Cruise Report

February – March 2004

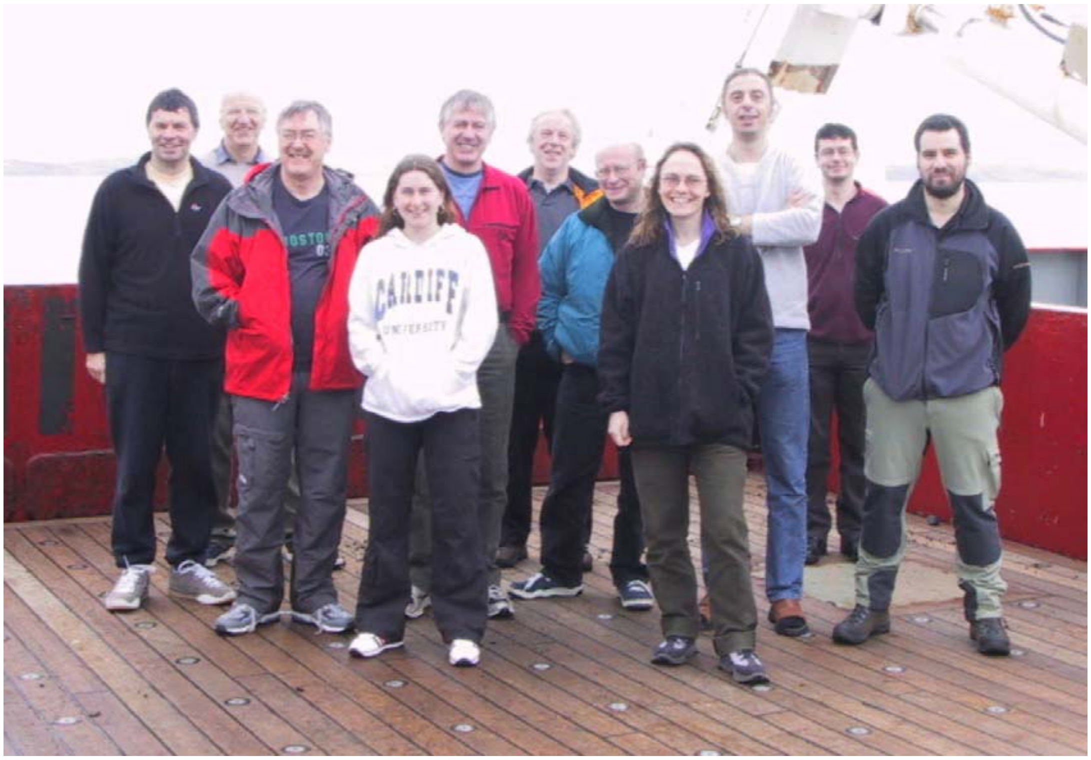
JR77

Phil Leat, Julian Pearce

JR78

Roy Livermore, Peter Morris

30th March 2004



JR77/JR78 Scientific Team

From left: R.A. Livermore, P. Morris, J. Pearce, J.Sas, I. Millar, G. Potter, P.T. Leat, T. Barry, M. Preston, J. Edmonston, F. Bohoyo

JR77/78 Cruise Report

Introduction

Combined cruises JR77 and JR78 were postponed from season 2002/2003, following an incident in which the ship was damaged by collision with another vessel while tied up at FIPASS. The ship sailed from FIPASS at 11:00 on 15th February 2004, for a total of twenty days' bathymetric and magnetic survey, combined with rock dredging at fourteen sites. Thirteen dredges were successful in recovering oceanic rocks of mixed sizes up to very large boulders.

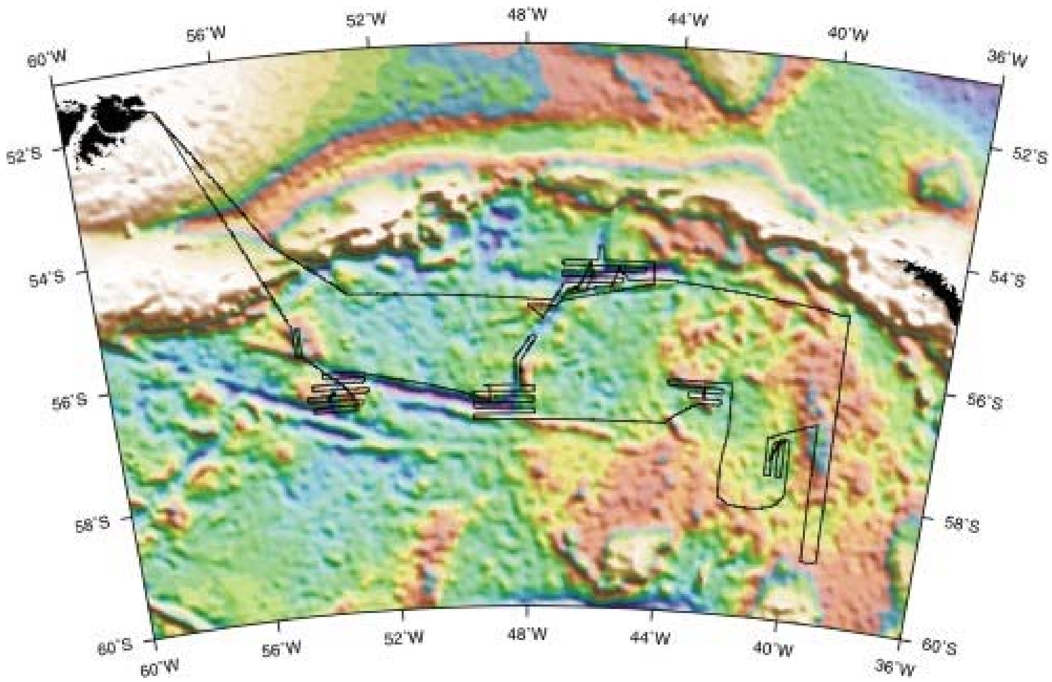


Fig. 1 Track plot for JR77/78 (see inside back cover for A3 version)

The southbound transit from the Falkland Islands was used to follow a flow line of West Scotia Ridge spreading, and so acquire useful magnetic anomaly data. Strong winds were experienced on several days during the leg, but operations were never curtailed, so that all objectives were met comfortably. The new bathymetric maps add considerably to knowledge of the West Scotia Ridge, and were vital in the choice of sampling sites. The rock haul should help address several questions associated with the flow of upper mantle and ocean currents through Drake Passage.

JR77 Personnel

LEAT Phil	Ch/Scientist
PEARCE Julian	Ch/Scientist
MILLAR Ian	Geochemist
BARRY Tiffany	Geochemist
SAS Julia	PhD Student

JR78 Personnel

LIVERMORE Roy A	Ch/Scientist
MORRIS Peter	Data Manager
BOHOYO Fernando	Geophysicist
EDMONSTON Johnnie	Computing
PRESTON Mark	Electronics

Ship's Company

BURGAN Michael JS	Master
GOOBERMAN David BG	Ch/Off
KING David J	2nd/Off
CLARKE Paul I	3rd/Off
SUMMERS John W	Dk/ Off
GLOISTEIN Michael EP	R/O
ANDERSON Duncan E	Ch/Eng
SMITH Colin	2nd/Eng
STEVENSON James S	3rd/Eng
ELLIOTT Thomas	4th/Eng
TREVETT Douglas P	Deck Eng
ROWE Anthony K	Elec
TURNER Richard J	Purser
PECK David J	Bosun
BOWEN Albert M	SG1
TAYLOR Mark J	SG1
RAPER Ian	SG1
DALE George A	SG1
HOLMES Kevin J	SG1
ROWE Martin T	SG1
MACASKILL Angus l	MG1
SMITH Bruce D	MG1
HUME William J	Ch Cook
HYSLOP William R	2nd Cook
JONES LEE J	Sr Stwd
GREENWOOD Nicholas R	Stwd
RAWORTH Graham	Stwd
WEIRS Michael	Stwd

Science Objectives

The combined cruises had two main objectives. JR77 aimed to acquire rock samples to constrain the history of the mantle beneath the Scotia Sea, from which the oceanic crust was derived by melting. JR78, by contrast, sought to understand the role of the central Scotia Sea in the development of a deep connection between the Pacific and Atlantic oceans.

Surveys

A program of bathymetric mapping and rock sampling using a dredge was planned at sixteen sites in five areas (see chart at back of this report). For convenience, these were given names corresponding to nearby features. These were:

1. Burdwood (after Burdwood Fracture Zone, see Fig. 2)
2. Central Scotia (see Fig. 3)
3. Lost Fracture Zone (see Fig. 4)
4. Endurance (after Endurance Fracture Zone, see Fig. 5)
5. Quest (after Quest Fracture Zone, see Fig 6).

Burdwood

This survey was located over the so-called Burdwood Fracture Zone (Fig. 2). A systematic survey with W-E oriented lines was completed initially, to assist in the selection of sampling sites. Later swaths were added during transits between dredge sites, and while leaving the area on an easterly heading. Five dredges were collected on the inside corners of the West Scotia Ridge – Burdwood FZ offset, with mixed results.

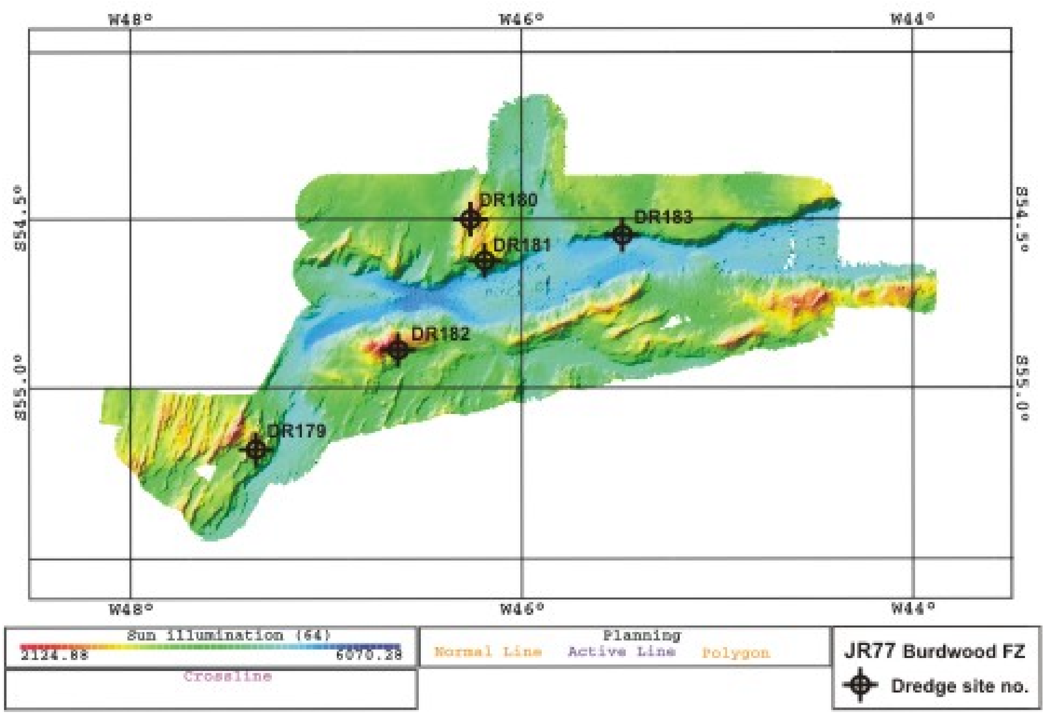


Fig. 2 JR77 Burdwood FZ dredge sites

Central Scotia Sea (CSS)

Tracks were run in an area of prominent W-E magnetic anomalies. The survey lines were oriented N-S, the optimal direction for magnetic data. Seismic profiles indicated that a double-peaked basement feature might be suitable for sampling by dredging. The hauls were predominantly erratics, although some samples may prove to be *in situ.*

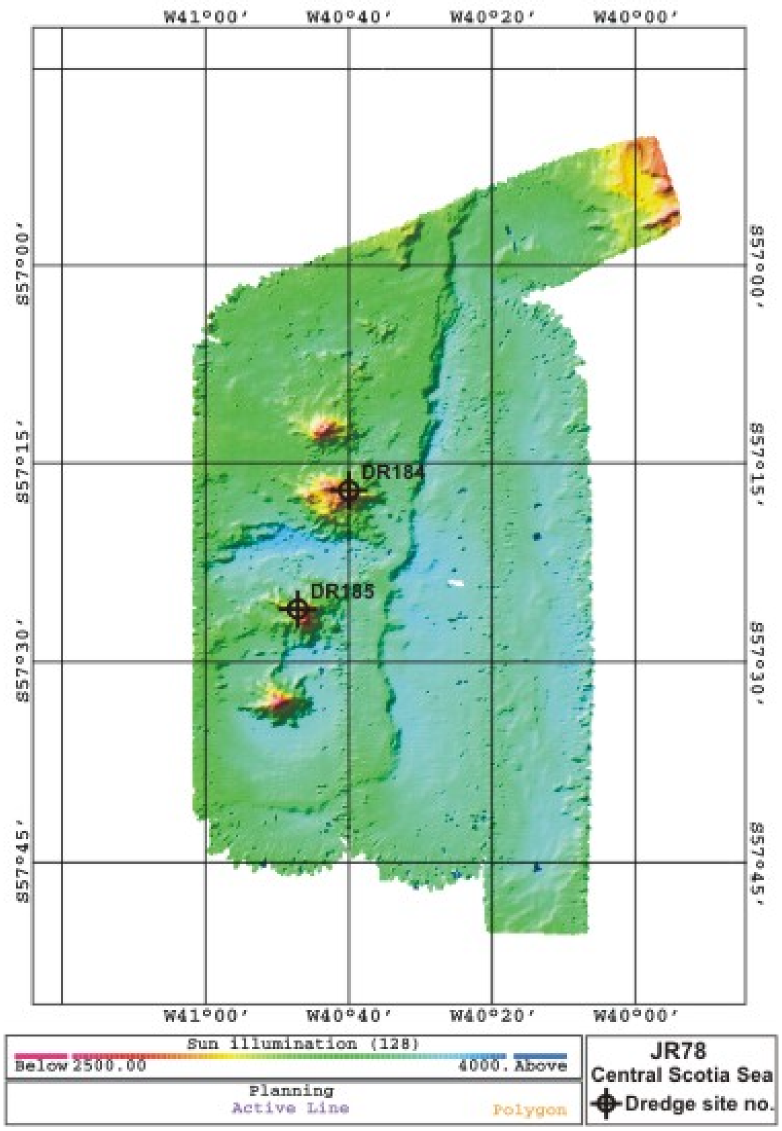


Fig. 3 Central Scotia Sea survey and dredge sites

Lost FZ

This survey mapped a feature prominent in the satellite-gravity field, believed to be a fragment of inactive fracture zone – hence ‘Lost FZ’. Results suggest an uplifted fragment of ocean crust, possibly at a ridge-transform offset. Dredging at one site produced many dropstones, but also some probable *in situ* material.

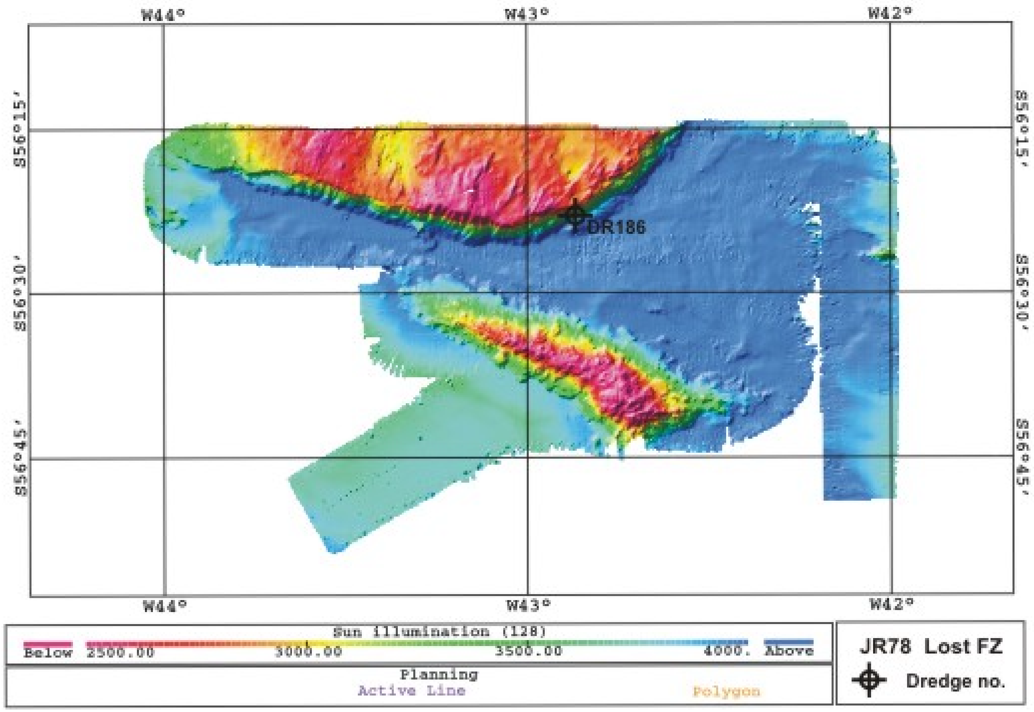


Fig. 4 ‘Lost FZ’ survey and dredge sites

Endurance

The eastern ridge-transform intersection (RTI) of the West Scotia Ridge (segments W5 and W6) with the long-offset Endurance Fracture Zone, was mapped and three dredges attempted, one on a curious structure near the 'inside corner' of the RTI. One dredge was empty, but the others produced promising samples of oceanic rocks.

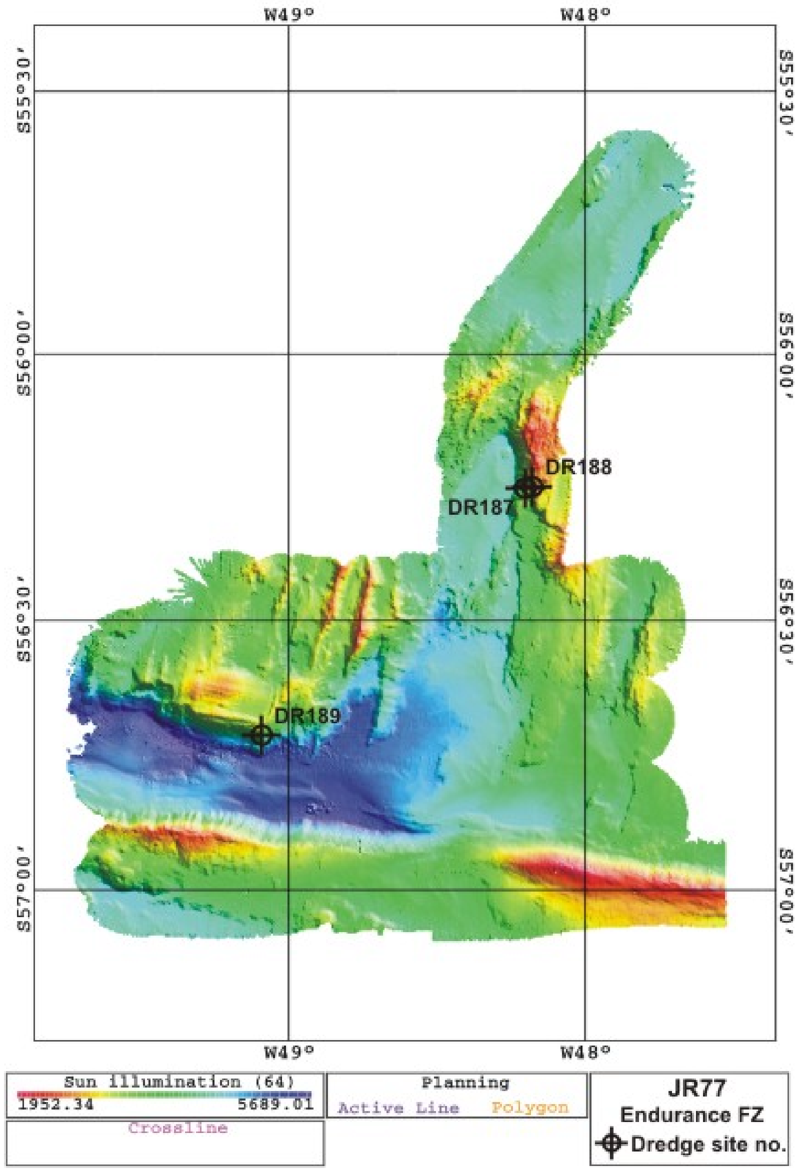


Fig. 5 Endurance FZ survey and dredge sites

Quest

Although named ‘Quest’, this survey covered the whole of WSR segment W5 between the Quest and Endurance fracture zones. Dredges were collected on either flank of the spreading centre, and one, DR191, along the axis. All produced probable *in situ* basalts, together with a few ultramafic rocks.

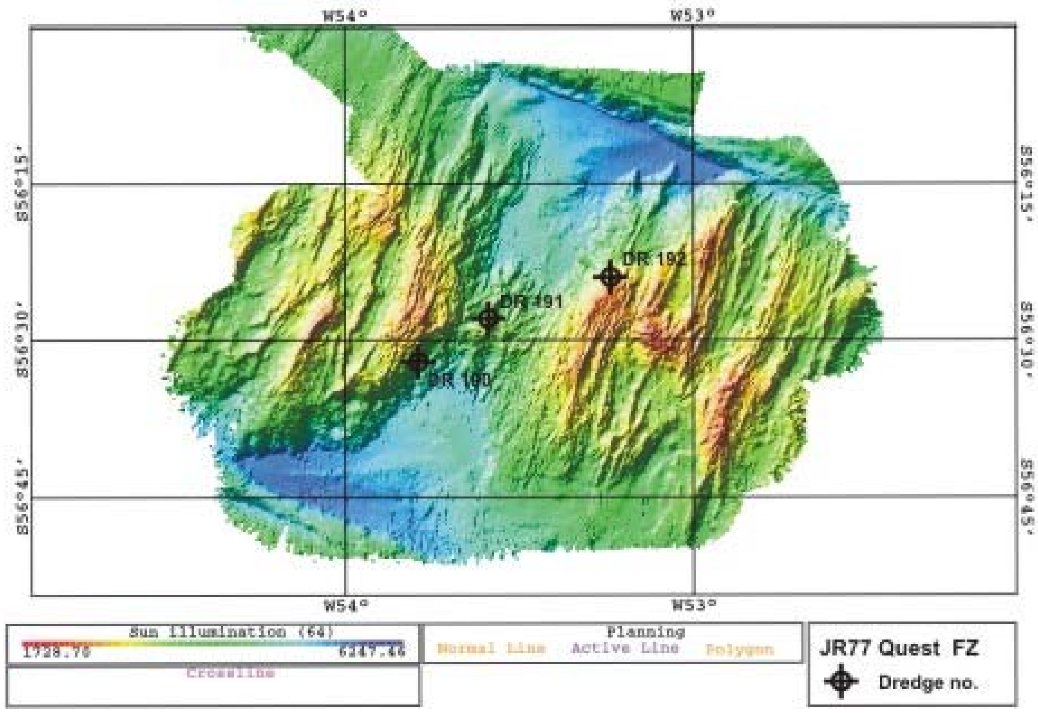


Fig. 6 Quest survey and dredge sites

Rock Dredging

Dredge Procedure

The procedure adopted was as follows:

i. ship stopped at starting site,
ii. pinger fitted 200 m above dredge,
iii. PES used to follow progress of dredge,
iv. dredge lowered at 75 m/min to 200m above sea floor,
v. dredge lowered slowly onto sea bed,
vi. ship moves ahead at 0.5 kts,
vii. wire-out monitor observed to detect ‘snags’,
viii. dredge path of up to 1 km followed,
ix. dredge lifted from sea bed and recovered at 75 m/min.

Dredge Rig

The rigging arrangement used for rock dredging on JR77/78 was identical to that employed on JR93, with the exception that the trawling winch was used instead of the mooring winch. The rig is shown in Figs. 7 and 8.

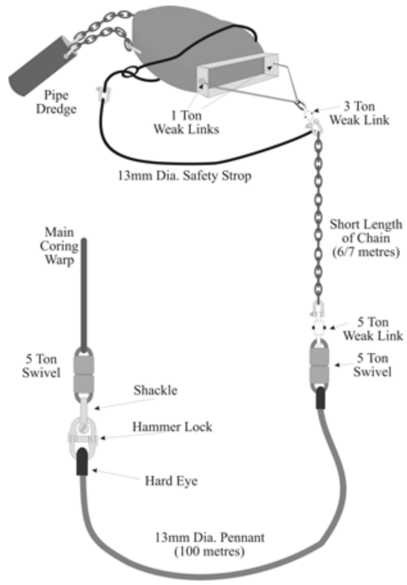


Fig. 7 Dredge rig

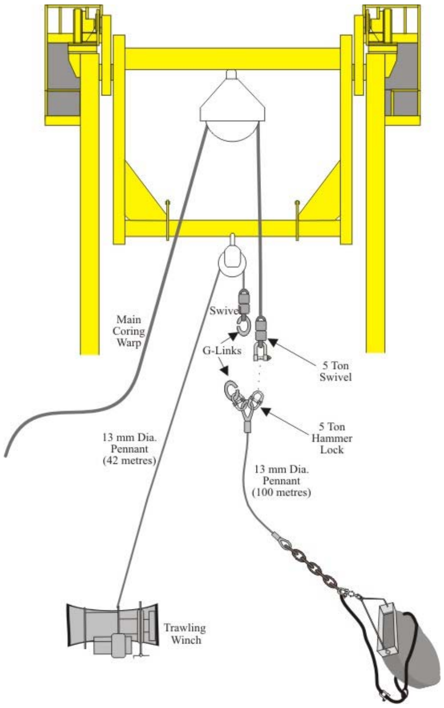


Fig. 8 Dredge deployment

Fig. 9 Dredge deployment from aft deck

Deployment

The method of deployment is shown in Figs. 8 and 9.

The 42 m pennant and the 100 m pennants are attached by means of the G-links. This is then wound on to the mooring winch barrel until the dredge clears the deck. It is then deployed over the stern by means of the gantry. The pennants are paid away until the G-links are above the stern roller when it is attached to the main warp. The weight having been passed to the main warp, the G-links are separated and the dredge deployed; a pinger is attached 200 m up the main warp. Recovery is just the reverse of this procedure.

The winch was operated at 75 metre/minute during the mid water veering and hauling operations. Once the dredge was deemed to be approaching the seabed it was stopped and position checked before being lowered onto the seabed. The winch continued to veer until the dredge; chain and approximately 50 metres of the pennant were on the seabed. The instruction was then given to move the ship at 0.7 knots along the selected track. During this time the winch was hauled or veered to maintain the pinger approximately 150 metres above the seabed.

Observations

On several occasions, the bottom echo became very unclear on the PES. This was attributed to the slope of the dredge cable, so that a week, erroneous depth was observed on the PES. The fixings of the pinger maintain it parallel to the wire, whereas a mechanism which allowed the pinger to pivot freely would overcome this problem.

Recommendation

The dredging rig described work satisfactorily in most cases. A larger dredge, with strengthened ‘teeth’ might assist in dislodging material, and thereby increase the proportion of *in situ* material recovered. Also, see JR93 cruise report. A means of articulating the pinger attachment to the dredge cable should be investigated, in order to maintain its vertical orientation.

Table I JR77/78 Dredge stations

Dredge		Time	Latitude	Longitude	Depth (m)	Comment
DR179	Start	19/02/2004 15:21	-55.1837	-47.3342	3324	Bag empty; mud and fragments of dropstones in pipe.
	End	19/02/2004 17:07	-55.1837	-47.3606	2880	
DR180	Start	20/02/2004 01:47	-54.6306	-46.1887	3735	Small-moderate haul (a few fragments in the bag, pipe full): mainly large basalt fragments and mud.
	End	20/02/2004 02:30	-54.6228	-46.1886	3248	
DR181	Start	20/02/2004 07:54	-54.5133	-46.2381	3076	Large haul (bag half-full, pipe full): mostly Mn-encrusted basalt fragments (some large)
	End	20/02/2004 09:39	-54.4984	-46.2596	2583	with rare gabbro and some mud.
DR182	Start	20/02/2004 17:12	-54.8964	-46.6473	2960	Moderate haul (bag part-full, pipe full): mostly laminated mudstones and basalt fragments of various
	End	20/02/2004 18:24	-54.8914	-46.6622	2593	sizes, plus mud.
DR183	Start	21/02/2004 04:09	-54.5519	-45.4829	4562	Moderate haul (bag part-full, pipe full): mostly basalt fragments, plus altered hyaloclastite with
	End	21/02/2004 05:47	-54.535	-45.4935	3731	some residual glass, gabbro and mud.
DR184	Start	24/02/2004 11:44	-57.2905	-40.6766	2853	Moderate haul (bag part-full, pipe full): predominantly Mn-coated dropstones comprising
	End	24/02/2004 12:48	-57.297	-40.6681	2797	igneous and high-grade metamorphic rocks, and mud.
DR185	Start	24/02/2004 16:11	-57.4272	-40.7851	3119	Moderate haul (bag part-full, pipe full): predominantly Mn-coated dropstones but some possible
	End	24/02/2004 17:33	-57.4339	-40.7728	2802	local gabbros, and mud.

Dredge		Time	Latitude	Longitude	Depth (m)	Comment
DR186	Start	26/02/2004 16:11	-56.3814	-42.8596	3484	Moderate haul (bag part-full, pipe full): predominantly Mn-coated dropstones but some possible
	End	26/02/2004 17:41	-56.3732	-42.8744	2813	local gabbros, plus local but highly altered peridotite. Some mud.
DR187	Start	29/02/2004 03:48	-56.2459	-48.2026	3362	Moderate haul (bag part-full, pipe part full): predominantly submarine basalt fragments
	End	29/02/2004 04:52	-56.2417	-48.1916	2696	(of pillows and sheet flows) with a little interstitial mud
DR188	Start	29/02/2004 07:50	-56.2442	-48.1951	2929	Zero recovery (bag or pipe)
	End	29/02/2004 08:28	-56.242	-48.1909	2626	
DR189	Start	29/02/2004 23:42	-56.7258	-49.0913	4128	Moderate haul (bag part-full, pipe full): Mainly large fragments of pyroxenite with some
	End	01/03/2004 01:23	-56.7143	-49.0949	3451	basalt (local and dropstone) and garnet amphibolite (likely dropstone. A little mud.
DR190	Start	02/03/2004 18:05	-56.5346	-53.7832	4097	Large haul (bag more than half-full, pipe full):mostly highly feldspar-phyric basalt, with
	End	02/03/2004 19:44	-56.5273	-53.7965	3594	Breccia containing fresh glass shards. Some mud.
DR191	Start	03/03/2004 00:09	-56.4772	-53.5886	3450	Moderate haul (bag part-full, pipe part-full): Three large fragments of basalt pillow lava and
	End	03/03/2004 00:52	-56.4716	-53.5924	3380	pillow tubes. Smaller fragments include peridotite nodules from pipe dredge. No mud.
DR 192	Start	03/03/2004 19:48	-56.3958	-53.2340	3024	Smallish haul (large fragment in bag; small fragments in pipe): large fragment and a number
	End	03/03/2004 22:01	-56.404	-53.2359	2755	of smaller fragments of pillow basalt. Some interstitial mud.

Echo Sounding

EM120 Operation

No hardware problems were encountered. The Mermaid acquisition system functioned satisfactorily throughout. Problems associated with incrementing file (line) numbers appear to have been corrected, and there were no system crashes. Raw data were automatically copied onto the Neptune machine every minute, and stored in one-hour files on the path:

/users/simrad/neptune/neptune/em120/raw/*survey name/file name*

An example of *survey name/file name* was:

```
burdwood/raw/0001_20031130_114139_raw.all
```

Depth Processing using MB-SYSTEM

Swath Bathymetry data were cleaned and processed using *MB-System v5.0*. *MB* is primarily a Unix command line package used to process a wide variety of bathymetry data formats. One advantage of *MB* is that different bathymetry sources can be processed and gridded together. It is closely integrated with *GMT* (Generic Mapping Tools), with most of the plotting and grid commands outputting *GMT* scripts that can be modified if necessary.

The following steps were used to process the raw data into gridded output.

Copying the data

EM120 data were reformatted into the new *MB* format 57, which allows more flexible processing (see JR93 Cruise Report, Livermore et al. 2004). The following Unix commands were used to achieve this:

```
foreach f (*.all)
      mbcopy -F56/57 -I$f -O../mb57/JR77_$f.mb57
end
cd ../mb57
ls *.mb57 > raw_datalist
```

This was run from the raw files directory, placing the reformatted raw files into a new directory (**../mb57**), addiing a cruise prefix (**JR77_**). A text file, (**raw_datalist**) containing the names of all the **.mb57** files is created to be used in subsequent *MB* commands. *MB v5* can now process data based on its suffix so no additional info (such as 57) is needed in the text file.

Creating auxillary files

Auxillary files are created to make other processes such as cleaning and gridding quicker to complete. In this and other processes, files are created with the same root name but with different suffixes. Three types of files are created; .inf files contain basic header information for each file (lat/lon limits, min/max depth etc), .fbt contain bathymetry data in a form more easily processed by *MB* and .fnv contain navigation data in a similar format. All three are created using the following command within the directory containing the **.mb57** data:

```
mbdatalist –Iraw_datalist –F-1 –O
```

-F-1 is the **MB** format for text lists of data files. By default, the auxiliary files are created in the same directory. Again this is a lengthy step, but only needs to be done once, and speeds up every subsequent action.

Cleaning the data

Data can be cleaned automatically or manually. The command *mbclean* has various options to run through the raw data and remove bad pings. The following are some of the more useful options

```
mbclean –Iraw_datalist –F-1
        -A100 (absolute deviation away from a median depth –100m here)
        -B500/5000 (simple high/low filter – only accept 500m – 5000m here)
        -C1 (maximum ping to ping slope angle – tan-1 1 = 45°)
        -G0.9/1.1 (proportional deviation from median depth)
        -M1  (flags the ping rather than zeroing it)
        -X5 (flags last 5 pings at either end of the swath ping)
```

There are many other options found in the *mbclean* man pages. Data collected on JR93 was cleaned using the above options but there was a tendency to remove too many pings that were considered good when inspected manually. Calm weather on both the passage and the main survey meant that very little data needed to be flagged though *mbclean* removed nearly a third of all pings. The main culprits seemed to be the –A and –C options. Indeed, even with the slope option set to –C4 (>75°), there were still a large number of pings flagged for excessive slopes. Further testing of the *mbclean* command is needed to find a variety of options that will provide a light cleaning to both almost clean and very noisy data alike.

JR77/78 data were cleaned manually to preserve as much depth information as possible. This was performed using a graphical editor within *MB* called by the command ***mbedit***. This contains an intuitive interface where the user can flag bad data on a line by line basis. Generally the data collected on JR77/78 needed only minor cleaning, mostly of the outer beams and in some cases when interference from *Topas* was apparent.

Both methods of cleaning the data create two additional files, a **.esf** file, which holds the flagging information and a **.par** file which contains a whole variety of edits including cleaning and navigation fixes.

Processing the data

The command ***mbprocess*** takes information from the **.par** file and processes the **.mb57** data to produce a final output file. If the input file is called **data.all.mb57**, the processed file becomes **data.allp.mb57**. ***mbprocess*** also creates additional auxillary files **(.inf, .fnv, .fbt).** The command takes the form:

```
mbprocess –Iraw_datalist –F-1
```

A text file containing the names of all the processed data can then be created (**proc_datalist** on this cruise). If at some point the user decides to go back and re-clean the data or edit the navigation for a single file, **mbprocess** can be run with the same command and it will process only the newly edited files.

To recap, the processes and the files they create are:

Input	Process	Output
Data.all.raw	mbcopy	Data.all.raw.mb57
Data.all.raw.mb57	mbdatalist	Data.all.raw.mb57.inf
		Data.all.raw.mb57.fbt
		Data.all.raw.mb57.fnv
Data.all.raw.mb57	mbclean/mbedit	Data.all.raw.mb57.esf
		Data.all.raw.mb57.par
Data.all.raw.mb57	mbnavedit	Data.all.raw.mb57.nve
		Data.all.raw.mb57.par (modified)
Data.all.raw.mb57	mbprocess	Data.allp.raw.mb57
		Data.allp.raw.mb57.inf
		Data.allp.raw.mb57.fbt
		Data.allp.raw.mb57.fnv

Gridding the data

The command ***mbgrid*** with its associated options produces a user defined grid as well as a *GMT* script that can be run straight away or modified to take advantage of the range of mapping options available within *GMT*. However, the majority of *GMT*'s functions are already embedded within the ***mbgrid*** command so it was generally unnecessary to alter the script produced. The command and some of the more common options are:

```
mbgrid  -Iproc_datalist  -O 'grid filename'
-R-65/-57.5/-60.5/-57.5 (bounding co-ords, min long/max long/min lat/max lat)
-E500/500/meters (grid resolution; 500m in this case)
-F1 (type of filter used; 1=gaussian weighting, 2=median weighting)
-C3 (spline interpolation into data free areas, 1500m in this case (grid
                                                          resolution x 3)
-M (outputs separate grids of standard deviation and data density)
-N (outputs null values as NaN. Useful for GMT and Matlab)
-W2 (width of the gaussian weighting function: twice the grid spacing in this
                                                                  case)
-K'background grid' (Adds a regional background grid behind the survey data)
```

Running the command produces an **output.grd** and an **output.grd.cmd**. Running the latter *GMT* script produces **output.grd.ps**, which can be viewed in **xv** or **ghostview.**

More advanced maps can be generated from the .grd files using the *MB* macro ***mbm_grdplot***. Another macro, ***mbm_plot*** is also useful for producing initial plots of swath data and for constructing cruise tracks. See their respective man pages for more details of the options available.

Observations

MB-System v5.0 performed well and provides a useful way of combining different bathymetry datasets. There were a few bugs found that should be brought to the attention of the software developers

1. *mbedit* has forward and backwards buttons to move through the swath files. However, pushing the backwards button crashed the application. The middle mouse button has the same functionality as the backwards button but this did not cause a crash.
2. Raw files copied from the EM120 machine were occasionally unable to be opened by *mbedit/mbnavedit*. Most of these files were very small and caused by problems changing survey line names in the EM120 software. Even though *mbedit* could not open the bad data, a .esf and .par file would be generated, essentially empty, for the data. These would be ignored when running *mbprocess*. Similarly an empty .nve and .par file would be produced when trying to open the bad data in *mbnavedit*. However, *mbprocess* would terminate every time a bad datafile was found that had an associated .nve file.
3. There is missing text in the –A option of the *mbgrid* man page.

Recommendations

1. Inform MB software developers of bugs.
2. Test the *mbclean* command on various datasets to see whether the excessive cleaning found was due to a bug or incorrect parameter setting (user error).
3. Locate and clean remaining datasets in the SFZ area to be used as a basemap for subsequent surveys. The current size of the mb_data directory is ~14Gb.

Sound Velocity Profiles

One XBT dip was taken on the outbound transit (see Table I). TK20 probes were deployed over the starboard quarter, and maximum depth achieved.

Precision Echo Sounder

The PES was operated at each dredge station to monitor the depth of the pinger, and hence to ensure contact with the bottom. The system worked without fault. Any future changes to this system must ensure that good communications between the operator and the winch driver are possible.

Magnetic Field Measurement

SeaSpy

The SeaSpy towed magnetometer is an enhanced proton precession instrument, which makes use of the so-called ‘overhauser effect’ to increase sensitivity and reduce power requirements. It was deployed during southbound transit, and whilst underway during JR93 survey. Deployment was over the port stern, passing the tow cable through a fairlead, protected by a clear plastic sleeve. The unit was found to be light and easy to deploy and recover, which was accomplished at a ship speed of 5 knots. Operation was faultless, and high quality data obtained throughout its operation. Towing depth was always less than a metre or two beneath the surface at tow speeds of up to 11 knots. A spare transceiver has been purchased for this unit, and is stored in the electronics lab adjacent to the UIC.

STCM

The original STCM was not functioning, but the newer system ran throughout the leg, and was logged by the SCS system.