RRS James Clark Ross

JR132 Cruise Report

Acoustic equipment trials
UK to Greenland

British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Cruise Report

RRS *James Clark Ross*

Cruise JR132

July 2004

Equipment trials (swath bathymetry, TOPAS sub-bottom profiling, SSU)

North Atlantic: UK to Greenland

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BAS Reference No ES6/1/2004/2
November 2004

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Front cover: RRS *James Clark Ross* at anchor off Qaqortoq.

Back cover: EM120 swath image of the Reykjanes Ridge. Shaded relief image, illumination from SE. Note the ocean-floor spreading fabric is not everywhere parallel to the ridge axis.

1. INTRODUCTION AND NARRATIVE

JR132 was a scientific equipment trials cruise with the main aim of integrating the new Bridge echo sounder (EA600) with the scientific echo sounders. As the time available was only 1-2 days extra to the passage from the UK to Greenland, no detailed scientific objectives were set. We did however run the swath and TOPAS systems and the magnetometers (towed and STCM) across the North Atlantic basin, and surveyed a line along the SE Greenland continental slope. A summary track chart is shown in Figure 1.

The technical objectives were as follows:

1. Test the EA600 operation.
2. Test the TOPAS Sub-Bottom Profiler after a software upgrade.
3. Test the multibeam after a software upgrade.
4. Test the SSU with the EA600, multibeam and TOPAS interfaced.

After completion of the ship's refit in Portsmouth, the JCR conducted engine and Dynamic Positioning trials on the way to Portland, anchoring off on Monday 12th July. The vessel docked the following morning and commenced bunkering and loading of scientific cargo for the summer cruises. The scientific party joined that evening (except for Jim Fox and Doug Willis who had been on board since Portsmouth). The ship sailed at 1220 (GMT) on Wednesday 14th July (Julian day 196) leaving Portland shrouded in sea mist.

The passage was uneventful for the first five days. Ship speed was 10.5 to 12.5 knots, slowed by head winds up to force 6 on day 198; the weather was mainly overcast but fine. After clearing the Scilly Is, the track was chosen to fill gaps in the magnetic coverage of areas either side of the Mid-Atlantic Ridge (Roest *et al.* 1996). The first two days were spent trying out the echo sounders (bridge EA600, EM120, EK60 and TOPAS) in various combinations and interfacing the EA600 to the SSU. About 1200 on day 198 we cleared Irish territorial waters, streamed the towed magnetometer and started recording magnetic, multibeam and TOPAS data. Expendable bathythermographs (XBT's) were deployed once per day to obtain the correct sound velocity.

We tried various settings for the instruments overnight (10 pm to 7 am) to determine the best settings if no watchkeeper is available. The most reliable is to have the EM120 and TOPAS pinging in sequence, the EA600 on passive setting and receiving the EM120 centre-beam. In deep water this gives rather few pings; if TOPAS is set on a 4-sec ping rate there is inevitable interference with the EM120, and if the depth is known to vary greatly it is not possible to cut down the interference by setting a narrow depth range on the EM120. More details are given in section 3.

On day 200 the wind backed to southeast heralding a deep depression. We had been heading for a mooring site of interest to the next cruise to conduct preliminary swath survey, but the following afternoon (day 201) the wind veered to west and increased to gale force. In the rapidly building sea, acoustic data quality was very poor. The ship hove-to for the night and the EM120 was left running with a beam angle of 45°. We had been hoping to run a roll calibration line for the EM120at about 39°W as this was the only flat area of seabed along our track, but the weather put paid to that. We also received an ice report from Greenland which showed pack ice a considerable distance south of Cape Farewell, and the required extra passage left us very little spare time. It was decided to omit the mooring sites and just run a line NE-SW along the continental slope requested by Professor I.N.McCave (University of Cambridge).

By the morning of day 202 the wind had moderated and the EM120 and TOPAS were both producing acceptable data; although there was still a swell from the west the EM120 beam angle could be broadened to 60°. At 0825z the ship lost main engine shaft power and slid to a halt for ten minutes. When power was restored we turned on to the southwesterly line, which took just over 5 hours. At the end of this line we recovered the magnetometer and headed for Qaqortoq, now effectively closer as we had a new ice report. That evening we stopped in 1600 m of water to run an XBT and the sound velocity probe in the same place, to compare sound velocity profiles from the two methods. Continuing past Cape Farewell we had a clear if distant view of spiky mountains about 30 miles away.

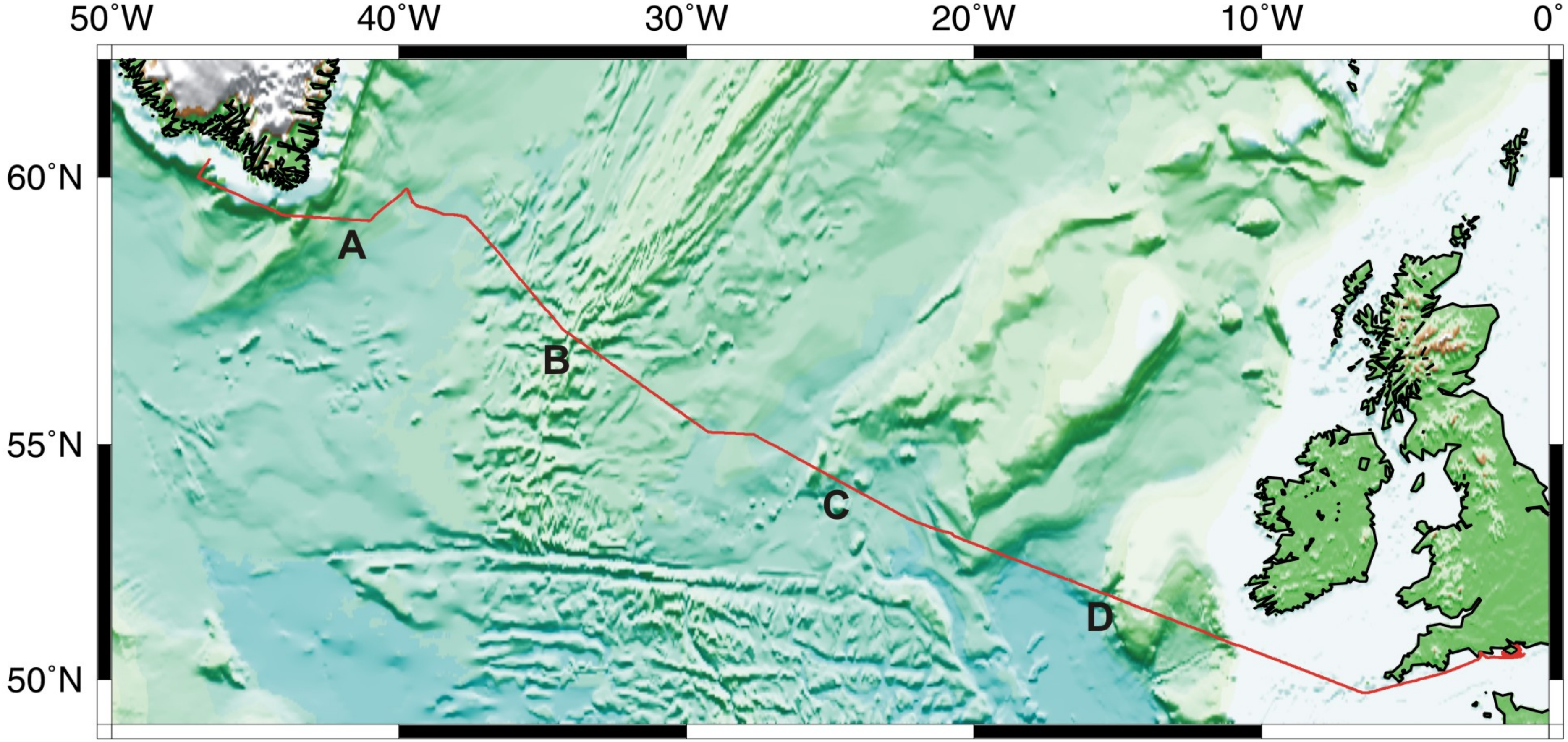
The morning of our arrival in Qaqortoq was calm and misty with rain. Data recording ceased at 1100z well before we entered the fjord. The ship anchored at 1500z (1300 local) with transfers ashore by boat. At 8 pm there was an electrical power failure (24v supply) and all the computers on the ship went down. In the 15 minutes it took to diagnose the problem most of the UPS's failed as well, and it took a considerable time to re-start and shut down the systems in a controlled way. The power spike killed the small monitor screen used for the SSU. Note that this power failure would not have had such serious consequences if it had occurred during a science cruise, because the watchkeepers would have had time to shut down the instruments before the UPS's failed.

We thank David Blake for sponsoring the cruise and Sophie Harmer for arranging our travel (a non-trivial task). Jon Shanklin sent us Greenland ice charts, particularly useful in the days before we could receive them locally. As always we thank the ship's company for an enjoyable cruise.

Roest, W.R., Verhoef, J. & Macnab, R. 1996. Magnetic anomaly map of the Atlantic north of 30°. *Geological Survey of Canada Open File* **3280** (1 map).

Figure 1. Summary track chart for JR132 plotted on shaded-relief GEBCO bathymetry. Letters ABCD correspond to the magnetic profile in fig. 5.

JR132 Track plot



2. EA600

This is a single beam 12kHz 16-degree echosounder owned by the Bridge and used mainly for bathymetry purposes. The depth reading is logged to the SCS. Note that this is the ship's primary deep-water echo sounder and is a navigational and safety aid for the ship when in shallow water. The bridge officers should keep the system running as required. The summary information below is for when bridge may allow the UIC to have control in deeper (>500m) water.

If '**Scroll lock**' light is illuminated then you have no control. Phone the bridge to give you access if you need it and explain to them what you are going to do. You see what the bridge sees. **Be very careful at night, the display is set dark for the purpose of the bridge officer's night vision – do not open the help dialogue at night as this is bright white.**

For the synchronization unit (SSU) in the UIC to operate correctly it is **important** that it is receiving the correct depth value from the EA600 (as displayed at the top of the EA600 screen). Although, for navigation purposes, it may not matter if the EA600 is reporting incorrect depths in deep water, it will matter for the other echo sounders on board. If the depth reading at the top of the EA600 screen is incorrect, then the quality of survey data being gathered may be highly compromised.

Other than the communications settings on the EA600 (which you should not need to touch), the important parameters are **echogram range** and **bottom detection range**.

<u>Bottom detection range</u>

The seabed depth must be within the bottom detection range. Unfortunately, the bottom detection range cannot simply be put on 0 to 10000m all the time - the EA600 may detect multiple echoes or interference and assume that these are the bottom; thus reporting an incorrect bottom depth. It is best to have a much smaller detection range to avoid this - set the max value of the range to less than twice the real seabed depth.

Right click on depth reading at top of screen.

This controls the depth window within which the EA600 will try to resolve the bottom depth. It is important that this is checked regularly. For best operation, set the minimum and maximum depth alarms to just inside the minimum and maximum depth settings. This means that when the bottom goes outside the set range, the alarm window will pop up and you should set a new range.

If this depth window is not set properly, depth readings will be incorrect. Note that the bottom detection range is independent of the echogram display range which you see on the screen. The EA600 will often report a depth of 0.00m on the screen, particularly when there is acoustic interference from TOPAS or during bad weather. Providing there is a good depth value occasionally reported, this is not a problem. For as long as 0.00m is displayed, the SSU will use the last non zero depth reading.

<u>Echogram range (Surface Range)</u>

This must be set so that the maximum value is close to but greater than the bottom depth (i.e. you can see the bottom on the screen).

Right click on area immediately to the right of the echogram (where the surface range is indicated at top and bottom of screen).

Change these values to change your view. Often a good idea to keep this depth range the same as the Bottom detection range. Note actual depth window start is Start Relative Surface, and end is Start Relative Surface plus Range.

<u>Active/passive</u>

Right click on '12kHz' -> (Mode)

Active is EA600 transmitting pings. Passive is EA600 not transmitting pings. When the EM120 is being used and is synchronized with the EA600 by the SSU, the EA600 should be set to passive. The EA600 then listens for the centre beam return echo. If the EA600 is set to passive but there is no seabed echo, either the EM120 has been set to free running (not SSU controlled) or it is off. DO NOT leave the EA600 with no seabed echo particularly in unsurveyed areas, or you will probably be keelhauled.

<u>Normal/External trigger</u>

File -> Operation -> tick/untick *Extern Trig*

Extern Trig on when under SSU control, otherwise off.
With the EA600 External trigger off mode, the SSU has no control over it, and the EA600 will interfere with other echo sounders if it is active; this is undesirable to the science. With the EA600 in External trigger on mode, the SSU will try to synchronize the EA600 with other echo sounders and will tell it when to ping – good for science.

<u>Ping Rate</u>

File -> Operation -> (Ping Rate)

Maximum for fastest ping rate. Interval to slow ping rate down (the deeper the water, the slower the ping rate will need to be, e.g. 2 second ping rate is good down to 1500 m).

<u>Transmit Power and Pulse Length</u>

Right click on '12kHz'

Higher transmit power, the stronger the signal in deep water. In shallow water a lower power may give a better bottom definition.

A shorter pulse length may give a better bottom definition. A greater length may give a stronger bottom echo in deeper water.

<u>Gain setting (Colour Scale)</u>

Right click on coloured palette in top right hand corner.

TVG = Time variable gain (i.e. receiver gain increases with increasing depth). TVG setting is indicated by right clicking on echogram or Options -> Status window. Usually kept on 20logR.

The higher the gain, the more detail will be shown in the water column. A 20logR value of about 50 is usually sufficient for bottom detection. Increase if bottom is weak. Decrease if too much detail showing in water column. Light blue is weakest, brown is strongest echo.

Note a left click on the colour bar will knock out the weaker colours (useful for 'cleaning up' the water column temporarily).

<u>Draught</u>

Right click on '12kHz' -> enter new draught. Draught equal to zero means zero meters is level with the hull transducer.

<u>Quick status summary</u>

Options -> Status Window

<u>Personalised settings</u>

Options -> Store User Settings or *Load User Settings*

Allows individual users to keep their own settings.

<u>History</u> (graphical images of data – replaces paper printouts)

File -> Operation -> (History) tick/untick *Save*

Will save sequential bitmap (.bmp) images of the screen. H number at bottom of screen will increment and will be red when history is on. View -> History to view bitmap images saved so far.

<u>Other Echogram controls</u>

Right click on echogram (main screen area).

Surface – Manual allows you to control the viewing window. Auto Range means EA600 tries to adjust the viewing range to suit conditions.

<u>Pinger mode</u>

File -> Operation -> (Ping Rate)

To be used with 12kHz pinger.

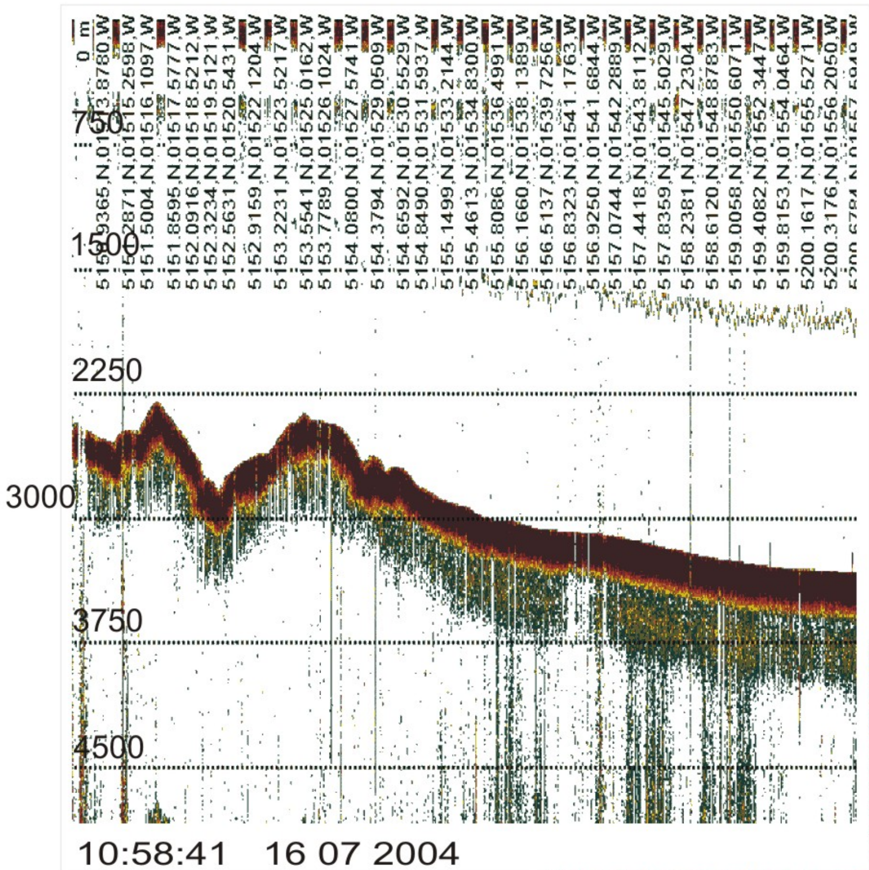
<u>To reboot</u>

File -> Exit, then

Start -> Shutdown -> Restart

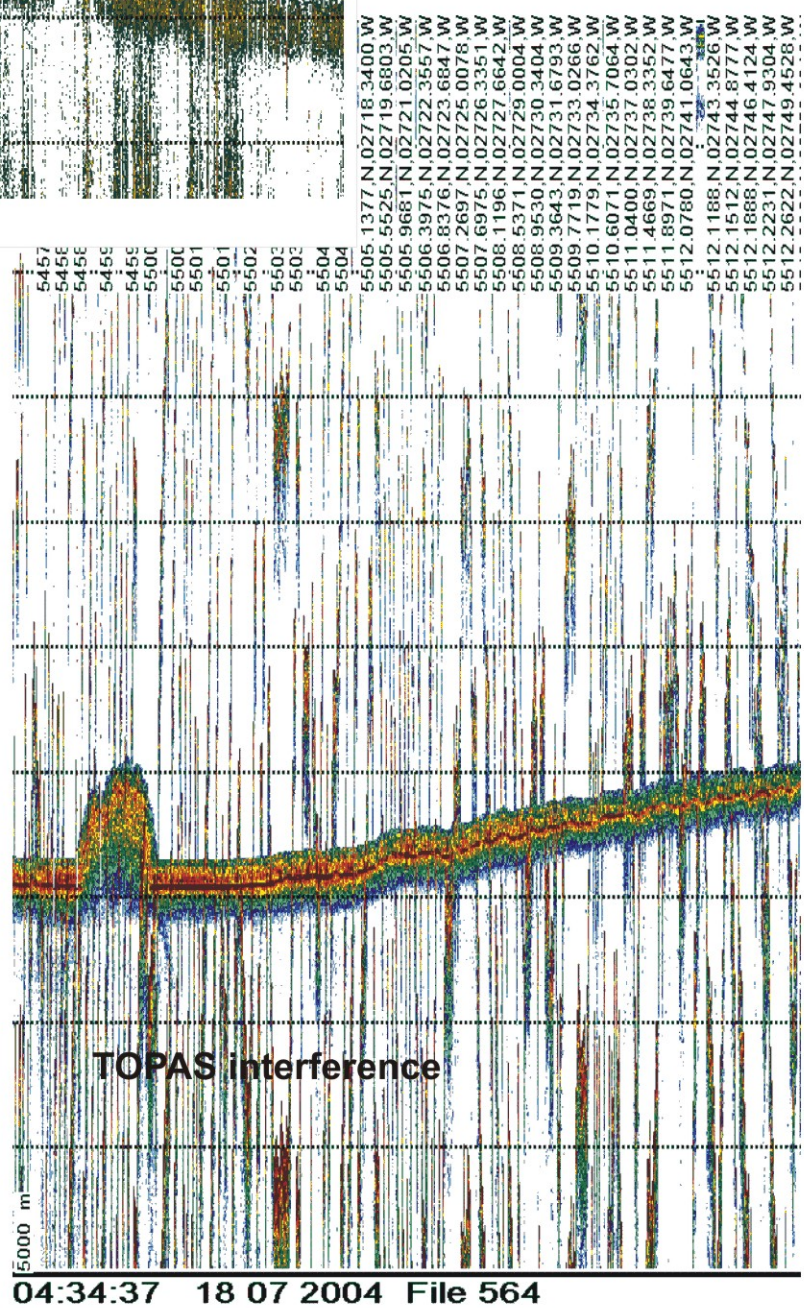
<u>E.g.</u> - EM120 swath survey, seabed at 1100m: set EA600 to ext trig, passive, echogram range 500-1500, bottom detection range 500-1500, min depth alarm 500, max depth alarm 1500.

Figure 2. Examples of History screens saved from the EA600. There are 10 scale lines so an echogram range of 7500 m will have scale lines every 750 m. A, just west of Porcupine Bank; B, central Atlantic about 28°W showing strong interference (vertical coloured lines) from TOPAS which was set on 4 sec manual ping interval.


0 m
750
1500
2250
3000
3750
4500
10:58:41 16 07 2004

A

B


TOPAS interference
5000 m
04:34:37 18 07 2004 File 564

3. EM120 and TOPAS

Both these instruments performed well during JR132, although the EM120 is suffering from general loss of transducer power (the transducer arrays are due to be replaced in summer 2005). With the onset of bad weather on day 200 we lost signal on all echo sounders. It is noticeable that the start of bad weather with an increasingly steep sea/swell is much more destructive than later on, when although the wind may be blowing just as hard the swell has lengthened, vessel motion is easier and there is less aeration under the hull.

Two surveys were recorded: JR132A from the edge of Irish territorial waters at about 16˚W to the onset of bad weather at 37˚40'W, and JR132B from 37˚40'W to just off Qaqortoq. Our planned calibration over the only reasonably level deep-water area along track (about 39˚W) was cancelled because of the gale.

For overnight (unmanned) settings, EM120 and TOPAS may be set to ping in sequence or TOPAS may be set to a manual ping rate (we tend to use a 4 sec interval in deep water). The reliability of TOPAS bottom tracking is quite variable. It introduces many more delay changes than a human watchkeeper would do, which makes for a rather messy paper record (fig. 3). With a smooth, reflective seabed and in calm weather TOPAS will track using internal delay, but in general it is more reliable to use externally controlled delay, which comes from the EM120. In very shallow water (less than 100 m) a convenient way to slow down the ping rate so that you get a reasonable amount of data is to use the SSU to put TOPAS on a fixed time add-on e.g. 1 sec.

(Note on the SSU - The number under 'TOPAS' is the detected depth being sent from the EA600. SSU timing calculations: TOPAS uses depth detected by EA600, while the EA600, EK60 and EM120 send a return signal when they have finished processing.)

The repaired EPC chart recorder was fine and it is a great help to have time and depth printed automatically. We still prefer the Waverley recorder, as the paper is a more convenient size.

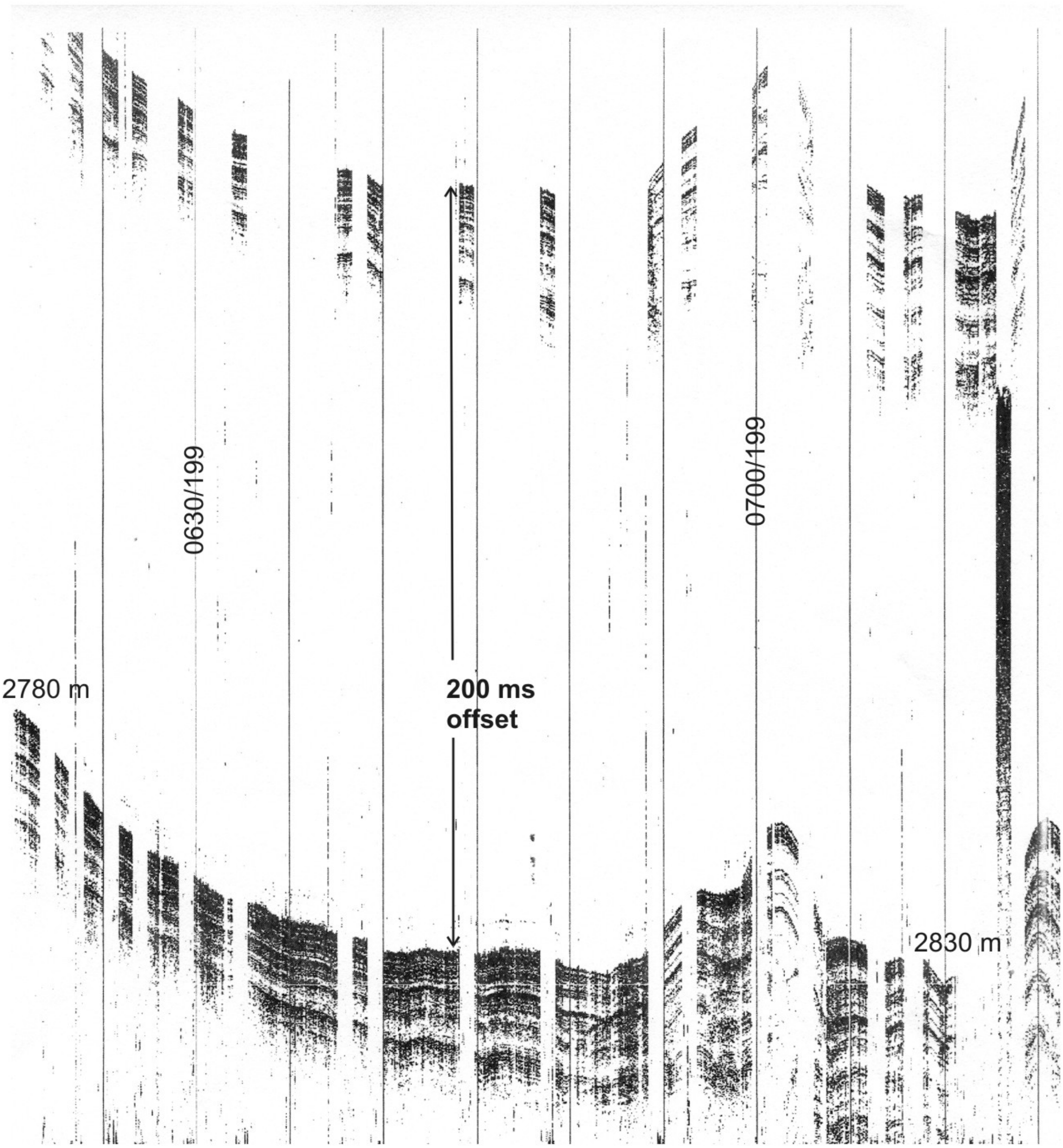
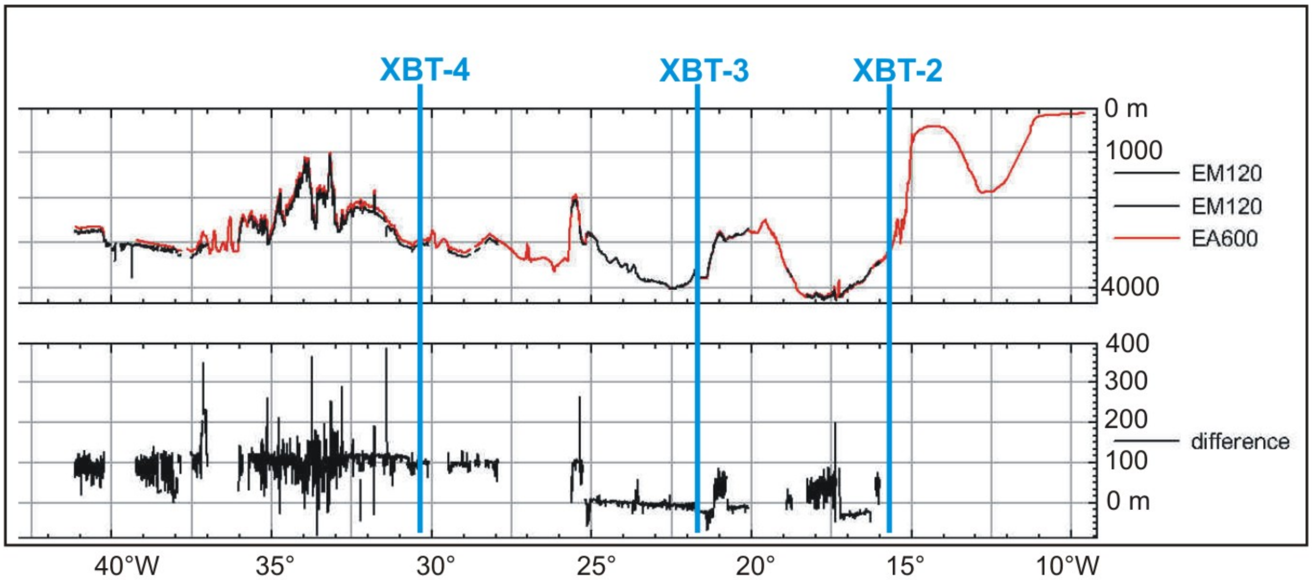


Figure 3. Section of TOPAS record showing the frequent delay changes of 200 ms which occur when internally controlled delay is used. Time marks are every 5 min.

Depth comparison between the EA120 and EA600

A comparison was made between the depths recorded using the EA600 and EM120 instruments. This produced a puzzling result. The centre beam depth of the EA120 was not logged during the cruise but was found by gridding the swath data and then interpolating this grid at every 1 minute position along the ships track.. When this is compared with the EA600 data (Fig 4) there is reasonable agreement up to 23:30 hrs on July 17th (about 25° 15' W) at which point there was a jump and after this time there is a roughly 100m difference between the two results , with the swath reading deeper than the EA600. This change was not due to a new velocity profile being applied to the swath. The positions of the XBT casts are shown on the figure. In the case of XBT-3 and XBT-4 there is an obvious small change in the difference value soon after the time of collection as each new velocity profile was applied to the EM120, but the resulting depth change is nowhere near 100m. The EA600 water velocity setting remained on 1500 m/sec throughout. From a comparison of the data with the GEBCO 1 Minute grid of the North Atlantic it would appear that the EA600 values are probably the more correct. No explanation has been found so far for this depth discrepancy but it is obviously something that needs watching on future cruises.

Figure 4 Depth comparison - EM120 and EA600



5. XBT's and Sound Velocity Probe

XBTs were deployed throughout the cruise with a 100% success rate (Table 1). Each deployment resulted in a binary (*RDF*) and ASCII (*EDF*) file being produced. The ASCII file was transferred onto the Neptune workstation using a floppy disk and following the written instructions by the Neptune machine. The called java program (*xbt.java*) takes the *EDF* file, removes the header and replaces it with a CALC AML header. The program also reduces the number of data values as the EM120 acquisition software can only handle 1000 values per sound velocity profile. The revised file can then be read into the EM120 software whereupon it is altered again into an *ASVP* file. Initially the filename is a date-time string but the user changes this after editing the profile (the profile also gets extended down to 12,000m automatically) and re-saving. By default all the *ASVP* files are stored in the */data/em120/shared* directory and this is the only directory that can be viewed from the acquisition software when choosing a new profile. Below are examples of the various files, including header information and several lines of data values.

Example 1: *EDF* file as produced by the XBT software.

```
// This is a MK21 EXPORT DATA FILE  (EDF)
//
Date of Launch:  12/31/2003
Time of Launch:  11:13:35
Sequence #    :  2
Latitude      :  51 53.40723S
Longitude     :  52 6.47803W
Serial #      :  301825
//
// Here are the contents of the memo fields.
//
JR103  number 1
//
// Here is some probe information for this drop.
//
Probe Type       :  T-5
Terminal Depth   :  1830 m
Depth Equation   :  Standard
Depth Coeff. 1   :  0.0
Depth Coeff. 2   :  6.828
Depth Coeff. 3   :  -0.00182
Depth Coeff. 4   :  0.0
Pressure Pt Correction:  100.0%
//
Raw Data Filename:  N:\JR103\T5_00002.RDF
//
Display Units    :  Metric
//
// This XBT export file has been noise reduced.
Noise Threshold :  3.0 (0.0% spikes)
//
// Sound velocity derived with assumed salinity: 34.00 ppt
//
Depth (m) - Temperature (˚C) - Sound Velocity (m/s)
2.0       7.24     1478.34
2.7       7.17     1478.10
```

Example 2: CALC AML format file.

```
CALC,3314,02-02-97,-1,meters
AML SOUND VELOCITY PROFILER S/N:3314
DATE:85047 TIME:1204
DEPTH OFFSET (M): 0.0
DEPTH (M) VELOCITY (M/S) TEMP (C)
  0.411  1441.928  -1.735
  1.68    1442.025  -1.753
```

Example 3: Simrad format *ASVP* file. The header information is (File type, version, ID, Date-time, Latitude, Longitude, Radii applicable (m), Valid from, Valid to, Source, File history, number of values). It should be noted that the date-time is the moment of file creation, not the time of the XBT deployment.

```
( SoundVelocity 1.0 0 200401240228 0 0 -1 0 0 SVP-16  PE 0984 )
4.10 1486.67
4.80 1486.65
```

Example 3 shows that useful header information does not make it through from the *EDF* file such as position and the time of XBT deployment.

It was also noted that EM120 data acquired on previous cruises often had incorrect sound velocity profiles associated with them. Finding a suitable sound velocity profile in the right area and at the right time of year to replace the incorrect profile requires a large amount of time investigating old *EDF* files and cruise reports. For these reasons, Doug Willis (BAS-ITS) has been tasked with writing a script that will change *EDF* files directly into *ASVP* format, and producing a database of previous XBT deployment positions and times.

The end result will mean that EM120 operators can choose a suitable sound velocity profile from a list if they do not have spare XBTs or time to deploy them. It could also mean a more efficient way of transferring new XBT data into the EM120 acquisition software without going through the CALC AML stage.

The Sound Velocity Probe was deployed as a test of the instrument itself and to compare with an XBT that was deployed at the same location. The probe was set up by Jim Fox and after deployment to 1000m and retrieval, the data was uploaded using Smart Talk software (located on the EK60 workstation). The binary *DAT* file produced was then exported to a comma separated ASCII file, an example of which is shown below.

Cast 1
SvPlus 3298

Time	Pressure	Temperature	Sound Velocity	Battery
	Dbars	Celsius	m/s	Volts
20/07/2004 19:18	1.40E+00	7.12E+00	1.48E+03	1.30E+01
20/07/2004 19:18	2.38E+00	7.23E+00	1.48E+03	1.30E+01
20/07/2004 19:18	3.36E+00	7.25E+00	1.48E+03	1.30E+01

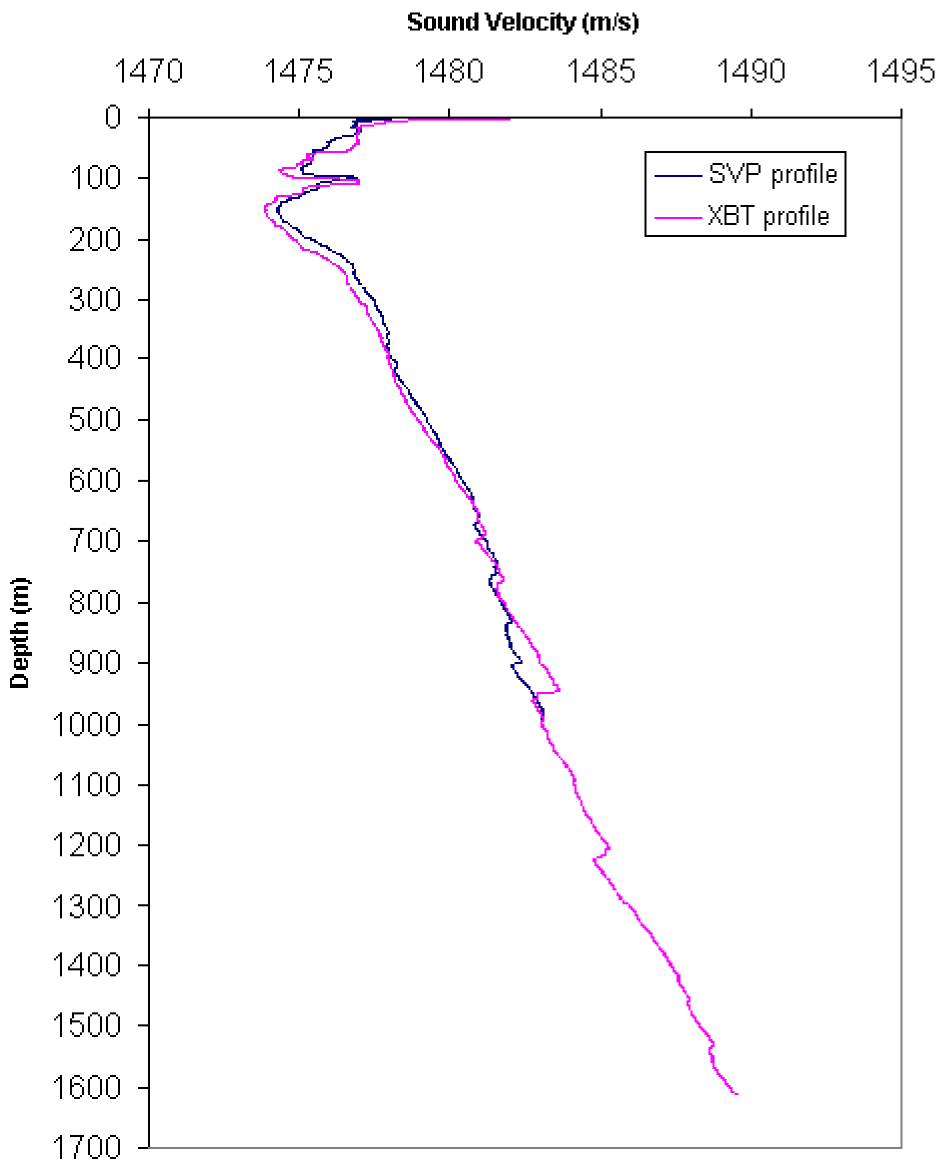
There are various ways of transferring this data to the EM120 but the one used involved making the data look like an *EDF* file. Battery and Time columns were dropped, negative pressures at the start of the cast (probe not in water) were deleted and the upcast data were removed. Finally the values were changed from scientific notation and the header information was changed for a random *EDF* file header. This altered file was then given an *EDF* suffix and transferred by floppy in the same way as XBT data.

Doug Willis has been tasked to produce a script that will shorten this fairly laborious process by automatically transferring files generated by the SVP into Simrad's ASVP format.

The comparison test between the SVP and XBT showed very little difference in sound velocity profiles (Figure 5). Although the SVP should theoretically provide more accurate values than an XBT as it measures sound velocity directly, it does require that the ship is stationary for up to an hour. There is also no way of knowing whether data have been recorded until the probe is interrogated on deck. XBT casts can be made while the ship is moving (though it's advisable to slow down to 6 knots), rarely take longer than 5 minutes and XBT data success/failure can be seen in real time. A further advantage is that the T-5 type XBT can reach 1860m while the SVP cable is only 1000m long.

In conclusion, this test showed that XBT deployment produces very similar sound velocity values to the SVP while being much more time efficient and user friendly.

Fig. 5. Comparison between SVP and XBT sound velocity profiles; location on track chart.

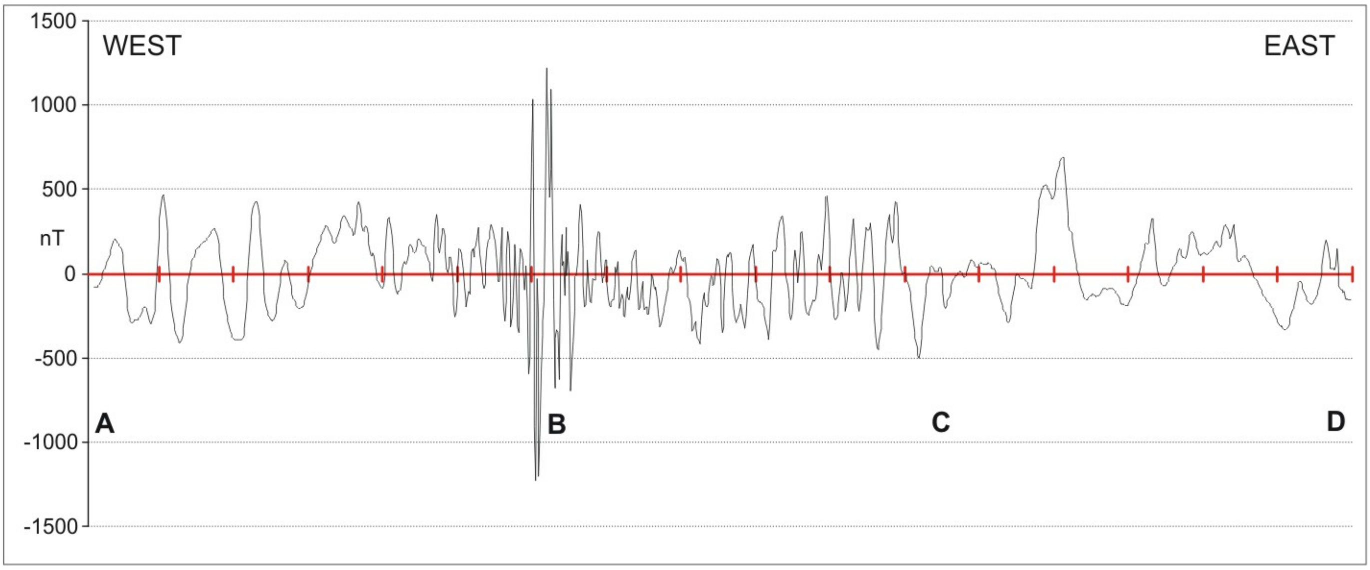


6. Magnetometer

As the cruise track lay across a part of the North Atlantic in which there are considerable gaps in the magnetic data coverage it was decided to tow the SeaSpy magnetometer during the voyage. This performed very well and a good magnetic profile was obtained which is shown in Fig 5. In this area the anomaly pattern is certainly not very symmetrical about the mid Atlantic ridge !

The magnetic data were added to the MGD77 file of underway data prepared for the cruise which will be forwarded to the appropriate World Data Centre in due course.

Figure 5. Total magnetic field anomaly, International Geomagnetic Reference Field removed. Ticks on X axis every 6 hours. Letters ABCD correspond to positions on fig. 1.



7. Crew List

Scientific Party

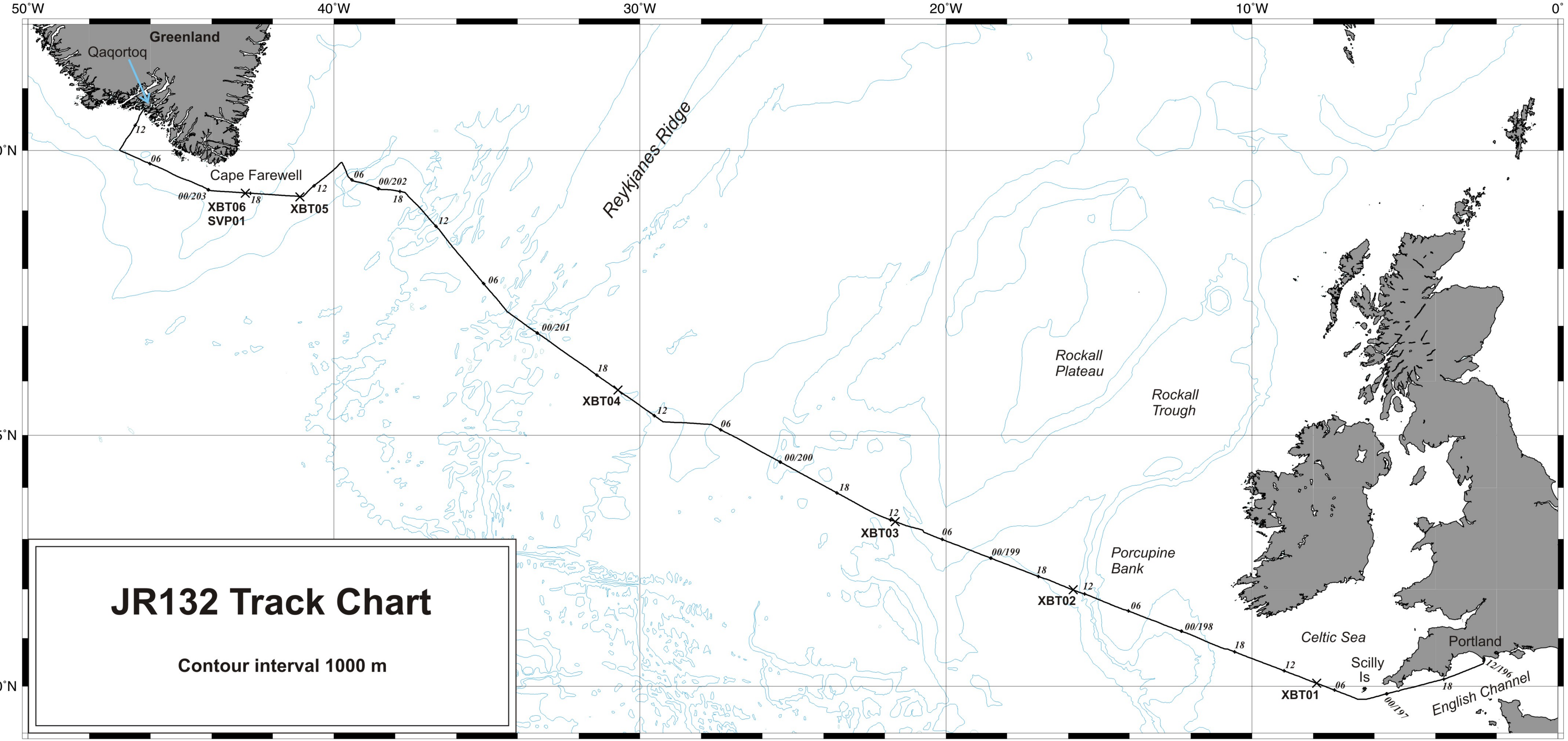
Dr Carol Pudsey	BAS GSD	Principal Scientist
Dr Peter Morris	BAS GSD	Geophysicist
Mr Alex Tate	BAS GSD	Geoscience Data Manager
Mr Jim Fox	BAS ETS	Electronics engineer
Mr Doug Willis	BAS ITS	Computer support
Mr Kjetil Aasekjaer	Kongsberg Simrad	Electronics engineer
Mr George Tupper	WHOI	Oceanographer
Mr Peter Koski	WHOI	Moorings engineer
Dr Emma Wilson	BASMU	Doctor

Ships Company

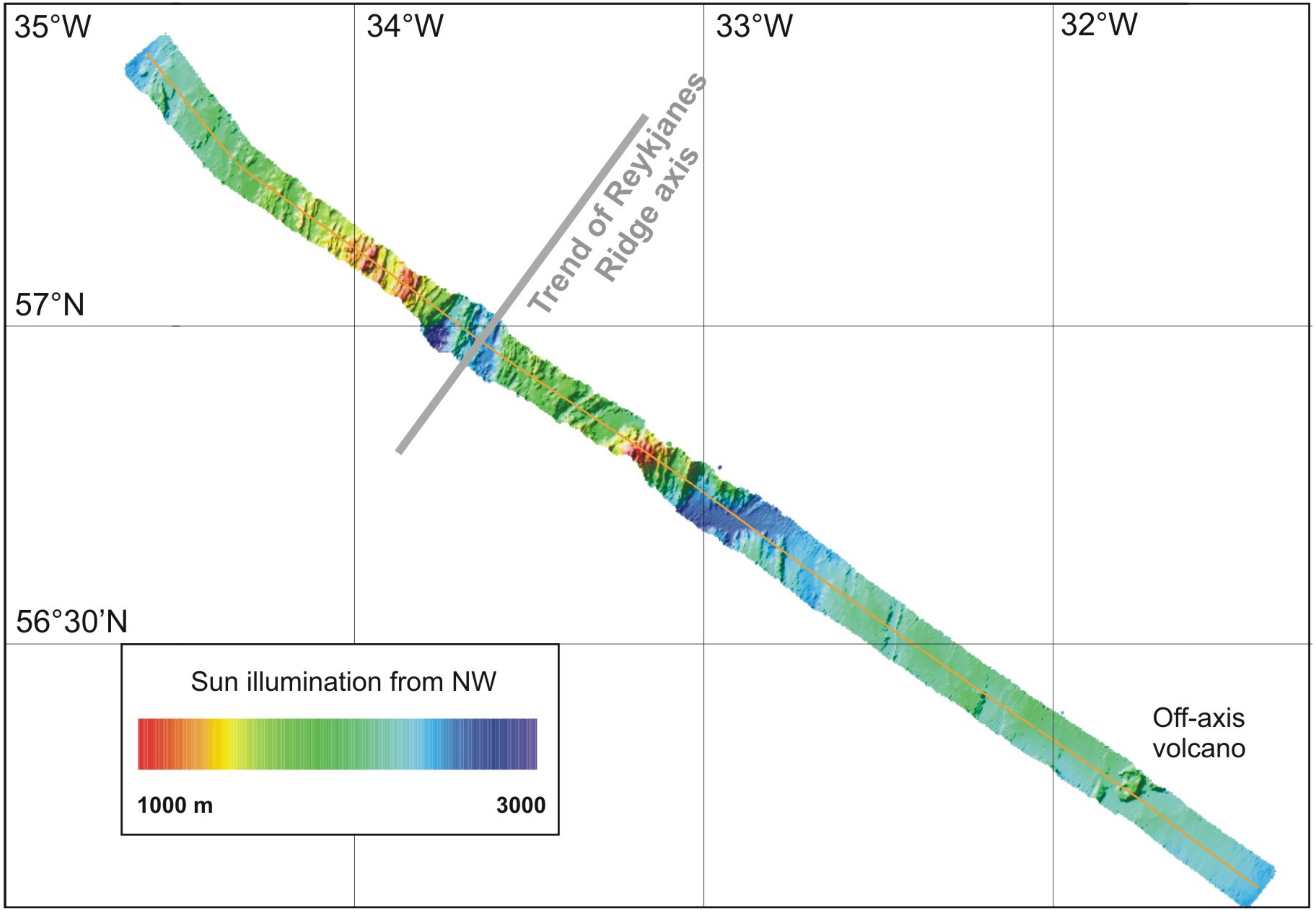
Christopher R Elliott	Master
Robert C Paterson	Chief Officer
Calum J Hunter	2nd Officer
Douglas J Leask	3rd Officer
John W Summers	Deck Officer
Charles A Waddicor	ETO (Comms)
David Cutting	Chief Engineer
Gerard J Armour	2nd Engineer
Thomas RW Elliott	3rd Engineer
Steven J Eadie	4th Engineer
Simon A Wright	Deck Engineer
Nicholas J Dunbar	ETO (Eng)
Hamish S Gibson	Purser
George M Stewart	Bosun
David O Williams	B' Mate
Derek G Jenkins	SG1
Lester Jolly	SG1
Marc A Blaby	SG1
John M Macleod	SG1
Clifford Mullaney	SG1
Mark Robinshaw	MG1
Sidney F Smith	MG1
Duncan N Macintyre	Chief Cook
Glen R Ballard	2nd Cook
Clifford R Pratley	Sr Steward
Derek W Lee	Steward
James Newall	Steward
Kenneth Weston	Steward

Table 1 XBT and SVP stations

Station	Probe	Lat N	Long W	Water depth	Cast length	Location
XBT01	T-7	50° 04.2’	07°55.9’	110 m	110 m	SW Approaches
XBT02	T-7	52° 00.2’	15° 55.8’	3396 m	760 m	W of Porcupine Bank
XBT03	T-7	53° 20.7’	21°39.9’	3768 m	760 m	S of Hatton Drift
XBT04	T-7	55°50.6’	30° 14.1’	3006 m	760 m	W of Gardar Drift
XBT05	T-5	59° 14.2’	41° 06.7’	2651 m	1830 m	SE of Cape Farewell
XBT06	T-5	59° 17.5’	42° 54.0’	1611 m	1611 m	S of Cape Farewell
SVP01		59° 17.5’	42° 54.0’	1611 m	1000 m	S of Cape Farewell



JR132 Track Chart
Contour interval 1000 m
50°W
40°W
30°W
20°W
10°W
0°
60°N
55°N
50°N
Greenland
Qaqortoq
Cape Farewell
XBT06
SVP01
XBT05
Reykjanes Ridge
XBT04
XBT03
XBT02
XBT01
Rockall
Plateau
Rockall
Trough
Porcupine
Bank
Celtic Sea
Scilly
Is
Portland
English Channel


35°W
34°W
33°W
32°W
57°N
56°30'N
Trend of Reykjanes Ridge axis
Sun illumination from NW
1000 m
3000
Off-axis volcano