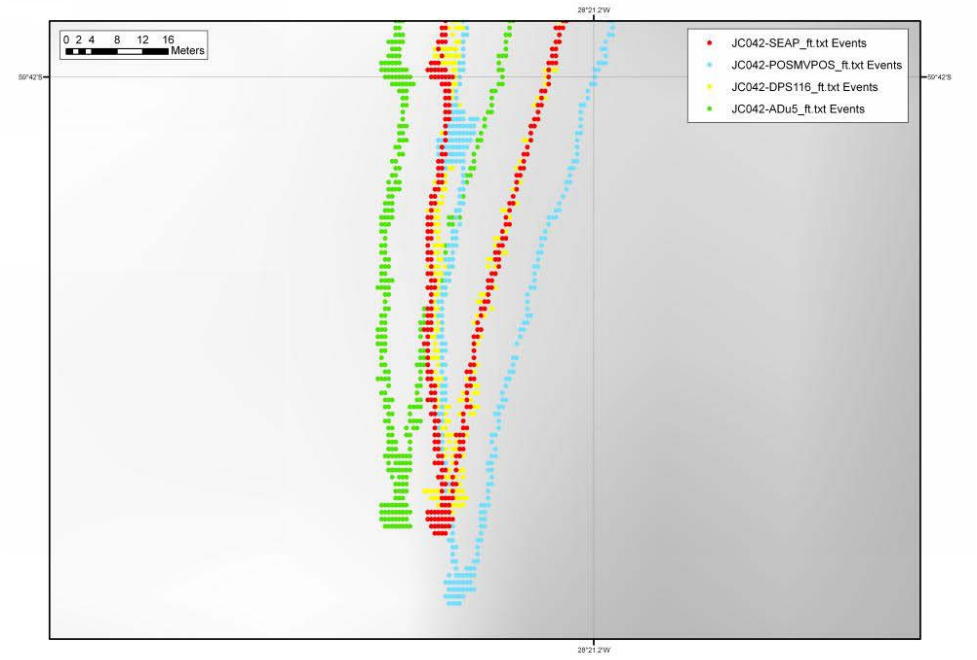


Figure 6.10 Example of GPS drift between navigation instruments.

When the vessel arrived in the vicinity of South Georgia there were considerable problems with the ships DPS116 system which kept getting dropouts owing to poor DGPS data.

These drop-outs not only caused significant problems with the ship holding station during operations (sometimes requiring manual operation of the ship), it also caused issues with tracking the ROV which uses the DPS116 NMEA input into the Fusion USBL sub sea tracking system.

These drop-outs meant it was increasingly difficult to track the ROV and for the ship to hold course during surveying. After consultation with the scientific party the USBL GPS feed was switched from the DPS116 to the POSMV system which was giving better GPS fixes and the survey continued, with the ship primarily using the Seapath 200 to hold station and the POSMV to display ship movements and ROV tracking using the Fusion system. However, alterations were later made to the setup in the sestar unit which receives DGPS corrections from reference stations

The seastar was reconfigured by the crew to ensure that good differential corrections were received at all times allowing the ship to hold station during ROV operations. To allow good DGPS, the Captain followed instructions from Fugro and the system was configured to use several DGPS stations although it does not usually require more than one reference station

These changes meant that the ship was mainly using a DGPS station located in Buenos Aires – some 3600 miles away. This would undoubtedly incur some degradation of the positional accuracy with international standards giving a figure of 0.22m per 100 miles (Around 8-9m). A reference station calculates differential corrections for its own location. These corrections can be received by UHF (when within 200km of land) or via satellite. Accuracy of DGPS decreases with distance from the reference station. The problem can be aggravated if the user and the station lack "inter visibility"—when they are unable to see the same satellites

Having multiple corrections and such distance reference stations caused a number of issues for the POSMV system. The seastar unit that receives these corrections only has one output port for corrections. As a result it sends the correction data via a serial line to a splitter located in the Bridge Electronics Space. The device splits the corrections which are theb distributed to each of the GPS systems onboard (with the exception of the ADU5). Each of the systems

receives exactly the same corrections as broadcast from the seastar. The POSMV is only able to operate with corrections from one DGPS station on a single port. The other systems can operate with corrections from multiple stations on a single port – choosing the best station.

This problem had not previously been encountered on any cruise. In all previous theatres the ship has been operating in close proximity to, or in a location where a single base station was used throughout the period of scientific operations. No requirement has yet existed for us (onboard RRS James Cook) to track an underwater object in 3000m with this degree of accuracy and in such a remote location. Owing to the remoteness of the location and the distance south, satellite coverage and tracking was also problematic and caused further problems with GPS tracking. Firstly, during periods of surveying high HDOP were encountered and this no doubt introduced errors. The HDOP was usually linked to a low number of satellites and this in most circumstances meant that the satellites we were seeing weren't enough to get corrections from BA and thus we changed to another reference station with a better level of commonality. When the number of satellites increased and the commonality between the ship and BA improved, corrections from the better station took preference.

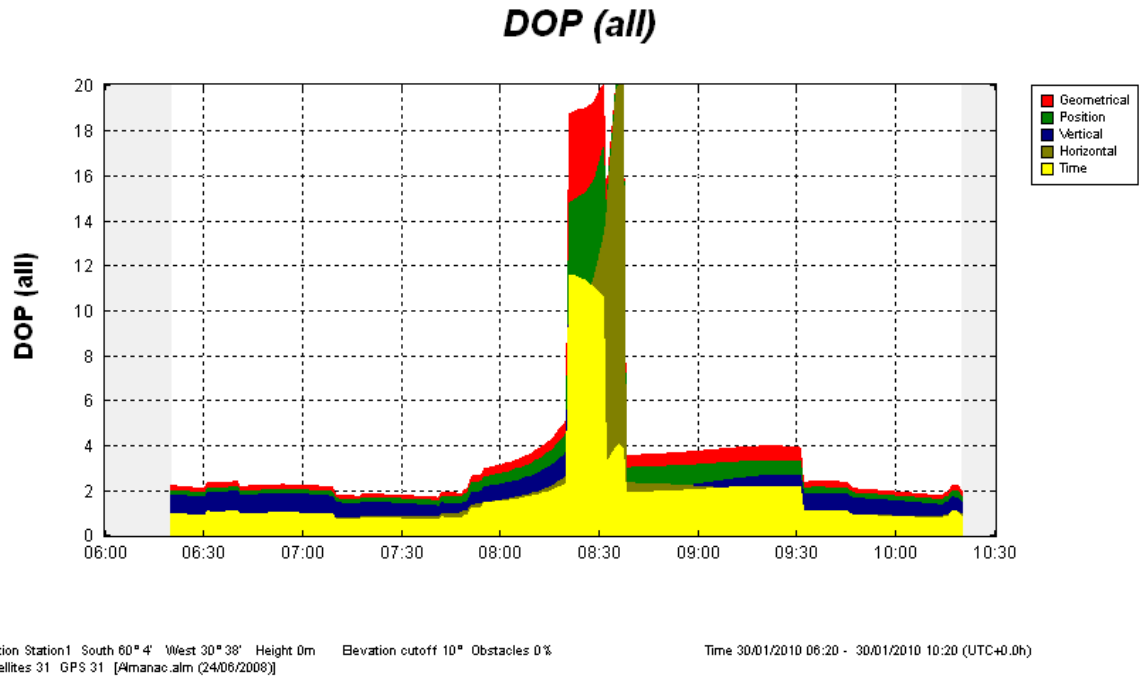


Figure 6.11. Example of large HDOP error encountered during JC042

The DPS116 and Seapath 200 systems are able to take into account the change in reference station. However, the POSMV just accepts the corrections and the jump between stations resulted in the POSMV being offset/wandering due to the different corrections being applied. With the exception of when we were operating off South Georgia the majority of these fixes were a constant offset from the other GPS (say a maximum of 10m).

Considering the problems with navigation Leighton Rolley proposed a number of actions post JC42 to improve navigation for subsequent cruise on the James Cook in the Southern Ocean.

- The POSMV is given a separate DGPS input. This would require an additional corrections unit being purchased.

- Closer consultation with our colleagues in the British Antarctic Survey to understand how they gain higher degrees of accuracy when operating in these areas and what reference stations they use.

- Due to the effect on Science GPS navigation, any changes to the seastar configuration must be relayed to the technician onboard.

- More frequent comparisons of GPS tracks especially in remote locations where reference stations are further away.

- It should be worth logging beam angle/range data from the USBL system. If the GPS input becomes useless. The beam angle/range data could potentially be used to deduce coordinates from a better GPS source

- Further consideration must be given to conducting survey during periods of high HDOP in these latitudes.

- Creation of an additional vehicle in Sonardyne Fusion system using another of the ship's GPS inputs to verify the science and ship GPS are producing the same outputs by watching them during subsea operations.

7.0 Acknowledgements

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8.0 References

Bachraty, C., Legendre, P. and D. Desbruyères (2009) Biogeographic relationships among deep-sea hydrothermal vents fauna at global scale. *Deep-Sea Research I* **56**: 1371-1378.

Benson, B., and D. Krause (1984) The concentration and isotopic fractionation of oxygen dissolved in fresh-water and seawater in equilibrium with the atmosphere. *Limnology and Oceanography* **29**: 620-632.

Campbell, K.A. (2006) Hydrocarbon seep and hydrothermal vent paleoenvironments and paleontology: Past developments and future research directions. *Palaeogeography, Palaeoclimatology and Palaeoecology* **232**: 362-407.

Clarke, A. (2008) Ecological stoichiometry in six species of Antarctic marine benthos. *Marine Ecology Progress Series* **369**: 25-37.

Cottin, D., Shillito, B., Chertemps, T., Thatje, S., Léger, N., and J. Ravaux (2010) Comparison of heat-shock responses between the hydrothermal vent shrimp *Rimicaris exoculata* and the related coastal shrimp *Palaemonetes varians. Journal of Experimental Marine Biology and Ecology* (in press).

Creasey, S. and A.D. Rogers (1999) Population genetics of bathyal and abyssal organisms. *Advances in Marine Biology* **35**: 1-151.

Desbruyères, D., Segonzac, M. and M. Bright (2006) *Handbook of Deep-Sea Hydrothermal Vent Fauna 2nd Edition*. Oberösterreichische Landesmuseen, Linz, Austria, 544pp.

German, C.R., Livermore, R.A., Baker, E.T., Bruguier, N.I., Connelly, D.P., Cunningham, A.P., Morris, P. Rouse, I.P., Statham, P.J. and P.A. Tyler (2000) Hydrothermal plumes above the East Scotia Ridge: an isolated high-latitude back-arc spreading centre. *Earth and Planetary Science Letters* **184**: 241-250.

Heilmeyer, O., Kohlber, G. and K. Beyer (2008) Cold Seep Bivalves. In: (ed. Gutt J) The Expedition ANTARKTIS-XXIII/8 of the Research Vessel "*Polarstern*" in 2006/2007. *Ber.*

Polarforsch. Meeresforsch. **569**: 80-81.

Karimi, R. And C.L. Folt (2006) Beyond macronutrients: element variability and multielement stochiometry in freshwater invertebrates. *Ecology Letters* **9**: 1273-1293.

Kiel, S. and C.T.S. Little (2006) Cold-seep mollusks are older than the general marine mollusk fauna. *Science* **313**: 1429-1431.

Klinkhammer, G.P., Chin, C.S., Keller, R.A., Dählmann, A., Sahling, H., Sarthou, G., Petersen, S., Smith, F. and C. Wilson (2001) Discovery of new hydrothermal vent sites in Bransfield Strait, Antarctica. *Earth and Planetary Science Letters* **193**: 395-407.

Krylova, E.M. and H. Sahling (in press) Vesicomyidae (Bivalvia): Current Taxonomy and Distribution. 19pp, 4 Fig

Linse, K. (2004) Scotia Arc deep-water bivalves: composition, distribution and relationship to the Antarctic shelf fauna. *Deep-Sea Research II* **51**: 1827–1837

Little, C.T.S. and R.C. Vrijenhoek (2003) Are hydrothermal vent animals living fossils? *Trends in Ecology and Evolution* **18**: 582-588.

MacPherson, E., Jones, W. and Segonzac, M. (2005) A new squat lobster family of Galatheioidea (Crustacea, Decapoda, Anomura) from the hydrothermal vents of the Pacific-Antarctic Ridge. *Zoosystema* **27**: 709-723.

McArthur, A.G., and V. Tunnicliffe (1998) Relics and antiquity revisited in the modern vent fauna. In: Mills, R.A., Harrison, K. (Eds.), *Modern Ocean Floor Processes and the Geological Record*. Geological Society, London.

Mironov, A.N., Gebruk, A.V. and L.I. Mosjalev (1998) Biogeography patterns of the hydrothermal vent fields: a comparison with non-vent biogeography. *Cahiers de Biologie Marine* **39**: 367–368.

Ravaux, J., Gaill, F., Le Bris, N., Sarradin, P.-M., Jollivet, D. B. And B. Shillito (2003) Heat-shock response and temperature resistance in the deep-sea vent shrimp *Rimicaris exoculata*, *Journal of Experimental Biology* **206**: 2345-2354.

Redfield, A.C. (1934). On the proportions of organic derivatives in seawater and their relation to the composition of plankton. In *James Johnstone Memorial Volume* (ed R.J. Daniel), pp. 176-192. Liverpool University Press, Liverpool, U.K.

Redfield, A.C. (1958) The biological control of chemical factors in the environment. *American Scientist* **46**: 205-221.

Rogachev K.A., Tishchenko P. YA., Pavlova G. Yu., Bychkov A.S., Carmack E. C., Chi Shing Wong and G.I. Yurasov (1996) The influence of fresh-core rings on the chemical concentrations (CO_2, PO_4, O_2, alkalinity, and pH) in the western subarctic Pacific Ocean", *Journal of Geophysical Research* **101**: 999-1010.

Shillito, B., Jollivet, D., Sarradin, P.-M., Rodier, P., Lallier, F., Desbuyères, D., and F. Gaill, (2001) Temperature resistance of *Hesiolyra bergi*, a polychaetous annelid living on deep-sea vent smoker walls. *Marine Ecology Progress Series* **216**: 141-149.

Sibuet, M. and K. Olu (1998) Biogeography, biodiversity and fluid dependence of deep-sea cold-seep communities at active and passive margins. *Deep-Sea Research II* **45**: 517-567.

Solorzano, "Determination of ammonia in natural waters by the phenolhypochlorite method", Limnology and Oceanography (1969), **14**, 799-801.

Spreen, G., Kaleschke, L. and G. Heygsler (2008) Sea ice remote sensing using AMSR-E 89 GHz channels. *Journal of Geophysical Research* DOI: 10.1029/2005JC003384

Sterner, R.W. and J.J. Elser (2002) *Ecological stoichiometry: the biology of elements from molecules to the biosphere* Princeton University Press, Princeton.

Thatje, S. and W.E. Arntz (2004) Antarctic reptant decapods: more than a myth? *Polar Biology* **27**: 195-201.

Tunnicliffe, V. (1997) Hydrothermal vents: a global system. In: *JAMSTEC Technical Reports: Deep Sea Research in Subduction Zones, Spreading Centers and Back Arc Basins*, pp105–114.

Tunnicliffe, V. and C.M.R. Fowler (1996) Influence of sea-floor spreading on the global hydrothermal vent fauna. *Nature* **379**: 531-533.

Tunnicliffe, V., McArthur, A.G. and D. McHugh (1998) A biogeographical perspective of the deep-sea hydrothermal vent fauna. *Advances in Marine Biology* **34**: 353–442.

Tyler, P.A., German, C.R., Ramirez-Llodra, E. and C.L. Van Dover (2003) Understanding the biogeography of chemosynthetic ecosystems. *Oceanologica Acta* **25**: 227-241.

Tyler, P.A. and C.M. Young (2003) Dispersal at hydrothermal vents: a summary of recent progress. *Hydrobiologia* **503**: 9-19.

Van Dover, C.L. (2003) *The Ecology of Deep-Sea Hydrothermal Vents*. Princeton University Press, Princeton, New Jersey, 424pp.

Van Dover, C.L., German, C.R., Speer, K.G., Parson, L.M. and R.C. Vrijenhoek (2002) Evolution and biogeography of deep-sea vent and seep invertebrates. *Science* **295**: 1253-1257.

Appendix A1 Summary data for CTDs

AREA	Latitude	Longitude	Date	Sample depths/bottles	Comments
Falklands Trough					
CTD 01	53°15.85	53°13.98	########	2000	Bottles filled at 2000m to clean them
South Georgia					
CTD 02	54°09.45	37°58.54	########	225/1-6 190/7-12	Suspected S. Georgia Gas hydrate site, 4 depths colected
E2					
CTD 03	56°05.303	30°19.129	########	2586/1-3 2574/4-6 2372/7-9 2277/10-12 1003/13-24	15 Niskin fired in triplicate at 5 distinct depths
CTD 04	56°05.324	30°19.074	########	2612/1-4 2506/5,6,11,12 2482/13-16 2349/17-20 995/21-24 No bottles 7-10	CTD with 2 SAPS on, one on frame and one 25m above.
CTD 05	56°05.325	30°19.10	########	2566/1-24 No bottles 7-10	CTD for microbiology. There was also a SAPS on for 3 hours
CTD 06	56°05.356	30°19.129	########	2263/1-21 2258/23-24 No bottles 7-10	CTD 06 is for microbiology, some samples taken for general geochemistry. SAPS on for 1 hours pumping

				Bottle 22 not firing	
CTD 07	56°05.315	30°19.09	########	2589/1-2	CTD 07 is an in plume distribution study. SAPS on for 2 hours.
				2612/3-4	
				2589/5-6,11-12	
				2600/13-16	
				2592/17-20	
				2587/21-24	
				No bottles 7-10	
				Bottle 22 not firing	
CTD 08	50°05.33	30°18.90	########	1000/1-24	CTD 08 is a 1000m background cast for microbiology
				Bottle 22 not firing	
E9					
CTD 09	60° 02.513	29°58.991	########	2100/1-6	CTD at the site of Shrimp find from last year, E9.
				7 not on rosette	
				2100/8-12	
				1500/13-24	
				Bottle 22 not firing	
CTD 10	60°02.593	28°58.921	########	2145/1-17	CTD over E9 for microbiology and geochemistry siderophore stability study
				1498/18-24	
				Bottle 22 not firing	
CTD 11	60°02.732	28°58.794	########	2242/1	CTD on E9 over suspected smoker with high Eh
				2145/2	
				2169/3	
				2119/4	
				2093/5	

				1994/6 2048/7 2000/8 1000/9-24 Missing 13-15,21,23 Bottle 22 not firing	
CTD 12	60°02.571	29°58.92	########	2270/1-24 No bottles 7-10 Bottle 22 not firing	CTD over E9 for microbiology in addition there was a SAPS on for 2 hours.
CTD 13	60°02.567	29°58.912	########	2300/1-24 Bottle 22 not firing	CTD over E9 over Black and White smoker to tie in with mini-niskins
CTD 14	60°02.905	29°58.895	########	2229/1-3 2303/4-6 2105/11-13 2352/14-16 1500/17-24 No bottles 7-10 Bottle 22 not firing	CTD over Ivory tower on E9, sampled in, below and above the BP full collection at the 3 depths then one background for Rachael James. SAPS for 2 hours
CTD 15	60° 02.563	29°58.894	########	2384/1-4 2344/5-9 2034/10-13 1984/14-17 1935/18-21 1873/23-24 Bottle 22 not firing	CTD at the Black and White smoker for in depth plume study for geochemistry.
McIntosh Caldera					
CTD 16-100	59°40.675	28°23.696	4-5/2/10	No samples taken	TowYo CTD over New crater area to locate plume.

CTD 101	59°41.867	28°21.096	########	1419/1-6 1414/11-16 1297/17-21,23-24 No bottles 7-10 Bottle 22 not firing	CTD over the Great Wall diffuse flow site, SAPS for 1 hour 10m above seafloor, then lowered to 5 m above for bottles, 10m above more bottles then in main plume.
CTD 102	59°41.667	28°21.095	########	1348/1-24 Bottle 22 not firing	CTD over Great wall for microbiology some support geochemical samples taken.
CTD 103	59°41.693	28°20.942	########	1390/1-4 1194/5-6,11-12 1054/13-14 957/15-18 695/19-24 No bottles 7-10 Bottle 22 not firing	CTD over Winter Palace, full plume study, SAPS ran for 2 hours in plume the CTD lowered and sampled all through plume

Appendix A2 Faunal samples

SAMPLE_ID	Ind	EVENT	No	PHYLUM	CLASS	ORDER	FAMILY	GENUS	SPECIES
JC42-F-0001	1	JC42-2		Crustacea	Malacostraca	Decapoda		Thymops	birsteini
JC42-F-0002	1	JC42-2		Echinodermata	Crinoidea				
JC42-F-0003	1	JC42-2		Echinodermata	Echinoidea	Spatangoida	Schizasteridae		
JC42-F-0004	28	JC42-2		Crustacea	Malacostraca	Amphipoda	Caprellidae		
JC42-F-0020	22	JC42-3-9	4	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0019	5	JC42-3-9	4	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0012	5	JC42-3-9	4	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0013	75	JC42-3-9	4	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0011	5	JC42-3-9	4	Cnidaria	Anthozoa			anemone	white
JC42-F-0016	10	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0017	10	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0018	20	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0015	20	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0014	5	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0076	5	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0079	5	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0071	~5	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0077	10	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, small
JC42-F-0070	5	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0075	5	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0060	10	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0061	10	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0062	10	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0064	6	JC42-3-9	12	Mollusca	Gastropoda	Muricoidea	Buccinidae?	"Pareuthria"-like	smooth, orange
JC42-F-0065	n/a	JC42-3-9	12	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0251	2	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, small
JC42-F-0271	24	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0066	4	JC42-3-9	12	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0091	5	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0090	5	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0095	1	JC42-3-9	12	Cnidaria	Anthozoa			anemone	white
JC42-F-0100	1	JC42-3-9	4	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, dactylus swollen
JC42-F-0082	7	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0080	1	JC42-3-9	12	Cnidaria	Anthozoa			anemone	white
JC42-F-0081	7 pieces	JC42-3-9	12	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0086	19	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0084	19	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0005	4	JC42-3-9	12	Crustacea	Malacostraca	Decapoda		Anomura larvae	white, eyeless
JC42-F-0006	2	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0008	1	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0007	7	JC42-3-9	12	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0010	5	JC42-3-9	12	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0009	23	JC42-3-9	12	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0033	7	JC42-3-9	12	Polychaeta	Sedentaria			Polychaet	white, small
JC42-F-0030	2	JC42-3-9	12	Polychaeta	Sedentaria			Polychaet	white, small
JC42-F-0035	1	JC42-3-9	12	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0036	3	JC42-3-9	12	Crustacea	Malacostraca	Decapoda		Anomura larvae	white, eyeless
JC42-F-0037	1	JC42-3-9	12	Crustacea	Malacostraca	Tanaideacea		Tani	white, slender
JC42-F-0039	1	JC42-3-9	12	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0032	1	JC42-3-9	12	Crustacea	Malacostraca	Decapoda		Embryo	

JC42-F-0034	2	JC42-3-13	portside biobox	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0031	5	JC42-3-13	starboard	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0040	14	JC42-3-13	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0022	3	JC42-3-13	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0028	2	JC42-3-13	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0038	6	JC42-3-13	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0027	2 chelae	JC42-3-13	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0021	3	JC42-3-13	green	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0029	26	JC42-3-13	starboard	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0024	2	JC42-3-13	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0025	8	JC42-3-13	starboard	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0026	rubble	JC42-3-13	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0050	2	JC42-3-13	blue	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0046	2	JC42-3-13	blue	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0041	rubble	JC42-3-13	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0045	13	JC42-3-13	green	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0047	6	JC42-3-13	green	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0042	rubble	JC42-3-13	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0044	rubble	JC42-3-13	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0059	rubble	JC42-3-13	portside biobox	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0056	1	JC42-3-13	basalt -07	?	?	?	?	?	?
JC42-F-0055	1	JC42-3-13	basalt -07	?	?	?	?	?	?
JC42-F-0051	1	JC42-3-13	basalt -07	?	?	?	?	?	?
JC42-F-0057	1	JC42-3-13	crab 8-F0040	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0052	5	JC42-3-13	blue	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0058	5	JC42-3-13	blue	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0121	1	JC42-3-15	starboard	Porifera	Demospongiea	Poecilosclerida	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0171	2	JC42-3-15	open box	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0113	5	JC42-3-15	black/blue	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0195	5	JC42-3-15	black/blue	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0124	65	JC42-3-15	black/blue	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0152	5	JC42-3-15	black/blue	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0127	3	JC42-3-15	black/blue	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0157	3	JC42-3-15	black/blue	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0137	1	JC42-3-15	black/blue	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0118	1	JC42-3-15	black/blue	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0139	1	JC42-3-15	black/blue	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0109	1	JC42-3-15	black/blue	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0119	1	JC42-3-15	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0180	1	JC42-3-15	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0132	35	JC42-3-15	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0185	6	JC42-3-15	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0170	12	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0160	15	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0166	45	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0101	45	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0123	45	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0122	10	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0144	5	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0112	5	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0138	5	JC42-3-15	yellow/green	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0117	4	JC42-3-15	yellow/green	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0102	rubble	JC42-3-15	yellow/green	n/a	n/a	n/a	n/a	n/a	n/a

JC42-F-0162	rubble	JC42-3-15	yellow/green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0104	rubble	JC42-3-15	yellow/green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0131	1	JC42-3-15	Trap 1	Crustacea	Malacostraca	Decapoda		shrimp Lebeus-type	sp. 1
JC42-F-0133	rubble	JC42-3-15	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0163	1	JC42-3-15	yellow/green	Polychaeta	Errantia			Polynoid	sp 1
JC42-F-0181	4	JC42-3-15	yellow/green	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0147	4	JC42-3-15	Trap 1	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0155	2	JC42-3-15	Trap 6	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0175	3	JC42-3-15	Trap 2	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0115	rubble	JC42-3-15	red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0125	sedimen t	JC42-3-15	scoop	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0140	2 rocks	JC42-3-15	scoop						
JC42-F-0105	3 rocks	JC42-3-15	scoop						
JC42-F-0130	217	JC42-3-15	green	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0116	107	JC42-3-15	green	Polychaeta	Sedentaria			Polychaet	white, small
JC42-F-0126	38	JC42-3-15	green	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0111	5	JC42-3-15	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0106	17	JC42-3-15	red	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0107	10	JC42-3-15	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0108	1	JC42-3-15	red	Polychaeta	Errantia			Polynoid	sp 1
JC42-F-0114	843	JC42-3-15	yellow/green	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0136	~many	JC42-3-15	yellow/green	Polychaeta	Sedentaria			Polychaet	white, small
JC42-F-0134	2	JC42-3-15	yellow/green	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0176	6	JC42-3-15	yellow/green	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	glossy
JC42-F-0186	1	JC42-3-15	yellow/green	?					
JC42-F-0190	3	JC42-3-15	yellow/green	Polychaeta	Sedentaria			Polychaet	tentacles
JC42-F-0145	2	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0129	4	JC42-3-17	starboard	Echinodermata	Brisingida	Brising	Freyellidae	Freyella	sp. Pink
JC42-F-0135	3	JC42-3-17	green	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0151	1	JC42-3-17	green	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0191	1	JC42-3-17	green	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0146	3	JC42-3-17	green	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0156	4	JC42-3-17	green	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0196	40	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0150	20	JC42-3-17	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0200	20	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0120	25	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0128	50	JC42-3-17	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0165	54	JC42-3-17	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0142	112	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0161	2	JC42-3-17	on brisingids	Nemertea				nemertean	pink
JC42-F-0201	rubble	JC42-3-17	red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0287	11	JC42-3-17	red	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0267	6	JC42-3-17	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0289	4	JC42-3-17	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0206	1	JC42-3-17	red	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	bulbious trunk
JC42-F-0211	1	JC42-3-17	yellow	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	thin trunk
JC42-F-0231	rubble	JC42-3-17	black	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0247	4	JC42-3-17	black	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0286	1	JC42-3-17	black	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0297	65	JC42-3-17	black	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0216	rubble	JC42-3-17	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0272	38	JC42-3-17	green	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green

JC42-F-0255	8	JC42-3-17	green	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0242	15	JC42-3-17	green	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0244	1	JC42-3-17	green	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white, small
JC42-F-0221	57	JC42-3-17	black	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0202	6	JC42-3-17	black	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0207	6	JC42-3-17	black	rocks					
JC42-F-0212	rubble	JC42-3-17	black	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0241	214	JC42-3-17	black	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0279	3	JC42-3-17	black	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0284	6	JC42-3-17	black	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0294	1	JC42-3-17	black	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0282	1	JC42-3-17	black	Crustacea	Copepoda?	Harpacticoida ?			small
JC42-F-0249	1	JC42-3-17	black	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white, small
JC42-F-0217	gravel	JC42-3-17	black	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0222	3	JC42-3-17	yellow	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0227	46	JC42-3-17	yellow	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0232	rubble	JC42-3-17	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0246	3	JC42-3-17	yellow	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0277	2	JC42-3-17	yellow	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	dark, medium
JC42-F-0292	146	JC42-3-17	yellow	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0266	1	JC42-3-17	yellow	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Carnivourus sponge	branched
JC42-F-0240	18	JC42-3-17	yellow	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white, small
JC42-F-0281	2	JC42-3-17	yellow	Crustacea	Ostracoda			Big carapace	white, smooth
JC42-F-0262	14	JC42-3-17	yellow	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0291	1	JC42-3-17	yellow	Porifera ?	Demospongie a	?	?	?	?
JC42-F-0296	3	JC42-3-17	yellow	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0235	1	JC42-3-17	red	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0234	2	JC42-3-17	trap 5	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0230	1	JC42-3-17	trap 4	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0229	1	JC42-3-17	trap 4	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0233	1	JC42-3-17	trap 5	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0228	1	JC42-3-17	trap 3	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0225	22	JC42-3-18	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0210	63	JC42-3-18	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0218	5	JC42-3-18	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0215	1	JC42-3-18	red	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0220	1	JC42-3-18	red	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	bulbious trunk
JC42-F-0219	2	JC42-3-18	starboard	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0213	rubble	JC42-3-18	red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0208	rubble	JC42-3-18	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0205	1	JC42-3-18	starboard	Crustacea	Malacostraca	Isopoda			sp. 1
JC42-F-0214	1	JC42-3-18	red	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0204	1	JC42-3-18	red	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0203	rubble	JC42-3-18	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0209	6	JC42-3-18	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0223	14	JC42-3-18	starboard	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0236	2	JC42-3-18	trap 5	Crustacea	Malacostraca	Decapoda		shrimp Lebeus-type	sp. 1
JC42-F-0480	Sven	JC42-4-7	starboard	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0304	10	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0299	5	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0254	6	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0259	5	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0245	Leigh	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0276	5	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1

JC42-F-0237	5	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0239	5	JC42-4-7	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0309	1	JC42-4-7	front	Crustacea	Malacostraca	Decapoda		shrimp Lebeus-type	white
JC42-F-0264	4	JC42-4-7	front	Cnidaria	Anthozoa			anemone	big
JC42-F-0252	2	JC42-4-7	front	Cnidaria	Anthozoa			anemone	big
JC42-F-0307	1	JC42-4-7	front	Crustacea	Malacostraca	Decapoda		Nematocarcinus	sp
JC42-F-0265	50	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0261	50	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0356	10	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0330	10	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0351	8	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0285	40	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0269	150	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0290	100	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0260	150	JC42-4-7	red	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0238	>100	JC42-4-7	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0280	>100	JC42-4-7	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0256	>100	JC42-4-7	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0257	6	JC42-4-7	red	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0300	>100	JC42-4-7	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0314	2	JC42-4-7	black	Crustacea	Malacostraca	Decapoda		Nematocarcinus	sp
JC42-F-0303	11	JC42-4-7	black	Crustacea	Malacostraca	Decapoda		Nematocarcinus	sp
JC42-F-0371	3	JC42-4-7	black	Echinodermata	Holothuroidea				spp
JC42-F-0349	1	JC42-4-7	black	Cnidaria	Octocorallia			stick	white
JC42-F-0364	1	JC42-4-7	black	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0295	4	JC42-4-7	blue	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	spp
JC42-F-0256	42	JC42-4-7	blue	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0275	2	JC42-4-7	blue	Porifera	Demospongiea	Poecilosclerida	Cladorhizidae	Abyssocladia-type	radiating
JC42-F-0275	sediment	JC42-4-7	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0339	1	JC42-4-7	green	Echinodermata	Asteroidea			5-armed starfish	big centre
JC42-F-0381	1	JC42-4-7	green	Echinodermata	Asteroidea			5-armed starfish	normal
JC42-F-0270	5	JC42-4-7	green	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0385	4	JC42-4-7	green	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0316	5	JC42-4-7	green	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0274	5	JC42-4-7	green	Crustacea	Copepoda?			Copepod	white
JC42-F-0346	rubble	JC42-4-7	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0465	2	JC42-4-7	green	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0495	1	JC42-4-7	green	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0357	35	JC42-4-7	yellow	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0340	25	JC42-4-7	yellow	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0306	10	JC42-4-7	yellow	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0336	20	JC42-4-7	yellow	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0369	many	JC42-4-7	yellow	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0359	rubble	JC42-4-7	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0344	4	JC42-4-7	yellow	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0321	2	JC42-4-7	yellow	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0331	Leigh	JC42-4-7	yellow	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0391	5	JC42-4-7	yellow	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0347	2	JC42-4-7	yellow	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0311	1	JC42-4-7	yellow	Worm-type	???	???	???	???	???
JC42-F-0330	10	JC42-4-7	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0390	many	JC42-4-7	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0327	10	JC42-4-7	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0324	many	JC42-4-7	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green

JC42-F-0301	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0396	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0302	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0352	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0365	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0318	10	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0332	40	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0350	Katrin	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0341	11	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0319	12	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0317	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0375	12	JC42-4-7	portside	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0320	3	JC42-4-7	portside	Cnidaria	Anthozoa			anemone	white-red
JC42-F-0315	rubble	JC42-4-7	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0425	16	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0437	2	JC42-4-7	portside	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0447	8	JC42-4-7	portside	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0496	2	JC42-4-7	portside	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	dark, medium
JC42-F-0489	1	JC42-4-7	portside	Crustacea	Malacostraca	Isopoda		isopod	white, small
JC42-F-0420	2	JC42-4-7	portside	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0408	many	JC42-4-7	portside	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	smooth
JC42-F-0329	83	JC42-4-8	front	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0313	155	JC42-4-8	black	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0355	many	JC42-4-8	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0365	100	JC42-4-8	black	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0386	20	JC42-4-8	black	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0342	1	JC42-4-8	starboard	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0362	rubble	JC42-4-8	front	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0431	4	JC42-4-8	front	Crustacea	Malacostraca	Isopoda		small	white
JC42-F-0401	14	JC42-4-8	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0481	2	JC42-4-8	front	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0486	1	JC42-4-8	front	???	???	???	???	???	???
JC42-F-0426	1	JC42-4-8	front	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white, small
JC42-F-0409	1	JC42-4-8	front	Mollusca	Gastropoda			"Littorinid"-type	orange
JC42-F-0464	1	JC42-4-8	front	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0474	1	JC42-4-8	front	Crustacea	Ostracoda			Ostracod	sp 2
JC42-F-0338	rubble	JC42-4-8	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0451	2	JC42-4-8	blue	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0500	11	JC42-4-8	blue	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0421	6	JC42-4-8	blue	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0439	1	JC42-4-8	blue	Cnidaria				anemone	white
JC42-F-0490	438	JC42-4-8	blue	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0450	11	JC42-4-8	blue	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0413	8	JC42-4-8	blue	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0436	1	JC42-4-8	blue	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white
JC42-F-0325	155	JC42-4-8	black	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0333	35	JC42-4-8	blue	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0328	35	JC42-4-8	black	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0335	8	JC42-4-8	black	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0354	many	JC42-4-8	black	Mollusca	Gastropoda				mix juveniles
JC42-F-0360	5	JC42-4-8	black	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0323	1	JC42-4-8	black	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	white, medium
JC42-F-0390	5	JC42-4-8	black	Mollusca	Gastropoda			Buccinid, smooth	orange

JC42-F-0337	many	JC42-4-8	black	Mollusca	Gastropoda				mix juveniles
JC42-F-0380	many	JC42-4-8	black	Mollusca	Gastropoda				mix juveniles
JC42-F-0312	20	JC42-4-8	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0376	50	JC42-4-8	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0345	10	JC42-4-8	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0326	52	JC42-4-8	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0334	2	JC42-4-8	starboard	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, rigid back
JC42-F-0366	2	JC42-4-8	starboard	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	small
JC42-F-0310	4	JC42-4-8	starboard	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0361	4	JC42-4-8	starboard	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	glossy pink
JC42-F-0471	3	JC42-4-8	starboard	mix					
JC42-F-0469	151	JC42-4-8	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0454	many	JC42-4-8	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0416	2	JC42-4-8	starboard	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	small
JC42-F-0443	many	JC42-4-8	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0405	sedimen t	JC42-4-8	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0417	915	JC42-4-8	starboard	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0476	many	JC42-4-8	starboard	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0456	6	JC42-4-8	starboard	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0452	9	JC42-4-8	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0497	1	JC42-4-8	starboard	Polychaeta	Sedentaria			Polychaet	green
JC42-F-0432	35	JC42-4-8	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0440	64	JC42-4-8	starboard	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0411	rubble	JC42-4-8	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0414	6			Mollusca	Gastropoda			Clione	sp
JC42-F-0461	many	JC42-4-10	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0403	1	JC42-4-10	blue	Echinodermata	Echinoidea			Sterechinus	sp
JC42-F-0433	4	JC42-4-10	trap E	Vertebrata				fish	
JC42-F-0479	3	JC42-4-10	trap D	Vertebrata				fish	
JC42-F-0430	2	JC42-4-10	black	Vertebrata				fish	
JC42-F-0459	many	JC42-4-10	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0477	13	JC42-4-10	starboard	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	small
JC42-F-0424	rubble	JC42-4-10	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0501	47	JC42-4-10	starboard	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0502	81	JC42-4-10	starboard	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0503	76	JC42-4-10	starboard	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0504	72	JC42-4-10	starboard	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0505	5	JC42-4-10	starboard	Polychaeta	Sedentaria			Polychaet	green
JC42-F-0506	2	JC42-4-10	starboard	Cnidaria				anemone	white
JC42-F-0507	1	JC42-4-10	starboard	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white
JC42-F-0418	many	JC42-4-10	trap E	Crustacea	Malacostraca	Amphipoda	Lysianassidae?		
JC42-F-0428	1	JC42-4-10	trap E	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0407	30	JC42-4-10	front	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	brown, big
JC42-F-0462	6	JC42-4-10	trap E	Echinodermata	Ophiuoidea			Odontaster?	
JC42-F-0434	rubble	JC42-4-10	front	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0508	15	JC42-4-10	front	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0509	13	JC42-4-10	front	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0510	37	JC42-4-10	front	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0511	11	JC42-4-10	front	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0512	1	JC42-4-10	front	Mollusca	Gastropoda	Trochoidea	Trochidae	Trochid	white
JC42-F-0422	many	JC42-4-10	front	Mollusca	Gastropoda	Vetigastropoda			eggs
JC42-F-0449	34	JC42-4-12	green	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0423	10	JC42-4-12	green	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1

JC42-F-0438	Leigh	JC42-4-12	portside	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0406	3	JC42-4-12	starboard	Echinodermata	Brisingida	Brising	Freyellidae	Freyella	sp. Pink
JC42-F-0410	1	JC42-4-12	starboard	Cnidaria	Octocorallia			big fat	beige
JC42-F-0457	rubble	JC42-4-12	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0515	4	JC42-4-12	blue	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	white, pink eyes
JC42-F-0516	11	JC42-4-12	blue	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0460	4	JC42-4-12	starboard	Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0419	1	JC42-4-12	blue	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0467	2	JC42-4-12	starboard	Echinodermata	Brisingida	Brising	Freyellidae	Freyella	sp. Pink
JC42-F-0472	1	JC42-4-12	starboard	Echinodermata	Asteroidea			5-armed seastar	cussion
JC42-F-0484	1	JC42-4-12	trap 3	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0482	5	JC42-4-12	trap 5	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0444	rubble	JC42-4-12	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0513	2	JC42-4-12	blue	Mollusca	Gastropoda	Vetigastropoda		"Meteuthria"-type	orange, spirals
JC42-F-0514	11	JC42-4-12	blue	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0402	30	JC42-4-12	portside	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1
JC42-F-0446	rubble	JC42-4-12	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0517	2	JC42-4-12	yellow	Polychaeta	Errantia	Polynoidae	Polynoidae	Polynoid	white
JC42-F-0518	2	JC42-4-12	yellow	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	sp 2
JC42-F-0519	25	JC42-4-12	yellow	Crustacea	Malacostraca	Decapoda	Galatheidae	Galatheid	sp. 1, larvae
JC42-F-0520	1	JC42-4-12	yellow	Crustacea	Malacostraca	Isopoda		isopod	white sp 1
JC42-F-0521	5	JC42-4-12	yellow	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0429	sedimen t	JC42-4-12	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0455	29	JC42-4-15	blue	Crustacea	Malacostraca	Decapoda		Nematocarcinus	sp
JC42-F-0487	3	JC42-4-15	green	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	thin trunk
JC42-F-0492	2	JC42-4-15	green	Arthropoda	Pycnogonida		Colossendeidae	Colossendeis-type	bulbious trunk
JC42-F-0441	9	JC42-4-15	yellow/black	Echinodermata	Ophiuoidea			Ophiuroid	sp 1
JC42-F-0427	5	JC42-4-15	red	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Abyssocladia-type	radiating
JC42-F-0404	1	JC42-4-15	green	Cnidaria				anemone	red, corn on cob
JC42-F-0491	4	JC42-4-15	yellow	Echinodermata	Holothuroidea				white, solid
JC42-F-0442	rubble	JC42-4-15	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0412	3	JC42-4-15	red	Porifera	Demospongie a	Poecilosclerid a	Cladorhizidae	Abyssocladia-type	radiating
JC42-F-0499	1	JC42-4-15	blue	Crustacea	Malacostraca	Decapoda		shrimp Lebeus-type	sp
JC42-F-0466	rubble	JC42-4-15	red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0522	2	JC42-4-15	red	Crustacea	Malacostraca	Amphipoda	Gammaridea	Gammarid	sp
JC42-F-0523	1	JC42-4-15	red	Polychaeta	Errantia	Polynoidae		polychaete	Nereis-type
JC42-F-0524	3	JC42-4-15	red	Mollusca	Gastropoda	Lepetodriloidea		limpet-like	brown-green
JC42-F-0525	1	JC42-4-15	red	Crustacea	Malacostraca	Isopoda		isopod	sp 2
JC42-F-0494	flock	JC42-4-15	starboard						
JC42-F-0435	flock	JC42-4-15	portside						
JC42-F-0572	2	JC42-5-4	starboard	Echinodermata	Asteroidea			Cushion star	big, orange
JC42-F-0589	1	JC42-5-4	suc	Mollusca	Chephalopoda			squid	red
JC42-F-0584	1	JC42-5-4	ISIS	Fish				Notolepis	annulata
JC42-F-0527	rubble	JC42-5-4	Suc	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0552	8	JC42-5-4	Suc	Mollusca	Gastropoda	Vetigastropod a	Pyropelatidae?	Pyropelta	medium
JC42-F-0566	10	JC42-5-4	Suc	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	pale
JC42-F-0595	36	JC42-5-4	Suc	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	pale
JC42-F-0592	20	JC42-5-4	Suc	Arthropoda	Pycnogonida		Ammotheidae	Pycnogonid	pale
JC42-F-0576	1	JC42-5-4	Suc	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0544	1	JC42-5-4	Suc	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0591	many	JC42-5-4	Suc	Polychaeta			Siboglinidae	Tubes	thin
JC42-F-0565	many	JC42-5-4	Suc	Polychaeta			Siboglinidae	Tubes	thin
JC42-F-0581	many	JC42-5-4	Suc	Polychaeta			Siboglinidae	Tubes	thin
JC42-F-0570	rubble	JC42-5-4	Suc	n/a	n/a	n/a	n/a	n/a	n/a

JC42-F-0541	20	JC42-5-4	Suc	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sulphur chimneys
JC42-F-0542	1	JC42-5-6	portside	Vertebrata				Humpackwhale	rip
JC42-F-0590	1	JC42-5-6	portside	Vertebrata				Humpackwhale	rip
JC42-F-0571	1	JC42-5-6	portside	Vertebrata				Humpackwhale	vertebrae
JC42-F-0549	1	JC42-5-6	portside	Vertebrata				Humpackwhale	vertebrae
JC42-F-0582	rubble	JC42-5-6	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0537	rubble	JC42-5-6	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0555	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0596	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0539	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0594	60	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0599	11	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0532	50	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0597	10	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0557	50	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp large
JC42-F-0574	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0580	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0554	bone cuts	JC42-5-6	portside	Vertebrata				Humpackwhale	bone
JC42-F-0603	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0628	25	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0633	25	JC42-5-6	portside	Polychaeta				polychaetes	small, brown
JC42-F-0623	25	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp large
JC42-F-0624	1	JC42-5-6	portside	Polychaeta				Osedax	sp
JC42-F-0526	5	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0575	5	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0530	10	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0535	10	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0585	5	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0600	57	JC42-5-6	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0587	10	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0586	10	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0559	10	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0534	38	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0569	23	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0562	100	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0531	100	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0540	110	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0579	100	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0545	60	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0618	60	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0602	6	JC42-5-6	portside	Polychaeta				Osedax	sp
JC42-F-0694	10	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0654	many	JC42-5-6	portside	Polychaeta	Errantia			polychaetes	small, brown
JC42-F-0695	38	JC42-5-6	portside	Crustacea	Malacostraca	Isopoda		isopod	sp 3
JC42-F-0680	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0682	many	JC42-5-6	portside	Crustacea	Malacostraca	Amphipoda		Lysianassidae	spp
JC42-F-0547	many	JC42-5-6	T-probe holder	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0649	5	JC42-5-9	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0681	5	JC42-5-9	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0669	5	JC42-5-9	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0700	rubble	JC42-5-9	front	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0619	11	JC42-5-9	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0674	10	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0529	15	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropod	Pyropelatidae?	Pyropelta	medium

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JC42-F-0634	15	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0687	20	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0626	32	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0636	many	JC42-5-9	front	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0644	5	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0664	5	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0631	5	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0615	35	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0671	3	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0641	rubble	JC42-5-9	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0675	rubble	JC42-5-9	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0536	many	JC42-5-9	starboard	Polychaeta				polychaetes	spp
JC42-F-0609	1	JC42-5-9	starboard	Mollusca	Bivalvia		Thyasiridae	Thyasira	sp big
JC42-F-0697	1	JC42-5-9	starboard	Echinodermata	Asteroidea			7-armed seastar	pink (8 arms)
JC42-F-0605	5	JC42-5-9	portside	Porifera	Demospongiea			sponge	soft
JC42-F-0696	5	JC42-5-9	portside	Porifera	Demospongiea			sponge	soft
JC42-F-0686	rock	JC42-5-9	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0661	many	JC42-5-9	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0632	rubble	JC42-5-9	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0650	2	JC42-5-9	portside	Polychaeta				tube worm	sp
JC42-F-0642	10	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0637	10	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0656	30	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0611	110	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0691	150	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0606	30	JC42-5-9	blue & red	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 2 raised
JC42-F-0614	30	JC42-5-9	blue & red	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0678	rubble	JC42-5-9	blue & red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0673	rubble	JC42-5-9	blue & red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0639	rubble	JC42-5-9	blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0660	12	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0662	rubble	JC42-5-9	blue & red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0627	rubble	JC42-5-9	red	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0620	140	JC42-5-9	blue & red	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0685	1	JC42-5-9	blue & red	Mollusca	Gastropoda	Vetigastropoda		Gastropod	beige
JC42-F-0689	51	JC42-5-9	blue & red	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0659	15	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0577	15	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0564	30	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0647	80	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0677	100	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0616	10	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0657	10	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0609	1	JC42-5-9	black	Mollusca	Bivalvia		Thyasiridae	Thyasira	sp big
JC42-F-0652	rubble	JC42-5-9	black	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0672	9	JC42-5-9	black	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0621	1	JC42-5-9	black	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light
JC42-F-0666	1	JC42-5-9	black	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0556	10	JC42-5-9	black	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0560	3	JC42-5-9	green	mix 2 fish, 1 ?					
JC42-F-0643	rubble	JC42-5-9	green	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0625	2	JC42-5-9	yellow	Crustacea	Cirripedia	Scalpellomorpha		stalked barnacle	light

JC42-F-0655	40	JC42-5-9	yellow	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 3 sulphur
JC42-F-0679	15	JC42-5-9	yellow	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 3 sulphur
JC42-F-0635	10	JC42-5-9	yellow	Mollusca	Gastropoda	Vetigastropoda	Lepetodrillidae?	Lepetodrillus	sp. 3 sulphur
JC42-F-0630	rubble	JC42-5-9	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0612	rubble	JC42-5-9	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0646	rubble	JC42-5-9	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0622	rubble	JC42-5-9	yellow	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0683	3	JC42-5-9	green	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0699	12	JC42-5-9	blue & red	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0604	24	JC42-5-9	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0601	39	JC42-5-9	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0667	rock	JC42-5-9	front	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0617	1	JC42-5-9	front	Mollusca	Bivalvia		Thyasiridae	Thyasira	sp big
JC42-F-0690	many	JC42-5-11	portside	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0790	1	JC42-5-11	portside	Polychaeta				polychaetes	bamboo
JC42-F-0713	rubble	JC42-5-11	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0797	rubble	JC42-5-11	portside	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0718	many	JC42-5-11	portside	Polychaeta				polychaetes	spp
JC42-F-0794	145	JC42-5-11	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0711	138	JC42-5-11	portside	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0728	52	JC42-5-11	portside	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0704	52	JC42-5-11	portside	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0607	rubble	JC42-5-11	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0706	30	JC42-5-11	starboard	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0676	5	JC42-5-11	starboard	Cnidaria				anemone	large, dark red
JC42-F-0663	4	JC42-5-11	starboard	Cnidaria				anemone	large, dark red
JC42-F-0658	12	JC42-5-11	starboard	Cnidaria				anemone	large, dark red
JC42-F-0651	?	JC42-5-11	starboard	Polychaeta			Siboglinidae	polychaetes	spp
JC42-F-0645	?	JC42-5-11	starboard	Polychaeta			Siboglinidae	polychaetes	spp
JC42-F-0640	rubble	JC42-5-11	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0684	1	JC42-5-11	green	Mollusca	Cephalopoda			squid	sp
JC42-F-0775	2	JC42-5-11	trap 6	2 pycno, 3 Pyropelta					
JC42-F-0705	8	JC42-5-11	trap 5	8 pycno, 1 eaten fish					
JC42-F-0629	10	JC42-5-11	red/black/blue	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0670	10	JC42-5-11	red/black/blue	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0638	30	JC42-5-11	red/black/blue	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0665	80	JC42-5-11	red/black/blue	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0613	70	JC42-5-11	red/black/blue	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0640	1	JC42-5-11	red/black/blue	Echinodermata	Holothuroidea			Psolus	pink
JC42-F-0668	rubble	JC42-5-11	red/black/blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0608	rubble	JC42-5-11	red/black/blue	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0730	5	JC42-5-13	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0800	62	JC42-5-13	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0739	6	JC42-5-13	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0714	9	JC42-5-13	front	Mollusca	Gastropoda	Vetigastropoda	Pyropelatidae?	Pyropelta	medium
JC42-F-0744	5	JC42-5-13	front	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0772	1	JC42-5-13	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0719	2	JC42-5-13	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0777	3	JC42-5-13	starboard	Mollusca	Bivalvia		Thyasiridae	Thyasira	sp big
JC42-F-0733	4	JC42-5-13	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0764	rubble	JC42-5-13	starboard	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0723	many	JC42-5-13	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0782	5	JC42-5-13	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp

JC42-F-0785	1	JC42-5-13	front	Vertebrata				Humpackwhale	vertebrae
JC42-F-0789	3	JC42-5-13	front	Polychaeta				Osedax	sp
JC42-F-0799	4	JC42-5-13	front	Polychaeta				Osedax	sp
JC42-F-0795	bits	JC42-5-13	slurp	Polychaeta			Siboglinidae	polychaetes	spp
JC42-F-0715	1	JC42-5-13	slurp	Fish				Notolepis	annulata
JC42-F-0720	bits	JC42-5-13	slurp	Polychaeta			Siboglinidae	polychaetes	spp
JC42-F-0725	many	JC42-5-13	slurp	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0724	3	JC42-5-13	slurp	Porifera	Demospongie a			sponge	soft
JC42-F-0734	rubble	JC42-5-13	slurp	n/a	n/a	n/a	n/a	n/a	n/a
JC42-F-0703	23	JC42-5-13	portside	Cnidaria				anemone	large, dark red
JC42-F-0749	1	JC42-5-15		Polychaeta	Errantia		Polynoidae	Polynoid	big
JC42-F-0759	7	JC42-5-15		Crustacea	Decapoda			shrimp Lebeus-type	sp
JC42-F-0791	3	JC42-5-15		Echinodermata	Echinoidea			Sterechinus	sp
JC42-F-0786	3	JC42-5-15		Echinodermata	Echinoidea			Sterechinus	sp
JC42-F-0707	1	JC42-5-15		Echinodermata	Echinoidea			Cidaroid	white
JC42-F-0769	1	JC42-5-15		Mollusca	Chephalopoda			squid	sp
JC42-F-0787	27	JC42-5-15		Crustacea	Decapoda			Nematocarcinu s	sp
JC42-F-0741	5	JC42-5-15		Cnidaria				soft corals	feathered
JC42-F-0771	many	JC42-5-15		Echinodermata	Ophiuoidea			Ophiuroid	white-ish
JC42-F-0721	5	JC42-5-15		Echinodermata	Ophiuoidea			Ophiuroid	white-ish
JC42-F-0766	5	JC42-5-15		Echinodermata	Ophiuoidea			Ophiuroid	white-ish
JC42-F-0708	5	JC42-5-15		Echinodermata	Ophiuoidea			Ophiuroid	white-ish
JC42-F-0795	1	JC42-5-15		Polychaeta	Errantia			polychaet	sp
JC42-F-0738	1	JC42-5-15		Echinodermata	Ophiuoidea			Ophiuroid	pink, feathered arms
JC42-F-0756	1	JC42-5-15		Cnidaria	Anthozoa			Umbellula	sp
JC42-F-0796	1	JC42-5-15		Cnidaria	Hydrozoa			Hydrozoa	feather-like
JC42-F-0740	1	JC42-5-15		Cnidaria	Octocorallia	Alcyonacea		Alcyonacea	purple
JC42-F-0716	1	JC42-5-15		Cnidaria	Octocorallia	Alcyonacea		Alcyonacea	purple
JC42-F-0751	3	JC42-5-15		Echinodermata	Holothuroidea			Psolus	sp
JC42-F-0779	2	JC42-5-15		Echinodermata	Holothuroidea			Psolus	sp
JC42-F-0755	1	JC42-5-15		Echinodermata	Asteroidea			7-armed seastar	pink
JC42-F-0761	2	JC42-5-15		Chordata	Ascidiacea			Ascidin	white
JC42-F-0746	2	JC42-5-15		Chordata	Ascidiacea			Synascidian	white, on rock
JC42-F-0760	2	JC42-5-15		Arthropoda	Pycnogonida			Pycnogonid	white, thin legs
JC42-F-0765	2	JC42-5-15		Echinodermata	Asteroidea			Cushion star	big, orange
JC42-F-0770	1	JC42-5-15		Fish				Notolepis	annulata
JC42-F-0702	1	JC42-5-15		Cnidaria				anemone	red, corn on cob
JC42-F-0722	1	JC42-5-15		Echinodermata	Asteroidea	Brisingida		Freyella	dark orange
JC42-F-0750	1	JC42-5-15		Echinodermata	Asteroidea	Brisingida		Freyella	dark orange
JC42-F-0780	1	JC42-5-15		Echinodermata	Asteroidea	Brisingida		Freyella	light orange
JC42-F-0736	2	JC42-5-15		Echinodermata	Holothuroidea			Bathypoltes?	pinkish
JC42-F-0776	3	JC42-5-15		Echinodermata	Holothuroidea			holothurian	dark purple spots
JC42-F-0731	1	JC42-5-15		Polychaeta			Polynoidae	Polynoid	sp
JC42-F-0752	1	JC42-5-15		Crustacea	Malacostraca	Isopoda		Natatolana	sp
JC42-F-0729	1	JC42-5-15		Echinodermata	Asteroidea			starfish	white, hard
JC42-F-0784	1	JC42-5-15		Echinodermata	Asteroidea			Cushion star	small, pink
JC42-F-0701	1	JC42-5-15		Polychaeta				Ophilia-type	pink, smellie
JC42-F-0732	1	JC42-5-15		Sipunculida				sip[unculid	small
JC42-F-0762	1	JC42-5-15		Polychaeta	Sedentaria			Ophilia-type	pink, smellie
JC42-F-0781	1	JC42-5-15		Polychaeta				tube worm	brown
JC42-F-0774	1	JC42-5-15		Polychaeta	Errantia		Polynoidae	polynoid	dark puple
JC42-F-737	11	JC42-5-17	starboard	Mollusca	Bivalvia	Veneroida	Vesicomyidae	Calyptogena	sp
JC42-F-0717	1	JC42-5-17	slurp	Echinodermata	Crinoidea			Promatochrinus	sp
JC42-F-0712	5	JC42-5-17	slurp	Crustacea	Malacostraca	Isopoda		isopod	sp 5

JC42-F-0726	5	JC42-5-17	slurp	Arthropoda	Pycnogonida			Pycnogonid	white, thin legs
JC42-F-0727	1	JC42-5-17	slurp	Crustacea	Decapoda			Nematocarcinus	sp
JC42-F-0757	1	JC42-5-17	slurp	Polychaeta			Polynoidae	Polynoid	sp
JC42-F-0754	2	JC42-5-17	slurp	Echinodermata	Asteroidea			7-armed seastar	pink (8 arms)
JC42-F-0742	3	JC42-5-17	slurp	Arthropoda	Pycnogonida			Pycnogonid	white, thin legs
JC42-F-0747	10	JC42-5-17	slurp	Polychaeta			Siboglinidae	polychaetes	sp
JC42-F-0801	many	JC42-5-17	slurp	Polychaeta				polychaetes	spp
JC42-F-0802	3	JC42-5-17	slurp	Crustacea	Malacostraca	Isopoda		isopods	spp
JC42-F-0803	5	JC42-5-17	slurp	Arthropoda	Pycnogonida			Pycnogonid	spp
JC42-F-0804	1	JC42-5-17	slurp	Crustacea	Malacostraca	Isopoda		isopod	spikey
JC42-F-0805	1	JC42-5-19	trap	Crustacea	Malacostraca	Isopoda		isopod	large
JC42-F-0806	1	JC42-5-19	trap	Vertebrata	Pisces		Macrouridae	Macrourid	sp
JC42-F-0807	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-0808	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-0809	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-08010	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-0811	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-0812	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	large white
JC42-F-0813	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	spp mixed
JC42-F-0814	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	spp mixed
JC42-F-0815	many	JC42-5-19	trap	Crustacea	Malacostraca	Amphipoda		Amphipod	spp mixed

Appendix A3

Typical EM120 and SBP120 Parameter Settings

(1) EM120 Acquisition Parameters

Ping Mode: Auto
Sector Coverage
Max Port Angle: 45–68°
Max Starboard Angle: 45–68°
Angular Coverage: Auto or specified
Beam Spacing: Equidistant
Pitch stabilization: On
Yaw stabilization: On
Min Depth: used to constrain depth or using chirp Tx on fixed cycle
Max Depth: used to constrain depth or using chirp Tx on fixed cycle
Sound Speed Profile
Current Sound Profile: JC042*.svp
Sound Speed at Transducer:
From: Profile
Filtering
Spike Filter Strength: Medium or Strong
Aeration: On
Sector Tracking: On
Slope: On
Interference: Off
Range Gate: Normal
Absorption Coefficient
Absorption (dB/km): 1.00
Seabed Imaging
TVG Crossover (deg) 6

(2) SBP Acquisition Parameters – taken from 'SBP120trials' settings file on the *JC*

The SBP120 was used in linear 'chirp' transmission mode throughout the cruise.

Source

Level: <80%

Ping interval: 0 ms (enables external, SSU trigger)

Pulseform: Linear Chirp

Sweep low frequency (Hz): 2500 Sweep high frequency (Hz): 7000

Length (ms): 40

Acquisition Menu

Speed of sound (m/s): 1498 (average)

Sample rate: 20000 Hz

Trace length (ms): 400

Gain: AGC

Filter: 1.00 kHz

Delay: External

Processing Menu

Filter: Matched (Auto)

TVG: OFF

Dereverb: OFF

Automatic Gain Control: ON

Window length: 20%

Amp. Scaling: 100%

Bottom Tracker: ON

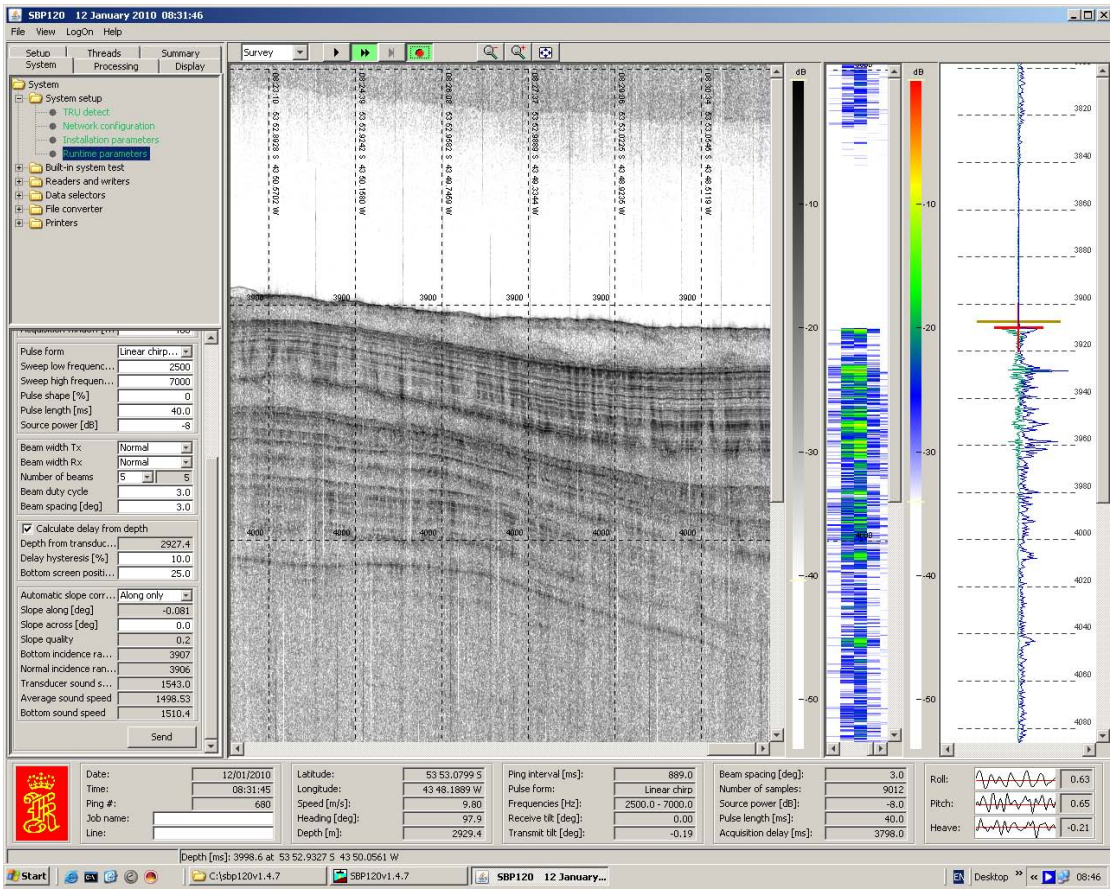
Gain correction: ON

Attribute: INST.AMP

LOG/Replay Menu

File size (Mb): 75

Raw data filter: Bandpass



(above) screenshot from the SBP120 showing data quality, and basic acquisition parameters.

Appendix A4 CTD Samples

CTD Cast

CTD 02			
Niskin Number	Sample No.	Depth (m)	CH_4 (nM)
1	1	225	50.53
1	2	225	48.35
1	3	225	41.50
1	4	225	48.57
1	5	225	44.35
12	7	190	43.47
12	8	190	43.55
12	9	190	48.92
12	10	190	45.82
12	11	190	41.40
12	12	190	48.48

CTD 03			
Niskin Number	Sample No.	Depth (m)	CH_4 (nM)
1	1	2586	11.54
1	1	2586	10.88
4	4	2574	16.53
4	4	2574	14.77
5	5	2586	14.42
5	5	2586	11.92
7	7	2574	17.63
7	7	2574	15.11
8	8	2372	6.41
8	8	2372	7.32
9	9	2277	5.45
9	9	2277	7.34
10	10	2372	4.69
10	10	2372	6.74
12	12	2277	5.38
12	12	2277	6.71
13	13	1000	14.70
13	13	1000	5.47

14	14	1000	5.09
14	14	1000	5.70
15	15	2574	13.64
15	15	2574	12.87
23	23	2574	12.54
23	23	2574	12.14

CTD 04

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	1	2612	9.73
1	4	2612	8.90
1	5	2612	9.68
6	7	2506	4.28
6	10	2506	2.76
6	9	2506	2.40
13	12	2482	2.57
13	14	2482	3.79
13	15	2482	3.84
17	17	2349	2.97
17	18	2349	9.69
17	19	2349	2.09
23	20	995	3.93
23	21	995	3.93
23	22	995	4.55

CTD 05

Niskin number	sample No.	Depth	CH_4 (nM)
1	11	2566	11.25
1	39	2566	12.47
1	29	2566	13.28

CTD 06

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
19	11	2263	5.35
19	39	2263	3.56

19	29	2263	3.61
CTD 07			
Niskin number	Sample No.	Depth (m)	CH4 (nM)
2	2	2589.00	2.37
2	2	2589.00	2.5
2	2	2589.00	2.78
11	11	2612.00	3.42
11	11	2612.00	3.09
11	11	2612.00	3.19
13	13	2600.00	5.61
13	13	2600.00	2.99
13	13	2600.00	3.66
17	17	2592.00	2.42
17	17	2592.00	3.06
17	17	2592.00	4.38

CTD 08
All for microbiology no samples taken

CTD 09

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	49	2100	6.91
1	50	2100	13.32
1	47	2100	11.69
1	48	2100	10.78

CTD 10

Niskin number	sample No.	Depth (m)	CH_4 (nM)
18	46	2100	15.80
18	45	2100	5.67
11	21	2100	6.11
11	44	2100	4.36

CTD 11

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	46	2242	1.82
1	47	2242	3.50
2	18	2145	1.96
2	48	2145	2.45
3	4	2169	1.92
3	37	2169	0.00
5	20	2093	1.84
5	1	2093	1.81
6	25	1994	2.38
6	34	1994	1.90
7	7	2048	2.18

CTD 13

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
23	46	2300	19.6
23	7	2300	17.8
23	25	2300	18.5

CTD 14

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	38	2229	3.48
1	9	2229	2.45
1	3	2229	2.56
4	24	2303	2.71
4	18	2303	3.53
4	15	2303	3.21
11	11	2105	1.69
11	31	2105	2.78
11	33	2105	2.88
14	35	2352	0.85
14	45	2352	3.59
14	27	2352	2.42

CTD 15

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	30	2384	10.00
1	21	2384	10.08
7	18	2034	2.58
7	38	2034	3.20
10	11	2034	3.66
10	15	2034	3.58
14	33	1984	2.08
14	24	1984	2.35
18	31	1934	0.83
18	45	1934	2.12
24	28	1873	3.29
24	34	1873	2.59

CTD 101

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	21	1419	3.53
11	39	1414	2.77
17	36	1297	3.36

2 more from each depth collected and stored

CTD 102

3 samples collected from 1348m stored for NOC analysis

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1	3, 15, 48	1348	

CTD
103
Samples colected and stored for NOC analysis

Niskin number	Sample No.	Depth (m)	CH_4 (nM)
1390	43, 4, 50	1390	1390.00
1194	40, AA, CC	1194	1194
1054	BB, 42, 27	1054	1054
957	41, 47, 23	957	957
695	29, 32, 35	695	695

Total Geochemical Samples Collected on JC42

	CTD Cast	Firing positions	Methane	DIC	DOC	CSV	Trace metals	Isolute columns	Filters	Comments
S.Georgia	02	4	11							
	03	5	24	8	5	10	5	9	10	
	04	5	15	7	5	10	5	4	10	no methane or DIC for 2 firing positions
E2	05	1	3	1	1		1		1	
	06	2	3	1	1	2	1	1	2	Microbiology support
	07	4	12	4	4	8	4	4	8	Microbiology support
	08			1	1		1			
	09	1	4							Microbiology support
	10	2	4	1	2	4	2	8	8	
E9	11	6	11							
	12	1	2	1	2		1	1	1	
	13	1	3	2	1	2	1	1	2	
	14	4	12	4	4	6	3	4	6	
	15	6	12	12	6	12	6	6	12	
MC	101	3	9	3	3	6	3	3	6	
	102	1	3	1	1	1	1			
	103	5	15	4	5	5	5	5	8	
			132	**50**	**41**	**66**	**39**	**46**	**74**	**448**

Appendix A5 Summary of Video / DVD Media

JC42 recording media usage

Isis dive #	HDV	DVCAM	DVD	
124	8	6	10	
125	16	8	18	
126	12	6	12	
127				no dive 127 folder
128	24	12	36	
129	12	6	20	
130	24	12	27	
131	12	6	18	
132				not recorded on electronic version of overview sheet; no electronic video record sheet
133	16	8	15	
134	24	12	24	
135	24	12	24	
136	4	2	6	no electronic overview sheet, or video record sheet
137				electronic overview sheet is BS; this dive aborted during descent
138	28	14	30	
139	24	12	33	
140	32	16	36	
141	16	8	15	
142	20	10	21	
143				no dive folder
144	12	6	12	
145	8	4	12	
146	8	4	9	
147	36	18	42	
148	32	16	52	
149	20	10	24	
150	16	8	18	
151	20	10	21	
152	20	10	21	
153	12	6	15	
154	8	4	6	
TOTALS	**488**	**246**	**577**	

Appendix 6 Summary Dive Statistics

JC42 bottom time

Isis dive #	arrive	leave	date	site	approx depth	bottom time (mins)
124	14:57	16:45	10/01/2010	test dive	2600	108
125	00:39	10:29	14/01/2010	S Georgia	250	590
126	02:17	07:18	16/01/2010	E2	2600	301
127				E2	2600	
128	22:04	11:43	17-18/01/2010	E2	2600	819
129	22:23	06:07	18-19/01/2010	E2	2600	464
130	19:16	08:01	19-20/01/2010	E2	2600	765
131	19:37	02:42	20-21/01/2010	E2	2600	435
132	05:23	22:23	22/01/2010	E2	2600	1020
133	10:44	19:04	23/01/2010	E2	2600	500
134	04:16	16:42	24/01/2010	E2	2600	716
135	00:36	09:51	25/01/2010	E2	2600	555
136	00:39	01:25	26/01/2010	E2	2600	46
137				E9	2400	
138	12:58	06:07	27-28/01/2010	E9	2400	1029
139	14:31	04:39	28-29/01/2010	E9	2400	848
140	14:00	11:50	29-30/01/2010	E9	2400	1190
141	18:00	22:22	30/01/2010	E9	2400	262
142	18:43	06:52	01-02/02/2010	E9	2400	729
143				E9	2400	
144	16:29	22:54	02/02/2010	E9	2400	385
145	11:45	05:59	03-04/02/2010	E9	2400	1094
146	11:45	13:13	04/02/2010	E9	2400	88
147	11:45	23:46	05/02/2010	Caldera	1400	721
148	07:50	06:15	07-08/02/2010	Caldera	1400	1345
149	13:36	03:33	08-09/02/2010	Caldera	1400	837
150	10:05	22:21	09/02/2010	Caldera	1400	736
151	05:53	17:58	10/02/2010	Caldera	1400	725
152	22:55	11:04	10-11/02/2010	Caldera	1400	729
153	15:05	22:30	11/02/2010	Caldera	1400	565
154	09:35	11:53	12/02/2010	Caldera	1400	198

total mins	17800
hours	296.6666667
days	12.36111111
weeks	1.765873016

12 days 8 hours 40 minutes total bottom time
14 dives longer than 12h bottom time
Longest dive 22h 25mins bottom time

Appendix 7 Microbial samples

Unfixed, frozen samples.

sample label	sample type	amount	treatment
JC42-F-347-01.2010B	animal: anemone	1	unfixed
JC-F-0137-01.2010	animal: anemone	1	unfixed
JC42-F-782.1-3	animal: clam A gills	3	unfixed
JC42-F-744.1-3	animal: clam B gills	3	unfixed
JC42-F-300-01.2010B	animal: limpet	20	unfixed
JC42-F-351-01.2010B	animal: snail	4	unfixed
JC-F-0119-01.2010	animal: snail	1	unfixed
JC-F-0191-01.2010	animal: sponge	1	unfixed
JC42-F-0081-01.2010	animal: squat lobster	3	unfixed
JC42-F-254-01.2010B	animal: squat lobster	6	unfixed
JC-F-0027-01.2010	animal: squat lobster - arms	4	unfixed
JC42-F-391-01.2010B	animal: stalked barnacle	10	unfixed
JC-F-0109-01.2010	animal: stalked barnacle	1	unfixed
142-09-S5	microbial substratum	1	unfixed
144-S7	microbial substratum	1	unfixed
145-S8	microbial substratum	1	unfixed
147-S9	microbial substratum	1	unfixed
149-S11	microbial substratum	1	unfixed
150-S12	microbial substratum	1	unfixed
152-S13	microbial substratum	1	unfixed
152-S14	microbial substratum	1	unfixed
ISIS140-S4	microbial substratum	8	unfixed
JC42-132-05	microbial substratum	1	unfixed
JC42-ISIS130-14-S2	microbial substratum	3	unfixed
JC42-ISIS130-9-S1	microbial substratum	1	unfixed

Fixed samples

sample label	sample type	amount	treatment
JC42-F-347-01.2010A	animal: anemone	1	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC-F-0118-01.2010	animal: anemone	1	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-300-01.2010A	animal: limpet	20	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC42-F-351-01.2010A	animal: snail	3	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC-F-0180-01.2010	animal: snail	1	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC-F-0151-01.2010	animal: sponge	1	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-0210-01.2010	animal: squat lobster	4	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-0218-01.2010A	animal: squat lobster	3	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-0218-01.2010B	animal: squat lobster	2	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-254-01.2010A	animal: squat lobster	5	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC42-F-438-02.2010	animal: squat lobster	2	EtOH
JC42-F-391-01.2010A	animal: stalked barnacle	10	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC42-F-461-02.2010	animal: stalked barnacle	20	4% PFA o/n, rinsed, then stored in abs. EtOH at -80C
JC-F-0139-01.2010	animal: stalked barnacle	1	4% PFA o/n, rinsed, then stored in 70%EtOH at -80C
JC42-F-631	animals: clam gills A	5	PFA fixation (4%), wash, stored in 50%EtOH/PBS
JC42-F-669	animals: clam gills B	5	PFA fixation (4%), wash, stored in 50%EtOH/PBS
JC42-F-550	animals: limpets	10	PFA fixation (4%)
JC42-F-471-02.2010?	microbial substratum	1	PFA fixation (4%)
JC42-F-494-02.2010	bacterial flocs	1	glutaraldehyde fixation (0.5%)
JC42-F-435-02.2010	bacterial mat	1	EtOH

PFA = Paraformaldehyde.