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RECORD 1987/44

RIG SEISMIC RESEARCH CRUISE 6,
NORTHERN AUSTRALIA HEATFLOW:
EXPLANATORY NOTES TO ACCOMPANY RELEASE OF
GEOPHYSICAL DATA

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INTRODUCTION

The purpose of this report is to summarise the processing techniques applied to the non-seismic geophysical data on *Rig Seismic* Research Cruise 6 (Survey 53; northern Australian continental margin heatflow).

GEOPHYSICAL SYSTEMS & PERFORMANCE

The following non-seismic geophysical systems were employed during Survey 53:

Navigation

Prime System: Magnavox MX1107RS dual-channel short-count TRANSIT satellite navigator; ship speed from Magnavox 610D dual-axis sonar doppler and heading from Arma-Brown SGB 1000 gyro-compass.
Secondary System: Magnavox MX1142 single-channel short-count TRANSIT satellite navigator; ship speed from Raytheon DSN-450 dual-axis sonar doppler and heading from a Robertson gyro-compass.
Tertiary System: Magnavox T-Set Global Positioning System (GPS).

Performance Comments: Both TRANSIT satellite navigators generally performed reliably. The MX1107RS was interfaced to the Data Acquisition System (DAS) and latitude, longitude, course, speed (every 10 seconds) and all satellite fix details were transferred and recorded. The DAS interface for the MX1142 was configured to its printer port and the information on the screen was 'printed' to the DAS at the maximum rate (60 s); satellite fix information was also passed by the same route.

The GPS system was operational for about 12-14 hours per day, of which about 8 hours provided usable data.

The Magnavox and raytheon speed logs both performed quite reliably, except when sea conditions became rough.

Both gyro-compasses performed satisfactorily for the entire survey.

Bathymetric Systems

Raytheon Deep-sea Bathymetric System, with a maximum power output of 2 kW at 12 kHz. This system, purchased in the early 1970's, was of very sophisticated design for its day, providing in addition to digital depths and various alarm flags, an automatic tracking facility that should theoretically provide usable bathymetric data even in marginal recording conditions.

Performance Comments: Data quality was generally good, due in part to the low sea states. The extensive processing required to retrieve acceptable bathymetric data is described fully later in this report.

Magnetics

Two Geometrics G801/803 proton precession magnetometers were installed in

the instrument room. Single channel magnetic data were recorded on the longer transits.

Performance Comments: The magnetometer performed without serious problems. Noise levels were generally less than 3 nT.

Gravity

A Bodenseewerk KSS-31 marine gravity meter was installed in the main instrument room.

Performance Comments: Gravity data were recorded for the entire survey with no problems. Gravity ties were performed at Townsville prior to the cruise, and at Fremantle on completion of the cruise. Gravity tie information is provided in Table 1.

DATA ACQUISITION SYSTEM (DAS)

The shipboard DAS is based on a Hewlett-Packard (HP) 1000 E-Series 16-bit minicomputer which during Survey 53 was fitted with 512 kw of memory. The DAS programs run under the HP Real Time Executive (RTE-6/VM) disc-based operating system, which allows a multiprogramming environment and a large number of interactive users. Data are acquired either directly from the appropriate device through an RS-232C interface (gravity, Magnavox MX1107RS, Magnavox MX1142), or through a BMR-designed 16-bit digital multiplexer (magnetics, bathymetry) and attached gyro-log interface (for both sonar dopplers and gyro-compasses). After preliminary processing, plotting on strip-chart recorders, and listing on a variety of printers, the data were recorded on 9-track, 1600 bpi, phase-encoded magnetic tape in HP's 32-bit floating-point format.

Data were acquired and saved at a 10-second rate, regardless of ship speed. The data were written to tape in 1.0 minute (6 record) blocks with 80 channels of data being recorded. The channels that were recorded are listed in Table 2.

Table 1: Gravity tie information for Survey 53.

Place	Date	Time (GMT)	KSS-31 value	Corrected value
Townsville	10 Jan 1986	0430	-1799.862	978632.278
Perth	08 Feb 1986	0415	-1000.664	070424.720

Gravity meter drift - Townsville to Fremantle = 6.76 mgal

Table 2: Acquisition channel allocations

The following is a list of the channel allocations for the geophysical data for Survey 53.

1 - Clock (survey & day number)
2 - GMT acquisition time from computer clock (hours,mins,secs)
3 - Master clock time at acquisition (hours,mins,secs)
4 - Latitude (radians)
5 - Longitude (radians)
6 - Speed (knots) - best estimate
7 - Heading (degrees) - best estimate
8 - Magnetometer No 1 (nT)
9 - Magnetometer No 2 (nT)
10 - Bathymetry No 1 (metres)
11 - Bathymetry No 2 (metres)
12 - Magnavox sonar doppler - fore/aft
13 - Magnavox sonar doppler - port/starboard
14 - Raytheon sonar doppler - fore/aft
15 - Raytheon sonar doppler - port/starboard
16 - Not used
17 - Not used
18 - Heading No 1 Arma Brown gyro-compass
19 - Heading No 2 Robertson gyro-compass
20-24 - Not used
25 - Hifix fine A
26 - Hifix fine B
27 - Hifix fine C
28-31 - Not used
32 - T-Set time (GMT secs)*2
33 - T-Set (Dop)
34 - T-Set latitude (radians)
35 - T-Set longitude (radians)
36 - T-Set height (above Geoid)
37 - T-Set speed (knots) * 10
38 - T-Set course (degrees) * 10
39 - T-Set frecuency bias No 1
40 - T-Set GMT (hours,mins,secs)
41-49 - Not used
50 - GMT time from MX1107 satnav
51 - Dead-reckoning time from MX1107
52 - Latitude (radians) from MX1107
53 - Longitude (radians) from MX1107
54 - Speed (knots) from MX1107
55 - Heading (degrees) from MX1107
56 - Set (degrees) from MX1107
57 - Drift (knots) from MX1107
58 - Set/drift flag, 0 = No 1 , 1 = auto from MX1107
59 - GMT from MX1142 satnav
60 - Dead-reckoning time from MX1142
61 - Latitude (radians) from MX1142
62 - Longitude (radians) from MX1142
63 - Speed (knots) from MX1142
64 - Heading (degrees) from MX1142

65 - Set (degrees) from Mx1142
66 - Drift (knots) from MX1142
67 - Set/drift flag, 0 = No 1 , 1 = auto from MX1142
68 - Vector speed Magnavox sonar dopplar
69 - Vector speed Raytheon sonar doppler
70-73 - Not used
74 - Gravity (mGal * 100)
75 - ACX (m/s/s * 1000)
76 - ACY (m/s/s * 1000) pitch
77 - Sea state
78-80 - Not used

DATA PROCESSING

The data were processed on an in-house Hewlett-Packard 1000 F-Series minicomputer utilising similar hardware and the same operating system as the DAS. The processing was applied in two phases, as follows:

Phase 1: transcription of field tapes; correction of time errors; production of raw data plots; bulk editing (principally deletion of bad data segments); retrieval of water depth data; retrieval of velocity data; minor editing; filtering of gravity, magnetic, GPS, and speed log data; computation of incremental latitudes and longitudes; production of final check plots; final editing.

Phase 2: tying of the dead-reckoned (DR) track to the satellite fixes using a cubic spline fitting technique to model ocean currents; assessment and deletion of poor quality satellite fixes; computation of final positions for each DR system; computation of final ship position from an appropriate mix of the available DR systems and the GPS system; computation of final Eotvos-corrected gravity, including a correction for gravity meter drift; final data editing (particularly gravity data during turns).

A brief summary of the processing steps follows, with some detail of the techniques applied.

PHASE 1

FCOPY: All field tapes were transcribed to processing tapes with several field tapes being combined into a single processing tape. Processing tapes were separated at obvious breaks (such as recording system crashes), or after about seven days recording. During the transcription, data were re-blocked to 2-minute blocks (12 records/block). Time jumps (positive or negative) were reported for processing in the next phase.

FIXTM: Time jumps reported in *FCOPY* were corrected, either automatically, or with a file of manual time corrections. data channels were re-ordered and reduced to 64 in number to simplify further processing.

VARPL: All raw data channels requiring processing were plotted as strip records on a drum plotter. These plots were used to determine where editing was required and as a first guide for the setting of filter parameters.

FTAPE: This program was used for a variety of tasks as follows -

(1) Removal of hardware/software flags in the bathymetric data. The Raytheon echo-sounder system provides, in addition to digital bathymetry, 'flags' indicating that the echo-sounder has lost track or that the digitiser gate is searching for an echo. These flags were removed, as appropriate, and such values were replaced by the number 1.0E10 (10 raised to the power 10), to indicate absent data.

(2) 'Bulk' deletions were done of any large blocks of irretrievable data in particular channels.

(3) Automatic interpolations were done across data gaps of up to

120 seconds for selected data channels.

GMULT: All raw gravity data were divided by 100 to reduce them to milligals. Magnavox and Raytheon speed logs (each of which outputs a fixed number of 'clicks' per nautical mile travelled) were reduced to give speeds in knots.

EDATA: This is a utility program used for the manual editing of problem areas that are not amenable to filtering or automatic editing.

SALVG (Water depths): Briefly stated, the problem of bathymetry recovery is to fill in all the gaps left after the Raytheon hardware/software flags were removed and to discriminate against the bad bathymetric values that still remain.

To accomplish this, a file was first created of manually digitised water depths at selected points; this file was then read in conjunction with the processing data file. SALVG then performs a straight line interpolation between adjacent tie points and compares the interpolated depth with the 10-second digital depth. If the difference is less than a user-specified threshold, then the digital depth is accepted and is used to replace the previous first tie point. If the difference is greater than the threshold, then the 10-second digital depth is replaced by the interpolated depth. In this way, the program tracks along the acceptable water depths, providing the threshold is small enough to reject bad data and large enough to accept the good data. In the case of the digital data being totally unacceptable, as during poor sea conditions, the threshold was set to a very small number (0.01 m) and the process became one of simple linear interpolation between adjacent tie points. In practice, the interval between manually digitised tie points varied from several hours in the case of good digital 10-second data, to several minutes in the case of poor 10-second data or a very rugged seabed.

The success of this process, which is routinely applied to all *Rig Seismic* bathymetric data, can be seen in the 'before' and 'after' plots of Figure 1.

SALVG (Velocities): Where reliable velocities could not be obtained by filtering the raw data, program SALVG was used to produce a linear interpolation of velocities between manually supplied values.

FDATA: The magnetic, gravity, and Magnavox and Raytheon speed log data were filtered using a sophisticated form of the median filter, a highly successful spike deletion tool. Filter parameters for each channel are summarised in Table 3.

MUFF: This program uses a SINC function filter to smooth selected data channels. All velocity channels were smoothed to provide acceptable speeds, while the gravity and magnetic data were filtered as an anti-aliasing measure prior to resampling to 60 s. The filter coefficients and the approximate responses of the filters to a sine wave are given in Table 4.

Figure 1: Bathymetry traces before (upper) and after processing by program SALVG. Vertical scale is 100 m/inch; horizontal scale is 30 minutes/inch. The input data are of fairly poor quality.

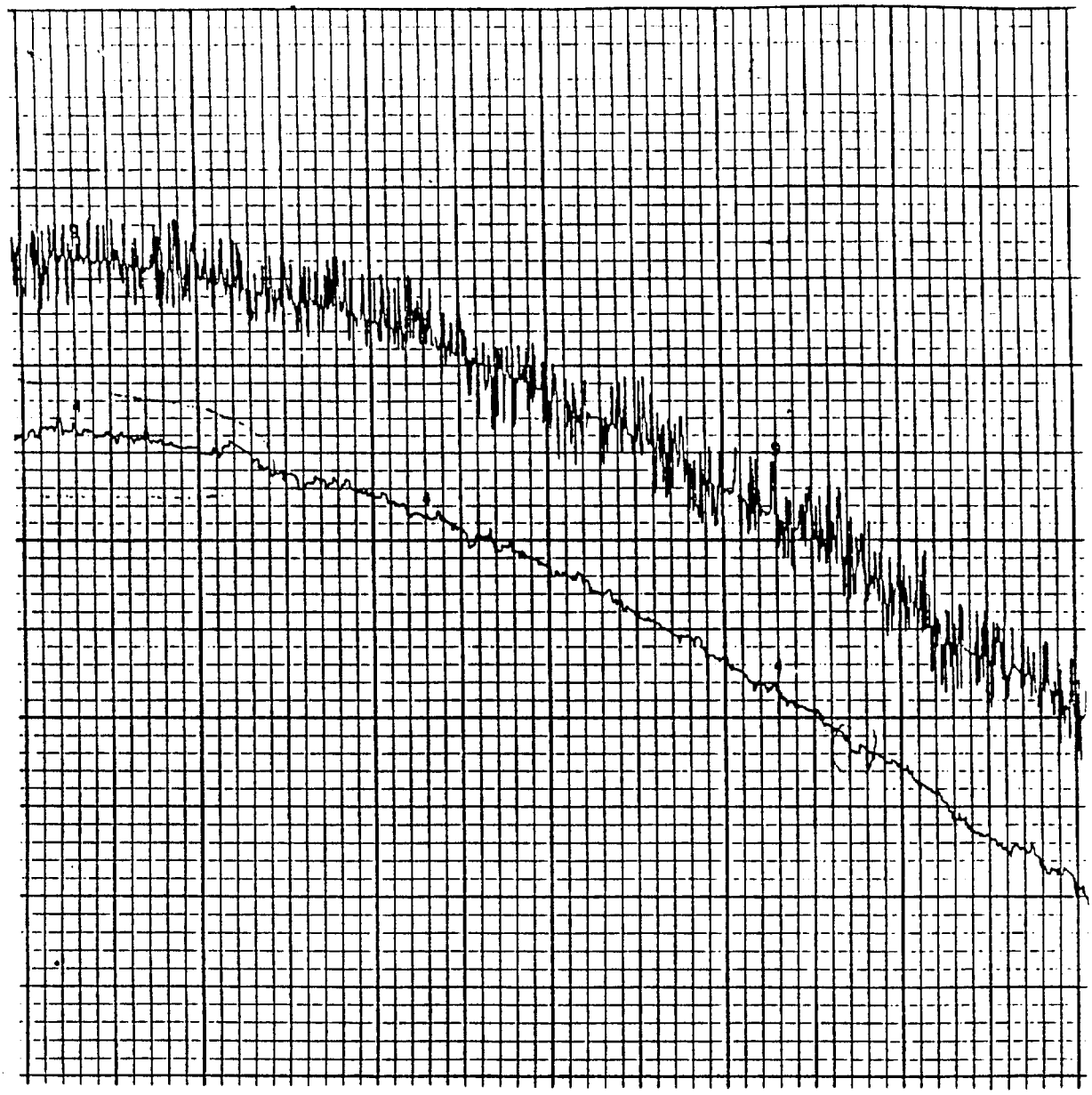

Table 3: Median filter parameters.

Data Channel	Filter length (samples)	Threshold (data units)
magnetics	13	7
gravity	13	7
Magnavox fore-aft	13	1
Magnavox port-stbd	13	1
Raytheon fore-aft	13	2
Raytheon port-stbd	13	2

Table 4: Smoothing filter coefficients and approximate response of filter to sine wave input.

Filter 1: Applied to - Magnavox sonar-doppler (fore-aft & port-stbd) and Magnavox T-Set GPS latitude and longitude.
Period of filter - 60 sec.
Cutoff at 3rd zero crossing

[illegible] OF POINTS IN FILTER 121

FILTER COEFFICIENTS AS FOLLOWS

.006 .013 -.000 -.03e -.053 .000 .136 .272 .334 .272
.130 .000 -.053 -.03e -.000 .013 .006

FRACTION	PERIOD	RESPONSE	db
.500	30.0	.00112	-59.0
.518	31.1	.00424	-47.4
.536	32.2	.00642	-43.9
.555	33.3	.00642	-43.9
.574	34.5	.00359	-48.9
.595	35.7	-.00185	-54.7
.616	36.9	-.00877	-41.1
.637	38.2	-.01530	-36.3
.660	39.6	-.01912	-34.4
.683	41.0	-.01782	-35.0
.707	42.4	-.00930	-40.6
.732	43.9	.00801	-41.9
.758	45.5	.03499	-29.1
.785	47.1	.07175	-22.9
.812	48.7	.11770	-18.6
.841	50.5	.17168	-15.3
.871	52.2	.23210	-12.7
.901	54.1	.29714	-10.5
.933	56.0	.36488	-8.8
.966	58.0	.43348	-7.3
1.000	60.0	.50125	-6.0
1.035	62.1	.56674	-4.9
1.072	64.3	.62876	-4.0
1.110	66.6	.68649	-3.3
1.149	68.9	.73927	-2.6
1.189	71.4	.78679	-2.1
1.231	73.9	.82892	-1.6
1.275	76.5	.86573	-1.3
1.320	79.2	.89742	-.9
1.366	82.0	.92433	-.7
1.414	84.9	.94680	-.5
1.464	87.8	.96529	-.3
1.516	90.9	.98024	-.2
1.569	94.2	.99208	-.1
1.625	97.5	1.00126	.0
1.682	100.9	1.00816	.1
1.741	104.5	1.01316	.1
1.803	108.2	1.01659	.1
1.866	112.0	1.01874	.2
1.932	115.9	1.01987	.2
2.000	120.0	1.02020	.2

Filter 2: Applied to magnetics, gravity, and Raytheon sonar doppler (fore-aft and port-stbd).
Period of filter - 180 sec.
Cutoff at 3rd zero crossing

FILTER COEFFICIENTS AS FOLLOWS

.006	.011	.007	.003	.004	.006	.010	.008	-.000	-.004
-.006	-.012	-.015	-.018	-.018	-.015	-.009	.000	.012	.027
.043	.060	.076	.091	.102	.109	.111	.105	.102	.091
.076	.060	.043	.027	.012	.000	-.009	-.015	-.018	-.018
-.015	-.012	-.008	-.004	-.000	.003	.004	.004	.004	.003
.002	.001	.000							

FRACTION	PERIOD	RESPONSE	db
.500	90.0	.00108	-59.3
.518	93.2	.00442	-47.1
.536	96.5	.00672	-43.5
.555	99.9	.00672	-43.5
.574	103.4	.00380	-48.4
.595	107.0	-.00178	-55.0
.616	110.8	-.00884	-41.1
.637	114.7	-.01548	-36.2
.660	118.8	-.01934	-34.3
.683	122.9	-.01804	-34.9
.707	127.3	-.00946	-40.5
.732	131.8	.00793	-42.0
.758	136.4	.03500	-29.1
.785	141.2	.07183	-22.9
.812	146.2	.11784	-18.6
.841	151.4	.17184	-15.3
.871	156.7	.23226	-12.7
.901	162.2	.29726	-10.5
.933	167.9	.36499	-8.8
.966	173.9	.43355	-7.3
1.000	180.0	.50127	-6.0
1.035	186.3	.56672	-4.9
1.072	192.9	.62872	-4.0
1.110	199.7	.68641	-3.3
1.149	206.8	.73918	-2.6
1.189	214.1	.78669	-2.1
1.231	221.6	.82862	-1.6
1.275	229.4	.86564	-1.3
1.320	237.5	.89735	-.9
1.366	245.9	.92426	-.7
1.414	254.6	.94676	-.5
1.464	263.5	.96527	-.3
1.516	272.8	.98024	-.2
1.569	282.5	.99210	-.1
1.625	292.4	1.00129	.0
1.682	302.7	1.00821	.1
1.741	313.4	1.01322	.1
1.803	324.5	1.01665	.1
1.866	335.9	1.01881	.2
1.932	347.7	1.01994	.2
2.000	360.0	1.02028	.2

DELTA: Incremental (delta) latitude/longitudes were produced every 10 seconds by combining the ship speed with the headings from the Arma-Brown and Robertson gyro-compasses. This produced three separate dead-reckoning (DR) systems (Magnavox + Arma-Brown; Magnavox + Robertson; Raytheon + Arma-Brown).

INTEG: The filtered incremental latitude/longitudes were re-integrated over running 60-second intervals. These 60-second incremental distances were then used in the Phase 2 processing to compute the DR vector over each satellite fix interval.

VARPL/EDATA: As the final stage of the Phase 1 processing, all processed channels were plotted again as 'strip' plots with program VARPL. Program EDATA was then used to correct any minor residual data problems.

PHASE 2

Phase 2 processing encompasses the following tasks -

1. Re-formatting and production of assessment listings of satellite fixes;

2. Resampling Phase 1 data;

3. Assessment of satellite fixes and deletion of those considered dubious or unacceptable;

4. Constrainment of DR track to remaining satellite fixes and computation of 1-minute positions for each DR system;

5. Selection of a suitable mix of navigation systems to produce final positions;

6. Application of Eotvos and drift corrections to gravity data and conversion to absolute values;

7. Final plots and editing as necessary.

In rather more detail, the programs applied were as follows -

RESAF: Re-format the ASCII parameter file of satellite fixes and adjust each fix to the nearest whole minute of survey time using the ship speed and heading applying at that time in the Phase 1 data file.

FIXES: Produce a listing of the satellite fixes for assessment purposes (Table 5).

RESAM: Concatenate the Phase 1 data files, as appropriate, and resample to produce 1-minute data.

SAT12: Two passes of this program are required for each round of satellite fix assessment. During each pass, a number of options are called, as follows:

Pass 1

a. SATEL - reads in the file of satellite fixes and stores them in memory. Any fix intervals with dubious speeds (too low or too high) or any intervals that are very short (<15 minutes) or very long (>120 minutes) are flagged in the output listing.

b. DRNAV - uses the incremental latitude/longitudes stored on the Phase 1 file and the satellite fix information to compute the DR path (or DR vector) for each satellite fix interval. This is saved as an ASCII parameter file.

c. CALNV - reads the DR file created by DRNAV and computes the ratio of the average DR velocity to the velocity computed from successive satellite fixes. This is done for each DR system used, and the results are listed.

d. CALPL - produces a line printer plot of the velocity ratios for each satellite fix interval.

Pass 2

a. CFACT - uses the DR file and a user-created file of calibration factor intervals to compute velocity calibration factors for each DR system.

b. APROX - uses the calibration factors computed in CFACT and the DR file to produce an approximately calibrated DR file.

c. ASSES - uses the approximately calibrated DR file created by APROX to produce a line printer plot of the current and summed error vectors at and between satellite fixes. The plot is produced at a 10-minute sample interval.

The basis of the processing is that option 'ASSES' takes the summed latitude and longitude error vectors at each fix (*ie* a running sum of the DR position to satellite fix position vectors at the time of each fix) and uses a piece-wise cubic polynomial curve-fitting function (the Akima spline) to compute error vectors at all times between satellite fixes. It is assumed that the ensuing smooth variation of the error vector is due to ocean currents, winds, etc. Poor quality fixes will produce unrealistic or large and variable ocean currents. At each round of assessment (and usually at least three rounds are required for each file), the satellite fixes are checked wherever the summed error and current vectors suggest a problem, and those fixes of poor quality are deleted for the next program run. The effect of this process can be seen in the example in Figures 2 and 3.

SAT3: uses the final file of satellite fixes and the DR data to produce final positions for each DR system. This program again uses the Akima spline to compute the assumed currents acting at all times between satellite fixes and applies those currents to the DR data to compute positions.

FINAV: performs the following functions -

a. Computes final 1-minute positions based on a 'mix' of DR systems and the Global Positioning System according to a file specified by the user.

b. The gravity data (which was in mgals relative to an arbitrary datum) was converted to absolute values corrected for meter drift and with Eotvos corrections applied.

VARPL/EDATA/FIXTM/EDATA/MUFF: As a final check, the Phase 2 positions, water depths, magnetic, and gravity data were plotted and editing applied as necessary. Program FIXTM was then used to re-block the data to 8 channels x 60 records per block (*ie* 1-hour blocks). The final channel allocations are shown in Table 6. As a final editing stage, the residual gravity spikes at turns are removed (EDATA) and the gravity channel is smoothed by a filter of 15-minute period to remove any remaining sea noise (MUFF).

Tracks from Survey 53 are shown in Figures 4-9, and a list of final station locations and water depths are included in Table 7.

Table 5: (Next page) Sample listing of satellite fix parameters produced by program FIXES.

Column headings as follows:

FIX - satellite fix number within file;
FIX TIME - computed time of fix in format SS.DDD.HHMMSS, where SS is the survey number (53), DDD is the Julian day number in 1986, and HHMMSS is the GMT time;
LAT, LONG - Latitude & longitude of fix in degrees & decimal minutes;
SYSTEM - Magnavox 1107 or 1142, or dummy fix (DFIX);
SAT - satellite number; OK - accepted (Y) or rejected (N) on-board;
ELEV - maximum elevation of satellite (degrees);
COUNT - number of doppler counts received;
ITER - number of iterations required to compute fix;
GEOM - geometry of pass; ERROR - amount of shipboard update (n. miles??
DIR - direction of shipboard update (degrees);
SLT, SLN - standard deviation of latitude & longitude (metres);
CODE - error code if fix not accepted by sat nav;
COURSE, SPEED - vessel's course and speed at time of fix.

Table 5

FIX	FIX TIME	LAT	LONG	SYSTEM	SAT	OK	ELEV	COUNT	ITER	GEOM	ERROR	DIR	SLT	SLN	CODE	COURSE	SPEED
34	53.026.074700	13 21.015	125 28.556	1107	480	Y	25	31	3	NE	1.07	315	0	0		230.8	9.7
35	53.026.080400	13 22.668	125 26.194	1107	130	Y	43	34	3	SW	.22	328	0	0		232.8	10.1
36	53.026.093500	13 31.984	125 13.216	1107	480	Y	36	35	3	NW	.99	339	0	0		231.8	11.3
37	53.026.103000	13 38.124	125 4.477	1107	300	Y	27	31	3	NE	.84	306	0	0		235.0	10.5
38	53.026.121700	13 50.150	124 48.793	1107	300	Y	31	32	3	NW	1.28	335	0	0		233.8	10.6
39	53.026.140900	14 4.099	124 31.849	1107	500	Y	50	37	3	NE	1.55	308	0	0		229.7	10.9
40	53.026.155600	14 12.429	124 31.915	1107	110	N	52	21	6	NE	15.4	72	0	0	5	235.8	11.3
41	53.026.164300	14 20.759	124 8.574	1107	200	Y	47	30	3	NE	1.89	318	0	0		231.3	9.6
42	53.026.174200	14 25.847	123 59.090	1107	110	Y	15	24	5	NW	.76	352	0	0		239.8	11.5
43	53.026.182800	14 29.521	123 51.071	1107	200	Y	13	22	3	NW	.68	328	0	0		234.5	10.6
44	53.026.194400	14 37.460	123 38.698	1107	480	Y	21	29	3	SE	1.03	322	0	0		223.5	11.4
45	53.026.211700	14 47.897	123 24.115	1142	130	Y	7	22	3		.60	217	0	0		229.9	11.4
46	53.026.213200	14 49.194	123 20.967	1107	480	Y	43	36	3	SW	1.80	313	0	0		226.7	11.3
47	53.026.222000	14 54.674	123 13.656	1107	300	Y	21	28	3	SE	.59	354	0	0		231.7	12.1
48	53.027.000700	15 6.432	122 55.963	1107	300	Y	46	36	3	SW	1.55	313	0	0		234.8	11.2
49	53.027.020600	15 19.298	122 37.509	1107	500	Y	42	35	3	SE	1.26	336	0	0		240.8	10.8
50	53.027.034000	15 28.011	122 23.076	1107	110	Y	33	27	2	SE	1.12	322	0	0		246.3	9.6
51	53.027.035400	15 29.522	122 20.653	1107	500	Y	21	26	3	SW	.33	283	0	0		235.8	11.1
52	53.027.041700	15 32.032	122 17.478	1107	200	Y	27	30	3	SE	.32	17	0	0		233.5	10.9
53	53.027.052700	15 39.318	122 6.313	1107	110	Y	26	30	3	SW	.94	308	0	0		231.5	10.9
54	53.027.060200	15 43.438	122 1.080	1107	200	Y	35	33	3	SW	.50	322	0	0		229.3	11.1
55	53.027.071500	15 50.315	121 49.201	1107	130	Y	54	32	3	SE	.95	341	0	0		230.2	10.6
56	53.027.090200	16 2.307	121 29.822	1107	130	Y	15	23	3	SW	1.82	315	0	0		231.5	12.1
57	53.027.095300	16 7.962	121 20.925	1107	300	N	8	21	3	NE	.71	324	0	0	1	233.9	10.8
58	53.027.114200	16 21.258	121 4.443	1107	300	N	80	36	4	NW	1.95	6	0	0	1	233.8	11.2
59	53.027.134500	16 35.791	120 43.799	1107	500	Y	25	32	3	NE	2.53	329	0	0		233.2	11.6
60	53.027.150600	16 44.165	120 30.799	1107	110	Y	12	23	3	NE	.87	356	0	0		233.7	12.0
61	53.027.153400	16 47.187	120 26.813	1107	500	Y	38	35	3	NW	.63	49	0	0		232.7	11.9
62	53.027.165300	16 56.007	120 13.762	1107	110	Y	61	35	3	NW	1.13	357	0	0		232.8	10.9

Figures 2 & 3 (following pages). Satellite fix assessment plots for a part of Survey 53. 10-minute time (DD.HHMM) along bottom of plot; satellite fixes indicated by vertical row of dashes (eg at 24.1140); traces on the plot are as follows:-
N & E - north and east currents for DR system 1;
1 & 2 - north and east summed error vectors for DR system 1;
Y & X - north and east currents for DR system 2;
3 & 4 - north and east summed error vectors for DR system 2.
Note in particular the large fluctuations in both the north and east currents and summed error vectors in Figure 2 around the satellite fixes at 24.0830 and 24.1400. Removal of this fix produces smoothly varying currents and summed error vectors in Figure 3.

Figure 2

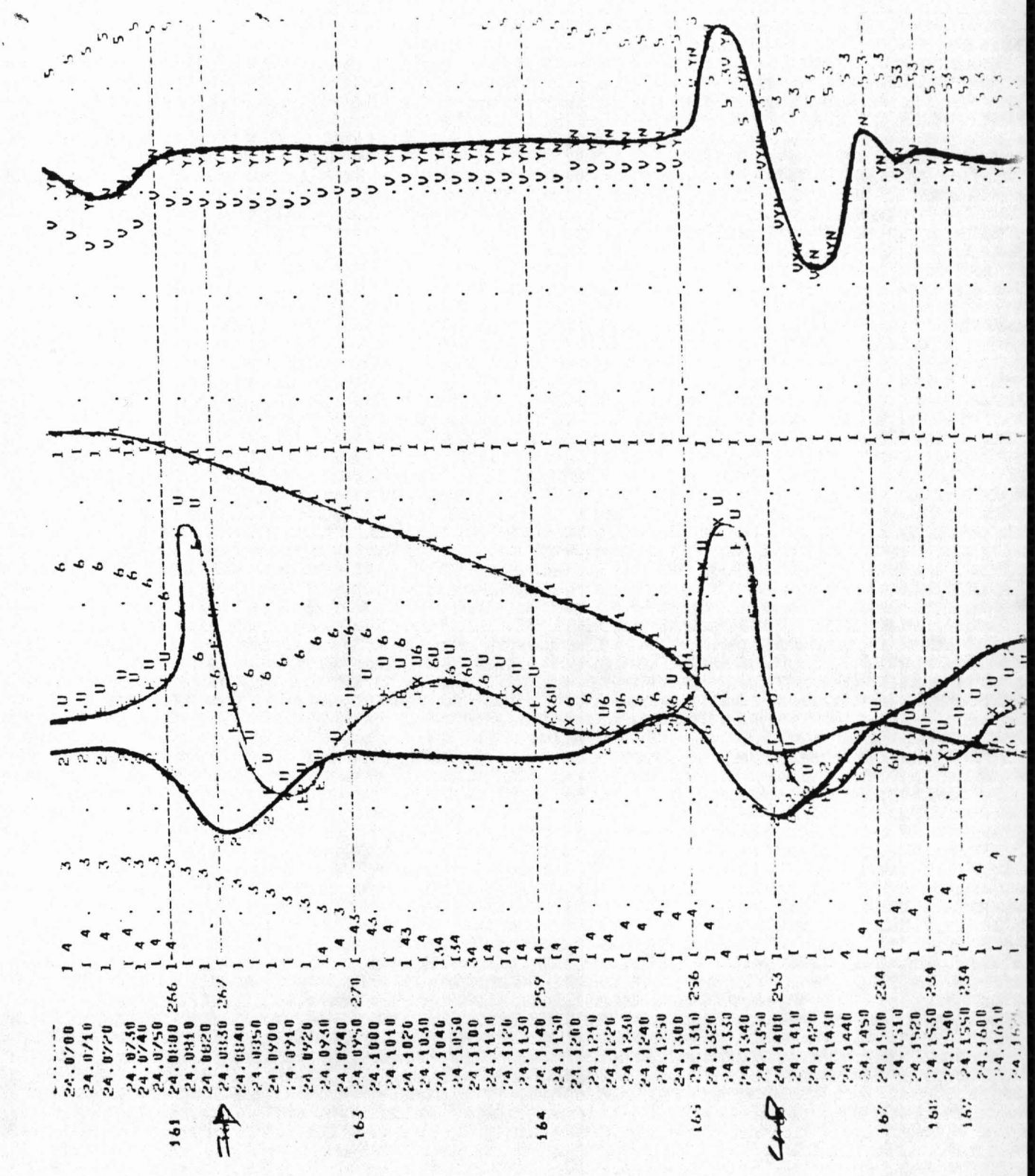

Figure 3

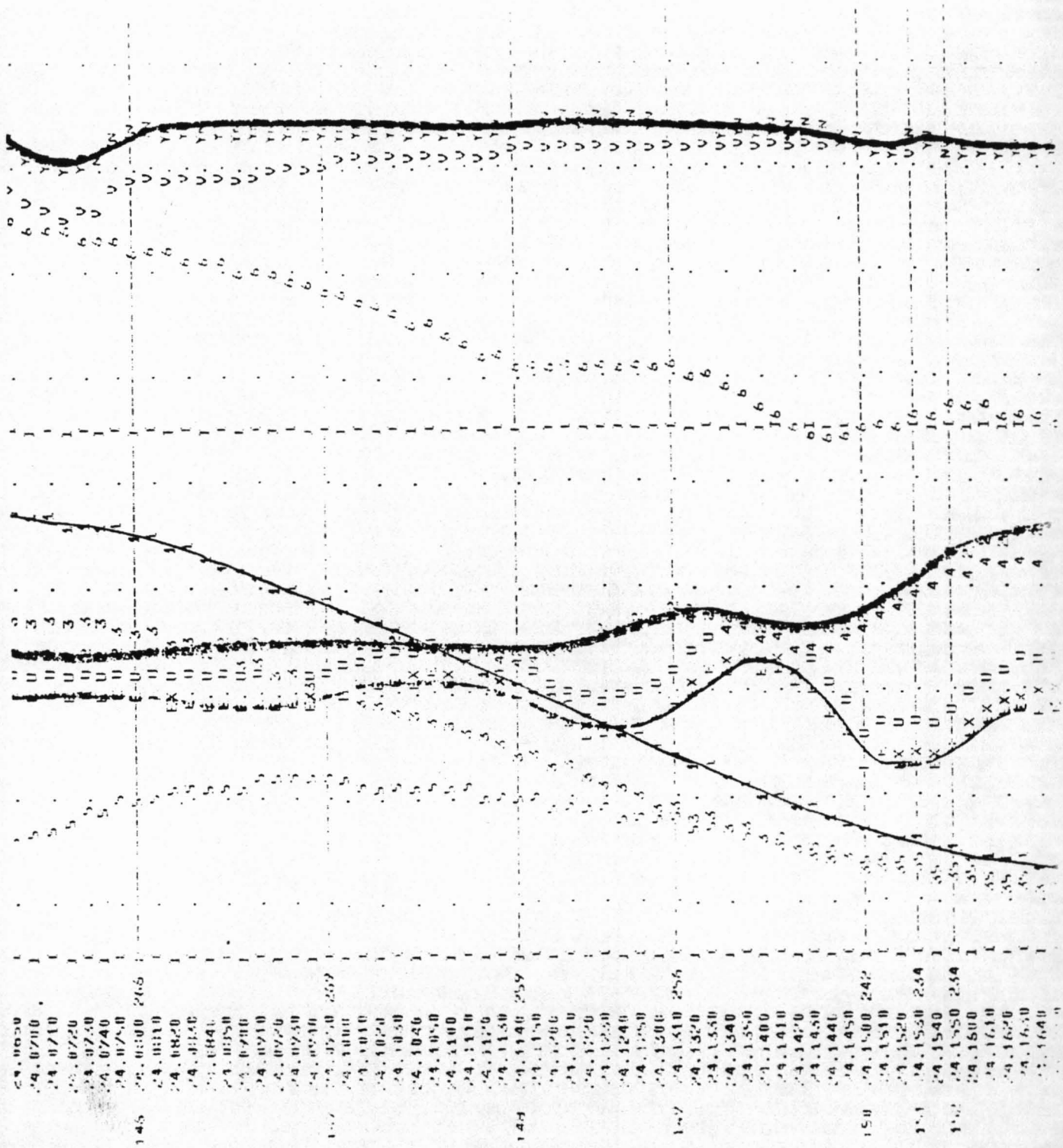

Table 6: Final channel allocations.

Channel number	Contents
1	Time (SS.DDD)
2	Time (.HHMMSS)
3	Latitude (radians)
4	Longitude (radians) - relative to 100E
5	Water depth (metres)
6	Gravity (mgals)
7	Total magnetic field (nT)
8	blank

Table 7: Station locations and water depths for Survey 53.

Station	Time	Lat	Long	Depth (m)
53/CS/TEST1	010.2345	19 2.589	146 47.258	****
53/CS/TEST2	011.0215	19 2.575	146 47.302	****
53/CS/TEST3	011.0510	19 2.615	146 47.278	****
53/CS/PC01	011.1850	17 21.598	147 2.899	1341
53/CS/HF01	012.0023	17 22.010	147 4.277	1355
53/CS/HF02	012.0627	17 11.526	147 15.848	1463
53/CS/HF03	012.0909	17 10.623	147 19.334	1441
53/CS/PC02	012.1229	17 10.637	147 20.548	1391
53/CS/PC03	012.2028	16 26.424	146 57.275	1744
53/CS/HF04	013.0152	16 26.054	146 56.688	1758
53/CS/PC04	013.0803	16 40.587	146 40.111	1550
53/CS/GC01	013.1012	16 40.421	146 39.673	1534
53/CS/PC05	013.1957	16 5.481	146 30.132	1797
53/CS/PC06	014.0220	16 27.804	146 37.615	1675
53/CS/HF05	014.0502	16 28.244	146 38.238	1665
53/CS/HF06	014.0850	16 37.037	146 42.911	1628
53/CS/HF07	014.1153	16 37.299	146 43.044	1623
53/CS/HF08	014.1551	16 33.043	146 52.130	1694
53/CS/HF09	014.1938	16 25.787	146 59.429	1737
53/CS/HF10	014.2214	16 25.484	146 59.110	1734
53/CS/HF11	015.0043	16 25.313	146 57.587	1747
53/CS/HF12	015.0656	15 55.604	146 25.854	1894
53/CS/HF13	015.1044	15 56.548	146 27.431	1890
53/CS/HF14	015.1426	15 51.670	146 24.141	1957
53/CS/GC02	015.1630	15 46.301	146 22.791	1995
53/CS/HF15	015.2041	15 46.866	146 22.919	1981
53/CS/GC03	016.0241	15 26.030	146 14.736	2084
53/CS/HF16	016.0616	15 26.195	146 14.150	2087
53/CS/HF17	016.0837	15 26.077	146 14.819	2089
53/CS/HF18	016.1408	15 6.678	146 6.627	2093
53/CS/HF19	017.1154	14 52.463	146 6.870	2509
53/CS/PC07	017.1514	14 53.207	146 7.094	2508
53/CS/HF20	017.1852	14 52.687	146 7.864	2511
53/CS/PC08	018.0122	14 10.446	146 1.853	2818
53/CS/HF21	018.0426	14 10.304	146 2.505	2816
53/CS/HF22	018.0750	14 10.444	146 3.018	2815
53/CS/HF23	018.1101	14 9.851	145 52.185	2823
53/CS/HF24	018.1520	13 55.192	145 45.200	2880
53/CS/GC04	018.2045	13 20.426	145 37.949	3019
53/CS/GC05	018.2231	13 21.407	145 38.022	3044
53/CS/HF25	019.0216	13 19.670	145 38.209	3060
53/GC/GC06	022.0722	11 10.627	139 57.814	109
53/EP/PC01	029.1246	19 53.594	114 58.227	1177
53/EP/HF01	029.1431	19 54.403	114 58.120	1162
53/EP/HF02	029.1731	20 3.358	114 50.089	1149
53/EP/HF03	029.1921	20 .387	114 45.612	1236
53/EP/GC01	029.2148	19 53.595	114 35.400	1279
53/EP/HF04	029.2322	19 53.240	114 34.208	1276
53/EP/HF05	030.0131	19 48.483	114 28.950	1328

53/EP/GC02	030.0352	19	42.669	114	20.106	1352
53/EP/HF06	030.0526	19	42.757	114	19.582	1353
53/EP/HF07	030.0724	19	41.348	114	10.794	1255
53/EP/HF08	030.0926	19	40.907	114	.470	1251
53/EP/HF09	030.1136	19	33.230	113	53.164	1139
53/EP/GC03	030.1249	19	32.124	113	52.975	1141
53/EP/HF10	030.1428	19	33.469	113	46.973	1175
53/EP/HF11	030.1628	19	38.561	113	40.400	1098
53/EP/GC04	030.1828	19	35.109	113	32.052	956
53/EP/HF12	030.2002	19	35.278	113	30.780	947
53/EP/HF13	030.2208	19	29.894	113	21.288	922
53/EP/HF14	031.0008	19	24.639	113	13.896	980
53/EP/GC05	031.0203	19	19.519	113	6.393	1279
53/EP/HF15	031.0343	19	19.908	113	6.443	1266
53/EP/HF16	031.0707	19	14.518	112	59.207	1490
53/EP/HF17	031.0953	19	7.716	112	51.266	1671
53/EP/HF18	031.1211	19	4.013	112	44.443	2000
53/EP/GC06	031.1345	19	3.170	112	45.139	1979
53/EP/GC07	031.1626	18	53.539	112	37.887	2256
53/EP/HF19	031.1857	18	53.330	112	37.557	2257
53/EP/HF20	031.2113	18	53.148	112	32.043	2220
53/EP/HF21	031.2311	18	52.573	112	27.902	2218
53/EP/HF19B	032.0222	18	53.272	112	36.975	2223
53/EP/GC08	032.0903	19	31.342	113	13.481	936
53/EP/HF22	032.1043	19	32.080	113	12.729	935
53/EP/HF23	032.1249	19	38.015	113	9.298	940
53/EP/HF24	032.1443	19	43.988	113	5.523	952
53/EP/HF25	032.1647	19	49.974	113	2.074	947
53/EP/HF26	032.1915	19	59.333	112	56.109	943
53/EP/GC09	032.2047	20	.253	112	55.880	962
53/EP/HF27	032.2317	20	5.648	112	52.082	909
53/EP/HF28	033.0137	20	11.981	112	47.858	850
53/EP/HF29	033.0400	20	17.380	112	44.152	852
53/EP/HF30	033.0616	20	23.914	112	39.968	875
53/EP/GC10	033.0809	20	29.899	112	35.154	947
53/EP/HF31	033.0925	20	29.887	112	34.647	953
53/EP/HF32	033.1126	20	35.408	112	31.515	1103
53/EP/HF33	033.1324	20	42.373	112	26.911	1264
53/EP/HF34	033.1539	20	48.040	112	23.857	1426
53/EP/HF35	033.1757	20	53.249	112	20.263	1427
53/EP/GC11	033.1940	20	53.688	112	20.013	1432
53/EP/HF36	033.2158	21	1.206	112	15.781	1541
53/EP/HF37	034.0026	20	59.632	112	4.462	1270
53/EP/HF38	034.0233	21	5.360	112	.486	1780
53/EP/HF39	034.0923	21	40.247	111	38.711	5053
53/EP/PC02	034.1340	21	39.008	111	40.628	5050
53/PB/GC12	037.0205	28	36.275	112	9.431	4557
53/PB/DR01	038.0615	31	13.936	114	35.587	2463
53/PB/DR01	038.0710	31	13.850	114	36.678	1899
53/PB/DR02	038.0853	31	13.868	114	39.569	1301
53/PB/DR02	038.0909	31	13.665	114	39.921	1275
53/PB/DR02	038.0909	31	13.665	114	39.921	1275

DATA AVAILABILITY

The northern Australia heatflow cruise geophysical data are available in two forms:

a. Magnetic Tape - 9-track, 1600 bpi, phase-encoded, as either
   - ASCII records, 80 characters per record, 10x1-minute records per block; or
   - Hewlett-Packard 32-bit floating point, 8 channels, 60x1-minute records per block.

   Enquiries concerning these data should be addressed to -

   Chief Scientist,
   Division of Marine Geosciences &
   Petroleum Geology,
   Bureau of Mineral Resources,
   GPO Box 378
   Canberra, ACT 2601, Australia

b. Track Maps - at 1:1000000 scale are available from -

   Copy Service,
   Assistant Government Printer (Production)
   PO Box 84,
   Canberra, ACT 2600, Australia

The heatflow data (including thermal gradients and thermal conductivities) are listed in Choi, Stagg, and others (Bureau of Mineral Resources, Geology & Geophysics, Report 274).

Figure 4: Tracks of Rig Seismic Research Cruise 6 (Survey 53) - Townsville to Fremantle.

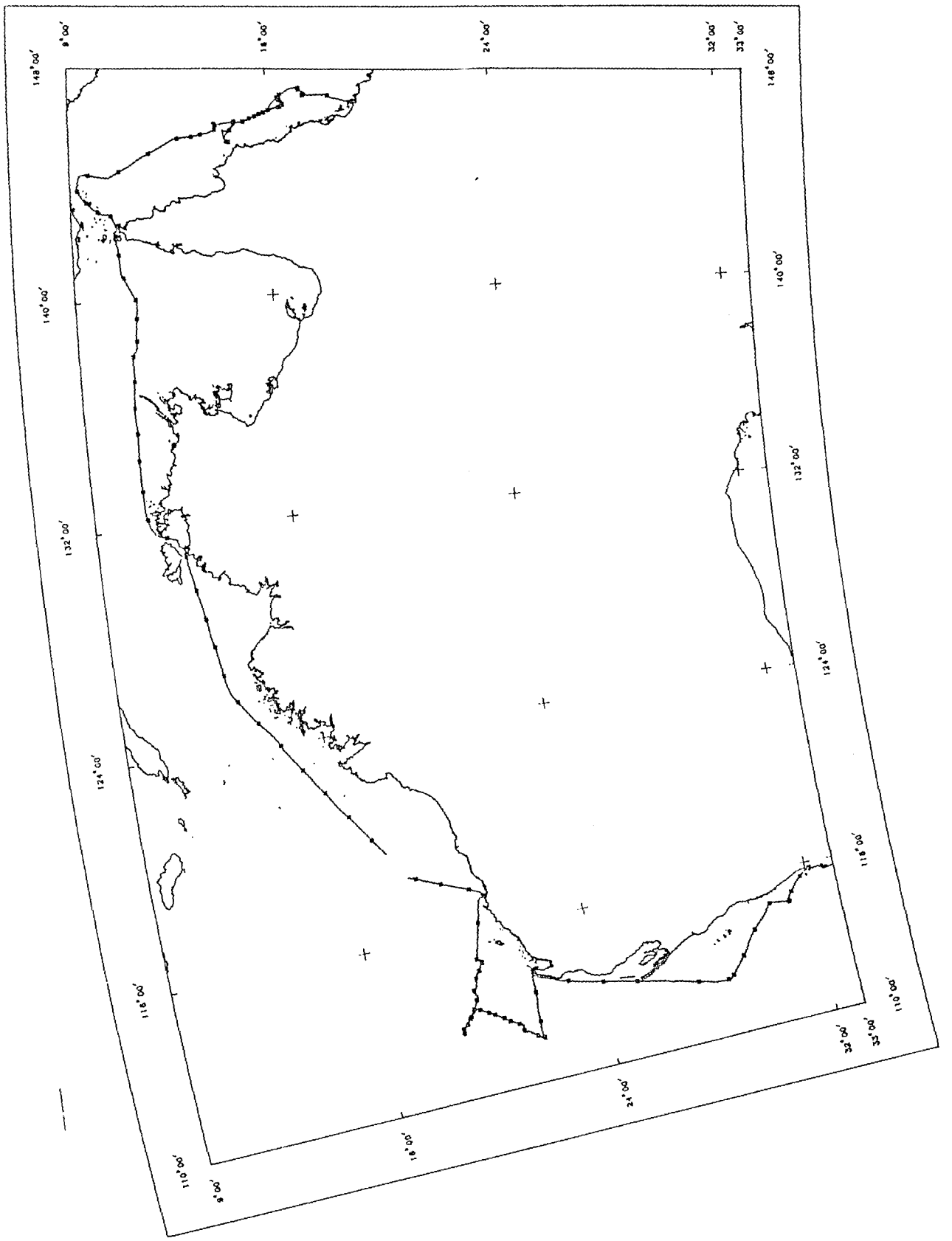

Figure 5: Tracks of *Rig Seismic* Research Cruise 6 (Survey 53) in the western Coral Sea.

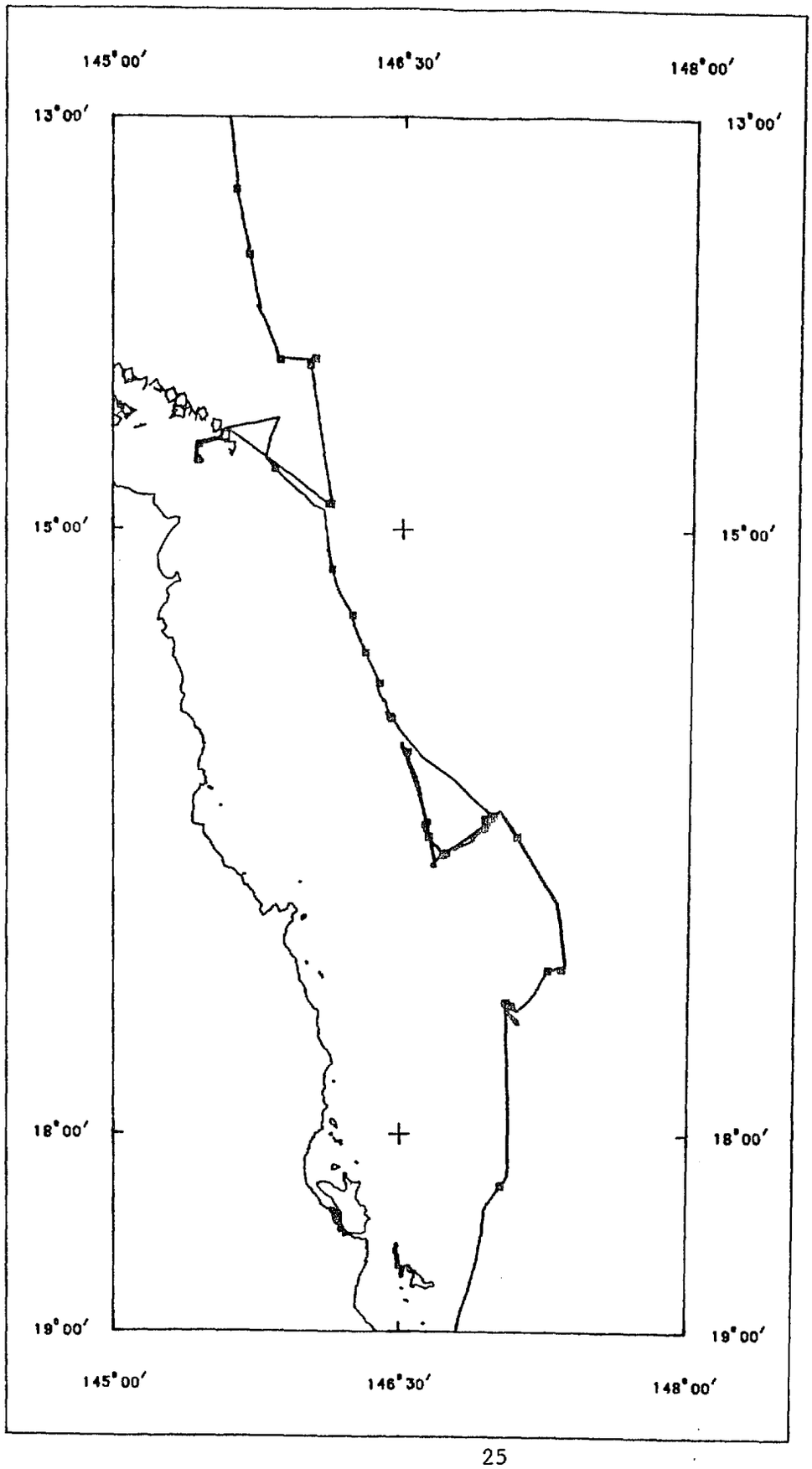

Figure 6: Tracks of *Rig Seismic* Research Cruise 6 (Survey 53) on the Exmouth Plateau.

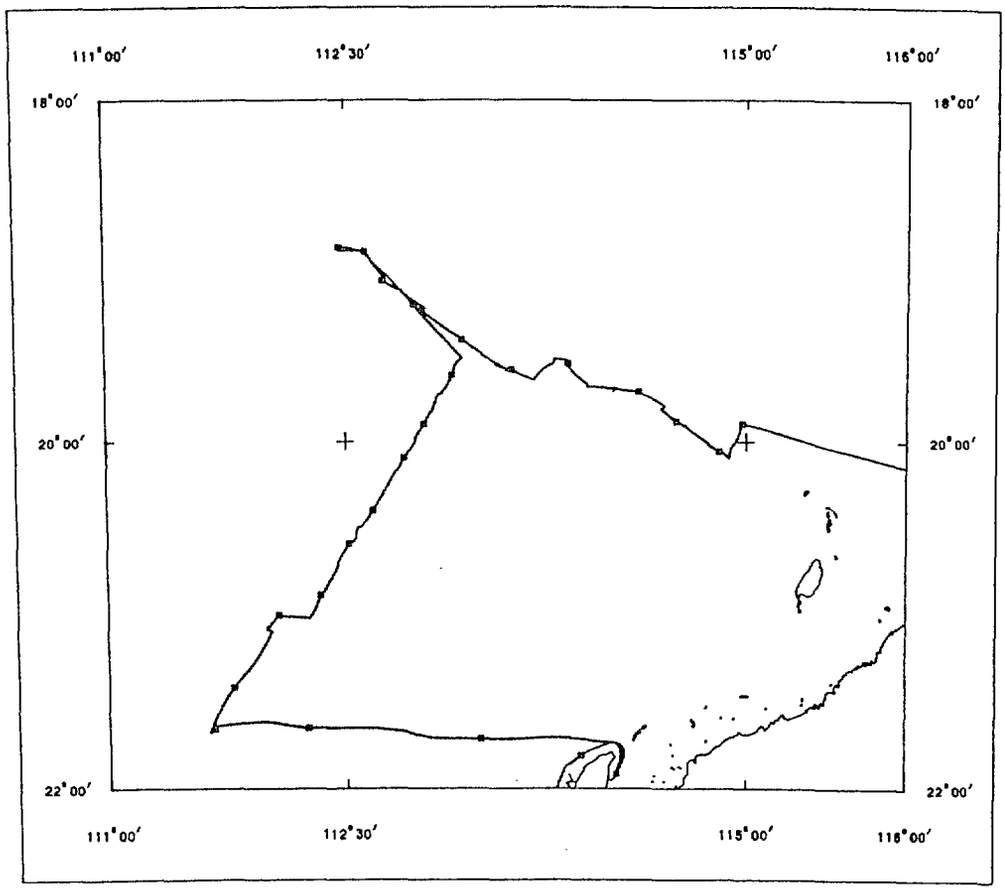

Figure 7: Tracks of *Rig Seismic* Research Cruise 6 (Survey 53) in the Gulf of Papua, Gulf of Carpentaria, and Arafura Sea along which side-scan sonar data were recorded.

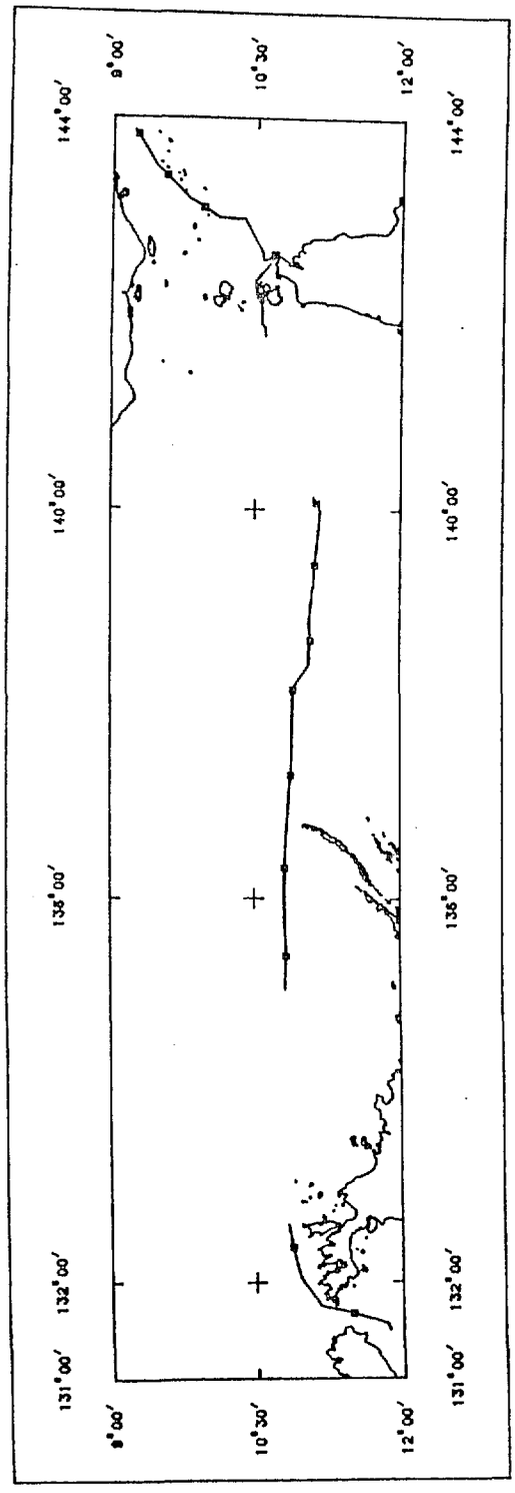

Figure 8: Tracks of *Rig Seismic* Research Cruise 6 (Survey 53) across northern Australia along which magnetic data were recorded.

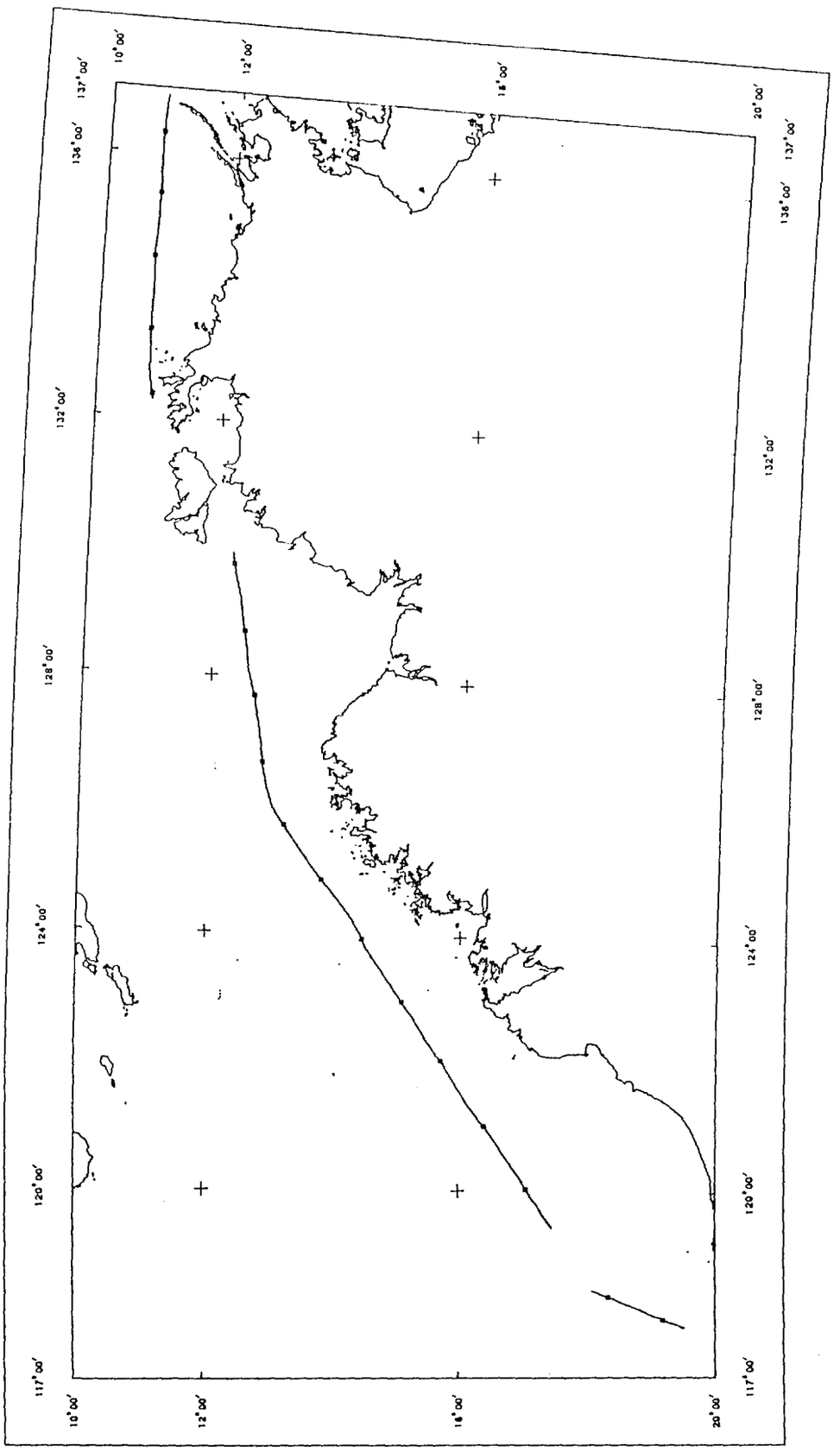

Figure 9: Tracks of *Rig Seismic* Research Cruise 6 (Survey 53) off Western Australia along which magnetic data were recorded.