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Gunnedah Basin Seismic Survey 1991: Operational Report

by K D Wake-Dyster & T J Barton

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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GUNNEDAH BASIN SEISMIC SURVEY 1991: OPERATIONAL REPORT

by

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NATIONAL GEOSCIENCE MAPPING ACCORD PROJECT:
SEDIMENTARY BASINS OF EASTERN AUSTRALIA

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EXECUTIVE SUMMARY

The Bureau of Mineral Resources, Geology & Geophysics (BMR) (now Australian Geological Survey Organisation), Commonwealth Department of Primary Industries & Energy, conducted the Gunnedah Basin Seismic Survey during January to April 1991. The major aim of the seismic survey was to record deep seismic reflection data across the Gunnedah Basin and bounding margins. The seismic survey would also address several problems relating to the geometry of structural units and major faults.

The location of the seismic line was determined in consultation with exploration companies and the NSW Department of Minerals and Energy (now Department of Mineral Resources). Factors controlling the positioning of the seismic line included the location of existing roads and tracks, avoiding surface basalts where possible, and ensuring the primary scientific objectives of the survey were targeted.

The deep seismic reflection survey by the BMR recorded 253 km of 8-fold CMP seismic data. The continuous seismic line, BMR91.G01, was quite crooked in places due to access problems in state forests and the extremely hilly area between Manilla and Uralla. Line BMR91.G01 crossed major geological features including the Gilgandra Trough, Rocky Glen Ridge, West Gunnedah Sub-basin, Boggabri Ridge, Maules Creek Sub-basin, Mooki Fault, and the Tamworth Belt, Peel Fault and Tablelands Complex within the New England Orogen. To generate a multi-disciplinary dataset, gravity observations were made at 360 m intervals along the seismic line, and the seismic line was also flown using the BMR geophysical aircraft to record aeromagnetics and radiometrics.

The seismic data have been processed, with the data showing good seismic reflection images of the main structural features targeted in the seismic survey. The seismic data will be interpreted to construct revised geological models of the Gunnedah Basin and adjacent basement terranes. Final seismic sections are available for purchase through the AGSO Sales Centre, GPO Box 378, Canberra, ACT, 2601.

INTRODUCTION

1.1 Background

The acquisition of a deep reflection seismic profile across the Gunnedah Basin and bounding margins was proposed by E. Scheibner and other members of the NSW ACORP (Australian Continental Reflection Profiling) Committee. A seismic profile was seen as a major priority, to test proposed models for the structure of fault systems bounding the Gunnedah Basin and their relationship to the Gunnedah Basin (Scheibner, 1985). Several positions for seismic lines were proposed to address the objectives of testing the proposed geological models. The final seismic line position was chosen on the basis of ease of access (minimal logistic problems), avoidance of surface basalts where possible, and maintaining the targeted geological objectives of the survey.

In May 1989, a short seismic test survey (Korsch & others, 1990; Wake-Dyster and Johnstone, 1993) was conducted by BMR to test whether deep seismic reflection events could be recorded over the prime objective areas of the major proposed seismic line. The results from the seismic reflection test sites indicated that shallow and deep reflection events could be recorded. Due to a higher priority of recording deep reflection seismic data in the Bowen Basin, the acquisition of a major deep seismic reflection profile across the Gunnedah Basin was delayed until 1991.

1.2 Location

The seismic survey operated in eastern New South Wales, from Gwabegar in the west to a location 28 km west of Uralla in the east. The seismic line was confined to the following 1:250000 mapsheets; SH 56-9 MANILLA and SH 55-12 NARRABRI. To assist in positioning the seismic line, aerial photographs, topographic maps and cadastral maps were used to identify and enable existing tracks and stock routes to be used where possible. A general location map of the seismic line is shown in Figure 1.

1.3 Seismic Line

One continuous deep reflection seismic line, BMR91.G01, of 253 km length was recorded during the survey. The seismic survey commenced 1 km east of Gwabegar at SP 1000 on the Cuttabri Road and extended in an easterly direction along numerous forestry roads and tracks through the Pilliga Forest. Further east the seismic line passed north of the township of Boggabri, following the Boggabri to Manilla road, and then passed through the township of Manilla. The seismic line then followed a network of winding roads through rugged hills around Red Jack Mountain, and finished at SP 5218 located 28 km west of Uralla.

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 two days earlier than the recording crew, to allow the shothole drilling to gain a lead on the seismic recording, to avoid recording delays in waiting

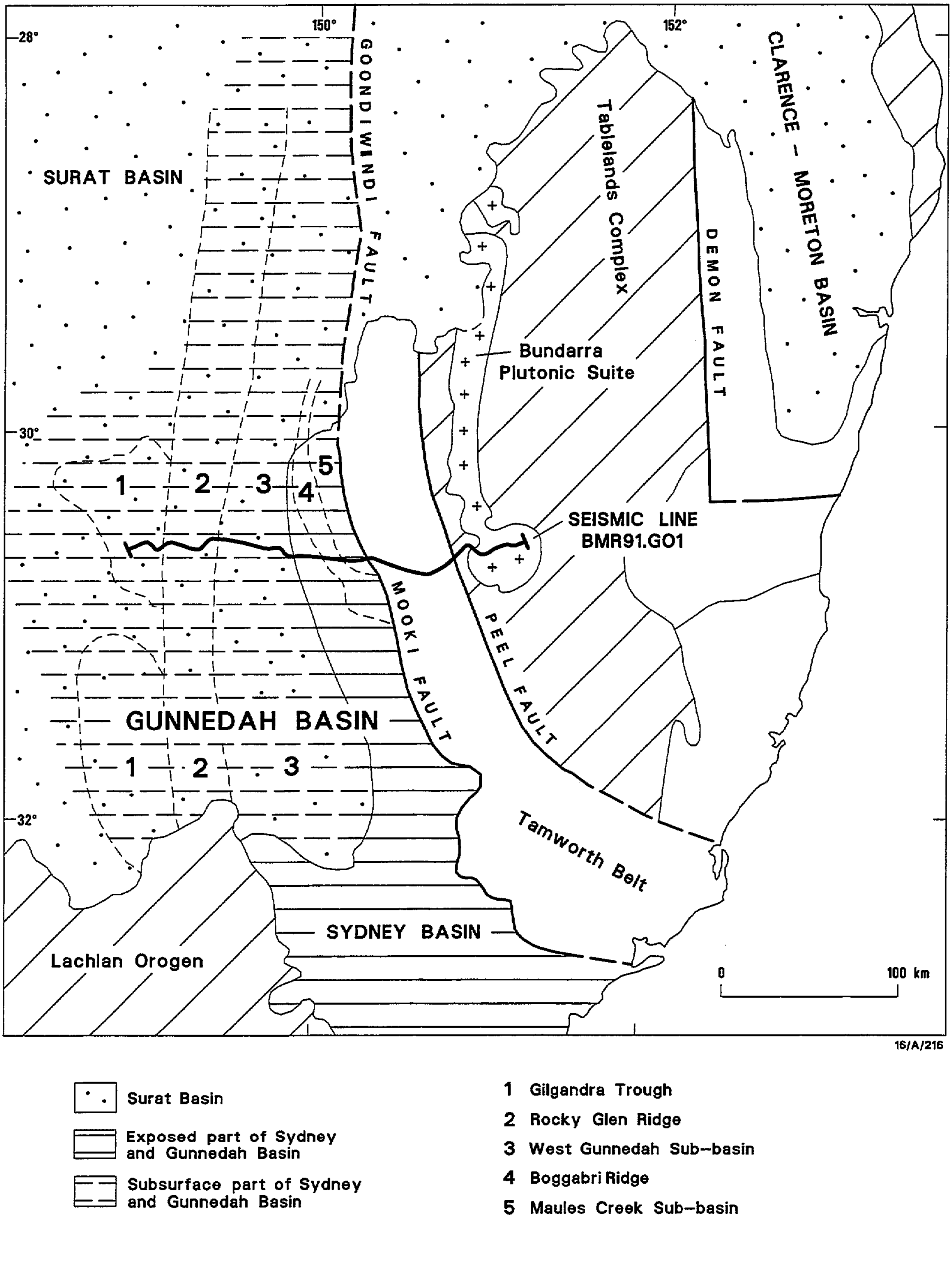

Figure 1. Location of the deep seismic reflection profile BMR91.G01 across the Gunnedah Basin and western New England Orogen.

for drill rigs to move off active portions of the recording spread. The contract surveyors commenced one month ahead of the drilling crew to avoid problems of the seismic acquisition crew gaining on the surveying team. At the completion of the seismic survey, the seismic crew moved to Kalgoorlie in WA to commence the Eastern Goldfields seismic survey, as part of a NGMA (National Geoscience Mapping Accord) project in that area.

Due to a shortfall in the number of permanent BMR employees, four drillers, five assistant drillers, and a field assistant to assist with explosive pre-loading were employed on contract. The contracts were in addition to the normal contract requirements of field hands, cooks and assistant cooks. A list of personnel employed on the survey is tabled in Appendix 2.

For survey operations, two campsite locations were utilised. Difficulty was found in locating suitable campsites for the seismic base camp, mainly due to the camping regulations in State Forests and the intense agriculture in other areas. However camping in the Pilliga State Forest southwest of Narrabri was permitted in designated campsites within the forest. In consultation with foresters from the NSW Forestry Commission located at Baradine, permission was given to camp at Kuhners Bore, located 30 km southwest of Narrabri, with reasonable access to Narrabri along Old Mill Road and the Newell Highway. After the drilling crew set up camp at Kuhners Bore, heavy rain limited the movement of trucks along forest tracks, resulting in the recording crew setting up camp at another campsite which was more accessible in wet weather. The recording crew camped at Lucky Flat, located 5 km southwest of Kuhners Bore, with good access to the Newell Highway along Pilliga Forest Way. Water for the camps was obtained from the dams at Kuhners Bore and Bohena Bore. Drilling water was obtained from dams scattered throughout the forest, located for the purposes of fire fighting. Supplies and stores were obtained from retailers in Narrabri. The Pilliga Forest campsites were used for recording the portion of the seismic line from Gwabegar to Boggabri. The second campsite was located at Borah Crossing, a TSR (Travelling Stock Route) Reserve, with permission granted by the Manilla Rural Lands Protection Board. Borah Crossing is located on the upper reaches of Lake Keepit Dam on the Namoi River, about 20 km west of the township of Manilla. The TSR Reserve provided enough camping area to support both the drilling and recording camps. Water for the camps was pumped from Lake Keepit Dam using billabong pumps. Food and stores were obtained in the townships of Manilla and Tamworth. The camping site at Borah Crossing proved to be one of the best campsites the BMR seismic crew has ever experienced.

1.5 Associated Geophysical Surveys

Gravity measurements were made at intervals of 360 m along all the seismic lines recorded during the survey. The BMR geophysical data acquisition aircraft was available at the time of the survey to record aeromagnetic and radiometric data along the length of the seismic lines, after completing airborne survey work in the Dubbo area. The seismic line was flown one way at a flight height of 150 m AGL, and flown in the reverse direction at 915 m AGL. Details of the gravity survey are given in Appendix 6.

1.6 Objectives and Program

The acquisition of a deep seismic reflection profile was undertaken to:

1. Determine the geometry of the components of the Gunnedah Basin.
2. Determine the geometry of the Mooki Fault at depth.
3. Determine if the Tamworth Belt is thin skinned, and overriding the Gunnedah Basin.
4. Image the Peel Fault (the eastern margin of the Tamworth Belt) and determine its relationship to the Gunnedah Basin and Tamworth Belt.
5. Determine the relationship between the Lachlan and New England Orogens.

Due to budgetary constraints, the seismic survey was limited to nine weeks field work, including the positioning of the survey crew from Canberra to the field. At the completion of the survey, several days were spent doing repair and maintenance to vehicles and equipment prior to moving to Western Australia for the Eastern Goldfields seismic survey. 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 265 km of deep seismic reflection data, with the extra kilometres in acquisition achieved by increasing production rates by reducing CMP fold coverage in the hilly and windy road areas east of Manilla (i.e., increasing shotpoint interval and decreasing the number of shotholes).

Some delays due to wet weather and equipment breakdowns were encountered on the survey, however the majority of the planned seismic line was recorded, and a total of 253 km of seismic reflection data were acquired.

FIELD OPERATIONS

2.1 General

One 8 fold CMP deep seismic reflection profile, Line BMR91.G01 was recorded with a total length of 253 km. Line BMR91.G01 was recorded from west to east, commencing at Gwabegar at SP 1000 and finishing west of Uralla at SP 5218. General spread and recording parameters for the seismic line are given in Appendix 5.

Shothole drilling production varied considerably along the length of the seismic line, depending on rock types encountered in the drilling. The Sercel SN368 seismic data acquisition system malfunctioned at the start of the survey, delaying recording for four days.

Access to the seismic line was good, although some long travelling times were needed to access the seismic line at the furthest distances from the seismic base camps. The additional travelling time was offset by the need for one less campshift. Overall the weather conditions during the survey were favourable, with only a few days lost due to wet ground conditions.

2.2 Reconnaissance

A brief reconnaissance survey of the area in the vicinity of the Tamworth Belt, between Manilla and Uralla was made by David Johnstone while attending the New England Orogen Symposium at Armidale in November 1988. The aim of the brief reconnaisance was to examine logistic problems of seismic line routes proposed by the NSW ACORP committee. Another short reconnaisance was made over a one week period during February 1989, by Kevin Wake-Dyster and David Johnstone, to select seismic test sites for a proposed seismic test survey. The seismic test survey was made during April and May 1989 over a 4 week period with 5 seismic test lines recorded in the Gunnedah Basin region and 3 further test sites in the Cobar Basin area (Wake-Dyster & Johnstone,1993). While on the seismic test survey portions of the proposed major seismic line were examined for access problems. Prior to the main seismic survey, another one week reconnaisance trip was made by Kevin Wake-Dyster and Ron Cherry in August 1990 to confirm the planned seismic line position and highlight any major logistical problems.

2.3 Environmental Issues

Existing tracks in the Pilliga State Forest were used by the seismic survey, due to the NSW Forestry Commission not allowing a new bulldozed line to be cut through the forest. The NSW Forestry Commission agreed to the widening of Monument Road (a forest track) to improve access along the road. This was also done because the Forestry Commission wanted better access for fire fighting trucks during bushfire seasons.

Prior to the seismic survey, the National Parks and Wildlife Service office in Coonabarabran were advised of the seismic survey operations. Since the seismic lines followed existing roads and tracks, no archaelogical site investigation survey was required.

2.4 Seismic Line Clearing

Due to the seismic line following existing roads and tracks, minimal line clearing was required for the seismic survey. Monument Road in the eastern part of the Pilliga Forest was widened at BMR expense by contracting a large wheel driven front end loader from the NSW Forestry Commission. West of Boggabri, the seismic line crossed a 3 km section of private farmland, where a local bulldozer was hired to clear vegetation regrowth along fence lines to improve access for the seismic survey. The road verge along sections of the Boggabri to Manilla Road was overgrown with grass and weeds. A tractor with a 2 m wide slasher was hired from the Manilla Shire to slash the road verges. The campsite at Borah Crossing was also overgrown in places with long dry grass, posing a potential fire risk to the camp. A large self-propelled slasher/mower ('Red Roo') was hired from Narrabri to slash the grass where needed, and additional paths were slashed along the seismic line near the Namoi River at Manilla.

2.5 Surveying

With a change in government policy, surveying requirements for the BMR seismic survey were made available to surveying contractors under the normal government tendering processes. In the request for tenders, tenderers were asked to provide costings based on either or both an hourly charge rate or "turnkey" rate per kilometre of seismic line. A comparison of tenders showed the the best option for the surveying contract would be a tender based on a "turnkey" per km rate. Tenders based on hourly rates were vunerable to contractors not meeting forecasted production rates. The successful tenderer was chosen as the most cost effective of tenders including both tenders using hourly rates and "turnkey" rates.

Fisher Stewart Pty. Ltd. was awarded the surveying contract, based on a "turnkey" rate of $ 156/km. Additional costs included the supply of pegs, star pickets and flagging tape, and the production of final survey plans. Fisher Stewart Pty. Ltd. used a two man crew with one four wheel drive vehicle and trailer. Surveying instrumentation included an AGA Geodimeter 440 total station theodolite, Geodat 126 data recorder and an IBM compatible PC computer. The two man crew developed a surveying technique whereby the pegging, chaining, levelling and horizontal control were all achieved in one pass along the seismic line. All geophone stations and shotpoint locations were pegged using wooden pegs, due to the risk of wire pin markers being removed along the road verges before the seismic crew arrived at the pegged seismic line. The total station theodolite with a data logger attached was used to both chain the seismic line and record vertical and horizontal angles to allow computation of elevations and AMG coordinates of geophone stations and shotpoint locations, using a portable IBM compatible PC computer. Final surveying results were provide on both hard copy paper and floppy disk in ASCII format.

Surveying results provided by the surveying contractor were error checked by BMR using software programs written in BASIC language and operating on an IBM compatible PC computer. The error checking programs were very successful in locating major surveying errors with the surveying contractors then being notified to provide correction updates. To assist in quality control of the survey data, a Magellan GPS (Global Positioning System) unit was borrowed from the BMR Minerals and Land Use Program to check the accuracy of the data being supplied by the contract surveyors, especially in areas along the seismic line where trigonometric control was sparse. The GPS results were nearly identical to the surveying results, give or take a few metres, highlighting the excellent surveying by the surveying contractors, and impressive results of the GPS unit.

At the completion of the contract seismic surveying, Fisher Stewart Pty. Ltd. provided a report on the surveying, complete with surveying plans, as required by the surveying contract.

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, but later reduced to 36 m (to improve drilling shothole production rates), to position the shot charge below the weathered layer. Both Tovex (Dyno-Westfarmers) and Powergel (ICI) explosive charges were used on the survey. ICI Star No.8 detonators were used to detonate the shot charges.

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

2.61 Drilling

In the Pilliga Sandstone area at the start of the line, drilling was reasonably good with air and water injection required. Near the Bohena Creek, the Pilliga Sandstone was more weathered with very loose sands requiring some mudpit drilling. Similarly, near the Namoi River north of Boggabri, mudpit drilling was required in the river flat areas to drill sequences of unconsolidated sands and gravels. In the region of the Tamworth Belt, rock types became very hard, with shallower shothole depths, but with shot charges still being placed in sub-weathered rock layers. Similarly, drilling in the Bundarra Plutonic Suite was very hard, resulting in shallow depth shotholes but charges still being placed in sub-weathered granites. Plots of shothole elevation, shothole depth and computed uphole velocities for seismic line BMR91.G01 are shown in Figure 2. An expanded plot of depth to the base of the charge for shotpoints is shown in Figure 3.

As seen in the drilling statistics in Appendix 1, lost drilling production due to breakdowns and maintenance was minimal.

2.62 Explosives

Tovex S1 (Dyno-Westfarmers) in 1 kg containers was used for the first part of the survey, with old stocks being used first, primed with one 1 kg charge of new stock. Shot charges were 10 kg in size, giving a shot charge length of 3.9 m. The seismic survey was completed using ICI Powergel in 80 mm diameter, 2 kg sausage packs and some 0.5 kg charges in Powergel Seismic plastic containers. The Powergel proved to be successful and decreased the shot charge length to 1.9 m. Blowouts occurred mainly in areas with drilling in river gravels, as the result of shallow shot depths and poor solid tamping fill.

2.7 Seismic Recording

The Sercel SN368 seismic reflection recording system was used for recording the seismic survey. 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 list of recording spread and acquisition parameters is given in Appendix 4 with details of the seismic line in Appendix 5. Operational statistics for the seismic recording are listed in Appendix 1.

The recording system malfunctioned badly at the start of the survey, with a tape transport problem. The problem was so severe that additonal technical support from BMR headquarters was requested, with Brian Maplestone being sent to the field to fix the problem.

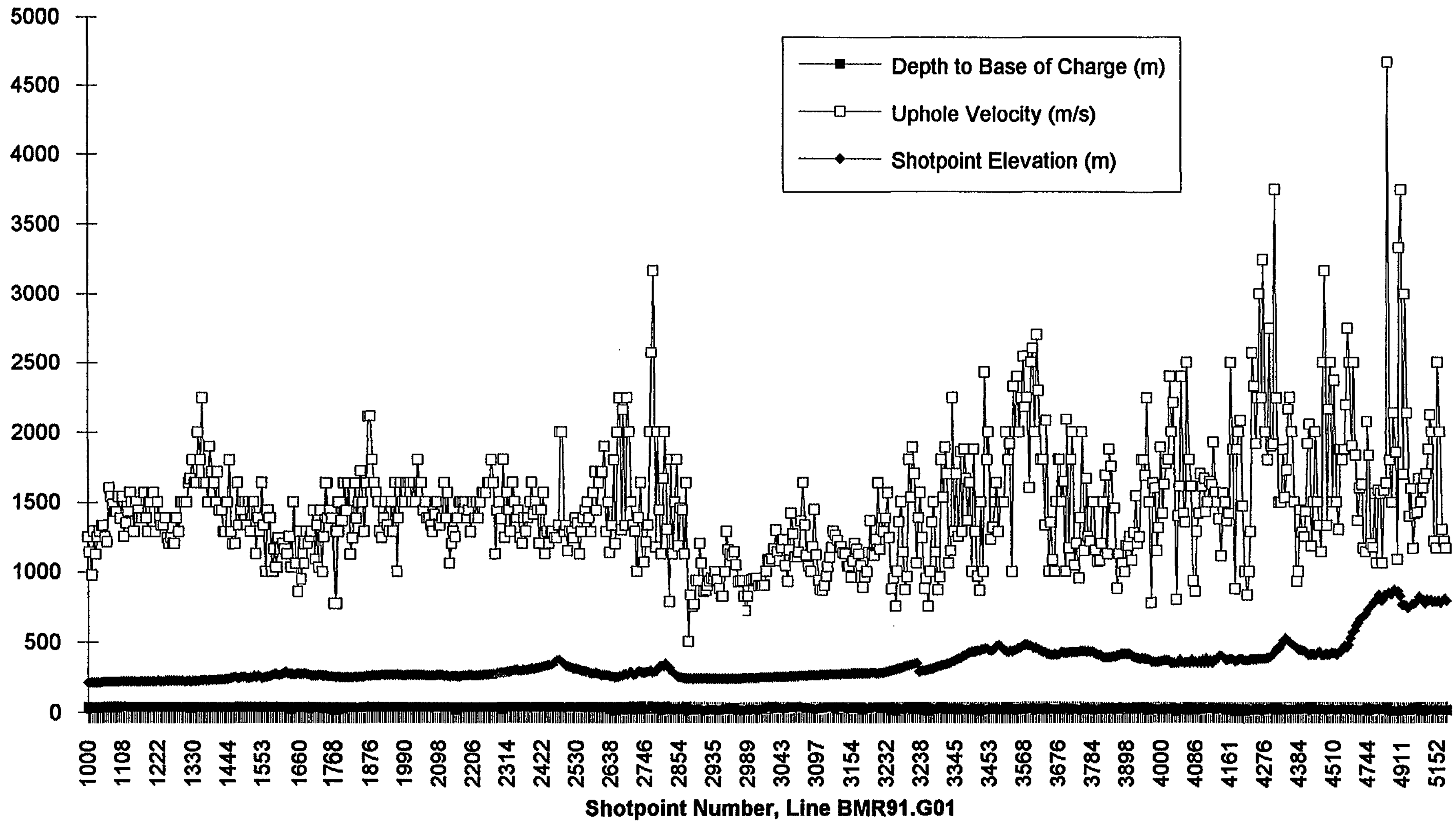

Figure 2. Shotpoint elevations, depth to base of charge and uphole velocities for Line BMR91.G01.

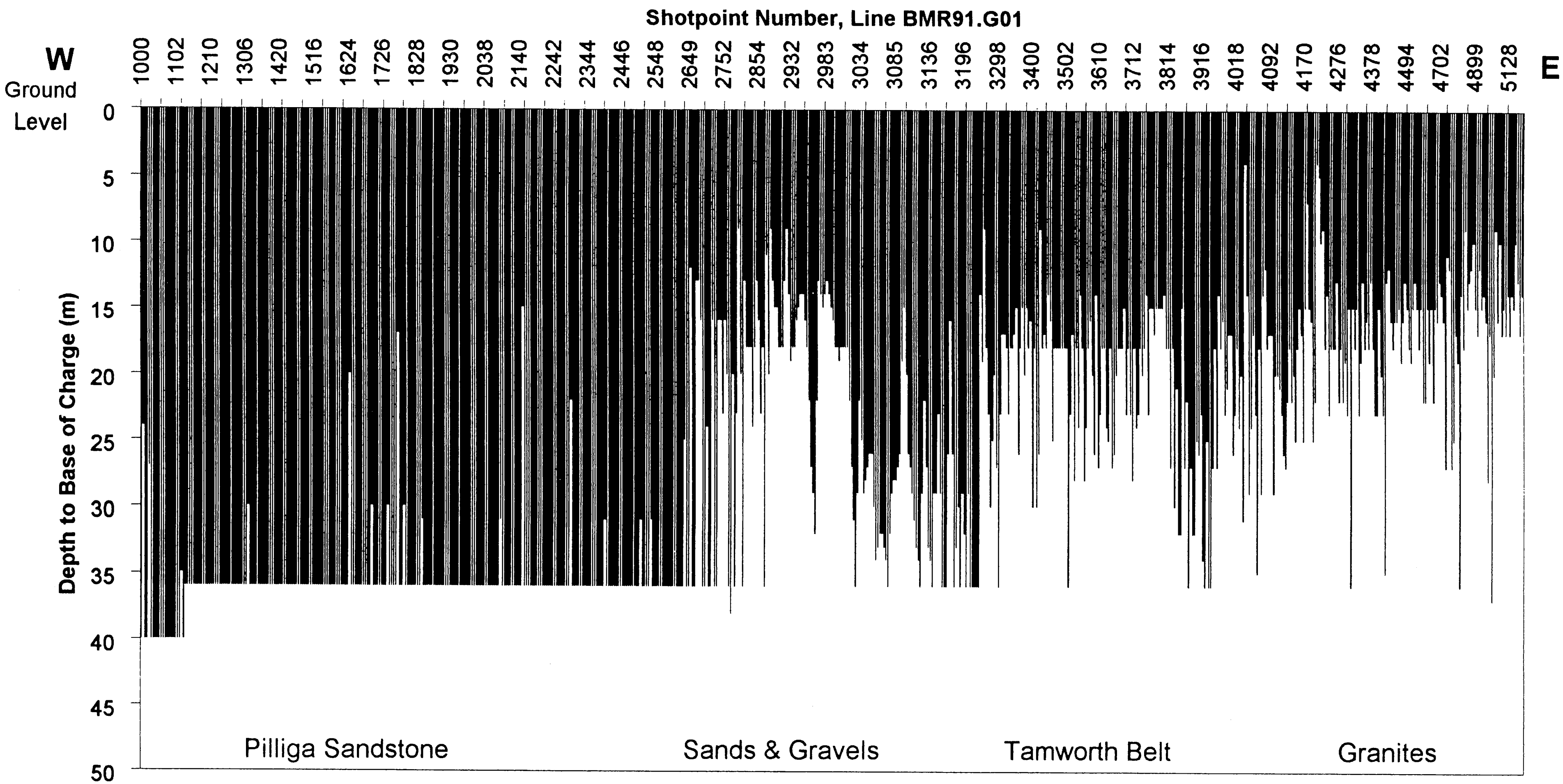

Figure 3. Depth to Base of Charge for shotpoints on Line BMR91.G01.

The seismic system was not able to recognise an end-of-file marker at the end of the shot records. Several components in the tape drive were found faulty and the tape heads required recalibrating in setting recording head levels. Following the repairs to the tape transport, the system work reasonably well, although line transmission errors were a problem in the mornings at the start of recording. The line transmission problems appear to be related to the recording cables, with several cable connectors found to have poorly soldered conductor terminations. A recommendation was made that either a new set of cables be purchased pre-assembled, or that the existing cables be reterminated at the completion of the survey to eliminate the line transmission errors.

A new seismic monitoring camera, an OYO DFM 480 was purchased to replace the aging SIE ERC-10 camera. The new camera uses digital technology and essentially consists of an IBM compatible 386 PC computer incorporating a thermal printer with a large print head. During recording of a shot, the camera does not start printing until the shot recording length is reached (ie. entire shot record is stored in a memory buffer before printing the buffer file), compared to the realtime display of the previous analog camera. The new camera operated without fault.

Security of the station units proved to be a problem when operating north of Boggabri. Three station units were disconnected and removed from the line during one night. A search of the area managed to locate all three station units, hidden behind logs and in tall grass. Another station unit was also shot at by rifle fire in the area east of Manilla, causing minor damage to some internal connectors, with the bullet hole repaired by filling the void with Selleys aluminium metal epoxy.

The Kubota 240 VAC generator continued to operated without fault. Vibration noise from the generator into the geophone groups continued to be a minor problem which was diminished by ensuring that the turnbuckles holding the generator to the truck were unwound during data acquisition.

2.8 Gravity

Gravity observations were made at 360 m intervals along the seismic line. Gravity readings were also made at star picket permanent markers at bend-points in the seismic line on an opportunity basis, to allow relocation and tie-points for future gravity surveys in the area. A gravity tie was made to the Australian National Gravity Network station located at Narrabri airport. 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. An IBM compatible PC XT computer was used in the field for error checking surveying results and routine survey management tasks. An IBM compatible AT PC computer was used to compile observer logs and shothole information from which DISCO job files were created using Fortran programming language on the PC. Floppy disks of geometry information and DISCO job files were freighted back to Canberra with the field tapes for further processing on the VAX-based DISCO seismic processing system.

A fairly 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 BMR91.G01:

Preliminary geological interpretations of the deep seismic reflection profile have been presented at several conferences and symposia by R.J. Korsch. For comprehensive details of the preliminary interpretations the following references are recommended: Korsch & others, 1993a, 1993b; Glen & others, 1993. Reduced-scale, deep seismic reflection sections for Line BMR91.G01 are shown in Figures 4 & 5, with preliminary interpretations of the seismic data. Preliminary intepretation of the seismic data has resulted in the following conclusions by Korsch & others, 1993a.

1. Deep seismic profiling by the BMR/AGSO across the Gunnedah Basin and western part of the New England Orogen (profile BMR91.G01) has led to an upgrade of our understanding of the tectonic development of this region.

2. The Gunnedah Basin contains a relatively thin succession, in contrast to a very thick succession that was deposited as a result of foreland loading in southern Queensland (Totterdell & Korsch, 1992). This indicates that the magnitude of the thrusting was less than that farther to the north, or that the thrust belt to the east of the Gunnedah Basin was located much further to the east and had a lesser influence on subsidence in the basin.

3. There is no evidence within the seismic profile to indicate that the two ridges or three sub-basins within the Gunnedah Basin are fault controlled.

4. The Tamworth Belt is deformed by thin-skinned, west directed thrusting, and has been thrust over the eastern margin of the Gunnedah Basin.

5. The boundary between the Tamworth Belt and Tablelands Complex is a major west-dipping fault that extends to at least the Moho. The Peel Fault is a late stage, high level structure that roots onto the west-dipping fault.

6. The Tablelands Complex contains west-dipping structures which are probably post-accretion in age, and younger than the emplacement of the Bundarra Plutonic Suite.

7. The Bundarra Plutonic Suite is relatively thin and has a pancake-like shape.

8. In the vicinity of seismic profile BMR91.G01, the New England Orogen appears to have been underthrust towards the west beneath the Lachlan Orogen, with the exception of the Tamworth Belt which was overthrust westwards.

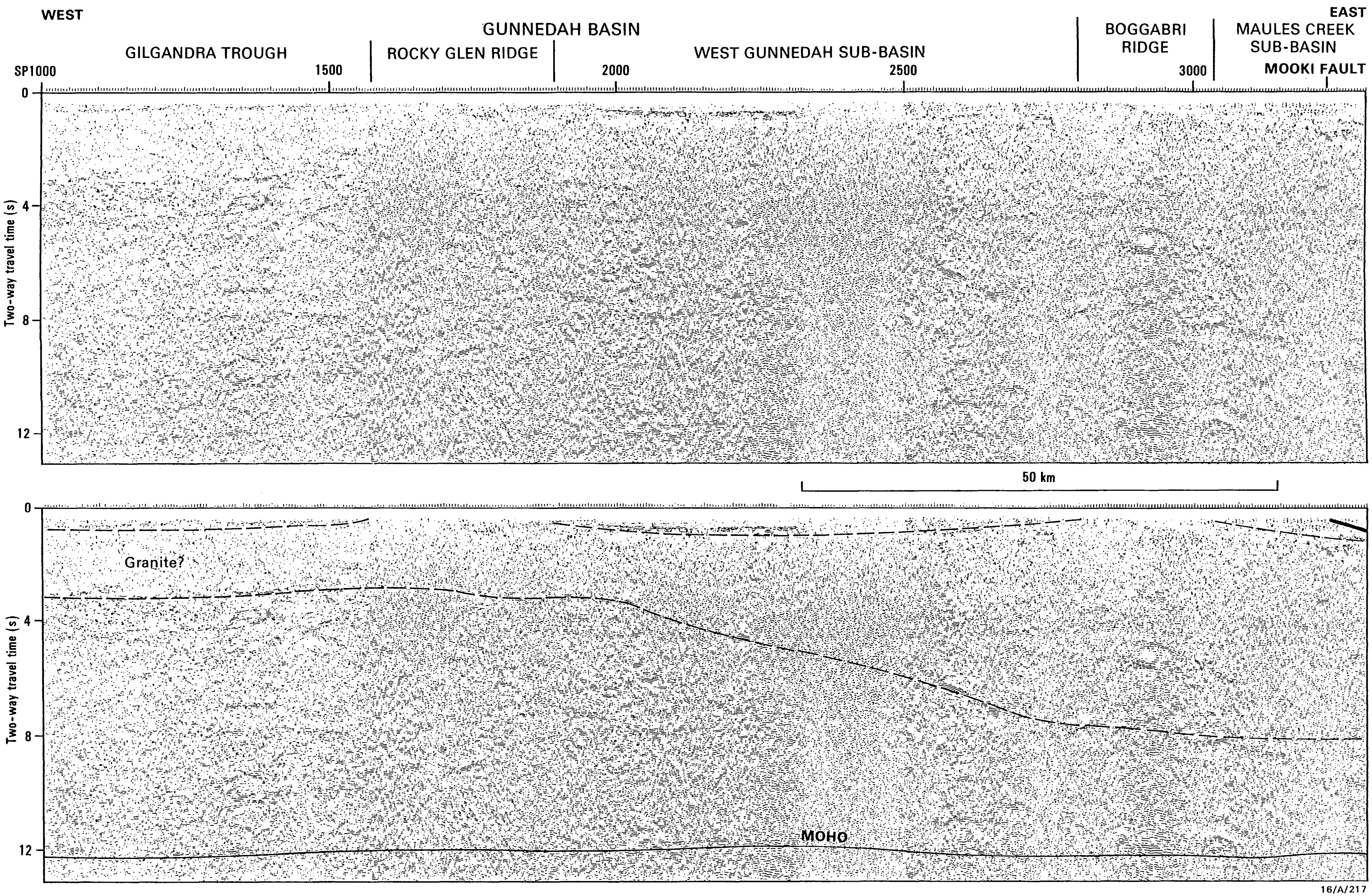

Figure 4. Western half of deep seismic reflection profile BMR91.G01 across the Gunnedah Basin showing preliminary interpretation. Dashed lines near the top of the section are at approximately the top of the volcanic succession. The dashed line just above 4 s in the west and dipping to about 8 s in the east is a major crustal boundary separating upper crust of low reflectivity from lower, more reflective crust. Vertical scale equals horizontal scale for a velocity of 6 km s^{-1}. (Korsch & others, 1993a).

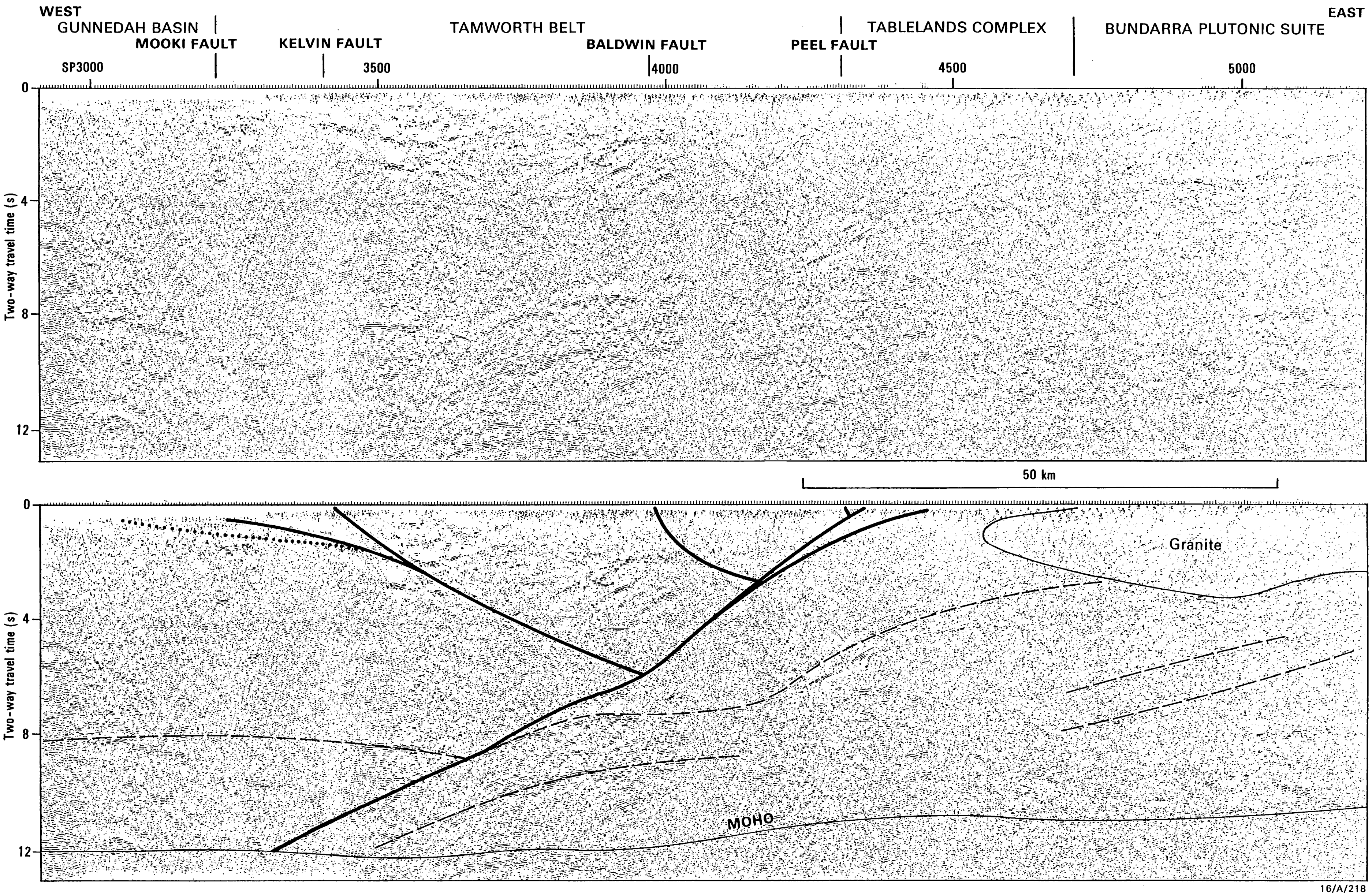

Figure 5. Eastern half of deep seismic reflection profile BMR91.G01 across the Tamworth Belt, Tablelands Complex and Bundarra Plutonic Suite showing preliminary interpretation. Heavy solid lines represent interpreted faults, light solid line in upper right hand corner defines the shape of the Bundarra Plutonic Suite, and dashed lines represent major reflective units in the middle to lower crust. Note there is a slight amount of overlap with Figure 4, and the dotted line in the top left hand corner is approximately the base of the sediments in the Gunnedah Basin (it equates with the dashed line in the upper right hand corner of Figure 4). Vertical scale equals horizontal scale for a velocity of 6 km s^{-1}. (Korsch & others, 1993a)

ACKNOWLEDGEMENTS

The contributions and efforts made by all members of the seismic party and contract surveying team are gratefully acknowledged. The cooperation of local authorities and landowners was highly appreciated.

REFERENCES

GLEN, R.A., KORSCH, R.J. and WAKE-DYSTER, K.D., 1993. A deep seismic cross-section through the Tamworth Belt: preliminary interpretation of the 4 seconds two-way time data. *In:* Flood, P.G. & Aitchison, J.C. (Editors), New England Orogen, eastern Australia Conference 1993 Proceedings. *Dept. of Geology and Geophysics, University of New England, Armidale, NSW, Australia.* p101-104.

KORSCH, R.J., WAKE-DYSTER, K.D. AND FINLAYSON, D.M., 1990. Land seismic data acquisition proposal: Gunnedah Basin, New South Wales. *Bureau of Mineral Resources, Australia, Record* 1990/93.

KORSCH, R.J., WAKE-DYSTER, K.D. and JOHNSTONE, D.W., 1993a. The Gunnedah Basin - New England Orogen deep seismic reflection profile: implications for New England tectonics. *In:* Flood, P.G. & Aitchison, J.C. (Editors), New England Orogen, eastern Australia Conference 1993 Proceedings. *Dept. of Geology and Geophysics, University of New England, Armidale, NSW, Australia.* p85-100.

KORSCH, R.J., WAKE-DYSTER, K.D. and JOHNSTONE, D.W., 1993b. Deep seismic reflection profiling in the Gunnedah Basin: Regional Tectonics and Basin Responses. *In:* Swarbrick, G.J. & Morton, D.J. (Editors), NSW Petroleum Symposium 1993 Proceedings. *Petroleum Exploration Society of Australia (NSW Branch).*

TOTTERDELL, J.M. and KORSCH, R.J., 1992. Structural configuration and tectonic development of the Bowen and Surat Basins in the Taroom region. *Bureau of Mineral Resources, Australia, Record* 1991/102, 35-52.

WAKE-DYSTER, K.D. and JOHNSTONE, D.W., 1993. Gunnedah Basin and Cobar Basin, New South Wales, Seismic Test Survey: Operational Report. *Australian Geological Survey Organisation, Record* 1993/89.

APPENDIX 1

Operational Statistics

Contract surveying commenced	07-01-1991
Drilling crew departed Canberra	04-02-1991
Recording crew departed Canberra	06-02-1991
Drilling crew arrived field	05-02-1991
Recording crew arrived field	07-02-1991
Drilling commenced	11-02-1991
Recording commenced	14-02-1991
Contract surveying completed	07-03-1991
Drilling completed	03-04-1991
Recording completed	03-04-1991
Drilling crew departed for Kalgoorlie	08-04-1991
Recording crew departed for Kalgoorlie	08-04-1991

Total line kilometres;	
Normal production reflection seismic	253 km
Seismic lines recorded	BMR91.G01

Recording:

Number of (Production) recording days worked	26
Recording days lost:	
Due to camp setting up & dismantling	3
Due to adverse wet weather	0
Due to recording equipment breakdown	7
Due to no available recording line	2

Reflection:

CDP fold coverage		8
Number of Production shots		688
Average number of production shots/ recording day		26
Average surface coverage/ recording day		9.4 km/day
Explosives used	(Dyno-Westfarmers Tovex, 1kg)	2155 kg
	(ICI, Powergel, 2 kg)	4250 kg
	(ICI, Powergel, Seismic, 0.5 kg)	97 kg
	Total	6502 kg
Detonators used (ICI, Star No.8)		697
Average charge size/ production shot (Line BMR91.G01)		9.4 kg

Drilling:

Number of drilling rigs	5
Total number of rig days worked	163
Rig days lost:	
Due to setting up & dismantling camp	15
Due to adverse wet weather	10
Due to equipment breakdowns & maintenance	17
Reflection shotholes;	
Total number of shotholes drilled	695
Total metres drilled	18586 m
Average depth/ shothole	27.0 m
Average number of holes/ rig/ working day	4.26
Average metres drilled/ rig/ working day	114.0 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 two weeks of survey)		J. Somerville
	(Contract)	R. Proudfoot
Geophysicists		D.W. Johnstone (Feb, March)
		T.J. Barton
Technical Officer (Engineering)		J. Whatman (Feb, April)
		B. Maplestone (Feb)
		P. Doolan (Feb, March)
Drillers		D. Eaton
	(Contract)	A. Porter
	(Contract)	J. Gebbett
	(Contract)	H. Latham
	(Contract)	G. Shelley
Mechanics		A. Crawford
		J. Keyte
Field Assistants (Explosives)		R.D.E. Cherry
		A.C. Takken
	(Contract)	S. Pardalis
Temporary Personnel (Contract):		
Assistant Drillers		M. Ramsay
		F. Ceichan
		A. Hinds
		N. Clark
		P. Kramer
Cooks		A. Tate
		A. Travers
Assistant Cooks		D. Haldane
		M. Bedey
Field Hands		R. Banks
		R. Deacon
		A.P. Miinin
		R. Fitzgerald
		J.B. Schejnin
		G. Hay (Feb)
		P. Lenehan
		J. Robinson
		J. Ryan
	Camp Attendant	B. Martin
	Camp Attendant	J. Kalma

Contract Surveying:

Fisher Stewart Pty. Ltd.
99 Hume Street
WODONGA 3690 Tel: (060) 24 2266 Fax: (060) 56 2392

Surveying Personnel: (2 man crew, 1 4WD & trailer)

Surveyor	Brendon Windsor
Surveying Technician	Phillip Crowe

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

Forestry Commission of NSW P.O. Box 63 BARADINE NSW 2396	Volvo F.E. Loader Isuzu 7 tonne truck Toyota Hilux	$44/hr $24/hr $22/hr
H.G. & S.H. Hunter "Caloola" BAAN BAA NSW	Cat D6	$70/hr
Manilla Shire 210 Manilla Road MANILLA NSW 2346	Tractor & Slasher	$68/hr

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-634
Cable truck	Mercedes 911 4tonne 4X4	ZBE-633
Stores truck	Mercedes 911 4tonne 4X4	ZBE-687
Computer truck	International 1830C 8 tonne	ZBE-964
Geophone carrier	Toyota tray top 4X4	ZJE-052
Geophone carrier	Toyota tray top 4X4	ZJE-053
Geophone carrier	Toyota tray top 4X4	ZJE-057
Geophone carrier	Toyota tray top 4X4	ZJE-058
Shooting truck	Toyota tray top 4X4	ZJE-054
Personnel carrier	Toyota troop carrier 4X4	ZBE-796
Personnel carrier	Toyota troop carrier 4X4	
Reconnaissance	Nissan Patrol S/W 4X4	
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	ZTV-022
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	ZJE-055
Personnel carrier	Toyota troop carrier 4X4	ZJE-011
Personnel carrier	Toyota troop carrier 4X4	ZJE-013
Office	4 wheel trailer	ZTL-996
Drilling spares	4 wheel trailer	ZTL-511
Kitchen	4 wheel trailer	ZTL-917
Ablutions	4 wheel trailer	ZTI-343
Workshop spares	4 wheel trailer	ZTV-023
Stores	4 wheel trailer	ZTL-674
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
Camera	OYO DFM 480
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 & Line intersections.

Line BMR91.G01:

Line Orientation	E-W (High SP numbers East, Trace 1 to the West)
Length	253.0 km
First Geophone station	1000
Last Geophone station	5218
First Shotpoint	1000
Last Shotpoint	5217
Geophone station interval	60 m
Shotpoint interval	360 m

Line Intersections:

BMR91.G01	SP 4808 + 02 m	-	BMR89 Test Line 1	SP 1000
BMR91.G01	SP 4856 + 21 m	-	BMR89 Test Line 1	SP 1048
BMR91.G01	SP 4904 + 33 m	-	BMR89 Test Line 1	SP 1096
BMR91.G01	SP 3828 + 03 m	-	BMR89 Test Line 2	SP 2048
BMR91.G01	SP 3876 + 08 m	-	BMR89 Test Line 2	SP 2095
BMR91.G01	SP 3167 + 38 m	-	BMR89 Test Line 3	SP 3000
BMR91.G01	SP 3215 + 42 m	-	BMR89 Test Line 3	SP 3048
BMR91.G01	SP 3262 + 34 m	-	BMR89 Test Line 3	SP 3095
BMR91.G01	SP 1934 + 07 m	-	BMR89 Test Line 4	SP 4000
BMR91.G01	SP 1981 + 33 m	-	BMR89 Test Line 4	SP 4048
BMR91.G01	SP 2027 + 59 m	-	BMR89 Test Line 4	SP 4095

APPENDIX 6

SEISMIC FIELD TAPE INDEX

Tape No.	Line	Shotpoints	Recording Dates	Record Mode	Survey
91001	BMR91.G01	Test Files	13/02/91-13/02/91	6250 bpi GCR	GUNNEDAH 1991
91002	BMR91.G01	1000 - 1066	14/02/91-14/02/91	6250 bpi GCR	GUNNEDAH 1991
91003	BMR91.G01	1073 - 1168	15/02/91-15/02/91	6250 bpi GCR	GUNNEDAH 1991
91004	BMR91.G01	1174 - 1180	15/02/91-15/02/91	6250 bpi GCR	GUNNEDAH 1991
91005	BMR91.G01	1186 - 1300	18/02/91-18/02/91	6250 bpi GCR	GUNNEDAH 1991
91006	BMR91.G01	1306 - 1438	18/02/91-25/02/91	6250 bpi GCR	GUNNEDAH 1991
91007	BMR91.G01	1444 - 1582	25/02/91-26/02/91	6250 bpi GCR	GUNNEDAH 1991
91008	BMR91.G01	1588 - 1744	26/02/91-26/02/91	6250 bpi GCR	GUNNEDAH 1991
91009	BMR91.G01	1750 - 1870	26/02/91-27/02/91	6250 bpi GCR	GUNNEDAH 1991
91010	BMR91.G01	1876 - 1990	27/02/91-27/02/91	6250 bpi GCR	GUNNEDAH 1991
91011	BMR91.G01	1996 - 2116	28/02/91-28/02/91	6250 bpi GCR	GUNNEDAH 1991
91012	BMR91.G01	2122 - 2248	01/03/91-01/03/91	6250 bpi GCR	GUNNEDAH 1991
91013	BMR91.G01	2254 - 2404	01/03/91-04/03/91	6250 bpi GCR	GUNNEDAH 1991
91014	BMR91.G01	2410 - 2572	04/03/91-05/03/91	6250 bpi GCR	GUNNEDAH 1991
91015	BMR91.G01	2578 - 2716	05/03/91-06/03/91	6250 bpi GCR	GUNNEDAH 1991
91016	BMR91.G01	2722 - 2860	06/03/91-07/03/91	6250 bpi GCR	GUNNEDAH 1991
91017	BMR91.G01	2866 - 2960	07/03/91-08/03/91	6250 bpi GCR	GUNNEDAH 1991
91018	BMR91.G01	2962 - 3028	08/03/91-08/03/91	6250 bpi GCR	GUNNEDAH 1991
91019	BMR91.G01	3031 - 3106	13/03/91-13/03/91	6250 bpi GCR	GUNNEDAH 1991
91020	BMR91.G01	3109 - 3196	14/03/91-14/03/91	6250 bpi GCR	GUNNEDAH 1991
91021	BMR91.G01	3202 - 3352	14/03/91-15/03/91	6250 bpi GCR	GUNNEDAH 1991
91022	BMR91.G01	3358 - 3496	15/03/91-15/03/91	6250 bpi GCR	GUNNEDAH 1991
91023	BMR91.G01	3502 - 3628	18/03/91-18/03/91	6250 bpi GCR	GUNNEDAH 1991
91024	BMR91.G01	3633 - 3778	18/03/91-18/03/91	6250 bpi GCR	GUNNEDAH 1991
91025	BMR91.G01	3784 - 3904	19/03/91-19/03/91	6250 bpi GCR	GUNNEDAH 1991
91026	BMR91.G01	3910 - 4033	19/03/91-20/03/91	6250 bpi GCR	GUNNEDAH 1991
91027	BMR91.G01	4097 - 4033	20/03/91-20/03/91	6250 bpi GCR	GUNNEDAH 1991
91028	BMR91.G01	4109 - 4251	21/03/91-22/03/91	6250 bpi GCR	GUNNEDAH 1991
91029	BMR91.G01	4263 - 4408	22/03/91-25/03/91	6250 bpi GCR	GUNNEDAH 1991
91030	BMR91.G01	4414 - 4498	25/03/91-26/03/91	6250 bpi GCR	GUNNEDAH 1991
91031	BMR91.G01	4510 - 4720	26/03/91-27/03/91	6250 bpi GCR	GUNNEDAH 1991
91032	BMR91.G01	4734 - 4899	28/03/91-28/03/91	6250 bpi GCR	GUNNEDAH 1991
91033	BMR91.G01	4911 - 4911	02/04/91-02/04/91	6250 bpi GCR	GUNNEDAH 1991
91034	BMR91.G01	4929 - 5140	02/04/91-03/04/91	6250 bpi GCR	GUNNEDAH 1991
91035	BMR91.G01	5152 - 5163	03/04/91-03/04/91	6250 bpi GCR	GUNNEDAH 1991
91036	BMR91.G01	5188 - 5217	03/04/91-03/04/91	6250 bpi GCR	GUNNEDAH 1991

APPENDIX 7

Operational details, Gravity survey

1. The gravity survey commenced on the 5th March 1991 and was completed on the 19th March 1991.

2. 721 new gravity stations were read with a spacing of 360m between stations.

3. BMR gravity meter, LaCoste-Romberg S/N G132 was used on the survey. For data reduction a calibration scale factor of 1.05820 mgal/counter reading, was adopted.

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

Station	Value	Lat	Long	Elev (m)
(Isogal65 mgal)				
6491.9108	979311.39	30.31833	149.82667	222.99
(NARRABRI A/P)				

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

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