AGSO

BROWSE BASIN - NORTH WEST KIMBERLEY SEISMIC REFRACTION SURVEY, 1993: OPERATIONAL REPORT

by

C.D.N. Collins, I.S. Lukaszyk & U.R. Rieke

RECORD 1995/76

AGSO

AUSTRALIAN
GEOLOGICAL SURVEY
ORGANISATION

AGSO

AUSTRALIAN
GEOLOGICAL SURVEY
ORGANISATION

AGSO RECORD 1995/76

BROWSE BASIN - NORTH WEST KIMBERLEY SEISMIC REFRACTION SURVEY, 1993: OPERATIONAL REPORT

by

C.D.N. Collins, I.S. Lukaszyk & U.R. Rieke

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Primary Industries and Energy: Hon. J. Anderson, M.P.
Minister for Resources and Energy: Senator the Hon. W.R. Parer
Secretary: Paul Barratt

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Executive Director: Neil Williams

ISSN: 1039-0073
ISBN: 0 642 24959 8

It is recommended that this publication is referred to as:

COLLINS, C.D.N., LUKASZYK, I.S., & RIEKE, U.R., 1995. Browse Basin - North West Kimberley Seismic Refraction Survey, 1993: Operational Report. Australian Geological Survey Organisation, Record 1995/76.

CONTENTS

APPENDICES:

SUMMARY

In June/July 1993 a regional deep seismic reflection survey was undertaken over the Browse Basin and adjacent continental margins by the Australian Geological Survey Organisation (AGSO) research vessel *R/V Rig Seismic*. During this survey, seismic recorders were placed along the west Kimberley coast, on Browse Island and inland on the Mitchell Plateau. These stations recorded long-offset wide-angle reflection and refraction arrivals from the air-gun shots along the reflection traverses . They provide continuous traverses of deep refraction and wide-angle reflection data from the coast across the Browse Basin and its margins.

This Record documents the field operations for the onshore refraction and wide-angle seismic data acquisition. It contains all the principal facts necessary for processing the data. It also contains a short summary of the processing stream developed for this data.

INTRODUCTION

In June/July 1993 a regional deep seismic reflection survey was undertaken over the Browse Basin and adjacent continental margins by the Australian Geological Survey Organisation (AGSO) research vessel *R/V Rig Seismic*. Some of the objectives of this survey (Survey 119; Symonds, 1993) were to (a) determine the regional framework of the basin and its relationship to adjacent features, (b) define the deep crustal structure of the region, and (c) develop a tectonic model for the basin and its relationship to the development of the continental margin and adjacent ocean basin.

During this survey, seismic recorders were placed on Browse Island and along the west Kimberley coast on Bigge Island, Lamarck Island and Cape Leveque, and inland on the Mitchell Plateau (Fig 1). These stations recorded long-offset wide-angle reflection and refraction arrivals from the air-gun shots along the reflection traverses . They provide continuous traverses of deep refraction and wide-angle reflection data from the coast across the Browse Basin and its margins. Other traverses were also recorded and should provide seismic data along travel paths with a variety of offsets and azimuths. The eastern 200 km of one traverse are reversed by the station on Browse Island, and other traverses are partially reversed.

This Record documents the field operations for the onshore refraction and wide-angle seismic data acquisition. It contains all the principal facts necessary for processing the data. It also contains a short summary of the processing stream developed especially to process this data.

OBJECTIVES OF THE REFRACTION RECORDING

The objectives of the refraction recording were to a) obtain deep velocity data within the Browse Basin and adjacent margins, b) identify major crustal boundaries and the crust-mantle boundary, c) provide a link between the marine crustal data and existing onshore crustal data and d) test the feasibility of using ocean-bottom seismographs in future surveys on the NW Shelf .

The velocities obtained from the refraction and wide-angle reflection data recorded by the land stations will be used to depth-convert the coincident deep reflection profiles, and in particular, to interpret deep reflections from within the mid- to lower crust and the crust-mantle boundary. Without additional petrologically-dependant data such as velocities, the identification of these reflectors is speculative. The correct identification of deep crustal boundaries and variations of the crust-mantle boundary (ie. crustal thickness) are crucial to the development of models for the region. The refraction data will also provide information about the crustal structure of the Kimberley Block which will constrain tectonic models of the area and its relation to neighbouring regions.

RECORDING SITES

Seismic recorders were deployed on Browse Island, Bigge Island, Lamarck Island, Cape

Leveque and at the landing strip on the Mitchell Plateau (Fig 1). The first priority was to record long-offset data along the major dip line 119/0401-0402 at stations on Browse Island and on the mainland to obtain a reversed profile across the Browse Basin and its margins. The sites on Bigge and Lamarck Islands are close together to provide some insurance against failure or poor site conditions. The site on Mitchell Plateau was chosen to provide longer offset distances, particularly for shots near the coast, to ensure at least one site was remote from coastal wave noise, and to be more favourably placed to provide data on the structure of the Kimberley Block. The site at the northern tip of Cape Leveque was chosen to record arrivals from the southern traverses.

The recorders were deployed by boat (Browse Island), helicopter (Bigge and Lamarck Islands) and vehicle (Mitchell Plateau and Cape Leveque). The positions of the sites were determined by Global Positioning System (GPS) (Table 1). The Browse Island site was located on coral sand surrounded by coral reef, with considerable seismic noise. The sites on Bigge and Lamarck Islands were on Proterozoic King Leopold Sandstone and were extremely quiet when set up. The site on Mitchell Plateau was on Tertiary bauxite overlying Proterozoic Carson Volcanics and the noise level was low to moderate when set up. The site on Cape Leveque was on sand overlying Cretaceous Broome Sandstone and was moderately noisy when set up.

RECORDING EQUIPMENT

Seven frequency-modulated analogue tape recording systems developed by AGSO (Finlayson and Collins, 1980) were deployed at the five recording sites (Fig. 1). Six were based on modified Precision Instruments (PI) 1/2 inch tape decks with a maximum continuous recording period of 16 days. The seventh was based on a modified Tandberg ¼ inch tape deck with a maximum recording period of 8 days. The PI recorders were powered by external 12 volt batteries and solar panels. These recorders require a dual supply: one 55 amp-hour battery was used for the amplifiers and clock (average current drain 60 mA), and two 80 amp-hour batteries and a 42 watt solar panel for the tape deck and time signal radio (average current drain 900 mA). The Tandberg was powered by a single 80 amp-hour battery.

The seismometer was a single vertical component Willmore Mk II seismometer (Mk III on the Tandberg) with a natural frequency of 1.5 Hz. The seismic channel was recorded at two gain levels 24 dB apart. A bandpass filter was applied to the signal before recording (see Table 1 for gain and filter settings). A coded clock signal was recorded on a third channel, and time signals from the Omega radio navigation facility at Yarram, Victoria, were recorded on a fourth channel. The clocks were synchronised to the radio time standard; the clock errors at the start and finish of the recording period are noted in Table 2. The clock drift was also derived later from analogue playouts of the timing channels (Table 4; Fig. 2).

Two PI recorders were deployed on Browse Island to reduce the chance of failure at this site. Moreover, if both worked satisfactorily, it would be feasible to stack the signals and improve the signal to noise ratio at what was expected to be a noisy site. As these recorders would run out of tape in 16 days, a Tandberg recorder was also deployed there and programmed to start up 12 days after deployment. This ensured that at least one recorder remained operating until

the end of the survey as it was not feasible to change the tapes on the PI recorders.

Solar panels were used for the first time to power the recorders on this survey. The solar panels were oriented north at an angle of 30° from horizontal. Several of the batteries were tested at the end of the survey and all except one were above 12 volts. All recorders had reached the end of the tape when picked up except Cape Leveque and the Tandberg which were both deployed for less than the maximum period. The recorder on Mitchell Plateau had no low gain for the first five days and was running fast when picked up (See Tables 1 and 3).

The radio time signals from the Omega navigation facility at Yarram, Victoria, were poorly received at some stations. The correct positioning of the Omega radio antennas was essential to receive a signal strong enough to trigger the Omega radio circuitry, and clearly record the 10 second pulses on tape. Even with three adjacent stations on Browse Island, each station required slightly different orientation and height of the antenna. Consequently noisy radio signals were recorded on tape, resulting in processing problems (see below).

ENERGY SOURCE

The air-gun array deployed by *R/V Rig Seismic* to shoot the offshore reflection profiles was used as the main energy source for the long-offset seismic data. The array was a tuned 3000 cu. inch (49 litre) HGS sleeve air-gun array comprising 20 individual guns in two sub-arrays of 10 guns each (Symonds, 1993). Each gun had a capacity of 150 cu. inch. The array was operated at 1800 psi and normally towed at a depth of 10 m.

The shots were fired with a shot point interval of 50 m along the traverse, resulting in a variable firing rate of approximately 20 seconds (Table 5), depending on the ship's speed (nominally 5 knots). The time of firing of each shot to within 0.01 second was obtained in Universal Time by synchronising the ship's seismic Data Acquisition System (DAS) clock with a GED clock. The GED clock was set initially by comparison with radio time signals from the Omega VLF navigation facility in Victoria. The clock's drift was estimated as 4.15 ms/day (slow) using linear regression. A plot of clock error values is given in Figure 3.

The locations of the shot traverses are shown in Figure 1 and listed in Tables 6. The shots were positioned by GPS.

SEISMIC DATA RETRIEVAL

The processing of offshore-onshore refraction data recorded on AGSO portable recorders is described by Collins and others (1995). The processing of Browse Basin data proved problematical due to the generally poor reception of the Omega time signals at most sites. This particularly affected the automatic tape-speed compensation which is computed as each shot is digitised from the original analogue field tapes. The tape speed may vary on the recorder and/or on the playback tape deck, with the result that the sample interval of the digitized signal will vary. The algorithm used to correct this uses the recorded radio time signal as a standard interval to sense whether the tape is running slow or fast, and it then

computes a ratio ('correction factor') to apply to the data. If the signal is not good, spurious pulses on the radio channel will give incorrect ratios, and hence incorrect sample intervals will be used in the subsequent processing. An additional step in the processing stream was developed to reduce this effect, and a number of other improvements were implemented. These are described below.

The analogue data on the original field tapes were converted to digital format on a PDP11 computer running the digitising program TEST97. This program was extensively modified from earlier versions (Finlayson and others, 1995). Digitising start times were set at 4 seconds before the expected arrival. The files were written to DU1:[BROWSE] prior to their subsequent transfer to AGSO's Novell network. The processing stream for the digitising of field tapes is shown in Figure 4. The programs NAVIG01, NAVIG02 and DISTANCE were extensively modified from earlier versions.

NAVIG01 combines the ship navigation file with the shot time file. Shot times are changed to local time of the recording stations (from UT and Julian date). NAVIG02 is then used to divide the resultant file into individual traverse files.

Program DISTANCE generates files in the format used by the digitising software on the PDP11. Station-to-shot distances are calculated from the Robbins equation for the Australian National Spheroid. The output file contains shot numbers, distances, times, azimuths and water depths. At the moment neither azimuth nor water depth data is written into the shot headers by TEST97.

Figure 5 shows the processing stream for digital data files. Clock drift corrections are done by program NEWTIME, which replaces earlier versions. NEWTIME works on large multi-shot data files making the process more efficient (formerly all processing was done using single shot files). Ship clock errors (Figure 3) were combined with the recorder clock errors (Figure 2) to produce net drift files for each station. For later surveys, a GPS clock is used on board the ship to time the shots, and consequently there is no ship clock drift.

NEWCF was developed to modify tape speed correction factors written into shot headers by TEST97. The sample interval used in the digitising process is dependant on the playback speed of the field tapes. In the case of PI recorders, tapes are played back at 4 times the true speed. The digitising sample interval is set to 4ms by INFILE.DAT, ie. The seismic data should be sampled at 16ms. TEST97 uses the separation of Omega radio pulses to test for the true tape playback speed. The resultant number is written into the shot header as the 'correction factor' (usually between .90 and 1.10). The value is then used to calculate the true sample interval. Because the Omega radio signal during the Browse survey was very poor in parts, incorrect correction factors were calculated for specific groups of shots. Program NEWCF averages correction factors over a given number of shots. For the Browse data this number was usually taken as 100. Figure 8 shows the original correction factors computed by TEST97, and the new correction factors computed by NEWCF. Figure 9 compares two record sections from Station 3 (Lamarck Is), Line 701. Identical processing parameters were used for both plots: 11 trace stack with 5-22Hz bandpass. The top section contains shotpoints with original correction factors, the bottom one the 'averaged' values.

The processing stream for the production of seismic record sections is shown diagramatically in Figure 6. The programs PLOT1, PLOT2 and PLOT3 were derived from earlier versions and now work on one single multi-shot data file, considerably speeding up the plotting process. This multi-shot file is produced by program ADDFILE if the original digitised data is contained in more than one file. PLOT2 requires a list file (produced by NEWCF) containing shot header record numbers, and original correction factors.

The digitised Browse Basin data were archived in AGSO's Seismic Refraction Database. The directory tree structure is shown in Figure 7. Naming conventions for data files are given in Appendix 2. Examples of data files are given in Appendix 3.

ACKNOWLEDGEMENTS

The following are thanked for their assistance during the field program: the Department of Land Administration and the Department of Conservation and Land Management, Kununurra; Mathew Gould of the Bureau of Meteorology, Broome; Bruce Stein and the crew of the Kingfisher III; Debby and Chris Holt of King Edward River Station; Jim Ryan of Heliworks, Kununurra; the manager of Kooljaman Resort and the One Arm Point Community, Cape Leveque; and Dan Gardner, CSIRO, Canberra.

REFERENCES

COLLINS, C.D.N., BRACEWELL, R., & DRUMMOND, B.J., 1992 - Playback and Processing of Data from AGSO Portable Seismic Recording Systems. *Australian Geological Survey Organisation, Record* 1992/88.

FINLAYSON, D.M., CHUDYK, E.C., COLLINS, C.D.N. & LUKASZYK, I.S., 1995 - Otway Basin 1994-95, Wide-Angle Seismic Recording using the "Rig Seismic" Airgun Source: Operational Report.

FINLAYSON, D.M. & COLLINS, C.D.N., 1980 -- A brief description of BMR portable seismic tape recording systems. *Australian Society of Exploration Geophysicists Bulletin,* 11, 75--7.

SYMONDS P.A., 1993 - Deep structure of the Browse Basin region, North West Shelf, Australia: Cruise proposal. *Australian Geological Survey Organisation, Record* 1993/40.

AGSO FIELD PERSONNEL - Onshore Recorder Deployment

C.D.N. Collins	6/6/1993 - 11/7/1993
U.R. Rieke	31/5/1993 - 18/6/1993

TABLE 1. Location of Onshore Refraction Stations

Site No.	Location	Latitude[1] (S) Deg Min	Longitude[1] (E) Deg Min	Recorder No.	Gain[2] dB	Filter Hz
1	Browse Island	14 06.545	123 32.863	16 17 30[3]	96 96 96	6-100 6-100 .01-20
2	Bigge Island	14 37.416	125 07.341	19	96	6-100
3	Lamarck Island	14 47.259	125 01.576	21	96	6-100
4	Mitchell Plateau	14 47.551	125 49.530	20	96[4]	6-100
5	Cape Leveque	16 23.884	122 55.639	18	96	6-100

Notes: 1) Positions of stations from GPS.
2) Gain level of high gain channel; low gain (high-24 dB) also recorded.
3) Recorder 30 is a Tandberg ¼ inch tape recorder; all others are Precision Instruments ½ inch recorders.
4) No high gain channel from 15:14:46 to 20:10:37; only low gain (72 dB) recorded. High gain was recorded from 20:10:37 on.

TABLE 2. Onshore Stations Recording Time Parameters

Site No.	Set No.	Date On	Time On d h m	Error[1] ms	Date Off	Time Off d h m	Error[1] ms
1	17	11/6	11 14 35	986	30/6	30 06 15	161
	16	11/6	11 15 01	995	30/6	30 06 26	877
	30	11/6	00 14 08[2]	001	30/6	19 06 49[2]	875
2	19	15/6	15 10 51	002	5/7	35 09 55	838
3	21	15/6	15 13 58	981	5/7	35 12 17	871
4	20	15/6	15 14 46	002	20/6	20 10 00	998
		20/6[4]	20 10 37	000	26/6	26 12 48	080
		26/6[4]	26 12 48	080	5/7	35 14 59	204
5	18	17/6	17 12 04	003	2/7	32 13 10	-[3]
		2/7[4]	32 13 10	-[3]	3/7	33 06 38	-[3]

Notes: 1) These errors are relative to Omega radio time pulses and are read from the comparator on the recorder clock. The errors vary slightly with each ten-second Omega radio pulse so the average value was taken over several pulses. An error of 950 means the clock was SLOW by 50 milliseconds, and an error of 005 means the clock was FAST by 5 milliseconds.

2) The clock was programmed to start the recorder after a delay of 12 days, so that it would start when the clock was at 12:00:00:00. It was set up on day "00", ie. true time of 11:14:08. Recording commenced at true time 23:00:00:00 and ceased at true time 30:06:49.

3) Error display not working. See Table 3 for details.

4) Visit site.

TABLE 3. Onshore Stations - Remarks

Site No.	Location	Remarks
1	Browse Island	Noisy site; seismometers buried in coral sand. Set 17, Tape finished when picked up. Set 16, Tape finished when picked up. Nearly 1 sec fast. Set 30, Start delayed by 12 days - see Table 2. Tape still running when picked up. Nearly 1 sec fast.
2	Bigge Island	Very quiet site; seismometer on rock. Tape finished when picked up (Tape drive on Fast Forward, but not operating). Clock seems a bit slow.
3	Lamarck Island	Very quiet site; seismometer on rock. Tape finished when picked up. Clock a bit slow.
4	Mitchell Plateau	Average site; seismometer buried in compacted gravel. Tape finished when picked up; drive running fast, servo not synchronised. High gain modulator board dropped out of mounting; board replaced on 20/6 - see Table 1.
5	Cape Leveque	Noisy site; seismometer buried in compacted sand. Tape still running when picked up. Clock comparitor not working (see Table 2). Visually and by sound of the radio relay, the clock seems almost correct, but slightly slow. By comparing it to watch however it is over ½ second fast.

TABLE 4. Recorder Clock Drifts

Site No.	Set No.	Local Time (Days)	Error (sec)	Remarks
1	16	11.626	-0.005	Comparator Value (1)
1	16	12.32986	0.02	Analogue Value (2)
1	16	18.20486	0.31	Analogue Value
1	16	19.90486	0.39	Analogue Value
1	16	24.51667	0.6	Analogue Value
1	16	27.80764	0.74	Analogue Value
1	16	27.80417	0.75	Analogue Value
1	16	28.87153	0.8	Analogue Value
1	16	30.268	0.877	Comparator Value
1	17	11.608	-0.014	Comparator Value
1	17	11.87847	-0.01	Analogue Value
1	17	14.43125	-0.04	Analogue Value
1	17	16.06806	0.03	Analogue Value
1	17	18.91528	0.02	Analogue Value
1	17	20.99722	0.07	Analogue Value
1	17	23.42847	0.11	Analogue Value
1	17	25.39444	0.1	Analogue Value
1	17	27.22778	0.11	Analogue Value
1	17	28.66667	0.14	Analogue Value
1	17	30.26	0.161	Comparator Value

TABLE 4 (Contd.)

Site No.	Set No.	Local Time (Days)	Error (sec)	Remarks
3	21	15.58194	-0.019	Comparator Value
3	21	15.75278	-0.02	Analogue Value
3	21	16.52847	-0.03	Analogue Value
3	21	16.53125	-0.02	Analogue Value
3	21	18.48611	-0.03	Analogue Value
3	21	18.91319	-0.03	Analogue Value
3	21	19.16319	-0.03	Analogue Value
3	21	21.60903	-0.075	Analogue Value
3	21	23.7	-0.09	Analogue Value
3	21	26.025	-0.12	Analogue Value
3	21	27.43264	-0.14	Analogue Value
3	21	31.37292	-0.14	Analogue Value
3	21	32.40972	-0.14	Analogue Value
3	21	35.51181	-0.129	Comparator Value
2	19	15.452	0.002	Comparator Value
2	19	16.21944	-0.02	Analogue Value
2	19	17.22431	0.01	Analogue Value
2	19	18.02708	-0.04	Analogue Value
2	19	19.83611	-0.04	Analogue Value
2	19	22.37708	-0.05	Analogue Value
2	19	25.85347	-0.11	Analogue Value
2	19	30.97083	-0.15	Analogue Value
2	19	32.18681	-0.15	Analogue Value
2	19	35.413	-0.162	Comparator Value

TABLE 4 (Contd.)

Site No.	Set No.	Local Time (Days)	Error (sec)	Remarks
4	20	15.615	0.002	Comparator Value
4	20	15.70556	-0.02	Analogue Value
4	20	16.37986	-0.03	Analogue Value
4	20	16.89861	0	Analogue Value
4	20	17.51667	0	Analogue Value
4	20	18.48472	-0.02	Analogue Value
4	20	19.95625	0.01	Analogue Value
4	20	20.167	-0.002	Comparator Value
4	20	20.442	0	Comparator Value
4	20	21.0875	0	Analogue Value
4	20	22.30486	0	Analogue Value
4	20	23.57917	0.06	Analogue Value
4	20	25.45764	0.06	Analogue Value
4	20	26.533	0.08	Comparator Value
4	20	35.624	0.204	Comparator Value
1	30	11.58889	0.001	Comparator Value (3)
1	30	30.28403	0.875	Comparator Value

TABLE 4 (Contd.)

Site No.	Set No.	Local Time (Days)	Error (sec)	Remarks
5	18	17.503	0.003	Comparator Value
5	18	19.34931	-0.04	Analogue Value
5	18	20.16944	-0.06	Analogue Value
5	18	21.14306	-0.08	Analogue Value
5	18	22.94236	-0.08	Analogue Value
5	18	24.11944	-0.11	Analogue Value
5	18	26.75903	-0.13	Analogue Value
5	18	28.73264	-0.14	Analogue Value
5	18	29.98403	-0.15	Analogue Value
5	18	31.07639	-0.15	Analogue Value
5	18	31.83542	-0.17	Analogue Value
5	18	33.18542	-0.18	Analogue Value (4)
Notes:				
(1) These values were read from the clock comparator.				
(2) These values were measured on the analogue playback of the clock and radio channels				
(3) Radio channel was not recorded on tape.				
(4) The comparator display failed.				

TABLE 5. Traverse Time Statistics, Survey 119

Line No.	Start Time (UT)	Stop Time (UT)	Start Time (Local)	Stop Time (Local)	Average Shot Rate
0101	159 16 34	160 00 57	09 00 34	09 08 57	19.38
0102	160 07 23	162 06 16	09 15 23	11 14 16	19.74
0201	162 17 52	163 03 02	12 01 52	12 11 02	19.83
0202	163 09 08	163 20 00	12 17 08	13 04 00	19.69
0301	166 06 55	166 22 59	15 14 55	16 06 59	21.64
0401	167 09 09	168 19 38	16 17 09	18 03 38	21.17
0402	169 03 00	169 14 26	18 11 00	18 22 26	19.80
0501	170 05 33	171 05 57	19 13 33	20 13 57	19.46
0502	171 11 43	171 23 40	20 19 43	21 07 40	19.13
0601	172 08 45	173 13 26	21 16 45	22 21 26	19.77
0701	173 23 56	175 09 45	23 07 56	24 17 45	20.39
0801	175 18 42	176 01 14	25 02 42	25 09 14	18.33
0802	176 06 20	176 21 44	25 14 20	26 05 44	18.65
0901	177 05 08	177 13 50	26 13 08	26 21 50	22.66
0902	177 19 24	178 13 40	27 03 24	27 21 40	20.99
1001	179 02 58	180 20 43	28 10 58	30 04 43	19.38
1101	181 08 30	182 05 48	30 16 30	01 13 48	18.93
1201	182 16 18	184 01 33	02 00 18	03 09 33	19.09

TABLE 6. Traverse Shot Statistics, Survey 119

Line No.	Shot No.	Time mth d h m	Latitude deg min	Longitude deg min
0101	173	06 09 00 34	12 28.723	123 57.004
	1730	06 09 08 57	13 02.009	123 30.623
0102	2090	06 09 15 23	12 59.299	123 32.785
	10642	06 11 14 16	15 49.999	120 52.754
0201	195	06 12 01 52	16 19.333	121 25.234
	1859	06 12 11 02	15 44.624	120 55.653
0202	2088	06 12 17 08	15 47.823	120 58.041
	4075	06 13 04 00	15 04.024	120 25.999
0301	185	06 15 14 55	14 10.518	121 19.811
	2858	06 16 06 59	13 15.976	122 08.006
0401	273	06 16 17 09	13 09.242	121 41.708
	6137	06 18 03 38	14 21.469	124 06.556
0402	7003	06 18 11 00	14 19.899	124 03.671
	9082	06 18 22 26	14 47.044	124 54.446
0501	188	06 19 13 33	14 50.169	123 59.175
	4703	06 20 13 57	14 04.256	122 02.630
0502	6069	06 20 19 43	14 08.717	122 08.077
	8318	06 21 07 40	13 25.014	121 25.012
0601	187	06 21 16 45	14 04.310	121 16.214
	5409	06 22 21 26	15 39.995	123 03.470
0701	190	06 23 07 56	15 20.315	122 30.715
	6160	06 24 17 45	13 33.897	124 34.649
0801	199	06 25 02 42	14 04.847	124 17.336
	1482	06 25 09 14	13 37.390	123 55.449
0802	2078	06 25 14 20	13 39.759	123 59.094
	5050	06 26 05 44	12 55.974	122 49.975
0901	240	06 26 13 08	12 31.603	123 07.478
	1622	06 26 21 50	12 45.247	123 42.844
0902	3080	06 27 03 24	12 41.885	123 37.706
	6213	06 27 21 40	13 43.850	124 36.545
1001	184	06 28 10 58	12 57.941	124 01.941
	7940	06 30 04 43	15 46.030	121 54.482
1101	182	06 30 16 30	15 54.388	122 09.834
	4233	07 01 13 48	14 36.026	120 50.752
1201	213	07 02 00 18	14 07.336	121 22.625
	6484	07 03 09 33	16 24.009	119 40.010

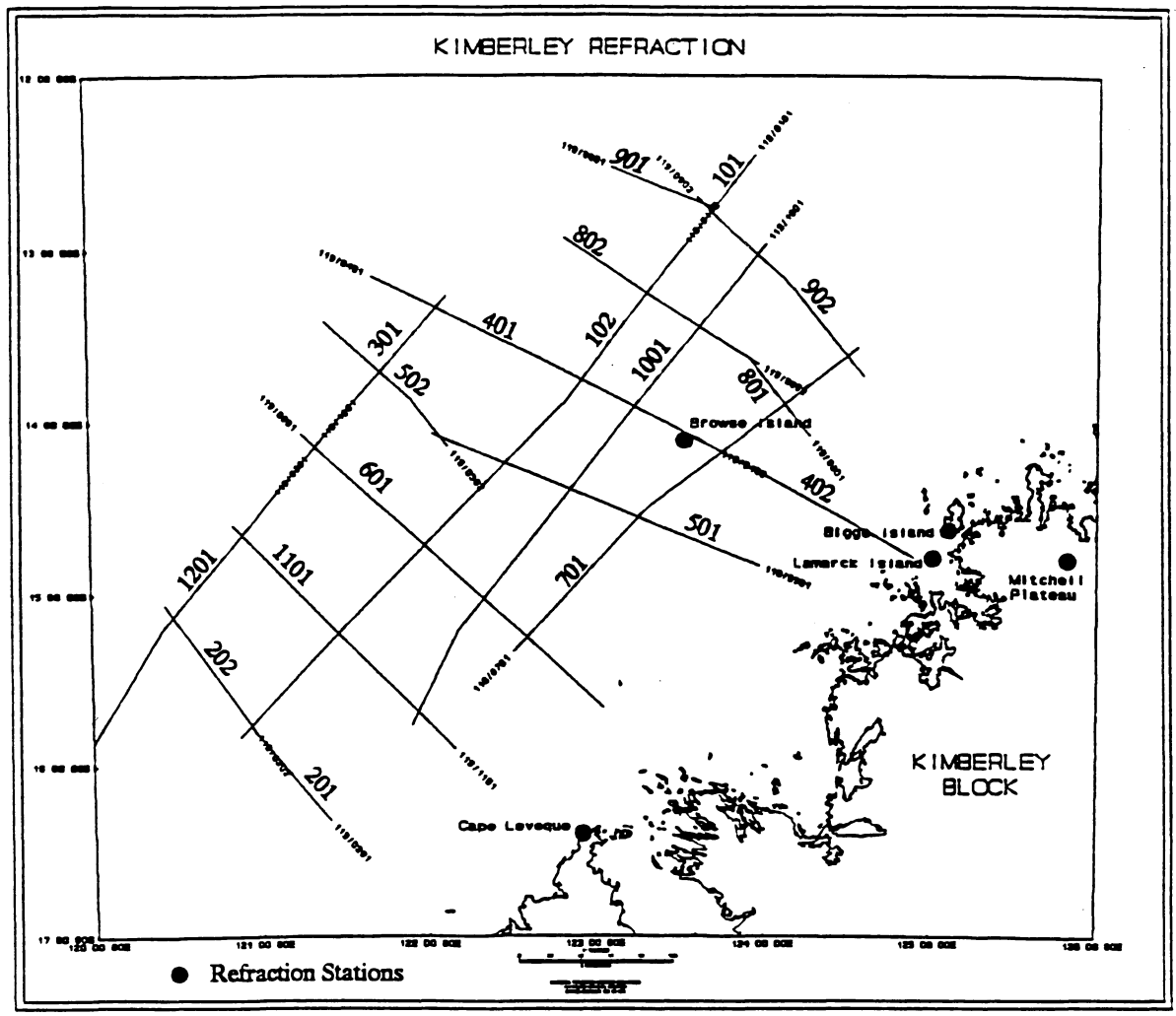
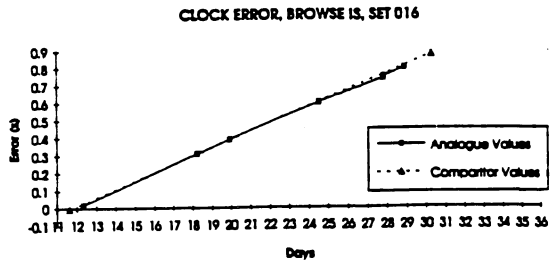
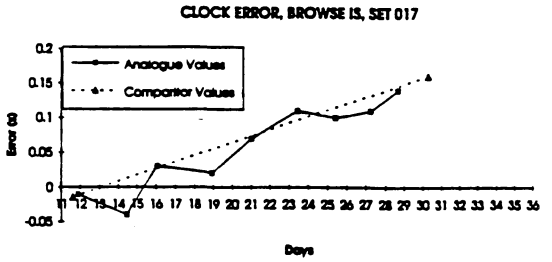
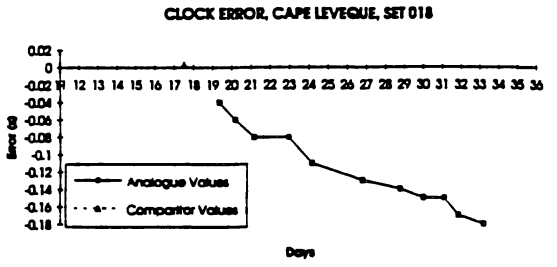
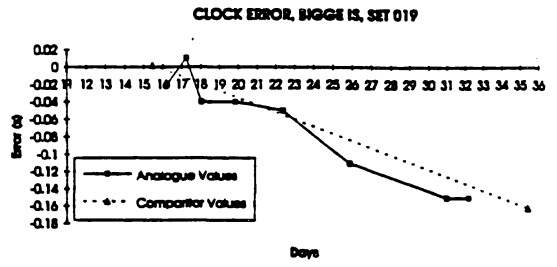


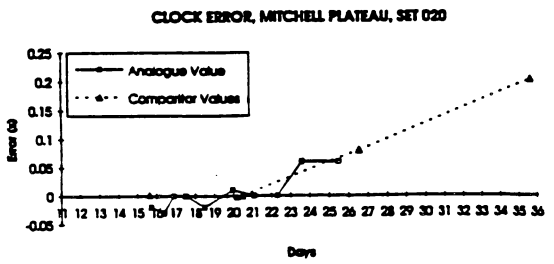
FIGURE 1. Location of Refraction Stations and Shot Traverses

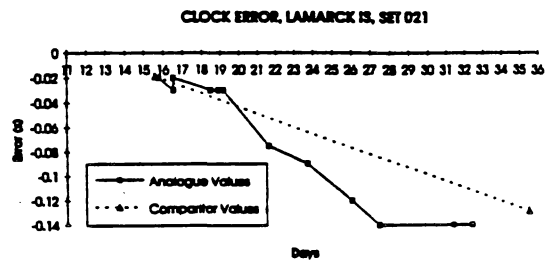












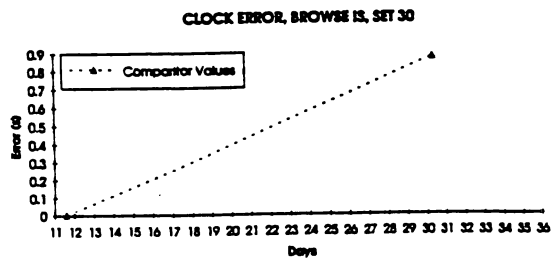


FIGURE 2. Recorder Clock Drift

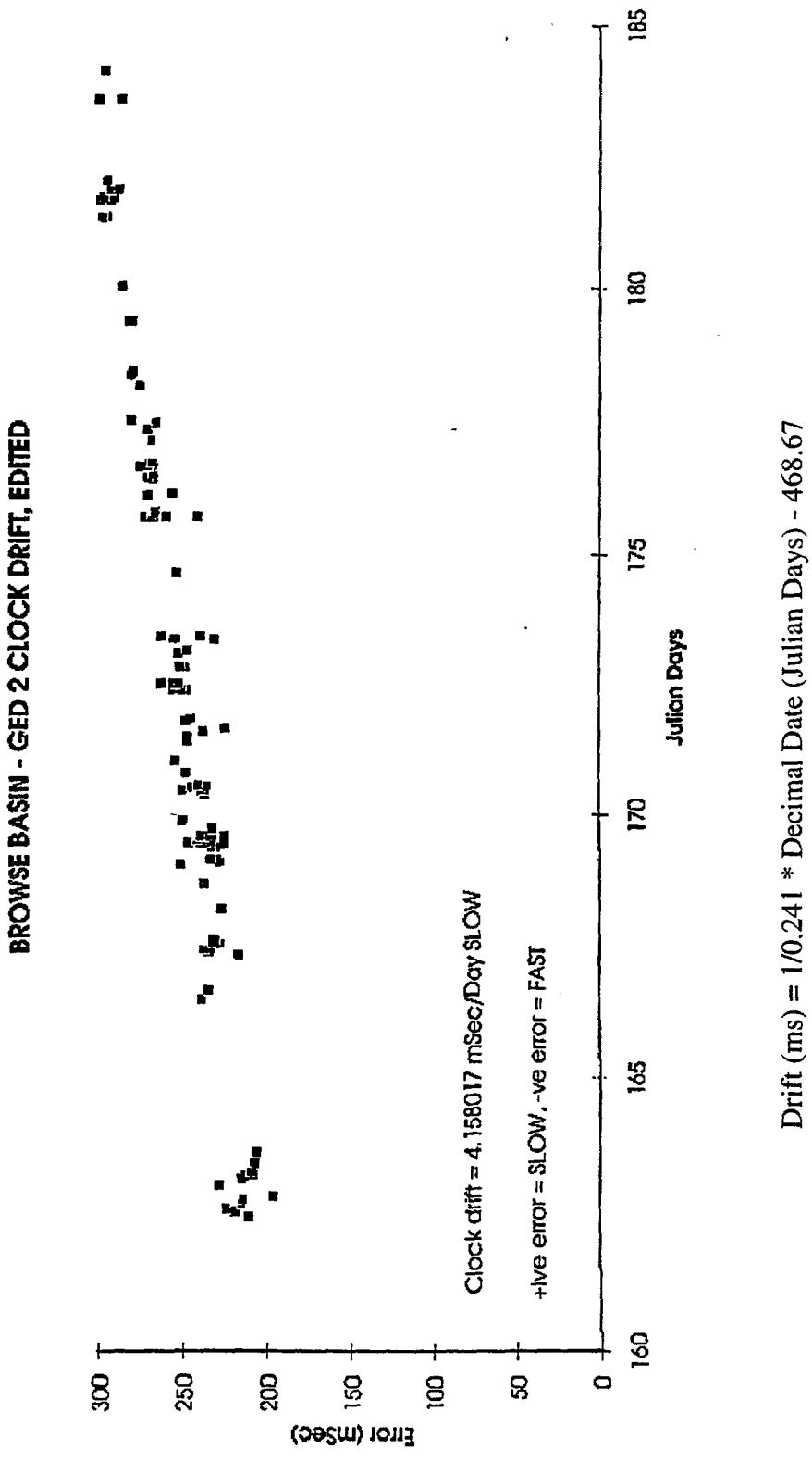


FIGURE 3. Ship's Clock Drift

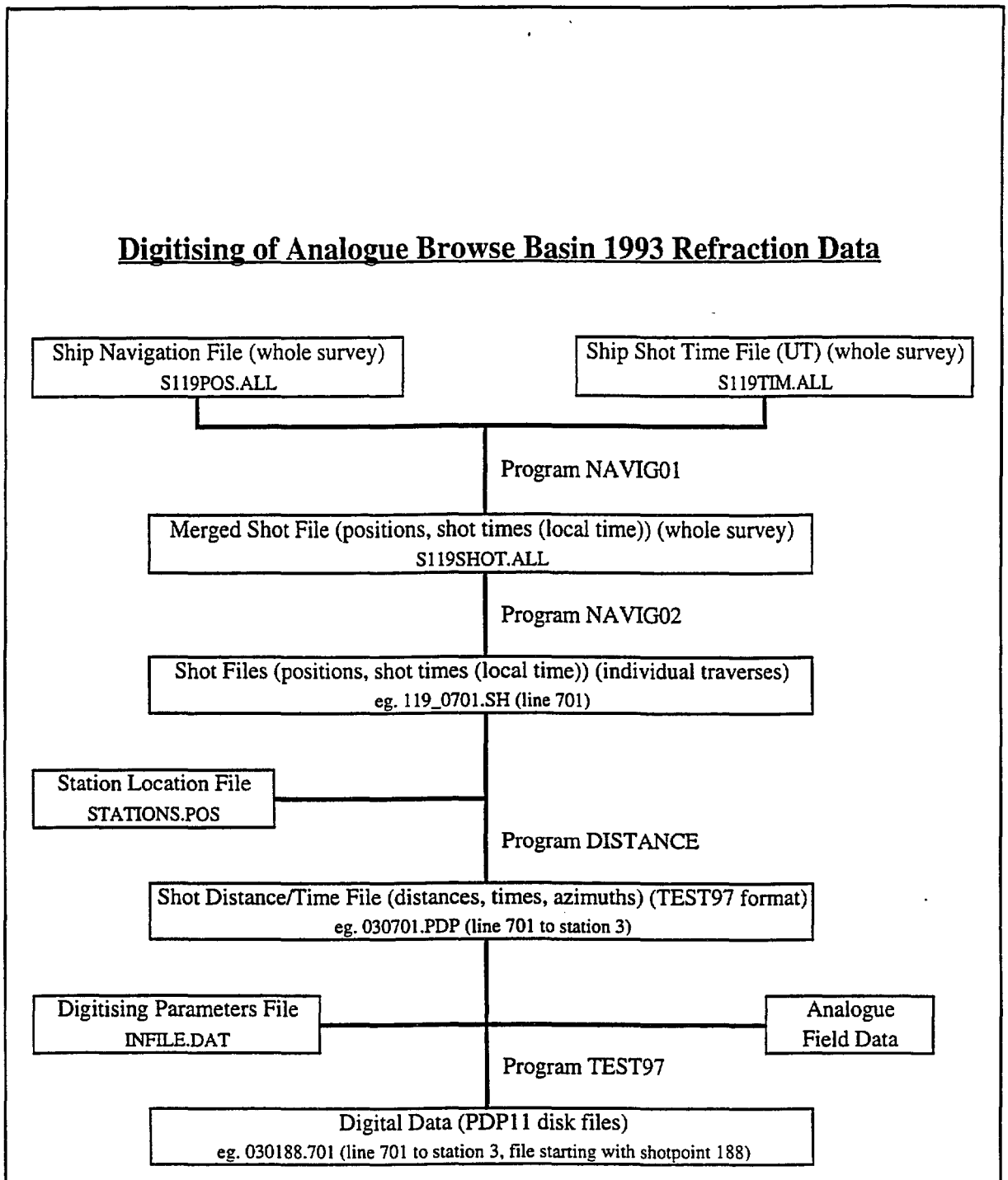


FIGURE 4. Processing Stream for Digitising Analogue Field Tapes

Processing of Digitised Browse Basin 1993 Refraction Data

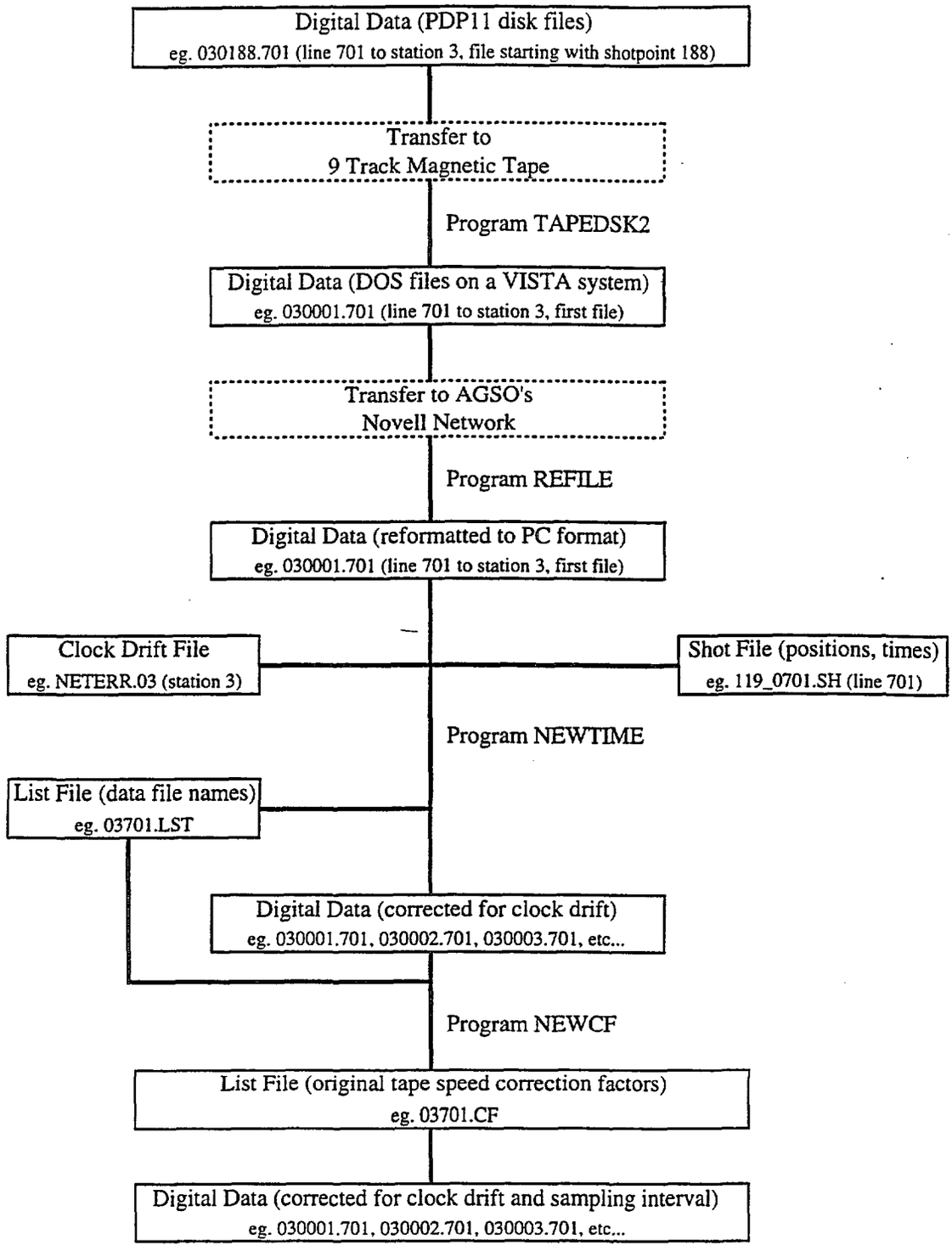


FIGURE 5. Processing Stream for Digital Data Files

Production of Browse Basin 1993 Refraction Record Sections

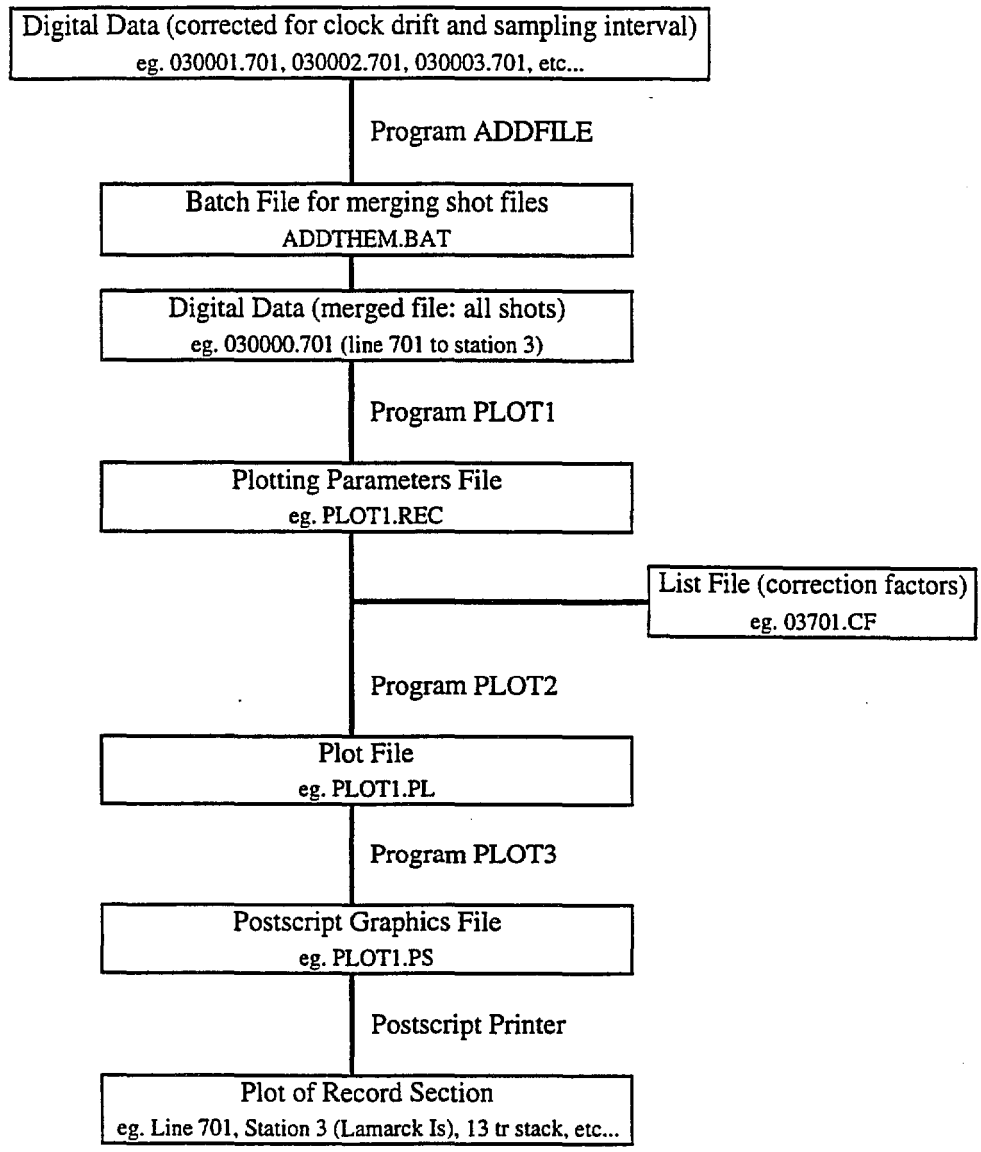


FIGURE 6. Processing Stream for Plotting Record Sections

Archiving of Browse Basin 1993 Refraction Data

Directory Structure used to store Survey119 refraction data:

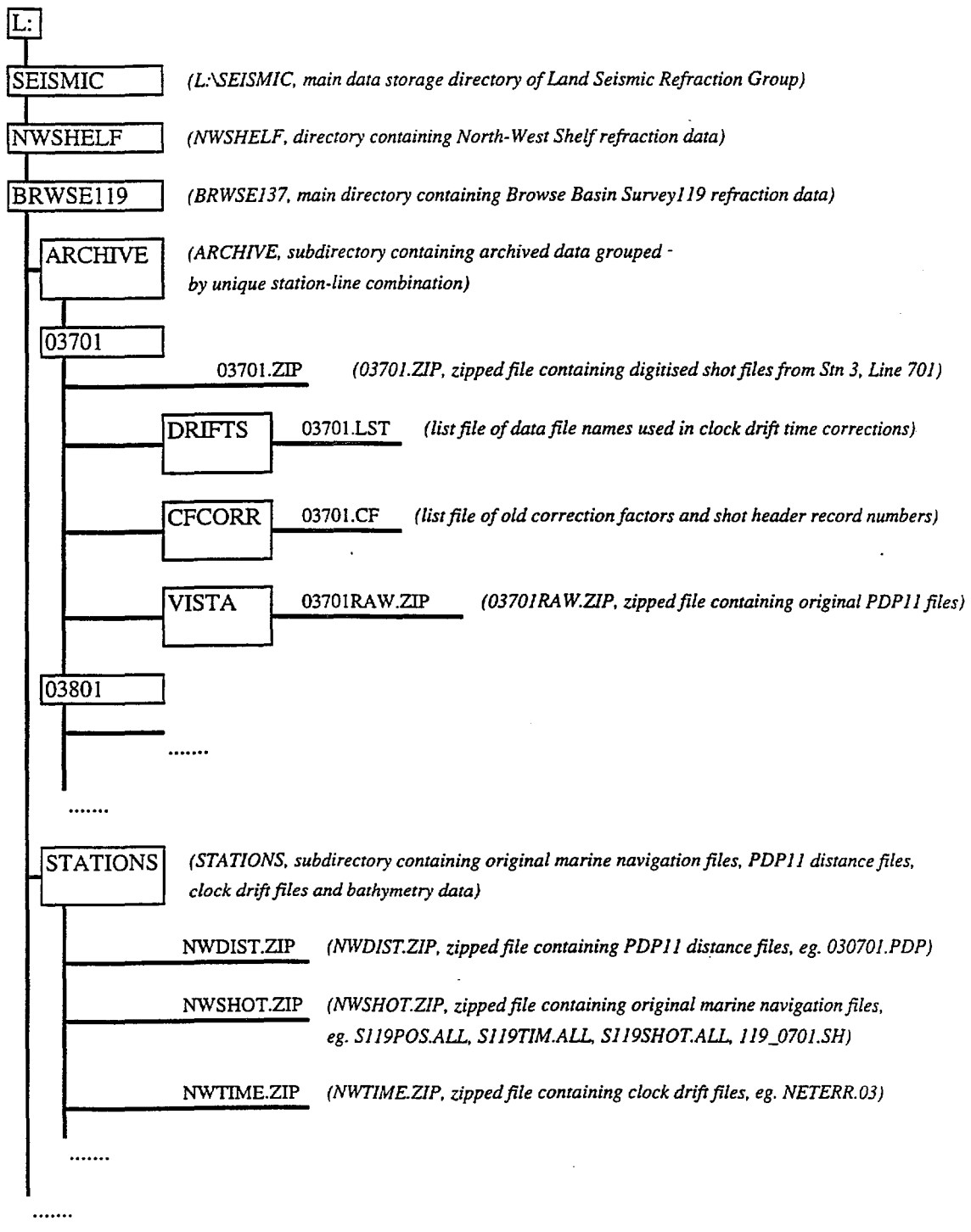


FIGURE 7. Directory Structure used for Archiving Browse Basin Seismic Data

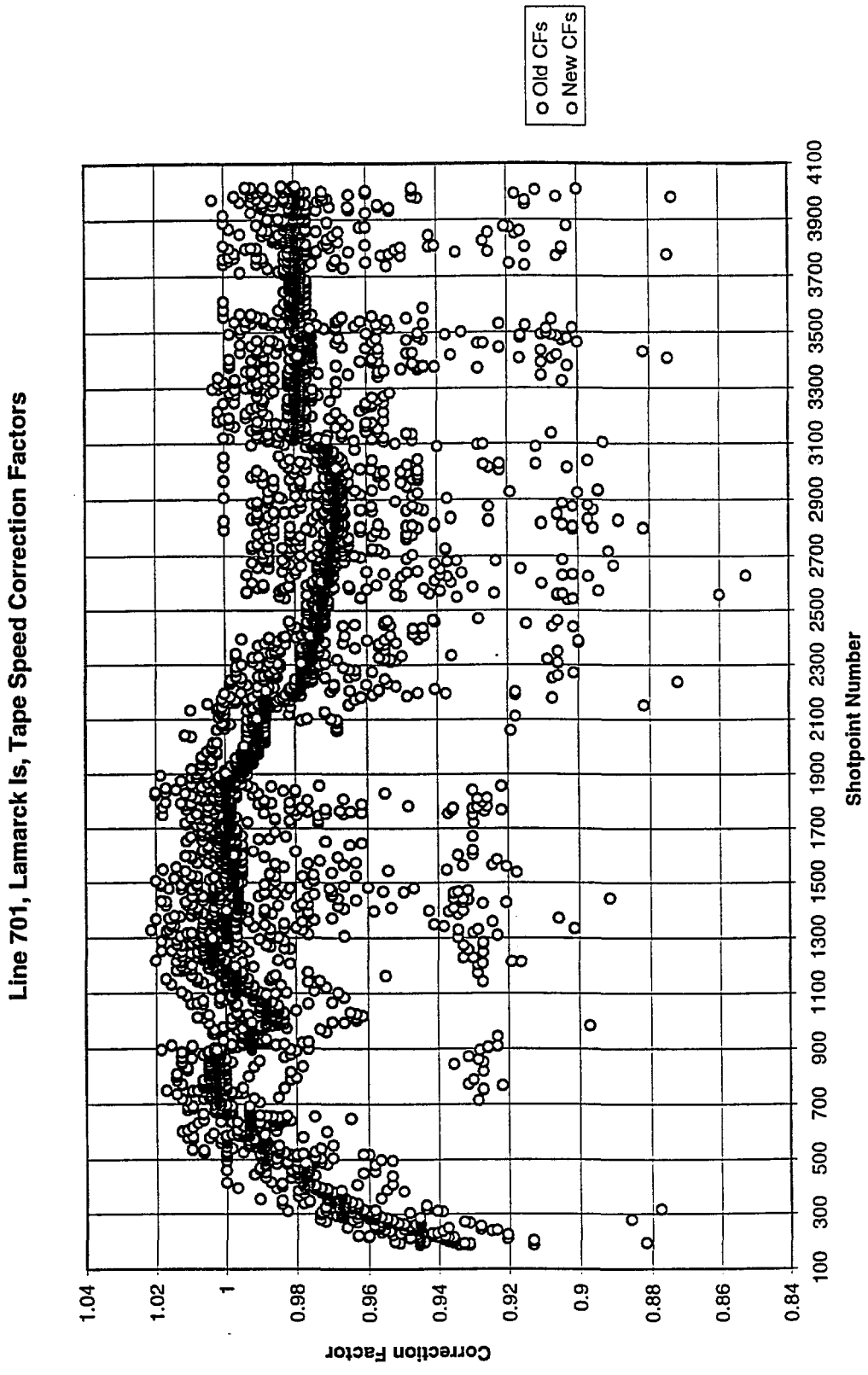


FIGURE 8. Original and Final Correction Factors, Stn 3 (Lamarck Island), Line 701

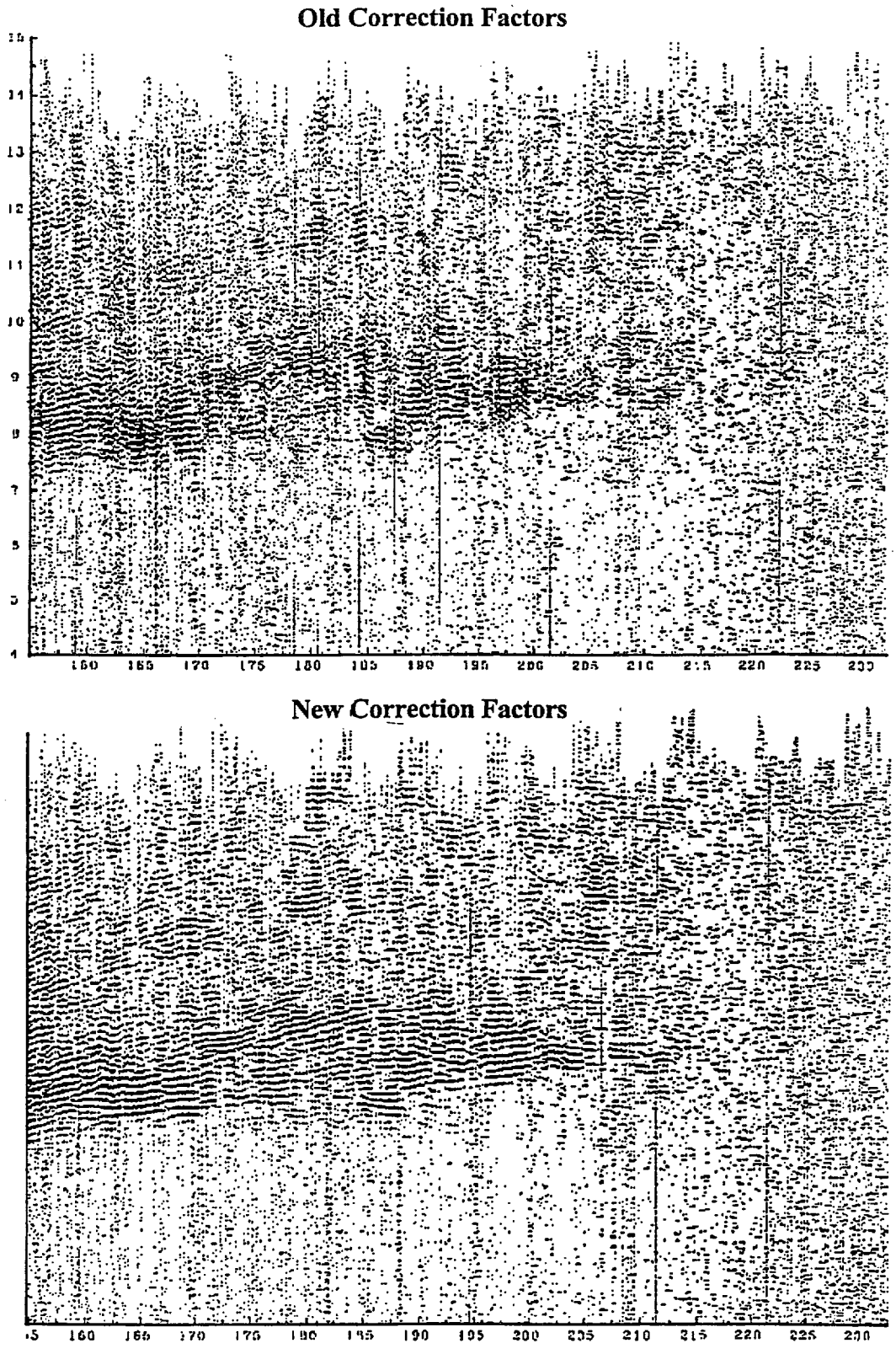


FIGURE 9. Comparison of Record Sections, Stn 3 (Lamarck Island), Line 701

APPENDIX 1

NAMING CONVENTIONS FOR DATA FILES

The following page gives naming conventions for data files used in the digitising, processing and production of record sections.

Naming Conventions for Data Files

Digitising Stage

Ship Navigation File (whole survey)	S111POS.ALL
Ship Shot Time File (UT) (whole survey)	S111TIM.ALL
Merged Shot File (positions, local times) (whole survey)	S111SHOT.ALL
Shot File (positions, local times) (individual traverses)	111_2222.SH
Station Location File (station numbers, decimal coordinates)	STATIONS.POS
Shot Distance/Time File (distances, times, azimuths)	332222.PDP
Digitising Parameters File (shot header values, sampling)	INFILE.DAT
PDP11 Data Files (shot headers, digitised traces)	334444.222

Processing Stage

PC Reformatted Data Files (shot headers, digitised traces)	335555.222
Clock Drift File (time in decimal days, error in seconds)	NETERR.33
List File (data file names)	33222.LST
List File (original tape speed correction factors)	33222.CF

Record Section Production Stage

Merged Data File (shot headers, digitised traces)	330000.222
Plotting Parameters File (filter settings, gain, etc...)	PLOT5.REC
Plot File	PLOT5.PL
Postscript Graphics File	PLOT5.PS

Legend

111	Marine Cruise Number
2222,222	Traverse Number
33	Station Number
4444	First Shotpoint Number in the File
5555,5	Sequential File Number

APPENDIX 2

EXAMPLES OF PROCESSING DATA FILES

The following pages contain examples of the data files used in the digitising, processing and production of record sections, illustrating the formats of the various files.

Examples of Data Files: Traverse 701 at Station 3 (Lamarck Is)

1. S119POS.ALL, Ship Navigation File (whole survey)

```
119/0101      103  122714.1S1235813.2E99999999     -89159161043999999
119/0101      104  122715.4S1235812.2E99999999     -89159161102999999
119/0101      105  122716.6S1235811.2E99999999     -89159161121999999
119/0101      106  122717.9S1235810.2E99999999     -89159161140999999
119/0101      107  122719.2S1235809.2E99999999     -89159161159999999
etc...
```

2. S119TIM.ALL, Ship Shot Time File (UT) (whole survey)

```
119/0101   103 159 16111665
119/0101   104 159 16113556
119/0101   105 159 16115452
119/0101   106 159 16121353
119/0101   107 159 16123259
etc...
```

3. S119SHOT.ALL, Merged Shot File (positions, shot times (local time)) (whole survey)

```
CRUISE 119 SHOT POSITION-TIME FILE (BROWSE 93) (UT DIFFERENCE 8 HRS)
0101  103  159 16 06 09 00 11 16 65  12 27.235  123 58.220  -89
0101  104  159 16 06 09 00 11 35 56  12 27.257  123 58.203  -89
0101  105  159 16 06 09 00 11 54 52  12 27.277  123 58.187  -89
0101  106  159 16 06 09 00 12 13 53  12 27.298  123 58.170  -89
0101  107  159 16 06 09 00 12 32 59  12 27.320  123 58.153  -89
etc...
```

4. 119_0701.SH, Shot File (positions, shot times (local time)) (line 701)

```
LINE 0701 SHOT FILE, CRUISE 119
188  15 20.342  122 30.688   -86  23 07 56 06 00
189  15 20.323  122 30.707   -86  23 07 56 26 00
190  15 20.303  122 30.725   -86  23 07 56 46 35
191  15 20.285  122 30.745   -87  23 07 57 07 01
192  15 20.265  122 30.763   -88  23 07 57 27 69
 etc...
```

5. STATIONS.POS, Station Location File

```
TABLE 1.  Location of Onshore Refraction Stations
 1   14 06.545   123 32.863
 2   14 37.416   125 07.341
 3   14 47.259   125 01.576
 4   14 47.551   125 49.530
 5   16 23.884   122 55.639
```

6. 030701.PDP, Shot Distance/Time File (distances, times, azimuths)

```
STN 03, LINE 0701 SHOT DISTANCE FILE
0188  277.184  23075606.000  257.0   -86.0
0189  277.143  23075626.000  257.0   -86.0
0190  277.104  23075646.350  257.0   -86.0
0191  277.062  23075707.010  257.0   -87.0
etc...
```

7. INFILE.DAT, Digitising Parameters File

```
110693
BROWSE93
84
1.0
2
4
4
3
11
4
37000
03701.PDP
```

8. NETERR.03, Clock Drift File (station 3)

```
DAYS VERSION OF: SITE 03, LAMARCK IS, SET 21, NET CLOCK ERRORS
3          15.58194     0.2012
3          15.75278     0.2002
3          16.52847     0.1943
3          16.53125     0.2043
3          18.48611     0.2026
3          18.91319     0.2026
3          19.16319     0.2026
3          21.60903     0.1701
3          23.70000     0.1634
3          26.02500     0.1417
etc...
```

9. 03701.LST, List File (shot file names)

```
030001.701
030002.701
030003.701
030004.701
030005.701
etc...
```

10. 03701.CF, List File (original tape speed correction factors)

```
030001.701    1 0188 0.931291
030001.701    5 0189 0.934385
030001.701    9 0190 0.913149
030001.701   13 0191 0.934385
030001.701   17 0192 0.932836
etc...
```

11. ADDTHEM.BAT, Batch File for merging shot files

```
copy 030001.701/b+030002.701/b+030003.701/b 030000.701
```

12. PLOT1.REC, Plotting Parameters File (Line 701, Station 3)

```
119/701, STN 3 (LAMARCK IS), 13TR STACK @ 8KM/S, 5-22Hz, SP 190-500
1.00    2.50      !Time Scale, Distance Scale
100.00  200.00    !Minimum Distance, Maximum Distance
8.00              !Reduction Velocity
-1.00  0.00   0.00 !Distance,Gain,ShotWeight Normalizing
5.0    22.0       !Low cut, High cut Filter
11.00             !Trace Length (Seconds)
030001.701          !Data Filename
2255 4021           !First shot number, Last shot number
Record Numbers of the headers of the requested shots:
8189  8193  8197  8201  8205  8209  8213  8217  8221  8225
8229  8233  8237  8241  8245  8249  8253  8257  8261  8265
8269  8273  8277  8281  8285  8289  8293  8297  8301  8305
8309  8313  8317  8321  8325  8329  8333  8337  8341  8345
etc...
```