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Charles Darwin Cruise 48:
Gravity and magnetic data
in the Celtic Sea.
Barry to London June 20-26 1990.

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INTRODUCTION

Darwin cruise 48 was a short cruise undertaken to collect gravity data to strengthen the BGS gravity data base. The ship was scheduled to sail from Barry to London between two normal scientific cruises where she would take part in celebrations to mark the 25th birthday of NERC. Approximately two days were added to the time allowed for this passage to allow gravity data to be acquired in the Celtic Sea and the English Channel. Some equipment development and testing was undertaken and a number of supernumeraries took passage in the ship.

DIARY

- 20 June (day 171): equipment loaded and installed; scientific party embarked.
- 21 June (day 172): left Barry Dock 0600z; started work running just south of the Welsh coast observing gravity and magnetic fields and testing modifications to recently delivered Simrad hydrographic echo-sounder. A fresh easterly wind veered to SSW during the afternoon then died away only to blow strong later from the SW. A moderate swell caused cross-coupling errors of up to 17 mGal on S-84.
- 22 June (day 173): Darwin continued along the southern Irish coast with the westerly wind strengthening to gale force. Beyond Mizen Head she turned north to complete a short line then south to run towards Biscay. Wind and sea died down along this line.
- 23 June (day 174): The line was terminated at about 48°N , 10°W and the Simrad echo-sounder tested in over 3700m of water. The acoustic doppler current profiler was also tested at this time. Darwin then steamed up the Western Approaches towards a location 74 miles south of Newlyn.
- 24 June (day 175): Turned north and sailed for Newlyn: 0830z arrived off Newlyn: 0845z disembarked. Prof. Knill and Mr. T. Cumming then continued on a south-easterly course past Lizard in poor visibility and a fresh breeze from the SSW. Turned north east to cross the Eddystone gravity range by which time the wind had died down and cross-coupling on S-84 was around 2 mGal. At the end of this line turned east and continued up the Channel.

25 June (day 176): The Mid Channel traffic separating zone was crossed at right-angles and Darwin continued in the east-bound zone arriving off Ramsgate where the pilot boarded. Scientific work underway was terminated, when traffic congestion was demanding frequent course alterations, at 1145z.

26 June (day 177): Darwin berthed alongside HMS Belfast at approximately 0430z. The scientific party disembarked during the forenoon.

29 June (day 180): Harbour gravity base established in Great Yarmouth.

FUNCTIONING OF EQUIPMENT

Gravity meters

The Lacoste and Romberg meter S-84 had recently been redelivered to RVS having been fitted with the L & R newly developed PC-based digital control and readout. This system replaces all the electronics external to the meter and platform itself but requires the meter to have been converted to capacitance as apposed to to optical readout. The main display is via a CRT and a single colour dot matrix printer replacing the two chart recorders, with data being logged internally on a disc that has a capacity for 49 days. The data were also logged via an A level interface to the ships' logger: A software fault in the ships' logger led to loss of some data until it was observed and it proved relatively straightforward to copy data from the S-84 internal disc to floppy disc and, after reformatting, transfer the lost data to the ship logger files.

The meter appeared to perform satisfactorily although the output to the logger was somewhat noisier than that from S-40. On processing the data the outputs from the two meters were observed to have diverged during periods of rough weather.

L & R meter S-40, the oldest RVS meter, appeared to function properly on this cruise but its output differed from that of S-84. Errors in the cross-coupling corrections of either or both meters are most likely to be the cause of the

discrepancy. Data logged in S-84 will be analysed by the L & R engineer on his return to Austin. Unfortunately no 9400 or equivalent logger was available for S-40 so its cross-coupling cannot be checked for this cruise.

A fault was diagnosed when the cross-coupling pen began tracking zero in tollerably rough weather, which was apparently corrected when one of the amplifiers in the meter was replaced.

Magnetometer

The Varian magnetometer fitted for cruise 48 functioned satisfactorily throughout. Data were apparently logged continuously. The sensor was towed approximately 200m astern.

Simrad echo-sounder

A new Simrad hydrographic echo-sounder, model EA 500, was installed and accompanied on this cruise by a design engineer who effected a number of software modifications during the cruise. After a few hours running the instrument was interfaced to the ship's logger and data were logged throughout except for periods when the instrument was taken off-line for modifications. During these periods the Mufax system was run and analogue depths were keyed in to the logger.

Depth is displayed on a CRT with echoes colour-coded according to their strength, enabling recognition of different types of bottom and sub-bottom. The section of traces in the vicinity of the sea bed can be displayed as a seperate display with the undulations of the sea bed removed, and the picture can be printed with a colour printer.

Sequentially numbered fix marks were available on the printer and the software was modified to provide time and date as an alternative at each fix.

Depths in excess of 3700m were obtained in position approximately 48°N 10°W. The overside transducer fish was generally used before arrival in the western Channel. After leaving Newlyn the hull transducer was used.

Doppler log

The doppler log had not been used for some time previous to this cruise and the locating collar was loose on the shaft. When deployed the log was positioned approximately by eye. Later the cross velocity appeared to be erroneously high and the electronics found to be overheating. Application of a fan reduced the cross velocities and the value logged must be considered suspect. During the passage up the Channel the log was effectively out of action.

Data logger

The ships data logger is normally operated continuously, capturing all inputs and performing some processing to reduce the amount of data recorded. The following inputs which are of particular interest for this cruise were logged.

1. Gravity meter S-84, all parameters.
2. Gravity meter S-40, gravity.
3. Electromagnetic log.
4. Doppler log (data are suspect - see previous section).
5. GPS.
6. Magnavox recorded transit satellite data.
7. Magnetometer.

The logger functioned throughout. A software fault was present in the S-84 interface whereby the penultimate parameter being logged erroneously assumed the value of the last parameter, then the next parameter also assumed this value. If left this process worked through the whole data string until all slots were showing the same (changing) value. When spotted, this problem was temporarily cured by resetting the interface. Uncorrupted data were transferred subsequently to the logger file from the built-in logger for this gravity meter.

DATA ACQUIRED

Good gravity and magnetic data were acquired over virtually all the lines run. Depth data were logged when the Simrad echo-sounder was running. Apart from the first 3 hours or so of the first line, data gaps were filled with depths keyed in for 2 minute intervals.

All instruments were logged continuously and tagged with date and time. No fix numbers were assigned to data points. Lines are defined as listed in appendix 1.

NAVIGATION

Ships' tracks have been recorded from what was considered to be most likely, bearing in mind the status of GPS fixes, the altitude and number of iterations of Transit satellite fixes, the course and distance made good from ship's compass and doppler log (when available) and known deviations from the preferred course to avoid shipping etcetera. Plots of tracks at 1:250,000 scale were produced on board.

REDUCTION OF GRAVITY DATA

Using the first draft of position data, Eötvös and gravity values were calculated and plotted on board using the Sun workstations provided for logging and data processing. Areas of correlation between Eötvös and gravity were examined and the navigation checked and, where appropriate, re-calculated. Several jumps in position based on GPS observations using the rubidium frequency standard occurred when the number of satellites available changed. In such cases positions based on fewer than 3 satellites were ignored.

Using the finally accepted navigation data free air anomalies were calculated for both meters. Depth data were edited to remove erroneous values and Bouguer anomalies calculated. Output data were taken to Barry at the end of the cruise and transcribed to data tapes on GF3 format.

GRAVITY BASE TIES

A harbour base value was established at Barry using the station established in 1969 by IGS outside the now demolished RVS computer laboratory. It was not possible to obtain a reading on the portable meter close to the ship so a number of readings were made around the base demonstrating negligible variation in g in the vicinity. Accordingly the IGS base value was used for the ship base value. The height of the water in the dock above mean sea level was estimated at 5m.

A Hydrographic Department station established on the access quay beside HMS Belfast was used as a ship base value in London. With both of the above stations no record was found of the height of water relative to the quay when the station was established consequently using the values given for the stations may introduce errors not exceeding about 0.1 mGal.

On both gravity meters there was an apparent drift of about 4 mGal between Barry and London which casts doubt on the harbour base values at one or both places. Using the base tie for Great Yarmouth on 29 June (day 180) gave an apparent drift of +0.7 and +1.1 mGal for meters S-40 and S-84 respectively, over a period of 8 days, suggesting the London base is suspect. On crossing the Eddystone gravity range S-84 was observed to be about 1 mGal high and S-40 about 4 mGal high.

HARBOUR BASES AND STILL READINGS

	day	time	base	S-40	S-84
Barry	171	1924	981 192.7	09535.2	12440.9
London	177	0845	981 187.7	09534.2	12439.1
Great Yarmouth	180	0830	981 300.8	09644.9	12550.5
Calibration				0.9917	0.9967
(mGal/div)					

COMMENTS

The passage from Barry to London went smoothly and the ship functioned satisfactorily. I would like to thank the Master, officers and crew of Charles Darwin and RVS shore-based staff for their efforts in making this cruise successful.

We were fortunate on this cruise to be able to compare the performance of gravity meter S-84 incorporating the newest La Coste and Romberg electronics with that of the old S-40 meter. Although both meters appeared to function satisfactorily there was a significant divergence of output exceeding 20 mGal during the roughest weather. This almost certainly demonstrates that the cross-coupling connections were not being correctly applied to S-40. Since all meter parameters were logged for the reconditioned upgraded S-84 it should be possible to confirm the correct application of cross-coupling corrections

with that meter and subject to that check it is strongly urged that meter S-40 be returned to Austin for overhaul and, hopefully, for conversion to the new specification electronics. This also demonstrates the value of logging all output parameters and it is requested that meter S-84 is retained on board for forthcoming gravity cruises.

APPENDIX 1

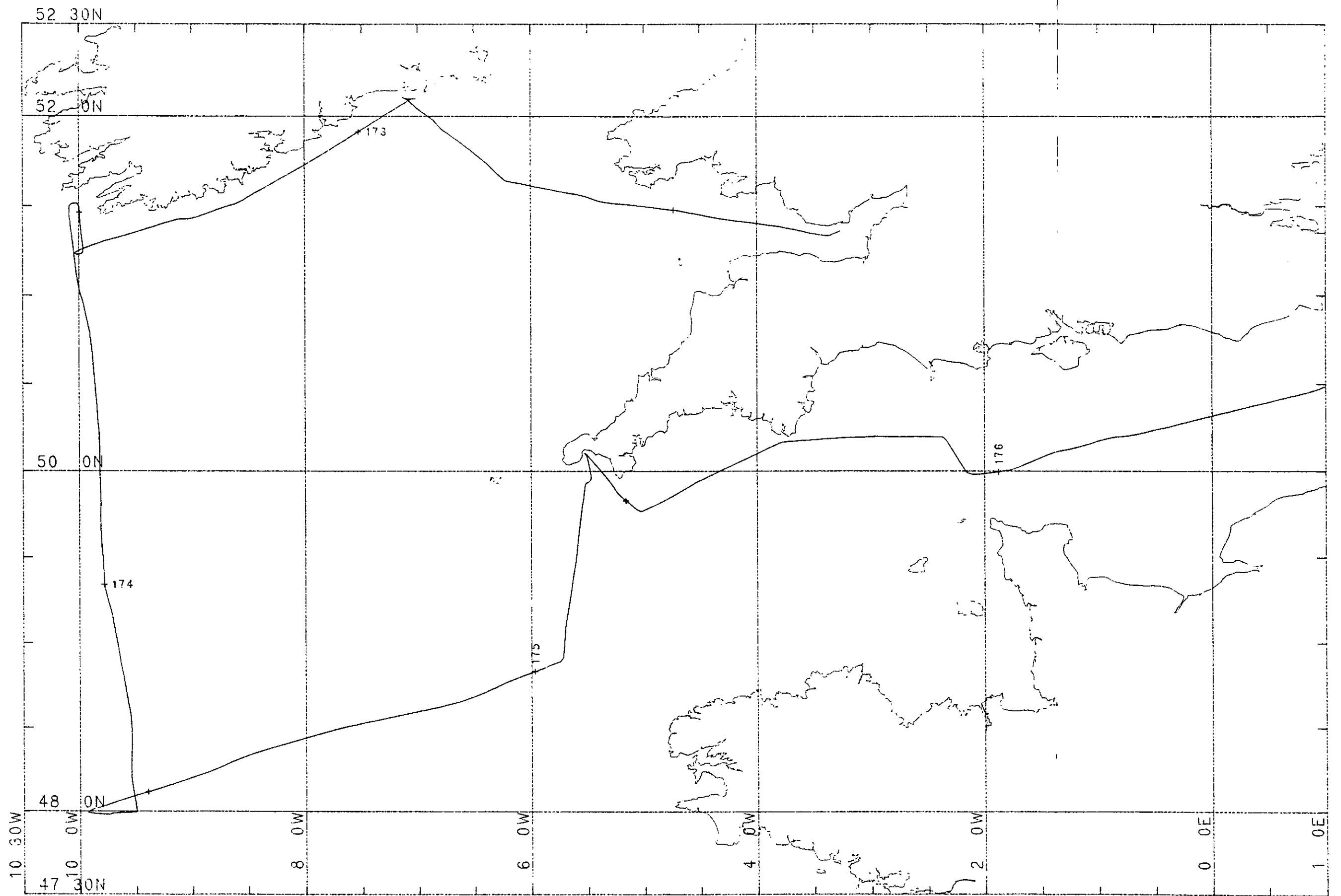
LINE LIST

LINE NO.	START	FINISH
1	172/0800	172/1730
2	172/1740	172/2127
3	172/2220	173/0425
4	173/0430	173/1018
5	173/1100	173/1213
6	173/1300	174/0729
7	174/1100	175/0050
8	175/0130	175/0700
9	175/0920	175/1722
10	175/1730	175/2151
11	175/2210	175/2306
12	175/2330	176/1145

APPENDIX 2

SUPERNUMERARY AND CABIN LIST

PSO	GEOFF DAY	BGS
NO. 4	DAVE SMITH	BGS
NO. 5	ROB LLOYD	RVS
NO. 6	ANDY BAKER	BAS
NO. 7	OLAV LANGEWAND	SIMRAD
NO. 8	ANDREW WINTERBOTTOM	HYD. DEPT.
NO. 9	HERB VALLIANT	La COSTE & ROMBERG
NO.10	COLM MURPHY	U. COLL. GALWAY
NO.11	TONY CUMMING	RVS
NO.14	CHRIS RYMER	RVS
NO.15	MIKE PERRY	RVS
NO.16	CHRIS PAULSON	RVS
NO.17	PROF. KNILL	CHAIRMAN NERC



MERCATOR PROJECTION

SCALE 1 TO 2500000 (NATURAL SCALE AT LAT. 43)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

GRID NO. 1

— Track plotted from astrav

RRS Charles Darwin Cruise 48