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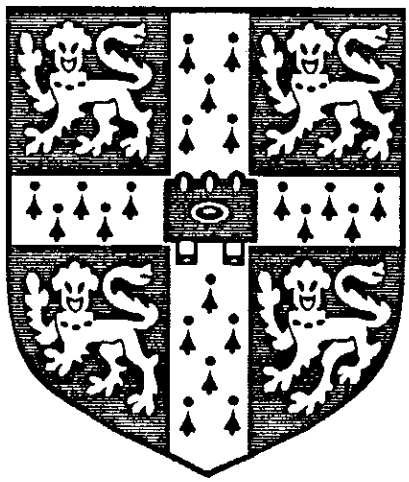

Department of Earth Sciences

Cruise Report

R.R.S. CHARLES DARWIN

Cruise 54

Magnetics, gravity and bathymetry survey of the OCEAN site

December 1990 - January 1991

RRS Charles Darwin Cruise CD54/90
OCEAN site survey
Cruise Report

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Contents

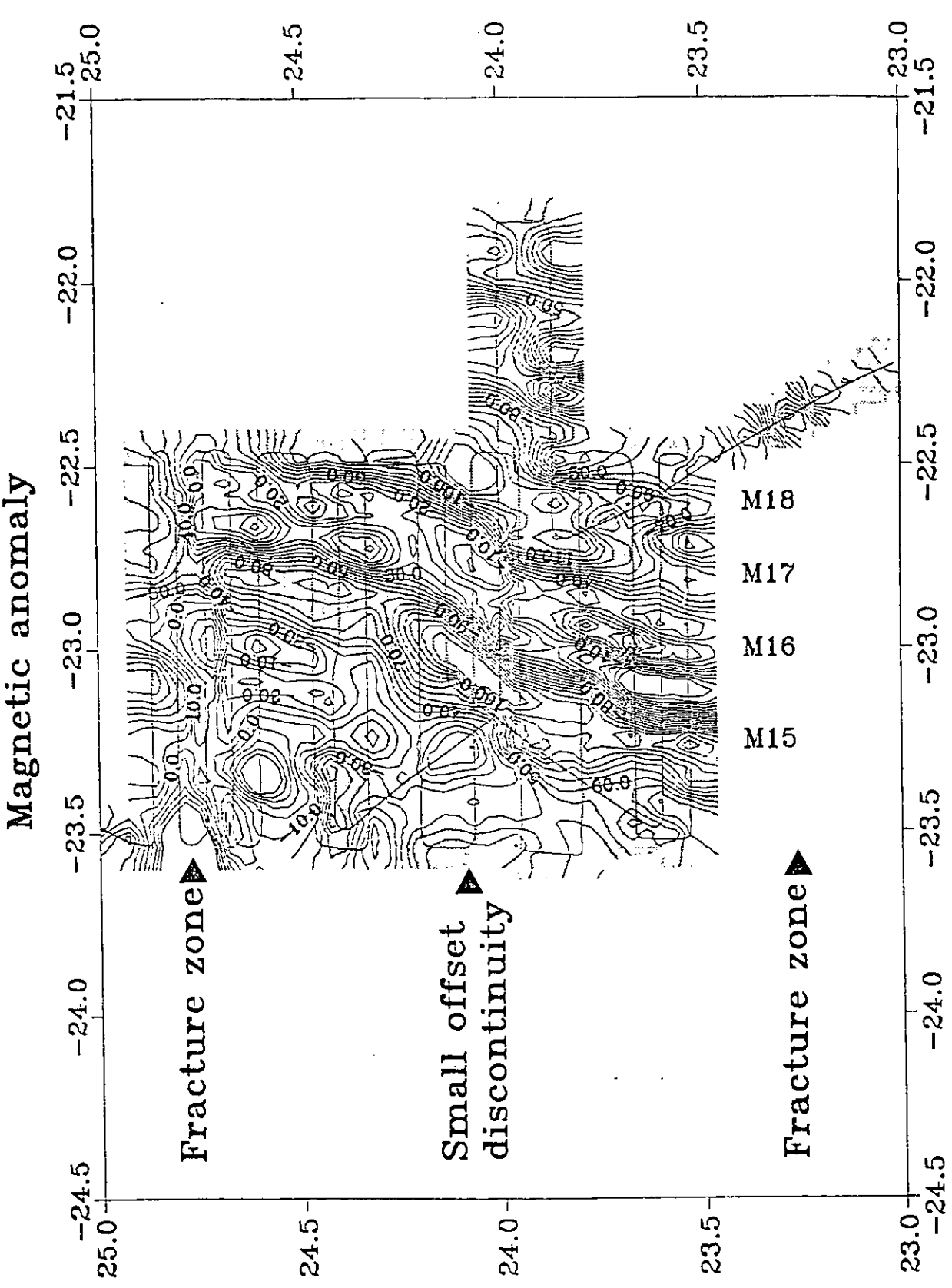
Objectives

The objective of RRS Charles Darwin cruise CD54/90 was to investigate the tectonics of a region of the Mesozoic North Atlantic. The study area was approximately conjugate to that studied using seismic profiling on RRS Discovery cruise DY171/87, and is the future site for the OCEAN survey which BIRPS are to carry out. The method used was to make underway measurements of bathymetry, gravity and magnetics, and from these to identify the presence of fracture zones and crustal thinning. We planned to investigate an area of about 150km × 100km, centred on 24 ° N, 23 ° W. We intended to lay down survey lines at intervals of 4nm or 8nm, running E-W, and several diagonal tie lines.

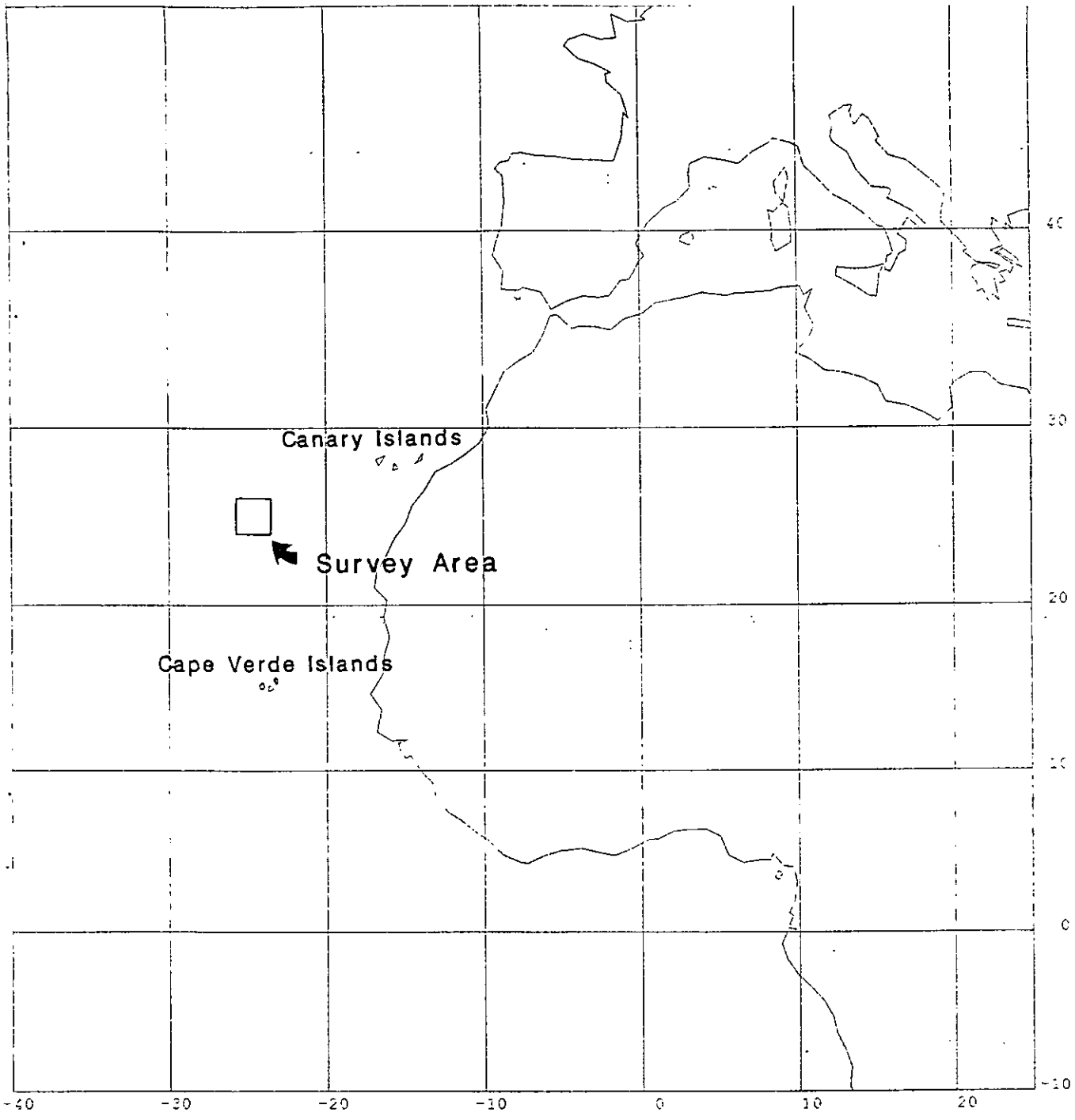
Summary

This was a very successful program. Almost 2500km of high quality along track data were acquired in the immediate survey region, as well as about 600km of data on the lead in to the main experiment.

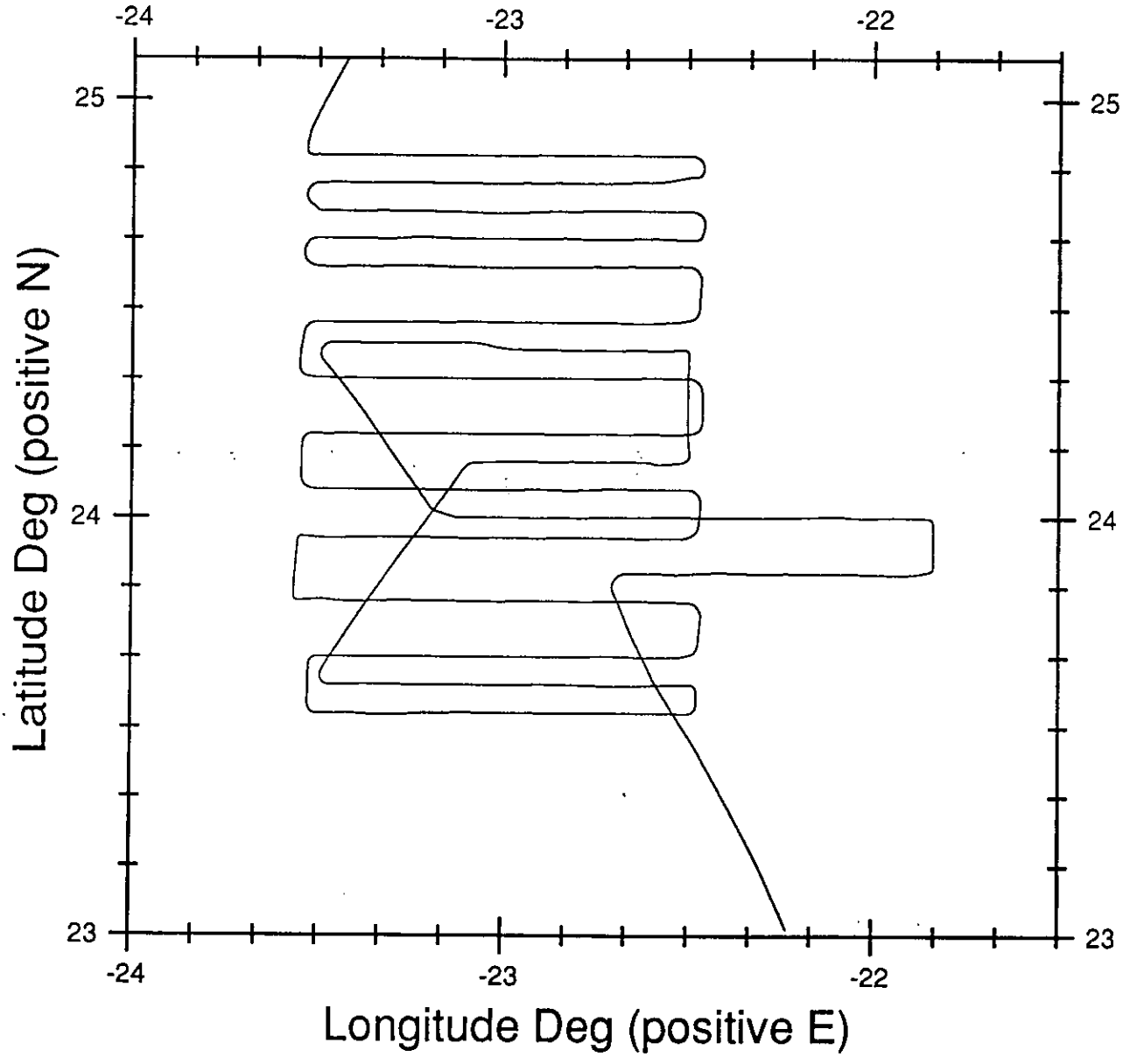
The magnetic data show the presence of a 50km offset fracture zone running E-W at about 24 ° 50'N, and a more variable offset discordant zone at about 24 ° N. The first of these was located to within 4km, the second is a more diffuse structure. Both offset the ridge axis in a right lateral sense. The sediments have a flat upper surface, dipping gently to the west by about 500m in 200km. The water depth is a little less than 5000m on average. Free air gravity anomalies show the fracture zone corresponds to a relatively narrow region of high north-south gravity gradients. The discordant zone is traced out by a broad (about 15km wide) positive gravity anomaly. The gravity structure lies in a roughly east-west direction (ie spreading, rather than ridge, parallel.)



Contoured and interpreted survey results. Solid line is track control



Location of survey region


-24
-23
-22
25
24
23
Latitude Deg (positive N)
Longitude Deg (positive E)

Track chart

Narrative

19 December - 27 December 1990
Passage Barry - Survey region

The ship made very good time, both during the work which BGS were carrying out in the Irish Sea, and on passage to our survey area. This was despite very heavy weather until we had cleared the Bay of Biscay. During the passage we ran the gravimeter occasionally in order to allow it to adjust to the lower gravity heading towards the equator.

GPS visibility predictions at this time suggested that there should be a minimum of three satellites above the horizon for the whole of the survey period, and at most times four or five. After discussion with the officers and technicians about past experience with the system, we decided to set the GPS receiver for a minimum of two satellites per fix, and a maximum of three. In the past four satellite fixing has been unreliable, presumably due to non-independence of the data which is then available.

28 December - 29 December 1990
Run in line

The ship hove to at 1500(Z) on 28 December for the deployment of the PES fish and the magnetometer head. On deploying the PES fish at its working depth of 8m, the winch brake became inoperative due to a sheared split pin. This was replaced, and the ship resumed course with the magnetometer 200m astern. We ran the gravimeter from this time, and logged all instrumentation from 1600(Z). Turns were to be carried out at full speed, using a turn rate of 6° per minute in order to maximise the magnetics track

coverage, even at the cost of losing gravity data at the beginning of each line.

Overnight the bridge switched to an adaptive autopilot which makes more gentle course corrections. This would reduce disruption of gravity data from within the lines, although potentially increasing the deviations from the planned survey. Given good GPS coverage, this was not a drawback for our purposes.

At 1340(Z) on 29 December the spare Level B tape drive, which had been in use for some considerable time, showed as faulty, and the Level B unit failed when we attempted to restart the tape back-up logging. Reseating the tape controller board in the Level B unit did not solve the problem, and the spare board appeared to be incorrectly configured for the ship-board system. There seemed to be no problem with the data-buffering action of the disk, so we decided that the spare board should be reconfigured but not fitted, and that a back-up of the Level C disk onto alternate streamer cartridges should be carried out every two hours by the watch-keeper.

We also found on occasions that some Level A units (particularly that attached to the gravimeter) appeared to get out of synchronisation with the data logging system, which could be cured by resetting them. Subsequently the gravimeter Level A was reset at least once every 24 hours during an end of line section.

29 December 1990 - 3 January 1991
Main survey

The main survey commenced at 2200(Z) on 29 December. Two minor problems associated with the Level A software emerged: bathymetry data was often flagged as unchanged for too long, and magnetics as changing too rapidly. This was largely due to being at the edge of an abyssal plain, with high gradients in the magnetic field. We also discovered during the morning of 30 December whilst examining the data from the first line that one of the GPS satellites had apparently been switched off during our period of three satellite visibility. This meant that for short times around 0200(Z) we had been reduced to using two satellite fixes. The inaccuracies caused by this lead to spikes in the eotvos correction to the gravity data and hence to spikes in the free air anomaly. We found that it was better in these intervening

periods to use a combination of dead reckoning and interpolation, since the coverage provided by the Transit-sat system was minimal.

We also found on 30 December that the tape drives attached to the Level B passed all their in-built diagnostics, but when we attempted to restore the tape cover at the end of line 4, the Level B unit crashed once more. We concluded that it was better to not try to use the tapes after this unless the later levels of the data logging system failed.

The magnetometer was fine-tuned to optimise the signal at frequent intervals in order to try and overcome the problem of apparent noise which was affecting the Level A. (On return to Bullard the raw magnetics actually seem to be exceptionally clean, with a standard deviation of around 2nT abbout the mean at any time.)

At 1500(Z) on 30 December the Level C data logger crashed during a streamer back-up, and about five minutes of data were lost before the Level B started to buffer new data. The Sun network required more than one attempt to reboot because of the cross-mounting of the disks, but we were able to establish the extent of the data loss during the turn onto line 9. At this time we also checked the whole of the magnetometer system. The remade connections improved the signal by almost 20temperature of the computer room up to this time (and in fact the Level C crash coincided with a peak in the temperature of almost 30° C.) Eventually the engineers were able to get the air conditioning working correctly, and there were no further difficulties with this.

At 0230(Z) on 1 January 1991, large inaccuracies developed in the GPS display, with the system being lost entirely from 0244(Z) to 0400(Z). This meant that the completion of Line 10 and the turn onto Line 11 were made on the transit system. On reprocessing any errors due to this were smoothed, and no velocity-induced spikes in the free air anomaly remained. Amusement was caused due to the gravimeter insisting that it was day 366 of 1990 (and subsequently day 367.) On 2 January we received a telex from Prof. White suggesting that we should continue a line eastwards in order to look for changes in spreading rate immediately prior to the formation of crust in the main survey area. The last eastwards line was intended to provide more detail about an apparent small-offset discontinuity at 24° N, so it was decided to continue this until 21° 50'W, then return a little to the south into the edge of the survey area to make another set of diagonal ties.

Hove to at 0800(Z) on 3 January for recovery of the magnetometer

sensor and the PES fish.

3 January - 5 January 1991
Passage to Dakar

We resumed full speed at 0824 on 3 January on course for Dakar. The passage was uneventful, if a little choppy passing through the trade winds, and mostly spent in producing a master navigation file and carrying out preliminary data analysis. Engine problems on the morning of 5 January were swiftly dealt with, and we were alongside in Dakar at Berth 1 Mole 1 by 1200(Z). Once there we ran the gravimeter up once more for a base tie at the adjacent gravity station.

Equipment used on CD54/90

Precision echo sounder

SIMRAD EA500 echo sounder using a 10kHz fish-mounted transducer. The fish was towed at approximately 8m depth. With this system only one pulse is in transit at any time, and bottom sensing software is used to calculate the depth. Long pulses were used at the full power setting, with a noise margin of 21dB and bottom detection parameter of -50dB. Output was taken to a colour printer, giving a plot anotated for a sound speed of 1470.6m/s, and to a Waverley chart recorder, giving an analogue record in time. The data was also logged automatically, assuming a constant sound velocity of 1500m/s, and subsequently corrected using Carter tables. Examining the colour records shows that the bottom identification was consistently clear and strong, and a cross check between the analogue record and the logged data suggested the identification was correct.

Magnetometer

A proton precession magnetometer was used, with a sensor head towed approximately 200m astern. Output was to chart recorder, and logged automatically.

Gravimeter

Seasys gravimeter system (Lacoste and Romberg S84, with pc for control and data logging). The gravimeter was mounted on a gyroscopically stabilised platform, in the controlled temperature laboratory on the port side

of the ship. Data was logged on the pc hard disk, and output to paper in the style of the old analogue chart recorder (although with self anotation) using a four minute low pass filter. The data passed to the Level A system is initially unfiltered; processing at a later stage includes a five minute low pass filter. The gravimeter was run for several hours before the start of the run-in line.

Calibration was as follows:

a) Base station at RVS Barry		
Gravity	=	981192.81
Meter reading at RVS Barry	=	12429.7 units
Meter calibration constant	=	0.9967
b) Base station at Dakar (Seaward side of berth 1 mole 1)		
Gravity	=	978469.26
Meter reading	=	9699.6 units
Drift, Barry to Dakar	=	0.06 mgal/day

Navigation

For navigation a Trimble GPS receiver was used, together with a rubidium clock to extend the coverage. The receiver was set for a minimum of two and a maximum of three satellites to be used for each fix.

Report of proceedings

Main objectives of cruise

The collection of gravity, magnetic and bathymetry data in order to establish the tectonic framework of the survey region.

Geographical area

Approx 1 °× 1 ° square centred on 24 ° N 23 ° W

Sea and weather conditions encountered

Sea conditions generally calm during survey with weather settled and clear.

Conduct of cruise

Few problems encountered during cruise. Collected a large amount of good quality data in the region which should give good control over the survey area.

Equipment performance

Survey equipment performed well; SIMRAD echo sounder particularly effective, as was GPS positioning due to good satellite cover. However, Level B tape drives in the data logging system both failed (reason currently unknown). The Level B tape is supposed to be the last resort back-up of the data logging system, so a failure in this is a matter of great concern. There were some problems initially with the a/c in the computer room, leading on at least one occasion to machine shutdown due to overheating. During the

data collection period the Level C data logging Sun crashed (possible due to heat) and as a result of the lack of tape back-up, approximately five minutes of data were lost (the only loss of data during the survey). The remaining data during the down period were accumulated on the Level B FIFO hard disk which worked successfully. Had any more serious failure occurred with the computer system the consequences would have been large amounts of data loss. There were also no correctly configured spares available for the system.

Ship performance

Ship performance was very good, such that the time available in the survey area was one and a half days more than was anticipated, and the survey was able to be carried out at 12.5 kt.

Any recomendations

There should be a complete spare Level B (set up) on each ship since this is a crucial part of the data collection system. This would enable the loss of data due to a failure to be minimised. It might also be appropriate to have an output from the Level A units to which a PC could be connected in case of a total logging failure. Currently the gravimeter is mounted in one of the worst possible locations, being off-centre, relatively high, and in a room with strong vibration. An alternative location would almost certainly enhance the data quality.

Signature and date

T.Henstock, 4/1/91

Details of survey lines

Line Number	Start time	Start position	End time	End position
1	2200/363	24 52.0N 23 29.9W	0234/364	24 52.0N 22 30.0W
2	0306/364	24 48.8N 22 30.0W	0745/364	24 48.0N 23 30.0W
3	0816/364	24 44.0N 23 30.0W	1251/364	24 44.0N 22 30.0W
4	1328/364	24 40.0N 22 30.0W	1802/364	24 40.0N 23 30.0W
5	1835/364	24 36.0N 23 30.0W	2311/364	24 36.0N 22 30.0W
6	0000/365	24 28.3N 22 29.9W	0440/365	24 28.0N 23 30.2W
7	0538/365	24 20.0N 23 30.0W	1017/365	24 20.0N 22 29.9W
8	1105/365	24 12.0N 22 29.7W	1541/365	24 12.0N 23 30.0W
9	1640/365	24 04.0N 23 30.0W	2136/365	24 04.0N 22 29.9W
10	2218/365	23 57.1N 22 30.0W	0253/365	23 57.2N 23 32.6W
11	0344/001	23 47.8N 23 32.7W	0903/001	23 47.8N 22 29.9W
12	0949/001	23 40.2N 22 30.1W	1412/001	23 40.0N 23 30.0W
13	1500/001	23 32.0N 23 30.0W	2015/001	23 32.0N 22 29.9W
14	2043/001	23 36.1N 22 29.4W	0100/002	23 36.0N 23 28.0W
15	0117/002	23 38.1N 23 29.2W	0429/002	24 07.2N 23 06.2W
16	0438/002	24 07.9N 23 04.6W	0725/002	24 07.8N 22 31.2W
17	0732/002	24 09.4N 22 29.7W	0849/002	24 23.6N 22 29.8W
18	0854/002	24 24.1N 22 30.7W	1323/002	24 25.0N 23 28.0W
19	1341/002	24 22.6N 23 29.2W	1600/002	24 22.6N 23 29.2W
20	1606/002	24 00.8N 23 10.6W	2241/002	24 00.0N 21 51.0W
21	2322/002	23 52.3N 21 50.2W	0304/003	23 52.0N 22 40.0W
22	0322/003	23 49.3N 22 42.0W	0800/003	23 00.1N 22 12.9W

Julian day conversion

Date	Julian day
25 December	359
26 December	360
27 December	361
28 December	362
29 December	363
30 December	364
31 December	365
1 January	1
2 January	2
3 January	3
4 January	4
5 January	5

Acknowledgements

Thanks must go to the officers and crew of RRS Charles Darwin for their patience and assistance during the cruise. Thanks are due also to all at RVS in Barry, particularly Gary White and Rod Pearce, the technicians on board. The success of the cruise was enhanced by the flexibility of BGS who curtailed their gravity survey in the Irish Sea when the ship's departure was delayed. The contribution of NERC in maintaining these valuable research facilities is gratefully acknowledged.