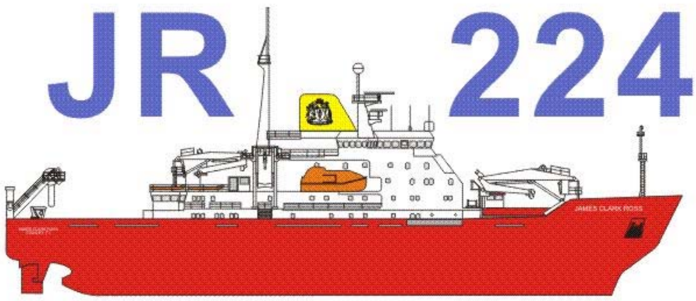
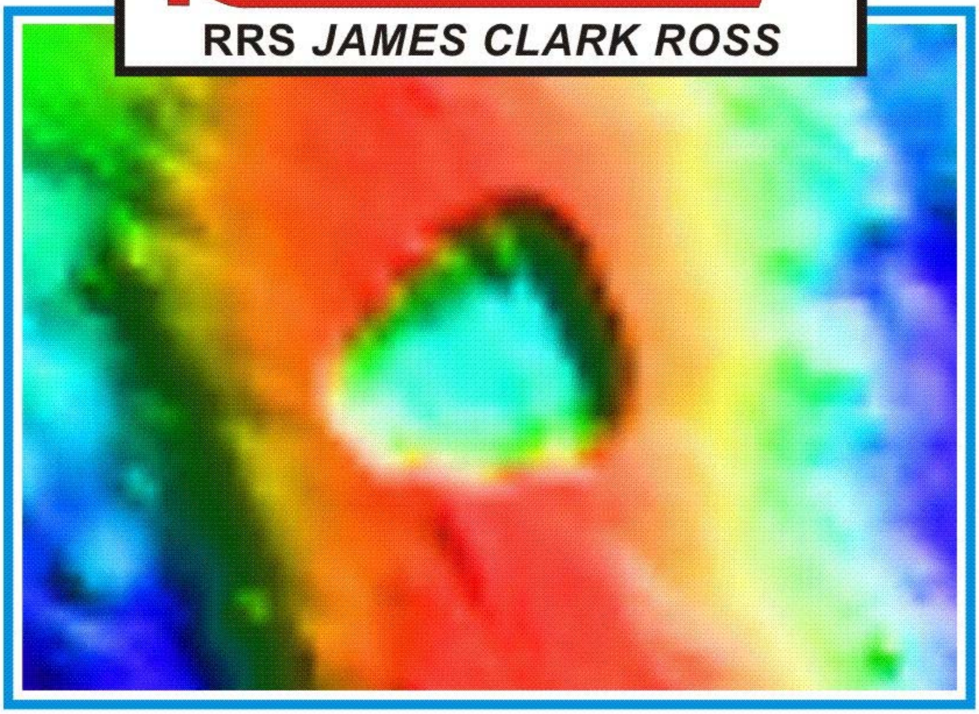
CRUISE REPORT

Chemosynthetically-driven Ecosystems South of the Polar Front Consortium Programme

JR 224



RRS *JAMES CLARK ROSS*



Multidisciplinary exploration to constrain hydrothermal vent and cold seep locations in the Scotia Sea

January – February 2009

CRUISE REPORT

RRS *James Clark Ross*
Cruise JR224

January to February 2009

Chemosynthetically-driven Ecosystems
South of the Polar Front consortium programme

Multidisciplinary exploration to constrain hydrothermal vent
and cold seep locations in the Scotia Sea

R.D. Larter, P.A. Tyler, D.P. Connelly, J.T.P. Copley, A. Rogers, S.A. Bennett,
C.F.A. Flouquet, A.G.C. Graham, A.M. Hilario, E.Z. Ramirez-Llodra, A.D. Beaton,
D.R. Owsianka, V. Afanasayev, J.S.P. Cooper, P.J. Mason and D.D. Willis

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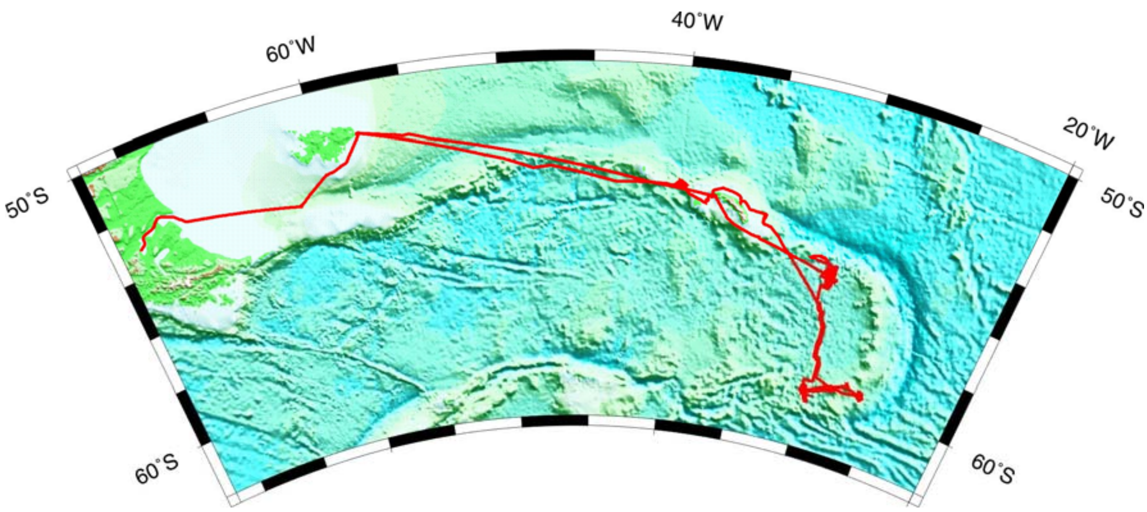
1. Summary

JR224 was the first of three cruises funded as part of the 'Chemosynthetically-driven Ecosystems South of the Polar Front: Biogeography and Ecology' consortium programme (ChEsSo). The consortium comprises the National Oceanography Centre, Southampton, the British Antarctic Survey, the Institute of Zoology, and the universities of Bristol and Newcastle. The main aim of this cruise was to constrain hydrothermal vent and cold seep locations in the East Scotia Sea, so that the second consortium cruise can go directly to them and carry out detailed investigations using the *Isis* remotely-operated vehicle. The cruise was very successful in constraining hydrothermal vent locations on both the East Scotia Ridge and the South Sandwich volcanic arc. A mound investigated in the South Sandwich forearc appears not to be a mud volcano, as previously thought, but evidence of methane seepage was found at a location on the South Georgia continental shelf. An additional significant discovery was a previously unknown, hydrothermally active, submerged caldera adjacent to a seamount that is part of the South Sandwich volcanic arc.

Figure 1. Cruise track of JR224



2. List of Personnel

2.1 Scientific and Technical (17)

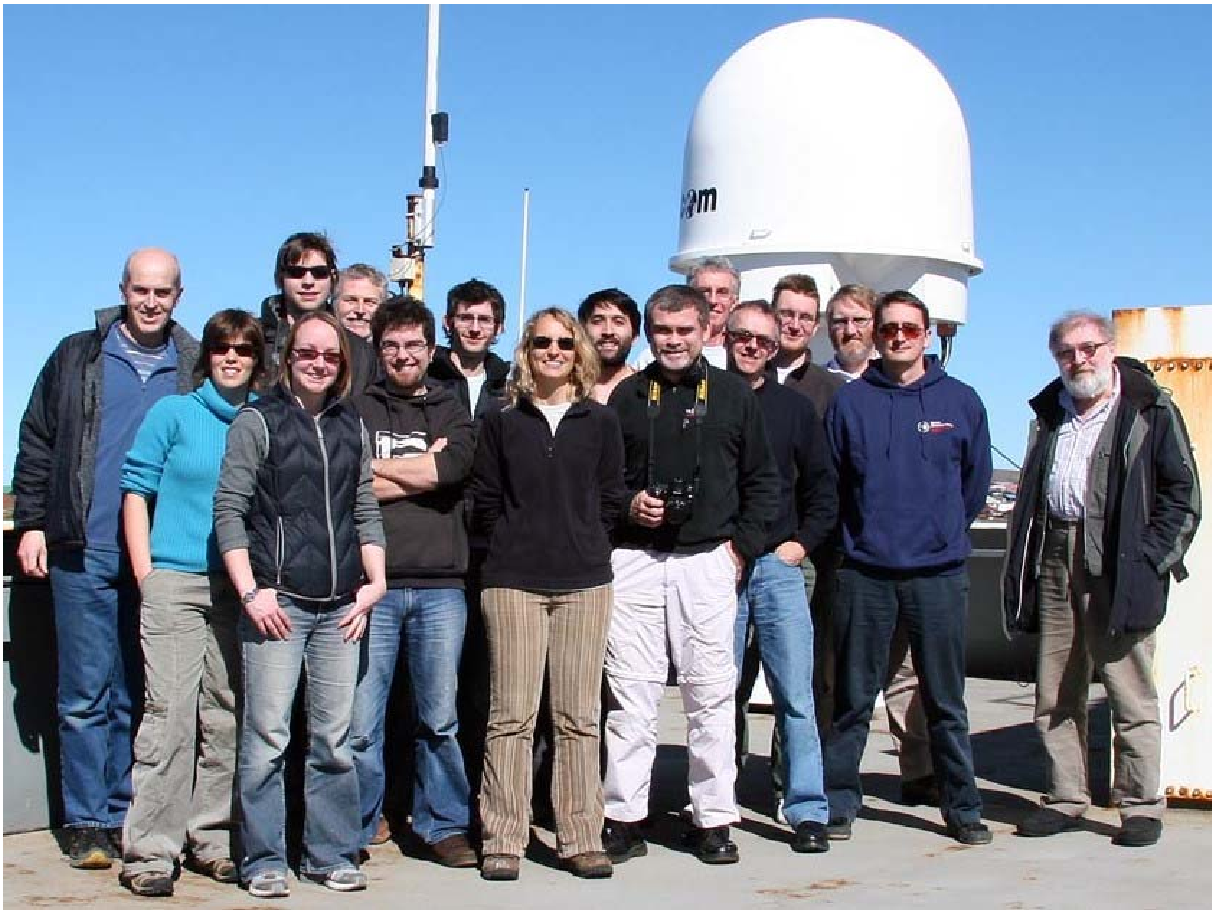
R.D. Larter	BAS	Chief Scientist/Geophysicist
P.A. Tyler	NOCS	ChEsSO Consortium PI/Biologist
D.P. Connelly	NOCS	Chemist
J.T.P. Copley	NOCS	Biologist
A. Rogers	ZSL	Biologist
S.A. Bennett	NOCS	Chemist
C.F.A. Flouquet	NOCS	Chemist/Sensor Engineer
A.G.C. Graham	BAS	Geophysicist
A.M. Hilario	University of Aveiro	Biologist
E.Z. Ramirez-Llodra	University of Barcelona	Biologist
A.D. Beaton	University of Southampton	PhD student chemist
D.R. Owsianka	University of Southampton	PhD student chemist
J.S.P. Cooper	NMFSS	Instrumentation Engineer
P.J. Mason	NMFSS	Instrumentation Engineer
V. Afanasayev	BAS	AME (Electronic Engineer)
D.D. Willis	BAS	ICT (Computing Engineer)
N.M. Lewis	BASMU	Doctor

BAS = British Antarctic Survey; AME = BAS Antarctic & Marine Engineering Section; BASMU = BAS Medical Unit; ChEsSO = Chemosynthetically-driven Ecosystems in the Southern Ocean; ICT = BAS Information Communications Technology Section; NMFSS = National Marine Facilities Sea Systems; NOCS = National Oceanography Centre, Southampton; ZSL = Zoological Society of London;

2.2 Ship's Company (28)

M.J.S. Burgan	Master	D.J. Peck	Bosun
T.S. Page	Chief Officer	A.M. Bowen	Bosun's Mate
G.M. Bonner	2nd Officer	K.E. Chappell	Seaman
A.J. Spooner	3rd Officer	G.A. Dale	Seaman
J.W. Summers	Deck Officer	T.A. Patterson	Seaman
D.E. Anderson	Chief Engineer	I. Raper	Seaman
T.RW. Elliott	2nd Engineer	D.W. Triggs	Seaman
J.S. Stevenson	3rd Engineer	C.J. Moore	Motorman
R.H. Tulloch	4th Engineer	G.M. Wale	Motorman
M.E.P. Gloistein	Radio Officer	A.A. Huntley	Chief Cook
D.P. Trevett	Deck Engineer	J.E. Lee	2nd Cook
J.P. McManmon	Electrical Engineer	L.J. Jones	Senior Steward
R.J. Turner	Purser	N.R. Greenwood	Steward
		G. Raworth	Steward
		M. Weirs	Steward

Figure 2. Shipboard scientific team photograph (photo by D.P. Connelly)



Back row: R.D. Larter, A.D. Beaton, P.A. Tyler, A.G.C. Graham, J.S.P. Cooper, P.J. Mason, C.F.A. Flouquet, D.D. Willis

Front row: A.M. Hilario, S.A. Bennett, D.R. Owsianka, E.Z. Ramirez-Llodra, A. Rogers, D.P. Connelly, J.T.P. Copley, Z. Afanasayev

3. Timetable of Events

January 2009

11 Embarkation of scientific party and start of mobilisation. Fibre-optic winch installed.

12 Continued mobilisation and engineering maintenance. Fibre-optic winch load tested.

13 Completed mobilisation and engineering maintenance.

14 RRS *James Clark Ross* departs from Muelle Mardones at 0910 local time (1210Z).

15 Multibeam echo sounder and TOPAS logging started, and trial deployment of magnetometer carried out. Snagged fishing line under vessel and decided to head for Stanley to get a diver to check nothing is still attached.

16 Anchored in Port William in morning, then waiting on weather to allow diving.

17 Diver gave all clear. Moved off at 1320Z. Multibeam echo sounder and TOPAS logging started, and magnetometer deployed on passage towards South Georgia.

18 Passage towards South Georgia.

19 Continued passage. Trial deployments of CTD and BRIDGET carried out. Magnetometer not redeployed after BRIDGET trial.

20 Attempted trial deployment of SHRIMP on South Georgia shelf abandoned due to connector damage. CTD cast over mound on South Georgia shelf, then magnetometer deployed for passage towards East Scotia Ridge.

21 CTD cast between South Georgia and East Scotia Ridge. Magnetometer recovered on arrival at E2 segment of East Scotia Ridge. CTD cast at location where hydrothermal plume signal was detected in 1999, then BRIDGET deployed.

22 Completed two N–S BRIDGET lines and CTD cast over ‘Mermaid’s Purse’ on E2 segment, then swath bathymetry survey started.

23 Continued E2 segment swath bathymetry survey, then hove-to from 1445Z.

24 Hove-to, then returned to work area.

25 Swath bathymetry survey, then ENE–WSW BRIDGET lines across ‘Mermaid’s Purse’.

26 Hove-to while remounting conducting cable storage drum, then recovered BRIDGET. ENE–WSW CTD tow-yo transects across ‘Mermaid’s Purse’.

27 Short N–S CTD tow-yo transects over eastern side of ‘Mermaid’s Purse’, then SHRIMP survey in same area.

28 Further CTD tow-yo survey over eastern side of ‘Mermaid’s Purse’, then tow-yo transect running southwards. SHRIMP survey over southern part of ‘Mermaid’s Purse’.

29 CTD cast at station where recovered SHRIMP. Completed E2 segment swath bathymetry survey, then started transit southwards along East Scotia Ridge to E9 segment, collecting swath bathymetry data opportunistically along each intervening segment. CTD cast in centre of E5 segment.

30 Continued transit southwards to E9 segment. CTD cast in centre of E8 segment. CTD cast in ‘Devil’s Punchbowl’ caldera on E9 segment, the tow-yo survey to W and NW.

31 Continued CTD tow-yo survey, then started swath bathymetry survey of segment E9.

February 2009

1 CTD tow-yo survey over NE part of ‘Devil’s Punchbowl’ caldera and caldera rim, then SHRIMP survey in same area.

2 CTD tow-yo survey over E part of ‘Devil’s Punchbowl’ caldera, then tow-yo transects northwards and eastwards, followed by detailed tow-yo survey of area at end of transect eastwards. SHRIMP survey starting in latter area and extending to NW.

3 Further swath bathymetry survey over E9 segment, then CTD tow-yo survey over part of E9 axial ridge to NW of caldera.

4 Continuing CTD tow-yo survey, then hove-to, then started transit to Kemp Seamount.

5 Swath bathymetry survey over Kemp Seamount, then CTD casts on upper flanks of seamount. SHRIMP transect across summit and down upper part of NE flank.

6 Further swath bathymetry survey over Kemp Seamount, then transit to forearc mounds area. Swath bathymetry and TOPAS survey over forearc mounds.

7 CTD transect across forearc mound, then SHRIMP towed along part of same transect. Transit to Southern Thule. Five CTD casts, SHRIMP transect, swath bathymetry survey and TOPAS profiling in Douglas Strait. Transit towards E9 segment.

8 Completed transit to E9 segment. SHRIMP survey over part of E9 axial ridge to NW of ‘Devil’s Punchbowl’ caldera, then SHRIMP transects between that area and the caldera.

9 Transit to caldera west of Kemp Seamount. Completed swath bathymetry survey of caldera. CTD tow-yo transect across western rim and western part of caldera. TOPAS profiles across centre of caldera.

10 SHRIMP transect from centre to western rim of caldera west of Kemp Seamount, then transit towards South Georgia via segments E8 to E4 of the East Scotia Ridge, collecting swath bathymetry data opportunistically along route.

11 Transit towards South Georgia collecting swath bathymetry data opportunistically along route, then swath bathymetry and TOPAS survey of area of upper continental slope to NE of South Georgia

12 Transit NW along shelf to Stewart Passage collecting swath bathymetry and TOPAS data opportunistically along route, interrupted by brief visit to Grytviken. Swath bathymetry, TOPAS and EK60 survey of shelf area where high methane levels were detected earlier.

13 CTD casts and water sampling over suspected area of methane seepage, then box core and SHRIMP survey in same area.

14 Box core 5 km west of previous one, then reconnaissance swath bathymetry and TOPAS survey to determine course of shelf trough. Transit to eastern end of Shag Rocks Bank, the SHRIMP survey.

15 Swath bathymetry survey of passage between Shag Rocks Bank and South Georgia continental shelf, then second SHRIMP transect up flank of Shag Rocks Bank. SHRIMP recovered, then magnetometer deployed and passage to Falkland Islands started.

16–17 Passage to Falkland Islands, collecting swath bathymetry and magnetic data opportunistically along route. Magnetometer recovered at 2000Z on 17th.

18 Swath bathymetry data collection stopped at 0900Z. RRS *James Clark Ross* arrives at FIPASS at 1030 local time (1330 Z). Started demobilisation.

4. Introduction

4.1 ChEsSO Consortium (PAT)

JR224 was the first of three cruise associated with the consortium grant ‘Chemosynthetically-driven Ecosystems South of the Polar Front: Biogeography and Ecology’ (ChEsSo) that is investigating the chemosynthetic environments and associated ecosystems south of the Polar Front. Sites in the East Scotia Sea (East Scotia Ridge, South Sandwich Arc and forearc), which will then be compared with chemosynthetically-driven communities in the Bransfield Strait, and north of King George Island, Antarctica. The primary objective of this work is to evaluate whether these sites, collectively, represent a Southern Ocean “gateway” to enable gene-flow of chemosynthetic fauna from the Southern Pacific Ocean to the South Atlantic Ocean. To address this issue the consortium of PIs are conducting a detailed investigation and analysis of four contrasting types of chemosynthetically-driven communities, together with their regional tectonic setting, and the specific hydrothermal vent and cold seep environments they inhabit. The communities chosen for our investigation comprise: those associated with high-temperature, bare-rock hydrothermal vents on the East Scotia Ridge, high-temperature, sediment-hosted hydrothermal activity (Bransfield Strait), mud volcanoes (South Sandwich forearc basin) and methane hydrates (north of King George Island).

To achieve these aims, we proposed a three-cruise and laboratory-based programme. Cruise 1 (JR224) is to the East Scotia Sea where we aimed to locate vent and seep sites, using existing evidence for active plumes, examine their tectonic setting and sample the discharge at hydrothermal and cold seep sites. This cruise relied primarily on proven water-column survey techniques, combined with very high resolution bathymetric mapping and video/image capabilities. The primary aim of cruise 1 was to locate precisely and begin to characterise individual vent and seep environments on the deep sea-floor. Cruise 2 will be to the same area and will use the UK’s Remotely Operated Vehicle (ROV) *Isis* to dive on, sample and thoroughly characterise the biological, chemical and physical environment surrounding vent and seep sites identified during Cruise 1. Cruise 3 will be a combined geophysical, chemical and biological cruise, using the ROV *Isis* to dive upon and examine hydrothermal vent and cold seep environments, at least some of which have been closely spatially-constrained already, both north and south of King George Island, Antarctic Peninsula. Subsequent analysis of geological, chemical and biological (both microbial and metazoan) samples will allow us to compare the hydrothermal and seep communities among these four sites. This cruise report is the first in the consortium programme.

4.2 JR224 (RDL)

The primary objective of cruise JR224 was to accurately locate hydrothermal vent and cold seep sites in the East Scotia Sea so that the second ChEsSO Consortium cruise can take the *Isis* remotely operated vehicle straight to them and study them in detail.

The East Scotia Ridge (ESR) had previously been identified as a likely location for hydrothermal venting on the basis of geological and geophysical investigations carried out as part of the BAS Active Plate Margins programme during the late 1990s (Livermore et al., 1997, 2003; Bruguier & Livermore, 2001). That programme built on results from pioneering geophysical investigations by the University of Birmingham Antarctic Marine Group in the 1970s (Barker & Hill, 1981). Results from the Active Plate Margins programme suggested that the most likely locations along the ESR for hydrothermal venting to occur were the central parts of segments E2 and E9, which have axial ridges similar to those at fast spreading ridges. Compelling evidence for the presence of hydrothermal venting in both these locations was obtained on the final cruise of the programme, JR39b, in 1999 (German et al., 2000). However, subsequent attempts to obtain funding to study the vents foundered, largely because their location was not sufficiently well constrained.

In view of this issue, the ChEsSO Consortium decided to devote its first cruise to locating the vent sites. The primary tools to be used were a hull-mounted multibeam echo sounder, optical and chemical sensors, water chemistry, an autonomous submersible carrying high-resolution sea-floor mapping tools and sensors, and a towed camera system. It had been hoped that the ABE or Sentry autonomous submersible would be made available through collaboration with Chris German and Tim Shank of Woods Hole Oceanographic Institution (WHOI). Our collaborators at WHOI succeeded in obtaining a research grant from the National Science Foundation (NSF) but, owing to complexities in the way NSF funding for marine science is structured, the autonomous submersible could not be made available for this cruise. Furthermore, Chris Tim and both had to cancel their participation in the cruise at a very late stage for personal reasons.

While the primary targets of the cruise were hydrothermal vent sites on the ESR, six days ship time were allocated for exploration for additional hydrothermal sites on the South Sandwich volcanic arc and to evaluate a possible cold seep site in the forearc. Recent studies on the Southern Kermadec and Mariana arcs have shown that many submerged arc volcanoes host hydrothermal vent sites, that these exhibit chemical differences from mid-ocean ridge and back-arc basin sites, and the globally-integrated flux from them may be comparable to that from spreading centres (de Ronde et al., 2001; Baker et al., 2003, 2008). In the forearc, a multichannel seismic reflection profile collected as part of the BAS Active Plate Margins programme had revealed a mound about 100 m high and 1 km across sitting on top of a succession of stratified sediments more than 1 km in thickness. This had been interpreted as a mud volcano (Vanneste et al., 2002) and was targeted for investigation as a potential location of cold seeps.

4.3 Achievements (RDL)

The cruise was very successful in achieving the aim of locating hydrothermal vent sites on both the East Scotia Ridge and the South Sandwich volcanic arc. The full nature of the evidence for this claim and the precise locations are not included in this report, as to do so might prejudice publication of results in the highest impact scientific journals.

The forearc mound previously interpreted as a mud volcano is one of several mounds on the same part of the forearc basin, but the one investigated in detail appeared to consist of consolidated sedimentary strata. The mode of origin of these features needs to be re-evaluated.

A trial CTD cast near a location on the South Georgia continental shelf from which unusual material had previously been trawled revealed very high levels of methane in the water. Further investigation towards the end of the cruise confirmed this result, but the location of the methane seep was not identified.

Additional achievements of the cruise include:

Discovery and comprehensive bathymetric mapping of a previously unknown submerged caldera adjacent to a seamount that is part of the South Sandwich volcanic arc.

First high-resolution multibeam bathymetric survey of the axial region of eight of the nine spreading segments that comprise the ESR.

Discovery and sampling of hydrothermal plumes from multiple locations on both the E2 and E9 segments of the ESR.

Discovery and sampling of hydrothermal plumes from multiple locations in and around the newly-discovered volcanic arc caldera.

Evidence for hydrothermal activity within the Douglas Strait caldera, Southern Thule, South Sandwich Islands.

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5. Initial Scientific Reports

5.1 Geophysics

Alastair Graham and Robert Larter

5.1.1 Site survey objectives

The principle objective of marine geophysical work on cruise JR224 was to establish a geological and bathymetric context for potential hydrothermal vent sites in the Southern Ocean, as part of an overall preliminary site survey of the East Scotia Ridge (ESR) and its surrounding region (see *Introduction* for a detailed scientific rationale). Geophysical data collection consisted of seafloor mapping using a multibeam echo sounder (see 5.1.2), and sub-bottom profiling using a parametric echo sounder (see 5.1.3). The main sites for data collection comprised (in operational order): (i) a site where yellow crystalline material had been recovered in a past trawl (pers. comm. from Mark Belchier), south of Bird Island on the South Georgia shelf, (ii) Segments E2 and E9 of the ESR where compelling evidence for hydrothermal activity had previously been reported, (iii) the Kemp Seamount, on the southern tip of the South Sandwich volcanic arc, (iv) a possible mud volcano site to the southeast of the South Sandwich arc, and (v) the Douglas Strait caldera, which is considered a relatively young and possibly active volcanic feature (surveyed sites labelled in Figure 5.1).

In most cases, existing bathymetric data in these areas had either poor coverage or inadequate resolution; for example, prior to this cruise the best available bathymetric data from the East Scotia Ridge were the HAWAII MR-1 data (collected by BAS on cruise JR09a in 1995), which have a spatial resolution c. 300 m at best (see overlay on Figure 5.1). Pre-cruise data collation of TOBI sidescan and phase bathymetry over segments E2 and E9 of the ESR highlighted the lack of detail in the regional bathymetric grids, and the need for greater understanding of the geological setting of the targets. Thus, a main purpose of geophysical data collection on this cruise was to provide new high-resolution bathymetry on which smaller-scale geological structures could be resolved (such as fissures or mounds of hydrothermal mineral deposits), and from which sites of likely seafloor venting could be further investigated.

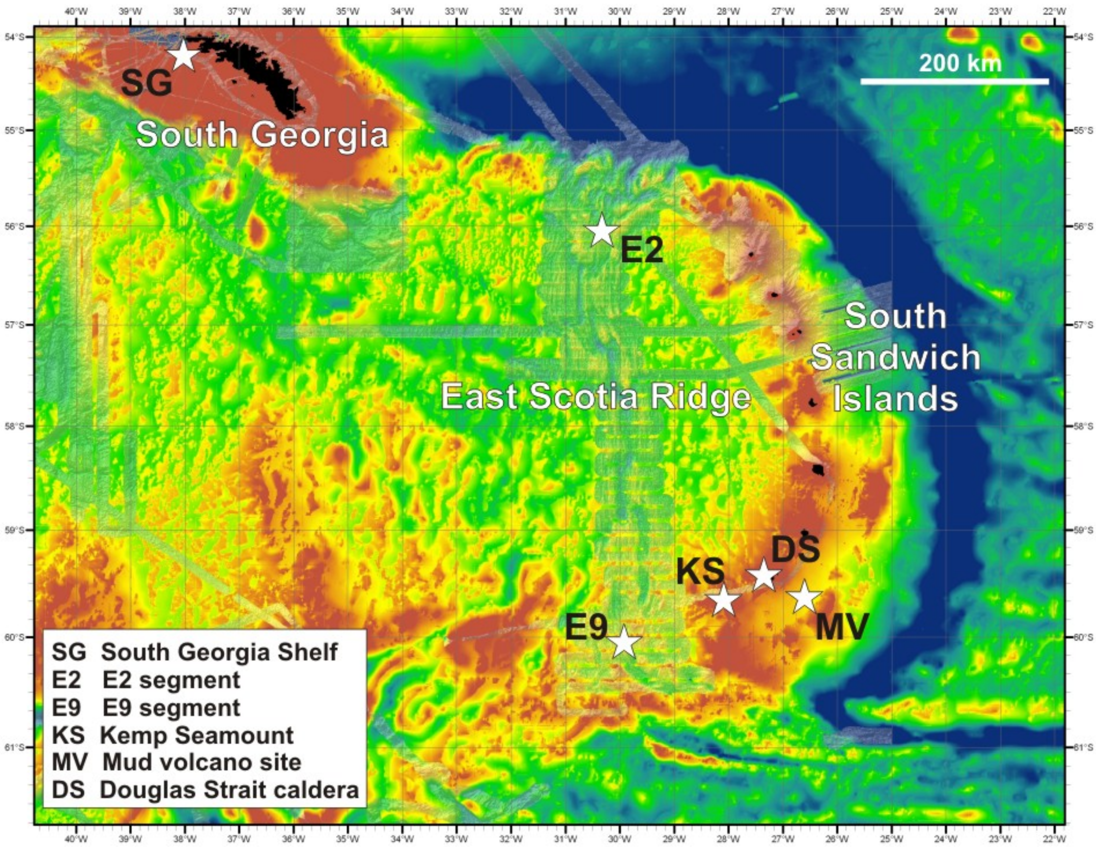

Figure 3. Location map of the East Scotia Ridge and surrounding region. The five sites where detailed multibeam echo sounder surveys were carried out are starred and labelled. HAWAII MR-1 bathymetry and BAS multibeam echo sounder bathymetry are overlain on Smith and Sandwell, version 11 1-minute topography. Hot colours represent shallow bathymetry, cold colours deep. Mercator projection.

5.1.2 Multibeam echo sounder surveys: work at sea, and preliminary results.

Multibeam swath bathymetry surveys were conducted at each of the five target locations shown in Figure 3 where blocks of the seafloor were mapped out, normally adopting the strategy of 'filling' the seafloor with multiple overlapping swaths. Elsewhere, individual lines were recorded routinely on transit to and from survey areas, as well as on passage to and from Stanley/Punta Arenas. While sparse, these latter data should still be of value to scientists working in, and outside of, the ChEsSO project.

The JCR's hull-mounted Kongsberg Simrad EM120 multibeam echo sounder was used near-continuously for the duration of the cruise. The EM120 system emits 191 beams (at 1 degree resolution) with frequencies of 11.25-12.75 kHz, providing a practical spatial resolution between ~10-70 m (but dependent on water depth), and a swath width of up to a maximum of ~5 times the survey water depth (c. 68 degree beam angles, both port and starboard of the ship). Beam raypaths and seafloor depths were calculated in near-real-time using sound velocity profiles derived from conductivity-temperature-depth and expendable bathythermograph casts collected both prior to JR224, and during cruise operations (see Table of SVP's used during cruise; Table 1).

Table 1. Summary table of Sound Velocity Profiles (SVPs) used on JR224, as recorded in the EM120 cruise underway log.

Filename (*.asvp)	**Julian Day and Time**
FI_SHELF_T5000001_ed	015/1445
JR116_T500041_ed	019/1659
JR224_CTD03_ed	021/0939
JR224_CTD182_ed	030/0835
JR224_CTD183_ed	030/1732
JR224_CTD473_ed	038/0915
JR224_CTD183_ed (reactivated)	039/0722
JR224_CTD03_ed (reactivated)	042/0923
JR224_CTD02_ed	043/2114
JR116_T500041_ed (reactivated)	045/1105
JR224_CTD537_ed	045/1458

Ping-editing to remove anomalous depths was carried out while onboard, using the MB-system in Unix, and following the "processing multibeam data" handout, prepared by the BAS geophysics data manager. Although the main application of the multibeam echo sounder was a tool for site survey, the bathymetric data obtained on JR224 revealed new (and often unexpected) information about the geology of various parts of the Southern Ocean. These findings are outlined here-in.

The EM120 system was switched on at 1445 on J-day 015. The first target for deployment of SHRIMP lay several miles south of Bird Island, southwest of South Georgia. On days 019-020, multibeam data were collected across the South Georgia shelf and slope, covering new areas of previously unmapped seafloor. These data may be useful to current and future BAS science projects (e.g., for the glacial history of the sub-Antarctic within the BAS GRADES/IceSheets programmes). Detailed swath bathymetry collected on the approach to the deployment site and while on station revealed a ~50-m high mound at the seafloor, with an irregular upper surface, capped by several smaller mounds or cones (Figure 4). During further investigation of the site using multibeam and TOPAS profiles on the return leg to South Georgia, it was established that at least part of the mound is an outcrop of basement rock, with surrounding regions filled by thick sediments.

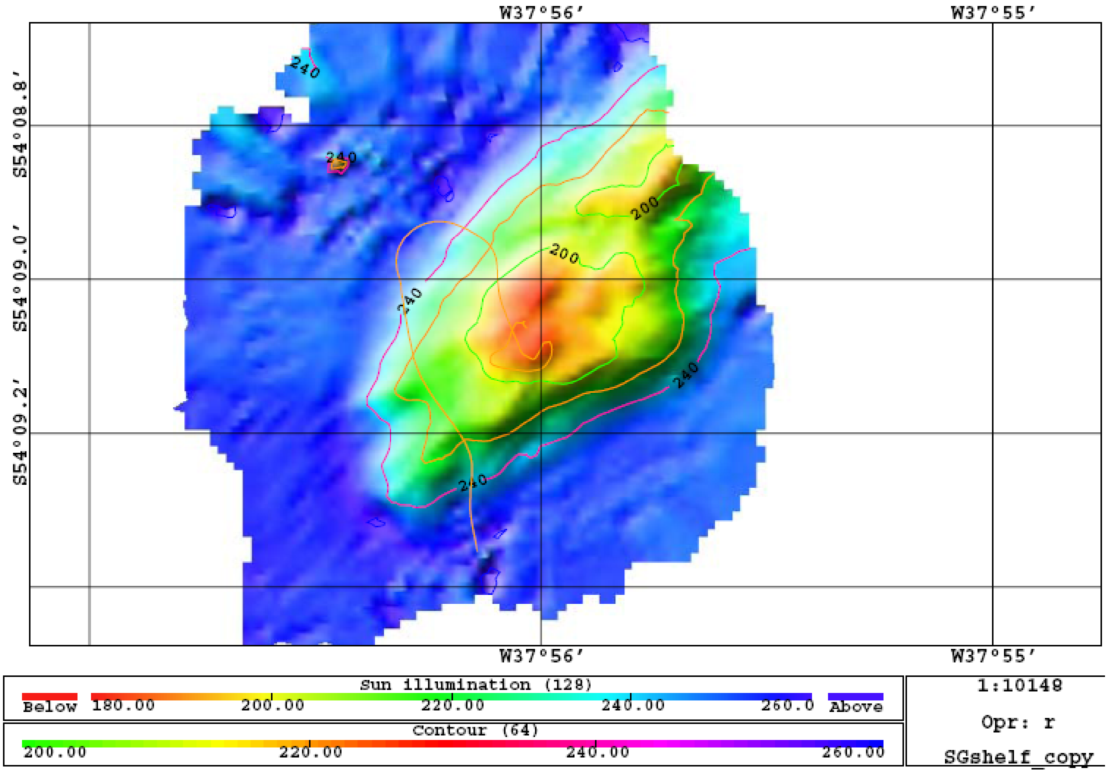

Figure 4. Prominent mound at the seafloor, imaged by multibeam swath bathymetry, south of Bird Island, South Georgia shelf. Note the irregular upper surface, and smaller mounds at the crest. Gridded in Neptune software. Mercator projection.

Multibeam survey ran continuously on transit from South Georgia to the northern end of the East Scotia Ridge. At the E2 ridge segment, detailed surveys of the axial ridge known as "The Mermaid's Purse", as well as the wider regional setting of the segment, were conducted (days 020-029). The main objective of multibeam survey on E2 was to identify geological features that might host hydrothermal vents (Figure 5). Swath bathymetry identified several new north-south trending seafloor structures (interpreted as faults, often associated with fissures observed on corresponding TOBI sidescan data and on SHRIMP underwater camera surveys), as well as small mounds and regions of topographically-rough seabed. Raw plots of the newly-collected multibeam data served as useful basemaps of the E2 region, which helped to guide subsequent CTD and SHRIMP surveys (Figure 5).

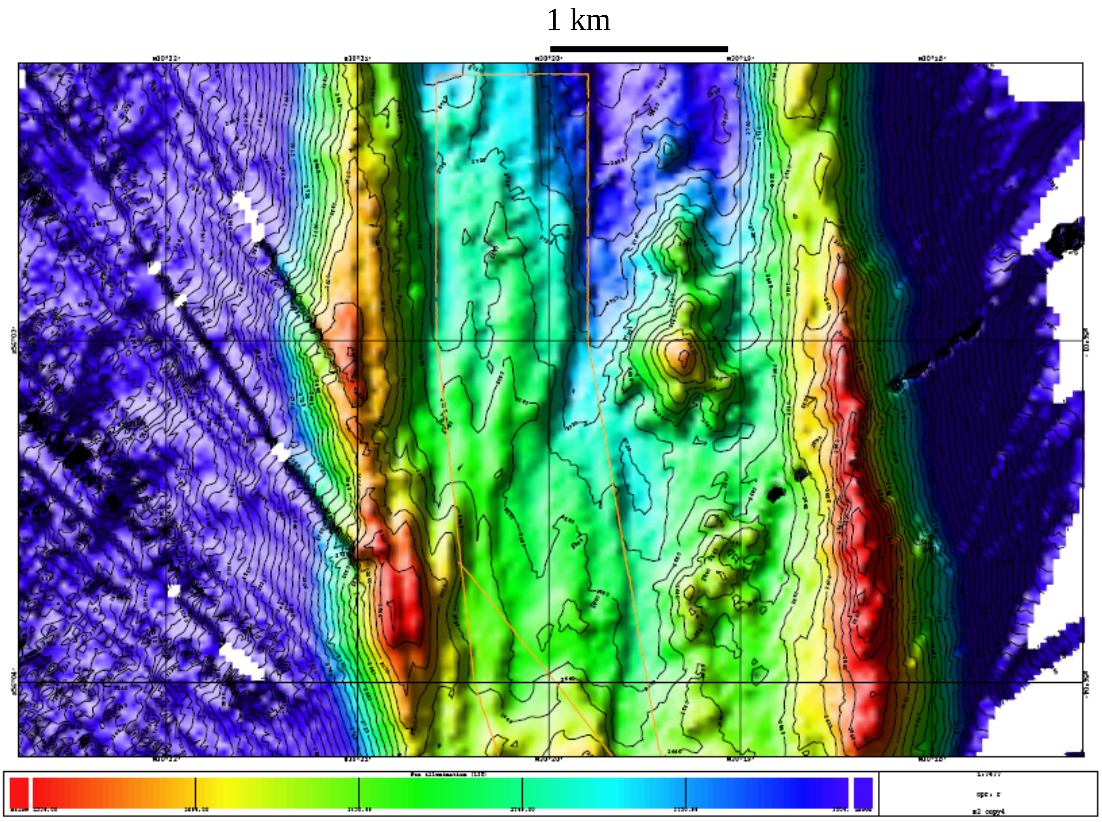

Figure 5. Sun-illuminated example of unprocessed EM120 multibeam swath bathymetry over "The Mermaid's Purse", part of the central portion of the E2 segment on the East Scotia Ridge. Data gridded at 30 m cell size in Neptune software. The image shows the remarkable level of detail afforded by the new surveys. Mounds on the ridge were targeted for signs of hydrothermal venting. Mercator projection.

Yaw correction was switched off for the majority of BRIDGET, CTD and SHRIMP operations on E2, which were generally carried out at slow speeds (typical SMG of 0.1-0.5 knots). At such slow speeds the natural yaw of the vessel increases the spread of reflection points on the sea floor. Using yaw correction based on the filtered heading would have restricted the spread of points, resulting in an even higher density of coverage, which was already multiply redundant, from a more restricted area. In areas of particular interest, the beam coverage was also narrowed to focus returns on a smaller area of the seafloor, effectively saturating the designated target with extra pings, and avoiding collecting returns from wider beam angles from which the depth measurements would have greater uncertainties. While the practical limit of resolution of the EM120 in the working water depth

(c. 2600 m) was calculated at ~45 m, it was found that more detail (and fewer spurious pings) could be resolved in the resulting gridded bathymetry through this method.

Because backscatter information may also be useful for seafloor characterisation around hydrothermal vents, the EM120 was configured to a fixed depth mode (e.g., ‘Deep’) during site surveys. This approach eliminates shifts in recorded backscatter amplitudes associated with acquisition mode changes, which can occur frequently when the EM120 is operated in ‘Auto’ mode, greatly complicating the processing of backscatter data. The uniform configuration of the raw data in fixed-depth mode allows for easier post-acquistion processing and affords a more reliable interpretation of the processed backscatter results.

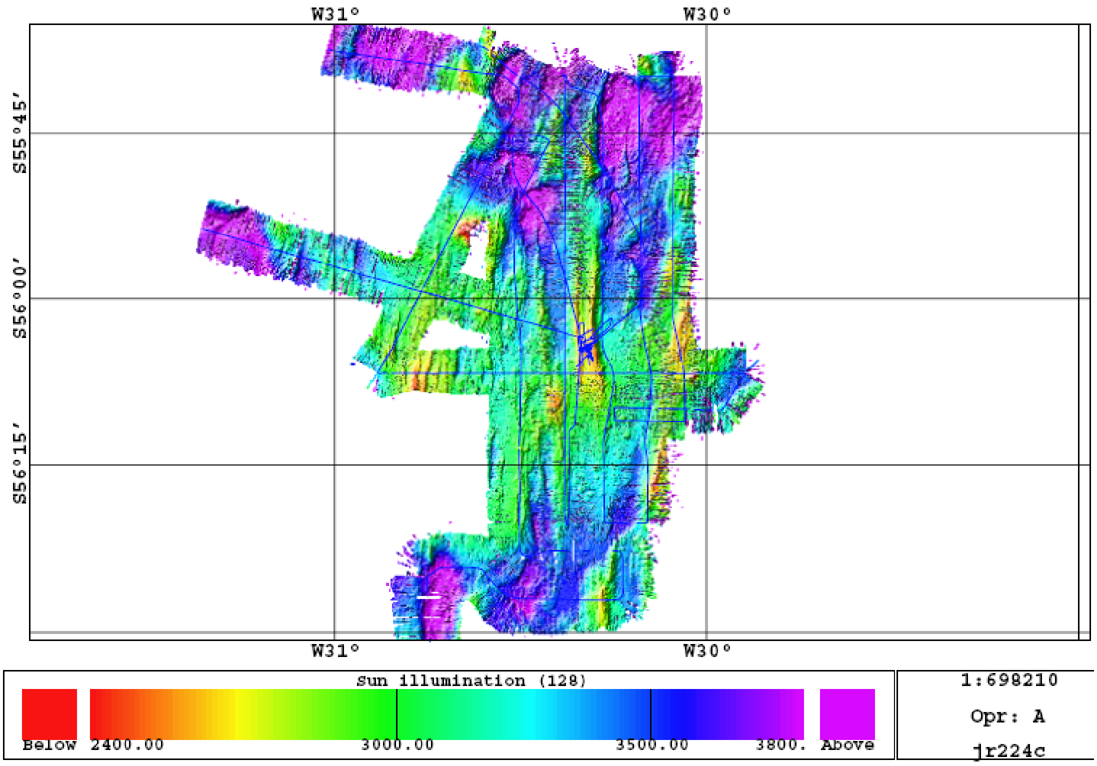

Figure 6. Unprocessed EM120 multibeam swath bathymetry over the E2 segment of the East Scotia Ridge, and in its surrounding regions. 85 m grid cell size, gridded in Neptune software. Mercator projection.

Downtime due to poor weather during days 022-025 provided the opportunity to complete a wider multibeam survey of the E2 area. This involved ‘blocking in’ a designated rectangular area around the ridge, with four or five adjacent, approximately parallel swaths. The survey plan had to be altered several times due to deteriorating data quality under poor weather conditions, but the completed map includes the whole axial ridge as well as the segment boundaries between E2 and E1, and E2 and E3. These new data show the morphology of the northern East Scotia Ridge sector at an unprecedented level of detail (Figure 6).

On transit south to segment E9 (days 029-030), a multibeam survey was designed to map out the main axial valleys of each of the ESR segments, from E2 through to E9. The survey was successful in producing a seabed map of the main spreading centre along the entire length of the ESR, and may be useful for future geological investigations along this feature.

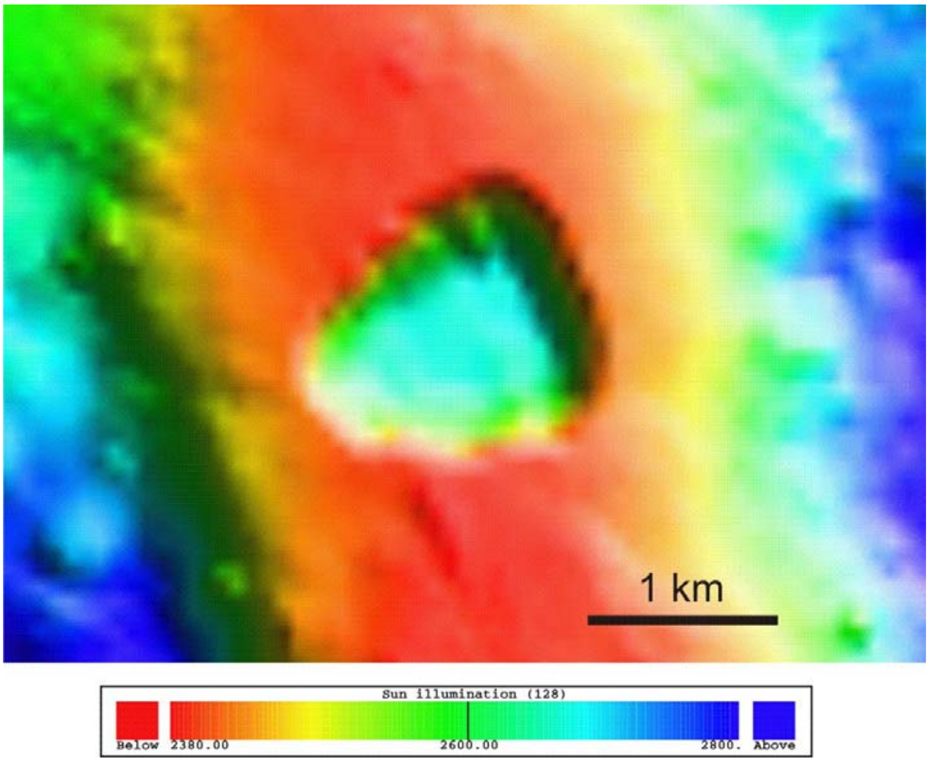

Figure 7. Unprocessed EM120 multibeam swath bathymetry of the pit crater capping the crest of the E9 ridge segment, southern East Scotia Ridge. Gridded in Neptune software, with an 80 m grid cell size. Mercator projection.

Multibeam surveys over the E9 segment, from days 030-035 (plus supplementary data collected on day 039), followed similar objectives and methods to those described for segment E2; yaw correction was turned off for CTD tow-yow and SHRIMP activities, and continuous logging produced maps with an optimal resolution over the main ridge axis. Poor weather that precluded deployment of any equipment (day 034) allowed for additional multibeam mapping of the E9 segment on a regional scale. Highlights of the new survey data include a detailed bathymetric map of the pit crater (Figure 7), which sits over the ridge's axial high, as well as improved characterisation of the ridge morphology (found to be generally smooth, but with several prominent mounds to the north of the crater which were later identified on SHRIMP cameras as ridges of pillow lavas).

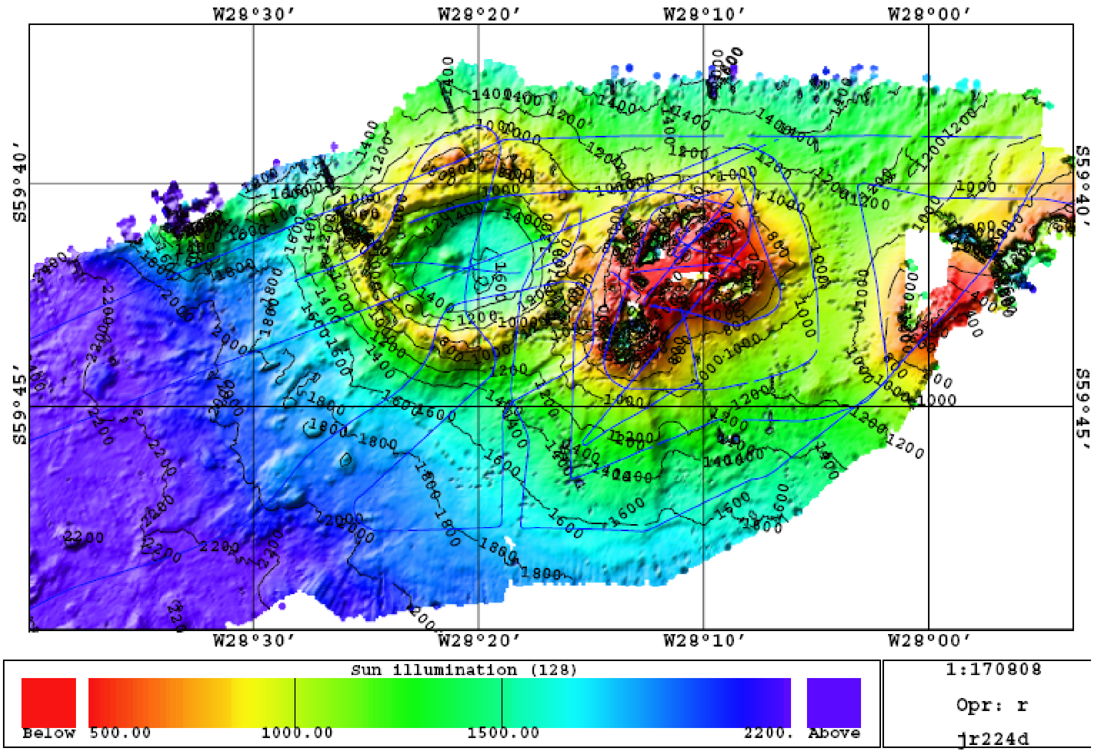

Figure 8. EM120 multibeam swath bathymetry around the area of Kemp Seamount. Note the newly-discovered caldera to the west of the seamount, and large slide blocks that have detached from the steep slopes to the southwest of the caldera. Gridded at 100 m cell size in Neptune software. Mercator projection.

Routine multibeam survey was conducted on transit to the Kemp Seamount (part of the Vysokaya Bank) on day 036. On arrival, a series of multibeam surveys were carried out prior to, during, and subsequent to CTD/SHRIMP operations (between days 036-037, and supplemented by extra data during a return visit on days 040 and 041); the resulting swath map covered the large majority of the seamount, and its neighbouring seafloor. The most significant scientific discovery was that of a caldera to the west of the Kemp Seamount (Figure 8). This previously unseen feature is ~2.5 km wide, and over 700 metres deep from rim to base. The ‘fresh’ morphology of the structure and its lack of sedimentary infill suggest a particularly young age for the caldera, confirmed by seafloor observations of exposed rock surfaces and by the presence of blocky lavas at the caldera floor. Further observations within and away from the caldera include the presence of slide blocks and mass movement structures (e.g., debris flow chutes) on the flanks of the caldera and seamount, which testify to the instability of slopes both here, and elsewhere along the South Sandwich arc.

A brief work period was spent mapping the seafloor to the southeast of Southern Thule, on days 037 and 038. However, images from a SHRIMP dive quickly established that the elongate structures at the seafloor, originally hypothesised as mud volcanoes, were unlikely to host seeps. The origin of these mounds remains undetermined at present, though existing seismic profiles show that they sit above a thick sedimentary basin, and are not protrusions of deeper acoustic basement. Although results of the site survey were unexpected, the multibeam survey carried out in this region was extensive, and may help to answer future questions about geological processes operating close to a major plate boundary.

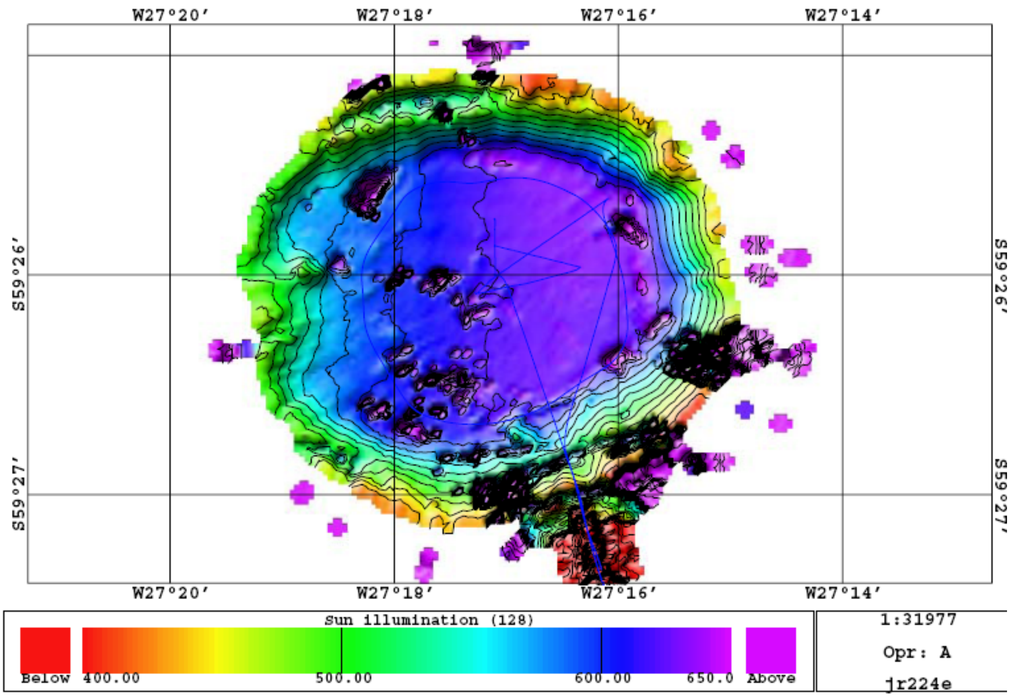

Figure 9. Unprocessed EM120 multibeam swath bathymetry from the Douglas Strait Caldera. Gridded at 40 m cell size. Mercator projection.

Towards the middle of day 038, Multibeam data were collected on the transit into the Douglas Strait caldera and within the caldera itself. The EM120 had problems picking the bottom over the shallow sill (~20 m) that bounds the southern edge of the caldera, but had few problems once into deeper water within the caldera (Figure 9). It was noted that the unusual water structure within the caldera is likely to render the SVP used for acquisition (which remained loaded from previous surveys over the forearc region) inappropriate. A more appropriate velocity profile, obtained from one of the CTD casts within Douglas Strait itself, should be applied retrospectively to the data in order to yield accurate bottom depths. These corrected bathymetries can then be used in comparisons to previous soundings from the caldera floor to see whether the basin is uplifting, subsiding or deforming as a result of tectonic or volcanic processes.

Following two brief day-long return visits to sites at both E9 and the Kemp Seamount, multibeam surveys were conducted routinely on the northern passage back to South Georgia. Care was taken to overlap and add to the swath data collected on the reciprocal journey south at the start of the cruise (days 041-043). These tracks served to effectively double the swath coverage over the main axis of the East Scotia Ridge.

The main targets for swath survey at South Georgia were the potential cold seep environments on the shelf south of Bird Island, discovered earlier on in the cruise. Regional mapping of the shelf in the vicinity of CTD 02 was conducted on day 044, and provided a useful bathymetric overview of the trough, in which the unusual seafloor mound was first mapped. (described earlier in the text, and in Figure 4)

With time in-hand after further SHRIMP activity around the mound, a passage was mapped west across the South Georgia shelf to a final site east of Shag Rocks (day 045 and 046) where multibeam survey was carried out both during, and between, two final SHRIMP deployments. The survey in this region should contribute to a compilation of multibeam data helping to characterise the regional tectonic framework of the Scotia Arc and define the geometry of an important pathway for Antarctic Circumpolar Current flow through the North Scotia Ridge.

The EM120 ran continuously on JCR's passage back to Stanley, where the multibeam surveys were terminated. Data from the final leg will go into the BAS Long-Term Monitoring and Survey (LTMS) archive of swath bathymetry, which over the seasons, is slowly building up a picture of the seabed across the Drake Passage and Southern Ocean.

Raw data files were logged and stored in 6 separate surveys, divided loosely by their working area, and described in the table below (Table 2).

Table 2. Table of EM120 surveys

Survey	Approximate operating area
jr224a	Initial passage from Punta Arenas to Falklands
jr224b	New passage from Stanley, via South Georgia, to E2, and work south of Bird Island and in Shag rocks region.
jr224c	E2 work area and transit to southern end of of E3, plus survey across northern South Georgia shelf.
jr224d	Transit to/from E9, E9 work area, and Kemp Seamount
jr224e	Forearc site and Douglas Strait caldera

5.1.3 Sub-bottom profiler surveys: work at sea and preliminary results.

TOPAS was operated intermittently throughout the cruise, and in a variety of modes dependent on its application. The main operational settings are outlined in Appendix A5, but generally a chirp source was used with the TOPAS system synchronised to the SSU. The following summarises the scientific work carried out using TOPAS on JR224:

TOPAS ran continuously using a chirp source from day 015/1600 to arrival in the Falklands on 016.

TOPAS ran continuously from departure from the Falklands on 016 to 018/1437

TOPAS was used to look at the upper water column while crossing the polar front (from 018/1443 until 019/1819, and then from 019/1920 until 020/0003)

TOPAS was set to look at the seafloor from 020/0003, while crossing the South Georgia shelf, and remained logging until arrival at the site for CTD 03 at 021/0757.

TOPAS was turned on again on 030/2214 to look for sediments at the floor of the E9 crater, using a chirp source. Logging was abandoned at 030/2253.

TOPAS was used to see if it could image the top of a suspected hydrothermal plume, with logging of the record from 031/1250 to 031/1432. Some feint reflections were observed.

TOPAS was used to image sediments in the E9 crater (032/2216 to 033/0457).

TOPAS was used to image sediments on the shallow parts of the E9 segment ridge (033/1522 to 034/0141).

TOPAS was used with a Ricker source and secondary frequency of 3 kHz to image the top of the Kemp Seamount, starting at 036/2113, ending at 037/0018.

A chirp source was used to image the seafloor of the forearc, and occasionally operated with an independent trigger cycle because of conflicts with the EM120 (037/1005 to 037/2313)

TOPAS was pinging from 038/1221 to 038/2203 in the vicinity of Douglas Strait caldera where nicely layered sediments were imaged. The thickness of sediments (up to 8 m) was quite surprising given that the caldera is an apparently young volcanic feature.

Two targeted TOPAS profiles were acquired West-East across the caldera west of Kemp Seamount, on day 041 between 0041 and 0156. The aim was to image any sediments infilling the crater, with a view to then recovering a box core on site. Subsamples would be used to establish a minimum Pb-210 age with which to constrain the age of the caldera (suspected very young based on the caldera morphology). In practice, very few sediments were imaged, even in the deepest part of the caldera (estimated thickness of ~1.5 m from TOPAS records, but apparently less based on the SHRIMP seafloor imagery). The lack of a significant sediment infill supports the interpretation that the caldera is a recent geological feature. No box core was taken.

TOPAS started logging on the slope east of South Georgia on day 042. It was run near-continuously during transit across the South Georgia shelf, and during CTD and SHRIMP deployments south of Bird Island. These transits yielded superb sub-bottom acoustic profiles of the various sediment-filled glacial troughs and intervening barren banks that characterise the shelf.

5.1.4. Magnetic surveys

Magnetic field data were collected continuously throughout the cruise on the BAS Shipboard Three Component Magnetometer, and on several passage tracks using the towed SeaSpy proton precession magnetometer. The data collected augment the coverage of magnetic profiles in the Scotia Sea region, which are the most important data constraining the chronology of development of the Scotia Sea and the opening of the Drake Passage gateway. BAS maintains a large LTMS archive of magnetic profiles in the region. The passage profiles collected on the southern flank of the North Scotia Ridge will be particularly valuable in constraining the history of sea-floor spreading as they are approximately parallel to the spreading direction. Similarly, the profile collected between South Georgia and E2 will be particularly useful because it runs parallel to the trend of pseudofaults generated at the East Scotia Ridge, and should thus provide an uninterrupted record of spreading rates during expansion of the East Scotia Sea.

The towed magnetometer was first deployed on day 015, before the unscheduled visit to the Falklands, but this deployment did not yield any useful data due to an error in the way the cable was connected to the front of the towfish.

The second deployment was at 1920 on day 017, after departing from the Falklands. The magnetometer was towed for two days along a passage profile that crossed the North Scotia Ridge obliquely. It was then recovered prior to a trial deployment of BRIDGET at 1740 on day 019, and was not redeployed until after CTD002 on the South Georgia shelf, with logging restarting at 1308 on day 020. From there on, data were collected on another long passage profile that continued to the E2 segment, where data logging was stopped at 1743 on day 021 prior to recovery of the towfish. There were two brief interruptions in the profile running eastward from South Georgia: firstly due to an interruption in power to JCR’s drive motor at about 1715 on day 020, and secondly for CTD003.

The towed magnetometer was not used again until a final deployment following the final SHRIMP dive on Shag Rocks Bank, at 2010 on day 046. It was then towed on the passage back towards the Falklands, until being recovered at 2000 on day 048.

5.1.5 Box coring

The main application of the box corer was as a supplementary sampling tool to: (i) aid characterisation of the seafloor sediments, (ii) sample near-surface biology, and (iii) to provide material for geochemical analyses at sites where either mud volcanoes were discovered, or at sites where a thick sediment cover was present. For the cruise, only two cores were recovered; both near the mound, south of Bird Island, where a potential cold seep site had been identified.

The first deployment, BC524, south of Bird Island (JD 044), resulted in a relatively low recovery (26-30 cm), but adequate sub-cores were obtained none-the-less (14-17 cm in length). The material in the box consisted of an olive green sticky mud with black specks and black pods, abundant benthic organisms and a strong sulphidic smell. Six surface samples were taken in total; three for geochemistry and three for microbiological analyses. Two of the three sub-cores (BC524x, BC524z) were frozen for further geochemical work by colleagues in Bristol, while BC524y was kept for BAS archives.

The second deployment, BC525, approximately 5.5 km west of BC524, was used as a control site for the first sediment recovery. The box-core recovered 22-27 cm of olive-grey-green sticky mud with black speckles. Fewer organisms were present on the surface, and the sulphidic smell was less potent (though remained). One bagged surface sample was recovered from the side of the box for geochemistry. Four sub-core extractions were then attempted. The first two failed, for reasons unknown (perhaps the vacuum was lost during extraction? Or holes not large enough in end caps?). The second two were pushed downwards through the box, with a view to recovering them at the base, but the cohesiveness of the sediment in the liners meant that they could be pulled swiftly pulled back out through the top of the box without loss. One subcore (BC525x 0-23 cm) was frozen in the –20 freezer for geochemical work; the other (BC525y 0-18 cm) stowed in the cool store, to be used by BAS marine geologists to determine recent sedimentation rates in this area.

5.2. Water column studies

Douglas Connelly, Sarah Bennett, Cedric Floquet, Alex Beaton and David Owsianka

5.2.1. Bridget and CTD deployments

A full list of the CTD operation locations can be seen in Appendix XX.

A full list of samples collected can be seen in the CTD Bottle log in Appendix XX.

The first operation (CTD 01) was carried out to collect seawater at 100m to fill the Niskin bottles. On recovery of the CTD, 10ml of concentrated hydrochloric acid was added to each bottle and left for 24 hours to clean. This operation removes any excess metal contamination from the bottles. The Niskin bottles were internally sprung and mounted in a stainless steel frame along with the Seabird sensor system.

The first scientific samples of the cruise were taken on the 20th of January over a site to the south west of South Georgia. This site was chosen as a result of some interesting crystalline material that had been dredged up a few years ago. This was a shallow CTD cast with Niskin bottles fired every 5m from the seafloor to a depth of 55m in the water column. These bottles were sampled and analysed for methane. CTD 03 was a dip to 1000m to collect clean background seawater to be used during the cruise as blank seawater for our sensor systems.

We then proceeded southeast to segment E2 on the East Scotia Ridge. Our first CTD station was a reoccupation of a station sampled in 1999 by German et al. that indicated the presence of hydrothermal activity. This produced our first evidence for hydrothermal activity on the East Scotia Ridge.

This was followed on the 19th of January by a test deployment to 1500m of the towed vehicle Bridget, with a test firing of the onboard bottles. This test was extremely successful with all of the sensors functioning. On recovery it was found that the bottles for Bridget had the wrong length of lanyard so the bottles were modified to allow continued usage.

The first full deployment of Bridget began on the 21st of January and finished on the 22nd of January. Two lines were run parallel to the ridge segment to determine the presence of plume activity. The system was in the water for a total of 17 hours and all systems performed well.

CTD 05 was taken on the 22nd January, intercepting weak plumes and all bottles were fired in the water column. Bridget was deployed again on the 25th of January to perform a series of lines orthogonal to the ridge axis. We encountered a problem with the onboard LSS, resulting in recovery of the instrument in order to clean the LSS and add a second LSS as a back up. However, problems with both LSS's continued but we continued anyway as it was possible to discern some features in the LSS data. The only feature on the Bridget system that had changed since the first successful deployment was the connection of an acoustic beacon. Therefore during recovery, the acoustic beacon for the USBL system was disconnected (i.e. left to run on its internal batteries) and Bridget redeployed. This solved the problem, suggesting the presence of cross talk on the channels from the beacon and LSS. We redeployed to the beginning of the transect lines and continued our deployment. In the early hours of the 26th of January the storage drum for the ship's conducting cable malfunctioned and we had to end operations. Although we recovered Bridget we were unable to use the system again as the storage drum problem proved to be irreparable.

With Bridget out of commission we resorted to using the CTD in TowYo mode to achieve a finer scale resolution and faster collection of water column data than that obtained by using the CTD in the more conventional vertical cast mode.

A series of 2 very long TowYo deployments were performed over segment E2, with Niskin bottles fired during elevated LSS signals, in the typical region of a hydrothermal plume (100 to 300m above the seafloor). The Niskin bottles were sampled for methane analysis carried out on board the ship, as well as trace metal analysis, to be carried out back at NOC. The latter TowYo identified an area of strong LSS signals towards the southern end of the 'Mermaid's Purse' area. Here a vertical CTD cast was taken and samples were collected for the complete suite of analyses. In addition to methane and trace metal samples, the Niskin bottles were also sampled for nutrients, dissolved Fe/Mn and phosphate (see section 5.2.2). Following this CTD work SHRIMP was deployed for a visual survey of the area.

This was the end of our time at the E2 segment and we began our transit to E9. On our way, we carried out a vertical CTD cast at the centre of the E5 segment but we observed no elevated LSS signals. Another CTD cast was carried out at segment E8, but again, no anomalous LSS signals were observed.

Once we arrived at the E9 segment, a series of 4 TowYo casts were performed. Many of these lines indicated hydrothermal activity, with much higher LSS signals compared to the E2 segment. This led to a series of SHRIMP deployments to identify the site of hydrothermal activity. One of the biggest issues at this site was the unrestricted movement of water due the absence of an axial valley. Therefore the presence of a high hydrothermal signal at one CTD deployment appeared to have a short lifetime (sometimes on the order of hours), indicating relatively strong, ever changing, current movements. The temperature profile also indicated a number of different water masses moving across the E9 segment. On return to NOC, it will be useful for an in depth analysis of these water movements by a physical oceanographer.

Due to bad weather, we moved to the Kemp seamount on the 5th of February, for a Swath survey. At this site we carried out 4 exploratory CTD casts to the N, S, E and W of the mount. None of these casts produced any evidence of hydrothermal activity. To check for any chemical anomalies, we fired Niskin bottles for methane analysis but the concentrations were within the background concentration range.

From the Kemp seamount we moved east to an area that had previously been identified from seismic data as a potential mud volcano. We performed a TowYo across the area and took samples for methane analyses, 10 to 15 m above the seabed, from North to South. Subsequent analysis of these samples showed no appreciable methane signals.

Leaving the area of the suspected mud volcano we proceeded to a caldera in Douglas Strait, that lies between Cook and Thule Islands in the South Sandwich Islands. This was a shallow area (~620 m in the middle of the caldera) and we carried out a series of CTD's in the crater with samples taken for the full suite of analyses. The samples showed high concentrations of methane and may be associated with the high level of organic matter at the seabed in this crater. There was additional evidence from the LSS for the presence of a potential hydrothermal source in the crater. Further analyses back at NOC should confirm whether this is the case.

Swath analyses over the Kemp seamount had identified the presence of a previously unknown caldera. After the work off Cook and Thule we moved to this area and carried out a couple of TowYo casts starting to the West of the caldera and descending into the centre. Samples were collected on each run and again a full suite of analyses both on board and back at NOCS. We found areas with very high LSS signals, more than four times those observed at the E2 and E9 segment.

Following the work at the newly discovered caldera we returned to the area to the South of South Georgia where we first identified methane anomalies in the water column to perform a more thorough study. We did a series of CTD casts over the site having identified that the area was more bathymetrically interesting than was previously thought. This survey took around 12 hours and samples were collected from 16 separate CTD deployments for the analysis of methane. These samples showed high levels of methane in the water column with some areas being more elevated than others; this data provided a number of sites to be further investigated using SHRIMP.

5.2.2. Water Analyses

5.2.2.1 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 occurs. 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. Samples of this headspace gas were taken and analysed using a 7850 Agilent Gas Chromatograph.

5.2.2.2 Total Fe and Mn

After methane sampling, samples for total metal analysis were collected in acid cleaned LDPE bottles, using trace metal techniques to avoid contamination. The bottles were rinsed with seawater from the CTD (3 times) before sample collection. These samples will be returned to NOCS, where they will be acidified prior to analysis.

5.2.2.3 Filtered Fe/Mn and phosphate

Approximately 140 frozen nutrient samples were collected, of which 40 were filtered into 30 and 60ml aliquots for phosphate / trace metal analysis back at NOCS.

These are detailed in Table 3 below.

Table 3. Frozen water samples

CTD Number	Number of bulk nutrient samples taken	Number of samples filtered for phosphate analysis	Number of samples filtered for Fe analysis
140 / 160 / 167	26	-	-
181	21	6	6
253	0	8	8
482 / 485	10	10	10
492 / 510	24	6	6

519	23	6	6
537	4	4	4

On board chemical analysis had some limited success, however some trace metal work showed erratic results, and so the majority of analyses will be performed at NOCS. Sensor deployment was hindered by problems with ancillary subsystems, although a bench-top system yielded desired results. A deep-sea control deployment with a phosphate analogue was performed, initial results of which are promising, however further analysis of these are required to reveal their full significance.

5.2.2.4 Nutrients

Samples for nutrient analysis were drawn from the CTD after all the other sampling. 30 ml samples were collected in plastic tubes and immediately frozen. These samples will be analysed back at NOCS using a nutrient autoanalyser.

5.2.2.5 Fe(II) analysis

Elevated concentrations of Fe and Mn exist in the end-member fluid but once the Fe(II) leaves the reduced sub-surface environment, it oxidises with the surrounding seawater. However, it has been suggested that a fraction of the Fe(II) is stabilised and has a slower oxidation rate than predicted from oxygen and hydroxyl concentrations. To investigate this further, it was hoped that during the sampling of the hydrothermal plumes, Fe(II) would be measurable in some of the ‘juicier’ and therefore younger plumes. During the cruise, three of the CTD casts demonstrated the presence of a young hydrothermal plume (CTD 181, 253 and 510). Samples were taken from the Niskin bottles immediately after the CTD was brought on deck into acid cleaned 1L Teflon bottles, after rinsing. A 25 ml fraction of this sample was then analysed for Fe(II) using the Ferrozine method (Stookey et al. 1971). This is a colour change reaction that can be detected using UV spectroscopy at 560 nm. After the reaction had completed the samples were analysed in a 10 cm cell (detection limit ~20 nM).

No Fe(II) was detected in any of the sample analysed, suggesting that either all the Fe(II) had oxidised or that it was in a form undetectable by the ferrozine method (e.g. very strong organic complexation).

5.2.3 Sensor development

5.2.3.1 Objectives

The primary objective was to deploy and evaluate under field conditions the mark 3 version of a newly designed Manganese sensor (Mn sensor). Deployments in realistic field conditions are crucial stages in a sensor development project, which will help identifying the limitations and issues associated with this type of deployment. Although the effects of temperature and pressure can be tested in laboratories, it is rather difficult to replicate their combined effect onto a system. The impact of the velocity of the CTD as well as the mechanical stress and constraints associated with tow-yo deployments cannot be modelled easily in the laboratory.

The sensor housing and the pressure compensating technology used to build the sensor will also be evaluated and revised if necessary.

A measurement strategy to overcome any pressure, CTD velocity or temperature dependence issues should emerge after the first set of deployments.

The secondary objective was the deployment and characterisation of a nutrient microsensor. Microsensor technology was tested and validated for the first time in October 2008 during D333 on the RRS *Discovery*. Valuable information on the performances of the sensor will be collected and the feedbacks will help in refining or revising the microsensor design.

5.2.3.2 Results

The Manganese sensor (Mn sensor) was deployed for a total of 41 hours at a maximum depth varying from 1000m to 3600m: two tow-yo's (CTD107 to CTD180, duration of 14 hours, maximum depth of 2600m and CTD184 to CTD253 duration of 17 hours, maximum depth of 2600m) and three CTD casts (CTD181, CTD182 and CTD183).

Critical component failure (of initial components and spares) forced us to abandon further deployments and to focus on the nutrient sensor.

In order to prevent additional failure of components, the nutrient sensor was assembled and tested on the bench initially, and then was deployed during CTD537 for 2 hours at a maximum depth of 1000m.

Issues due to the mechanical stress transferred to the sensor while tow-yoing were corrected after the first deployments. The compensating bladder attachment was modified to prevent any further failure, fluid leaks inside the housing were stopped and a leaking waterproof connector causing intermittent faults was replaced. Following a valve failure, a cleaning procedure was implemented. As seawater is evaporating when the sensor is not in use, salt crystals are formed leading to blockage and permanent damage of the valve. Rinsing the sensor with deionised water at the end of the deployment prevented further damage.

The pump, data logger and electronic driver, optical cell, pressure housing and valves were validated.

The bulk of the data collected during the CTD deployments of the Mn sensor is still being analysed. Preliminary results show a strong pressure dependence, which could be compensated for by in situ calibration and measurements at a fixed depth when practicable. Figure 10 shows the pressure effect on the system.

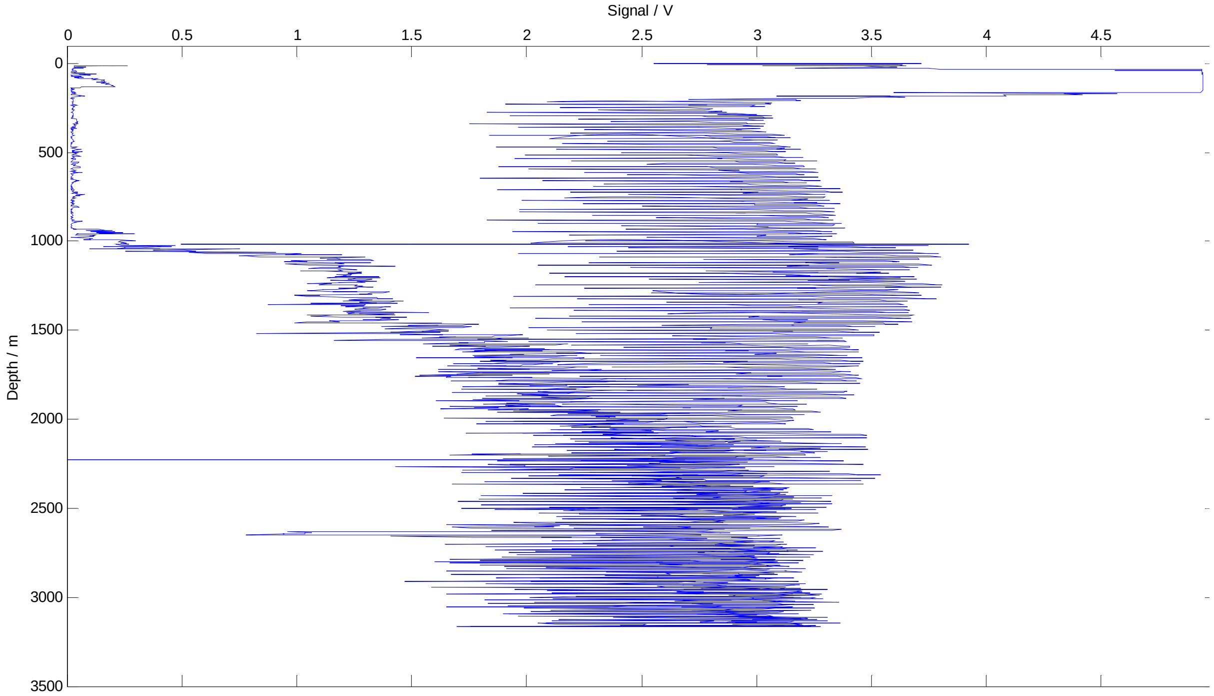

Figure 10. Pressure effect on the optical signal. The raw signal output of the optical cell is plotted versus pressure from the data acquired during CTD183. An amplitude variation of up to 2V was recorded. The same experiment in laboratory conditions shows a variation of less than 0.05V.

The nutrient sensor was assembled and initially tested on the bench to then be deployed during CTD537. The optical cell on the microfluidic chip, the pressure housing, data logger, driver and valves were validated. The system was maintained at 1000 m for 12 minutes during which an onboard standard was measured (blank). Working at a null CTD velocity and no pressure change allowed for the standard to be measured, however, this highlighted a potential issue with the pump and mixer showing reduced performances when operating at low temperature and high pressure. Further investigation is required in the laboratory.

Valuable information and experience that can only be gained from field deployment were obtained and will be fed back in a revised design to improve performance.

On a personal note I (Douglas Connelly) would like to express my gratitude to Sarah, David Alex and Cedric for all of the help they have given me during this cruise. Due to last minute changes we lost 2 experienced geochemists from the cruise, this was daunting to me, but with the help of Sarah, David, Alex and Cedric, all of whom went beyond the call of duty, this cruise was extremely successful. I would like to give a heartfelt thank you to them all.

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5.3 Biology

Jon Copley, Paul Tyler and Alex Rogers

5.3.1 SHRIMP observations

SHRIMP (Seabed High-Resolution IMaging Platform) was deployed for 12 dives, totalling 96 hours 27 minutes of bottom time, in the locations described below.

E2 segment

Based on information from the CTD casts, SHRIMP dives #1 and #2 examined the northern and southern sides respectively of a topographic high on the E2 segment.

The topographic high consisted of pillow lavas, often with a glassy appearance, with pelagic sediment cover in depressions and on horizontal surfaces. Sheet flows with some collapse features were observed to the NE of the topographic high during Dive #1, along with a further, separate small pillow mound.

Dive #2 explored a slope to the south of the topographic high, as well as examining the steep eastern wall of the axial valley, and the talus slope at its base. Dive #2 also encountered N-S fissures near the ridge axis, to the south of the topographic high.

Fauna observed on the basalts and ponded sediments included ophiuroids, octocorals (at least two common species: one white with a single slender stem, one purple and more bushy in appearance), small sylasterines, two common types of holothurians, macrourid fish, hexactinellid sponges, anemones, ascidians, stalked crinoids and an octopus.

An active high-temperature hydrothermal field was encountered during Dive #2. Examination of the vent field was constrained by the limited manoeuverability of SHRIMP; description of its fauna will therefore await a detailed survey with the *Isis* ROV in 2010. Initial observations suggest that the dominant species from Mid-Atlantic and Eastern Pacific vents are largely absent; aggregations of galatheids were observed in crevices and anemones observed on sulphides.

E9 segment

Three dives (#3, #4, #8) took place on the E9 segment, exploring the northern margin of its caldera and the ridge to its north. Dive #3 examined the seafloor NE of the caldera, where pillow basalts gave way to flat sheet flows and occasional outcrops of ropy lavas (pahoehoe) closer to the ridge axis. Dive #3 also descended the northern rim of the caldera, crossing a salient feature. The wall of the caldera consisted of split pillow basalts, with yellow and rust-coloured alteration on exposed surfaces, particularly on the undersides. The sheer wall of the caldera was also interrupted by a series of rubble ledges. Dive #3 also encountered fissures running N-S in predominantly sheet flows near the ridge axis to the north of the caldera.

Dive #4 examined an area further north, slightly to the east of the ridge axis, where pillow basalts and pahoehoe were apparent. Dive #8 began further north again, on the western margin of the ridge, encountering sediment-covered pillow basalts interrupted by ropy lavas and pahoehoe, before proceeding SE to inspect several topographic highs. N-S fissures were encountered to the east of these pillow-constructed features and eventually followed south towards the caldera, where the seafloor became predominantly sheet flow with collapse features.

Fauna inhabiting the basalts and sedimented areas included ophiuroids, holothurians (both in sediment ponds and on basalt outcrops; several genera were observed, including one specimen of *Enypniastes*), octocorals (white, single slender stem similar to E2), octacnemid ascidians, long-tentacled anemones, shrimp (?*Nematocarcinus*), brisingids, other asteroids, sponges, stalked crinoids, macrourid fish.

An extinct hydrothermal deposit was found east of the topographic highs examined during Dive #8. No signs of active venting were observed and the only fauna present were occasional brisingids occupying the edges of peaks of eroded sulphide edifices.

A separate, limited area of active venting was also encountered during Dive #8. Similar fauna were observed compared with the vent area examined at E2, with aggregations of stalked barnacles also apparent. Surveying was limited by the manoeuverability of SHRIMP and only one actively-venting structure was seen; the area and its fauna therefore require further investigation with the *Isis* ROV next year.

Kemp Seamount

Dive #5 examined the summit of "Kemp Seamount". Lots of particulate organic matter was observed in the water column during descent. The dive transect ran across the two peaks of the seamount and down the upper part of its flanks. Seabed was cobbled, with gravelly and coarse sedimented areas. Iceberg plough marks were apparent in shallower regions.

A high density of at least three species of ophiuroids was present on the upper slopes of the peaks. Other fauna included large yellow anemones, which were observed ingesting *Periphyla* medusae drifting across the surface of the seabed. Pennatulids (*Umbellula* *antarctica*), sabellids, stalked crinoids, nemerteans, aphroditid polychaetes were also observed. The upper flank of the seamount was dominated by beds of live and dead brachiopods (with occurrence of dead valves possibly increasing with depth), followed by a zone of sponges and octocorals at greater depth (possibly beyond ice keel scour depth).

Forearc putative mud volcano target

Dive #6 examined a possible "mud volcano" feature on the forearc, as suggested by a seismic profile. The seafloor observed during this short dive was sedimented and inhabited by several species of holothurians (including *Psychropotes*), asteroids, echinoids, stalked crinoids, shrimp and occasional macrourid fish.

Douglas Strait caldera

Dive #7 examined the caldera between Thule and Cook Islands. The seafloor in the caldera was sedimented with numerous patches of macroalgal detritus, including recognisable kelp fronds. Patches of fauna were associated with these macroalgal falls, including ascidians and anemones. Fish were sparse, with occasional nototheniods observed later during the dive.

New caldera

Dive #9 examined the newly-discovered caldera west of the Kemp seamount. A high abundance of nekton was observed in the water column during descent in the caldera. The dive made a single transect from the deepest part of the caldera to a topographic high within it, before climbing the caldera wall to the NW. The SHRIMP temperature sensor recorded 0.26 °C where it arrived on the seafloor at 1600 m deep. The seabed in the deeper part of the caldera was sedimented, interrupted by a series of basalt outcrops, giving way to cobbled seafloor closer to the topograhic high. This steep-sided feature consisted of basalts. The caldera wall also consisted of a series of sheer faces of hexagonal basalt pillars.

Holothurians (*Peniagone*) were abundant on the sedimented floor of the caldera, oriented in same direction, along with at least two other holothurian genera, occasional dense patches of cerianthids, and some asteroids. The basalt outcrops were dominated by dense coverage of ophiuroids, with brisingids and other suspension feeders (e.g. *Xenia*, sponges, anemones) occasionally also present. The cobbled ground towards the topographic high was dominated by ascidians and shrimp. Bacterial mats on were observed on the underside of basalts of the topographic high, with ascidians, spotted holothurians, macrourids also present. Two ray were also observed during the dive and SHRIMP appeared to be followed by a squid for several hours. The more sedimented, flatter top of the topographic high was inhibited by ophiuroids, giving way to ascidians again during the descent onto its steeper sides, with occasional asteroids, echinoids, tubed polychaetes and soft coral. The wall of the caldera was dominated by ophiacanthids, particularly on basalt blocks at the base of the wall of hexagonal columns, which was itself occupied by yellow tube sponges, brisingids on upper edges of steps and more ophiacanthids.

South Georgia shelf

Dive #10 investigated a mound discovered on the South Georgia shelf, where methane signals were apparent from CTD casts. A dense swarm of krill was encountered during descent, which then followed the camera sled for most of the dive and obscured vision when SHRIMP was stationary on the seabed. The dive undertook two transects across the bipartite mound feature, before exploring its margins and the seafloor to the SE. The seabed off the mound was sedimented. Patches of hard substratum found on the mound, most apparent on the steeper slopes of its flanks. Patches of fauna associated with these areas included anemones, sponges, octocorals, euryalid ophiuroids, large stalked ascidians. Asteroids (and feeding pits) and large aphroditid polychaetes were also observed. Several species of fish were observed, including nototheniods possibly associated with scour features near anemones. Seabed striations off the mound were suggestive of possible trawling or recent grounding of a large iceberg.

Southeastern Shag Rocks Bank

Dives #11 and #12 investigated the southeastern margin of Shag Rocks Bank, where high levels of coral by-catch had been recorded during commercial trawling.

5.3.2 Biological water sampling (Alex Rogers)

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 porewater. The objective of the microbiology sampling on JR224 was to obtain initial samples for analyses of prokaryotic diversity associated with hydrothermal vent plumes and the waters above other chemosynthetic habitats. The samples will be subject to study using denaturing gradient gel electrophoresis (DGGE) and clone library approaches. DGGE enables the assessment of differences in the dominant members of microbial communities between samples. Clone library approaches enable a direct assessment of microbial diversity through amplification and sequencing of the prokaryote small subunit RNA region. Sequences from samples will then be compared with known SSU sequences and amongst samples giving an initial idea of microbial diversity of the Scotia Sea chemosynthetic communities and the relationship of Southern Ocean / Antarctic sites with chemosynthetic communities from the Pacific, Atlantic and Indian Oceans and the Arctic.

Materials and methods

All filtration equipment was washed thoroughly in ultrapure distilled water and then rinsed three times in the water from which samples were taken. 1-2 litres of water were taken from each CTD bottle sampled and then filtered using a Sartorius Model D3400 vacuum filtration unit (Sartorius UK, Epsom, United Kingdom). Initially samples were prefiltered using Whatman 47mm GF/D glass fibre microfilters and then filtered using Whatman 47mm 0.2 µm cellulose nitrate membranes (Whatman International Ltd., Maidstone, Kent, United Kingdom). However, because of the limited number of vacuum filtration units available and their limited capacity (250ml) prefiltration was dispensed with after the first set of samples. All filter membranes were placed in 50ml Sterilin vials (Sterilin, Aberbargoed, Caerphilly, United Kingdom), labelled and then frozen at -80^{o}C temperature for transport back to the U.K. Where possible samples were taken from vent plumes and, as a control, from above plumes although it is recognised that bacteria from chemosynthetic habitats may be found throughout the water column in areas adjacent to vent or seep sites. For details of all samples see Appendix 6.

6. List of Scientific Equipment Used

6.1 Echo Sounders

Kongsberg Simrad EM120 multibeam echo sounder

Kongsberg Simrad TOPAS PS018 sub-bottom profiler

Kongsberg Simrad EA600 (Bridge navigational echo sounder)

Kongsberg Simrad EK60 echo sounder

Kongsberg Simrad synchronizing unit (SSU)

6.2 Oceanographic instruments

Seabird Conductivity-Temperature-Depth (CTD) system, also including light scattering sensor, oxygen sensor, fluorometer, transmissometer, PAR sensor and altimeter

BRIDGET (towed CTD including light scattering sensor, transmissometer, oxygen sensor, eH sensor and altimeter)

RDI 75 kHz Acoustic Doppler Current Profiler (ADCP)

BAS Oceanlogger, including thermosalinograph, fluorometer, uncontaminated seawater intake thermometer, air temperature thermometer and anemometer

Sea-floor photography

SHRIMP (Seabed High-Resolution Imaging Platform), including Bowtech, Simrad and camcorder video cameras and integral CTD

6.4 Winches and wire monitoring

30-tonne traction winch, ship’s conducting cable and CLAM wire monitoring system

Hydrographic wire, 10-tonne traction winch and CLAM wire monitoring system

NMF fibre-optic cable and deck-mounted winch

6.5 Coring, dredging and trawling equipment

Duncan and Associates box corer (300 mm square box)

6.6 Potential Field Equipment

Shipboard three-component magnetometer (STCM)

SeaSpy towed Overhauser magnetometer

6.7 Navigation

Seatex Seapath 200 (input to EM120 and TOPAS)

Furuno GP-32 GPS receiver

Ashtech GG24 GPS+GLONASS receiver

Ashtech GDU-5 3D GPS receiver

TSS300 heave, roll and pitch sensor

Chernikeeff Aquaprobe Mk5 electromagnetic speed log

Sperry Doppler speed log

Gyro

Sonardyne ultra-short baseline (USBL) acoustic navigation system

6.8 Data Logging

NOAA Scientific Computer System (SCS) system

7. Equipment performance

7.1 EM120 multibeam echo sounder (A.G.C. Graham)

Logging of EM120 data was initiated at 1445Z on J-day 015, east of Punta Arenas. The system was operated at virtually all times when the vessel was in motion. Logging was stopped at 0900Z on day 049.

7.1.1 Standard settings

For the majority of the cruise, 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. Under favourable conditions, beam angles were set as wide as 65º, 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. This was particularly found to be a problem on beams on the 'upslope' side of the ship when running parallel to a steep slope, probably because in this situation the multiple reflection can be stronger than the primary one. Sound velocity profiles were changed appropriate to the water structure of the survey area (see Table 5.1).

7.1.2 Problems encountered

Two minor problems were encountered with the EM120 on the cruise:

In work areas with acute (steep) seafloor slopes, the EM120 had great difficulty in 'looking upslope' at seafloor targets, particularly where these lay in its outer beams. The result was often spurious pings at the swath edges, mainly due to the EM120 picking the multiple seafloor reflection (which may have a stronger signal than the actual return). This is not a fault with the EM120 *per se*, but highlights the difficulty of distinguishing a weak, highly oblique primary reflection from a stronger, less oblique multiple reflection. To counter unwanted noise, we found the best remedy was to simply narrow the beam angles where multiples were being encountered; else, reducing the maximum depth to a limit inside the range of the seafloor multiple can usually reduce the problem.

East of the Kemp Seamount, in rough seas on day 036, the EM120 could not find the sea-floor reflection, despite attempts at forcing the depth, narrowing the beams, and stopping/restarting logging (i.e., standard procedures for such a situation). Our southwestwards track south turned to a westerly heading, and the problem was immediately rectified without any further action being taken. It was concluded that on our southwesterly heading, the ship had an unusual set of >10 degrees (measured up to 17 degrees at the time, with wind of >40 knots on the beam) forcing large amounts of air under the ship. In similar future scenarios, it would be advisable to conduct swath survey, if possible, on a heading that avoids excessive set (N.B. the Kongsberg-Simrad manuals provide the same advice).

7.2 TOPAS Sub-bottom profiler (A.G.C. Graham)

Logging was started at 1600Z on day 015, and used on an as-required basis until 2300Z on day 045.

7.2.1 Standard settings

Typical parameter settings on the control workstation are listed in Appendix A5. In shallow water (<1500 m), the TOPAS trigger was generally operated in a synchronized mode through the SSU. Occasionally in greater water depths, TOPAS was operated with an internal trigger in order to obtain pings sufficiently close together to produce a reasonable profile. In these situations, care was taken to select a trigger interval that the EM120 ping cycle time is not an exact multiple of, which is known to cause unwanted TOPAS interference on the EM120. In most cases, the TOPAS system was operated using a chirp source, with source signal strength of 95%. A time-variable gain (TVG) and acquisition gain adjustments were used to improve imaging of the sea floor on the screen display and on the analogue (to paper) plotter.

7.2.2 Problems encountered

The single problem encountered with TOPAS on JR224 was a failed fuse in the transducer box on day 042, which caused a temporary loss of power to the system. Once replaced, the TOPAS system functioned as normal.

On several cruises over the past four years, 100 Hz noise has been reported in the raw TOPAS data, which was particularly in resulting profiles when using the system in ‘Ricker’ or ‘burst’ transmission modes. We note no similar evidence for the noise problem on this cruise (having used several different modes), suggesting that either the problem was resolved by work carried out in refit, or it is triggered by conditions not encountered on this cruise.

7.3 EA600 Echo Sounder (A.G.C. Graham)

The Kongsberg EA600 12 kHz echo sounder, the control console for which is located on the Bridge, was used for navigational purposes. Depths recorded by the system were all calculated using a constant assumed acoustic velocity of 1500 ms^{-1} and were logged on the NOAA SCS logging system. The calculated depths were unreliable when the TOPAS system was being used with an internal trigger, as the TOPAS signal confuses the automatic depth picking process. For most of the cruise the EA600 was triggered by the SSU, synchronized with the EM120, and operated in ‘passive’ mode, with the EA600 calculating its depth from the EM120’s first return. On the rare occasion that the Bridge used the EA600 for navigation (e.g., in shallower water), the EA600 was switched to an ‘active’ mode and internal trigger.

7.4 EK60 echo sounder (D.D. Willis)

The EK60 was operated intermittently during the cruise and controlled through the SSU. The EK60 suffered a number of software failures that resulted in management software closing down without warning and the SSU holding up the other sounders because it was not receiving a completion signal from the EK60. The software needed to be re-started and the sounders re-synchronised with the SSU. The compressing by the Echolog60 worked fine.

It was noted that during the initial setup of the system it was using a previous cruise name, JR188, for the file names. This was corrected.

Table 4. Summary of EK60 logging gaps:

Date	Comment
18/01/09 14:41	Data logging started
20/01/09 10:13	Software crash. Data hole 52 minutes
20/01/09 11:36	Software crash. Data hole 41 minutes
28/01/09 00:10	Software crash. Data hole 1 day, 7 hours and 8 minutes
29/01/09 13:24	Software crash. Data hole 31 minutes
29/01/09 14:35	Software crash. Data hole 7 hours 36 minutes

31/01/09 06:26	Software crash. Data hole 4 hours 35 minutes minutes
04/02/09 08:08	Software crash. Data hole 4 hours 13 minutes
05/02/09 00:36	Software crash. Data hole 28 minutes
05/02/09 14:48	Software crash. Data hole 42 minutes
05/02/09 15:36	Software crash. Data hole 10 minutes
06/02/09 04:34	Software crash. Data hole 16 minutes
06/02/09 23:09	Software crash. Data hole 1 day 18 hours 51 minutes
09/02/09 20:45	Software crash. Data hole 1 hour 8 minutes
12/02/09 04:03	Software crash. Data hole 4 hours 47 minutes
12/02/09 11:39	Software crash. Data hole 3 hours 38 minutes
14/02/09 10:22	Software crash. Data hole 2 hours 24 minutes

The EK60 system crashed a number of times without clear indication of the cause. On investigation it was noted that there was a continuing fault being registered in the application event log reporting that a registry corruption could not be repaired due to a lack of disk space on the C drive. The C drive is configured with only a 2GB partition which is far too small to accommodate the OS and applications while leaving space for system functions. As a temporary measure the swap file was relocated onto the D drive and non-critical software was uninstalled and compression was enabled on the C drive. This seems to have been sufficient to allow the system to recover the registry.

7.5 Box corer (A.G.C. Graham)

The BAS box-corer (BC) was used to recover undisturbed sea-floor surface sediments in the vicinity of a suspected cold seep site on the South Georgia continental shelf. The box-corer performed well during the cruise, but was only used at two sites. On both deployments (BC524 and BC525) south of Bird Island (JD 044 and 045), a relatively low recovery (between 22-30 cm) was achieved, but adequate sub-cores were obtained from each none-the-less (between 14-23 cm in length). The methods employed for sub-core recovery followed those adopted and refined on previous BAS cruises (e.g. JR141, JR179), and now work seamlessly and effectively. For BC525, the spades had to be opened, and the sub-core liners pushed through to the base to facilitate extraction (2 of the 4 initial attempts to take sub-cores having failed during first attempts at extraction). Despite having a different liner and end caps to previous outings, the work on-deck went smoothly. Past observations that the box-corer has a tendency to fall over at the seabed (see JR179 cruise report), were not repeated on this cruise.

7.6 Cable Logging and Monitoring (CLAM) system (R.D. Larter)

The CLAM system was used for monitoring the amount of wire out, hauling and veering rates and wire tension while doing CTD casts and box coring. It would be helpful for coring operations if there was an option to expand the y-axis of the wire tension display to use the full height of the screen, as only the lower half of the 10-tonne scale is used during most wire operations.

7.7 BRIDGET (P.J. Mason)

BRIDGET is a towed vehicle that houses many sensors whose data is transmitted via the ships deep tow conducting cable to the surface, where it is logged and displayed.

BRIDGET was configured to carry the following sensors for this cruise….

- CTD
- Light scattering sensor
- Transmissometer
- Nephelometer
- Eh Sensor
- Mg Sensor
- Fe Sensor
- Altimeter
- Heading and Attitude

Initially the system had a communication problem through the ship's deep tow cable. This was due to its modem being dependent upon the characteristics of the tow cable. This was addressed and then data passed reliably up and down the cable.

After the first deployment the cable had a cat's paw in it and needed to be re-terminated. On the next deployment it was noticed that there was a twist in the cable. The vehicle was floated round on deck two complete turns to remove this twist. From then on the vehicle never showed any signs of twisting the cable when recovered on deck.

The first brief dive showed that although BRIDGET was operating well the data displayed on the surface had the wrong variable names and calibrations associated with them. This was addressed so that subsequent dives had the correct displays for the respective sensors.

Sensors for Mg and Fe were not made available to complete the full set of instruments that had been intended to be operated on BRIDGET during this cruise.

One problem that was not overcome was that the Eh sensor's data was displayed as raw data in the control dialogue box but was not displayed or logged, along with all the other data. Due to the failure of the ship's conducting cable storage drum on 26th January, this problem was not pursued; the sensor was removed and installed on the SHRIMP instrument for subsequent deployments (see section 7.10).

BRIDGET completed four successful dives and produced good data that was used to help locate the positions of likely vent sites. However, on the second and third dives the LSS data were degraded by cross-talk from a USBL beacon that had been connected to a power upply on the vehicle (see section 5.2.1). Plots of relevant data were produced when interesting features were observed.

The logged data were transferred onto the 'legdata' drive on the ship's network for communal access.

7.8 Conductivity Temperature Depth (CTD) System (D.P. Connelly)

The CTD system used was a Seabird 911 with a 24-bottle rosette. The bottles were internally sprung Niskin bottles with a Teflon coated spring. With the exception of CTD468 the CTD functioned well. CTD 468 surfaced with 2 bottles missing and a third was damaged, the cause of this is unknown, most likely the CTD rosette hit the bottom of the ship on the way up.

7.9 Seabed High-Resolution IMaging Platform (SHRIMP) (J.S.P. Cooper)

7.9.1 Specification

Figure 11. The SHRIMP camera sled

Main Umbilical cables

Power : 2 x Burton 3pin male // Burton 3pin male high voltage cables

Video/data : 1 x DGO'Brian single mode fibre link female /female

Instrumentation

Video/Data : Focal 901 fibre optic video/data multiplexer

Cameras : 1 x Simrad Kongsberg SIT (Not Operational)

1 x Forward looking Simrad Kongsberg Colour CCD

1 x Downward looking Bowtech Mini cam

1 x Downward looking 3 chip camera recorder

Lights : 2 x Deep sea power and light 400Watt HID lamps

Echo sounder : 1 Mesotech 808 300Khz echo sounder, approx 200m range

CTD : Seabird SBE37 CTD

Subsea Transformer Housing (SHRIMP FRAME)

Rating : 1,500Volt AC step down to 240VAC

Connectors: 2 x Burton pin plug for 1,500 Live/Neutral

1 x 3pin Subconn Impulse ILB3 high current battery plug

7.9.2 Camera Details

7.9.2.1 SIMRAD PAL colour CCD camera (type OE1364)

Mounted on the forward section of the frame, inclined at approximately -45˚ from horizontal (i.e. forward and down)

The camera specification is as follows,

Sensor type	:	Interline-transfer CCD(752 x 582 picture elements)
Scanning	:	625 50Hz PAL
Resolution	:	460 lines horizontal
Light sensitivity limit	:	0.1Lux
Lens	:	6mm f1.4
Focus	:	50mm to infinity
Angle of view	:	56˚ diagonal in water

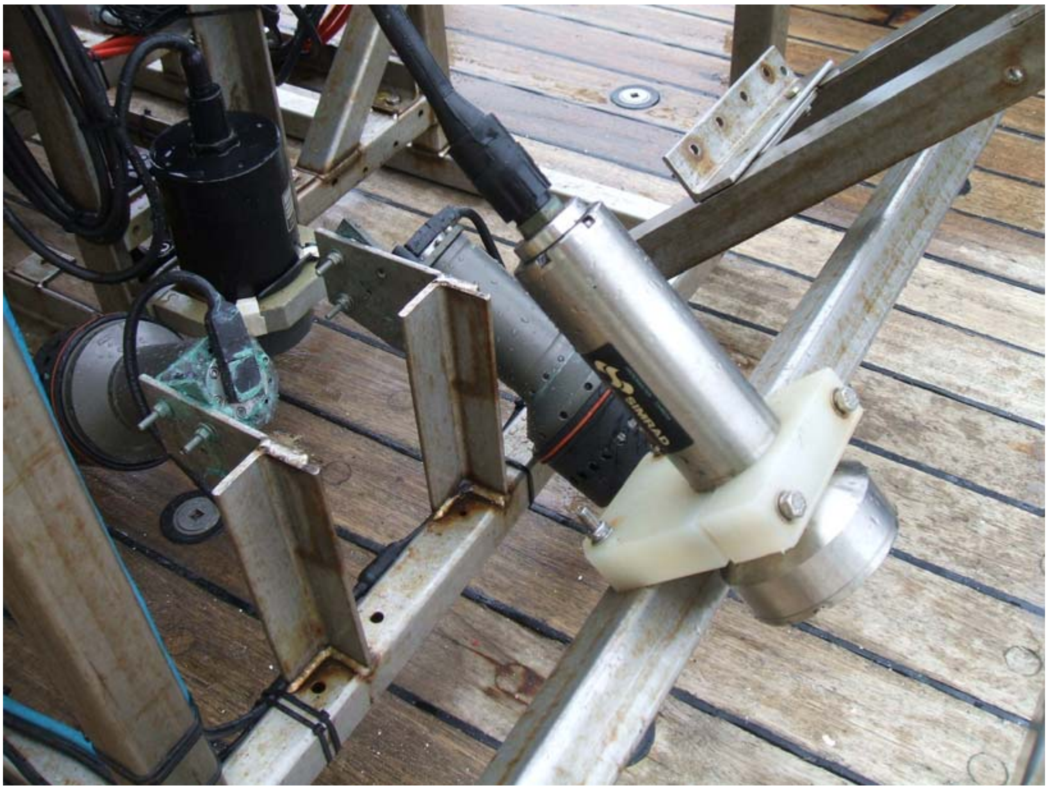

Figure 12. View of the front of the SHRIMP frame showing the forward looking SIMRAD camera the two SeaArc 400Watt lamps

7.9.2.2 Domestic 3 chip Panasonic camcorder

Situated just in front of the BOWTECH camera (see 7.9.2.3) and facing vertically downwards.

When video is displayed on the deck unit monitor, the top of the video screen represents the side of the camera closest to the front of the frame.

7.9.2.3 BOWTECH PAL colour CCD camera (type L3C-550)

Mounted at the rear of the camera sled frame and facing vertically downwards.

When video is displayed on the deck unit monitor, the top of the video screen represents the side of the camera closest to the front of the frame.

The camera specification is as follows,

Sensor type	:	1/3” Sony CCD
Scanning	:	625 50Hz PAL
Light sensitivity limit	:	0.1Lux
Lens	:	2.9mm f1.4
Focus	:	100mm to infinity
Angle of view	:	92 diagonal in air, 65 diagonal in water

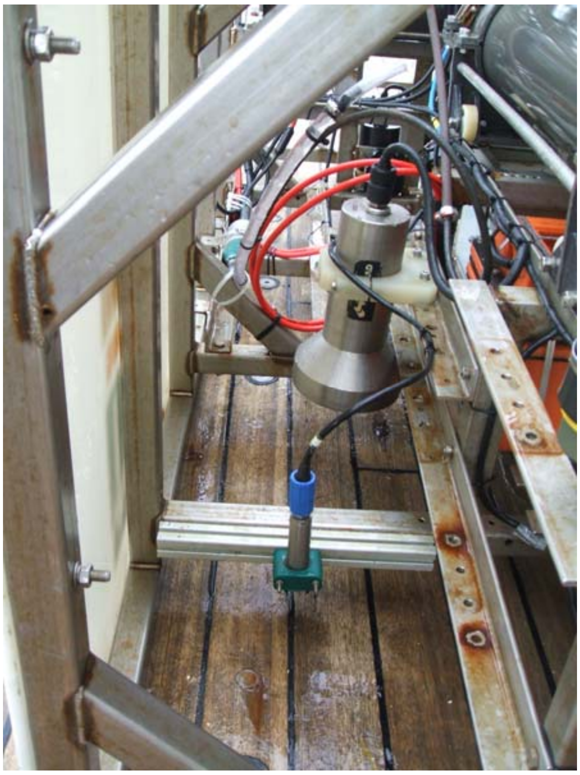

Figure 13. View from the rear of the SHRIMP frame showing the downward facing BOWTECH camera (foreground) and the larger silver pressure vessel holding the domestic camcorder.

7.9.3 Lighting

Two ‘Deep sea power and light’ 400 watt high intensity discharge SeaArc lamps are used for lighting. One is mounted facing down and rear, to provide illumination for the downward facing cameras. The other is mounted forward and down for the Simrad forward looking camera.

The lamp specification is as follows,

Lamp wattage	:	400W
Lumens	:	32,000
Luminous efficiency (lum/W)	:	80
Bulb	:	Daylight, temperature 5600˚K

7.9.4 SEABIRD SBE 37 SIP MicroCAT CTD

On one of the plastic vertical side panels, a Seabird CTD is mounted. The unit is set to autonomous sampling mode, transmitting data to the deck PC at 1 Hz. Initial clock, date and work area latitude values (to calculate depth) are entered and stored at the beginning of each dive.

7.9.5 SHRIMP frame

The SHRIMP sled is a rectangular stainless steel frame with two main pressure tubes mounted within. One tube houses the fibre optic multiplexer, the other houses the power systems and lighting ballasts. A pressure compensated casing containing the main transformer is fitted just underneath the main power tube.

Figure 14. The main pressure compensated power transformer housing, situated just under the main pressure tube.

The frame is attached to the fibre optic tow cable via four lengths of chain link to a central attachment point on the fibre optic tow cable mechanical termination. The gross mass of the frame and pressure tubes is approximately half a tonne in air.

7.9.6 Time stamping for video tape (P.J. Mason)

A technique to write the date and time onto the left audio channel of the video recordings was developed. This was achieved via a programme written in labview. Another programme was written to read back and display this data when the video was replayed. This technique records just the date and time and will be expanded upon for future cruises that use video recorders.

7.10 Eh sensor (P.J. Mason)

The Eh Sensor was on loan from a Japanese collaborator and intended to be used with BRIDGET. However, due to the failure of the ship’s conducting cable storage drum and the abandoning of further BRIDGET deployments, it was removed and installed on the SHRIMP vehicle.

Prior to SHRIMP dive #10, the Eh sensor was connected to SHRIMP’s compass port and powered from a 24V battery . A special lead was made up that incorporated a 15 V power supply to operate the instrument from. Three programmes were written; to read the serial data, to timestamp and log these data to disc and to display the data in real time. The installation and software worked well for the remaining SHRIMP dives. The Eh data was transferred onto the ‘legdata’ drive on the ship’s network for general access.

7.11 Acoustic Doppler Current Profiler (D.D. Willis)

7.11.1 Introduction

RRS *James Clark Ross* has a 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP.

The OS75, in principle, is capable of profiling to deep levels in the water column, and can also be configured to run in either narrowband or broadband modes.

Logging of ADCP data was only started on day 041, and continued until day 049.

7.11.2 Instrument and configuration

The OS75 unit is sited in the transducer well in the hull of the *JCR*. This is flooded with a mixture of 90% de-ionised water and 10% monopropylene glycol. The new OS75 unit uses a phased array transducer that produces all four beams from a single aperture at specific angles. A consequence of the way the beams are formed is that horizontal velocities derived using this instrument are independent of the speed of sound (vertical velocities, on the other hand, are not), hence this correction is no longer required.

The OS75 transducer on the *JCR* is aligned at approximately 60 degrees relative to the centre line. This differs from the recommended 45 degrees. The hull depth was measured by Robert Patterson (Chief Officer) on a previous cruise, and found to be 6.47m. Combined with a value for the distance of the transducer behind the sea-chest window of 100-200 mm and a window thickness of 50 mm, this implies a transducer depth of 6.3m. This is the value assumed for JR224. The heading feed to the OS75 is the heading from the Seapath GPS unit.

The OS75 was controlled using Version 1.42 of the RDI VmDas software. The logging PC also had Version 1.13 of the RDI WinADCP software installed.

The OS75 ran in two modes during JR224: narrowband (with bottom-tracking on) and narrowband (with bottom-tracking off). Both modes were enabled with sixty-five 16-metre bins. Narrowband profiling was also enabled with an 8- metre blanking distance. The time between pings was set to 2 seconds. Salinity at the transducer was set to zero, and Beam 3 misalignment was set to 60.08 degrees (see above discussion). The full configuration files for each of the modes used are given in the Appendix.

7.11.3 Notes for Instrument Setup

Set up the ADCP to run in narrowband mode

Open VMDAS

> file > collect data

> options > edit data options

ADCP setup tab: ADCP set up from file (using required command file)

set time between ensembles to 2 seconds

Recording tab: name: JR224_ (filenames will then update in correct format)

number:1

max size: 10

dual output directories: U: drive (making unix the primary drive)

C: local (as secondary drive)

Transform tab: heading source: nmea/prdid

tilt source: fixes tilts 0, 0

Command Files should have line of code added to run the ADCP through the SSU:

; Set Trigger In/Out [ADCP run through SSU]

CX1,3

ADCP needs to be pinging every five seconds or faster for decent data - can be checked by looking at *N1R files and picking out lines starting $PADCP

7.11.4 Outputs

The ADCP writes files to a network drive that is samba-mounted from the Unix system. (Should the network fail, there is an alternative write path to the local ADCP PC hard drive to preserve data until the link is restored). When the Unix system is accessed (via samba) from a separate networked PC, this enables post-processing of the data without the need to move files.

Output files are of the form jr224_XXX_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte.

ZZZ are the filename extensions, and are of the form:-

.N1R (NMEA telegram + ADCP timestamp; ASCII)

.ENR (Beam coodinate single-ping data; binary)

.VMO (VmDas configuation; ASCII)

.NMS (Navigation and attitude; binary)

.ENS (Beam coordinate single-ping data + NMEA data; binary)

.LOG (Log of ADCP communication and VmDas error; ASCII)

.ENX (Earth coordinate single-ping data; binary)

.STA (Earth coordinate short-term averaged data; binary)

.LTA (Earth coordinate long-term averaged data; binary)

7.12 Expendable Bathythermograph (XBT) System (R.D. Larter)

XBT probes were taken on the cruise so that they could be used to derive sound velocity profiles (SVPs) for input to the EM120 multibeam echo sounder. However, adequate SVPs were available from XBTs deployed on previous cruises (used only for SVPs during collection of data on passage) and from CTD casts carried out during this cruise. Thus no XBT probes were deployed during the cruise and the XBT system was not used.

7.13 Oceanlogger (R.D. Larter)

The Oceanlogger was operated during the cruise in order to monitor changes in surface water properties that could affect sound propagation, and hence indicate when it might be necessary to change the SVP being used by the EM120 multibeam echo sounder.

The flow of uncontaminated sea water that is required by the Oceanlogger was interrupted at about 0000Z on 21st January and was not restarted until about 1200Z the same day, so the water properties recorded during this period are unreliable.

7.14 Magnetometers (R.D. Larter)

Two magnetometer systems were operated during the cruise:

7.14.1 SeaSpy Overhauser Magnetometer

The SeaSpy magnetometer was deployed over the port quarter during most of the passage to the East Scotia Sea and the return passage from Shag Rocks Bank (days 015–021 and 046–048). Data were logged to the SCS. No data were recorded during the first trail deployement on day 015 because of an error in the way the cable was connected to the front of the towfish, so the first data were recorded on day 017 after departing from the Falkland Islands.

7.14.2 Shipboard Three-Component Magnetometer (STCM)

The STCM operated continuously throughout the cruise. There is still no data feed from the STCM to the SCS, so data had to be downloaded separately from the PC that controls the system.

Navigation Systems (R.D. Larter)

The navigation systems on board comprised:

7.15.1 Seapath System

This combined GPS and motion reference unit provides navigational data for the Kongsberg EM120 multibeam and TOPAS sub-bottom profiler systems. In previous seasons differential corrections were obtained from a Racal Skyfix unit via an Inmarsat feed and applied in real time by the GPS receiver. However, the subscription to the Skyfix service has been discontinued, so differential GPS data were not available during this cruise. Data from this unit were logged onto both the Kongsberg EM120 system and the NOAA Scientific Computing System (SCS).

7.15.2 Furuno GP-32 GPS Receiver

This GPS receiver is located on the Bridge and used primarily for navigation. The position fixes from the unit were logged to the NOAA SCS.

7.15.3 Ashtech GG24 GPS/GLONASS Receiver

This was operated throughout the cruise and position fixes calculated by this system were logged to the NOAA SCS.

7.15.4 Ashtech G12 GPS System

This dual redundant GPS unit is used by the ship's dynamic positioning system.

7.15.5 Ashtech GDU-5 3D GPS and TSS300 Systems

These instruments provide heading, pitch, roll and heave information. Data from both systems were logged to the NOAA SCS. This 3D GPS system regularly (approx every 5 days) stopped outputting heading information and required power cycling (see ICT report, section 8.1).

7.15.6 Sonardyne Ultra-Short Baseline (USBL) Acoustic Navigation System

The deep-water USBL beacon was mounted on BRIDGET, SHRIMP and the CTD during most deployments of these instruments in order to track their position. The resulting positional data were logged to the SCS system.

The USBL transducers on *JCR* are mounted on a retractable pole that is deployed through a gate valve in the hull. During this cruise the transducers were usually deployed to a position approximately flush with the hull and this proved to be adequate to track the deployed instruments. The positional data include a small number of clear outliers and exhibit some short period variation, but acceptable track data for the deployed instruments can be obtained by rejection of the outliers and appropriate filtering of the remaining data. The real-time data, also proved effective for navigating SHRIMP in the vicinity of vent sites. Once the position of a site had been noted it proved possible to cross and re-cross it with SHRIMP by specifying ship movements, controlled through the Dynamic Positioning System (DPS), of a few tens of metres. The results achieved through the combined use of SHRIMP, USBL navigation and the DPS are technological, as well as a scientific, triumph.

We were surprised to discover during the cruise that BAS only has one USBL beacon that is rated to ocean depths (>1000 m). Considering the investment in the system, the provision of a single deep-water beacon seems rather short sighted. Failure or loss of the beacon would have had serious consequences for the objectives of this cruise. Furthermore, the relatively short battery life of the beacon (c. 12 hours) was a limit on operations. In an attempt to overcome this limitation the beacon was connected to a power supply on the BRIDGET vehicle, but the charging and discharging of the beacon with each ping caused cross talk on the LSS data. Therefore, it was necessary to revert to using the beacon on battery power, recharging it between deployments. The recharging time (c. 2 hours) then became a limitation on operations which had to be accommodated.

7.16 NOAA Shipboard Computing System (R.D. Larter and D.D. Willis)

Since the summer of 2000, the main shipboard data logging system on *JCR* has been a Windows-based system provided by the U.S. National Oceanic and Atmospheric Administration (NOAA), called the Scientific Computer System (SCS). The SCS program allows data to be logged centrally on a server featuring RAID disk tolerance. Time stamping of data is achieved by synchronising to a GPS receiver. The SCS is also a NTP server which allows other machines onboard to synchronise their time.

Data on the SCS system is stored in two formats:

RAW data written to disk in exactly the same format it was sent from the instrument.

ACO ASCII Comma Delimited, data is stored in plain ASCII text.

Once the Data has been logged to disk the ACO files are exported to the Level C of the former ABC data logging system using NFS. A process on the Level C reads the data in and writes to the Level C database. The Level C continues to be used to allow scientists to use existing routines to extract data.

The following data streams were logged to the SCS during JR224:

Stream name	Data Source
gps_glos	Ashtech GG24 GPS/GLONASS Receiver
gps_ash	Ashtech 3D GPS

gps_nmea	Furuno GP-32 GPS Receiver
anemom	Anemometer
tsshrp	TSS300 heave, roll and pitch sensor
oceanlog	Oceanlogger
em_log	Chernikeeff Aquaprobe Mk5 electromagnetic speed log
dop_log	Sperry doppler speed log (water speed)
sim500	Kongsberg Simrad EA600 single-beam echo sounder (12 kHz)
em120	Kongsberg Simrad EM120 multibeam echo sounder (12 kHz)
winch	Cable Logging and Monitoring (CLAM) System
seatex	Seapath combined differential GPS and motion reference unit
seaspy	SeaSpy towed Overhauser magnetometer
gyro	Gyro
usbl	Sonardyne USBL acoustic navigation system
streamstates	Status log of other data streams

8. ICT and AME reports

8.1 ICT report

D.D. Willis

A short summary of ICT systems and any problems/resolutions during the JR224 cruise.

8.1.1 Netware

JRNA is unable to perform the background sync to the hot spare server due to a problem while running vcbSnapshot. This is being investigated hopefully a solution will be found in due time.

During the change over to vmware the open file backup option needed to be disabled due to issues with the Netware nss disk system and the VMWare file systems. Unfortunately there was a requirement to restore two files for the ship's Master that he keeps open 24 hours a day and they were not on tape at all. There is a new backup system being worked on in Cambridge that should address this issue.

8.1.2 Unix

Installed the latest versions of GMT/NetCDF and MB software on jrua.

Installed phpldapadmin on jrlb to make UNUX user management easier. http://jrlb/phpldapadmin

Installed MRTG on jrlb to monitor the squid cache on JRLA and to monitor the wan link usage. http://jrlb/mrtg/jcr/squid & http://jrlb/mrtg/jcr

The Neptune processing system suffered a spillage in the keyboard that has stopped a number of keys on the numeric keypad and navigation keys working. This will require the keyboard to be replaced during refit.

8.1.3 SCS Logging System / Data Logging

The Ashtech 3D GPS regularly (approx every 5 days) stops outputting heading information and requires power cycling.

Table 5. Ashtech 3D GPS data acquisition events

Data Acquisition Events	
Date / Time	*Event / Reason*
06/01/2009	Data logging started
07/01/2009 12:34:00	Data logging stopped due to power problems
07/01/2009 13:35:30	Data logging resumed
07/01/2009 14:58:00	Data logging stopped due to repairs on prop motor
07/01/2009 18:48:30	Data logging resumed.
09/01/2009 16:27:12	ADU5 reset as not sending heading. Gap in data between 07/01/2009 07:58:47 and 09/01/2009 16:27:11
11/01/2009 11:39:30	Data logging stopped due to maintenance works
11/01/2009 14:16:00	Data logging restarted
15/01/2009 11:50:00	ADU5 not sending heading. Gap in data between 10:36:34 and 11:50:10
20/01/2009 11:13:00	ADU5 not sending heading. Gap in data between 20/01/2009 10:39:34 and 20/01/2009 11:11:52
20/01/2009 14:09	EA600 is having an intermittent fault sending the under hull depth stream to the scs.
21/01/2009 23:30	Connected USBL to SCS and started logging ROV position information
24/01/2009	ADU5 not sending heading. Gap in data between 24/01/2009 03:07:08 and 24/01/2009 11:02:01
30/01/2009	ADU5 not sending heading. Gap in data between 30/01/2009 21:50:24 and 31/01/2009 06:12:13

8.1.4 USBL Data.

The USBL system is able to output a GGA string for the position of the beacon being tracked. The USBL system was connected to the scientific wiring and then to the SCS system

USBL port 5A -> Science wiring port AFYO/G2 -> Uplink port 6 -> SCS port 26

A data stream was created in the SCS config file with the same parameters as the seatex GGA string and this was also replicated in the rvs system. The scs2levc.xml file was modified to import the new data stream.

8.1.5 EK60

The EK60 system was run during the cruise and crashed a number of times without clear indication of the cause. On investigation it was noted that there was a continuing fault being registered in the application event log reporting that a registry corruption could not be repaired due to a lack of disk space on the C drive. The C drive is configured with only a 2GB partition which is far too small to accommodate the OS and applications while leaving space for system functions. As a temporary measure the swap file was relocated onto the D drive and non critical software was uninstalled and compression was enabled on the C drive. This seems to have been sufficient to allow the system to recover the registry.

8.1.6 Network

No problems reported.

8.2 AME report

V. Afanasyev

Instrument	Used?	Comments
XBT (aft UIC) (PC, I/F box, handgun)		
Scintillation counter (prep lab)		
AutoSal (labs on upper deck) S/N 63360		
AutoSal (labs on upper deck) S/N 65763		
AutoSal (labs on upper deck) S/N 68533		
AutoSal (labs on upper deck) S/N 68959		
Portasal S/N 68164		
Magnetometer STCM1 (aft UIC)	Y	O.K
AME workshop PC	Y	O.K

GPS, MRU, Gyro

GPS Furuno GP32 (bridge – port side)	Y	O.K
DGPS Ashtec ADU5 (bridge – port side)	Y	Needs episodic reset
DGPS, MRU Seatex Seapath (UIC – swath suite)	Y	O.K
DGPS Ashtec Glonass GG24 (bridge – starboard side)	Y	O.K Needs reset (5 days)
Gyro synchro to RS232 Navitron NT925HDI (UIC – aft)	Y	O.K
TSS HRP (UIC repeater)	Y	O.K

ACOUSTIC

Instrument	Used?	Comments
ADCP (aft UIC)	Y	O.K
PES (aft UIC)		
EM120 (for'd UIC)	Y	O.K, but needs new monitor
TOPAS (for'd UIC)	Y	O.K.
EPC plotter (used with TOPAS)	Y	O.K.
EK60 (mid UIC)	Y	Frequently crashed due to disk space limitation (see 8.1.5)
HP deskjet 1 (used with EK)		
HP deskjet 2 (used with EK)		
SSU (for'd UIC)	Y	
SVP S/N3298 (cage when unused)		
SVP S/N3314 (cage when unused)		
10kHz IOS pinger		
Benthos 12kHz pinger S/N 1316 + bracket		
Benthos 12kHz pinger S/N 1317 + bracket		
MORS 10kHz transponder		
Sonardyne USBL (aft UIC)	OK	
Sonardyne 7970 SSM Beacon cupboard 709 (by pes)	OK	
Sonardyne 7973 SSM Beacon cupboard 709 (by pes)	Y	NOT OK at 400 Meters. By mistake was deployed to 2000 meters

OCEANLOGGER

Instrument	Used?	Comments
Main logging PC hardware and software	Y	O.K
Barometer (back of logger rack) #V145002 (7/03)	Y	O.K
Barometer #V145003 (7/03)	Y	O.K
Barometer #Y2610005		
Barometer #W4620001		
Air humidity & temp (for'd mast) #15619015	Y	O.K
Air humidity & temp (for'd mast) #60000120	Y	Diagnosed faulty/undetected ADC module. Replacement module configured, awaiting installation opportunity
Air humidity & temp (Drawer No. 907 aft UIC) #60000119		
Air humidity & temp #15619025		
Air humidity & temp #28552023 (HT1, 7/03)		
Air humidity & temp #18109036 (HT2, 7/03)		
Thermosalinograph SBE45 (prep lab) #4524698-0016		
Thermosalinograph SBE45 # 4532920-0072		
Thermosalinograph SBE45 #4524698-0018 (7/04)	Y	O.K
Fluorometer (prep lab)	Y	O.K
TIR sensor (pyranometer) (for'd mast) #990684	Y	O.K
TIR sensor #32374 (TIR1, 7/03)		
TIR sensor #990685		
TIR sensor #011403 (TIR2, 7/03)		
PAR sensor (for'd mast) #990069	Y	O.K
PAR sensor #990070		

PAR sensor #30335 (PAR1, 7/03)		
PAR sensor # 010224 (PAR2, 7/03)		
Flow meter (prep room) #45/59462		
Uncontaminated seawater temp (transducer space)	Y	

CTD (all kept in cage/ sci hold when not in use)

Instrument	**Used?**	**Comments**
Deck unit 1 SBE11plus S/N 11P15759-0458		
Deck unit 2 SBE11plus S/N 11P20391-0502	Y	O.K
Underwater unit SBE9plus #09P15759-0480 Press #67241		
Underwater unit SBE9plus #09P20391-0541 Press #75429	Y	O.K
Underwater unit SBE9plus #09P30856-0707 Press #89973		
Underwater unit SBE9plus #09P35716-0771 Press #93686		
Carousel & pylon SBE32 #3215759-0173		
Carousel & pylon SBE32 #0248		
Carousel & pylon 24 Bottle	Y	O.K
CTD swivel linkage	Y	O.K
CTD swivel S/N196115	Y	O.K
CTD swivel S/N196111		

CTD contd – C & T & pumps – please state which primary and secondary

Temp sensor SBE3plus #03P2191		
Temp sensor SBE3plus #03P2307		
Temp sensor SBE3plus #03P2366		
Temp sensor SBE3plus #03P2679		
Temp sensor SBE3plus #03P2705		
Temp sensor SBE3plus #03P2709		
Temp sensor SBE3plus #03P4235	Y	O.K, Secondary T2
Temp sensor SBE3plus #03P4302	Y	O.K, Primary T1
Cond sensor SBE4C #041912		
Cond sensor SBE4C #041913		
Cond sensor SBE4C #042222		
Cond sensor SBE4C #042248		
Cond sensor SBE4C #042255		
Cond sensor SBE4C #042289		
Cond sensor SBE4C #042813	Y	O.K, Secondary C2
Cond sensor SBE4C #042875	Y	O.K, Primary C1
Pump SBE5T # 51807	Y	O.K
Pump SBE5T # 51813		
Pump SBE5T # 52371		
Pump SBE5T # 52395		
Pump SBE5T # 52400		
Pump SBE5T # 53415	Y	O.K

CTD contd

Instrument	Used?	Comments
Fluorometer Aquatracka MkIII #088216		
Fluorometer Aquatracka MkIII #088249		
Standards Thermometer SBE35 #3515759-0005		
Standards Thermometer SBE35 # 3527735-0024		
Standards Thermometer SBE35 # 3535231-0047		
Altimeter PA200 #2130.26993	Y	Initially OK. Failed to detect steep bottom. Replaced.
Altimeter PA200 #2130.27001	Y	OK
Transmissometer C-Star #CST-396DR		
Transmissometer C-Star #CST-527DR	Y	O.K
Transmissometer C-Star CST 846DR		
Oxygen sensor SBE43 #0242		
Oxygen sensor SBE43 #0245		
Oxygen sensor SBE43 #0620		
Oxygen sensor SBE43 #0676	Y	O.K
PAR sensor #7235		
PAR sensor #7252		
PAR sensor #7274		
PAR sensor #7275		

Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc.		Cable jumped sheave and damaged. Removed 200m of cable and re-terminated. Slip rings cleaned – all o.k.

AME UNSUPPORTED INSTRUMENTS BUT LOGGED

Instrument	Used?	Comments
EA600 (bridge and UIC remote)	Y	O.K
Anemometer	Y	O.K
Gyro	Y	O.K
DopplerLog	Y	O.K
EMLog	Y	O.K
CLAM winch monitoring system	Y	O.K

Additional notes and recommendations for change / future work:

On one occasion CTD touched the ship. Two bottles lost. One damaged.

On one occasion CTD touched the bottom. Sea cable had to be reterminated. No damage to CTD detected.

“Back-UPS Pro 1000” failed. It was used for EK60.

LSS worked OK on CTD. Returned to customer.

9. Acknowledgements

We thank Captain Burgan, the officers and crew of the RRS *James Clark Ross* for helping to make this a successful and enjoyable cruise. Once again, the quality of support for the scientific programme from all of the ship’s company was second-to-none. The Engineers kept the ship running smoothly, and successfully re-mounted the conducting cable storage drum at sea when there seemed a real possibility that we might lose BRIDGET and more than 2000 m of the cable. Rich and the Galley crew kept everyone well fed, and Rich tried his best to keep up our levels of fitness.

John Summers and the deck crew applied expert seamanship to the deployment and recovery of a range of scientific equipment. Pete Mason and James Cooper did an excellent job in mobilising and getting the best out of BRIDGET and SHRIMP. Their concentration during many hours of controlling the winch throughout the SHRIMP dives was also on important factor in making possible the breathtaking video images that are a highlight of the cruise.

Thanks are also due to many in the BAS Operations, Logistics and Personnel Sections, and those at NMF Sea Systems who planned and prepared equipment for the cruise

10. Acronyms

ADCP	Acoustic Doppler Current Profiler
AME	BAS Antarctic Marine Engineering Section
BAS	British Antarctic Survey
ChEsSO	Chemosynthetically-driven Ecosystems South of the Polar Front: Biogeography and Ecology consortium programme
CLAM	Cable Logging and Monitoring system
CTD	Conductivity-Temperature-Depth
ESR	East Scotia Ridge
FIPASS	Falkland Islands Port And Storage System
GPS	Global Positioning System
ICT	BAS Information and Computing Technology Section
JCR	RRS *James Clark Ross*
LSS	Light scatting sensor
NMF	National Marine Facilities
NSF	U.S. National Science Foundation
NOAA	U.S. National Oceanic and Atmospheric Administration
NOCS	National Oceanography Centre, Southampton
SCS	Shipboard Computing System
SHRIMP	Seabed High-Resolution IMaging Platform
SSU	Simrad Sequencing Unit
STCM	Shipboard Three-Component Magnetometer
TOPAS	TOpographic PArametric Sonar
TVG	Time variable gain
SVP	Sound Velocity Probe/Profile
UIC	Underway Instrumentation and Control room
USBL	Ultra-short baseline acoustic navigation system
WHOI	Woods Hole Oceanographic Institution
XBT	Expendable Bathythermograph
ZSL	Zoological Society of London