BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1988/19

Survey 98

R.V.RIG SEISMIC RESEARCH CRUISE 3,

OFFSHORE,OTWAY BASIN:

EXPLANATORY NOTES TO ACCOMPANY RELEASE OF NON-SEISMIC DATA

by

C.Lawson & M.Hazell

Bureau of Mineral Resources, Geology & Geophysics

DIVISION OF MARINE GEOSCIENCES & PETROLEUM GEOLOGY

RECORD 1988/19

R.V.RIG SEISMIC RESEARCH CRUISE 3,

OFFSHORE,OTWAY BASIN:

EXPLANATORY NOTES TO ACCOMPANY RELEASE OF NON-SEISMIC DATA

by

C.Lawson & M.Hazell

CONTENTS

FIGURES

TABLES

INTRODUCTION

The purpose of this report is to summarise the processing techniques applied to the non-seismic geophysical data on *R.V.Rig Seismic* Research Cruise 3 (BMR Marine Survey 48, Otway Basin of Bass Strait). The cruise was conducted between 15 June and 12 July 1985 and formed part of project 1D06 (1985/1986) and project 1C03 (1986/1987) .

GEOPHYSICAL SYSTEMS & PERFORMANCE

The following non-seismic geophysical systems were employed during Survey 48:

Navigation

Three totally independent navigation techniques were run simultaneously;

1. Magnavox Global Positioning System (GPS) T-Set, giving continous 2-D positioning to within 35 m RMS, during periods of satellite availability and good geometry.

2. Motorolla Miniranger Radio Navigation System, utilizing four shore based transponders. This system has a potential accuracy to within 5 metres.

3. A dead reckoning (DR) system, incorporating satellite navigators, gyro compasses, and sonar dopplers. The primary system, consisted of a Magnavox MX1107RS dual-channel satellite navigator, with speed input from Magnavox MX610D sonar doppler and headings from an Arma-Brown gyro-compass. The secondary system, consisted of a Magnavox MX1142 single channel satellite navigator, with speed input from Raytheon DSN 450 sonar doppler and headings from a Robertson gyro-compass. This system has a potential accuracy of 0.2km at fixes rising to around 1km between fixes in deep water.

Performance Comments: Both 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 percentage of the total time that each system was the primary navigation system during the cruise is;

T-Set :27%

Radio Nav :12%

Dead Reckoning :61%

Both gyro-compasses performed satisfactorily for the entire survey. Both sonar dopplers performed fairly satisfactorily in low sea states but were generally erratic in high sea states.

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.

A new 3.5 kHz system was installed in Melbourne prior to Survey 48. This new system included an additional 8 transducers bringing the total to 16.

Performance Comments: Data quality was generally poor due to the high sea states encountered on the survey. 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; signals were acquired from both single and dual channel (horizontal gradient) sensors towed astern of the vessel.

Performance Comments: Performance was not as good as expected due to excessive noise. Noise level for the magnetometer was in excess of plus/minus 3 nT.

Gravity

A Bodenseewerk KSS-31 marine gravity meter has been installed on the *Rig Seismic*. Gravity data were recorded for the entire survey.

Performance Comments: The KSS-31 is a highly sophisticated single-axis marine gravity meter with extensive microprocessor control. The KSS-31 is designed to be interfaced to an external navigation system that can provide speed and heading input at a rate of as fast as 1 second; the speed and heading are then used by the processor to provide gyro corrections to the gravity meter to improve performance in heavy seas or during turns. For Survey 48, satisfactory gravity data have been achieved with appropriate post-survey filtering, except at sample sites where poor speed control and continuous vessel manoeuvring have produced erratic Eotvos corrections.

Due to system malfunction no data were acquired between 48,181,213200 and 48,183,055000.

DATA ACQUISITION SYSTEM (DAS)

The shipboard DAS is based on a Hewlett-Packard (HP) 1000 E-Series 16-bit minicomputer. 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), 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 and independently of the seismic acquisition system. The data were written to tape in 2.0 minute (12 record) blocks with 80 channels of data being recorded. The channels that were recorded are listed in Table 1.

TABLE 1: Field tape channel allocations

1 - Clock (survey & day number)
2 - GMT acquisition time from computer clock (hours ,minutes and seconds)
3 - Master clock time at acquisition (hours,minutes and seconds)
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 - Arma-Brown gyro-compass (degrees)
19 - Robertson gyro-compass (degrees)
20 - Not used
21 - Miniranger 1
22 - Miniranger 2
23 - Miniranger 3
24 - Miniranger 4
25 - Not used
26 - Not used
27 - Not used
28 - Not used
29 - Not used
30 - Not used
31 - Not used
32 - T-Set Time (GMT seconds)*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 frequency bias No 1
40 - T-Set GMT (.hhmmss)
41 - Not used
42 - Not used
43 - Not used
44 - Not used
45 - Not used
46 - Not used
47 - Not used
48 - Not used
49 - Not used
50 - GMT time from MX1107RS satnav
51 - Dead-reckoning time from MX1107RS
52 - Latitude (radians) from MX1107RS
53 - Longitude (radians) from MX1107RS
54 - Speed (knots) from MX1107RS
55 - Heading (degrees) from MX1107RS
56 - Set (degrees) from MX1107RS
57 - Drift (knots) from MX1107RS
58 - Set/drift flag, 0 = No 1 , 1 = auto
59 - GMT from MX1142RS satnav

60 - Dead-reckoning time from MX1142RS
61 - Latitude (radians) from MX1142RS
62 - Longitude (radians) from MX1142RS
63 - Speed (knots) from MX1142RS
64 - Heading (degrees) from MX1142RS
65 - Set (degrees) from MX1142RS
66 - Drift (knots) from MX1142RS
67 - Set/drift flag from MX1142, 0 = manual,
1 = automatic
68 - Vector speed Magnavox sonar doppler
69 - Vector speed Raytheon sonar doppler
70 - Not used
71 - Not used
72 - Not used
73 - Not used
74 - Gravity (ums**-2 * 1000)
75 - ACX (ms**2 * 1000)
76 - ACY (ms**2 * 1000)
77 - Sea State
78 - Not used
79 - Not used
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; assessment and retrieval of velocities; medium filter of magnetics and gravity; manual editing of problem areas; computation of incremental latitudes and longitudes; anti-alias filtering (smoothing) of magnetics, gravity, 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, GPS system and radio nav 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. 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 (Table 2) to simplify further processing.

SALVG (Water depth recovery): 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 threshhold, 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 to accept good data. In the case of good digital data being totally unacceptable, as during poor sea conditions, the threshold was set to a very small number (0.01m) and the process became one of very simple linear interpolation between adjacent tie points.

TABLE 2: Processing channel allocations

1	-	Clock (survey & day number)
2	-	GMT acquisition time from computer clock (hours ,minutes and seconds)
3	-	Master clock time at acquisition (hours, minutes and seconds)
4	-	Latitude (radians)
5	-	Longitude (radians)
6	-	Heading (degrees) - best estimate
7	-	Speed (knots) - best estimate
8	-	Bathymetry No 1 (metres)
9	-	Bathymetry No 2 (metres)
10	-	Magnetometer No 1 (nT)
11	-	Magnetometer No 2 (nT)
12	-	Magnetic gradient
13	-	Gravity (ums**-2 * 1000)
14	-	Pitch acceleration (m/s**2)
15	-	Roll acceleration (m/s**2)
16	-	Sea state filter number
17	-	Magnavox sonar doppler - fore/aft
18	-	Magnavox sonar doppler - port/starboard
19	-	Raytheon sonar doppler - fore/aft
20	-	Raytheon sonar doppler - port/starboard
21	-	T Set Latitude
22	-	T Set Longitude
23	-	Arma-Brown gyro-compass (degrees)
24	-	Robertson gyro-compass (degrees)
25	-	Not used
26	-	Miniranger 1
27	-	Miniranger 2
28	-	Miniranger 3
29	-	Miniranger 4
30	-	Not used
31	-	Not used
32	-	Not used
33	-	Not used
34	-	Not used
35	-	Not used
37	-	10-sec delta longitude - Magnavox S/D + Arma-Brown
38	-	10-sec delta latitude - Magnavox S/D + Robertson
39	-	10-sec delta longitude - Magnavox S/D + Robertson
40	-	10-sec delta latitude - Raytheon S/D + Arma-Brown
41	-	10-sec delta longitude - Raytheon S/D + Arma-Brown
42	-	60-sec delta latitude - Magnavox S/D + Arma-Brown
43	-	60-sec delta longitude - Magnavox S/D + Arma-brown
44	-	60-sec delta latitude - Magnavox S/D + Robertson
45	-	60-sec delta longitude - Magnavox S/D + Robertson
46	-	60-sec delta latitude - Raytheon S/D + Arma-Brown
47	-	60-sec delta longitude - Raytheon S/D + Arma-Brown
48-64		-Not used

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 sea bed. 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 Figures 1 and 2.

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.

FDATA: The magnetic,gravity, and Magnavox and Raytheon speed log data were filtered using a sophisticated form of the medium filter, a highly successful spike deletion tool.

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

MUFF: This program uses a SINC function filter to smooth selected data channels. All velocity channels were smoothed to provide acceptable speeds, while 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 3.

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 effectively gave two distinct dead-reckoning (DR) systems.

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.

SMOOTH FILTER 1 PUTS CHANNEL 11 INTO 11

FILTER CUT-OFF AT 3.RD ZERO

SAMPLING INTERVAL IN SECONDS 10.0

PERIOD OF FILTER IN SECONDS 180.0

APPROXIMATE RESPONSE OF FILTER TO SINE WAVE

NUMBER OF POINTS IN FILTER 53

FILTER COEFFICIENTS AS FOLLOWS

.000	.001	.002	.003	.004	.004	.003	-.000	-.004
-.008	-.012	-.015	-.018	-.018	-.015	-.009	.000	.012	.027
.043	.060	.076	.091	.102	.109	.111	.109	.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	-10.5
.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	.29728	-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	.82882	-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

TABLE 3: Filter coefficients and approximate response of filter to sine wave for magnetics smoothing filter.

PHASE 2

Phase 2 processing encompasses the following steps -

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 4).

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.

SATELLITE FIX LISTING

NAME OF INPUT PARAMETER FILE - SAT01
SECURITY CODE, CARTRIDGE (DEFAULT=888,36) - ,20

FIX	FIX TIME	LAT	LONG	SYSTEM	SAT	OK	ELEV	COUNT	ITER	GEOM	ERROR	DIR	SLT	SLN	CODE	COURSE	SPEED
1	48.165.232000	38 24.710	144 28.072	1107	480	Y	35	32	3	NW	.03	317	0	0		22.4	2.1
2	48.166.020000	38 31.087	144 24.684	1107	500	Y	10	25	4	NE	.13	106	0	0		210.1	3.7
3	48.166.042300	38 36.475	144 18.578	1107	110	Y	14	24	4	NE	.17	178	0	0		269.2	2.2
4	48.166.053700	38 37.106	144 15.184	1107	500	Y	18	26	2	NW	.09	225	0	0		281.3	3.5
5	48.166.055200	38 37.134	144 14.004	1107	200	Y	34	28	2	NE	.03	140	0	0		237.3	4.0
6	48.166.061000	38 38.154	144 14.793	1142	110	N	84	34	3		.70	80	0	0	1	232.5	4.0
7	48.166.073700	38 39.442	144 15.023	1107	200	Y	29	26	3	NW	.11	186	0	0		59.5	5.9
8	48.166.075600	38 38.949	144 17.791	1142	110	Y	12	26	2		.30	137	0	0		60.3	5.7
9	48.166.094400	38 34.455	144 27.447	1107	480	Y	50	36	3	SE	.25	114	0	0		66.3	4.8
10	48.166.111800	38 31.268	144 37.273	1142	130	Y	11	26	2		.80	134	0	0		60.5	4.5
11	48.166.113200	38 30.461	144 37.850	1107	480	Y	27	32	3	SW	.25	109	0	0		84.3	4.8
12	48.166.141300	38 38.316	144 26.510	1107	500	Y	15	27	5	SE	.48	213	0	0		239.2	4.8
13	48.166.160100	38 43.867	144 16.477	1142	500	N	88	34	2		1.50	289	0	0	1	239.3	5.4
14	48.166.162300	38 44.892	144 15.160	1142	110	Y	14	27	2		1.20	298	0	0		240.0	4.5
15	48.166.174000	38 46.183	144 11.609	1107	200	Y	33	31	3	SE	.58	217	0	0		208.0	1.9
16	48.166.180900	38 47.521	144 13.949	1142	110	N	86	32	3		.80	97	0	0	1	162.4	2.6
17	48.166.192600	38 41.407	144 15.787	1107	0	Y	39	0	0	SE	-9.1	0	0	0	5	28.5	5.7
18	48.166.194400	38 40.408	144 17.357	1107	130	Y	14	25	3	SE	.09	146	0	0		54.3	6.7
19	48.166.195600	38 39.781	144 18.584	1107	110	Y	12	18	3	SW	13.5	0	0	0		43.1	6.0
20	48.166.210800	38 36.643	144 22.744	1107	480	Y	29	34	3	NE	.19	31	0	0		41.4	4.3
21	48.166.213000	38 35.530	144 25.855	1142	130	N	85	27	3		.50	106	0	0	1	40.2	4.8
22	48.166.225800	38 30.041	144 28.313	1107	480	Y	48	37	3	NE	.10	56	0	0	5	249.1	3.3
23	48.166.231800	38 30.747	144 27.109	1107	130	Y	12	24	3	SW	.14	158	0	0		243.4	2.9
24	48.167.013600	38 35.143	144 19.294	1142	500	N	6	20	2		.70	310	0	0	1	239.0	2.5
25	48.167.032600	38 39.035	144 9.441	1107	500	Y	53	37	3	SE	.35	246	0	0		235.0	4.9
26	48.167.044200	38 43.505	144 3.520	1142	200	Y	8	22	2		.60	293	0	0		229.3	5.7
27	48.167.051500	38 44.881	143 59.506	1107	500	Y	26	31	3	NW	.18	959	0	0		235.3	4.9
28	48.167.062800	38 49.049	143 53.633	1142	200	N	76	26	3		.90	281	0	0	1	233.4	5.4
29	48.167.070800	38 50.741	143 49.154	1107	110	Y	30	30	3	NW	.29	229	0	0		235.3	4.5
30	48.167.081200	38 53.922	143 43.404	1107	200	Y	13	22	4	NW	.05	220	0	0	1	233.3	5.2
31	48.167.084200	38 55.477	143 40.816	1107	130	Y	42	32	3	NE	.11	120	0	0		234.2	3.9
32	48.167.092100	38 57.347	143 37.531	1107	0	Y	35	0	0	NW	14.8	0	0	0	2	233.3	4.2
33	48.167.102900	39 .421	143 31.488	1107	130	Y	30	31	3	NW	.12	218	0	0		236.5	6.0
34	48.167.111000	39 2.442	143 27.635	1107	480	Y	40	36	3	SW	.05	165	0	0		233.4	5.4
35	48.167.135100	38 56.744	143 13.252	1142	500	Y	9	24	2		1.30	13	0	0		303.2	5.0

Table 4: Sample satellite fix listing from Survey 48. Headings are follows:-
FIX - fix number within file; FIXTIME - time of fix to nearest minute;
LAT, LONG - fix position adjusted to nearest minute;
SYSTEM - indicates MX1107 or MX1142 fix; SAT - satellite ID code;
OK - Y or N indicates fix accepted or rejected by satellite navigator;
ELEV - maximum of elevation during fix, in degrees;
COUNT - number of doppler counts received during pass;
ITER - number of iterations required for fix to compute;
GEOM - geometry of pass;
ERROR, DIR - distance (nautical miles) and bearing (degrees) of fix update (based on shipboard DR data);
SLT, SLN - standard deviation of latitude and longitude (metres);
CODE - error code, blank if fix accepted by MX1107 or MX1142;
COURSE, SPEED - course (degrees) and speed (knots) of ship at time of fix.

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, Global Positioning System and Miniranger according to a file specified by the user. The final navigation is shown at small scale in Figure 4.

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. Gravity ties were performed in Melbourne, Victoria prior to the cruise,and in Brisbane, Queensland at the end of the cruise. Summary of results are as follows:

Ship's value (ums**-2)		Corrected Value (ums**-2)
Pre-Otway	= -4349.75	9799884.6
Time & Date	4/6/85 1515 hrs (local)	
Post Otway	=-12618.75	9791675.63
Time & Date	19/7/85 1430 hrs (local)	
Difference	= 8269.0	8209.0

Drift = 60 ums**-2.

VARPL/EDATA: 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. The final channel allocations are shown in Table 5. 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).

Table 5: Final channel allocations.

Channel No	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 1(nT)
8	Total magnetic field 2(nT)

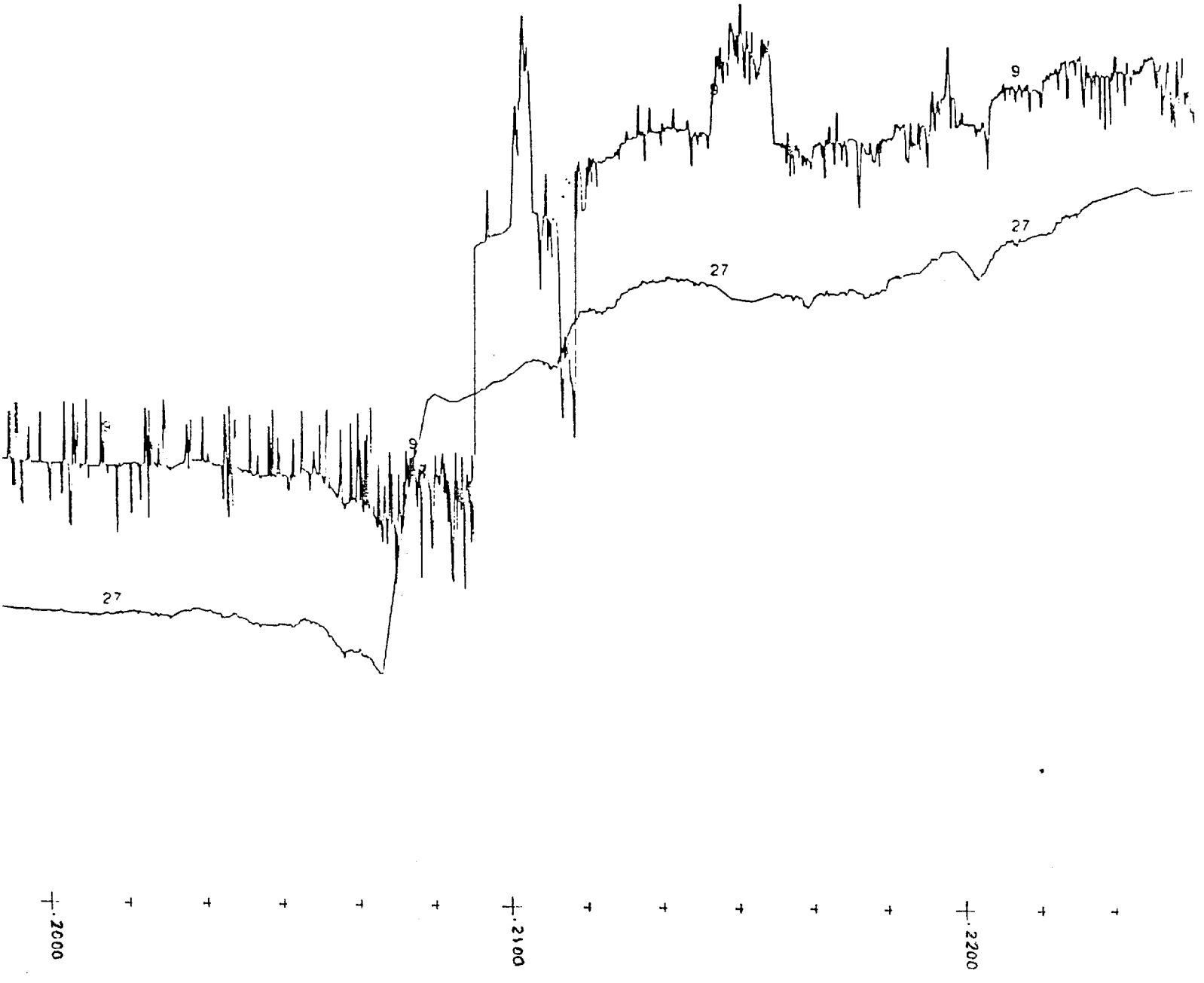
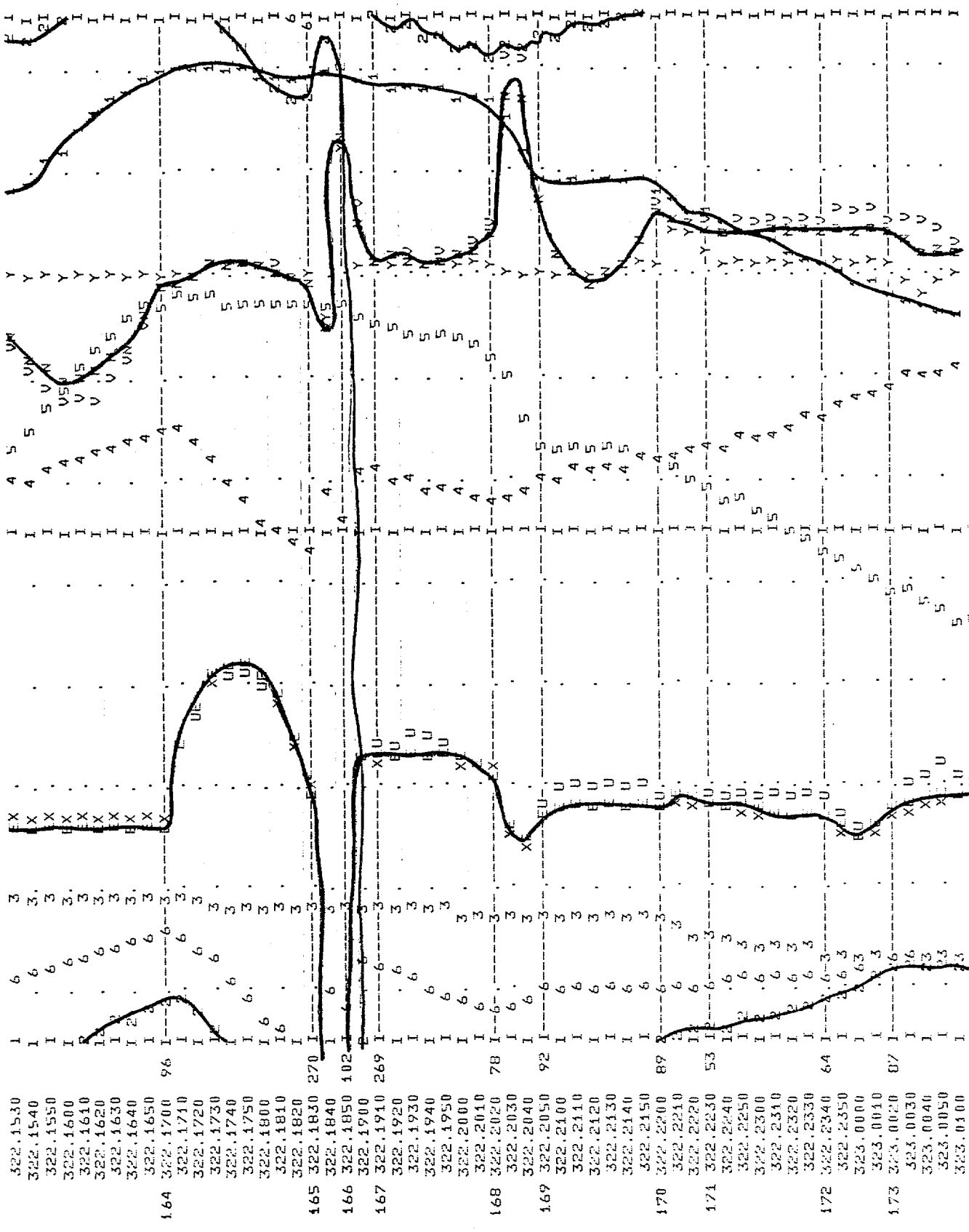
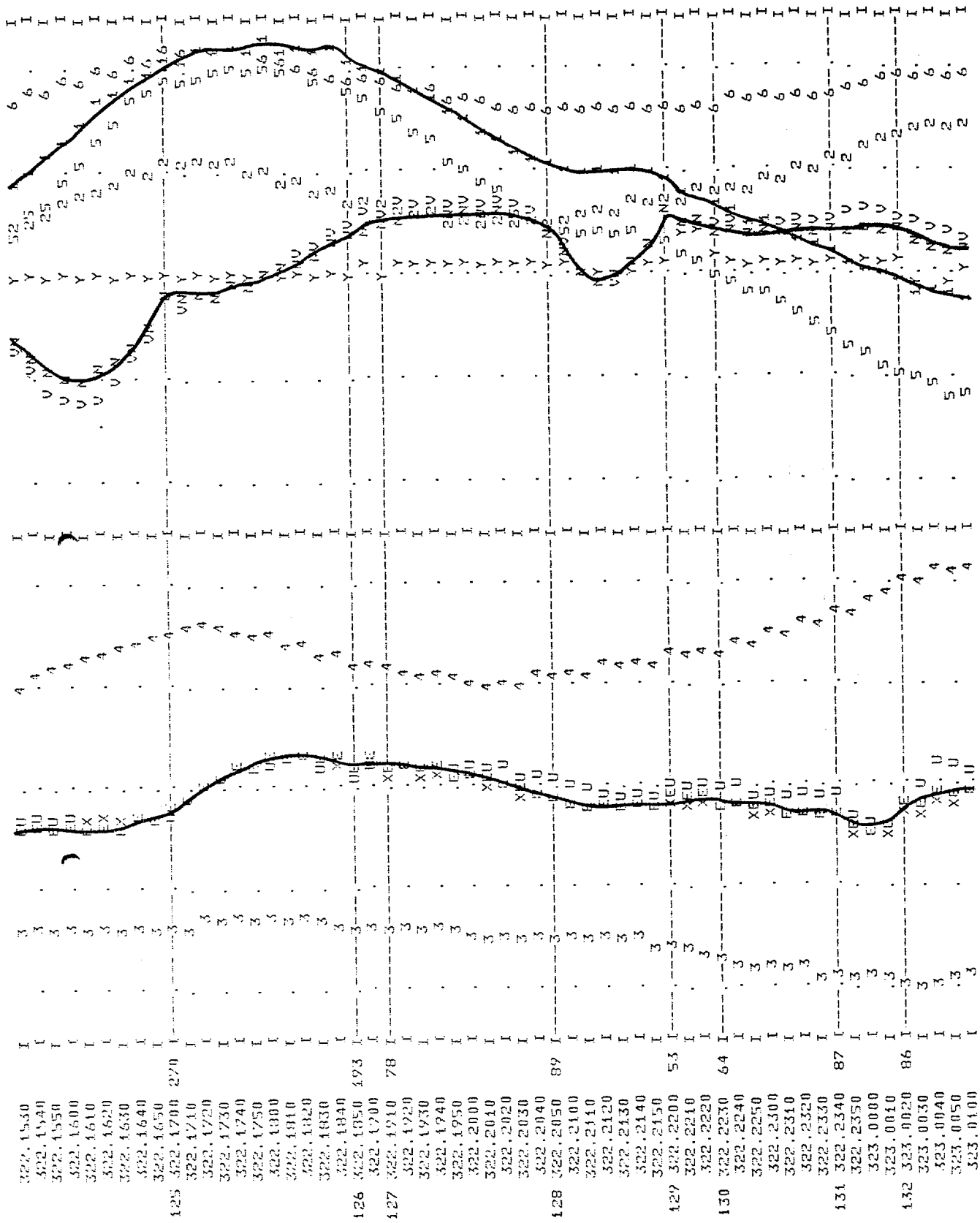


Figure 1: Bathymetry traces before (upper) and after processing by program SALVG. Vertical scale is 100 m/inch; horizontal scale is 3 inches/hour.



1.7cm = 1 nautical mile

Figure 2: Satellite fix assessment plot. 10-minute time (DD.HHMM) along bottom of plot; satellite fixes indicated by row of dashes (eg. at 322.1700); traces on the plot are as follows:-
N & E - north & east currents for DR system 1;
1 & 2 - north & east summed error vectors for DR system 1; Y & X - north & east currents for DR system 2; 3 & 4 - north & east summed error vectors for DR system 2.
Note in particular the large fluctuations in the east current and the east summed error vector on the left-hand half of the plot.



1.7cm = 1 nautical mile

Figure 3: Same plot as for Figure 2, but after removal of satellite fixes at 332.1830 and 332.2020. Note that the large fluctuations in the east currents and summed vectors have been smoothed out.

Track Map

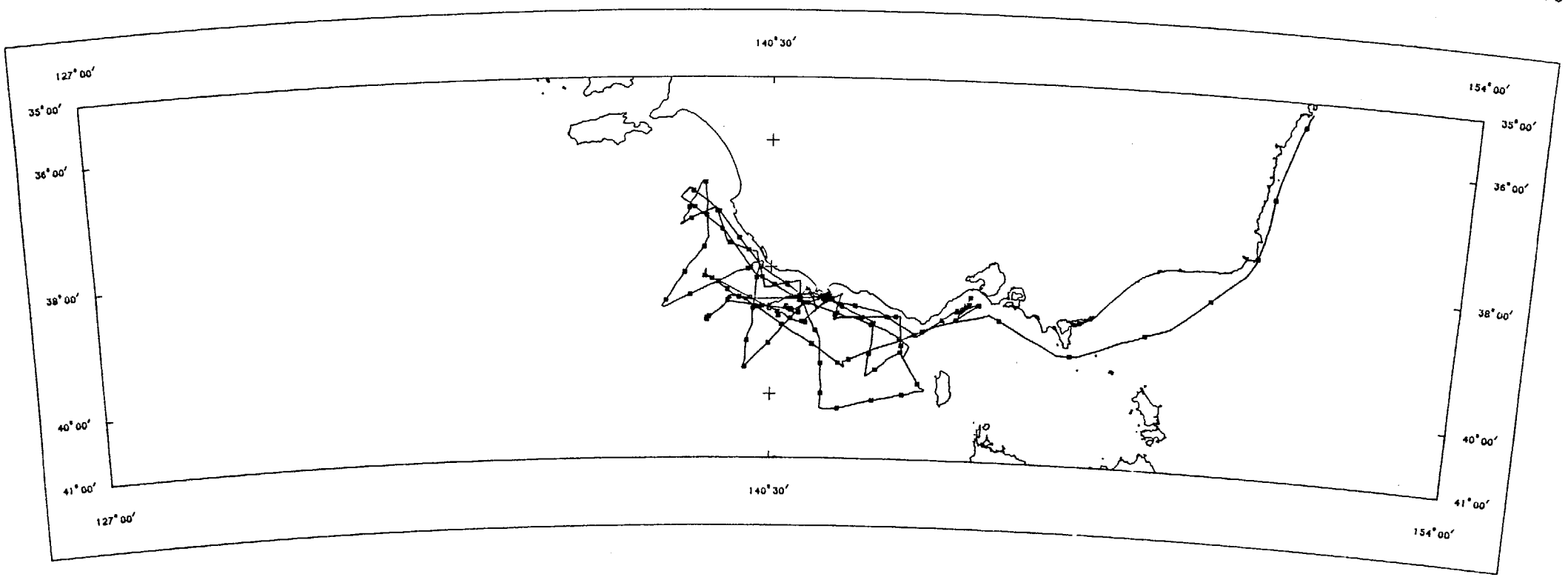


Figure 4: Tracks of Rig Seismic , Survey 48 in the Offshore Otway Basin.

DATA AVAILABILITY

The Otway Basin non-seismic data are available in two forms:

1. 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 the digital data should be addressed to

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

2. b. Anologue Displays- in film or paper form.

	Product Code
- Otway survey Track Map, 1:1000000 Map sheet	M-480001P
- Otway survey: 1:1000000 Map sheets(2 sheets in each set)	
Residual Magnetic Anomalies profile maps	M-480003P
Free-air Anomalies profile maps	M-480004P
Observed Magnetics posted map values	M-480005P
Observed Magnetic Anomalies posted map values	M-480006P
Observed Gravity posted value maps	M-480007P

Enquiries concerning the anologue data should be addressed to :

Copy Service,
Bureau of Mineral Resources
G.P.O. Box 378
Canberra A.C.T 2601 , Australia.