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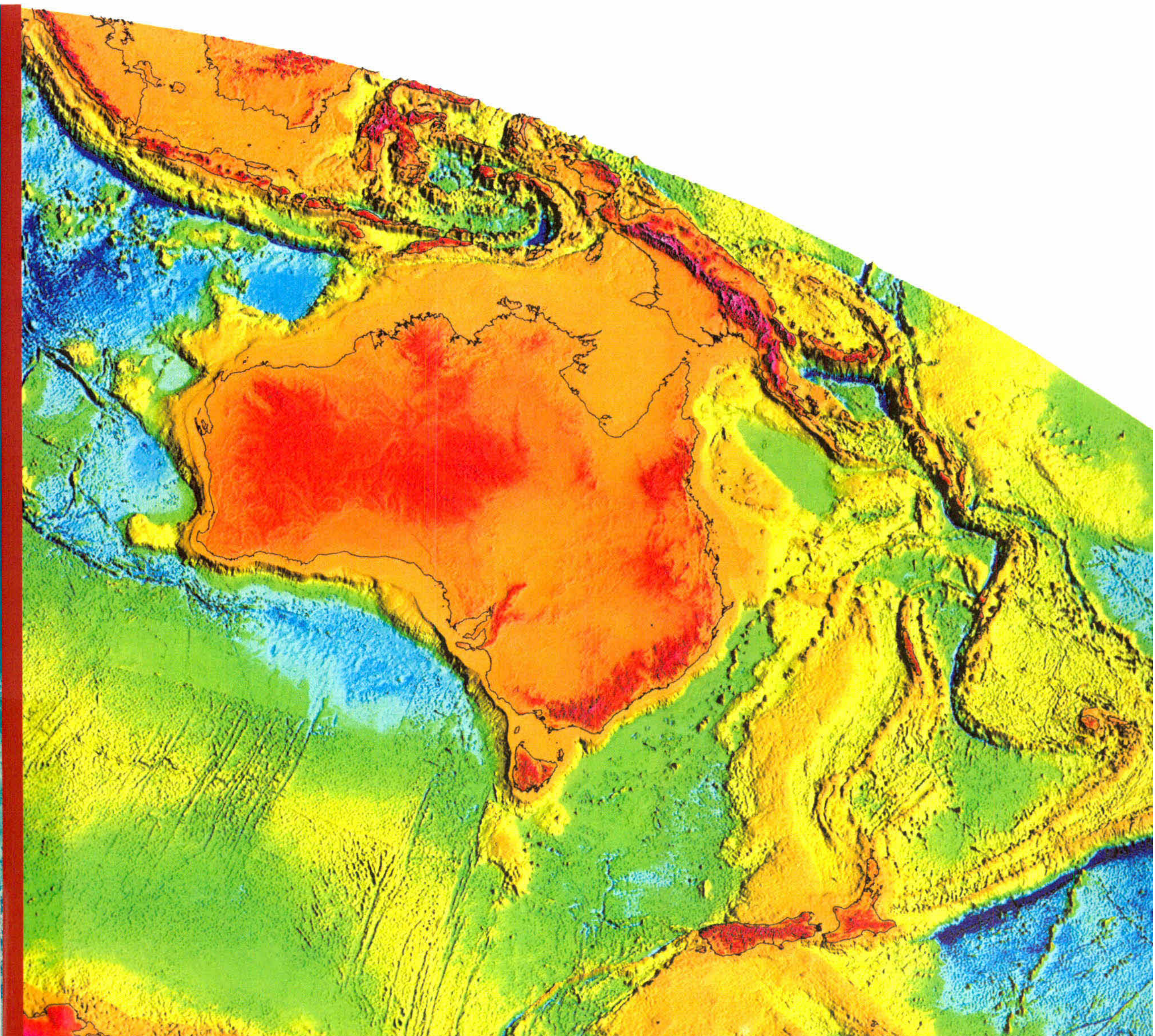
AUSTRALIAN NATIONAL SEISMIC IMAGING RESOURCE

Record 2003/20

L160 Multi-component High Resolution Seismic Survey

OPERATIONS REPORT: Narrabri, NSW – April 2003

T. Fomin, L. Jones, T. Barton, D. Johnstone and A. Crawford



SPATIAL INFORMATION FOR THE NATION

L160 Multi-component High Resolution Seismic Survey

OPERATIONS REPORT

NARRABRI, NSW

April 2003

T. Fomin, L. Jones, T. Barton, D. Johnstone, A. Crawford

ANSIR AUSTRALIAN NATIONAL SEISMIC IMAGING RESOURCE

Department of Industry, Tourism & Resources

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EXECUTIVE SUMMARY

An experimental high-resolution seismic survey was undertaken in the Pilliga State Forest near Narrabri, NSW in April 2003. The Australian National Seismic Imaging Resource (ANSIR) carried out the field work on behalf of a Geoscience Australia research project. A NSW State Forests Special Purposes Permit was obtained for the survey.

This survey was designed to collect a seismic dataset for shallow high-resolution seismic imaging in an area of known high data quality. Both P- and S-wave seismic sources were employed with data recorded using 14 Hz 3 component geophones. The objective of this project was to provide researchers with an over-sampled multi-component, multi-source shallow high-resolution seismic data set for the development of acquisition and processing methodologies.

1. INTRODUCTION

In April 2003 the Australian National Seismic Imaging Resource (ANSIR) collected a Multicomponent high resolution seismic data set in the Gunnedah Basin near Narrabri in NSW on behalf of Geoscience Australia. This data set was intended to demonstrate P- and S-wave imaging of shallow features and be made available to the broader research community. Appendix 1 contains the original ANSIR project proposal which provides a summary of the scientific objectives for this survey. This survey used the ANSIR facility equipment comprising a T15000 IVI Minivib and an ARAM24 acquisition system. Appendix 2 lists the equipment used in this experiment.

The seismic survey was located ~30 km southwest of Narrabri (Figure 1) in the Pilliga State Forest of NSW. A permit for undertaking this survey was obtained from State Forests of NSW (Appendix 3). The acquisition methodology employed ensured that there was minimal environmental disturbance from survey operations.

This region was chosen on the basis of previous seismic reflection data acquired by the Bureau of Mineral Resources (now Geoscience Australia) in 1989 and 1991 using explosive sources for a regional study (Wake-Dyster & Barton, 1993). We chose this particular site for this experiment as it coincided with the location of a seismic test survey undertaken on Sparrow Road in 1989 (Wake-Dyster & Johnstone, 1993). The test survey conducted in 1989 included an uphole shoot at this location using dynamite that provides good seismic weathering control for this dataset. The site has good shallow reflectivity in a number of sequences within the Pilliga Sandstone as shown on the lower-resolution regional parameter seismic test line (Figure 2).

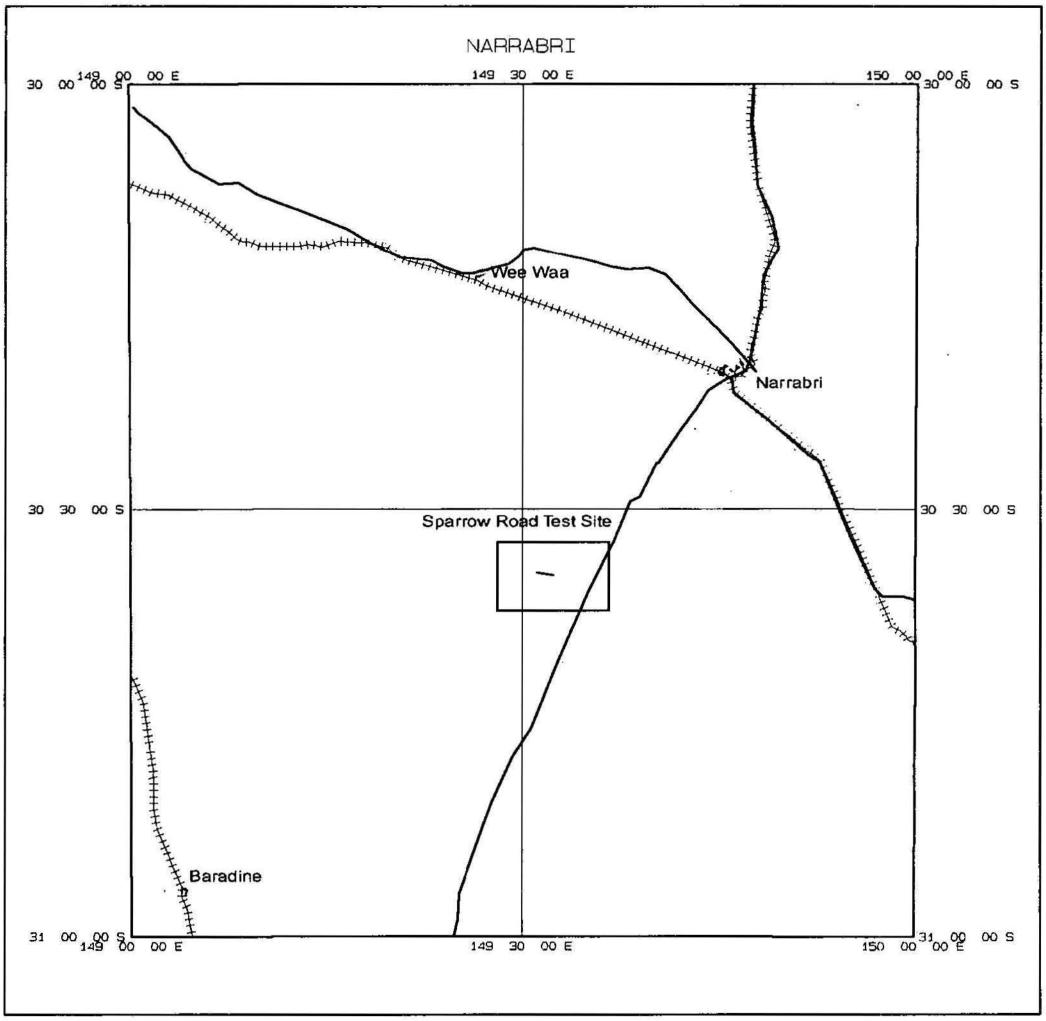


Figure 1. Location of seismic test line (03GA-MC) at Sparrow Road.

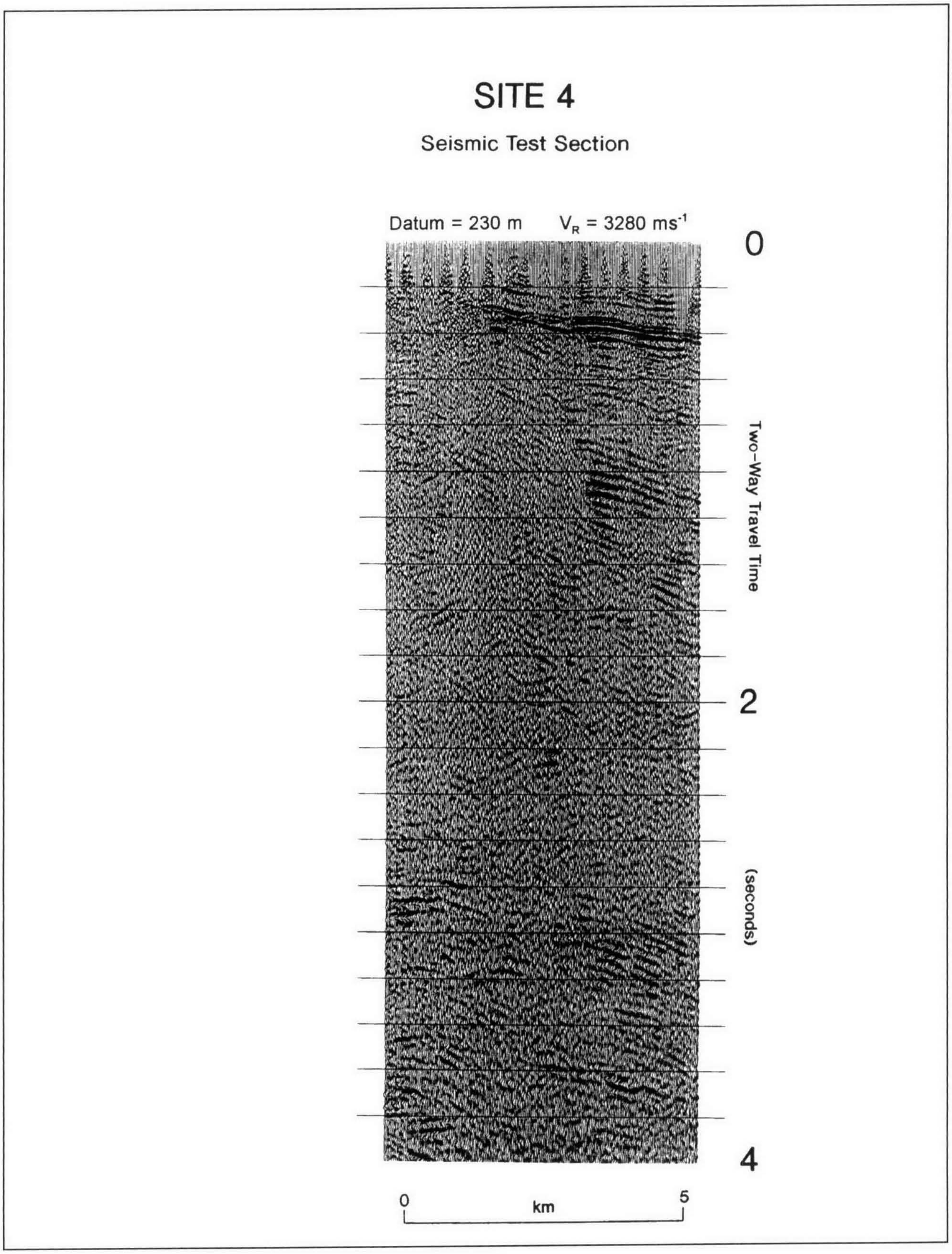


Figure 2. Seismic Stack section of the 1989 Site 4 test line (BMR89-T04) in an area of outcropping Pilliga Sandstone on the western margin of the Gunnedah Basin (from Wake-Dyster and Johnstone, 1993).

2. FIELD ACQUISITION

Field seismic acquisition was conducted by ANSIR staff with funding from Geoscience Australia. A seismic observer from the ANSIR facilities manager, Trace Energy Services Pty Ltd, was operated the ARAM24 seismic acquisition system. A list of the crew for this survey is given in Appendix 4. This survey was scheduled to follow the completion of a 3-component 3-D seismic experiment in Dubbo, NSW, with all of the equipment moved by ANSIR and Trace Energy personnel on the 13th April 2003. Additional ANSIR crew from Canberra arrived in Narrabri township in the late afternoon. Three members crew from the Dubbo survey departed for Sydney on April 14.

The seismic survey consisted of three stages. Firstly, a test program using P-wave mode for source parameter selection, a production phase in P-wave mode, and a production phase in S-wave mode using sweep parameters derived from P-wave results. The testing program is described in the next section.

The location of specific stations along the previous 1989 (BMR89-T04) and 1991 (BMR91-G01) seismic lines were found using a hand held GPS. Surveying details for this line and its relationship to the previous lines are given in Appendix 5.

The equipment was deployed on the line upon arrival. No line clearing was required for this survey, as the seismic line was along the verge of the un-sealed Sparrow Road.
For this survey 120 stations were pegged at a 1 m interval numbered from station 1000 at the western end of the line. Additional stations off the eastern end of the line (stations 1124 to 1160 and stations 1237 to 1239) were also pegged for off-end vibrator source points (VP's). The recording cab was sited approximately 100 m to the west of station 1000 for the entire survey to minimize generator noise on the active spread.

The experimental program was started in the late afternoon of April 13. Severe storms throughout the region overnight prevented any operations being undertaken on April 14 as the line was too wet to work on and that delayed the start of data acquisition by one day. The weather remained fine for the rest of the survey allowing most of the program to be completed. The test program resumed on April 15 once conditions had dried out sufficiently. However, water on the geophone connectors caused a delay of several hours while the crew rectified line problems.

The ANSIR IVI T15000 Minivib (Figure 3) was used as the energy source for the seismic survey. The Minivib is designed to generate either vertical (P-wave) or horizontal (S-wave) movements (Appendix 6). Two different baseplates can be used to couple energy into the ground, a flat baseplate used for P-wave generation on pavement surfaces, and a corrugated baseplate which can be used for both P- and S-waves. For this survey, we used the corrugated plate. Throughout this report, P-wave mode or configuration means vertical shaking with the baseplate, while S-wave mode refers to horizontal shaking, either in-line or cross-line.

Figure 3. T15000 Minivib vibrating next to the receiver line.

Recording sensor used for this survey were 3 component 14 Hz geophones, and strings of 4 vertical component 10 Hz geophones. Technical specifications of these geophones are given in Appendix 2.

The P-wave production phase commenced on April 15, after completion of the test program. A test program planned for S-wave mode was cancelled due to the weather related delays. S-wave production acquisition was completed at 3:30 pm and the crew picked up and packed all equipment by 5:30 pm on April 16. The crew departed Narrabri on April 17 dropping the Trace Observer at Dubbo airport and returned to Canberra late in the afternoon.
There were no crew injuries or fluid leakages from the equipment during operations for this survey.

2.1 Test Program

We planned a test program on the basis of previous Minivib data recorded at Bungendore, NSW (2001) and at Narromine, NSW (2002) for other high-resolution seismic reflection experiments. This program took approximately four hours.

The main objective of the tests was to select optimal source parameters, such as:
- sweep frequencies,
- sweep length,
- number of sweeps at each source point.

For the test program 120 sets of vertical geophones (10 Hz, groups of 4) were deployed at 1 m group spacing along the receiver line. The geophone arrays were orientated perpendicular to the line over 1 m (Figure 4). 14 Hz three-component geophones were planted at 1 m spacing along the same receiver line (Figure 4). Only the Z-component (vertical) and H2 (cross-line direction) components were connected. A comparison of data recorded with the vertical geophones and the Z-component of the 3-component geophones showed no marked difference in the data quality from the two receiver types. Therefore, the vertical geophones were disconnected, and the 3-component geophones used for the rest of the survey.

Figure 4. 10 Hz geophones strings (groups of 4) and the larger 3-component geophones.

All data from the test program were collected with the Minivib in P-wave configuration. The reference sweeps used were filtered ground force (FGF) for tests 1 to 12, ground force (GF) for test 13, and synthetic for test 14. Table 1 describes the receiver configuration used for each of the tests whilst Table 2 provides a summary of the source parameters used in the test program. Appendix 7 provides a full listing of all test files acquired.

Table 1. Receiver line allocation used for test program.

Test No	Receiver line	Length (m)	Component	Direction	Channel number
1	R1	120	vertical geophone	Vertical	1 -120
	R2	120	Z	Vertical	121-239
2-11	R1	120	vertical geophone	Vertical	1-120
	R2	120	Z	Vertical	121-236
	R3	120	H2	Cross-line	237-352
12-14	R1	120	H1	in-line	1-119
	R2	120	Z	Vertical	120-235
	R3	120	H2	Cross-line	236-351

Table 2. **Summary of source parameters used for test program.**

Test No	Reference Sweep	Sweep Frequencies (Hz)	Sweep Length (s)	No. Sweeps	Comments
1	FGF	10-80	9	3	Test for sweep frequency
2	FGF	10-120	9	3	Test for sweep frequency
3	FGF	10-200	9	3	Test for sweep frequency
4	FGF	10-250	9	3	Test for sweep frequency
5	FGF	20-200	9	3	Test for sweep frequency
6	FGF	20-250	9	3	Test for sweep frequency
7	FGF	10-300	9	3	Test for sweep frequency
8	FGF	10-250	3	3	Test for sweep length
9	FGF	10-250	6	3	Test for sweep length
10	FGF	10-250	12	3	Test for sweep length
11	FGF	10-250	9	4	Test for no. of sweeps
12	FGF	10-250	9	4	Test for no. of sweeps
13	GF	10-250	9	3	Test for reference sweep
14	SYN	10-250	9	3	Test for reference sweep

2.2 Production Recording Parameters

The recording parameters used for the production phase for this project are given in Table 3.

To ensure that the base plate was lowered at the correct peg position, a crew member was located at the rear of the minivib to signal the vibe operator at each move-up to the next vibration point (VP).

Table 3. Production Recording Parameters.

Recording System	ARAM24
Type of geophones	GS-20DM, 3-component (14 Hz)
Number of active channels	351
Record length	2 sec
Sample interval	0.5 ms
Group interval	1 m
Maximum source offset	120 m (P-wave) & 160 m (S-wave)

The three-component 14 Hz geophones were spaced at 1 m intervals along a receiver line over a total length of 120 m (Table 4). Note that the receiver stations are numbered from the west (1000) to the east (1119).

Table 4. Three-component geophone line configuration.

Receiver line	Length (m)	Component	Direction	Chan #	Station number
R1	118	H1	in-line	1-119	1000-1118
R2	115	Z	vertical	120-235	1000-1115
R3	115	H2	cross-line	236-351	1000-1115

The source line lay parallel to the receiver line with a perpendicular offset (to the south) of approximately 4 m. The centre of the minivib baseplate (VP position) was at a peg location. The source parameters chosen from the test program are shown in Table 5.

Table 5. Production Source Energy Parameters.

Vibrator	Minivib T-15000
Vibration pont interval (VP)	1,2 & 4 m
Number of sweeps at each VP	3
Sweep length	9 sec
Sweep type	mono
Sweep frequencies	10-250 Hz
Reference signal	Filtered Ground Force

Data were acquired for 108 shots in P-wave mode. Field files 676-786 correspond to P-wave mode (files 742-744 are void).

The last stage of the multi-component seismic survey involved data acquisition in S-wave mode. Prior to the acquisition of these data the source mass on the Minivib was rotated from the vertical to horizontal orientation. This took approximately two hours to complete on the morning of the 16 April. Recording and source parameters were the same as for P-wave mode except for the Vibration Point (VP) interval. The VP interval was increased to 2 m for S-wave acquisition to expedite the production phase. The Minivib completed four traverses of the source line, once for each orientation of the source mass as detailed in Table 6. The Minivib operated from west to east for each of the 2 m VP lines.

Following acquisition of field files 787 – 1033, the source line was extended by 40 m at the eastern end of the line, with a VP interval 4 m up to a maximum receiver offset of 160 m. For these off-end VP's the Minivib turned around on the line after each run so as to avoid having to rotate the mass 90° each time. This was done so that the tests could be completed and the equipment picked up before the end of the day. These are also detailed in Table 6 with a summary of the field files corresponding to each orientation of the mass in S-wave configuration. Further details are given in the observer's logs (Appendix 8).

Table 6. Source mode configuration for S-wave production.

FFID Range	VP Interval (m)	VP Range	Source Orientation	Direction of the First Motion of the Mass	Void files
787-847	2	1000-1120	cross-line	South (ie, Top of mass to the RHS of the Minivibe. Vehicle traveling West to East)	
848-908	2	1000-1120	cross-line	North (ie, Top of mass to the LHS of the Minivibe, Vehicle traveling West to East)	
909-970	2	1000-1120	in-line	East (ie, Top of mass to the front of the Minivibe, Vehicle traveling West to East)	954
971-1033	2	1000-1120	in-line	West (ie, Top of mass to the rear of the Minivibe, Vehicle traveling West to East)	994,1023
1034-1045	4	1124-1160	cross-line	South (ie, Top of mass to the RHS of the Minivibe, Vehicle traveling West to East)	1034,1044
1046-1055	4	1160-1124	cross-line	North (ie, Top of mass to the RHS of the Minivibe, Vehicle traveling East to West)	
1056-1065	4	1124-1160	in-line	East (ie, Top of mass to the front of the Minivibe, Vehicle traveling West to East)	
1066-1075	4	1160-1124	in-line	West (ie, Top of mass to the front of the Minivibe, Vehicle traveling East to West)	

3. DATA QUALITY CONTROL AND FIELD PROCESSING

During the test program field monitor displays from the ARAM24 system were used to choose optimal acquisition parameters. All data were recorded on 3490E magnetic tapes with backup 5Gb Exabyte tapes being generated at the completion of each day of operations. Appendix 9 contains a list of all field tapes.

GA supplied an in-field processing facility for the entire program that was set up at the crews accommodation in Narrabri. At the end of each day, ANSIR staff carried out established QC procedures on the data. Seismic data tapes were read in order to verify tape contents and to check data quality.

Examples of raw seismic data records from an off-end (Figure 5) and a mid-spread (Figure 6) source. Note that on the off-end records, reflection events are less contaminated by source generated noise than the records where the source is mid-spread.

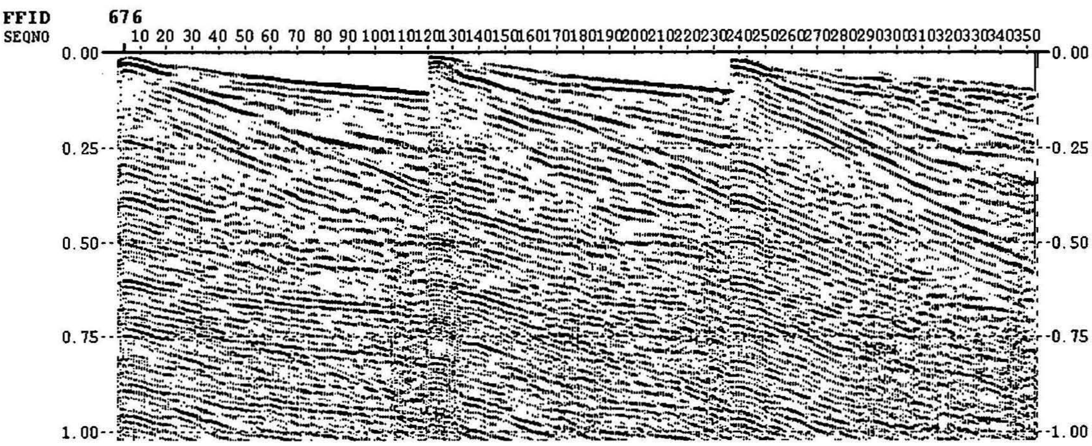


Figure 5. Shot record. P-wave source located at station 1000. Channels 1-119 In-line Horizontal (H1), Channels 120-235 Vertical (Z), Channels 236-351 Cross-line Horizontal (H2).

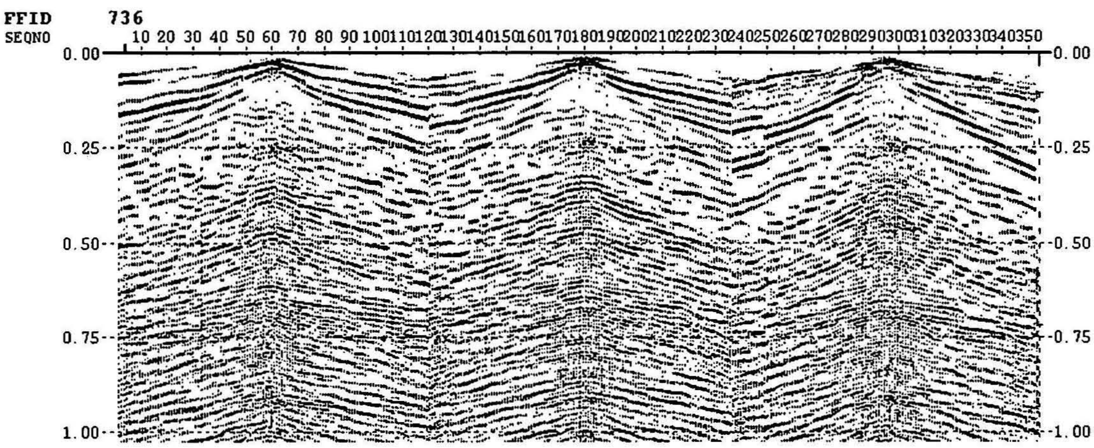


Figure 6. Shot record. P-wave source located at station 1060. Channels 1-119 In-line Horizontal (H1), Channels 120-235 Vertical (Z), Channels 236-351 Cross-line Horizontal (H2).

A field P-wave stack (P-wave source and vertical component geophone) was produced by the end of the survey (Figure 7). The stack section shows reflections dipping gently towards the east as expected from the results obtained from the earlier regional surveys. Note that the stacking process has attenuated the source generated noise visible on the shot records shown above.

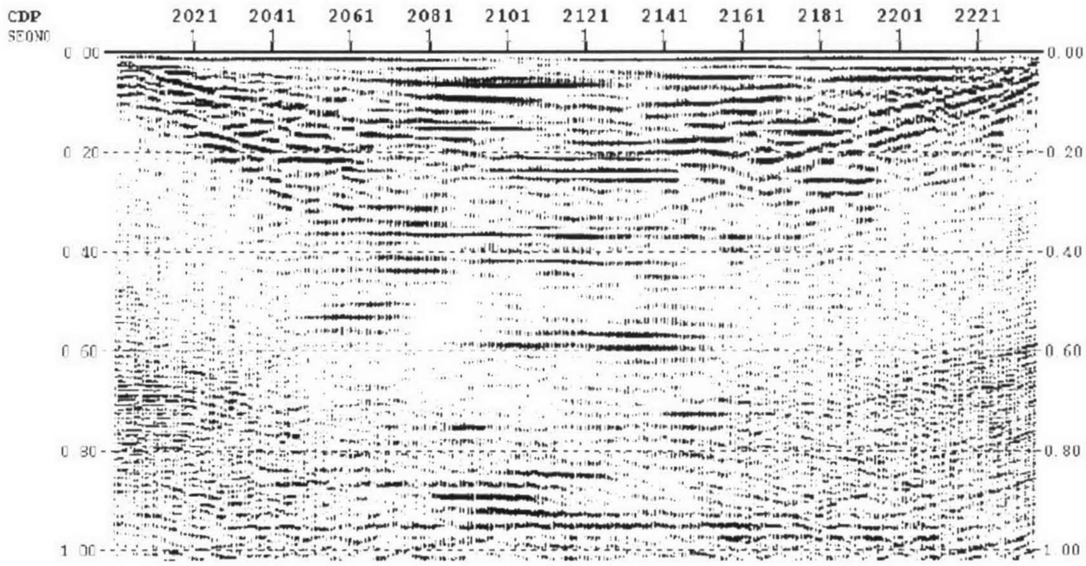


Figure 7. Field stack produced with P-wave source and vertical (Z) component geophone. CDP number is twice station number. Vertical axis is two-way time in seconds.

4. ACKNOWLEDGEMENTS

ANSIR would like to acknowledge the assistance provided by the Research Division and the Barradine Office of State Forests of NSW who granted us a permit to work in the Pilliga State Forest at short notice.

5. REFERENCES

Wake-Dyster K.D. and Johnstone D.W., Gunnedah Basin and Cobar Basin Seismic Test Survey 1989: Operational Report. Australian Geological Survey Organisation, Record 1993/89, 40 pp.

Wake-Dyster K.D. and Barton T.J., Gunnedah Basin Seismic Survey 1991: Operational Report. Australian Geological Survey Organisation, Record 1993/92, 25 pp.

APPENDIX 1 ANSIR PROJECT PROPOSAL

ANSIR

AUSTRALIAN
NATIONAL
SEISMIC IMAGING
RESOURCE

03-08R

APPLICATION FOR USE OF FACILITY EQUIPMENT

1. PROJECT TITLE

Multicomponent high resolution data set

2. PRINCIPAL INVESTIGATOR

Name: Barry Drummond

Position: Group Leader

Organisation: Geoscience Australia

Address: GPO Box 378
Canberra ACT 2601

Email: barry.drummond@ga.gov.au

Phone: 02 6249 9381

Fax: 02 6249 9972

3. CO-INVESTIGATORS

Bruce Goleby, Tim Barton, Tanya Fomin, Leonie Jones, Dave Johnstone (All at the above address)

4. SUMMARY OF SCIENTIFIC OBJECTIVES

Seismic reflection and refraction imaging at very resolution should in theory be capable of imaging the structure within and immediately below the regolith. It should therefore be suitable for applications relating to salinity, landscape evolution, and exploration and mining within and through the weathered zone. ANSIR has equipment capable of very high resolution reflection and refraction imaging. However, many of the potential clients who approach ANSIR seek some form of comfort that they will get results for the money they have to spend on their projects. ANSIR therefore would benefit from access to suitable case studies. This project would attempt to collect a totally oversampled (in space and bandwidth) data set that could be used to demonstrate the reflection and refraction methods at this scale. It would provide ANSIR with a data set that could be reworked, resampled and reprocessed to demonstrate the methods to clients. It would also be a research data set in its own right, and could be made available to other researchers wishing to study P- and S-wave imaging, including using converted phases.

5. Summary of Equipment Request
Source: Minivibrator + operator Recorder: ARAM plus observer Sensors: 144×3-component geophones; 144×10 Hz geophones in groups of 4 (note: groups of 12 would be acceptable but logistically difficult and not entirely suitable because of potential inductive coupling in the tight groups that would be used)

6. Proposed Timing
First half of 2003 because this is when the funding is available. Proposed as a 1-2 day add on to another suitable high resolution survey. One of the main factors is that it is done in a reasonably well known geological environment.

7. Class of Application		
Preliminary - Funding under Application		Funding Available **YES - $5,200 available now**

8. Scientific Justification - 1 page maximum

The parameters used for data acquisition are usually a compromise between those preferred based on sampling theory and what can be achieved with the budget available. In the case of high resolution experiments, the budgets are usually small compared to the task at hand. The resulting image is therefore almost always of a lesser quality that could be achieved. ANSIR's experience with seismic reflection and refraction imaging is almost all at the regional, crustal scale. The translation of this experience to the high resolution scale is not straightforward. Issues that need to be considered, but for which there is no data to allow a systematic study, include but are not limited to:

- In theory, the maximum resolution that can be achieved in any experiment will depend on the width of the central lobe of the autocorrelated pilot sweep. In practice, it is dependent on the correlation of the pilot with the signal returned from the ground, which usually has attenuated higher frequencies. What frequencies can we expect the Earth to return? The degree of effective attenuation (includes scattering) of high frequency energy is unknown. High frequencies are also required to provide the bandwidth needed to reduce correlation side lobes, reduce ringing and thereby increase the sharpness of the stacked section. We do have experience that the problem of large side lobes and ringing in high resolution sections cannot always be resolved with deconvolution filters.
- Linearity of the vibrator mechanics; length of the sweeps; number of sweeps - do fewer, longer sweeps allow for higher fidelity signal or can we achieve better results with more, shorter sweeps in which non-coherent noise can be reduced through stacking
- What are the effects of radiated noise from the baseplate. This can effect near-offset traces and reduce the effective near-vertical-incidence fold in the stack at very small two-way travel times;
- Shear phases at any frequency have shorter wavelengths than P waves, and should provide for higher resolution images. Can clean S waves be generated by subtracting records generated by a shear vibrator with initial motions in opposite directions? According to the literature this works for a hammer source but we have no experience with a vibrator. Can the difference between the cleaned sections and the original sections be used to generate cleaner P-wave sections, and to study converted phases?
- What is the simplest processing stream needed to produce stacked images? The application of statics corrections is fundamental for aligning phases for stacking in deep sections, but in high resolution shallow sections we want to preserve the effects of the weathering. Will the data be sufficiently coherent to allow stacking, and if so, over how many traces? Are there any scale-specific issues in migrating the stacks?

9. EQUIPMENT REQUEST AND PROPOSED EXPERIMENTAL DESIGN
- 1 page maximum + A4 size map

The field layout is shown in the following diagram:

Four straight lines would be laid out on flat ground.

One line would connect 144 groups of 4×10Hz vertical geophones, with the string of 4 phones preferably placed at right angles to the line over a length of a metre or less. The strings would be 1 m apart along the line, so that the line would be 143 m long.

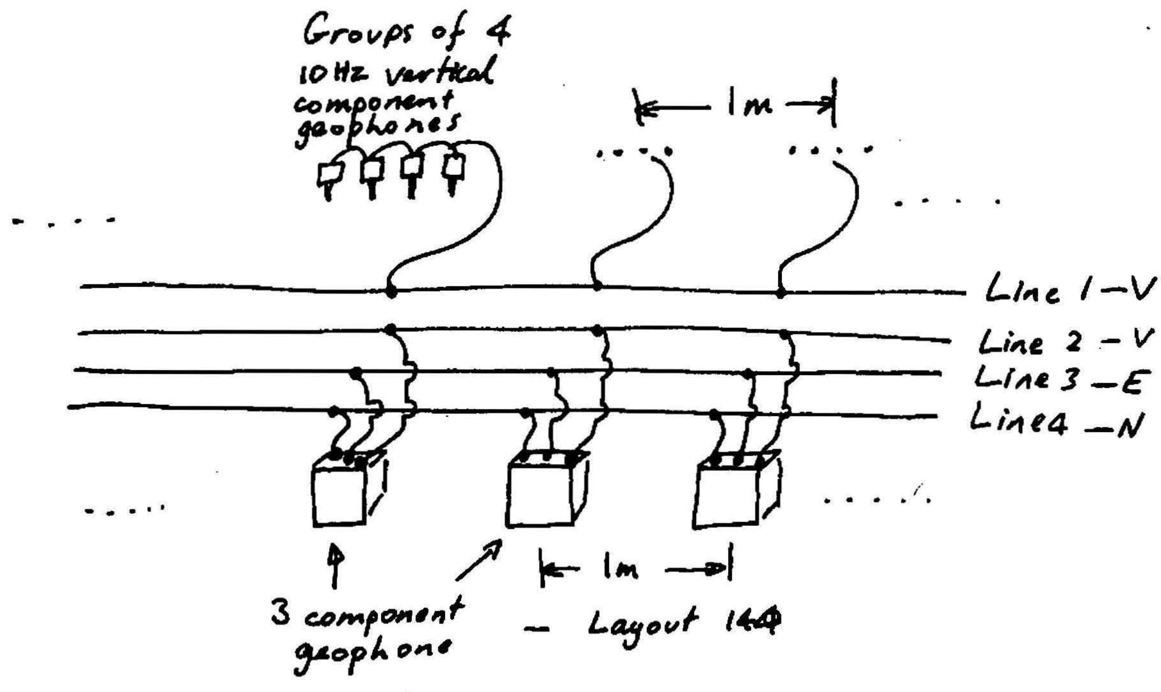
The other three lines would connect 144 3-component geophones, one line to the Z-component, one line to the E component, and one line to the N component, where N and E are parallel and orthogonal to the line direction. The geophones would be 1 m apart along the line, so that the line would be 143 m long.

With the minivibrator set to vertical mode, a series of tests would be conducted on sweep length, bandwidth, and number of sweeps per vibration point, recording into the vertical component geophones. The minivibrator would then sweep the entire line of 144 vertical component geophones, as well as record the vertical component of the three component phones. ANSIR has only around 400 active channels, so this exercise would ensure that the maximum number of channels are recorded in vertical mode before the next phase of coincident multicomponent work is undertaken.

If the vertical component recordings show comparable results from the vertical phones and the vertical components of the 3-component phones, then the recorder would then be set to 3 line mode to record the 3-component geophones, otherwise it would be set to 4 line mode, with 96 active channels per line. All four lines would be swept in roll along mode from end to end with the minivibrator in vertical mode. If sufficient time exists at the end of the day, the line could be extended beyond 144 stations.

The recorder would then be converted to horizontal mode. A series of sweep tests similar to those for P would be undertaken. The lines would then be swept twice with the vibrator in the in-line direction, and twice with it at right angles to the line, with the first motion in each direction reversed between each sweep of the line, so that the records from each vibration point can be added to enhance P and subtracted to enhance S.

The individual lines should be recorded as separate lines within the ARAM system for ease of processing.



10. MINIMUM EQUIPMENT CONFIGURATION

Source: Minivibrator + operator
Recorder: ARAM plus observer
Sensors: 144×10 Hz geophones in groups of 4

11. ALTERNATIVE PROJECT DATES & TIMING CONSTRAINTS

Funding: Final accounts need to be paid by early June.

12. NATURE AND SOURCE OF FUNDING

Government appropriation

The Institution proposing a project is responsible for the costs of the project, including mobilisation of the equipment and the costs of any ANSIR personnel used in support of the project. The Institution is required to provide a guarantee of Insurance for all equipment used in the project.

13. SIGNATURE OF PRINCIPAL INVESTIGATOR

.... DATE: ....

14. CONFIRMATION OF INSTITUTIONAL SUPPORT AND ACCEPTANCE OF THE STANDARD TERMS FOR ACCESS TO ANSIR EQUIPMENT

.... DATE: ....

POSITION HELD:

APPENDIX 2 EQUIPMENT

SEISMIC RECORDING EQUIPMENT

Geo-X ARAM24 NT (Ver 1.309) 24B-63 Seismic Data Acquisition System
45 x Remote Acquisition Modules (360 Channels)
45 x Telemetry Data Cables (360 Channels), 104 metres long with 8 take-outs at 13 metres.
119 x Geospace GS-20DM (14Hz), 3-component geophones
120 x Geospace GS-32CT Groups of four 10Hz geophones

1 x IVI RTS-100 Vibrator Sweep Controller

Geo-X website http://www.aram.com/
Geospace website http://www.geospacelp.com/

SOURCE EQUIPMENT

1 x IVI MiniVib T15000 Peak Force is 6000 lbs, P & S-wave mode
1 x IVI ST-100 Controller
1 x 386 based PC with IVI Sweep Generating Software

IVI website http://www.indvehicles.com/9min.htm

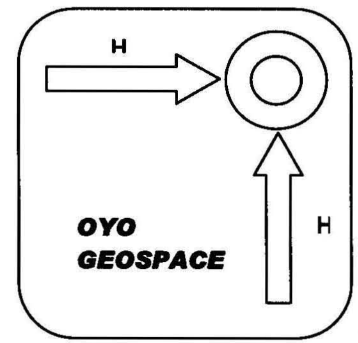
VEHICLES

1 x Toyota Landcruiser 4x4 Station Wagon
1 x Toyota Landcruiser 4x4 Cable/Geophone Ute
1 x Isuzu 4x4 Recording Truck
1 x Isuzu 4x2 Minivib
1 x Dual Axle Enclosed Trailer

Geophone Specifications

Geophone Type	Series	Parallel	Fn (Hz)	Rc (Ω)	G (V/cm/s)	m(g)	bo	Ro (Ω)	Rs (Ω)	bt	Rg (Ω)	Zg (Ω)	Array Resist.	Array Imped.	Length (m)	Spacing (m)	Nos. of Strings
GS-20DM (3)	1	1	14	240	0.177	7.8	0.700	326	0	0.7	240	566	240	566			36 + 84
GS-32CT	2	2	10	395	0.275	11.2	0.316	1700	1000	0.7	283	677	283	677	12	4	200

GS-



- **Fn** natural frequency
- **Rc** coil resistance (ohms)
- **G** intrinsic voltage sensitivity (transduction constant)
- **m** suspended mass (grams)
- **bo** intrinsic or open circuit damping (due to coil form principally)
- **Ro** $10^7 G^2/(2\ PI\ Fn\ m\ 2bo)$ equivalent open circuit damping resistor (ohms)
- **Rs** shunt resistance (ohms)
- **bc** damping due to coil currents with a shunt resistor, neglecting coil inductance
- **bt** bo + bc total damping
- **Rg** Rc//Rs geophone resistance (ohms)
- **Zg** (Ro + Rc)//Rs maximum geophone impedance (at resonance)

Note: All geophone arrays and assemblies are wired such that the "Positive" wire is connected to the "Wide" contact of the CTO-21 connector, and that the "Negative" wire connects to the "Narrow" contact of the CTO-21 connector.

APPENDIX 3 NSW STATE FORESTS PERMIT

APPLICATION FOR SPECIAL PURPOSES PERMIT TO CONDUCT RESEARCH IN NEW SOUTH WALES STATE FOREST

Form No. R20/98

SPECIAL PURPOSE PERMITS FOR RESEARCH

STATE FORESTS

State Forests of
New South Wales

Research and Development Division

121-131 Oratava Avenue
West Pennant Hills NSW 2125
PO Box 100
Beecroft NSW 2119 Australia
Phone (02) 9872 0111
Fax (02) 9871 6941

APPLICATION FOR SPECIAL PURPOSES PERMIT TO CONDUCT RESEARCH IN NEW SOUTH WALES STATE FORESTS

The undersigned applies for a Permit as above designated and hereby agrees to abide by the interactions and conditions overleaf.

1. Name Tim Barton

Employer Commonwealth of Australia, Geoscience Australia

Address GPO Box 378 Canberra

ACT Postcode 2601

Tel 02 6249 9625 (h) 0412 501 836 (w) Fax 02 62 4999 972

.... 10th April 2003
Signature of applicant Date

Other persons intended to be covered by application (if more than two, supply separate list)

2. Name Dr Barry Drummond	3. Name
Employer Geoscience Australia	Employer
Address GPO Box 378 Canberra	Address
ACT Postcode 2601	Postcode

4. Qualifications and experience of applicants

Geophysicists with 20+ years experience in seismic reflection data acquisition

Office Use Only

Recommended Permit be issued subject to additional Condition/s attached*

Regional Manager ....

Date ....

** Delete if inappropriate*

....
DEPUTY GENERAL MANAGER
RESEARCH AND DEVELOPMENT DIVISION

PROJECT DETAILS

5. PROJECT TITLE AND OBJECTIVE *(please attach separate information if insufficient space)*

Experimental High resolution 3-component seismic reflection survey

The objective of this project is to trial a number of different seismic acquisition parameters to provide a specialized dataset for researchers. This will be used to develop seismic acquisition and processing techniques that will be applicable to the seismic imaging of the regolith and depth to water tables. The chosen site in the Pilliga State Forest is an area where Geoscience Australia (previously known as the BMR and AGSO) have conducted previous (1989 and 1991) large scale seismic surveys. This area is known to provide good shallow seismic data and has been chosen on this basis. The survey will be undertaken by the Australian National Seismic Imaging Resource (ANSIR) a Commonwealth Government Major National Research Facility.

6. PROPOSED RESEARCH AREA Pilliga State Forest along the verge of Sparrow Road, approx 5 km west of Newell Highway. Survey line will be along 200 to 300m of road verge.

(STATE FORESTS GRID REFERENCE OR MARKED MAP) In the vicinity of Site 4 on the attached map.

Approx location is:

Latitude -30.577 S Longitude: 149.540 E

7. NATIONAL PARKS AND WILDLIFE SERVICE
SCIENTIFIC LICENCE NUMBER/S Not Applicable VALID TO *(date)*
(Please attach copy)

8. C.S.I.R.O. BIRD BANDING LICENCE NUMBER/S Not Applicable
(Please attach copy)

9. DOES THIS PROJECT INVOLVE TRAPPING, COLLECTING OR SURVEY OF VERTEBRATE ANIMALS?
YES/NO No IF YES, ATTACH COPY OF ANIMAL RESEARCH AUTHORITY.
(see Form R21/98 for details of Animal Research Authority)

ANIMAL CARE AND ETHICS APPROVAL

NAME OF COMMITTEE

AUTHORITY NO.

VALID PERIOD

10. DESCRIPTION OF FIELD ACTIVITY INCLUDING SPECIES TO BE COLLECTED/TRAPPED INCLUDING QUANTITIES AND METHODS OF COLLECTION
(Please attach separate information if insufficient space)

This project involves NO collection of samples or species of any description.

The techniques employed in the data collection are non-invasive and do not require any significant disturbance to the site used.

The field activities for this project consist of laying cables and geophones (fig 1.) along the road verge at 1 m intervals and connecting the cables to a truck containing a data acquisition system (fig 2.). The seismic data is collected using a Mini-Vibrator source (fig 3.) that is mounted on a small truck which lowers a plate to the ground surface and hydraulically vibrates the plate to impart seismic waves into the ground. Fig 4 shows a schematic of the field operations. The resulting seismic waves are detected by the geophones and transmitted via the cables to the recording system

As this is a high resolution seismic survey the total seismic line length will be of the order of a few hundred metres.

This experiment is envisaged to take 3 to 4 days of field activities weather permitting.

Fig 1. Cables and geophones

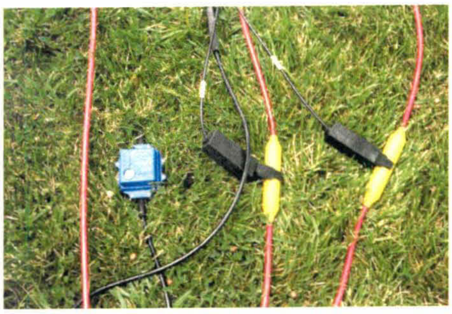
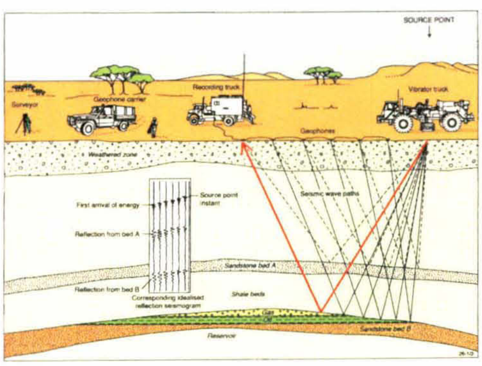


Fig 2 Recording Cab

Fig 3 Mini-Vibrator

Fig 4 Schematic of seismic operations



PERIOD OF ACTIVITY: FROM 13 April 2003 TO 16 April 2003

APPENDIX 4 CREW LIST (13/4/2003 – 17/4/2003)

	NAME	POSITION
1	Tim Barton	Crew Chief / Geophysicist (GA)
2	Mike Bokor	Observer (Trace Energy Services)
3	Alan Crawford	MiniVib Operator (GA)
4	Tanya Fomin	Geophysicist (GA)
5	David Johnstone	Geophysicist (GA)
6	Leonie Jones	Geophysicist / Processor (GA)
7	Peter Taylor	Field Assistant (GA)
8	Derecke Palmer	Geophysicist (UNSW) 13/4-14/4
9	Ramin Nikrouz	PhD student (UNSW) 13/4-14/4
10	Andrew Spyrou	Student (UNSW) 13/4-14/4

APPENDIX 5 SEISMIC LINE LOCATION

Line 03GA-MC

1 m station spacing. The line

Hand held GPS readings 15/4/2003.

Datum WGS84
Zone 55
Co-ordinates MGA94

Station	Easting	Northing	Distance (m)	Av. Station Spacing (m)
1000	743795	6614697	0.0	
1060	743856	6614689	61.5	1.03
1119	743911	6614655	56.1	0.95
1239	744030	6614655	121.2	1.01
			238.8	

Note: no elevation data available. Elevation variation along entire line <0.2 m.

Line BMR89-T04

60 m station spacing.

Co-ordinate AMG values extrapolated from 1.:250 000 topographic maps.

Datum AGD66
Zone 55
Height AHD
Co-ordinates AMG

Station	Easting	Northing	Elevation (m)	Comments
4000	741780	6615280	266.00	
4035			266.44	
4036			266.24	Uphole shoot at Station 4036.
4037			266.14	
4095	747410	6614360	265.36	

Line BMR91-G01 – in the region of line 03GA-MC test line

60 m station spacing.

Total station surveying with AGA Geoidometer.

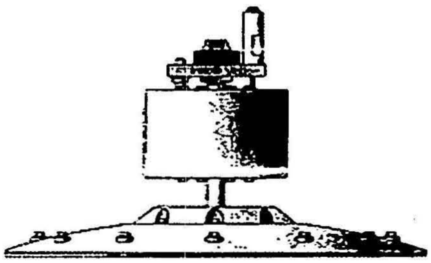
Datum AGD66
Zone 55
Height AHD
Co-ordinates AMG

Station	Easting	Northing	Elevation (m)	Comments	
1934	741499	6614910	266.8		
1934+7m	741505	6614903	267.0	PM & BMR89-T04	SP 4000
1981	744273	6614400	264.6		
1981+33m	744305	6614388	265.1	PM & BMR89-T04	SP 4048
2027	746989	6613902	266.9		
2027+59m	747046	6613887	267.0	PM & BMR89-T04	SP 4095

APPENDIX 6 MINIVIB SOURCE SYSTEM OVERVIEW

INDUSTRIAL VEHICLES INTERNATIONAL, INC.

6737 EAST 12TH STREET, TULSA, OKLAHOMA 74112 U.S.A. PHONE (918)836-6516 E-MAIL:IVI@INDUSTRIALVEHICLES.COM FAX (918)838-8529



'minivib' Seismic Source System

OVERVIEW

The 'minivib' is a high fidelity, controllable, vibratory seismic source developed for geophysical surveys. It is capable of generating a frequency modulated signal over a range of 5.8 octaves from 10 to 550 Hz.

Unlike other traditional seismic sources like dynamite and impulse sources the 'minivib' is an environmentally "soft" source which spreads its energy out in time. Surface impulse sources will generate an area of high impact or pressure on a small area of the ground. This will result in surface damage and large ground roll. Ground roll is very difficult to overcome, particularly in very shallow surveys.

The 'minivib' is different than standard Oil and Gas exploration vibrators in that the 'minivib' is a more efficient acoustic projector than a traditional vibrator, and is also able to generate much broader bandwidth signals. From this perspective it is not correct to put the 'minivib' in the same category as other vibrators. The 'minivib' generates less ground roll than a traditional vibrator.

Since the 'minvib' has such an unusually broadband output, it is able to be applied to a wide variety of surveys. For the first time, it is possible to do very high resolution engineering surveys tens of meters deep, and also do deeper oil and gas surveys with the same source. It is necessary, though, to configure the survey parameters differently to obtain these diverse objectives. Since the 'minivib' source signal can be so dramatically altered to each survey's unique objectives, it is necessary for the attending geophysicist to be actively involved in defining the source parameters. And, since the 'minivib' can be field converted to generate either P-wave or S-wave output, it offers much greater flexibility than other sources.

THE SYSTEM

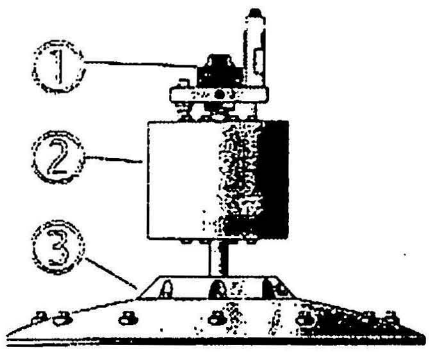
The 'minivib' system consists of four major components. These four components are the projector, the power supply, the deployment system, and the controller. The projector radiates an acoustic signal into the earth. The power supply supplies the projector with the necessary hydraulic pressure and flow. The deployment system defines the mobility, productivity, and environmental impact of the 'minivib'. The controller generates an electrical signal which drives the projector and triggers the system.

1. THE PROJECTOR

The 'minivib' projector converts the electrical signal generated in the controller into an acoustic wave which radiates down into the earth. The 'minivib' system strives to project a high fidelity signal in an acoustically efficient way.

'minivib'

THE SERVOVALVE
The 'minivib' servovalve converts the electrical signal generated in the controller into a hydraulic signal.



The High Fidelity 'minivib' acoustic projector

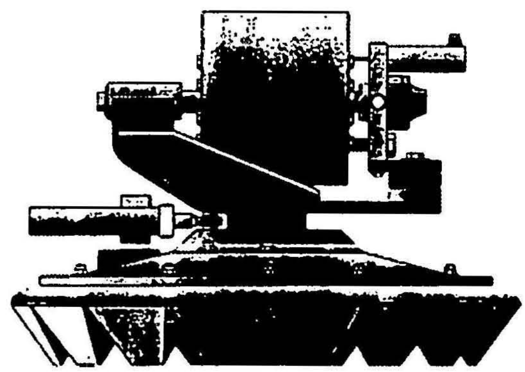
THE ACTUATOR
The 'minivib' actuator converts the hydraulic signal into mechanical motion.

THE BASEPLATE The 'minivib' baseplate is designed and constructed to transparently pass the signal generated by the actuator into the earth.

SHEARWAVE OPTION
The normal P-wave configuration of the projector can be converted, in the field, into an S-wave projector. This is done by repositioning the actuator horizontally, and adding a shearwave baseplate attachment.

2. THE POWER SUPPLY
The 'minivib' power supply consists of an engine driven hydraulic pump and other hydraulic accessories such as filters, coolers, tanks, and valves. The hydraulic pressure and flow necessary to actuate the projector comes from the power supply. The exact configuration of the power supply will vary depending on the deployment system.

3. THE DEPLOYMENT SYSTEM
There are currently four deployment systems available for the 'minivib'. These include the T-2500, the T-7000, the T-15000, and the 'minibuggy'. The two main considerations of the various deployment systems are the mobility of the system in the field, and the amount of holddown weight which each system can exert on the baseplate. It is important to understand the relevance of holddown weight to the 'minivib' system. Each 'minivib' deployment system weighs a set amount. Each system also is able to put some amount of this total weight onto the baseplate of the 'minivib'. This is referred to as holddown weight. Theoretically, the 'minivib' can generate a maximum of 6,000 pounds of output force. This theoretical output can only become actual output if the holddown weight is greater than 6,000 pounds. If the holddown weight of the system is less than 6,000 pounds then the actual output of the 'minivib' will be less than the theoretical maximum.



The Shearwave 'minivib'

APPENDIX 7 TEST PROGRAM

NARRABRI Multi-component seismic survey — 13/04/2003 & 15/04/2003
1 m group interval, 1 m vibe interval — Survey No L160
0.5 ms sample rate
Record length 2 sec — Project code 23008
MiniVib in P-wave mode

FFID No.	Test No.	VP	Set No.	Spread	Reference Sweep	Sweep Freq. (Hz)	No. Sweeps	Sweep length (sec)	Comments
547	1	1000	1	1000-1119	FGF	10-80	3	9	**Sweep frequency test**
548		1001		1000-1119					Void files 545, 546, 550-552
549		1002		1000-1119					(observer comments.doc)
553		1059		1000-1119					**R1** - vertical geophones
554		1060		1000-1119					**R2** - Z vertical from 3C
555		1061		1000-1119					
556		1237		1000-1119					
557		1238		1000-1119					
558		1239		1000-1119					
559	2	1000		1000-1119	FGF	10-120	3	9	**Sweep frequency test**
560		1001		1000-1119					**R1** - vertical geophones
561		1002		1000-1119					**R2** - Z vertical from 3C
562		1059		1000-1119					**R3** - H2 cross-line from 3C
563		1060		1000-1119					
564		1061		1000-1119					
565		1237		1000-1119					
566		1238		1000-1119					
567		1239		1000-1119					
568	3	1000		1000-1119	FGF	10-200	3	9	**Sweep frequency test**
569		1001		1000-1119					
570		1002		1000-1119					
571		1059		1000-1119					
572		1060		1000-1119					
573		1061		1000-1119					
574		1237		1000-1119					
575		1238		1000-1119					
576		1239		1000-1119					
577	4	1000		1000-1119	FGF	10-250	3	9	**Sweep frequency test**
578		1001		1000-1119					
579		1002		1000-1119					
580		1059		1000-1119					
581		1060		1000-1119					
582		1061		1000-1119					
583		1237		1000-1119					
584		1238		1000-1119					
585		1239		1000-1119					
586	5	1000		1000-1119	FGF	20-200	3	9	**Sweep frequency test**
587		1001		1000-1119					
588		1002		1000-1119					
589		1059		1000-1119					
590		1060		1000-1119					
591		1061		1000-1119					
592		1237		1000-1119					
593		1238		1000-1119					
594		1239		1000-1119					

595	**6**	**1000**		1000-1119	FGF	20-250	3	9	**Sweep frequency test**
596		**1001**		1000-1119					
597		**1002**		1000-1119					
598		**1059**		1000-1119					
599		**1060**		1000-1119					
600		**1061**		1000-1119					
601		**1237**		1000-1119					
602		**1238**		1000-1119					
603		**1239**		1000-1119					
604	**7**	**1000**		1000-1119	FGF	10-300	3	9	**Sweep frequency test**
605		**1001**		1000-1119					
606		**1002**		1000-1119					
607		**1059**		1000-1119					
608		**1060**		1000-1119					
609		**1061**		1000-1119					
610		**1237**		1000-1119					
611		**1238**		1000-1119					
612		**1239**		1000-1119					
613	**8**	**1000**	**2**	1000-1119	FGF	10-250	3	3	**Sweep length test**
614		**1001**		1000-1119					
615		**1002**		1000-1119					
616		**1059**		1000-1119					
617		**1237**		1000-1119					
618	**9**	**1000**		1000-1119	FGF	10-250	3	6	**Sweep length test**
619		**1001**		1000-1119					In observer's log instead of
620		**1002**		1000-1119					VP numbers 1237, 1238 &
621		**1237**		1000-1119					1239 are number 1237,
622		**1238**		1000-1119					1238 &1239 (see Observer
623		**1239**		1000-1119					comments.doc)
624		**1059**		1000-1119					
625		**1060**		1000-1119					
626		**1061**		1000-1119					
627	**10**	**1000**		1000-1119	FGF	10-250	3	12	**Sweep length test**
628		**1001**		1000-1119					
629		**1059**		1000-1119					
630		**1060**		1000-1119					
631		**1237**		1000-1119					
632		**1238**		1000-1119					
633	**11**	**1000**	**3**	1000-1119	FGF	10-250	1x4	9	**No. Sweeps test**
634		**1001**		1000-1119					**cross-correlate each sweep**
635		**1002**		1000-1119					**with reference signal**
636		**1059**		1000-1119					**before stack**
637		**1060**		1000-1119					
638		**1061**		1000-1119					
639		**1237**		1000-1119					
640		**1238**		1000-1119					
641		**1239**		1000-1119					
642	**12**	**1000**		1000-1119	FGF	10-250	4	9	**No. Sweeps test**
643		**1001**		1000-1119					**cross-correlate after stack**
644		**1002**		1000-1119					**R1** - H1 in-line from 3C
645		**1059**		1000-1119					**R2** - Z vertical from 3C
646		**1060**		1000-1119					**R3** - H2 cross-line from 3C
647		**1061**		1000-1119					
648		**1237**		1000-1119					
649		**1238**		1000-1119					
650		**1239**		1000-1119					

651	**13**	**1000**	4	1000-1119	GF	10-250	3	9	**Reference sweep test**
652		**1001**		1000-1119					
653		**1002**		1000-1119					
654		**1059**		1000-1119					
655		**1060**		1000-1119					
656		**1061**		1000-1119					
657		**1237**		1000-1119					
658		**1238**		1000-1119					
659		**1239**		1000-1119					
660	**14**	**1000**		1000-1119	SYN	10-250	3	9	**Reference sweep test**
661		**1001**		1000-1119					
662		**1002**		1000-1119					
663		**1059**		1000-1119					
664		**1060**		1000-1119					
665		**1061**		1000-1119					
666		**1237**		1000-1119					
667		**1238**		1000-1119					
668		**1239**		1000-1119					

APPENDIX 8 ARAM24 OBSERVERS LOG

****Date: 2003/04/14

Time	File #	Comments
06:51:02	545	Start of Testing 10-80Hz 3 Sweeps 9 Seconds FGF Reference
06:52:50	546	Void file 545 - Wrong sweep length 10-80Hz 3 Sweeps 9 Seconds FGF Reference
06:54:16	547	Void file 546 - Wrong SP number 10-80Hz 3 Sweeps 9 Seconds FGF Reference
06:55:54	548	10-80Hz 3 Sweeps 9 Seconds FGF Reference
06:56:57	549	10-80Hz 3 Sweeps 9 Seconds FGF Reference
06:59:51	550	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:01:14	551	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:02:09	552	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:04:53	553	Void files 550 to 552 Vibe in wrong position 10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:07:14	554	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:08:08	555	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:11:07	556	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:14:34	557	10-80Hz 3 Sweeps 9 Seconds FGF Reference
07:15:28	558	10-80Hz 3 Sweeps 9 Seconds FGF Reference

****Date: 2003/04/15

Time	File #	Comments
10:31:28	559	Vibe offset 4M from phones 10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:36:34	560	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:37:43	561	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:39:09	562	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:40:04	563	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:41:00	564	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:43:18	565	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:44:17	566	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:45:10	567	10-120 Hz 3 Sweeps 9 Seconds FGF Reference
10:53:08	568	10-200 Hz 3 Sweeps 9 Seconds FGF Reference
10:54:30	569	10-200 Hz 3 Sweeps 9 Seconds FGF Reference
10:56:41	570	10-200 Hz 3 Sweeps 9 Seconds FGF Reference
10:58:01	571	10-200 Hz 3 Sweeps 9 Seconds FGF Reference
10:59:03	572	10-200 Hz 3 Sweeps 9 Seconds FGF Reference
11:00:09	573	10-200 Hz 3 Sweeps 9 Seconds FGF Reference

11:02:23	574	10-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:03:18	575	10-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:04:18	576	10-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:10:22	577	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:11:14	578	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:12:13	579	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:13:26	580	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:14:23	581	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:15:12	582	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:16:59	583	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:17:58	584	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:18:48	585	10-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:22:49	586	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:24:17	587	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:25:07	588	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:26:33	589	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:27:22	590	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:28:14	591	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:29:53	592	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:30:45	593	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:31:37	594	20-200 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:35:43	595	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:36:36	596	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:37:27	597	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:38:53	598	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:39:42	599	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:40:31	600	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:42:11	601	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:43:01	602	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:44:13	603	20-250 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:50:44	604	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:51:38	605	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:53:01	606	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:54:22	607	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:55:13	608	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference
11:56:06	609	10-300 Hz	3	Sweeps	9	Seconds	FGF	Reference

11:57:54	610	10-300 Hz 3 Sweeps 9 Seconds FGF Reference
11:58:46	611	10-300 Hz 3 Sweeps 9 Seconds FGF Reference
11:59:36	612	10-300 Hz 3 Sweeps 9 Seconds FGF Reference
12:04:08	613	10-250 Hz 3 Sweeps 3 Seconds FGF Reference
12:04:57	614	10-250 Hz 3 Sweeps 3 Seconds FGF Reference
12:05:46	615	10-250 Hz 3 Sweeps 3 Seconds FGF Reference
12:07:04	616	10-250 Hz 3 Sweeps 3 Seconds FGF Reference
12:09:08	617	10-250 Hz 3 Sweeps 3 Seconds FGF Reference
12:14:05	618	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:14:54	619	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:16:29	620	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:18:56	621	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:19:53	622	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:20:41	623	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:24:05	624	1037 To 1039 Should be 1237 To 1239 10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:24:52	625	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:25:39	626	10-250 Hz 3 Sweeps 6 Seconds FGF Reference
12:30:37	627	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
12:31:31	628	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
12:33:10	629	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
12:34:12	630	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
12:36:00	631	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
12:36:54	632	10-250 Hz 3 Sweeps 12 Seconds FGF Reference
13:01:18	633	Correlate Before Stack 10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:02:26	634	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:03:31	635	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:05:07	636	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:06:12	637	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:07:23	638	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:09:17	639	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:10:26	640	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
13:11:34	641	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:14:52	642	Correlate After Stack. R1 Geophones have been changed to H1 10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:16:28	643	Tania Scares all the people in the truck 10-250 Hz 4 Sweeps 9 Seconds FGF Reference

14:17:58	644	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:19:44	645	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:22:20	646	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:23:29	647	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:25:35	648	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:26:41	649	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:27:53	650	10-250 Hz 4 Sweeps 9 Seconds FGF Reference
14:33:35	651	Back to Correlate Before Stack 10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:34:47	652	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:35:47	653	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:37:14	654	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:38:16	655	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:39:38	656	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:41:30	657	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:42:25	658	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:43:23	659	10-250 Hz 3 Sweeps 9 Seconds GF Reference
14:47:46	660	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:48:52	661	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:49:47	662	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:51:20	663	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:52:13	664	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:53:06	665	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:55:03	666	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:56:03	667	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
14:57:03	668	10-250 Hz 3 Sweeps 9 Seconds SYN Reference
15:01:10	669	Aram Start Time set to 594,175 10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:19:11	670	Calibration Data Applied in Sweep Ware 10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:22:53	671	10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:24:43	672	10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:27:31	673	10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:28:29	674	10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:31:11	675	Flitered FGF Software 10-250 Hz 3 Sweeps 9 Seconds FGF Reference
15:43:07	676	Start of Production 10-250 Hz 3 Sweeps 9 Seconds FGF Reference
16:48:40	745	Reshot - Wrong vibe position

16:50:22	747	Void files 742,743,744
17:26:25	772	Power Shutdown
17:27:37	773	Shooting 2 M VP

****Date: 2003/04/16

Time	File #	Comments
10:38:05	787	Start of S Wave tests. Top of Mass is on the right of the truck
10:40:12	789	R1=H1, R2=Ver, R3=H2
11:40:38	848	Start again. Top of Mass on the left side of the truck
12:55:56	909	Start again. Top of Mass at the front of the truck
13:33:47	955	Void file 954
13:56:09	971	Start again. Top of Mass at the rear of the truck
14:17:03	995	Void file 994
14:40:55	1024	Void File 1023
14:51:47	1034	Shooting Off End. 4M Source Interval
14:53:12	1035	Void File 1034 - Missed Sweeps
14:55:00	1037	Top of Mass is at the back of the truck for this data set
15:02:25	1045	Void File 1044
15:05:36	1046	Truck turned around and shooting back through the spread
15:16:49	1056	Start again. Top of Mass to the left of the truck
15:27:48	1066	Truck shoots back through the spread. Top of Mass to the right
15:35:33	1075	End of Narrabri

APPENDIX 9 FIELD TAPE LISTING

3490E Tapes

#	Line	Tape No.	FFID(1)	FFID(n)	Comments
1	03GA-MC	L16003001	545	708	Files 545 To 675 are tests
2	03GA-MC	L16003002	709	868	
3	03GA-MC	L16003003	869	1028	
4	03GA-MC	L16003004	1029	1075	

Exabyte Tapes

1	03GA-MC	E16003001	545	786	Files 545 To 675 are tests
2	03GA-MC	E16003002	787	1075	