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Bowen Basin Seismic Survey 1989: Operational Report

by K D Wake-Dyster

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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BOWEN BASIN SEISMIC SURVEY 1989: OPERATIONAL REPORT

by

K.D. WAKE-DYSTER[1]

[1]Onshore Sedimentary & Petroleum Geology Program
Australian Geological Survey Organisation, GPO Box 378, Canberra, ACT 2601, Australia.

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Resources: Hon. Michael Lee, MP
Secretary: Greg Taylor

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EXECUTIVE SUMMARY

The Bureau of Mineral Resources, Geology & Geophysics (BMR) (now Australian Geological Survey Organisation (AGSO)), Department of Primary Industries & Energy, Australian Government, conducted the Bowen Basin Seismic Survey during July to October 1989. The major aim of the seismic survey was to record deep seismic reflection data across the northern part of the Bowen Basin, to test geological (extensional) models for the formation of the Bowen Basin.

The locations of the seismic lines were determined in consultation with exploration companies and the Department of Resources Industries (now Dept. of Minerals & Energy), Queensland State Government. The requirement that the seismic lines be targeted and constrained to follow a proposed geological corridor was a controlling factor in the positioning of the seismic lines.

The deep seismic reflection survey by the BMR recorded 254 km of 8-fold CDP seismic data, along three seismic lines. Line BMR89.B01, 157 km in length, crossed major features including the Comet Ridge, Bowen Basin, Duaringa Basin and Gogango Overfolded Zone. Line BMR89.B02 was recorded as an easterly extension of Line BMR89.B01, positioned further north due to ease of access. Line BMR89.B03 was positioned to provide a north-south line crossing inferred transfer faults of the geological corridor followed by Line BMR89.B01. One expanding spread consisting of 9 shots was recorded on Line BMR89.B01 centred at SP 2025 with maximum offsets of 25.6 km. Gravity observations were made at 480 m intervals on all seismic lines.

The seismic data have been processed, with final seismic sections available for purchase from the AGSO Sales Centre, GPO Box 378, Canberra, ACT, 2601.

INTRODUCTION

1.1 Background

The deep seismic reflection survey in the northern Bowen Basin developed from a project proposal instituted by the BMR. The project proposal was aimed to further studies of the Late Palaeozoic and Mesozoic Sedimentary Basins of Eastern Australia, specifically the Gunnedah, Bowen and Surat Basins. Following distribution of the project proposal to interested parties for comment, a majority of parties considered that a high priority area for investigation should be the northern portion of the Bowen Basin. A prime objective of the project proposal was to provide an improved basis for resource exploration in the region. A better understanding of the structure and tectonic evolution of the sedimentary basins, adjacent orogens and the sedimentary architecture of the basins, were the main aims addressed by the survey.

1.2 Location

The seismic survey operated in northern Queensland, west of Marlborough and Rockhampton, between Comet and Duaringa (Fig 1). The seismic lines are confined to the following 1:250000 mapsheets; SF 55-12 ST LAWRENCE, SF 55-15 EMERALD, SF 55-16 DUARINGA. To assist in positioning the seismic lines, aerial photographs, topographic maps and cadastral maps were used to identify existing tracks and stock routes, and areas with topographic obstacles. A general location map of the seismic lines is shown in Figure 1.

1.3 Seismic Lines

Three seismic lines were recorded during the survey. Line BMR89.B02 was recorded first, 55 km in length, oriented W-E, and located along the old inland Sarina to Marlborough road. Line BMR89.B01, 157 km in length, commenced 40 km north of Duaringa and progressed WSW passing 4 km south of Blackwater and ending 10 km south of Comet. Line BMR89.B01 required one bowtie crossover of the seismic line in an area of rugged terrain SE of Comet. Line BMR89.B01 was therefore processed in two parts but named Line BMR89.B01 along its entire length. Line BMR89.B03, 41 km in length and oriented S-N, was recorded last, following the Comet to Rolleston gravel road and intersected Line BMR89.B01 south of Comet.

Operational statistics for the seismic survey are listed in Appendix 1 and seismic line recording spread parameters in Appendix 5.

1.4 Operations - Commencement, Personnel and Vehicles

Commencement and completion details for the seismic survey are tabled in Appendix 1. The drilling crew commenced one week earlier than the recording crew and also finished one week earlier than the recording crew. Due to a very short lead time for organisation of the survey, the AUSLIG surveying crew also only had a one week lead time over the drilling crew. At the completion of the seismic survey, the seismic crew moved to Cobar in NSW to commence a jointly sponsored seismic survey in that area.

Due to a shortfall in the number of permanent BMR employees, three additional drillers and a field assistant to assist with explosive pre-loading were employed on contract.

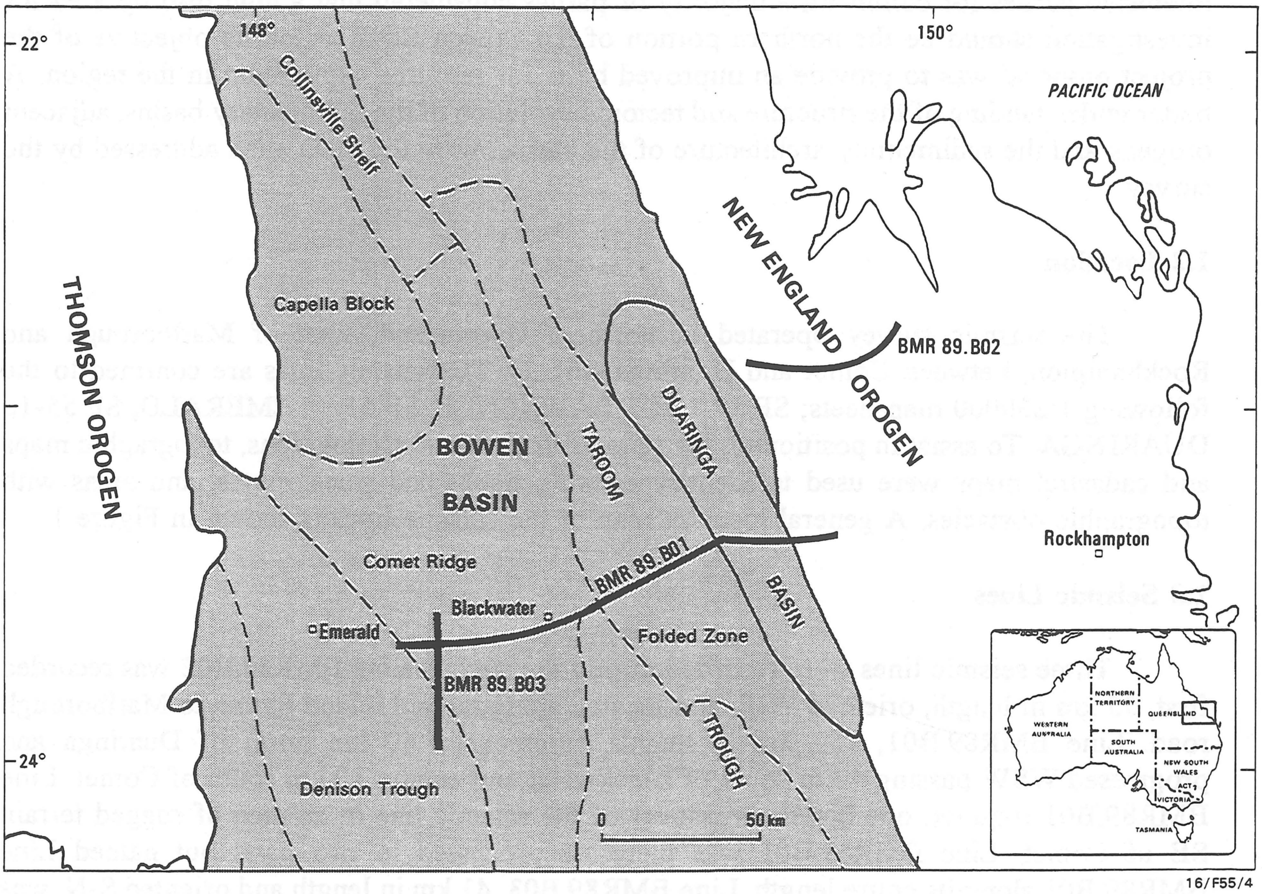

Figure 1. Location of the 1989 BMR deep seismic reflection survey lines in the Bowen Basin.

The contracts were in addition to the normal contract personnel requirements of field hands, assistant drillers, cooks and assistant cooks. A list of personnel employed on the survey is tabled in Appendix 2.

For survey operations, three campsites were required, with drilling and recording camps normally located within 500 m of each other. The first camp was located in a clump of trees, at the T-intersection of the old Marlborough to Sarina Road and the Apis Creek Road, with bitumen access to Rockhampton via Marlborough for stores runs. Water for the camp was obtained from a concrete causeway creek crossing on the Ogmore Road north of the camp. The campsite proved ideal for the recording of Line BMR89.B02, and the eastern end of Line BMR89.B01, up to the Mackenzie River. To record the central section of Line BMR89.B01, a campsite 3 km west of Dingo and 1 km south along a gravel road, proved satisfactory, with stores runs to Rockhampton and Blackwater. Water for the camp was obtained from the shire at Dingo. The final campsite was located in an uncleared paddock 9 km south of Comet on the Rolleston Road, at the intersection of Line BMR89.B01 and Line BMR89.B03. Stores runs were made to Blackwater and Emerald, with water obtained from the Mackenzie River at Rileys Crossing north of Comet.

Seismic survey vehicles used on the survey are listed in Appendix 3. All five BMR Mayhew 1000 drilling rigs were used for shothole drilling. The AUSLIG surveying crew and numerous bulldozing contractors supplied their own vehicle requirements.

1.5 Associated Geophysical Surveys

Gravity measurements were made at intervals of 480 m along all the seismic lines recorded during the survey. Details of the gravity survey are given in Appendix 6.

1.6 Objectives and Program

The main objective of the seismic survey was to test tectonic and structural models proposed for the formation and development of the Bowen Basin. The Bowen Basin has been interpreted as a foreland basin (Murray, 1985), extensional basin (Ziolkowski & Taylor, 1985; Hammond, 1987) and transtensional (strike-slip) basin (Harrington, 1982; Harrington & Korsch, 1985). More recent models propose a mixed-mode origin of extension (or transtension) followed by compression (or transpression) (e.g. Hammond, 1988; Korsch & others, 1988; Elliott, 1989; Fielding & others, 1990). To test the various tectonic and structural models, a seismic line was planned to follow a geological corridor between two major inferred 'transfer faults'. Further seismic lines were also planned to cross the inferred 'transfer faults' to test whether the inferred 'transfer faults' could be imaged using deep reflection seismic methods.

Due to budgetary constraints, the seismic survey was limited to ten weeks field work, not including the positioning and de-positioning of the survey crew from the field to Canberra. Based on previous BMR seismic survey work averages, and accounting for delays due to rain and equipment breakdowns, for a five day working week the BMR seismic crew averages about 25 km per week in seismic production progress. Using these values, the seismic program was designed to acquire 250 km of deep seismic reflection data.

FIELD OPERATIONS

2.1 General

Three 8 fold CMP, 20 seconds two-way travel time, deep seismic reflection lines were recorded with a total length of 254 km of new seismic reflection data acquired. Line BMR89.B02 was recorded first to allow sufficient time for bulldozer clearing along Line BMR89.B01 to advance and for landowners to be consulted. On completion of Line BMR89.B01, Line BMR89.B03 was recorded, but due to problems in obtaining a suitable bulldozer for clearing, the southern end was deviated to follow the shire road instead of heading due south from Comet Downs. General spread and recording parameters for all seismic lines are given in Appendix 5.

Shothole drilling was reasonably good, with hard drilling conditions along Line BMR89.B02 and the eastern end of Line BMR89.B01, resulting in shallow shothole depths (ie. basement rock type areas). Some mudpits were required on Line BMR89.B01 in the area east of the MacKenzie River, where many older river channels existed. Seismic recording progress was about average, with only minor problems with the Sercel SN368 seismic recording system.

Access to the seismic lines was good, with the only extended travelling time to the seismic line from the seismic camp being at the eastern end of Line BMR89.B01. The additional travelling time was offset by the need for one less campshift. Overall, weather conditions during the survey were extremely favourable, as heavy rainfall of prolonged duration in the black soil areas would have delayed the survey considerably.

2.2 Reconnaissance

A reconnaissance survey of the area was made over a two week period during February and March 1989, by Kevin Wake-Dyster and David Johnstone. Potential problem areas were investigated, such as the location of the seismic line to tie with petroleum exploration well A.F.O. Comet No.1 (Mines Administration Pty. Ltd., 1965) and other areas where the line may pass through privately owned properties. No landowners were consulted during the reconnaissance trip, as the purpose of the trip was to define areas where the seismic line could or could not be positioned. Also, the Bowen Basin seismic survey was planned to be done in early 1990, but due to a change in priority of projects, the Bowen Basin seismic survey was brought forward to the later half of 1989.

As a result of the seismic survey being brought forward to an earlier date, minimal preparation time was available to consult landowners affected by the seismic survey lines passing through their properties. Most landowners were cooperative towards the seismic survey passing through their properties, given the short notice of the approaching seismic survey. However, access to one property required negotiations with the owner's solicitor and the signing of a document adhering to certain access conditions before seismic survey activities were permitted on the property. Another landowner refused to allow any grading or bulldozing on the property.

2.3 Environmental Issues

Farmland in the Duaringa, Dingo, Blackwater and Comet areas consists of arable land produced by the 'pulling' of Brigalow scrub using bulldozers and heavy 'pulling' chains to clear the scrub to produce grazing land paddocks. Many paddocks were then planted with Buffel Grass to produce a rich fodder grass for beef cattle production. Different varieties of Sorghum are also sometimes planted to provide fodder for cattle. Buffel Grass is an introduced grass from other overseas countries and a problem now exists because non-certified Buffel Grass seed containing other plant seeds besides Buffel Grass was introduced at some stage. The result has seen the gradual spread of another plant species called Parthenium, known locally as 'Rag Weed'. The result is that if paddocks of Buffel Grass are overgrazed, the Parthenium will gradually replace the Buffel Grass. The Parthenium is not edible for cattle and can sometimes grow to tall heights and render a paddock useless. A compounding problem is that sucker regrowth of Brigalow scrub is starting to appear. This is usually overcome by 'blade ploughing' the paddocks and at the same time re-seeding the Buffel Grass.

Local landowners not affected by Parthenium are very cautious in allowing vehicles (especially bulldozers) from affected areas entering their properties, in an attempt to limit the spread of the weed. The Queensland Department of Primary Industries also requires vehicles to be washed-down when moving from an affected Parthenium area to a 'clean' area so that Parthenium seed is not spread by vehicle movements. Due to the Parthenium problem, the use of local landowner bulldozers for line clearing was advantageous, because introducing a contract bulldozer from elsewhere may have resulted in the spreading of Parthenium seed.

Fortunately for the seismic survey operations, the recording on Line BMR89.B01 commenced at the eastern end, an area relatively free of the Parthenium weed. However, west of Blackwater, some areas of badly infestated regions of Parthenium existed, allowing the seismic survey work to progress from a Parthenium free area to an infected area, and not vice versa. Seismic survey vehicles were washed down whenever the risk of spreading Parthenium seed arose.

2.4 Bulldozing

Due to the short leadup time for the seismic survey, a contract bulldozer using tendering procedures was not a viable option for areas requiring clearing of the seismic line. The seismic line was positioned to maximise the use of existing roads and tracks where possible, and minimise the amount of bulldozer clearing required. As a result, local bulldozers were hired for clearing operations based on the best of three quotes for the particular areas to be cleared. In many cases, this resulted in the hire of landowner's bulldozers with clearing of the seismic line across their own properties. Where landowner's bulldozers were not available, a bulldozer contractor from Rockhampton was used.

Overall, hire of several bulldozers to clear different areas at the one time, allowed the seismic line to be cleared so that surveyors and seismic crews were not delayed by the lack of cleared seismic line. However if additional leadup time was available, a single bulldozer contractor for the entire line may have been a better option. Using local landowner bulldozers minimised the cost of positioning and depositioning machinery, and the hire rates included fuel and lubricants, which saved time in organising fuel deliveries. A list of hired bulldozers is provided in Appendix 2, with the size of machinery and hourly costs including fuel and lubricants.

At the end of the survey, graders from some local shires were hired to remove drill cuttings from several roads and restore damaged gravel roads to their original condition.

2.5 Surveying

Surveying requirements were provided by the Brisbane regional office of the Australian Land Information Group (AUSLIG), Australian Government Department of Administrative Services. A six man surveying team was used to provide chaining and line pegging at 60 m intervals, AMG coordinates and elevations (AHD) for geophone stations and seismic line bendpoints. The AUSLIG surveyors were also involved in guiding the bulldozers.

Magnavox satellite positioning stations were made at accessible parts of the seismic lines to provide accurate surveying control points.

2.6 Drilling and Explosives

Five BMR Mayhew drilling rigs and water tankers were used for shothole drilling on the survey. Shothole depths were nominally 40 m, to position the shot charge below the weathered layer. Tovex (Dyno-Westfarmers) explosive charges were the main type of explosives used, together with a small amount of ICI Anzite left over from previous surveys. Similarly, the remaining Dupont detonators in storage were used up first, with the majority of shots being detonated using new ICI Star No.8 detonators.

A summary of drilling statistic averages and explosive charge sizes used during the survey are given in Appendix 1.

2.61 Drilling

Average shothole drilling depths for each of the three seismic lines are given in Appendix 1. Shothole depths on Line BMR89.B02 were on average shallower than normal, due to the hard drilling conditions in basement rock types. The shallower shothole depths on Line BMR89.B02 were still below the weathered layer in most cases. Shotholes on the eastern end of Line BMR89.B01 were also shallow due to the same reasons as on Line BMR89.B02. The remainder of the shotholes along Line BMR89.B01 and Line BMR89.B03 were nearly all drilled to 40 m depth with good drilling conditions. Figures 2, 4 and 6 show graphs of shotpoint elevations, depth to base of charge and computed uphole velocities for Lines 1, 2 and 3. Similarly, Figures 3, 5 and 7 show expanded displays of depth to base of charge for Lines 1, 2 and 3.

From the drilling statistics in Appendix 1, it should be noted than on average at least one drilling rig per drilling day was either broken down or requiring routine maintenance, ie. only four drilling rigs were operational out of five on most drilling days.

2.62 Explosives

Two types of explosive charges were used during the seismic survey with average charge sizes of between 9 and 10 kg per shothole. Along Line BMR89.B02, ICI Anzite in 4.1 kg "Geolok" containers was used, sometimes in combination with Dyno-Westfarmers Tovex in 1 kg plastic containers. Due to the unreliability of Dupont detonators, along Line BMR89.B02, two detonators per shothole were used, one positioned at the top of the charge, the other at the base of the charge. On using all the Dupont detonators stored from previous surveys, the remaining charges required only one ICI Star No.8 per shothole.

The Tovex supplied by Dyno-Westfarmers in the 1 kg plastic containers (were supposed to be 4.1 kg charges), proved to be a logistical nightmare for the shotfirers.

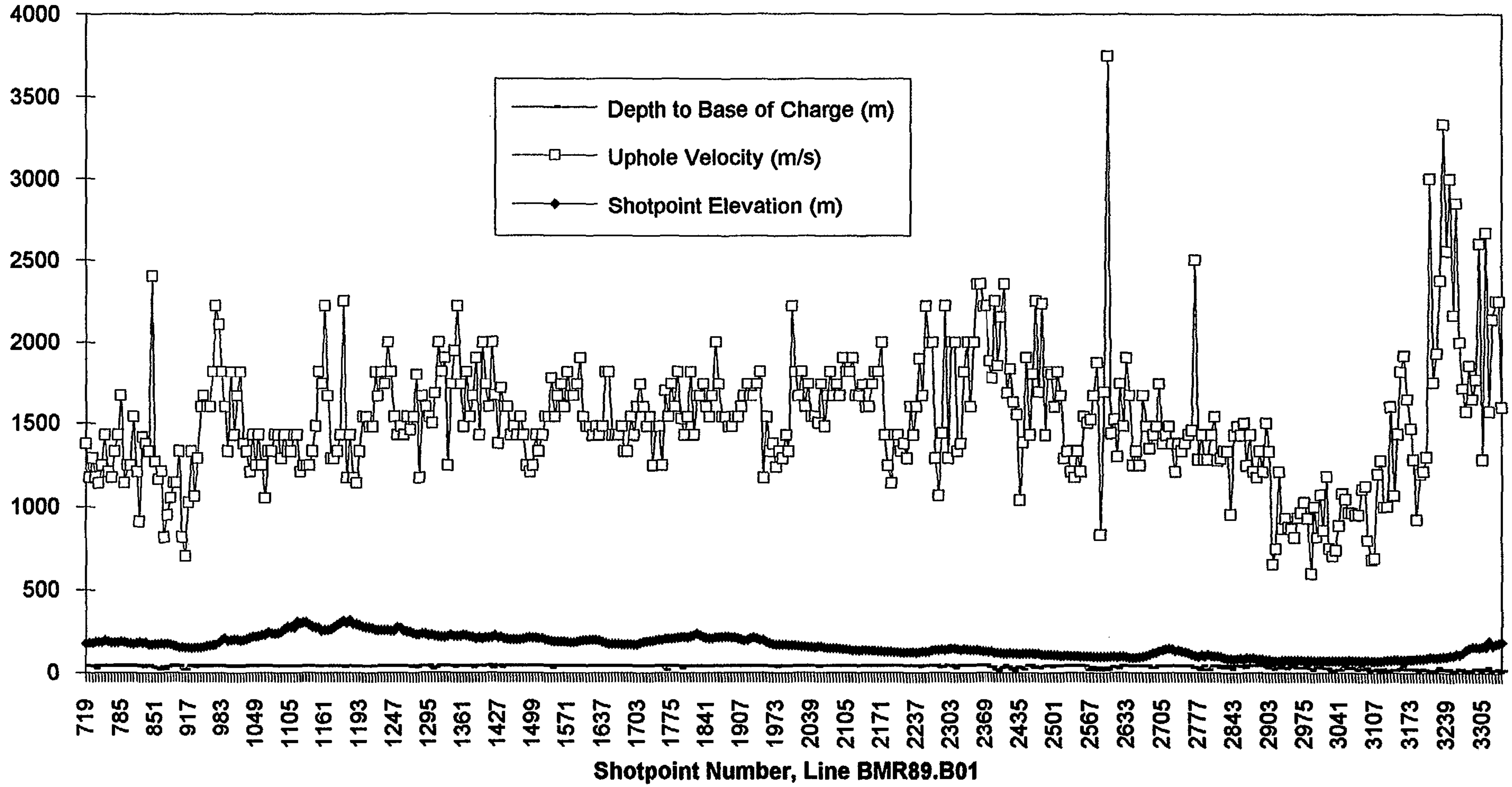

Figure 2. Shotpoint elevations, depth to base of charge and uphole velocities for Line BMR89.B01

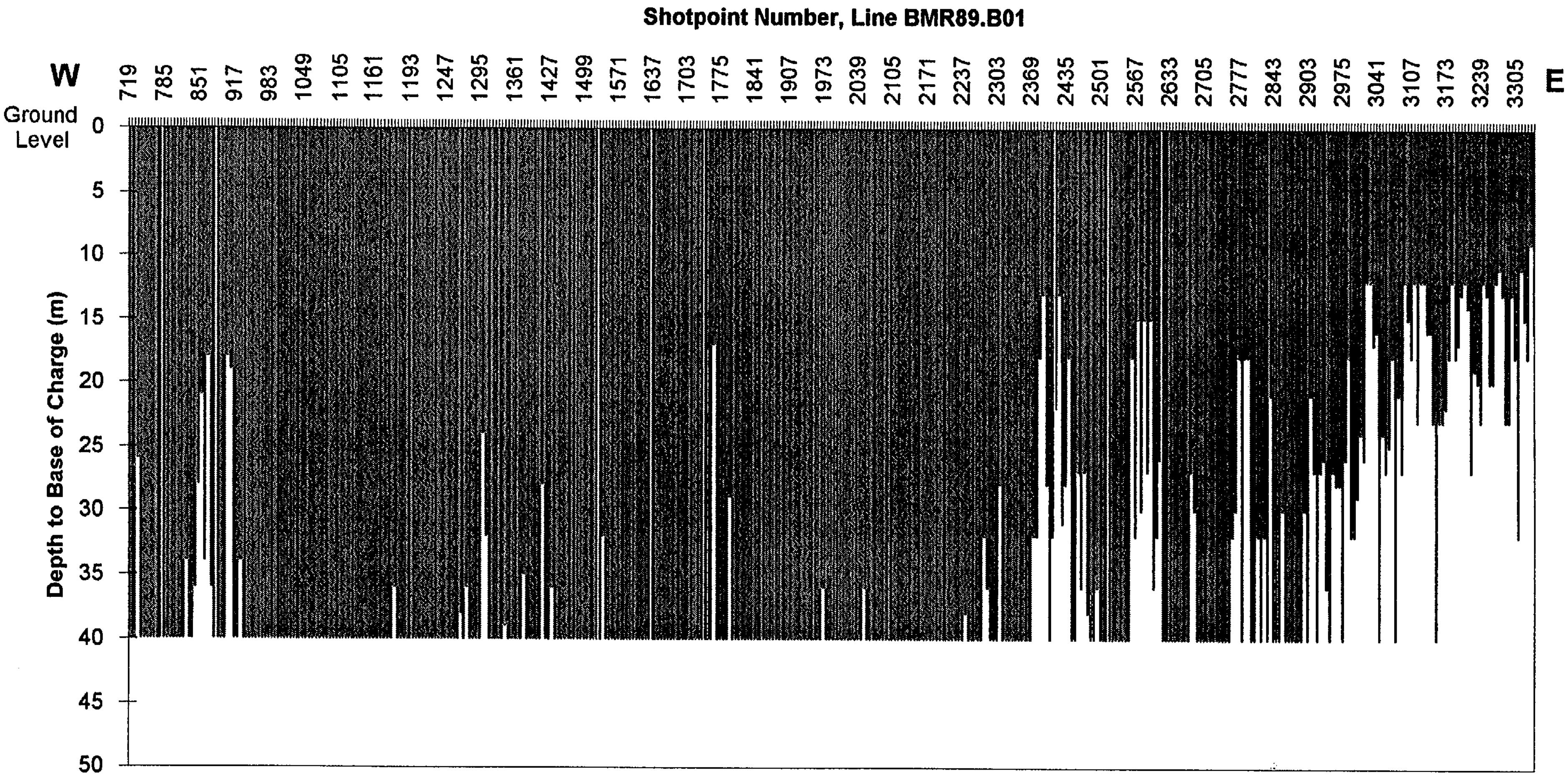

Figure 3. Depth to Base of Charge for shotpoints on Line BMR89.B01.

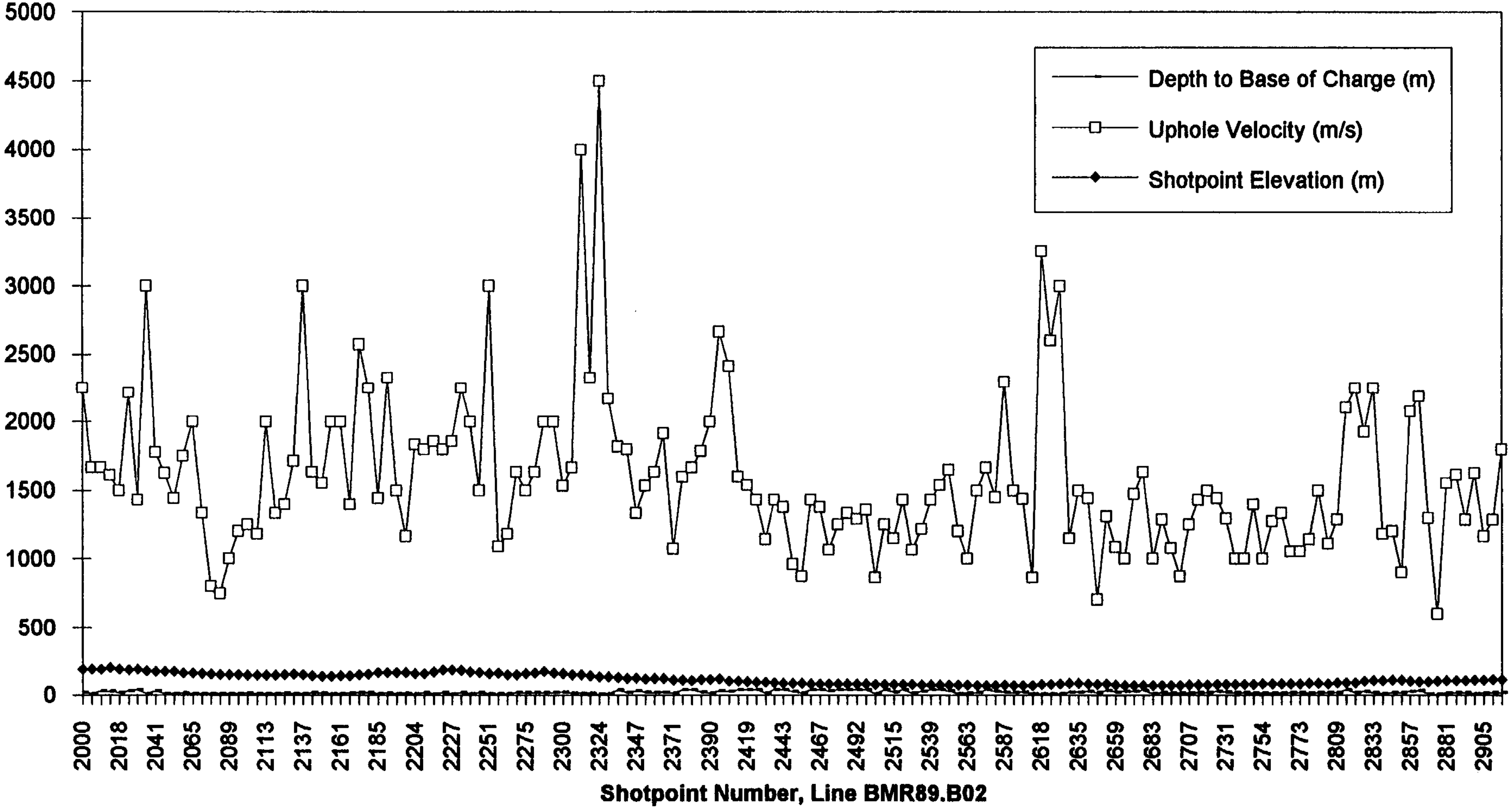

Figure 4. Shotpoint elevations, depth to base of charge and uphole velocities for Line BMR89.B02

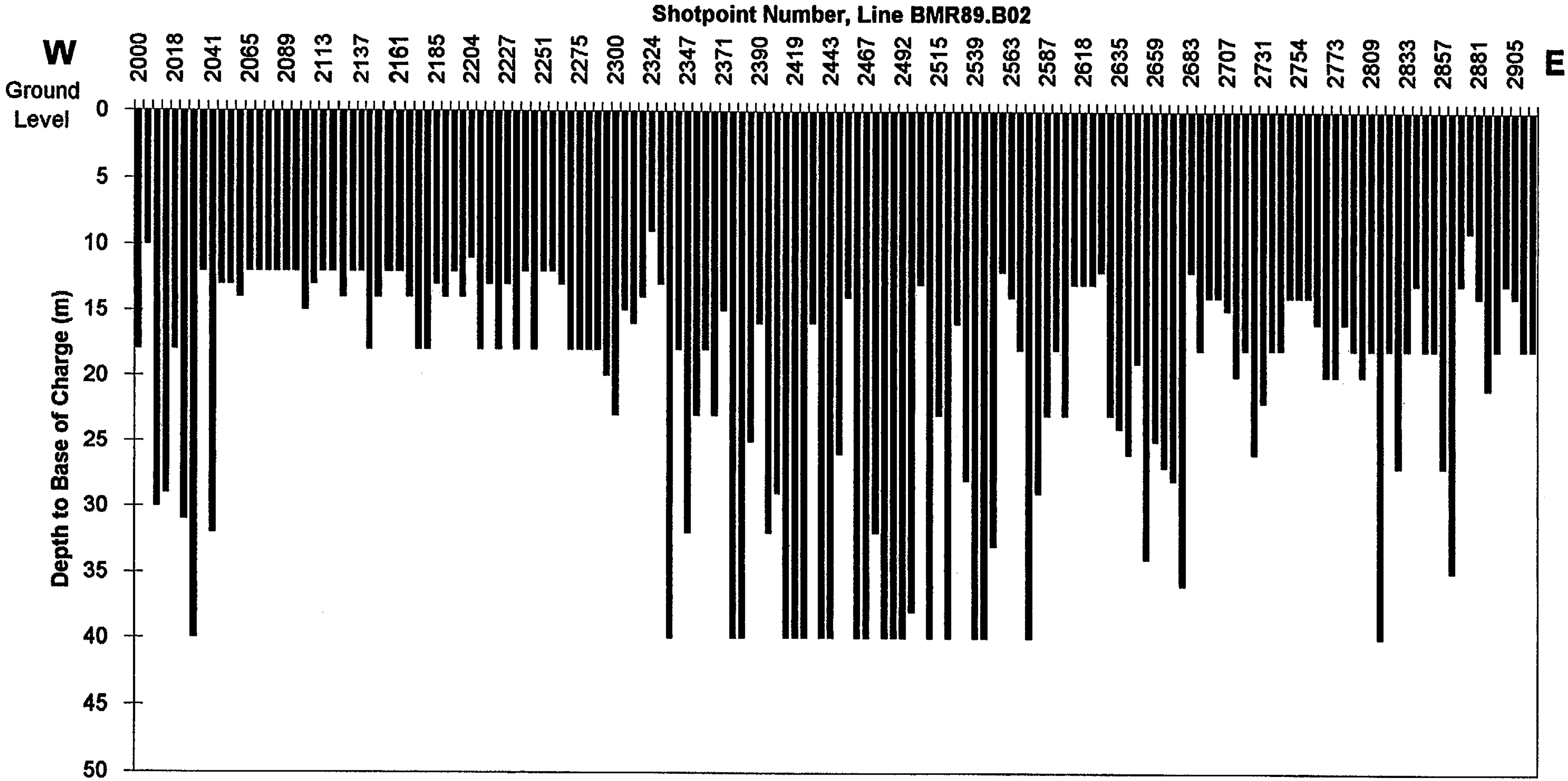

Figure 5. Depth to Base of Charge for shotpoints on Line BMR89.B02.

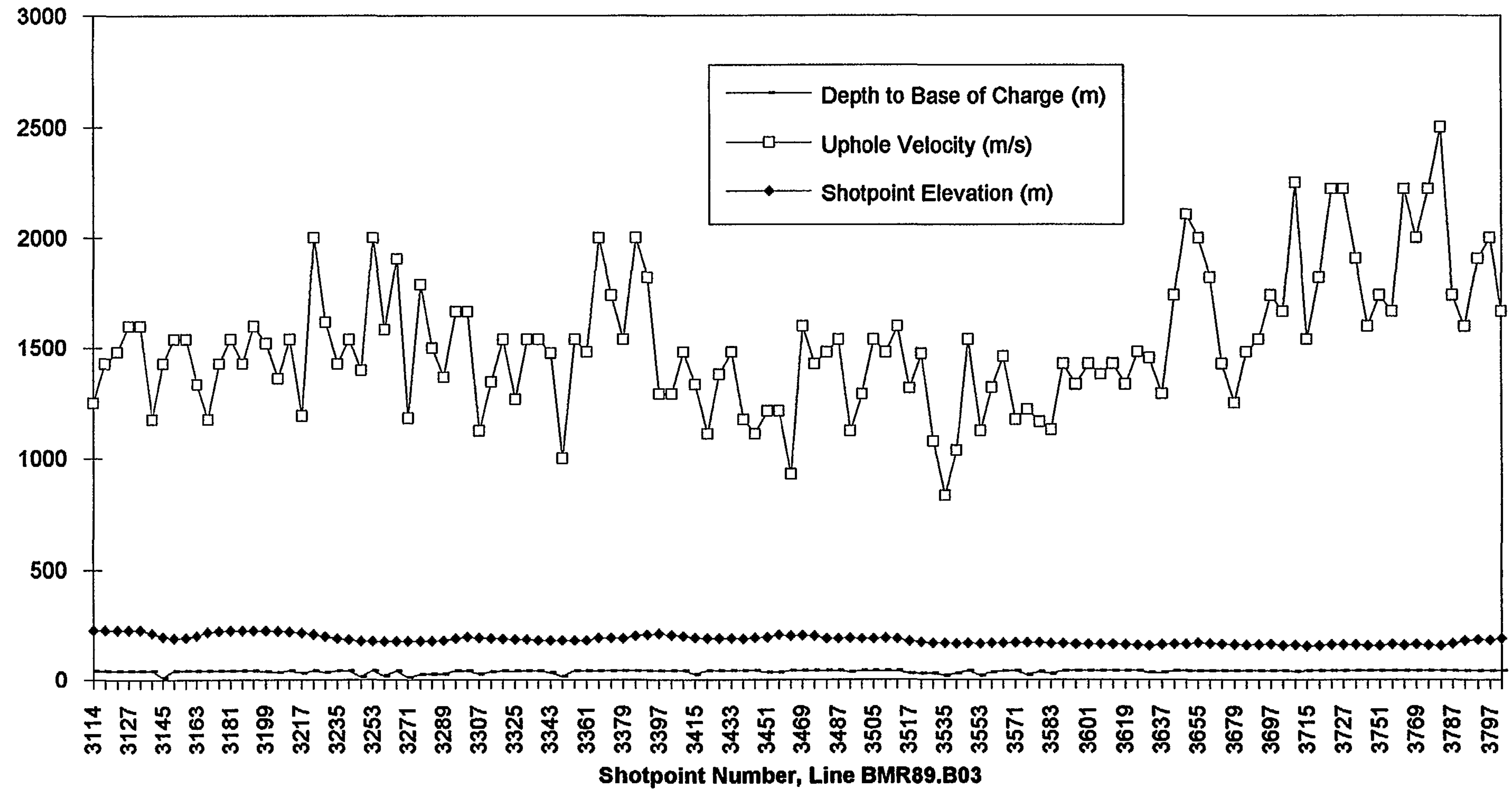

Figure 6. Shotpoint elevations, depth to base of charge and uphole velocities for Line BMR89.B03

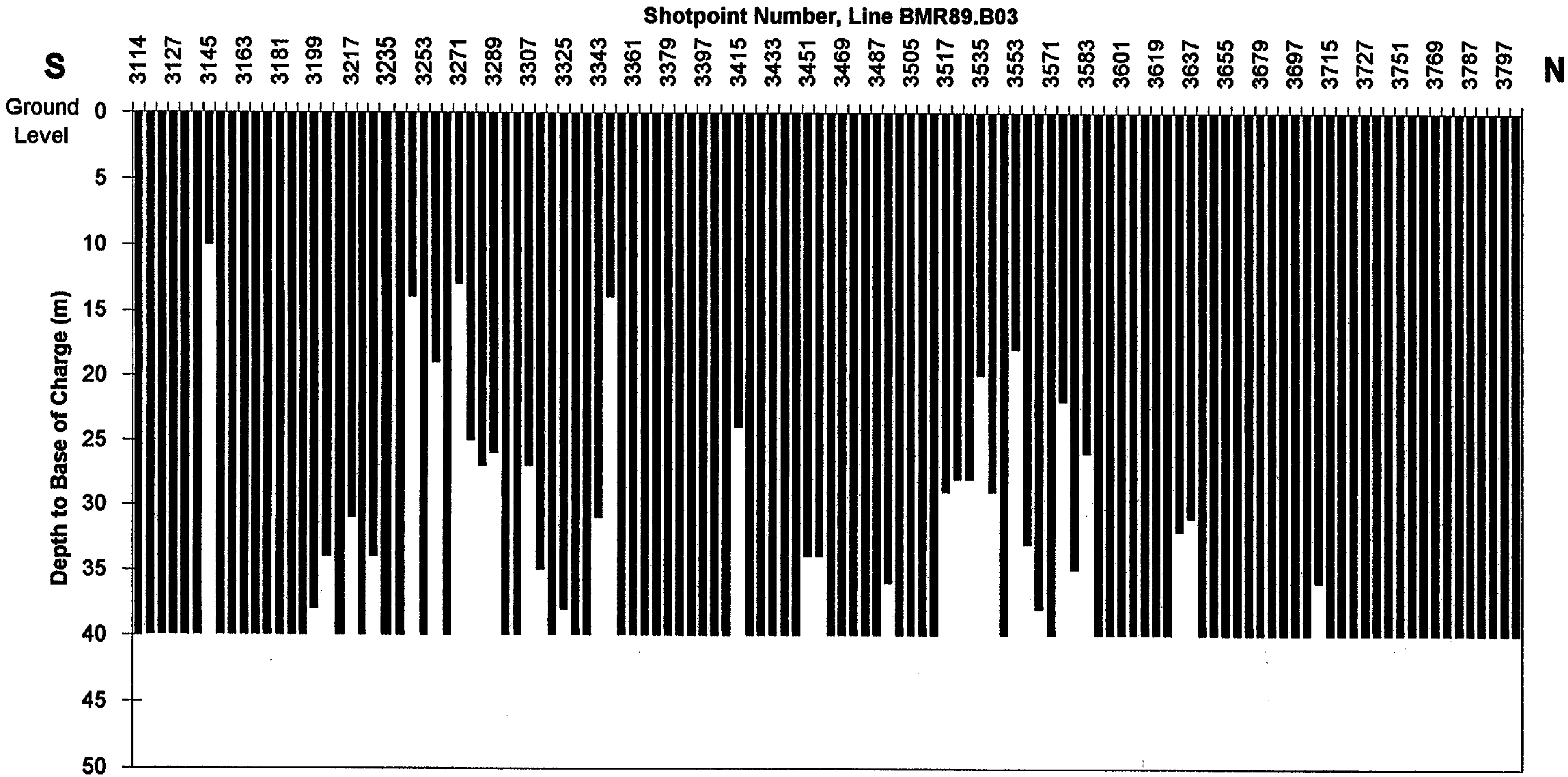

Figure 7. Depth to Base of Charge for shotpoints on Line BMR89.B03.

Ten kilogram shot charges with 1 kg shot charge containers pushed together made a very long unmanageable shot charge, about 3 m in length. Also the plastic charge containers were often not completely full of explosive gel (Tovex), which on occassions could explain the occassional partial detonation of the charges when fired. The problem of partial detonations was later overcome during the following Cobar Basin Seismic Survey, by taping a length of Geoflex explosive cord down the length of the charge and using one detonator placed at the top of the charge.

2.7 Seismic Recording

The BMR Sercel SN368 seismic reflection recording system was used for recording the seismic reflection data. 96 seismic channels were recorded for each shot, with geophone groups spaced 60 m apart and shotpoints on average at 360 m intervals, giving a nominal 8 fold CMP coverage for the survey. Record lengths were 20 seconds and recorded on magnetic tape at 2 ms sampling in GCR 6250 bpi recording mode. A comprehensive list of recording spread and acquisition parameters is given in Appendix 4 with details of individual seismic lines in Appendix 5. Operational statistics for the seismic recording are listed in Appendix 1.

The recording system operated fairly well for most of the survey with only a few faults which proved to be intermittent and unable to be repaired. About a dozen station units also appeared to become faulty by failing geophone pulse tests. The cause of this fault was tracked down to incorrect rank values in context memory for geophone testing. Also the percentage error in the geophone testing was increased due to high daily diurnal temperature changes affecting the relative resistance of the geophone string and in turn affecting the responses from geophone tests.

The Kubota 240 VAC generator operated without fault. Vibration noise from the generator into the geophone groups was an initial problem due to tie-down turnbuckles holding the generator to the recording cab chassis being too tight. An operational practice was instituted whereby after each cab shift the turnbuckles were loosened to decouple the generator vibration from the recording truck. This practice generally eliminated generator noise from the recording spread even when parked close to the line.

2.8 Gravity

Gravity observations were made at 480 m intervals along the seismic lines and at several star picket permanent markers to allow relocation and tie-points for future gravity surveys in the area. Gravity ties were made to stations within the Australian National Gravity Network at Rockhampton and Clermont airports. Operational details for the gravity survey are described in Appendix 7.

2.9 Data Processing

No field seismic data processing was performed on the survey. A very basic IBM PC XT computer clone was used in the field for routine survey management tasks and compiling shot to spread tables for data acquisition purposes.

Since no field processing system was available for the field, the majority of the field geophysicist's time was spent back in the office in Canberra processing the seismic data shipped from the field, using the BMR DISCO seismic data processing system. Utilising the field geophysicist back in Canberra enabled preliminary processing of the seismic data and a better turnaround to a final stack product. Delays in final processing were a result of erroneous surveying data and a higher priority allocated to processing of the Cobar Basin seismic survey data which was acquired after the Bowen Basin seismic survey.

A routine seismic data processing stream was used, with the basic processing steps documented in Table 1. Shot and receiver statics were computed using the 'Uphole Method'.

TABLE 1

Processing sequence for the seismic sections using the BMR/AGSO Disco processing system.

1. Demultiplex field tapes (SEGD to SEGY Disco internal format).
2. Crooked geometry definition.
3. Quality control displays and trace editing.
4. Spherical divergence correction.
5. Statics computation by the uphole method.
6. CDP sort and brute stack.
7. Velocity analysis with statics applied.
8. Normal Moveout correction.
9. Pre-Stack NMO mute (25% stretch).
10. Common Depth Point Stack.
11. Time varying equalisation (gate length 500ms).
12. Bandpass Filtering.
13. Time varying equalisation (gate length 1000ms).
14. Signal enhancement (Digistack)
15. Display section with gravity data.

PRELIMINARY RESULTS

Line BMR89.B01:

Line BMR89.B01 was positioned to follow an inferred geological extensional corridor between two inferred transfer faults as interpreted by Hammond (1987). A portion of the reflection seismic section for Line BMR89.B01 is shown in Figure 8 along with a preliminary geological interpretation of the seismic data, as shown in Korsch & others (1992). A significant feature displayed by the seismic section is a series of easterly dipping thrusts beneath the Yarrabee Zone and Dawson Fold Zone interpreted to represent an imbricate thrust fan structure. The Triassic sequences show very poor internal coherent reflectivity, although the deeper Permian coal reflection events are very prominent. Good reflection events were also recorded over the Tertiary Duaringa Basin because of high acoustic impedances between interbedded claystone and oil shale units. The western margin of the Duaringa Basin is steeply faulted, and near vertical, suggesting transtensional tectonics for the formation of the Duaringa Basin (Korsch & others 1990a,b; Korsch & others 1992).

Line BMR89.B02:

Topographic problems were encountered in extending Line BMR89.B01 further east than the last easterly shotpoint recorded on Line BMR89.B01. To 'extend' Line BMR89.B01 to the east, Line BMR89.B02 was located to traverse a similar suite of basement margin rock units (Gogango Overfolded Zone) but located further north and having easier access along an existing road. The seismic section for Line BMR89.B02 shows many deep reflection events associated with the Gogango Overfolded Zone, and reflection events on the eastern end of the line, perhaps related to serpentinites in the area.

Line BMR89.B03:

Line BMR89.B03 was located to use an existing road for access and to test the ability of the reflection seismic method to resolve inferred 'transfer faults' either side of the geological corridor that Line BMR89.B01 traversed. Reflection events were recorded, however difficulty exists in interpreting whether the 'transfer faults' can be inferred or not. The seismic data on Line BMR89.B02 is not conclusive in determining the existence or non-existence of the 'transfer faults'.

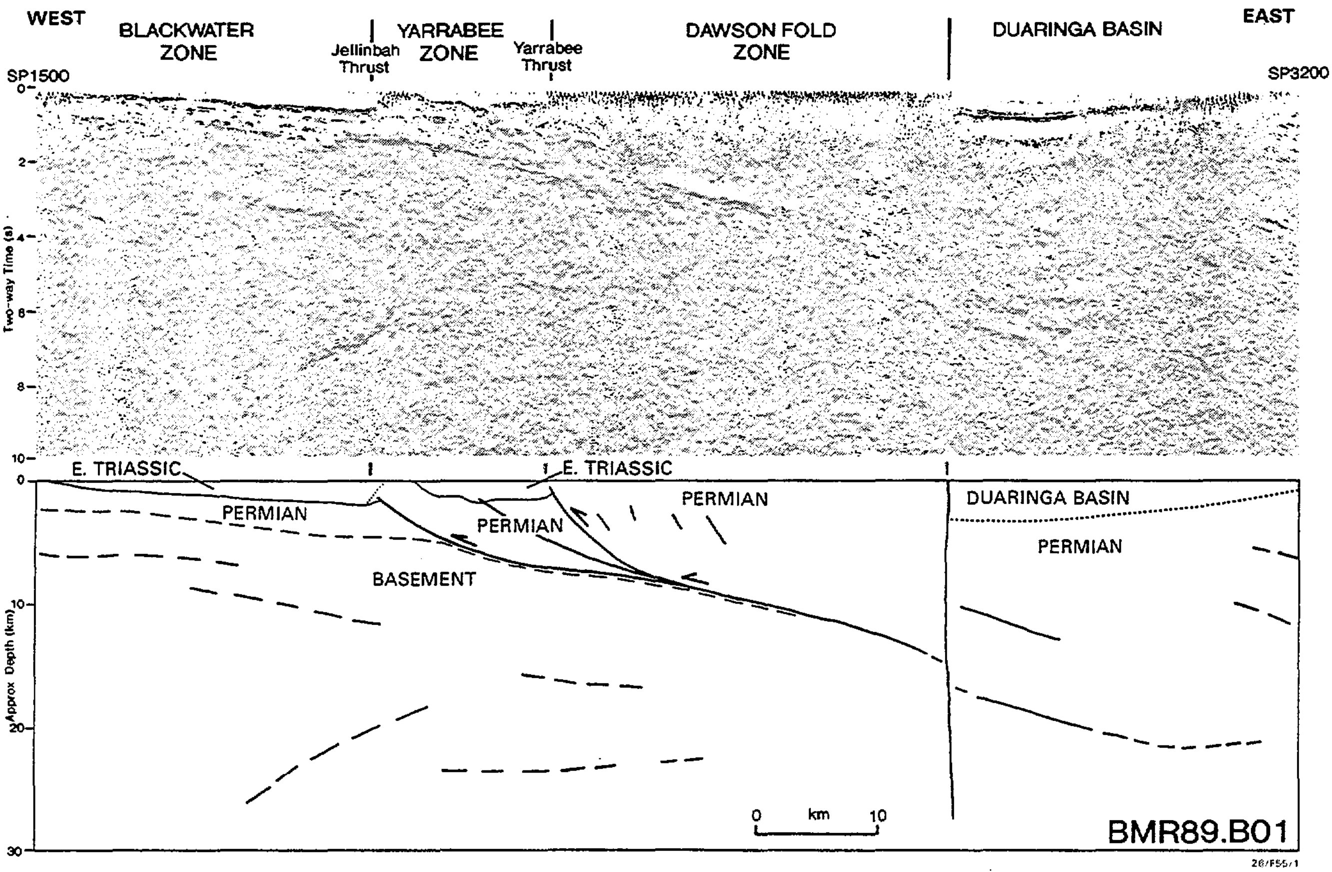

Figure 8. Unmigrated seismic section of part of Line BMR89.B01 and preliminary geological interpretation. V/H=1 for velocity of 6 kms^{-1}.

ACKNOWLEDGEMENTS

The contributions and efforts made by all members of the seismic party and AUSLIG surveying team are gratefully acknowledged. The cooperation of local authorities and landowners, considering the very short lead time in notification of the seismic survey was greatly appreciated.

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APPENDIX 1

Operational Statistics

Drilling crew departed Canberra	10-07-1989
Recording crew departed Canberra	17-07-1989
Drilling crew arrived field	14-07-1989
Recording crew arrived field	21-07-1989
Drilling commenced	18-07-1989
Recording commenced	24-07-1989
Drilling completed	18-09-1989
Recording completed	26-09-1989
Drilling crew departed for Cobar	25-09-1989
Recording crew departed for Cobar	02-10-1989

Total line kilometres;	
Normal production reflection seismic	254 km
Seismic lines recorded	1A, 1B, 2, 3

Recording:

Number of (Production) recording days worked	38
Number of (Testing) recording days worked	2
Recording days lost:	
Due to camp setting up & dismantling	6
Due to adverse wet weather	1
Due to recording equipment breakdown	1
Due to no available recording line	2

Reflection:

CDP fold coverage	8
Number of Testing shots	5
Number of Production shots	725
Average number of production shots/ recording day	19
Average surface coverage/ recording day	6.7 km
Maximum number of production shots in one day	32
Explosives used (Dyno-Westfarmers Tovex, 1kg)	6621 kg
(ICI, Anzite, Geophex, 4.1kg)	541 kg
Detonators used (Dupont)	283
(ICI, Star No.8)	581
Average charge size/ production shot	
(Line BMR89.B01)	9.9 kg
(Line BMR89.B02)	9.3 kg
(Line BMR89.B03)	10.0 kg

Expanding Spread (Centre, Line BMR89.B01 SP 2025):

Total number of shots	9
Explosives used (Dyno-Westfarmers Tovex, 1kg)	535 kg
Detonators used (Dupont)	31

Common shotpoint expanding spreads:

Line BMR89.B01 SP 2025; 2 shots	
Explosive used (Dyno-Westfarmers Tovex, 1kg)	50 kg
Detonators used (Dupont)	6

Line BMR89.B01 SP 881; 3 shots	
Explosives used (Dyno-Westfarmers Tovex, 1kg)	50 kg
Detonators used (ICI, Star No.8)	8

Disposal of Aquaflex explosive cord:

Detonators used (Dupont)	16

Drilling:

Number of drilling rigs	5
Total number of rig days worked	165
Rig days lost:	
Due to setting up & dismantling camp	25
Due to adverse wet weather	5
Due to equipment breakdowns & maintenance	35
Due to preparation for Cobar survey	20
Reflection shotholes;	
Total number of shotholes drilled	736
Total metres drilled	23829 m
Average depth/ shothole (all lines)	32.4 m
(Line BMR89.B01)	36.2 m
(Line BMR89.B02)	16.5 m
(Line BMR89.B03)	39.4 m
Expanding Spread shotholes;	
Total number of shotholes	13
Total metres drilled	520 m
Average depth/ shothole	40.0 m
Common shotpoint expanding spread shotholes;	
Total number of shotholes	4
Total metres drilled	160 m
Average depth/ shothole	40 m

Average number of holes/ rig/ working day	4.6
Average metres drilled / rig/ working day	148 m

APPENDIX 2

Seismic Survey Personnel

Bureau of Mineral Resources, Geology & Geophysics:

Seismic survey Party Leader		K.D. Wake-Dyster
Drilling Supervisor		E.H. Cherry
Party Clerk (1st half of survey)		J. Somerville
(Contract)(2nd half of survey)		R. Dickinson
Geophysicist (Part-time only)		D.W. Johnstone
Technical Officer (Engineering)		J. Whatman
(Part-time only)		G. Jennings
Technical Officer (Science)		G.B. Price
Drillers		E. Lodwick
		D. Eaton
	(Contract)	T. Shanahan
	(Contract)	J. Gebbett
	(Contract)	P. Van Mil
Mechanics		A. Crawford
		J. Keyte
Field Assistants (Explosives)		R.D.E. Cherry
		A.C. Takken
	(Contract)	S. Pardalis

Temporary Personnel (Contract):

Assistant Drillers	B.E. Dickinson
	F. Ceichan
	D.J. O'Reilly
	R.J. Lewis
	D. Westende
Cooks	B. Cassilles
	L. Price
Assistant Cooks	D. Calder
	S. Black
Field Hands	E. Tong
	P.R. Skidmore
	A.P. Miinin
	S. Fletcher
	J.B. Schejnin
	D.J. Bourke
	T. Begbie
	R. Leggett
	D.A. Noakes
	Z. Petrovic

AUSLIG

(Surveyor in charge, Brisbane)	H. Kenward
Surveyor	G. Roberts
Technical Officers & Chainmen	5

Contract Bulldozers, Grading & Slashing:
(rates incl. fuel & lubricants)

Huntly Dozer & Low Loader Hire Dooley St, ROCKHAMPTON QLD 4700	Komatsu D65 $85/hr
J.M. MacTaggart & B.G.Wilson "Balcomba" DUARINGA QLD 4702	Cat D4 $50/hr
P.J. & P.D. & R.T. & R.K. Donovan "Melmoth" DINGO QLD 4702	Cat D6C $65/hr
P.F. & F.J. Talbot "Columba" BLACKWATER QLD 4717	Cat D6C, cable $60/hr
J.W. McKenzie "Rhudanna" COMET QLD 4702	Cat D6C $75/hr
R.B. McIntosh "Lurline" P.O. Comet COMET QLD 4702	Cat D8 $110/hr

Contract Grading & Slashing:

F.W. & D.S. Christensen "Burngrove" BLACKWATER QLD 4717	Tractor/slasher $40/hr Grader $50/hr
Bauhinia Shire Council Eclipse St., SPRINGSURE QLD 4722	Grader
Duaringa Shire Council William St., DUARINGA QLD 4702	Grader

APPENDIX 3

Seismic Survey Vehicles

Recording:

Recording truck	Mercedes 911 4tonne 4X4	ZBE-748
Workshop truck	Mercedes 911 4tonne 4X4	ZBE-689
Water truck	Mercedes 911 4tonne 4X4	ZBE-781
Cable truck	Mercedes 911 4tonne 4X4	ZBE-633
Stores truck	Mercedes 911 4tonne 4X4	ZBE-169
Computer truck	International 1830C 8 tonne	ZUE-121
Geophone carrier	Toyota tray top 4X4	ZBE-791
Geophone carrier	Toyota tray top 4X4	ZBE-792
Geophone carrier	Toyota tray top 4X4	ZBE-793
Geophone carrier	Toyota tray top 4X4	ZBE-794
Shooting truck	Toyota tray top 4X4	ZBE-734
Personnel carrier	Toyota troop carrier 4X4	ZBE-796
Personnel carrier	Toyota troop carrier 4X4	ZBE-731
Reconnaissance	Nissan Patrol S/W 4X4	ZBE-862
Kitchen	4 wheel trailer	ZTL-914
Ablutions	4 wheel trailer	ZTI-344
Generator	4 wheel trailer	ZTV-021
Stores	4 wheel trailer	ZTV-020
Workshop spares	4 wheel trailer	ZTL-674
Water	2 wheel trailer	ZTV-018

Drilling:

Drilling rig	Mayhew 1000/Mack R600 6X8	ZSU-606
Drilling rig	Mayhew 1000/Mack R600 6X8	ZSU-471
Drilling rig	Mayhew 1000/Mack R600 6X8	ZSU-472
Drilling rig	Mayhew 1000/Mack R600 6X8	ZSU-473
Drilling rig	Mayhew 1000/Mack R600 6X8	ZSU-529
Drill W/Tankers	Mack R875 6X6 8645 litres	ZSU-863
Drill W/Tankers	Mack R875 6X6 8645 litres	ZSU-864
Drill W/Tankers	Mack R875 6X6 8645 litres	ZSU-865
Drill W/Tankers	Mack R875 6X6 8645 litres	ZSU-866
Drill W/Tankers	Mack R875 6X6 8645 litres	ZSU-911
Water tanker	Mercedes 911 4tonne 4X4	ZBE-782
Workshop	Mercedes 911 4tonne 4X4	ZBE-647
Explosives truck	International 1830C 8tonne	ZUE-136
Stores truck	Mercedes 911 4tonne 4X4	ZBE-645
Preloading truck	Toyota tray top 4X4	ZBE-735
Personnel carrier	Toyota troop carrier 4X4	ZBE-730
Personnel carrier	Toyota troop carrier 4X4	ZBE-733
Office	4 wheel trailer	ZTL-739
Drilling spares	4 wheel trailer	ZTL-514
Kitchen	4 wheel trailer	ZTL-917
Ablutions	4 wheel trailer	ZTI-343
Workshop spares	4 wheel trailer	ZTV-023
Stores	4 wheel trailer	ZTL-916
Generator	2 wheel trailer	ZTL-984
Welding	2 wheel trailer	ZTL-501
Water	2 wheel trailer	ZTL-016

APPENDIX 4

Spread and Recording Parameters

Spread length	5760 m
Number of recording channels	96
Number of station units available	144
Geophone station interval (Production seismic)	60 m
CDP fold coverage	8
Number of geophone/ geophone string	16
Geophone pattern (GSC-20D)	in-line
Geophone spacing	4 m
Blaster type	OYO Model 1340
Sercel SN368 instrument settings:	
Recording format	digital
Tape format	SEG-D
Number of input channels:	
Data	96
Auxiliary	4
Tape:	9 track, 6250bpi, GCR format,
0.5inch, 8.5inch reels, 1200ft.	
Record length	20 seconds
Sample rate	2 ms
Input filters;	
Low-cut	8 Hz/18db/Oct
Hi-cut (anti-alias)	178 Hz
Pre-amplifier Gain	7**2
Playback Parameters;	
Low-cut filter	12 Hz
Hi-cut filter	90 Hz
Slope	18 ms
Seismonitor gain	42 db
Output Adjust	4 db
Gain Curve	1
Release Time	10 ms
Compression Delay	8 ms
Early Gain	0 db
AGC	1
Recovery Delay	32 ms

APPENDIX 5

Seismic line recording spread parameters, seismic line intersections & well ties

Line BMR89.B01A:

Line Orientation	E-W (High SP numbers East, Trace 1 to the West)
Length	130.0 km
First Geophone station	1181
Last Geophone station	3348
First Shotpoint	1180
Last Shotpoint	3347
Geophone station interval	60 m
Shotpoint interval	360 m

Line BMR89.B01B:

Line Orientation	E-W (High SP numbers East, Trace 1 to the West)
Length	27.7 km
First Geophone station	719
Last Geophone station	1180
First Shotpoint	0719
Last Shotpoint	1180
Geophone station interval	60 m
Shotpoint interval	360 m

Line BMR89.B02:

Line Orientation	E-W (High SP numbers East, Trace 1 to the West)
Length	55.1 km
First Geophone station	2000
Last Geophone station	2921
First Shotpoint	2000
Last Shotpoint	2918
Geophone station interval	60 m
Shotpoint interval	360 m

Line BMR89.B03:

Line Orientation	N-S (High SP numbers North, Trace 1 to the South)
Length	41.2 km
First Geophone station	3114
Last Geophone station	3800
First Shotpoint	3114
Last Shotpoint	3800
Geophone station interval	60 m
Shotpoint interval	360 m

Line Intersections;

Line BMR89.B01	SP 1161 + 00 m	-	Line BMR89.B01	SP 1239 + 14 m
Line BMR89.B01	SP 0953 + 32 m	-	Line BMR89.B03	SP 3671 + 46 m

Well Tie;

A.F.O. Comet No. 1	Line BMR89.B01	1061 + 53m

APPENDIX 6

Expanding Spread Parameters

Line BMR89.B01, Centre Shot SP 2025, Total of 9 shots

Shotpoint	Spread FCP LCP	Charge Size (kg)	Record Length(s)	Tape No.	FFID
1835	2167 - 2262	100		89/035	399
1882	2120 - 2215	100		89/035	412
1930	2072 - 2167	50		89/036	420
1977	2025 - 2120	25	20	89/036	429
2025*	1977 - 2072	10		89/036	438
2072	1930 - 2025	25		89/037	448
2120	1882 - 1977	50	40	89/037	458
2167	1835 - 1930	75		89/038	468
2215	1787 - 1882	100		89/038	478

APPENDIX 7

Operational details, Gravity survey

1. The gravity survey commenced on the 23rd August 1989 and was completed on the 23rd September 1989, with a break in observations from 10/9/89 to 21/9/89.

2. 574 new gravity stations were read with a spacing of 480m between stations.

3. BMR gravity meter, LaCoste-Romberg S/N G132 was used on the survey. For data reduction a calibration scale factor of 1.05741 mgal/counter reading, was adopted.

4. The survey was tied to the following base stations.

Station	Value (Isogal65 mgal)	Lat	Long	Elev (m)
6499.0149 (ROCKHAMPTON A/P)	978874.20	23.375	150.475	9.82
6491.0150 (CLERMONT A/P)	978776.50	22.776	147.623	271.30

5. All stations were seismic geophone stations and were surveyed optically to third-order standard.

6. The gravity observer was H. Reith (BMR).