

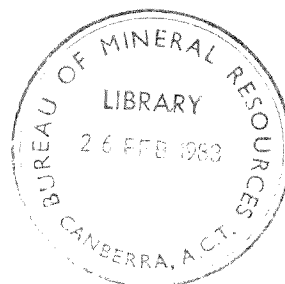
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD



Record 1987/62

Tumut Trough Seismic Survey

New South Wales, 1987.

Operational Report

by

J.H. Leven and M. Rickard

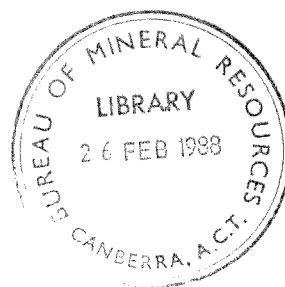
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The authors wish to acknowledge the contribution
of all members of the seismic party.

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ABSTRACT

A joint project between the Geology Department of the Australian National University and the Geophysics Division of the Bureau of Mineral Resources, Geology and Geophysics was conducted to investigate the crustal structure underlying the Tumut Trough, NSW. The objective of this survey was to image the bounding faults of the Tumut Trough, in order to test various geological models which have been proposed for its formation.

Forty five kilometres of nominal 8-fold common mid-point (CMP) seismic reflection data were collected in the two week recording period of the ANU vacation, from the 4-16 May. The traverse was chosen to cross the trough perpendicular to strike given the constraint of using existing roads and tracks. The seismic traverse started 8 km NNE of Adjungbilly and finished 3 km SW of Midway.

There is no evidence in the seismic data of the listric bounding faults which were envisaged prior to the survey. A particularly strong reflection event was observed in the vicinity of Adjungbilly beneath the Young Granodiorite at 7.2 seconds two-way reflection time (twt) dipping to the west. Other reflection events beneath the trough are generally weak and dip to the east.

In addition to the CMP seismic reflection data, two "piggy-back" experiments were conducted using portable seismic recording equipment which recorded the production shots. The first of these was a tomographic experiment designed to image the Coolac Serpentine to a depth of a few kilometres depth using refracted arrivals. Thirty two BMR analogue recorders and 14 ANU digital recorders (RSES) were deployed in an array surrounding the Honeysuckle Range for the duration of this tomographic experiment. The second experiment recorded 3-component seismic data from the production shots to investigate the use of shear wave seismic phases in the interpretation of near surface structure. In addition gravity observations were made at a nominal 360 metre interval along the traverse by the Potential Fields Group of the BMR.

The seismic data are currently being processed using the BMR's DISCO Seismic Processing Facility, and a preliminary line diagram of the reflection segments has been incorporated into this report.

INTRODUCTION

1.1 Background

The idea of a seismic survey across the Tumut Trough had been proposed before, and was included as one of the Australian Continental Reflection Profiling (ACORP) programs which were proposed by the Lithospheric Transect Studies of the Australian Continent (LITSAC) committee, as discussed by Moss and Goleby (1985). However, it is unlikely that the planned schedule of these ACORP proposals would have accommodated the Tumut project within the next decade.

The BMR program for the use of the SERCEL SN368 seismic acquisition system suggested that a short field trial near Canberra for the SN368 would be advantageous before the planned Canning Basin survey, to investigate intermittent equipment failure which had been identified during earlier test at Millmerran, Queensland (Johnstone and others, 1987) and the Southeast Queensland survey of 1986 (Wake-Dyster & Barton, in prep.). On this basis, the Geology Department, ANU submitted a proposal to the ANU Faculty Research Grant Scheme to fund a portion of the cost of a seismic survey across the Tumut Trough. A faculty research grant was awarded to the Geology Department, and subsequently, the BMR agreed to fund the remaining cost of this survey.

Students from the Geology Department were employed as field hands for this survey. This placed a rigid time constraint on the survey, as the seismic recording had to be completed within the two week student vacation period.

1.2 Aims and Objectives

The aim of this survey was to use the seismic reflection method to image the bounding faults of the Tumut Trough, and thereby test the various models which had been proposed for the formation of this trough.

1.3 Location and Maps

The location of the survey was severely constrained by the inability to bulldoze the seismic line as has been usual BMR practice for prior surveys. This was due to:

- (a) the sensitive rural environment of the Tumut Valley,
- (b) restrictions on clearing within the region due to erosion control, and
- (c) lack of available funds for such earthworks.

Three survey routes which transected the trough roughly perpendicular to its strike were suggested on the basis of

existing roads and tracks. A reconnaissance trip to investigate these settled on the route from Adjungbilly through Brungle, along the Westview-Califat Road to the Bandang Road (Figure 1). The survey area is covered by the Tumut 1:100,000 map sheet (8527, 1976). Four map sheets of the 1:25,000 series covered the area, and were generally used for operations: Adjungbilly, Tumorrana, Brungle, and Tumut. Figure 1 shows the location of the seismic line in relation to the boundaries of the trough.

1.4 Climate

As the Tumut Valley usually experiences wet winters, it was imperative that operations be completed before "the wet set in". Only one working day (Thursday 14 May) was lost due to rain, and the rainfall on this day did not hamper operations on the following days to the extent that had been expected. Two days of relatively strong wind were experienced on the 8 and 9 of May. Unfortunately these days corresponded with operations on the top of the Honeysuckle Range, and the consequent wind noise adversely affected the tomography experiment.

1.5 Associated Geophysical Surveys

Gravity measurements were made along the whole length of the survey traverse at a nominal spacing of 360 metres by the Potential Fields Group of the Division of Geophysics (Appendix 7). Although this duplicated some existing gravity work over a portion of the traverse, the better elevation and latitude control afforded by the surveyed seismic traverse warranted this work.

Five shot holes (Table 1) were logged using the BMR logging facility to obtain some measurement of the seismic velocity and density of the various rock types. A separate report will be made of these logging operations (Chopra and Spence, in prep.).

TABLE 1.
GEOPHYSICAL LOGGING OF SELECTED SHOTHOLES

Station	Depth metres	Rock type	Sonic Log	Density		Caliper Log
				Short	Long	
1926	26.3	Granite	X	X	X	X
1669	21.2	Serpentinite		X	X	X
1668	16.3	Serpentinite		X	X	X
1659	17.8	Harzburgite		X	X	X
1658	26.0	Harzburgite	X	X	X	X

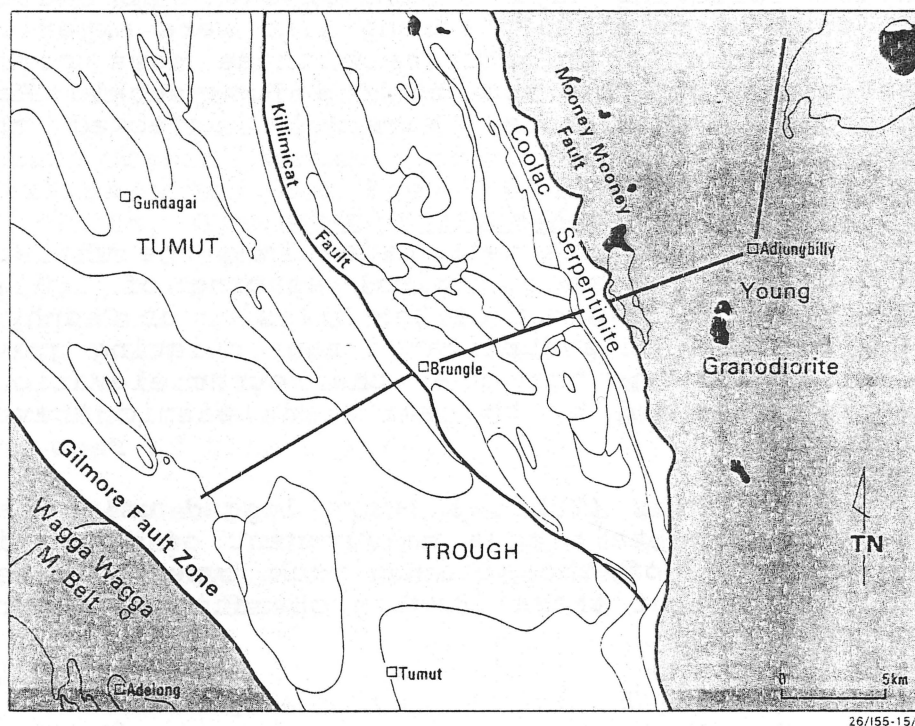


Figure 1. Locality map for the seismic traverse showing the major geological features of the Tumut Trough.

GEOLOGY

Interest in the Tumut Trough stems from the occurrence there of ultramafic rocks and Silurian flysch not found elsewhere in the Lachlan Fold Belt. The presence of ultramafic rocks along the boundary faults of the trough indicate deep penetration and involvement of mantle material. The association of ultramafics, gabbros, pillow basalts, cherts and turbidites with felsic volcanics has led to a variety of interpretations of the trough development from simple deep rift (Ashley and others, 1979), a pull-apart basin (Powell, 1983) to a collided island arc zone (Crook, 1980).

The stratigraphic sequence is set out in Figure 2. The earliest deposits were basic volcanics now highly deformed into nappe-like slices of actinolitic schists (Bullawyarra Schist). These represent an Ordovician Island Arc deposit distinctly different from the quartz-rich flysch found elsewhere in the Lachlan Fold Belt. Subsequent Silurian development of the trough involved different facies; with metabasalts and quartz-poor flysch in the east, and felsic and basic volcanics followed by quartz-intermediate to quartz-rich flysch and shales in the west. Both sequences were covered by extensive sheets of felsic S-type volcanics in the Middle Silurian (Blowering Volcanics). Volcanic activity continued with the Devonian I-type felsic volcanics and local granites and molasse sediments. Thus only in pre-Blowering times was the palaeogeography different from elsewhere in the Lachlan Fold Belt.

Deformation is variably mild to intense with strong folding and intense shearing along the major fault zones. Detailed geological mapping of the structure along the seismic traverse is described in another report (Stuart-Smith, in prep.).

Expected seismic targets were:

- 1) the major fault shear zones which were presumed to flatten eastwards at depth,
- 2) the Bullawyarra Schist should act as a local basement to the trough, since equivalent rocks crop out to the west of the Nacka Nacka amphibolite zone (Duff and others, 1985)
- 3) the large Young Batholith at the eastern margin was expected to show a floor in the 5-10 km depth zone.

Solution of the deep structure of the Tumut Trough will provide important constraints to the interpretation of the structural development and palaeogeography of the Lachlan Fold Belt.

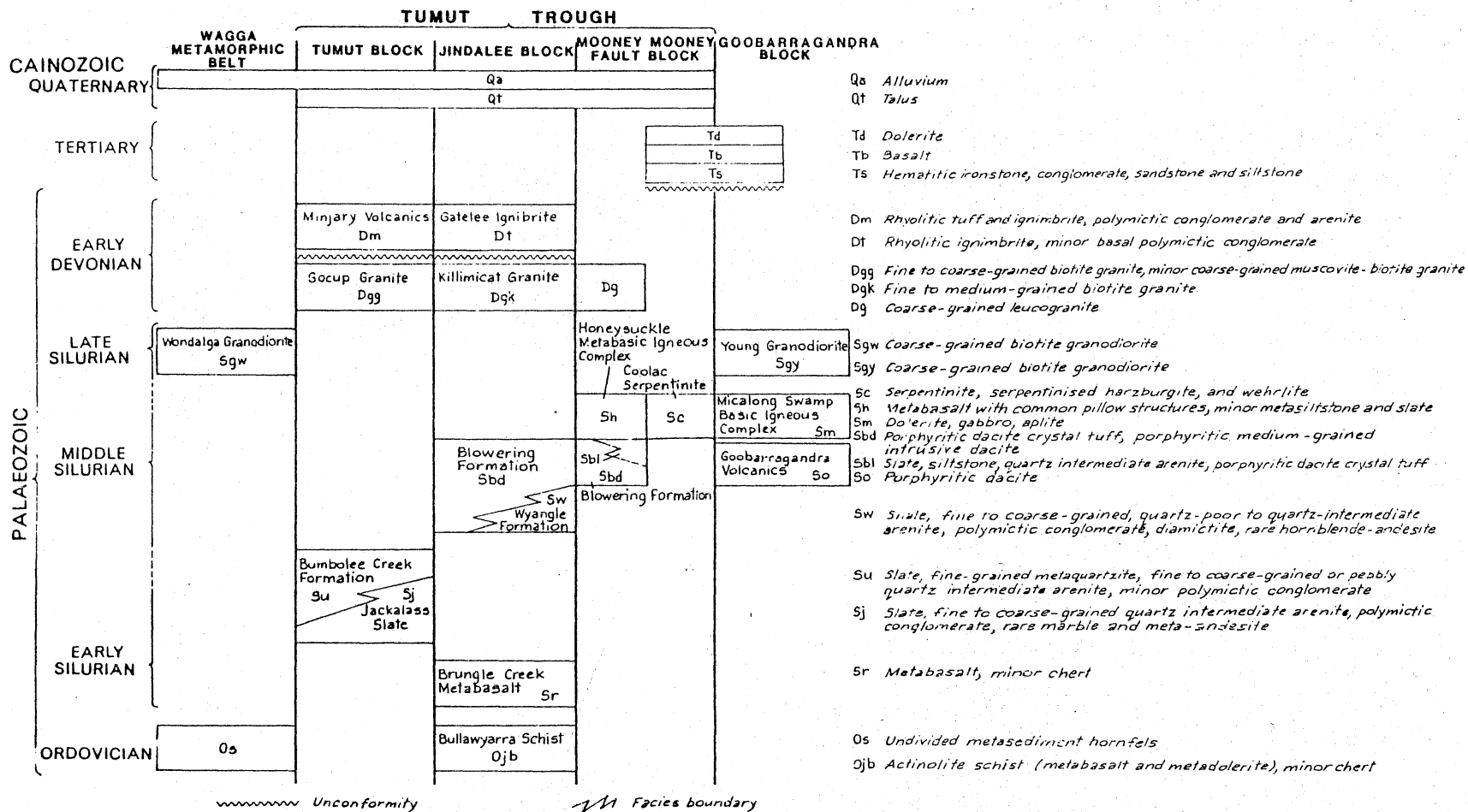


Figure 2. The geological units of the Tumut Trough region (after P. Stuart-Smith, 1988).

FIELD OPERATIONS

3.1 General

A single nominal 8 fold traverse was planned to cross the Tumut Trough with a length of 58.3 km. This line was geographically biased towards the the east and recording commenced at the eastern end as it was thought to be most likely that the bounding faults (which were the target of the survey) dipped eastwards at depth.

Progress of the seismic recording was slower than expected, due mainly to three factors:

(a) the difficulty of not having access along the whole traverse and the associated travel times around the various geographic obstacles which the trough provided,

(b) the intermittent failure of the SN368 equipment and the associated technical problems and delays,

(c) the additional time required while working in a populated area to ensure no vehicles were on the seismic spread before firing a shot.

Forty five of the planned fifty eight kilometres were recorded in the 2 week period.

3.2 Reconnaissance and Landowners Permission

Reconnaissance for the survey commenced in January 1987. The area's proximity to Canberra meant that most of the pre-survey organization was done on one or two day trips from Canberra. A reconnaissance trip which included representatives from the surveyors, drillers, geologists, and geophysicists investigated the feasibility of the proposed survey line early in January, and assessed that the difficulties were not insurmountable.

The names and addresses of landowners were obtained from the Tumut and Gundagai Shire Councils and the Wagga Lands Office. Posting of initial letters to landowners was coordinated with a press release to the local newspaper to disseminate information of our proposed activity. Personal visits were made to all landowners along the route, and permission sought to operate through their property. Most landowners were very cooperative and agreed to our operations. However, landowners in the vicinity of the Adelong gold fields were particularly sensitive to requests which related to "mineral operations" due to adverse past experience. Because of the small size of the average property, a significant effort was involved in this phase of the field operations.

3.3 Party Personnel, Vehicles and Accommodation

The total party comprised 37 persons, and a total of twenty three BMR vehicles were used during the course of the survey (Appendix 3).

During the survey, commercial accommodation in Tumut was used, as it was inefficient to set up a field camp for a two week period.

3.4 Surveying

Surveying of the seismic traverse was done by the Australian Survey Office. The surveying commenced on the 7 April and was completed on the 11 May. The seismic line was pegged then traversed using theodolite and electronic distance measuring equipment (EDM) to obtain station location and elevations. The accuracy of the EDM surveying was more than sufficient for the seismic and gravity surveys. Station spacing was 60 metres, and the stations were surveyed from east to west with the station numbers increasing to the east. The surveyors provided the AMG coordinates and the elevations referenced to the Australian Height Datum for all stations.

The surveyors also provided a valuable service by preparing "mud maps" which detailed the position of, and access to, the seismic line. In the case of this survey, where there was no bulldozed line, this information was essential.

3.5 Drilling and Explosives

Drilling commenced on the 27 April one week ahead of the seismic recording and finished on the 14 May. Three Mayhew rigs and associated tankers were used. Drilling conditions varied significantly along the traverse. Shotholes were not drilled to 40 metres (as is usual BMR practice), but were drilled to a depth such that the hole had one rod length into "hard rock". Hence the average depth of shotholes is 18 metres. This allowed reasonable drilling progress, while still achieving the aim of detonating shots below the weathering layer.

Charge sizes were either 8.2 or 12.3 kg of ANZITE blue. Larger charge sizes were used around the Honeysuckle Range to increase the distance at which these shots would be recorded by the portable seismic recorders used for the tomography experiment.

3.6 Seismic Recording

The recording parameters used for this survey are detailed in Appendix 2, and were similar to those used for the Millmerran equipment tests (Johnstone and others, 1987), as the time constraint did not allow experimental tests to be conducted.

One purpose of this survey was to field test the Sercel SN368 prior to the Canning Basin survey in 1988. Problems with the

recording unit persisted throughout the survey, and Table 2 lists those shots which gave system errors during recording. Additionally, the SN368 "locked up" on a number of occasions, but the cause of this has not been identified.

TABLE 2.

TAPE ERRORS DURING TUMUT SURVEY

TAPE PARITY	Shot Numbers		
	7A20	7A16	7A17
12	1	49*	128 #
13	21	115 #	44*
14	22		
44	64		
45	113		
55			
58			
62			
63			

* and other problems

non-recoverable problems on Demux

The decision to record the line from east to west when the station numbering increased towards the east meant that cable and recording operations were done backwards. This caused some problems for the operator and field hands, and although this operation conformed to BMR convention, this backward operation is not recommended for future surveys.

Field operations were similar to those described by Johnstone and others (1987), except that the spacing of shotpoints was not regular along the line. Requirements that no shots be detonated in close proximity to houses or concrete water tanks, and the need to concentrate shotpoints at bends in the traverse led to this irregular shotpoint distribution. Shotpoints were also concentrated around the Honeysuckle Range for the tomography experiment. As a consequence of this shot point spacing, the seismic spread location and common mid-point coverage for shots were designed in the field to maintain the sub-surface coverage on the assumption of straight line geometry. For future crooked-line surveys, it would be ideal if the surveying data and information on possible shot locations could be obtained prior to drilling, so that shotholes could be positioned to optimize the fold.

Radio firing of shots remote from the line was successfully used, both for undershooting the Honeysuckle Range and for the offline tomography shots. The off-line shots were fired over distances of up to 10 kilometres. Inherent in the radio firing is a time delay of 20 milliseconds (Johnstone, pers. com.).

3.7 Tomographic Experiment

An experiment designed to image the Coolac Serpentine using a tomographic technique was piggy-backed onto the reflection seismic recording experiment. The production shots of the reflection survey were recorded by an array of portable seismic recorders installed within a circle of radius 15 km centred on the point where the reflection traverse crossed the Honeysuckle Range. Thirty two portable recorders were deployed for this experiment, and these have been numbered from 2001 to 2032. Details of their location and the duration of their installation are listed in Appendixes 5 and 6.

3.8 3-Component Experiment

An auxiliary experiment to investigate the utility of recording 3-component data from a reflection survey was also piggy-backed, again using the production shots as sources. Sets of three portable seismic recorders were connected to 3-component geophones to record vertical, transverse and radial components.

PROCESSING AND PRELIMINARY RESULTS.

4.1 Data Processing

Data from the reflection survey has been processed at the BMR using the Disco system. Demux of the SEG-D tapes was performed using the SEGB module (Sexton, pers.com., 1987), as the DISCO SEG-D module version 6.0 did not work, and the DISCO SEG-D version 7.2 is currently unable to handle 20 second records recorded at 2 milliseconds sample rate. The most time consuming step in the processing to brute stack was the editing of the shot records. It was necessary to edit out as much as possible of the cultural noise recorded during the survey, as the target of the survey is relatively low amplitude reflections. Over 3000 seismic edits were manually applied to the data. Apart from this editing, the processing sequence followed the standard land-seismic sequence (e.g. Johnstone and others, 1987).

4.2 Brute Stack

Figure 3 shows a line diagram of sub-coherent reflection segments which have been manually digitized from the brute stack seismic section, with some surface geology also plotted to aid interpretation. Notably, there is no evidence for listric east dipping bounding faults which had been the target of the survey. Relatively strong reflected refractions can be seen from both the eastern and western edges of the trough. Towards the eastern side of the trough, the structure within the Ordovician basement is imaged by the fabric of the sub-coherent seismic reflection segments.

Beneath the Young Granodiorite there is a relatively "transparent" zone on the seismic section, indicating that there are no significant sub-horizontal impedance contrasts to a depth of about 9 kilometres. At a two way reflection time of 7.2 seconds there is a particularly strong reflection event, which was observed in the vicinity of Adjungbilly.

4.3 Processing of Tomography Data

Although the charge size of the production shots was increased for this tomography experiment, preliminary analysis of the data tapes indicates that the recording of the production shots beyond about 5 kilometres was not successful. Wind generated noise caused by relatively high winds during the three days shooting period near the Honeysuckle Range has resulted in poor signal-to-noise ratio of the refracted arrivals. Because the first onsets have to be picked accurately for the tomographic analysis, this has reduced the capacity of this data to delineate the structure of the serpentinite. The Research School of Earth Sciences, ANU also deployed 16 digital remote seismic recorders to record these production shots. Their data are also adversely affected by the wind noise.

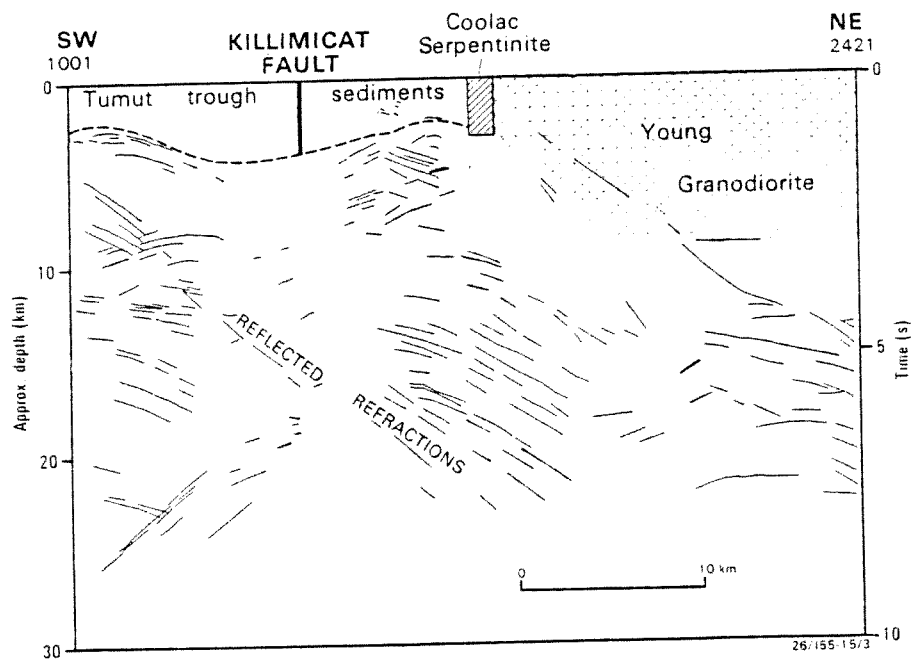


Figure 3. A line diagram of the sub coherent reflection segments from the Brute Stack, with some geological interpretation added.

4.4 Processing of the 3-Component Data

Preliminary playback of this data indicates that the closer offset recording was successful, and the data from the analogue tapes is currently being digitized.

ACKNOWLEDGEMENTS

The cooperation and assistance of the property owners, the officers of the Australian Survey Office, and the Tumut and Gundagai Shire Councils is gratefully acknowledged, as is the assistance of Sue Feary.

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APPENDIX 1

OPERATIONAL STATISTICS

Surveying Commenced	7 April 1987
Surveying Completed	11 May 1987
Drilling Commenced	27 April 1987
Drilling Completed	14 May 1987
Recording Commenced	4 May 1987
Recording Completed	16 May 1987
Total Sub-surface coverage	45 km
Number of recording days worked	11 days
Number of recording days lost due to weather	1 day
Total number of shots	156
Average no. of production shots/recording day	14.2
Average surface coverage/recording day	4.1 km
Max. Number of shots in one day	22
Explosives used	1476 kg
Number of detonators used	159
Average charge / production shot	9.5 kg
Total number of rig days worked	41
Rig days lost due to : breakdown	1
: travel	3

APPENDIX 2

RECORDING PARAMETERS

Spread length	varied 4.26 to 5.7 km
Geophone station interval	60 metres
Number of data channels	72 - 96
Nominal fold	8
Geophones per trace	16 inline, 4m apart
Recording format	SEGD
Number of recorded channels	96 + 4 aux
Tape	9 track GCR 6250bpi
Record length	20 seconds
Sample rate	2 milliseconds
Filters	Low-cut 8 Hz 18dB/octave
	Hi-cut 178 Hz 18dB/octave
Pre-amp gain factor	128
Notch filter	50 Hz IN

APPENDIX 3

PERSONNEL AND VEHICLES

Jim Leven	Party & Co-Project Leader
Mike Rickard	Co-Project Leader
Glenn Bush	Surveyor
John Davidson	Technical Officer
Ian Moore	Surveying Assistant
Dave Young	Surveying Assistant
Paul Tagliaferro	Surveying Assistant
Ned Lodwick	Driller
Andre Zoska	Driller
Des Eaton	Driller
Anton Maher	Driller
Graham Clements	Driller's Assistant
Graham Woods	Driller's Assistant
Allan Crawford	Mechanic
Dave Johnstone	Geophysicist
Geof Price	Observer
Chris Rochford	Technical Officer
Jim Whatman	Technical Officer
Brian Maplestone	Technical Officer
Shane Howard	Explosives Loader
Lars Rickardsson	Explosives Loader
Alex Takken	Shooter
Gary Gray	Field Hand
Phill Price	Field Hand
Crispin Cannon	Field Hand
Jan Hulse	Field Hand
Fred Pribac	Field Hand
Henry Cao Shun Hau	Field Hand
G.R. Richardson	Field Hand
G. Howells	Field Hand
G. Hawkes	Field Hand
G.R. Hunt	Field Hand
N.D. Evans	Field Hand
D Coad	Field Hand
C Newman	Field Hand
Clive Collins	Portable recorder deploy.
Cedric Wright	Portable recorder deploy.
Ray Bracewell	Portable recorder deploy.
John Williams	Gravity measurements

VEHICLES

Recorder	Mercedes	ZBE-748
Mech. W/Shop	Mercedes	ZBE-689
Elect. W/Shop	Acco	ZUE-121
Jugwagon	Toyota Traytop	ZBE-791
Jugwagon	Toyota Traytop	ZBE-792
Jugwagon	Toyota Traytop	ZBE-793
Jugwagon	Toyota Traytop	ZBE-794
Shotfirer	Toyota	ZBE-649
Expl. Magz.	Acco	ZUE-136
Pre-loader	Toyota	ZUE-167
Troop Carrier	Toyota	ZSV-624
Troop Carrier	Toyota	ZBE-731
Troop Carrier	Toyota	ZBE-733
Troop Carrier	Toyota	ZBE-730
Drillrig	Mack	ZBE-606
Drillrig	Mack	ZSU-529
Drillrig	Mack	ZSU-471
Tanker	Mack	ZSU-911
Tanker	Mack	ZSU-865
Tanker	Mack	ZSU-866
Welding	2W trailer	ZTL-501

Landrovers	for refract.	ZBE-787
Landrovers	for refract.	ZBE-788
Landrovers	for refract.	ZBE-789
Toyota SWB	for gravity	

ANU Vehicles

Geology Troop Carrier
RSES 4WD

APPENDIX 4

TUMUT TROUGH PRODUCTION SHOTS

SHOT No.	FFID No.	Station No.	Stat. Zm	Offset Nm	No. Em	Sticks	DD	Detonation HHMM	Time SS	Uphole ms	Time
1	5	1992	19	0	0	2	05	1234	??	???	12
2	6	1986	21	10	-24	2	05	1248	00	585	18
3	7	1980	33	10	0	2	05	1259	00	130	20
4	8	1974	18	23	0	2	05	1310	59	522	16
5	9	1968	33	-14	5	2	05	1408	59	860	32
6	10	1962	8	5	0	2	05	1430	59	945	18
7	11	1956	18	0	0	2	05	1445	00	098	18
8	12	1950	22	7	0	2	05	1459	00	340	18
9	13	1944	36	25	0	2	05	1513	59	840	24
10	14	1938	22	5	0	2	05	1526	00	023	16
11	15	1932	20	2	0	2	05	1543	59	815	10
12	17	1926	21	4	0	2	06	1013	59	735	16
13	18	1920	9	0	0	2	06	1031	00	895	10
14	19	1914	28	1	0	2	06	1044	00	300	18
15	21	1908	8	-21	0	2	06	1115	59	790	15
16	22	1902	17	-15	0	2	06	1128	00	165	18
17	23	1896	12	12	0	2	06	1138	00	055	20
18	25	1890	17	5	0	2	06	1413	00	915	18
19	26	1884	9	-15	0	2	06	1422	00	270	10
20	27	1878	5	5	0	3	06	1431	59	456	7
21	28	1872	15	-10	0	3	06	1443	00	200	12
22	29	1866	16	-9	0	3	06	1451	59	888	18
23	30	1860	9	2	0	3	06	1505	00	980	8
24	32	1854	12	3	0	3	07	1008	01	080	8
25	33	1845	12	-9	0	3	07	1021	00	272	14
26	34	1842	6	12	22	2	07	1031	59	982	10
27	35	1836	8	-11	0	3	07	1108	00	250	6
28	36	1830	36	-26	0	3	07	1124	00	360	25
29	37	1824	38	25	0	3	07	1142	00	340	24
30	38	1818	10	25	0	3	07	1358	00	480	14
31	39	1812	12	6	0	3	07	1407	00	345	18
32	40	1806	15	11	0	3	07	1421	59	930	15
33	41	1800	12	-7	0	3	07	1442	59	640	16
34	42	1794	27	-7	0	3	07	1511	00	290	22
35	43	1788	16	-18	0	3	07	1532	59	880	14
36	45	1782	18	-35	0	3	08	1034	00	430	20
37	46	1776	7	0	0	3	08	1048	00	290	5
38	47	1770	9	-25	0	3	08	1059	59	520	5
39	48	1764	9	-4	-2	3	08	1112	59	780	8
40	49	1759	9	4	0	3	08	1126	00	190	8
41	50	1752	9	12	0	3	08	1136	00	720	8
42	51	1746	18	21	0	3	08	1205	00	166	16

SHOT No.	FFID No.	Station No.	Stat. Zm	Offset Nm	No. Em	Sticks	Detonation DD	Time HHMM	Time SS	ms	Uphole Time
43	52	1740	15	0	0	3	08	1214	01	125	12
44	53	1735	18	0	0	3	08	1223	00	160	8
45	54	1728	8	0	0	3	08	1320	00	360	10
46	55	1722	15	0	0	3	08	1337	00	070	20
47	56	1716	18	0	0	2	08	1352	00	593	30
48	59	1710	18	0	0	2	08	1618	00	825	20
53	64	1704	10	5	0	2	08	1709	02	540	12
77	95	1698	15	0	0	2	11	1321	00	612	ra
55	66	1692	15	4	0	2	08	1731	00	095	10
56	67	1686	18	0	0	2	08	1747	00	295	27
57	68	1680	12	0	0	2	08	1756	00	412	18
78	96	1674	15	0	0	2	11	1344	00	543	ra
63	79	1672	17	3	0	2	09	1049	00	920	10
79	97	1669	23	0	0	2	11	1356	00	680	ra
80	98	1668	15	0	0	2	11	1401	00	290	ra
62	78	1666	18	0	0	2	09	1032	00	940	15
81	99	1664	18	0	0	2	11	1425	00	750	ra
82	100	1662	9	0	0	2	11	1430	59	912	ra
61	77	1661	9	0	0	2	09	1020	00	875	8
60	76	1660	9	0	0	2	09	1012	00	060	6
59	75	1659	18	12	0	2	09	1001	00	900	10
58	70	1658	27	0	0	2	09	0941	59	665	12
64	81	1650	40	0	0	3	11	1020	01	970	17
49	60	1649	32	0	0	3	08	1621	00	232	ra
65	82	1648	27	-2	0	3	11	1034	59	570	12
66	83	1647	27	2	0	3	11	1042	59	336	18
67	84	1646	9	-2	0	3	11	1050	00	270	10
50	61	1645	9	0	0	3	08	1632	02	090	ra
51	62	1644	15	0	0	3	08	1641	00	900	ra
52	63	1642	9	0	0	3	08	1653	00	250	ra
69	86	1638	9	0	0	3	11	1118	59	734	12
54	65	1632	32	0	0	3	08	1715	00	550	ra
71	88	1632	15	-12	0	3	11	1136	59	938	17
72	39	1620	20	0	2	3	11	1156	59	882	18
85	104	1620	16	0	0	3	12	0923	59	870	16
74	92	1619	19	0	0	3	11	1217	59	058	15
75	93	1594	18	0	0	3	11	1242	59	935	5
86	105	1593	9	0	0	3	12	0933	00	265	8
76	94	1592	18	0	0	3	11	1256	00	190	12
87	106	1591	3	2	3	1	12	0939	59	805	6
88	107	1587	20	3	0	3	12	0949	00	162	12
89	108	1584	14	0	0	2	12	1001	59	600	10
90	109	1582	13	0	0	2	12	1011	59	850	10
91	110	1577	18	8	-10	2	12	1019	59	569	4
93	112	1576	14	3	28	2	12	1346	00	828	8
92	111	1560	27	-5	3	2	12	1145	00	830	10
94	113	1560	27	-5	0	2	12	1400	00	340	20
95	114	1556	9	0	0	2	12	1413	00	317	9
96	115	1544	14	4	0	2	12	1421	00	507	3
97	116	1544	14	0	0	2	12	1428	00	165	10

SHOT No.	FFID No.	Station No.	Stat. Zm	Offset Nm	No. Em	Sticks	Detonation DD	Time HHMM	SS	ms	Uphole Time
98	117	1544	6	0	4	2	12	1435	00	440	10
99	118	1539	11	0	0	2	12	1447	00	720	9
100	119	1535	15	3	0	2	12	1454	00	643	12
102	121	1534	21	-3	0	2	12	1527	00	795	18
146	169	1532	12	0	0	2	16	1359	00	455	ra
101	120	1530	9	-7	0	2	12	1511	00	410	10
103	122	1527	5	0	11	2	12	1552	00	020	8
104	125	1500	12	-10	0	2	13	1002	00	460	10
106	127	1500	12	6	0	2	13	1127	59	590	8
105	126	1499	18	-7	0	2	13	1019	00	829	10
107	128	1491	13	9	0	2	12	1140	00	730	12
109	130	1490	14	11	0	2	13	1226	01	599	15
110	131	1489	9	0	0	2	13	1233	59	979	12
108	129	1487	10	-6	6	2	13	1149	59	920	10
111	132	1477	12	0	5	2	13	1253	01	060	12
147	170	1476	14	0	0	2	16	1417	59	708	ra
112	133	1470	22	0	0	2	13	1302	00	112	18
113	134	1470	21	3	0	2	13	1307	59	656	20
114	135	1468	13	0	0	2	13	1318	00	360	10
115	136	1466	13	0	0	2	13	1537	59	864	10
116	138	1464	20	0	0	2	13	1601	01	910	20
117	139	1458	6	0	0	2	13	1615	00	390	10
118	140	1456	6	22	0	2	13	1625	59	140	10
119	141	1451	18	-6	0	2	13	1651	59	322	12
129	151	1447	18	0	0	2	15	1529	59	650	ra
120	142	1444	15	-5	0	2	13	1702	00	392	10
148	171	1444	15	0	0	2	16	1430	59	500	ra
127	149	1442	18	0	0	2	15	1510	01	242	ra
128	150	1440	18	0	0	2	15	1517	51	825	ra
130	152	1435	23	0	0	2	15	1547	26	7077	ra
121	143	1435	23	-10	-5	2	15	1043	59	655	8
131	153	1434	27	0	0	2	15	1606	??	585	ra
132	154	1430	18	0	0	2	15	1613	??	320	ra
122	144	1428	23	-20	0	2	15	1101	01	925	14
149	172	1424	13	0	0	2	16	1442	59	590	ra
133	155	1375	32	0	-25	2	15	1622	??	775	10
123	145	1374	35	5	6	2	15	1109	59	560	15
124	146	1374	35	0	0	2	15	1117	00	235	16
134	156	1369	22	0	-5	2	15	1632	??	604	8
125	147	1364	18	0	0	2	15	1129	01	740	ra
135	157	1362	18	4	0	2	16	1010	59	540	10
136	158	1356	36	5	0	2	16	1023	59	437	20
126	148	1350	32	0	0	2	15	1156	01	100	ra
137	159	1350	30	0	0	2	16	1034	59	840	18
138	160	1344	27	0	0	2	16	1043	57	908	18
139	161	1338	32	-4	0	2	16	1056	59	785	19
140	162	1338	36	5	0	2	16	1208	59	418	20
141	163	1325	16	6	0	2	16	1226	59	290	12
142	164	1319	7	6	0	2	16	1242	59	515	4
143	166	1314	13	6	0	2	16	1301	58	280	8

SHOT No.	FFID No.	Station No.	Stat. Zm	Offset Nm	No. Em	Sticks	Detonation DD	Time HHMM	SS	ms	Uphole Time
144	167	1302	9	0	0	2	16	1322	59	350	14
145	168	1297	9	0	0	2	16	1338	59	360	5
150	173	1290	27	0	0	2	16	1451	59	870	15
151	174	1286	32	0	50	2	16	1512	59	330	28
152	175	1272	23	0	-5	2	16	1529	59	267	16
153	176	1270	40	35	-35	2	16	1554	04	?148	22
154	177	1266	40	0	35	2	16	1600	00	228	18
155	178	1260	40	-5	0	2	16	161?	??	707	8
156	179	1254	20	0	0	2	16	1616	58	990	12

Off-line shots near the tomography experiment recording sites

SHOT No.	FFID No.	Station No.	Stat. Zm	Offset Nm	No. Em	Sticks	Detonation DD	Time HHMM	SS	ms	Uphole Time
70	87	4	12	0	0	3	11	1130	00	755	ra
68	85	5	32	0	0	3	11	1105	00	040	ra
73	91	12	32	0	0	3	11	1209	00	610	ra
83	101	15	13	0	0	3	11	1445	01	075	ra
84	102	18	27	0	0	3	11	1503	00	875	ra

APPENDIX 5

SEISMIC STATION LOCATIONS

Station	Easting metres	Northing metres	Elevation metres
1026	589959.8	6097228.9	462.4
1027	590010.6	6097260.4	457.2
1028	590061.4	6097291.8	450.7
1029	590112.2	6097323.2	443.9
1030	590163.0	6097354.7	435.2
1031	590213.8	6097386.1	428.0
1032	590264.6	6097417.5	421.7
1033	590315.4	6097449.0	416.0
1034	590366.2	6097480.4	411.7
1035	590417.0	6097511.8	407.7
1036	590467.8	6097543.6	405.1
1037	590518.7	6097575.3	404.4
1038	590569.6	6097607.1	403.0
1039	590620.5	6097638.8	403.1
1040	590671.3	6097670.5	400.5
1041	590722.2	6097702.3	397.1
1042	590773.1	6097734.0	393.6
1043	590823.9	6097765.8	391.0
1044	590874.8	6097797.5	390.0
1045	590925.7	6097829.2	387.4
1046	590976.5	6097861.0	389.5
1047	591027.4	6097892.7	392.7
1048	591078.3	6097924.5	392.0
1049	591119.7	6097968.2	392.3
1050	591161.2	6098011.8	393.4
1051	591203.9	6098053.9	392.6
1052	591246.6	6098095.9	387.6
1053	591285.9	6098141.1	382.2
1054	591335.7	6098174.1	375.8
1055	591392.7	6098191.2	370.7
1056	591431.1	6098237.0	365.8
1057	591468.5	6098283.2	361.7
1058	591525.1	6098303.4	355.6
1059	591583.8	6098315.2	348.6
1060	591642.5	6098327.0	341.1
1061	591701.1	6098338.8	334.6
1062	591759.8	6098350.5	332.6
1063	591818.5	6098362.3	330.3
1064	591877.1	6098374.1	328.6
1065	591927.2	6098407.0	331.1
1066	591977.3	6098439.8	334.9
1067	592036.6	6098449.6	335.3
1068	592095.8	6098459.4	338.8
1069	592141.0	6098498.7	338.5
1070	592199.6	6098510.4	333.7
1071	592256.9	6098493.1	328.9

Station	Easting metres	Northing metres	Elevation metres
1072	592306.9	6098526.4	327.2
1073	592328.4	6098582.4	322.7
1074	592349.9	6098638.4	320.7
1075	592389.1	6098683.9	320.3
1076	592428.2	6098729.5	317.9
1077	592479.6	6098760.5	315.2
1078	592530.9	6098791.6	312.9
1079	592582.3	6098822.7	311.3
1080	592633.6	6098853.7	309.6
1081	592685.0	6098884.8	306.6
1082	592738.9	6098911.1	300.6
1083	592792.8	6098937.4	293.3
1084	592846.7	6098963.7	289.5
1085	592900.7	6098989.9	289.2
1086	592954.6	6099016.2	288.2
1087	593008.5	6099042.5	285.8
1088	593062.4	6099068.8	281.3
1089	593116.3	6099095.1	275.2
1090	593170.2	6099121.4	270.9
1091	593224.2	6099147.6	269.9
1092	593278.1	6099173.9	269.6
1093	593332.0	6099200.2	269.5
1094	593385.9	6099226.5	266.9
1095	593439.8	6099252.8	263.3
1096	593493.7	6099279.1	262.2
1097	593547.7	6099305.3	261.0
1098	593601.6	6099331.6	259.8
1099	593655.5	6099357.9	259.0
1100	593709.4	6099384.2	258.4
1101	593763.3	6099410.5	257.7
1102	593817.2	6099436.8	257.1
1103	593871.2	6099463.0	256.1
1104	593925.1	6099489.3	255.5
1105	593979.0	6099515.6	256.3
1106	594032.9	6099541.9	254.3
1107	594086.8	6099568.2	254.5
1108	594140.7	6099594.5	259.0
1109	594194.7	6099620.7	260.7
1110	594247.4	6099647.5	254.7
1111	594300.2	6099674.3	252.1
1112	594352.9	6099701.1	252.1
1113	594405.7	6099727.9	249.3
1114	594458.4	6099754.7	249.2
1115	594511.2	6099781.4	249.3
1116	594563.9	6099808.2	248.6
1117	594616.7	6099835.0	249.1
1118	594669.4	6099861.8	248.1
1119	594722.2	6099888.6	249.0
1120	594775.0	6099915.3	249.9
1121	594827.7	6099942.1	246.2

Station	Easting metres	Northing metres	Elevation metres
1122	594880.5	6099968.9	249.4
1123	594933.2	6099995.7	249.6
1124	594986.0	6100022.5	249.8
1125	595038.7	6100049.3	250.3
1126	595091.5	6100076.0	255.6
1127	595144.2	6100102.8	260.7
1128	595197.0	6100129.6	267.2
1129	595249.8	6100156.4	275.2
1130	595302.5	6100183.2	280.8
1131	595360.6	6100196.2	285.2
1132	595418.7	6100209.2	285.1
1133	595476.8	6100222.2	279.4
1134	595534.9	6100235.3	276.5
1135	595593.0	6100248.3	272.9
1136	595651.1	6100261.3	271.0
1137	595709.2	6100274.3	268.8
1138	595767.7	6100287.3	269.9
1139	595826.3	6100300.3	269.6
1140	595884.8	6100313.3	270.4
1141	595943.3	6100326.2	270.7
1142	596001.9	6100339.2	270.5
1143	596060.4	6100352.2	276.6
1144	596118.9	6100365.2	284.3
1145	596177.5	6100378.1	293.7
1146	596236.0	6100391.1	296.1
1147	596294.5	6100404.1	292.3
1148	596353.1	6100417.1	288.9
1149	596411.6	6100430.0	286.2
1150	596470.1	6100443.0	284.4
1151	596528.7	6100456.0	287.7
1152	596587.2	6100469.0	291.0
1153	596645.7	6100481.9	292.1
1154	596704.3	6100494.9	299.6
1155	596762.8	6100507.9	301.3
1156	596821.3	6100520.9	305.1
1157	596879.9	6100533.8	305.7
1158	596938.4	6100546.8	305.7
1159	596996.9	6100559.8	301.5
1160	597055.5	6100572.8	304.3
1161	597114.0	6100585.7	303.3
1162	597172.5	6100598.7	304.8
1163	597231.1	6100611.7	310.3
1164	597289.6	6100624.7	316.3
1165	597348.1	6100637.6	315.9
1166	597406.2	6100652.1	307.0
1167	597464.3	6100666.5	299.1
1168	597522.4	6100680.9	293.8
1169	597580.5	6100695.3	290.3
1170	597638.6	6100709.7	287.3
1171	597696.7	6100724.1	285.5

Station	Easting metres	Northing metres	Elevation metres
1172	597754.8	6100738.6	283.6
1173	597812.9	6100753.0	282.7
1174	597871.0	6100767.4	282.1
1175	597929.1	6100781.8	281.9
1176	597987.3	6100796.2	284.2
1177	598045.4	6100810.6	288.2
1178	598103.5	6100825.0	291.6
1179	598161.6	6100839.5	295.4
1180	598219.7	6100853.9	299.7
1181	598277.8	6100868.3	303.0
1182	598335.9	6100882.7	308.0
1183	598394.0	6100897.1	315.6
1184	598452.1	6100911.5	327.4
1185	598510.2	6100926.0	330.8
1186	598567.9	6100911.4	318.0
1187	598625.6	6100896.8	305.2
1188	598683.3	6100882.2	292.6
1189	598741.0	6100867.6	282.5
1190	598798.7	6100853.1	282.8
1191	598856.4	6100838.5	282.5
1192	598914.2	6100823.9	284.4
1193	598971.9	6100809.3	286.7
1194	599029.6	6100794.8	289.8
1195	599088.7	6100785.3	294.5
1196	599147.7	6100775.8	299.1
1197	599206.8	6100766.3	305.9
1198	599265.9	6100756.7	311.9
1199	599325.7	6100762.0	310.5
1200	599385.4	6100767.2	307.5
1201	599445.2	6100772.4	306.1
1202	599505.0	6100777.6	309.4
1203	599564.8	6100782.9	307.6
1204	599624.6	6100788.1	304.1
1205	599684.4	6100793.3	304.7
1206	599744.2	6100798.5	306.2
1207	599803.9	6100803.8	308.7
1208	599863.5	6100809.1	298.2
1209	599923.2	6100814.4	299.5
1210	599982.8	6100819.7	301.4
1211	600042.4	6100825.0	303.6
1212	600102.0	6100830.4	305.6
1213	600161.8	6100835.7	307.5
1214	600221.6	6100841.0	308.7
1215	600281.4	6100846.4	312.7
1216	600341.2	6100851.7	314.4
1217	600392.7	6100881.2	316.1
1218	600444.3	6100910.7	319.4
1219	600495.8	6100940.2	325.3
1220	600547.4	6100969.7	333.7
1221	600598.9	6100999.2	340.7

Station	Easting metres	Northing metres	Elevation metres
1222	600650.5	6101028.7	347.6
1223	600702.0	6101058.2	352.5
1224	600753.6	6101087.7	362.3
1225	600805.2	6101117.2	378.4
1226	600856.7	6101146.6	389.6
1227	600908.3	6101176.1	403.4
1228	600959.8	6101205.6	414.9
1229	601011.4	6101235.1	430.5
1230	601063.3	6101264.2	436.5
1231	601115.2	6101293.3	446.5
1232	601167.2	6101322.4	455.7
1233	601204.5	6101369.3	459.5
1234	601193.7	6101427.8	469.7
1235	601217.3	6101483.0	471.2
1236	601240.9	6101538.1	472.2
1237	601264.5	6101593.2	464.4
1238	601288.2	6101648.3	460.0
1239	601311.8	6101703.5	454.9
1240	601335.4	6101758.6	458.7
1241	601359.0	6101813.7	459.9
1242	601382.7	6101868.8	465.2
1243	601406.3	6101923.9	466.2
1244	601429.9	6101979.0	468.0
1245	601453.2	6102034.2	462.1
1246	601476.6	6102089.3	465.1
1247	601499.8	6102144.6	457.5
1248	601523.0	6102200.0	450.6
1249	601546.1	6102255.3	446.1
1250	601569.3	6102310.6	444.1
1251	601592.5	6102365.9	440.5
1252	601615.7	6102421.2	438.0
1253	601638.9	6102476.5	435.1
1254	601662.1	6102531.9	432.0
1255	601685.3	6102587.2	432.5
1256	601708.5	6102642.5	434.7
1257	601731.7	6102697.8	436.2
1258	601755.2	6102754.0	434.7
1259	601792.6	6102801.2	432.2
1260	601829.9	6102848.3	427.8
1261	601867.1	6102895.3	416.9
1262	601904.3	6102942.2	409.3
1263	601941.4	6102989.1	405.2
1264	601978.6	6103036.0	398.4
1265	602015.8	6103083.0	391.9
1266	602052.9	6103129.9	384.9
1267	602090.1	6103176.8	381.9
1268	602127.3	6103223.7	379.2
1269	602164.4	6103270.7	374.4
1270	602201.6	6103317.6	368.6
1271	602238.8	6103364.5	368.3

Station	Easting metres	Northing metres	Elevation metres
1272	602291.0	6103394.0	368.7
1273	602343.3	6103423.4	368.8
1274	602395.6	6103452.9	367.6
1275	602447.9	6103482.4	366.7
1276	602500.2	6103511.9	367.4
1277	602552.6	6103541.4	366.8
1278	602604.8	6103570.9	363.9
1279	602657.1	6103600.4	361.0
1280	602709.4	6103630.0	358.9
1281	602751.1	6103673.1	357.0
1282	602792.8	6103716.2	355.6
1283	602834.5	6103759.3	354.5
1284	602876.2	6103802.4	353.7
1285	602917.9	6103845.6	351.0
1286	602959.6	6103888.7	347.6
1287	603001.3	6103931.8	344.9
1288	603043.0	6103974.9	343.8
1289	603071.7	6104027.7	343.0
1290	603100.5	6104080.3	341.6
1291	603129.2	6104133.0	340.1
1292	603157.9	6104185.7	338.9
1293	603186.6	6104238.4	336.6
1294	603215.9	6104290.7	334.3
1295	603245.2	6104343.0	331.1
1296	603268.3	6104398.7	327.0
1297	603320.6	6104369.1	329.8
1298	603374.2	6104341.7	328.4
1299	603427.9	6104314.2	329.3
1300	603484.6	6104294.7	326.3
1301	603541.4	6104275.1	323.2
1302	603598.1	6104255.5	321.6
1303	603654.9	6104236.0	320.5
1304	603714.9	6104235.5	319.2
1305	603774.6	6104242.3	318.1
1306	603834.0	6104251.3	317.2
1307	603893.4	6104260.4	316.8
1308	603952.8	6104269.4	316.4
1309	604012.2	6104278.5	316.1
1310	604071.6	6104287.6	316.5
1311	604131.0	6104296.6	317.2
1312	604190.9	6104301.7	317.8
1313	604251.1	6104304.4	316.8
1314	604310.7	6104297.1	315.4
1315	604370.4	6104289.7	312.4
1316	604430.2	6104283.2	308.7
1317	604490.0	6104278.2	304.9
1318	604549.9	6104277.4	302.2
1319	604609.4	6104285.4	300.6
1320	604668.7	6104295.2	298.7
1321	604727.8	6104306.1	297.2

Station	Easting metres	Northing metres	Elevation metres
1322	604786.9	6104317.1	297.5
1323	604845.9	6104328.0	298.4
1324	604905.0	6104338.9	298.1
1325	604964.9	6104334.6	297.2
1326	605024.4	6104325.9	294.8
1327	605083.8	6104317.2	292.1
1328	605143.2	6104308.5	290.1
1329	605202.6	6104299.8	288.5
1330	605262.0	6104291.1	286.8
1331	605321.5	6104282.4	285.4
1332	605380.9	6104273.7	285.0
1333	605440.3	6104265.0	284.7
1334	605499.7	6104256.3	284.7
1335	605559.1	6104247.6	285.1
1336	605618.6	6104238.9	285.4
1337	605678.6	6104237.0	284.0
1338	605738.5	6104241.9	282.7
1339	605798.3	6104246.8	281.7
1340	605858.2	6104251.7	279.7
1341	605918.0	6104256.6	278.5
1342	605977.9	6104261.5	276.0
1343	606037.8	6104266.4	274.0
1344	606097.6	6104271.2	271.5
1345	606157.5	6104276.1	269.4
1346	606217.3	6104281.0	268.7
1347	606277.2	6104285.9	268.3
1348	606333.9	6104305.6	267.7
1349	606390.6	6104325.4	266.9
1350	606447.3	6104345.1	266.1
1351	606504.0	6104364.8	265.0
1352	606560.7	6104384.5	266.0
1353	606617.5	6104404.3	266.5
1354	606674.2	6104424.0	264.1
1355	606730.9	6104443.7	263.1
1356	606787.6	6104463.4	261.9
1357	606844.3	6104483.1	257.8
1358	606901.0	6104502.9	254.8
1359	606961.0	6104499.9	255.0
1360	607021.0	6104496.9	253.9
1361	607080.9	6104493.9	254.2
1362	607140.9	6104490.9	253.5
1363	607200.9	6104487.9	252.8
1364	607256.2	6104511.4	251.8
1365	607295.0	6104556.9	253.0
1366	607305.9	6104615.7	255.8
1367	607316.9	6104674.6	264.2
1368	607306.2	6104733.7	269.7
1369	607278.8	6104787.0	270.3
1370	607251.4	6104840.4	271.9
1371	607249.8	6104900.3	272.1

Station	Easting metres	Northing metres	Elevation metres
1372	607251.8	6104960.4	269.7
1373	607281.6	6105010.4	269.1
1374	607327.5	6105049.0	263.0
1375	607373.4	6105087.7	265.5
1376	607396.4	6105143.4	268.6
1377	607407.2	6105201.8	267.2
1378	607416.8	6105261.0	263.3
1379	607442.1	6105316.7	261.9
1380	607464.3	6105371.3	262.3
1381	607482.8	6105428.3	260.8
1382	607514.4	6105479.3	262.0
1383	607529.0	6105537.5	264.6
1384	607561.9	6105583.1	257.9
1385	607607.7	6105621.9	250.8
1386	607668.1	6105617.9	244.8
1387	607726.8	6105630.2	244.1
1388	607785.6	6105642.5	244.1
1389	607844.4	6105654.8	244.2
1390	607903.2	6105667.1	244.0
1391	607961.9	6105679.4	244.1
1392	608020.7	6105691.7	244.1
1393	608079.5	6105704.0	244.2
1394	608138.2	6105716.3	243.7
1395	608197.0	6105728.5	243.6
1396	608255.8	6105740.8	244.1
1397	608314.6	6105753.1	243.2
1398	608373.3	6105765.4	244.0
1399	608432.1	6105777.7	244.2
1400	608490.9	6105789.9	243.8
1401	608549.8	6105802.1	243.7
1402	608608.6	6105814.3	243.3
1403	608667.4	6105826.5	243.7
1404	608726.2	6105838.7	243.9
1405	608785.0	6105850.9	243.7
1406	608843.9	6105863.0	243.4
1407	608896.5	6105891.9	243.0
1408	608949.2	6105920.7	243.1
1409	609001.8	6105949.6	243.0
1410	609054.5	6105978.4	242.8
1411	609107.2	6106007.3	241.1
1412	609159.8	6106036.1	242.6
1413	609212.5	6106065.0	242.5
1414	609265.2	6106093.8	242.2
1415	609317.8	6106122.7	242.4
1416	609370.5	6106151.5	242.0
1417	609423.1	6106180.4	241.8
1418	609475.8	6106209.2	241.7
1419	609528.5	6106238.0	242.0
1420	609584.6	6106213.8	242.0
1421	609635.5	6106181.8	241.9

Station	Easting metres	Northing metres	Elevation metres
1422	609686.4	6106149.8	241.8
1423	609737.2	6106117.7	241.9
1424	609788.1	6106085.7	242.3
1425	609840.6	6106114.9	241.9
1426	609893.0	6106144.2	244.0
1427	609945.4	6106173.5	242.3
1428	609989.2	6106214.6	241.8
1429	610024.2	6106263.4	241.8
1430	610059.2	6106312.3	242.2
1431	610102.1	6106354.3	241.7
1432	610145.0	6106396.3	241.7
1433	610187.9	6106438.2	241.2
1434	610230.8	6106480.2	241.5
1435	610273.8	6106522.2	241.6
1436	610316.7	6106564.2	241.4
1437	610371.3	6106588.6	249.9
1438	610425.9	6106613.0	252.0
1439	610483.1	6106631.0	251.2
1440	610540.4	6106649.1	255.8
1441	610598.5	6106663.0	259.6
1442	610657.0	6106649.3	263.9
1443	610711.3	6106623.4	267.3
1444	610765.3	6106600.3	268.2
1445	610824.9	6106591.5	268.3
1446	610884.0	6106580.3	266.5
1447	610943.0	6106569.1	264.3
1448	611002.0	6106557.9	261.3
1449	611061.4	6106549.1	256.0
1450	611120.7	6106540.2	251.4
1451	611180.1	6106531.4	250.9
1452	611239.5	6106522.5	247.5
1453	611298.8	6106513.7	246.0
1454	611349.3	6106546.4	244.7
1455	611394.6	6106585.7	245.0
1456	611440.0	6106625.1	245.5
1457	611485.4	6106664.4	245.7
1458	611530.8	6106703.7	246.4
1459	611576.1	6106743.1	248.2
1460	611621.5	6106782.4	250.0
1461	611666.9	6106821.7	251.3
1462	611712.3	6106861.0	253.0
1463	611730.3	6106918.4	253.7
1464	611748.3	6106975.7	253.9
1465	611766.3	6107033.0	252.1
1466	611784.4	6107090.3	251.9
1467	611802.4	6107147.6	253.0
1468	611820.4	6107204.9	255.1
1469	611838.5	6107262.2	256.8
1470	611856.5	6107319.5	257.0
1471	611874.5	6107376.8	260.2

Station	Easting metres	Northing metres	Elevation metres
1472	611892.5	6107434.1	261.7
1473	611910.6	6107491.4	262.5
1474	611928.6	6107548.7	266.6
1475	611910.5	6107606.0	266.3
1476	611892.5	6107663.3	265.1
1477	611874.4	6107720.5	264.1
1478	611856.3	6107777.8	263.7
1479	611838.2	6107835.0	262.3
1480	611820.7	6107892.2	260.0
1481	611803.2	6107949.7	257.5
1482	611785.8	6108007.2	255.4
1483	611768.3	6108064.6	251.5
1484	611761.8	6108124.3	248.0
1485	611762.1	6108184.5	245.5
1486	611767.7	6108244.1	244.7
1487	611777.5	6108303.5	244.5
1488	611787.4	6108362.8	243.4
1489	611797.3	6108422.2	243.3
1490	611807.1	6108481.6	245.2
1491	611841.6	6108530.7	246.6
1492	611880.2	6108576.8	245.2
1493	611918.7	6108622.9	244.0
1494	611957.3	6108668.9	247.0
1495	611971.0	6108727.6	246.5
1496	612017.8	6108765.2	247.7
1497	612064.5	6108802.7	247.7
1498	612111.3	6108840.2	248.5
1499	612134.1	6108895.8	250.0
1500	612144.4	6108954.9	250.7
1501	612154.8	6109014.1	250.6
1502	612165.1	6109073.2	249.8
1503	612175.5	6109132.3	249.2
1504	612185.8	6109191.4	247.2
1505	612196.1	6109250.6	247.1
1506	612206.5	6109309.7	246.7
1507	612216.8	6109368.8	247.7
1508	612227.2	6109427.9	248.2
1509	612237.5	6109487.0	248.6
1510	612247.8	6109546.1	248.7
1511	612258.2	6109605.3	247.8
1512	612268.5	6109664.4	247.7
1513	612278.9	6109723.5	247.5
1514	612289.3	6109783.0	246.7
1515	612348.5	6109773.4	247.7
1516	612407.7	6109763.8	249.0
1517	612466.9	6109754.2	249.7
1518	612526.1	6109744.6	250.3
1519	612585.3	6109735.0	250.8
1520	612644.5	6109725.4	251.5
1521	612702.5	6109741.1	251.8

Station	Easting metres	Northing metres	Elevation metres
1522	612760.5	6109756.7	252.8
1523	612818.4	6109772.4	251.8
1524	612878.4	6109775.0	251.7
1525	612938.4	6109777.7	251.7
1526	612994.0	6109803.0	251.6
1527	613032.7	6109847.4	251.8
1528	613049.5	6109905.0	252.7
1529	613066.3	6109962.7	253.3
1530	613083.1	6110020.3	252.4
1531	613099.9	6110077.9	253.1
1532	613116.8	6110135.6	254.8
1533	613133.6	6110193.2	258.5
1534	613158.9	6110247.8	262.9
1535	613192.2	6110297.8	263.7
1536	613225.5	6110347.8	260.9
1537	613258.9	6110397.8	257.9
1538	613292.2	6110447.8	259.5
1539	613325.4	6110497.9	259.8
1540	613358.7	6110547.9	260.5
1541	613371.0	6110606.6	258.5
1542	613383.3	6110665.3	262.0
1543	613395.6	6110724.0	268.2
1544	613422.5	6110777.8	271.0
1545	613468.8	6110815.8	268.5
1546	613515.2	6110853.9	265.6
1547	613561.6	6110892.0	264.6
1548	613608.0	6110930.1	265.8
1549	613654.4	6110968.2	265.8
1550	613700.8	6111006.2	267.3
1551	613747.2	6111044.3	267.9
1552	613793.6	6111082.4	266.0
1553	613840.0	6111120.5	265.2
1554	613886.4	6111158.6	267.1
1555	613932.8	6111196.7	267.8
1556	613984.5	6111227.1	269.9
1557	614044.2	6111230.9	274.6
1558	614102.8	6111217.6	278.1
1559	614159.6	6111198.0	278.7
1560	614216.3	6111178.4	278.7
1561	614275.5	6111168.2	279.2
1562	614334.6	6111158.0	279.7
1563	614393.8	6111147.8	281.3
1564	614453.0	6111137.6	285.0
1565	614512.2	6111127.4	287.5
1566	614571.3	6111117.1	291.6
1567	614630.5	6111106.9	296.6
1568	614689.7	6111096.7	301.3
1569	614748.8	6111086.5	305.6
1570	614808.0	6111076.3	310.1
1571	614864.7	6111056.5	309.9

Station	Easting metres	Northing metres	Elevation metres
1572	614921.4	6111036.7	305.7
1573	614978.1	6111016.9	300.7
1574	615034.8	6110997.1	294.2
1575	615091.5	6110977.3	287.6
1576	615148.2	6110957.5	291.0
1577	615204.9	6110937.8	294.5
1578	615257.4	6110908.3	292.8
1579	615309.7	6110878.8	287.4
1580	615362.1	6110849.4	284.1
1581	615414.4	6110819.9	282.7
1582	615466.8	6110790.5	281.9
1583	615522.4	6110767.8	282.1
1584	615578.0	6110745.2	284.1
1585	615633.6	6110722.5	286.5
1586	615689.2	6110699.8	290.1
1587	615743.5	6110673.9	288.1
1588	615797.9	6110648.1	284.9
1589	615852.2	6110622.2	284.2
1590	615896.4	6110581.6	285.9
1591	615940.8	6110540.9	286.6
1592	615985.1	6110500.2	287.4
1593	616043.5	6110486.3	288.8
1594	616103.3	6110481.2	290.0
1595	616163.1	6110476.1	291.2
1596	616223.1	6110476.0	297.9
1597	616283.1	6110475.9	300.1
1598	616343.1	6110475.8	305.0
1599	616401.6	6110462.5	308.1
1600	616456.8	6110438.6	310.4
1601	616492.7	6110390.5	310.1
1602	616528.6	6110342.5	310.8
1603	616562.7	6110293.2	311.9
1604	616596.9	6110243.9	310.1
1605	616633.0	6110196.3	305.5
1606	616669.2	6110148.7	301.3
1607	616723.8	6110124.3	298.6
1608	616783.5	6110122.0	299.5
1609	616843.1	6110119.6	301.4
1610	616902.8	6110117.2	303.9
1611	616962.5	6110114.8	305.6
1612	617022.6	6110117.8	306.8
1613	617078.6	6110138.6	309.2
1614	617125.1	6110176.5	312.9
1615	617152.9	6110229.3	316.2
1616	617180.7	6110282.1	320.6
1617	617208.5	6110334.9	324.8
1618	617243.2	6110383.9	328.9
1619	617293.3	6110416.5	332.0
1620	617343.4	6110449.2	333.5
1621	617393.6	6110482.0	334.6

Station	Easting metres	Northing metres	Elevation metres
1622	617447.8	6110507.6	336.5
1623	617502.0	6110533.3	338.3
1624	617556.1	6110558.9	338.9
1625	617615.0	6110570.5	339.6
1626	617674.1	6110580.5	340.6
1627	617733.1	6110590.5	342.8
1628	617792.2	6110600.5	343.7
1629	617851.3	6110610.5	343.4
1630	617910.4	6110620.5	343.8
1631	617968.3	6110636.6	342.3
1632	618022.4	6110662.4	339.8
1633	618076.6	6110688.1	337.1
1634	618130.8	6110713.9	333.8
1635	618185.0	6110739.7	331.0
1636	618239.1	6110765.4	325.7
1637	618293.3	6110791.2	328.9
1638	618347.5	6110816.9	329.6
1639	618401.7	6110842.7	338.5
1640	618455.8	6110868.5	342.7
1641	618510.0	6110894.2	350.5
1642	618564.2	6110920.0	350.2
1643	618618.3	6110945.8	351.5
1644	618672.5	6110971.5	350.5
1645	618726.7	6110997.3	354.6
1646	618780.9	6111023.0	353.9
1647	618835.0	6111048.8	359.8
1648	618889.2	6111074.6	364.8
1649	618943.4	6111100.3	371.5
1650	618997.5	6111126.1	377.4
1651	619051.7	6111151.9	389.0
1652	619105.9	6111177.6	407.4
1653	619160.1	6111203.4	425.3
1654	619214.2	6111229.2	441.8
1655	619268.4	6111254.9	459.3
1656	619322.6	6111280.7	477.2
1657	619376.8	6111306.4	494.6
1658	619943.9	6111500.9	713.7
1659	620003.0	6111512.2	714.0
1660	620061.9	6111523.5	710.5
1661	620120.8	6111534.8	705.0
1662	620179.7	6111546.1	702.0
1663	620238.6	6111557.3	697.8
1664	620297.5	6111568.6	695.0
1665	620356.4	6111579.9	690.7
1666	620415.3	6111591.2	694.9
1667	620474.2	6111602.5	697.8
1668	620533.1	6111613.7	701.1
1669	620592.0	6111625.0	706.6
1670	620650.9	6111636.3	701.9
1671	620709.8	6111647.6	699.5

Station	Easting metres	Northing metres	Elevation metres
1672	620768.7	6111658.9	701.3
1673	620827.6	6111670.2	701.7
1674	620886.5	6111681.4	705.0
1675	620945.4	6111692.7	708.6
1676	621004.3	6111704.0	714.5
1677	621063.2	6111715.3	716.9
1678	621122.1	6111726.6	720.9
1679	621181.0	6111737.9	724.5
1680	621239.6	6111725.0	724.9
1681	621298.2	6111712.2	725.7
1682	621356.7	6111699.4	727.8
1683	621415.3	6111686.6	729.6
1684	621473.9	6111673.7	731.2
1685	621532.5	6111660.9	733.3
1686	621591.1	6111648.1	738.9
1687	621650.0	6111640.0	737.1
1688	621710.0	6111638.5	728.3
1689	621769.9	6111637.0	718.3
1690	621829.9	6111635.5	709.4
1691	621889.9	6111633.9	703.7
1692	621949.9	6111632.4	695.1
1693	622009.8	6111630.9	689.0
1694	622069.8	6111629.4	685.2
1695	622129.8	6111627.9	683.1
1696	622189.7	6111626.3	682.4
1697	622249.7	6111624.8	682.9
1698	622309.7	6111623.3	677.8
1699	622369.7	6111621.8	677.1
1700	622429.6	6111620.2	682.0
1701	622489.6	6111618.7	678.4
1702	622549.6	6111617.2	676.6
1703	622609.5	6111615.7	674.4
1704	622669.5	6111614.2	671.9
1705	622729.5	6111612.6	669.7
1706	622789.5	6111611.1	670.9
1707	622849.4	6111609.6	676.0
1708	622909.4	6111608.1	681.6
1709	622969.4	6111606.6	685.5
1710	623029.3	6111605.0	687.6
1711	623089.3	6111603.5	692.4
1712	623149.3	6111602.0	698.7
1713	623209.3	6111600.5	704.2
1714	623268.9	6111594.5	704.5
1715	623328.6	6111588.4	703.0
1716	623388.3	6111582.4	700.3
1717	623447.9	6111576.4	698.1
1718	623507.6	6111570.4	697.2
1719	623567.3	6111564.4	700.5
1720	623626.9	6111558.4	703.4
1721	623686.6	6111552.4	704.6

Station	Easting metres	Northing metres	Elevation metres
1722	623746.3	6111546.3	707.3
1723	623805.9	6111540.3	711.5
1724	623865.6	6111534.3	714.4
1725	623923.6	6111518.8	713.0
1726	623981.6	6111503.3	709.6
1727	624039.6	6111487.8	707.0
1728	624085.3	6111526.5	701.7
1729	624130.9	6111565.2	696.0
1730	624162.6	6111616.1	690.1
1731	624194.3	6111666.9	687.2
1732	624226.0	6111717.8	683.4
1733	624257.7	6111768.6	679.0
1734	624289.5	6111819.5	677.2
1735	624321.2	6111870.3	680.2
1736	624367.1	6111909.0	682.2
1737	624413.0	6111947.7	684.9
1738	624458.8	6111986.4	687.5
1739	624504.7	6112025.1	688.9
1740	624550.6	6112063.8	690.0
1741	624596.5	6112102.5	691.6
1742	624642.3	6112141.1	692.1
1743	624688.2	6112179.8	693.6
1744	624747.2	6112191.7	694.3
1745	624804.5	6112173.7	694.6
1746	624861.9	6112155.7	692.2
1747	624919.2	6112137.6	691.6
1748	624979.1	6112129.8	689.0
1749	625023.4	6112168.7	687.9
1750	625034.5	6112227.7	687.6
1751	625055.3	6112284.0	686.7
1752	625080.0	6112338.7	686.0
1753	625104.9	6112393.3	682.5
1754	625129.7	6112448.0	678.7
1755	625154.6	6112502.7	678.3
1756	625210.9	6112523.3	675.1
1757	625267.2	6112543.9	667.9
1758	625323.4	6112564.5	661.3
1759	625379.7	6112585.1	660.3
1760	625396.4	6112642.5	650.9
1761	625413.1	6112699.9	648.2
1762	625429.8	6112757.2	641.0
1763	625446.5	6112814.6	635.4
1764	625463.2	6112872.0	628.9
1765	625479.9	6112929.4	632.0
1766	625514.6	6112978.5	630.0
1767	625549.3	6113027.4	625.2
1768	625584.0	6113076.3	617.5
1769	625618.6	6113125.1	615.2
1770	625642.3	6113180.3	612.9
1771	625651.5	6113239.5	611.3

Station	Easting metres	Northing metres	Elevation metres
1772	625660.8	6113298.7	608.4
1773	625670.0	6113358.0	606.3
1774	625679.2	6113417.2	601.3
1775	625688.5	6113476.4	599.5
1776	625697.7	6113535.6	595.7
1777	625706.9	6113594.9	591.6
1778	625716.2	6113654.1	589.4
1779	625725.4	6113713.3	587.7
1780	625734.6	6113772.5	590.2
1781	625742.1	6113832.1	588.3
1782	625749.5	6113891.6	586.4
1783	625756.9	6113951.1	584.9
1784	625764.4	6114010.6	583.5
1785	625736.1	6114063.7	583.4
1786	625707.9	6114116.7	576.2
1787	625679.7	6114169.7	571.9
1788	625651.5	6114222.7	566.7
1789	625623.3	6114275.7	562.9
1790	625595.1	6114328.7	561.4
1791	625643.5	6114364.2	559.8
1792	625692.0	6114399.8	557.6
1793	625740.4	6114435.3	555.0
1794	625788.9	6114470.8	552.2
1795	625833.2	6114511.0	549.6
1796	625861.1	6114564.2	545.1
1797	625889.0	6114617.4	541.5
1798	625916.9	6114670.6	542.6
1799	625951.6	6114719.4	537.5
1800	625986.4	6114768.3	532.9
1801	626021.2	6114817.2	530.0
1802	626055.9	6114866.1	525.5
1803	626090.7	6114914.9	521.8
1804	626125.0	6114964.2	520.9
1805	626176.1	6114995.8	518.9
1806	626227.4	6115027.0	515.1
1807	626275.9	6115062.6	512.5
1808	626324.4	6115098.1	509.1
1809	626372.3	6115134.1	509.5
1810	626420.3	6115170.1	511.9
1811	626468.3	6115206.1	514.5
1812	626516.2	6115242.1	519.5
1813	626564.2	6115278.2	520.3
1814	626612.2	6115314.2	522.5
1815	626660.2	6115350.2	523.4
1816	626708.2	6115386.2	520.4
1817	626756.2	6115422.2	523.4
1818	626804.2	6115458.3	526.4
1819	626853.1	6115492.9	526.6
1820	626897.8	6115532.9	526.8
1821	626940.7	6115575.0	529.1

Station	Easting metres	Northing metres	Elevation metres
1822	626985.0	6115615.5	528.2
1823	627020.2	6115664.3	524.9
1824	627045.3	6115718.8	521.6
1825	627070.3	6115773.4	519.1
1826	627095.3	6115827.9	519.1
1827	627113.9	6115885.2	517.0
1828	627132.4	6115942.5	513.2
1829	627155.7	6115997.8	510.4
1830	627179.0	6116053.1	509.4
1831	627202.3	6116108.3	508.6
1832	627225.5	6116163.6	506.5
1833	627280.2	6116188.3	507.7
1834	627334.8	6116213.1	508.0
1835	627388.5	6116239.0	505.6
1836	627442.8	6116264.9	502.1
1837	627480.6	6116311.7	500.3
1838	627509.7	6116364.2	500.4
1839	627566.2	6116384.6	502.7
1840	627609.8	6116426.3	503.3
1841	627647.9	6116472.6	503.8
1842	627681.0	6116522.7	504.7
1843	627722.7	6116565.9	505.0
1844	627777.9	6116542.3	503.3
1845	627834.6	6116522.7	503.8
1846	627893.3	6116509.9	504.5
1847	627952.7	6116513.5	505.5
1848	628010.4	6116530.2	505.7
1849	628068.0	6116546.9	506.5
1850	628113.4	6116586.1	505.8
1851	628158.8	6116625.3	508.1
1852	628204.2	6116664.5	507.2
1853	628249.6	6116703.7	507.8
1854	628295.0	6116742.9	509.3
1855	628340.4	6116782.1	509.6
1856	628385.8	6116821.3	510.5
1857	628421.8	6116869.3	510.8
1858	628457.8	6116917.3	512.3
1859	628493.8	6116965.2	513.2
1860	628529.8	6117013.2	514.4
1861	628565.8	6117061.2	515.6
1862	628601.8	6117109.2	516.8
1863	628637.8	6117157.1	518.5
1864	628673.8	6117205.1	520.5
1865	628709.8	6117253.1	522.3
1866	628745.8	6117301.1	524.3
1867	628781.8	6117349.0	529.0
1868	628817.8	6117397.0	527.5
1869	628853.8	6117445.0	529.3
1870	628889.8	6117493.0	531.4
1871	628918.9	6117545.6	533.1

Station	Easting metres	Northing metres	Elevation metres
1872	628948.1	6117598.2	533.8
1873	628977.2	6117650.8	535.2
1874	629006.3	6117703.4	536.9
1875	629030.5	6117758.2	538.6
1876	629049.4	6117815.2	540.1
1877	629068.3	6117872.2	542.1
1878	629080.5	6117930.8	543.9
1879	629076.3	6117990.8	544.1
1880	629056.8	6118047.6	544.1
1881	629033.7	6118102.9	543.7
1882	629010.3	6118158.3	543.7
1883	628987.8	6118213.8	544.8
1884	628974.2	6118272.4	546.0
1885	628974.1	6118332.3	548.7
1886	628975.0	6118392.3	551.0
1887	628976.0	6118452.3	553.6
1888	628976.9	6118512.4	555.7
1889	628977.8	6118572.4	557.6
1890	628978.7	6118632.4	559.0
1891	628975.1	6118692.6	559.1
1892	628964.1	6118751.6	559.9
1893	628945.0	6118808.4	560.5
1894	628925.8	6118865.2	561.5
1895	628906.7	6118922.1	565.3
1896	628887.5	6118978.9	569.5
1897	628868.5	6119035.8	571.5
1898	628849.6	6119092.7	572.3
1899	628830.6	6119149.6	572.9
1900	628811.6	6119206.6	573.7
1901	628792.6	6119263.5	575.9
1902	628784.8	6119323.0	578.4
1903	628777.0	6119382.5	580.8
1904	628769.2	6119442.0	582.7
1905	628761.4	6119501.5	582.3
1906	628753.6	6119561.0	579.3
1907	628737.3	6119618.7	575.4
1908	628720.9	6119676.4	571.5
1909	628704.6	6119734.1	567.6
1910	628688.3	6119791.8	569.3
1911	628672.0	6119849.5	561.5
1912	628655.6	6119907.2	560.2
1913	628639.3	6119964.8	558.9
1914	628623.0	6120022.5	558.1
1915	628606.6	6120080.2	555.8
1916	628618.3	6120139.1	554.9
1917	628629.9	6120197.9	554.0
1918	628641.5	6120256.8	552.8
1919	628653.1	6120315.6	552.3
1920	628661.9	6120374.9	550.3
1921	628670.7	6120434.2	547.6

Station	Easting metres	Northing metres	Elevation metres
1922	628671.1	6120494.2	545.0
1923	628671.6	6120554.2	544.2
1924	628672.0	6120614.2	542.8
1925	628672.4	6120674.2	542.9
1926	628672.8	6120734.2	542.8
1927	628673.3	6120794.2	542.5
1928	628659.7	6120852.6	540.4
1929	628646.2	6120911.1	538.1
1930	628632.6	6120969.5	537.5
1931	628619.0	6121027.9	537.1
1932	628617.8	6121087.9	537.1
1933	628624.3	6121147.5	536.4
1934	628630.8	6121207.2	535.3
1935	628637.3	6121266.8	534.1
1936	628643.8	6121326.4	532.6
1937	628678.0	6121375.6	531.4
1938	628712.3	6121424.8	529.7
1939	628732.9	6121481.2	528.7
1940	628753.4	6121537.6	528.5
1941	628774.0	6121594.0	528.5
1942	628802.5	6121646.8	527.5
1943	628831.0	6121699.6	527.2
1944	628859.5	6121752.4	527.6
1945	628901.3	6121795.4	527.0
1946	628943.1	6121838.4	526.0
1947	628984.9	6121881.5	527.7
1948	629026.7	6121924.5	528.4
1949	629056.9	6121976.3	527.5
1950	629087.1	6122028.1	526.7
1951	629117.3	6122079.9	526.2
1952	629147.5	6122131.7	525.9
1953	629182.0	6122180.8	525.8
1954	629216.4	6122229.9	525.2
1955	629250.9	6122279.0	525.2
1956	629285.4	6122328.2	526.1
1957	629312.4	6122381.7	525.5
1958	629339.5	6122435.3	525.6
1959	629366.5	6122488.8	526.3
1960	629409.5	6122530.7	525.5
1961	629452.4	6122572.5	525.3
1962	629495.4	6122614.4	525.9
1963	629538.4	6122656.3	526.9
1964	629581.3	6122698.1	528.1
1965	629613.5	6122748.9	528.7
1966	629645.7	6122799.7	528.1
1967	629684.2	6122845.7	526.4
1968	629722.7	6122891.7	524.1
1969	629761.2	6122937.7	521.8
1970	629782.6	6122993.8	520.6
1971	629803.9	6123049.9	519.2

Station	Easting metres	Northing metres	Elevation metres
1972	629818.8	6123108.0	518.0
1973	629833.7	6123166.1	517.7
1974	629848.6	6123224.2	518.0
1975	629861.9	6123282.7	516.4
1976	629875.1	6123341.2	514.3
1977	629888.4	6123399.7	512.7
1978	629901.7	6123458.2	512.2
1979	629915.0	6123516.7	511.8
1980	629928.2	6123575.2	510.3
1981	629949.9	6123631.0	508.6
1982	629971.6	6123686.8	508.0
1983	629993.3	6123742.6	508.1
1984	630025.9	6123792.9	507.1
1985	630058.5	6123843.3	507.6
1986	630091.0	6123893.6	507.2
1987	630123.6	6123944.0	507.3
1988	630156.1	6123994.3	508.3
1989	630188.3	6124045.2	506.3
1990	630220.5	6124096.0	505.7
1991	630252.6	6124146.9	504.9
1992	630279.6	6124200.5	503.9
1993	630306.6	6124254.1	502.8
1994	630333.5	6124307.6	502.5
1995	630360.5	6124361.2	501.6
1996	630383.8	6124416.5	499.2
1997	630407.2	6124471.8	496.5
1998	630430.5	6124527.0	494.4

PORTABLE SEISMIC RECORDER STATIONS

Station	Easting metres	Northing metres	Elevation metres
2001	630410.	6114030.	680.
2002	628170.	6113000.	583.
2003	628025.	6116500.	505.
2004	626450.	6110180.	837.
2005	626400.	6107965.	765.
2006	623975.	6118015.	655.
2007	625235.	6114500.	560.
2008	624430.	6108550.	760.
2009	623853.	6011271.	723.
2010	623511.	6115792.	523.
2011	623000.	6107140.	625.
2012	622740.	6109090.	658.
2013	622250.	6112950.	648.
2014	622170.	6111371.	710.
2015	619400.	6112950.	690.
2016	620050.	6106350.	425.
2017	619275.	6108785.	370.
2018	618630.	6115000.	674.
2019	618610.	6111090.	373.
2020	617580.	6113120.	450.
2021	617870.	6107280.	405.
2022	617050.	6115000.	420.
2023	615300.	6110150.	280.
2024	614900.	6107600.	460.
2025	612300.	6115750.	450.
2026	611930.	6109100.	240.
2027	611680.	6105350.	240.
2028	611600.	6106850.	240.
2029	611130.	6111450.	270.
2030	610300.	6113200.	270.
2031	609880.	6108670.	240.
2032	608700.	6111025.	248.

APPENDIX 6

TUMUT TROUGH THREE COMPONENT SURVEY - EASTERN SECTION

STATION STATISTICS

SITE NO.	SET NO.	C O M	SWITCH ON dd hh mm	SWITCH OFF dd hh mm	CLOCK ERROR msec	GAIN dB	NOTE
1895	027	R	34	36 16 07	-037	108	
1895	003	T	30 16 16	36 16 07	+032	120	
1895	005	V	30 15 57	36 16 09	+009	108	1
1908	032	R	34 14 47	36 15 46	+318	108	
1908	033	T	34 14 43	36 15 42	-049	120	
1908	022	V	34 14 45	36 15 42	+031	108	
1925	008	R	35 12 59	36 15 22	+010	108	
1925	004	T	30 13 37	36 15 19	-025	108	
1925	008	V	34 15 18	35 12 54	+010	108	

NOTES

1: gain reset from 120

Components: R = Radial
T = Transverse
V = Vertical

Radial component was oriented 45 degrees east of magnetic North.

TUMUT TOMOGRAPHY SURVEY.

STATION STATISTICS.

SITE NO.	SET NO.	SWITCH ON dd hh mm	SWITCH OFF dd hh mm	CLOCK msec.	GAIN db	NOTE
2001	020	35 12 39	43 10 40	-055	96	1
2002	010	35 14 25	43 11 43	-070	96	
2003	021	35 12 02	43 09 10	-09	96	2
2004	028	35 14 43	43 12 01	-18	96	3
2005	006	35 14 58	43 12 32	-010	96	
2006	018	35 13 11	43 11 13	+737	90	4
2007	031	35 13 23	43 14 00	????	96	1
2008	007	35 15 38	43 12 54	-080	96	
2009	001	35 12 06	43 13 18	+402	96	
2010	002	35 13 48	43 14 32	-1.5sec?	96	1
2011	019	35 14 36	43 15 51	+015	96	
2012	030	35 11 54	43 15 26	-085	96	1
2013	029	35 12 25	43 13 38	+791	96	
2014	012	35 10 19	43 10 10	+208	96	
2015	011	35 10 48	43 10 47	+328	96	
2016	017	35 13 36	43 16 26	+018	96	
2017	024	35 13 17	43 16 51	-128	96	
2018	013	35 11 20	43 11 22	-056	96	
2019	025	35 12 58	43 13 55	-192	96	3
2020	015	35 12 33	43 13 23	-005	96	
2021	026	35 14 22	44 11 37	+028	96	6
2022	014	35 12 02	43 12 32	-917	96	
2023	016	35 14 48	43 16 46	+012	96	
2024	023	35 15 45	43 16 02	-133	96	
2025	008	37 12 32	44 10 50	-033	96	
2026	027	37 09 35	44 11 05	-124	96	
2027	003	37 09 00	44 10 14	+071	96	
2028	005	37 10 26	44 10 26	+023	96	
2029	033	37 11 07	14 12 34	-892	96	
2030	032	37 11 44	44 11 22	+544	96	
2031	022	37 14 54	44 11 43	+068	96	
2032	004	37 14 15	44 12 02	-935	96	

NOTES

- 1: Battery low
- 2: Battery flat
- 3: Continuous record; other stations operated 0700-1800
- 4: Seismometer sited on rocks
- 5: Clock reading 00 00 13
- 6: Day 44 = 43?

TUMUT TROUGH THREE COMPONENT SURVEY - WESTERN SECTION

STATION STATISTICS

SITE NO.	SET NO.	COMP TYPE	SWITCH ON			SWITCH OFF			CLOCK ERROR msec	GAIN db	NOTE
			dd	hh	mm	dd	hh	mm			
1235	030	R	45	09	15	49	11	31	-047	102	
1235	024	T	45	09	10	49	11	30	+334	102	
1235	031	V	45	09	12	49	11	33	-133	102	
1237	018	R	45	09	47	49	11	45	+392	102	1
1237	019	T	45	09	43	49	11	44	+018	102	
1237	017	V	45	09	45	49	11	49	+011	102	
1239	010	R	45	10	15	49	12	00	-070	102	
1239	006	T	45	10	14	49	11	58	-003	102	2
1239	002	V	45	10	30	49	11	59	-350	102	
1241	029	R	45	11	03	49	12	12	+476	102	
1241	028	T	45	10	58	49	12	10	-100	102	
1241	033	V	45	10	55	49	12	10	-108	102	
1243	023	R	45			49	12	35	-065	108	
1243	001	R	45	11	33	49	12	24	+257	108	
1243	007	T	45	11	32	49	12	24	-050	108	
1245	004	V	45	11	41	49	12	25	-050	108	
1245	022	T	45	12	13	49	12	36	+064	108	
1245	032	V	45	12	13	49	12	37	+597	108	
1247	011	R	45	12	54	49	13	11	+178	102	
1247	008	T	45	13	14	49	13	14	+011	102	
1247	013	V	45	12	47	49	13	11	-027	102	
1249	015	R	45	13	43	49	13	24	nil	102	3
1249	009	T	45	14	03	49	13	24	+157	102	
1249	014	V	45	13	42	49	13	24	-040	102	
1251	027	R	45	14	26	49	13	37	-063	102	
1251	026	T	45	14	28	49	13	40	+031	102	
1251	025	V	45	14	21	49	13	38	+006	102	
1253	005	R	45	14	53	49	13	52	+021	102	
1253	003	T	45	14	52	49	13	53	+060	102	4
1253	012	T	45	14	58	49	13	56	+141	102	
1255	020	R	45	15	32	49	14	09		102	1
1255	016	T	45	15	29	04	14	06	+025	102	5
1255	021	V	45	16	06	49	14	07	-040	102	

NOTES

- | | |
|-----------------|----------------------------|
| 1: Flat battery | 4: Set not on |
| 2: Spongy earth | 5: Clock read 04 on day 49 |
| 3: On by-pass | |

Components: R = Radial
 T = Transverse
 V = Vertical

Radial component was oriented 45 degrees east of magnetic North.

APPENDIX 7

GRAVITY DATA

Gravity readings were taken at a nominal 360 metre spacing along the seismic traverse by John Williams of the Potential Fields Group. The last four digits of the station number below correspond to the seismic station number.

Station	Latitude degrees	Longitude degrees	Elev. metres	Obs. Gravity $\mu \text{ ms}^{-2}$
87021026	35.2639	147.9890	462.40	9796457.96
87021032	35.2622	147.9923	421.70	9796535.40
87021036	35.2610	147.9946	405.10	9796562.42
87021042	35.2593	147.9979	393.60	9796578.83
87021048	35.2575	148.0012	392.00	9796573.82
87021054	35.2553	148.0040	375.80	9796597.54
87021062	35.2536	148.0087	332.60	9796665.67
87021068	35.2526	148.0124	338.80	9796645.56
87021074	35.2510	148.0151	320.70	9796666.07
87021080	35.2490	148.0182	309.60	9796679.68
87021083	35.2482	148.0200	293.30	9796707.69
87021089	35.2468	148.0235	275.20	9796734.91
87021096	35.2451	148.0276	262.20	9796745.11
87021101	35.2439	148.0306	257.70	9796748.82
87021107	35.2424	148.0341	254.50	9796752.72
87021113	35.2410	148.0376	249.30	9796757.72
87021118	35.2397	148.0405	248.10	9796754.42
87021124	35.2383	148.0439	249.80	9796745.01
87021130	35.2368	148.0474	280.80	9796675.08
87021136	35.2360	148.0512	271.00	9796676.88
87021142	35.2353	148.0551	270.50	9796663.07
87021148	35.2346	148.0589	288.90	9796615.05
87021154	35.2338	148.0628	299.60	9796593.53
87021160	35.2331	148.0666	304.30	9796582.43
87021166	35.2323	148.0705	307.00	9796572.82
87021172	35.2315	148.0743	283.60	9796611.04
87021178	35.2307	148.0781	291.60	9796585.73
87021183	35.2300	148.0813	315.60	9796527.30
87021189	35.2303	148.0851	282.50	9796572.32
87021194	35.2309	148.0883	289.80	9796556.81
87021200	35.2311	148.0922	307.50	9796520.70
87021206	35.2308	148.0961	306.20	9796512.09
87021212	35.2305	148.1001	305.60	9796504.89
87021218	35.2297	148.1038	319.40	9796467.97
87021224	35.2281	148.1072	362.30	9796368.51
87021230	35.2265	148.1106	436.50	9796210.33
87021236	35.2240	148.1125	472.20	9796139.79
87021242	35.2210	148.1140	465.20	9796151.30
87021248	35.2180	148.1155	450.60	9796176.61
87021254	35.2150	148.1170	432.00	9796212.93
87021260	35.2121	148.1188	427.80	9796218.03
87021266	35.2095	148.1212	384.90	9796295.68
87021272	35.2071	148.1238	368.70	9796328.09

Station	Latitude degrees	Longitude degrees	Elev. metres	Obs. Gravity $\mu \text{ ms}^{-2}$
87021278	35.2055	148.1272	363.90	9796337.80
87021284	35.2034	148.1302	353.70	9796362.31
87021290	35.2009	148.1326	341.60	9796393.13
87021296	35.1980	148.1344	327.00	9796427.95
87021302	35.1992	148.1380	321.60	9796436.15
87021308	35.1991	148.1419	316.40	9796447.16
87021314	35.1988	148.1459	315.40	9796453.26
87021320	35.1988	148.1498	298.70	9796498.88
87021326	35.1985	148.1537	294.80	9796500.18
87021332	35.1989	148.1576	285.00	9796522.90
87021338	35.1991	148.1615	282.70	9796530.30
87021344	35.1988	148.1655	271.50	9796557.31
87021350	35.1981	148.1693	266.10	9796575.32
87021356	35.1970	148.1730	261.90	9796587.13
87021362	35.1967	148.1769	253.50	9796609.24
87021368	35.1945	148.1787	269.70	9796581.93
87021374	35.1917	148.1789	263.00	9796591.23
87021380	35.1888	148.1804	262.30	9796599.44
87021386	35.1865	148.1826	244.80	9796639.56
87021392	35.1858	148.1864	244.10	9796647.06
87021398	35.1851	148.1903	244.00	9796641.76
87021404	35.1844	148.1942	243.90	9796640.16
87021410	35.1831	148.1977	242.80	9796647.46
87021416	35.1815	148.2012	242.00	9796652.97
87021422	35.1815	148.2047	241.80	9796658.07
87021428	35.1809	148.2080	241.80	9796652.56
87021434	35.1785	148.2106	241.50	9796644.96
87021440	35.1769	148.2140	255.80	9796618.55
87021446	35.1775	148.2177	266.50	9796595.93
87021452	35.1780	148.2217	247.50	9796624.35
87021458	35.1763	148.2248	246.40	9796617.25
87021464	35.1738	148.2272	253.90	9796594.73
87021470	35.1707	148.2283	257.00	9796585.53
87021476	35.1676	148.2287	265.10	9796574.72
87021482	35.1645	148.2275	255.40	9796605.64
87021488	35.1613	148.2274	243.40	9796634.06
87021494	35.1586	148.2292	247.00	9796619.55
87021500	35.1560	148.2313	250.70	9796624.15
87021506	35.1527	148.2319	246.70	9796632.75
87021512	35.1495	148.2325	247.70	9796637.76
87021518	35.1488	148.2353	250.30	9796636.06
87021524	35.1485	148.2392	251.70	9796644.66
87021530	35.1462	148.2414	252.40	9796668.17
87021536	35.1433	148.2429	260.90	9796667.07
87021542	35.1404	148.2446	262.00	9796676.08
87021548	35.1380	148.2471	265.80	9796670.07
87021554	35.1359	148.2501	267.10	9796681.68
87021560	35.1357	148.2537	278.70	9796670.77
87021566	35.1362	148.2576	291.60	9796659.77
87021572	35.1369	148.2615	305.70	9796642.36

Station	Latitude degrees	Longitude degrees	Elev. metres	Obs. Gravity $\mu \text{ ms}^{-2}$
87021578	35.1380	148.2652	292.80	9796668.27
87021584	35.1394	148.2687	284.10	9796684.28
87021590	35.1409	148.2722	285.90	9796678.48
87021596	35.1418	148.2758	297.90	9796657.67
87021602	35.1429	148.2792	310.80	9796634.86
87021608	35.1449	148.2820	299.50	9796652.06
87021614	35.1444	148.2858	312.90	9796629.85
87021620	35.1419	148.2881	333.50	9796591.93
87021626	35.1407	148.2917	340.60	9796574.22
87021632	35.1399	148.2955	339.80	9796569.92
87021638	35.1385	148.2991	329.60	9796569.92
87021644	35.1370	148.3026	350.50	9796517.99
87021650	35.1356	148.3062	377.40	9796438.25
87021656	35.1342	148.3097	477.20	9796214.43
87021662	35.1317	148.3191	702.00	9795747.89
87021668	35.1310	148.3230	701.10	9795742.98
87021674	35.1304	148.3268	705.00	9795734.98
87021680	35.1299	148.3307	724.90	9795684.75
87021686	35.1306	148.3346	738.90	9795642.13
87021692	35.1307	148.3385	695.10	9795740.38
87021698	35.1307	148.3424	677.80	9795772.70
87021704	35.1307	148.3464	671.90	9795786.71
87021710	35.1308	148.3503	687.60	9795756.29
87021716	35.1309	148.3543	700.30	9795725.47
87021722	35.1312	148.3582	707.30	9795710.07
87021728	35.1314	148.3619	701.70	9795719.07
87021734	35.1287	148.3641	677.20	9795764.99
87021740	35.1265	148.3670	690.00	9795732.68
87021746	35.1256	148.3704	692.20	9795725.47
87021752	35.1239	148.3727	686.00	9795736.88
87021758	35.1219	148.3754	661.30	9795782.00
87021764	35.1191	148.3769	628.90	9795839.43
87021770	35.1163	148.3788	612.90	9795866.55
87021776	35.1131	148.3793	595.70	9795897.46
87021782	35.1098	148.3798	586.40	9795908.47
87021788	35.1069	148.3787	566.70	9795948.49
87021794	35.1046	148.3802	552.20	9795968.30
87021800	35.1019	148.3823	532.90	9796001.52
87021806	35.0995	148.3849	515.10	9796032.14
87021812	35.0976	148.3881	519.50	9796016.53
87021818	35.0956	148.3912	526.40	9795999.02
87021824	35.0932	148.3938	521.60	9796004.72
87021830	35.0902	148.3952	509.40	9796024.13
87021836	35.0882	148.3981	502.10	9796036.04
87021842	35.0859	148.4006	504.70	9796025.93
87021848	35.0858	148.4042	505.70	9796020.53
87021854	35.0838	148.4073	509.30	9796006.92
87021860	35.0813	148.4099	514.40	9795988.11
87021866	35.0787	148.4122	524.30	9795966.40
87021872	35.0760	148.4144	533.80	9795942.29

Station	Latitude degrees	Longitude degrees	Elev. metres	Obs. Gravity $\mu \text{ ms}^{-2}$
87021878	35.0730	148.4158	543.90	9795918.48
87021884	35.0699	148.4145	546.00	9795913.97
87021890	35.0667	148.4145	559.00	9795887.46
87021896	35.0636	148.4135	569.50	9795866.55
87021902	35.0605	148.4123	578.40	9795848.64
87021908	35.0573	148.4115	571.50	9795859.74
87021914	35.0542	148.4104	558.10	9795881.86
87021920	35.0510	148.4108	550.30	9795892.26
87021926	35.0478	148.4109	542.80	9795904.37
87021932	35.0446	148.4102	537.10	9795915.17
87021938	35.0416	148.4112	529.70	9795926.38
87021944	35.0386	148.4127	527.60	9795924.08
87021950	35.0361	148.4152	526.70	9795923.18
87021956	35.0333	148.4173	526.10	9795921.48
87021962	35.0307	148.4196	525.90	9795917.18
87021968	35.0282	148.4220	524.10	9795912.67
87021974	35.0252	148.4234	518.00	9795922.48
87021980	35.0220	148.4242	510.30	9795937.09
87021986	35.0191	148.4259	507.20	9795939.19
87021992	35.0163	148.4279	503.90	9795943.39
87021998	35.0134	148.4295	494.40	9795957.50

APPENDIX 8

SUGGESTED GUIDELINES FOR PRE-SURVEY ORGANIZATION

1. Formulate aims of the survey
2. Investigate scientific feasibility
3. Investigate logistic feasibility of the survey
4. Planning meeting of scientists involved
5. Initial reconnaissance trip
6. Obtain maps - topographic, geological and cadastral
7. Contact Surveyors
8. Review logistic feasibility
9. Costing of the survey - initial estimates
10. Drilling requirements, inform Drilling Supervisor
11. Review geology
12. Inform Dept. of Main Roads of intended operations
13. Obtain exploration lease boundaries from Mines Dept.
14. Approach exploration lease holders for permission
15. NSW Dept of Industrial Relations - Chief Inspector of Dangerous Goods for transport of explosives.
16. Check licences of the loaders and shooters.
17. Check regulations regarding pre-loading
18. Discuss equipment requirements with STO
19. Inform NSW Geol. Survey of the work
20. Contact NSW Dept of Mines Aboriginal Liaison Officer
21. Contact Shires, re. permission to operate on shire roads parking space, magazines, property owners.
22. Contact Shire Engineer re permission to detonate shots along roads, water, parking, explosives, and bridge capacities.
23. Contact County Council (or Electricity Authority) for names of electricity users in the region and location of cables.
24. Contact Telecom regarding cables.
25. Inform Qld Chief Inspector of Mines if transporting explosives from Helidon
26. Inform NSW Aboriginal Land Council of operations
27. Contact Local Aboriginal Land Council
28. Contact Archaeologist NP&WS Queanbeyan
29. Determine vehicle requirements - discuss with Vehicles Officer
30. Mobile magazine requirements and licence
31. Look at precautions against compensation claims
32. Drilling requirements - time required, rigs, & hard rock bits
33. Meteorological data for the region
34. Inform local police of intended operations
35. Obtain names of landowners along proposed route from Shire Rates Office or Valuer General's Dept.
36. Press release to local newspaper
37. Send letter requesting permission to landowners
38. Obtain a telephone book for the area.
39. Ring landowners and make appointments to visit

40. Visit landowners
41. Party formation form
42. Requirements for surveying to ASO
43. Refraction/Tomography requirements
44. Radio/TV interviews
45. Gravity and aeromagnetism along the survey route?
46. Match personnel with vehicles
47. Accommodation bookings as necessary
48. Camping equipment requirements
49. Hire of field hands
50. Detailed costing of the survey
51. Detailed planning of movements
52. Ensure equipment is serviceable
53. Movement requisition for all field personnel

APPROACH LANDOWNERS

- Contact by
- (1) Letter
 - (2) Media - Newspaper, Radio, TV
 - (3) Personal visit

During personal visit

- (1) explain operations
- (2) request permission
- (3) obtain information on access
- (4) obtain information on areas to be avoided
(pipelines, bores, concrete tanks, houses)
- (5) note restriction specified by the landowner.