96-3873

340001

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EVALUATION
AGSO SEISMIC LINES T4, T5
TASMANIA

for
GREAT SOUTHLAND MINERALS PTY LTD

by
D.E. Leaman,

April 1996

EL 1/88

GSMAGSO

AMG REFERENCE POINTS ADDED

340002

INTRODUCTION

Five seismic lines were recorded in Tasmania during 1995 by the Australian Geological Survey Organisation (AGSO) as part of an industry/research program to define crustal structure. Although the basic specification was originally more suited to definition of deep (lower crustal) structure AGSO were persuaded to undertake the surveys with closer shot intervals and to allow for the local terrain.
Two of these lines (4 and 5) were observed within central Tasmania and sampled typical segments of the Permo-Triassic cover sequences and the included intrusions of Jurassic dolerite. These materials are loosely described as the rocks of the "Tasmania Basin". The location of the two lines is shown in Figure 1.

These surveys represent the only modern, industry-standard, seismic surveys onshore in Tasmania. They have been examined in order to appraise information gained, problems and specification requirements for future surveys.

COMMENTS ON PREVIOUS SEISMIC DATA

Previous reflection seismic surveys have been restricted in coverage, limited in CDP fold, and not adequately processed. It has never been possible to persuade processing centres that high initial velocities are the fact and independent processing has not been possible by any agency completing such surveys due to lack of hardware/software or budget. Considerable experimentation has been undertaken in terms of field layout and energy requirements in order to optimise signal and resolve the complex static problems which arise in terrain of varied relief with high and variable surface velocities.
Although many short profiles and soundings have been completed using high resolution digital recording equipment it must be stated that the surveys have been of research character and not undertaken in the manner of a normal industrial survey. In many respects such research surveys are of higher standard and resolution due to the fine tuning of signal and adjustment for on-line conditions which is not feasible in a routine long line survey.

All previous surveys involving rocks of the Tasmania Basin have, however, been limited by the effect of the dolerite intrusions. These have either caused total absorption or loss of signal or produced a seismic shadow for up to one second below the intrusion. The reasons are not fully understood. It is in this context that the new surveys are of particular interest.

Few previous surveys have line lengths much greater than 1 - 2 km although the best data to date (Fingal Tier, Gladstone and North Bruny Island) are on lines up to 7 km long.

Jurassic dolerite has posed the critical problems in all cases involving rocks of the Tasmania Basin. It presents a very sharp velocity profile if at surface (V > 5500 m/s at 50 m) and when not at surface velocities in excess of 5500 m/s are typical.

The intrusions are not simple, nor extensively concordant, in the shallowly-dipping Permo-Triassic (Parmeener Super Group) rocks. It is a mistake to presume sill character over distances much in excess of 2 km; multiplicity of intrusion and discordance on a large scale is endemic. At regional scales each intrusive sheet has a thickness of 320 - 450 metres. Any given cover section which is commenced in Triassic rocks may include two large sheets. Geometric considerations based on knowledge of intrusion forms suggest that diffractions and sideswipe effects should be common but mitigated by the very high velocites and the relative thinness of the sheets and the limited relief of discordances.

Velocity information is generally based on refraction data but may be summarised as follows.

Permian rocks:	4000-4500 m/s
Triassic rocks:	3500-4200 m/s
Jurassic dolerite:	5000-6000 m/s
Tertiary sediments:	1750-2000 m/s

Deeply weathered rocks and soils: <1600 m/s
Weathering profile generally less than 10 m in all rock types.

These velocities convert into two-way times (2WT) as

Permian :	50 millisecs per 100 m
Triassic:	56 ms/100m
dolerite:	35 ms/100m
Tertiary:	100 ms/100m

In terms of typical formation or section thicknesses total times may be estimated (minima)

Permian: about 700-800 m thick	0.35-0.4 seconds
Triassic: say 400 m qz section	0.25 s
dolerite sheet: say 400 m thick	0.14 s
Tertiary sediments: 50 m thick	0.05 s

Plus surface delay, weathering times where relevant.

On the basis of these estimates we should expect to see the base Parmeener unconformity at around 0.8 seconds over much of central Tasmania but with a range depending on the thickness of cover and the number of contained intrusive sheets (probably 0.5 to 1.2 s). For example, at North Bruny Island where the intrusive sheet is within the mid Lower Parmeener (Permian) rocks and the surface is within 100 m this interface could have been expected at about 0.4-0.5 seconds. It was, however, not observed due to the effect of dolerite and its seismic shadow.

This information and previous experience may now be considered in terms of the new survey.

1.0		25/36 - 84/36
2.0		20/36 - 72/36
4.0		16/36 - 72/36

[18] TIME VARIANT SCALING (GATE LENGTH 250 MS)

[19] DISPLAY GAIN 1

PROCESSED BY:
MARINE, PETROLEUM & SEDIMENTARY RESOURCES, AGSO

CANBERRA, A.C.T.

QUALITY CONTROL CHECK

LAND SEISMIC GROUP

DATE : OCTOBER 1995

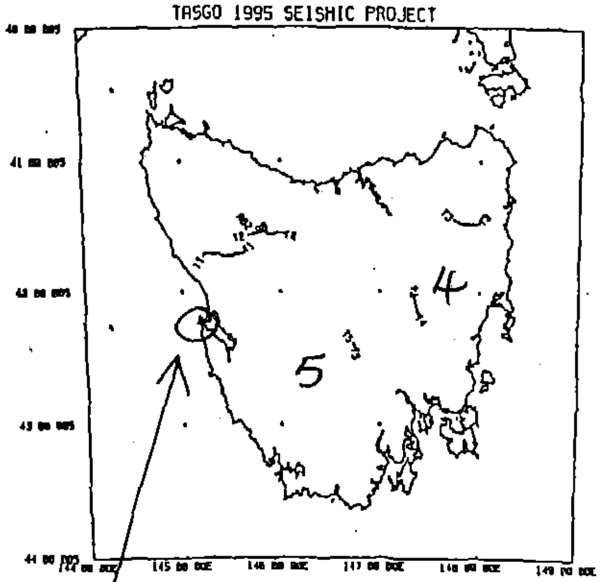
HORIZONTAL SCALE : 31.75 TRACES/INCH (1:25 000)

VERTICAL SCALE : 3.937 INCHES/SEC

V:H = 1:1 (AT 5000M/S)

POLARITY : -VE ON TAPE = UPWARD GROUND DISPLACEMENT = TROUGH (I.E. SEG CONVENTION)

TASGO 1995 SEISMIC PROJECT



AMG 348600E, 5326600N

LOCATION MAP

THESE DATA WERE ACQUIRED AS PART OF NGMA PROJECT 'TASGO'. CO-OPERATING PARTNERS ARE AGSO, CANBERRA AND TGS, TASMANIA
THESE SEISMIC DATA MUST BE KEPT EXCLUSIVELY FOR THE USE OF THE PURCHASER AND MUST NOT BE TRANSMITTED TO ANY THIRD PARTY, AND MAY NOT BE PUBLISHED IN ANY FORM OR USED IN A PROSPECTUS OR STATEMENT [illegible]

ILL (6200 MS @ 4.000 MS SAMPLE RATE)
OVER ENTIRE TRACE INCLUDING ZERO SAMPLES
.00 DIRECTION = LR

3.00
4.00
5.00
6.00

5 cm

AMG REFERENCE POINTS ADDED

340004

FIG 1

1.0	25/36 - 84/36
2.0	20/36 - 72/36
4.0	16/36 - 72/36

[18] TIME VARIANT SCALING (GATE LENGTH 250 MS)

[19] DISPLAY GAIN 1

PROCESSED BY:
MARINE, PETROLEUM &
SEDIMENTARY RESOURCES, AGSO

CANBERRA, A.C.T.

QUALITY CONTROL CHECK

LAND SEISMIC GROUP

DATE : OCTOBER 1995

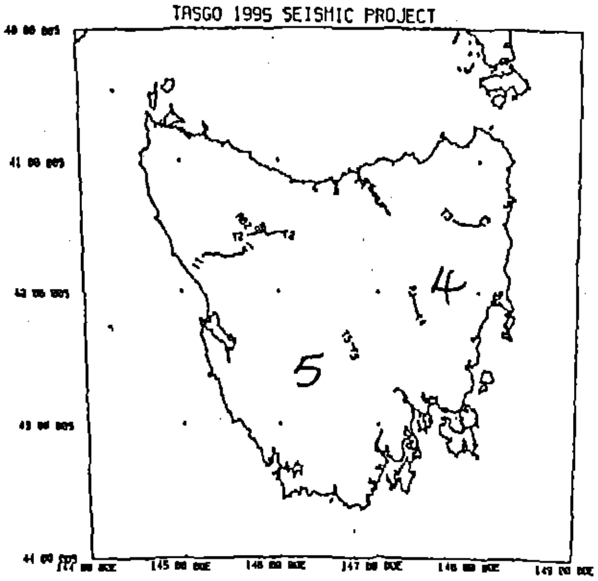
HORIZONTAL SCALE : 31.75 TRACES/INCH (1:25 000)

VERTICAL SCALE : 3.937 INCHES/SEC

V:H = 1:1 (AT 5000M/S)

POLARITY : -VE ON TAPE = UPWARD GROUND DISPLACEMENT = TROUGH (I.E. SEG CONVENTION)

TASGO 1995 SEISMIC PROJECT



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THESE SEISMIC DATA MUST BE KEPT EXCLUSIVELY FOR THE USE OF THE PURCHASER AND MUST NOT BE TRANSMITTED TO ANY THIRD PARTY, AND MAY NOT BE PUBLISHED IN ANY FORM OR USED IN A PROSPECTUS OR STATEMENT WITHOUT ...

3.00

4.00

5.00

6.00

ILL (6200 MS @ 4.000 MS SAMPLE RATE)
OVER ENTIRE TRACE INCLUDING ZERO SAMPLES
.00 DIRECTION = LR

340006

5 cm

FIG 1

LINE 4

The line was located west of Ross and Tunbridge in the northern Midlands of Tasmania. Orientation SSE.
Coordinates: 528 735E, 5346 282N to 532 166E, 5330 671N.
The line was located in an area of low relief immediately east of the escarpment of the Great Western Tiers (Gavins Tier, in particular) and adjacent to Bells Lagoon.

This location is immediately problematic.
(It is not choice I would have made or agreed to unless the line were oriented E-W)
The line runs parallel to, and directly above, a major change in basement or basement structuring. This is well defined by regional gravity data; one of the most significant gravity features in the Tasmanian crust passes through this locality and the Tiers escarpment is a rejuvenated version of it which has retreated due to erosion. Since current information (gravity and magnetic) indicate that the seismic line is located mid gradient, and therefore directly above the feature, complex reflections or sideswipes should be anticipated at shallow depth. A profile oriented as a dip line would be much more informative.

Geology along the line is somewhat variable.
The following comments are based on the available geological map of the area: Interlaken, 1:50000, S.M.Forsyth, 1986.
At the north end (start) there is a thin Tertiary and Recent cover on Triassic (quartz sequence) rocks. The Triassic rocks appear to dip SW at about ten degrees and are intruded by at least one dolerite intrusion.
The central section of the line samples Tertiary sediments overlying dolerite. The grain textures suggest the top of a sheet. The change from Triassic basement (to Tertiary cover) to dolerite can be related to faulting and offsets extending from the Tiers along the valley of the Isis River.
The south end of the line (end) appears to involve a thin Tertiary or Recent cover on dolerite but textures here indicate a much lower level within the dolerite sheet (lower part of top third).
The thickness and composition of any alluvials, sand cover or Tertiary materials is not known.

Details of the survey and processing specification are provided in Figure T4-1.

An interpretation is provided in Figures T4-2, 3, 4.

Gravity data indicate at least two thick pods of Tertiary sediments or surface cover. These occur between shot points 4070-4130 and 4300-4370 and the thickness may be estimated at up to 100 and 150 m respectively. These estimates require some presumptions about the background field and are not absolute.
Such materials could cause offset of reflections by up to 150 ms in these zones.

The Figures show that this does occur at each site. There is a distinct hinging of a strong reflection from SP 4070 and weak character which mirrors the gravity profile can be seen in the early part of the record. This is not as well developed near SP 4350 even though the southern occurrence is thicker (gravity indication).

Very clear reflection character is evident at the north end of the line where young cover overlies Triassic rocks and dolerite lies at some shallow depth. A half graben form related to the transverse fault along the Isis River makes a consistent picture. Assuming that the dolerite exposed up dip can be continued into the section then the labelling shown suggests that, unusually from past experience, both the upper and lower surfaces of the intrusion have yielded reflections. A patchy reflection within what is clearly the Permian sequence may be the freshwater deposition which subdivides the upper and lower glaciomarine formations.
The stronger lower reflection which, in places, rings has been interpreted as basement. This cannot be recognised beneath the small Tertiary basin; which may indicate less transmission energy or more disruption due to faulting. Note also that the line may slip on and off, or across, a major basement change.
A basement time depth of about 0.7 seconds is consistent with known velocities and a single intrusion in a section with exposure at Lower Triassic level.

The central section of the line (Figure T4-3) displays few clear or continuous reflections. There are no indications of several reflective horizons and only one is well defined: about 0.2 s near 4240-4290.
In this portion of the line soft, Recent/Tertiary cover overlies dolerite. Dolerite is exposed in many areas.
The interpretation suggests how the various textural observations and reflections might be combined to yield a solution consistent with the northern line segment (Fig T4-2). This part of the line is dominated by suites of diffractions and the horizon picks are based on links between diffraction-generating points. When this is done the pattern of layers is similar to the clear section at the north end but the definition is poor. Basement is barely distinguished.

The southern section of the line (Figure T4-4) offers little improvement and is complicated by the thicker Tertiary development and additional faulting.

It may be observed that the stacking velocities employed during processing are consistent with the values tabulated above and have been varied along the line as required by mapped changes in rock type.

Most of the structuring interpreted along the line can be associated with the Late Cretaceous and Tertiary development of the area even though this line orientation cannot suggest true shapes for the structures. There is some slight suggestion that the thickness of Permian(?) rocks may vary along line although this inference may be based on a varying amount of, combined, Permian and Triassic rocks beneath a dolerite sheet which is stepping across the sequence.

340008

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The magnetic profile suggests that the dolerite sheet may thicken or change form near SP 4140. This is very close to the Isis River Fault and location of the Tertiary ramp. No detailed modelling is possible with this data, or alignment, but it is possible that the fault is a rejuvenation of a Jurassic structure which has been intruded by a dyke or feeder of dolerite. This would also account for some of the degradation noted in the record in this zone.

The sections included in this evaluation are based on the 6 second records and the relevant processing. Although most of the differences in processing stream between the 6 second and deeper records applies after four seconds regional diffraction character is more easily recognised in the longer records. This indicates that much of the patchy character found in these profiles is generated off line. Only the shallower, sharper diffraction points have been defined and linked during interpretation in order to avoid confusion between features most likely sourced less than 1 second on line and thus not within basement either on or off line.

340010

SOUTH

RECORDING PARAMETERS

SHOT BY	: AGSO	DATE	: APRIL 1995
SYSTEM TYPE	: SERCEL SN368	SOURCE TYPE	: DYNAMITE
TAPE FORMAT	: SEGD & SEGY	CHARGE	: 10.0 KG (NOMINAL)
DENSITY	: 6250 BPI, GCR & EXABYTE	DEPTH	: 20 M (NOMINAL)
RECORD LENGTH	: 20 SECONDS		
SAMPLE RATE	: 2 MSEC	SP INTERVAL	: 240 M (NOMINAL)
		SPREAD PATTERN	: 2360 M - 0 - 2400 M
FILTERS	: LCF 8 HZ, 18 DB/OCT	NO OF CHANNELS	: 120
	: HCF 178 HZ, 72 DB/OCT	MAX. OFFSET	: 4760 M
	: NOTCH OUT	GROUP PATTERN	: 18 IN-LINE, 2.6M SPACING
		GROUP INTERVAL	: 40 M
GRAVITY DATA	: TGS, TASMANIA	COVERAGE	: 10 FOLD (NOMINAL)
RESIDUAL MAG	: COMP, AGSO		
		CREW CHIEF	: T. BARTON

PROCESSING SEQUENCE

[1] CROOKED LINE GEOMETRY DEFINITION

[2] FIELD SEGY TO 'DISCO' FORMAT

[3] RESAMPLE TO 4 MSECS

[4] QUALITY CONTROL DISPLAYS.TRACE EDITS.SELECTIVE MUTING

[5] CROOKED LINE BINNING (200 M)

[6] SPHERICAL DIVERGENCE AND GAIN CORRECTION

[7] DATUM STATICS APPLICATION
- DATUM 200 M

[8] SPECTRAL EQUALISATION

[9] CDP SORT

[10] VELOCITY ANALYSIS (CVS)

[11] NORMAL MOVEOUT CORRECTION

[12] PRE-STACK NMO MUTE

[13] COMMON DEPTH POINT STACK

[14] POST STACK BALANCE

[15] LINEAR FREQUENCY DOMAIN SIGNAL ENHANCEMENT (FXDECON)

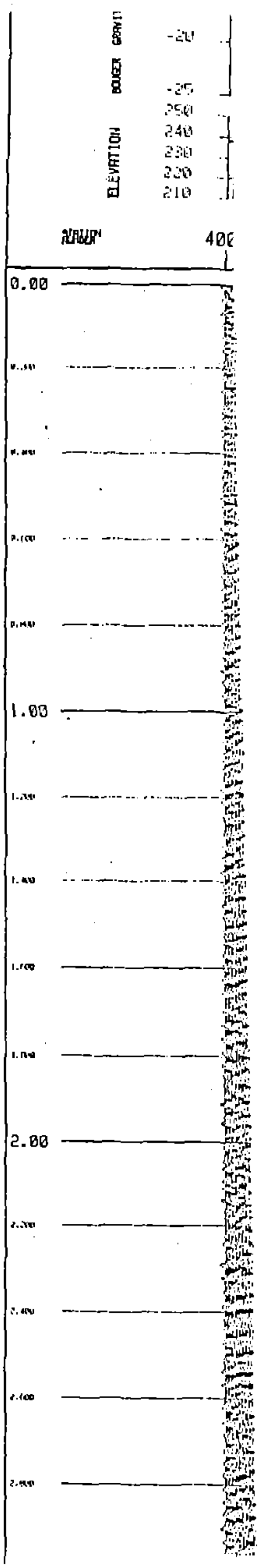
[16] SIGNAL ENHANCEMENT (DIGISTACK)

[17] BANDPASS FILTER

TIME (SEC)	BANDPASS(HZ)/SLOPE(DB/OCTAVE)
0.0	32/36 - 84/36
1.0	25/36 - 84/36
2.0	20/36 - 72/36
4.0	16/36 - 72/36

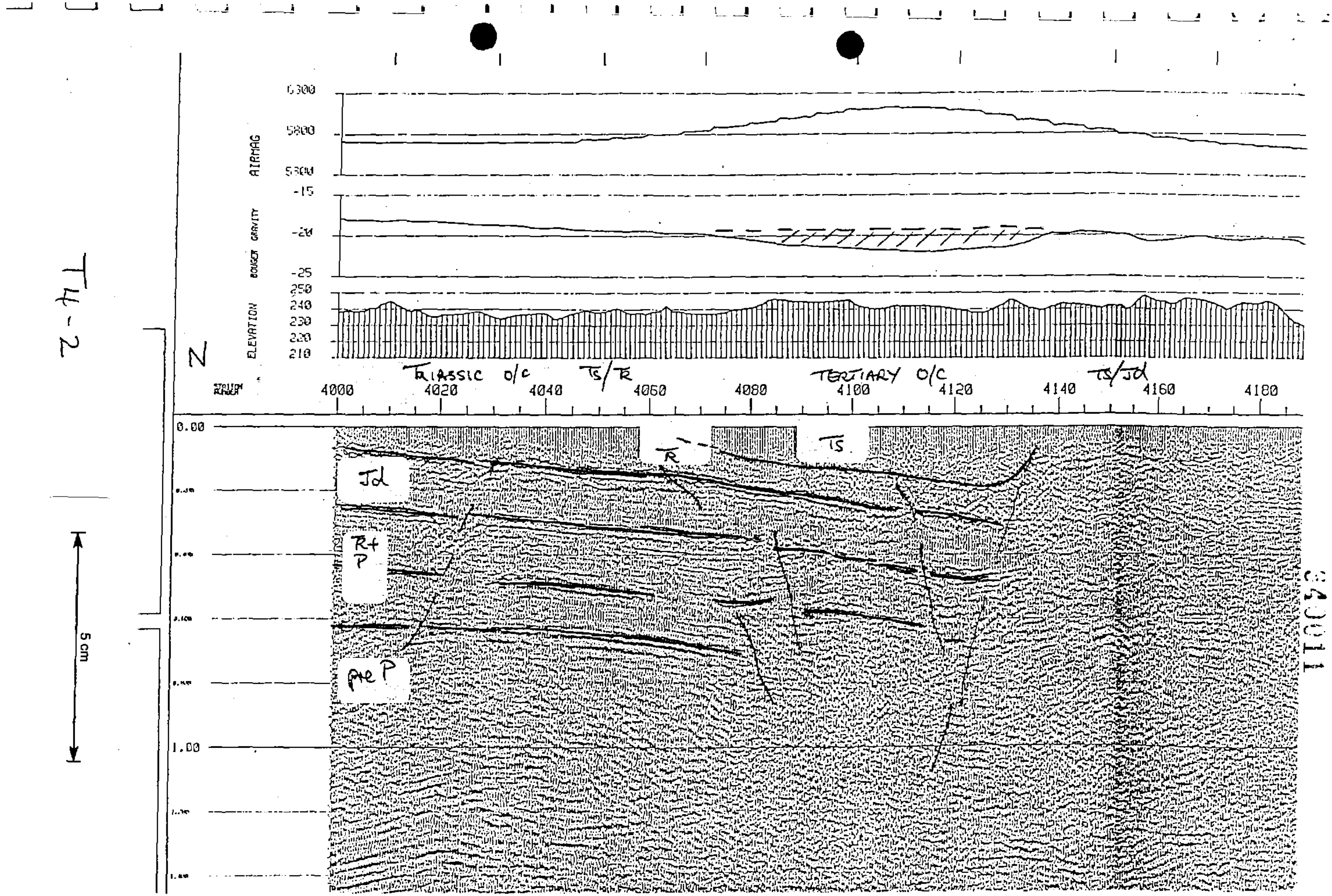
[18] TIME VARIANT SCALING (GATE LENGTH 250 MS)

[19] DISPLAY GAIN 1

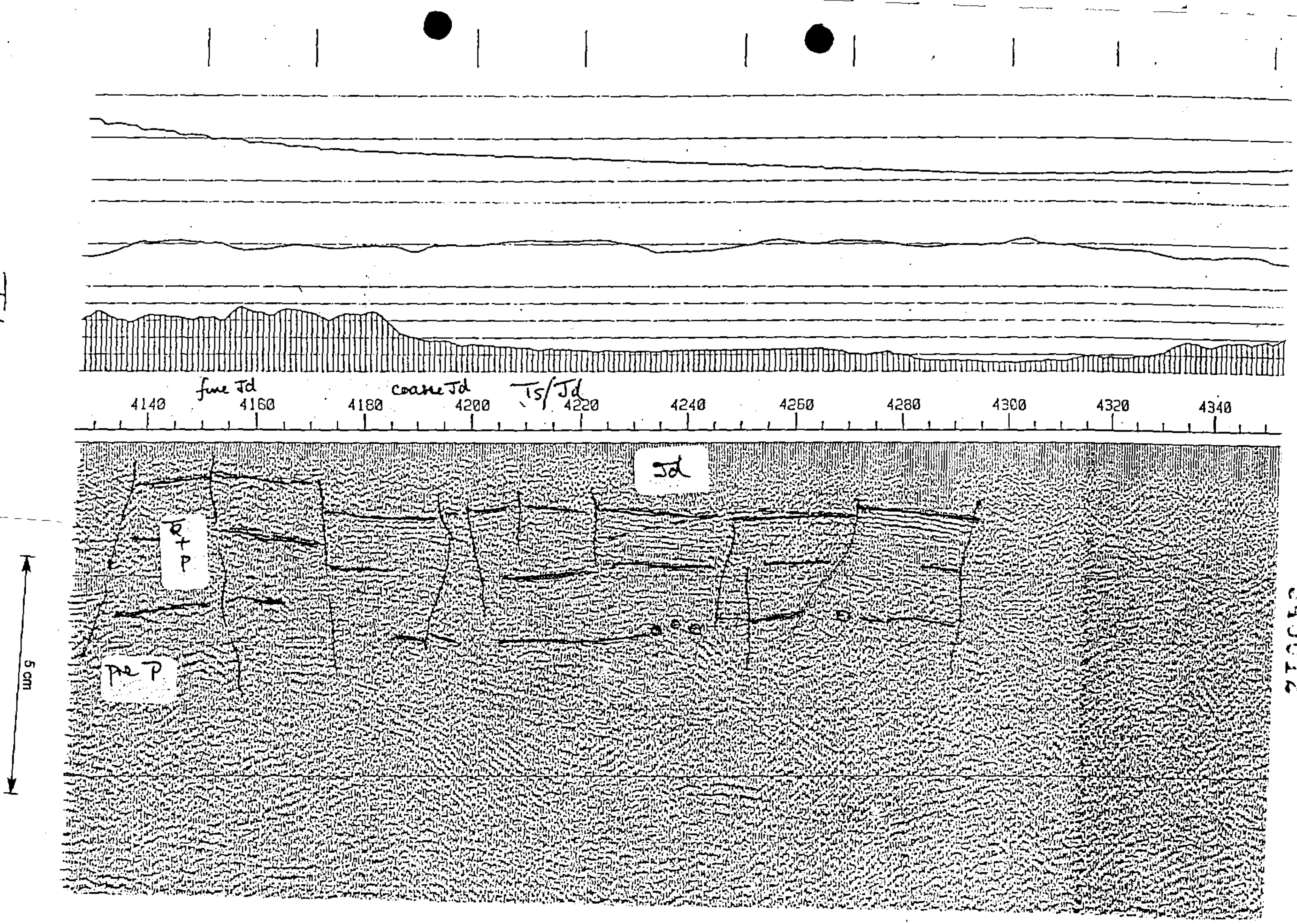


5 cm

TH-1

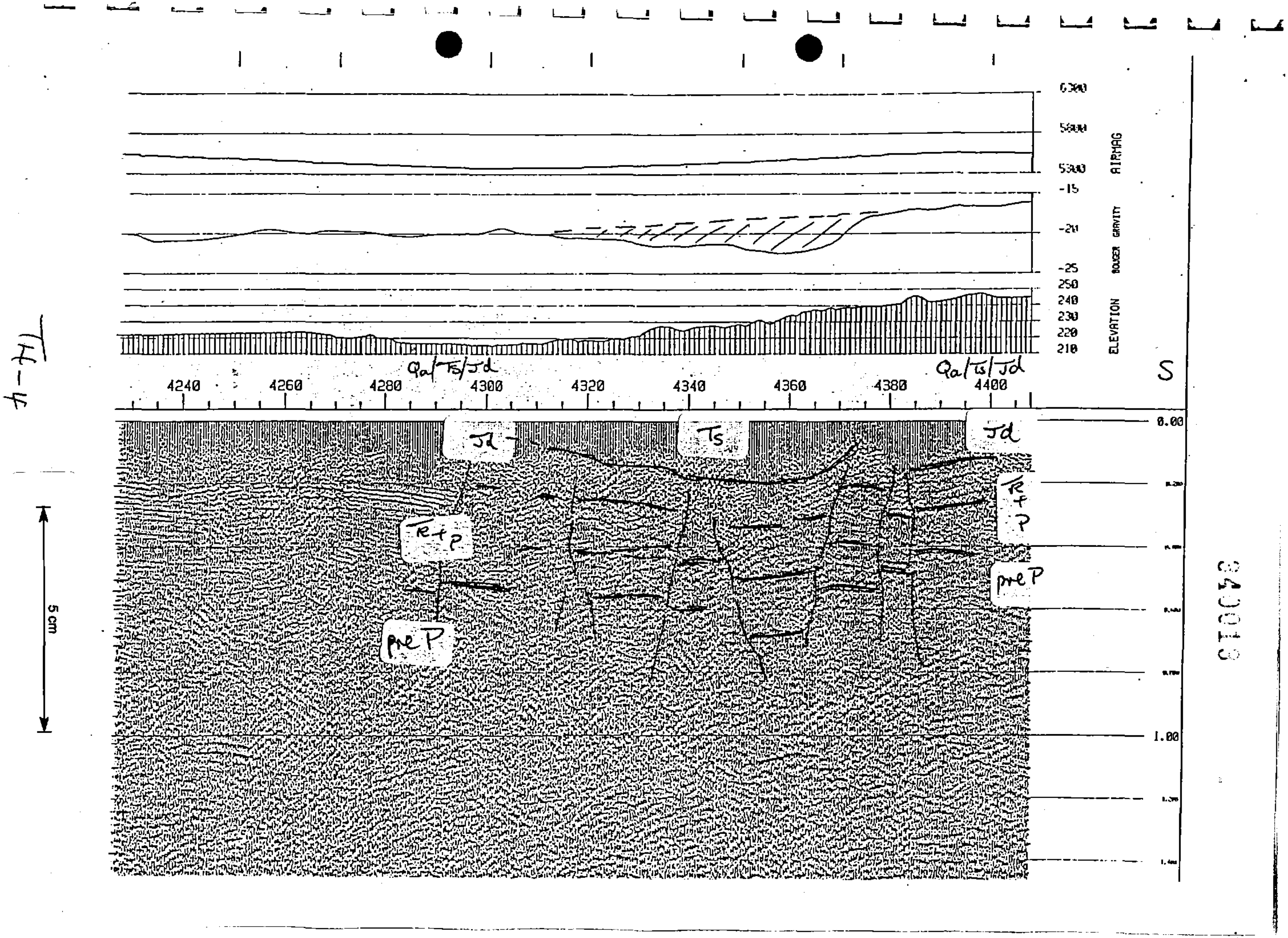

T4-2
AIRMAG
6300
5800
5300
BOUGER GRAVITY
-15
-20
-25
ELEVATION
250
240
230
220
210
N
TRIASSIC O/C
TS/R
TERTIARY O/C
TS/JL
4000
4020
4040
4060
4080
4100
4120
4140
4160
4180
0.00
1.00
R
TS
JL
R+P
pre P
5 cm

TH-3



fine Jd
coarse Jd
Ts/Jd
4140
4160
4180
4200
4220
4240
4260
4280
4300
4320
4340
Jd
Q+P
Pre P
5 cm

940012



AIRMAG
BOUGER GRAVITY
ELEVATION
5300
5300
-15
-20
-25
250
240
230
220
210
Qa/Ts/Jd
Qa/Ts/Jd
S
4240
4260
4280
4300
4320
4340
4360
4380
4400
Jd
Ts
Jd
preP
preP
0.00
1.00
5 cm

LINE T5

This line was located near Strickland west of the central plateau of Tasmania and oriented SSE.
Coordinates: 478 005E, 5306 495N to 479 614E, 5302 257N.

The geology of the area is not well known and no detailed maps are available. Triassic rocks and dolerite are exposed. The Triassic rocks are thought to be within the upper part of the Lower Triassic quartz sequence. At least one dolerite sheet could be expected within the Parmeener Super Group. Two sheets are probable.

Details of line and processing specification are given in Figure T5-1.

An interpretation is offered in Figure T5-2.
Little can be seen.
The clearer character at the northern end of the profile may be due to true reflections within the Triassic(?) rocks but even this is uncertain since there are suggestions of both sideswipe and distant diffraction in all events shallower than 0.4 seconds.
The remainder of the shallow record presents no clear reflections although there are possible ghosts of shallow and deep diffractions.

The geology along this line would have to be inspected in order to make sense of it. The gravity profile indicates a local increase in mass (usually due to dolerite) between SP 5040 and 5100 while the magnetic profile indicates that any change in magnetic rocks (also usually dolerite) occurs near SP 5120. It seems most unlikely that the change in seismic character along this line is due to a faulting of section whereby dolerite is introduced and exposed. The potential field data are not consistent with such a solution; nor are the stacking velocities which imply Triassic rocks overall.

No definite deep character can be recognised either. The diagram suggests a few critical points which are foci for diffractions and which may be generated at or near the basement unconformity. A time depth of 0.7 to 0.8 seconds is feasible for this if the Permian portion of the section is a little thinner than further east in the midlands.
The complex character of the deeper section suggests either complex structuring or poor processing. No features are evident.

ELEVATION

STATION NUMBER

RECORDING PARAMETERS

SHOT BY	: AGSO	DATE	: APRIL 1995
SYSTEM TYPE	: SERCEL SN368	SOURCE TYPE	: DYNAMITE
TAPE FORMAT	: SEGD & SEGY	CHARGE	: 10.0 KG (NOMINAL)
DENSITY	: 6250 BPI, GCR & EXABYTE	DEPTH	: 20 M (NOMINAL)
RECORD LENGTH	: 20 SECONDS	SP INTERVAL	: 240 M (NOMINAL)
SAMPLE RATE	: 2 MSEC	SPREAD PATTERN	: 2360 M - 0 - 2400 M
FILTERS	: LCF 8 HZ, 18 DB/OCT	NO OF CHANNELS	: 120
	: HCF 178 HZ, 72 DB/OCT	MAX. OFFSET	: 4760 M
	: NOTCH OUT	GROUP PATTERN	: 16 IN-LINE, 2.6M SPACING
		GROUP INTERVAL	: 40 M
GRAVITY DATA	: TGS, TASMANIA	COVERAGE	: 10 FOLD (NOMINAL)
RESIDUAL MAG	: COMP. AGSO		
		CREW CHIEF	: T. BARTON

PROCESSING SEQUENCE

[1] CROOKED LINE GEOMETRY DEFINITION

[2] FIELD SEGY TO 'DISCO' FORMAT

[3] RESAMPLE TO 4 MSECS

[4] QUALITY CONTROL DISPLAYS AND TRACE EDITS

[5] CROOKED LINE BINNING (200 M)

[6] SPHERICAL DIVERGENCE AND GAIN CORRECTION

[7] FIRST BREAKS STATICS APPLICATION
- DATUM 140 M

[8] SPECTRAL EQUALISATION

[9] 50 HZ NOTCH FILTER

[10] CMP SORT

[11] VELOCITY ANALYSIS (CVS)

[12] NORMAL MOVEOUT CORRECTION

[13] PRE-STACK NMO MUTE (55% STRETCH)

[14] COMMON MID POINT STACK

[15] POST STACK BALANCE

[16] LINEAR FREQUENCY DOMAIN SIGNAL ENHANCEMENT (FXDECON)

[17] SIGNAL ENHANCEMENT (DIGISTACK)

[18] BANDPASS FILTER

TIME (SEC)	BANDPASS(HZ)/SLOPE(DB/OCTAVE)
0.0	32/36 - 84/36
1.0	25/36 - 84/36
2.0	20/36 - 72/36
4.0	16/36 - 72/36

[19] TIME VARIANT SCALING (GATE LENGTH 500 MS)

[20] DISPLAY GAIN 1

0.00

1.00

2.00

3.00

5 cm

T5-1

T5-2

TASMANIA
DEVELOPMENT
AND RESOURCES

5 cm

:AMETERS

: APRIL 1995

: DYNAMITE
: 10.0 KG (NOMINAL)
: 20 M (NOMINAL)

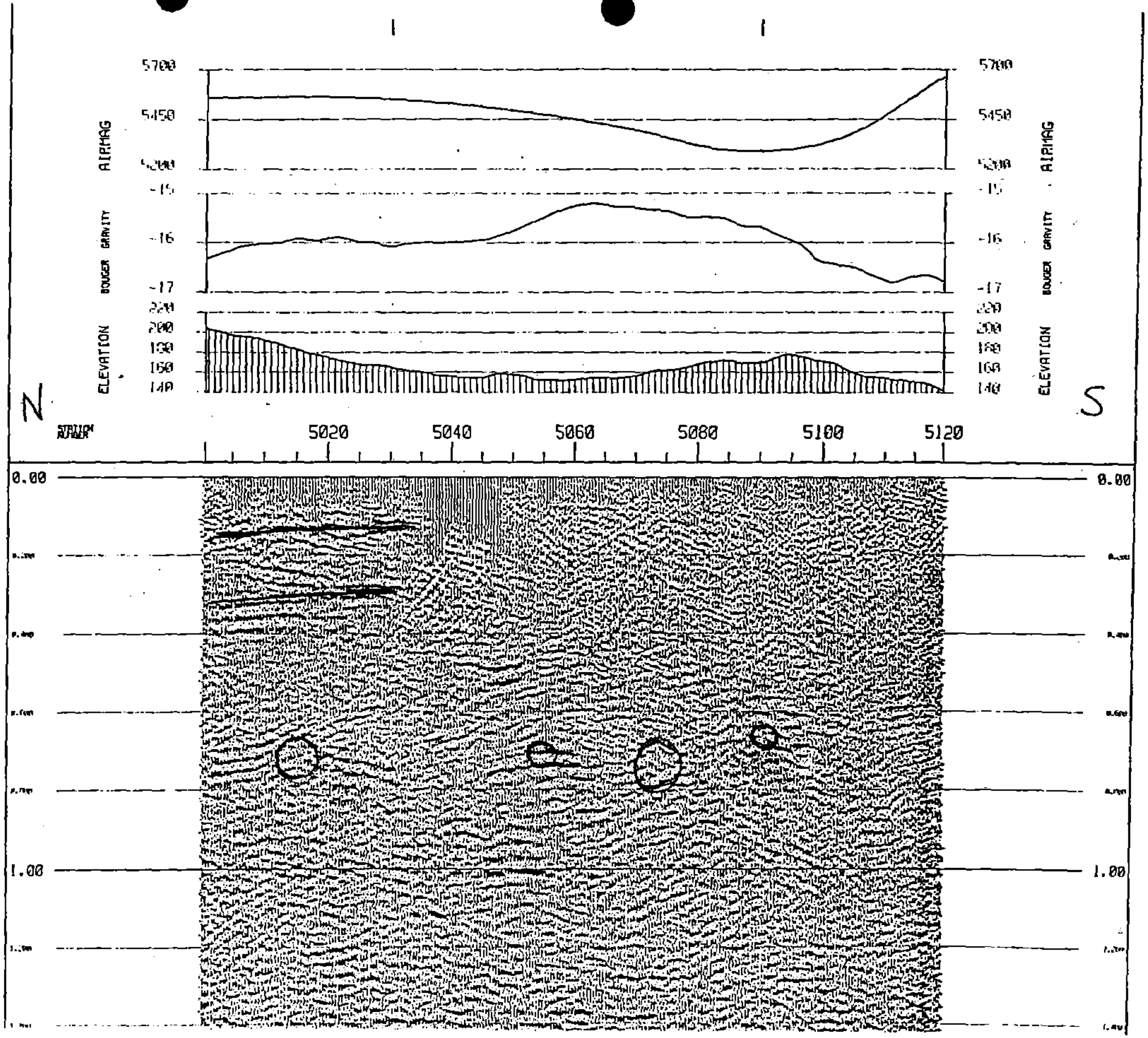
: 240 M (NOMINAL)
TERN: 2360 M - 0 - 2400 M
NELS: 120
T : 4760 M
ERN : 16 IN-LINE, 2.6M SPACING
RVAL: 40 M
: 10 FOLD (NOMINAL)

: T. BARTON

EQUENCE

EDITS

CTION



CONCLUSIONS

Neither data set offers any suggestion of distinctive or useful structuring below the probable level of the unconformity basal to the Parmeener Super-Group.

Line 4 presents a variable view of structural styles affecting the Parmeener Super Group; many small faults and half graben ramps.

Dolerite within a section, especially within Triassic rocks, may not present a significant seismic problem. Dolerite at surface, however, has caused significant degradation of signal and record as previously reported. This problem clearly requires further research.

Line 5 is a cause for concern. It is not certain that there is any true reflection character - all may be diffractions. Since the geology of this area cannot be considered sufficiently distinctive from that of line 4 (north end) we must ask why no clear reflections have been recorded. Is the surface cover of Tertiary and Recent materials (as at 4) a guarantee of better coupling than the weathered Triassic rocks (as at 5)? It may be commented here that I certainly found this to be the case during research near Richmond in 1977.

Both lines are deficient and inadequate tests.
Line 4 has a poor, indeed quite inappropriate, orientation and Line 5 is much too short to provide a fair test.

These surveys do not advance requirements or specification needs for future surveys; they are not good enough, and perhaps pessimistically indicate that either seismic methods will yield very patchy results in Tasmanian conditions or require extensive research - especially in terms of processing issues. In view of previous experience at Fingal Tier where dolerite was exposed I do wonder whether the charges used throughout these surveys were too large.

The surveys have clearly demonstrated, however, that the velocity data base built up over many years is generally valid and that the velocities indicated on the basis of rock type or stacking must be employed.

Only line 4 may have any direct exploration value. There is evidence that several horizons, including basement, have relief. No traps can be defined on the basis of a single line. A greater concern in terms of shallow traps, however, is related to the number of post Jurassic faults which disrupt the section. No deep structures have been identified.

Dr D.E. Leaman
F.Aus.I.M.M., M.I.C.A.
April 3, 1996