PR88/085G

1987 WEABER LAND

SEISMIC SURVEY

in

OP186, N.T.

OPEN FILE

PR88/085G

WP:4147x-2

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ABSTRACT

The size and limits of the Weaber gasfield were refined by the 1987 Weaber Seismic Survey. The results dictated the location of an appraisal well, Weaber-2.

INTRODUCTION

The purpose of the 1987 Weaber Seismic Survey was twofold:

1. To define the size and limits of the Weaber gasfield, and
2. To pick the location of an appraisal well, Weaber-2.

Eighteen seismic lines (140.58km) were recorded using Vibroseis. The 60-fold data quality was fair to good.

This final report is comprised of three parts:

1. Interpretation
2. Field Operations
3. Processing

INTERPRETATION

The Weaber structure was mapped at three levels:

1. Top Keep River Group
2. Enga Sandstone
3. Mid-Burt Range Unconformity

Two-way-time and depth contour maps were produced (figures 2-7). Dip and strike lines through the proposed well location are presented as figures 8 and 9. Table 1 gives the Weaber-1 Well Velocity Survey data used for the time-depth conversion.

The structure is interpreted to have formed as a result of drape and compaction over an erosionally formed paleotopographic high. The Ningbing Limestone and "Lower Burt Range" (?) formation are thought to have formed a high relief salient in the shelf margin which was then transgressed by sediments of the "Upper Burt Range" and Lower Milligans Formations. A high percentage of coarse clastics accumulated over the high, resulting in differential compaction and drape of the overlying sedimentary pile. Combined with slight easterly structural dip this resulted in the formation of the four-way dip closure mapped at the primary objective (Enga Sandstone) horizon. Offset of the crest of the mapped Enga Sandstone closure from the crest of the paleotopographic high, however, suggests the presence of a less compactable sand-rich wedge near the edge of the high.

Prospectivity of the primary objective Enga sandstone is dependent mainly upon its existence over the entire structure. Increased detail in the 1987 seismic data has enabled more confident mapping of this reservoir unit over the structure, with both geological and geophysical prognoses predicting its presence at the Weaber-2A proposed location. Mapping at the Enga Sandstone horizon shows a fault independent four-way dip closure of 4800 acres to be defined by the lowest closing contour.

Prospectivity of the secondary objective Burt Range Formation depends on the development of reservoir quality sands in the more basinal sequence which is prognosed at the Weaber-2A location. These sands are likely to be of mass-flow origin, deposited off the paleo-shelf edge. While no structural closure is mapped below the Enga Sandstone level at the Weaber-2A location, stratigraphic traps in Burt Range sandstones could be formed by updip closure against impermeable Ningbing limestones, or in isolated shale encased mass-flow sand bodies. Source would be provided by the more liquids prone basinal facies in which the reservoirs are intercalated.

Table 1

WEABER No.1 WELL VELOCITY SURVEY

	OFFSET	DEPTH	ELEV.REL K.B. (m)
GUN	63.40	0.40	6.40
GUN HYDROPHONE DEPTH			1.10

	m
G.L.	11.00
K.B.	17.00
DATUM	0.00

17.00 m. K.B.-DATUM

RECORD	D m	Z m	T s	Tv s	Te * s	Tc s	Vav m/s	Vint m/s
	291	274	0.108	0.1059	0.0178	0.0881	3110	
								3735
	414	397	0.140	0.1388	0.0178	0.1210	3280	
								3513
	503	486	0.165	0.1642	0.0178	0.1464	3320	
								3220
	623	606	0.202	0.2014	0.0178	0.1836	3300	
								3287
	699	682	0.225	0.2246	0.0178	0.2068	3299	
								3574
	839	822	0.264	0.2637	0.0178	0.2459	3342	
								3159
	972	955	0.306	0.3058	0.0178	0.2880	3316	
								3100
	1090	1073	0.344	0.3439	0.0178	0.3261	3290	
								3382
	1256	1239	0.393	0.3930	0.0178	0.3752	3302	
	1283	1266	0.401	0.4010	0.0178	0.3832	3304	
								3543
	1350	1333	0.418	0.4180	0.0178	0.4002	3331	
	1405	1388	0.435	0.4351	0.0178	0.4173	3327	
	1500	1483	0.454	0.4541	0.0178	0.4363	3399	4078
	1552	1535	0.471	0.4711	0.0178	0.4533	3386	
								5219
	1667	1650	0.493	0.4931	0.0178	0.4753	3471	
								6363
	1820	1803	0.517	0.5172	0.0178	0.4994	3610	
								6359
	1941	1924	0.536	0.5362	0.0178	0.5184	3711	

gun-hydrophone corr.+0.0005

* datum time from UH# 148-0.0209, less time to gun hydrophone depth (1.1m @350m/s)

SANTOS Ltd./B.Rumph/17 May,1988

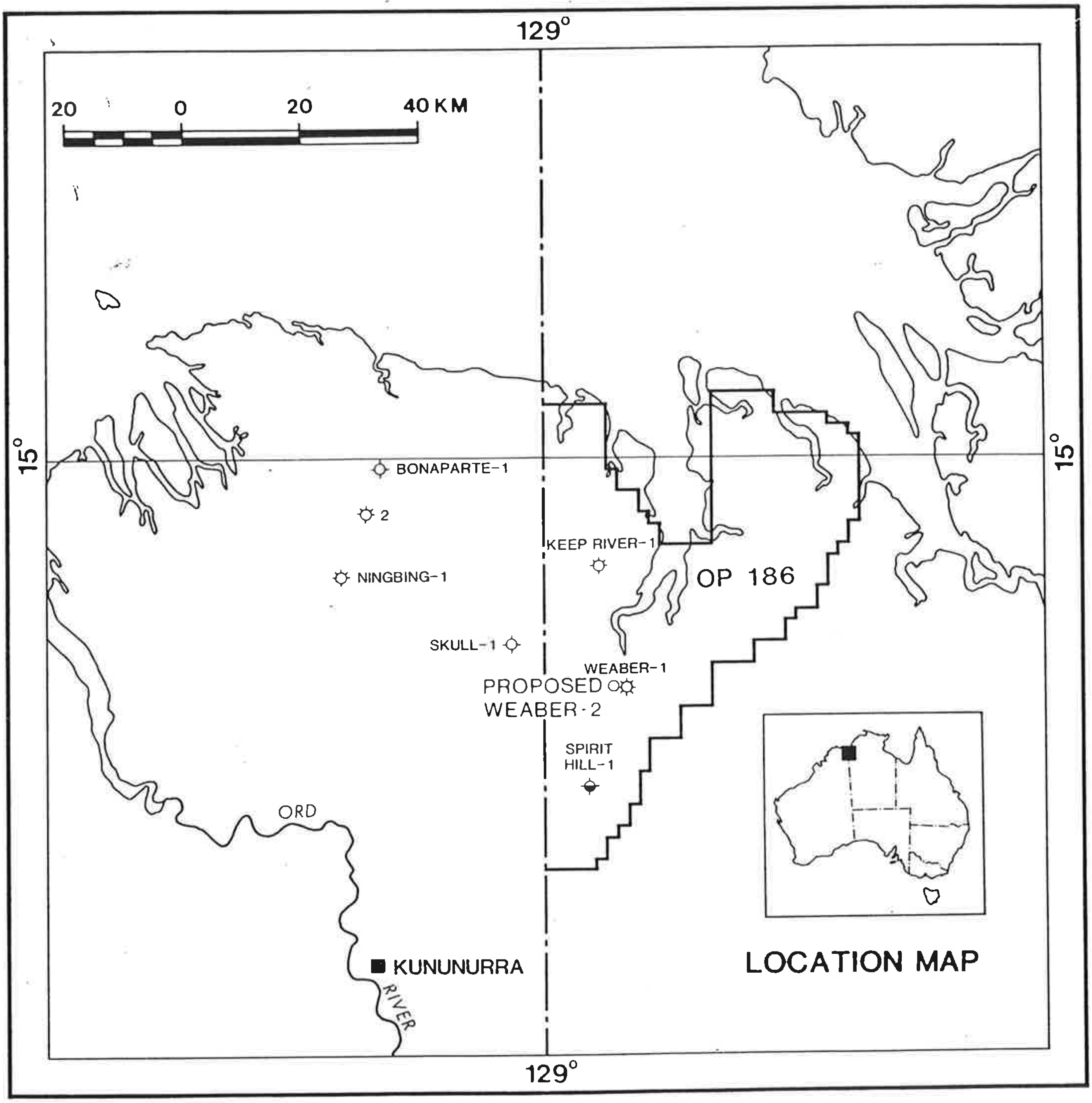
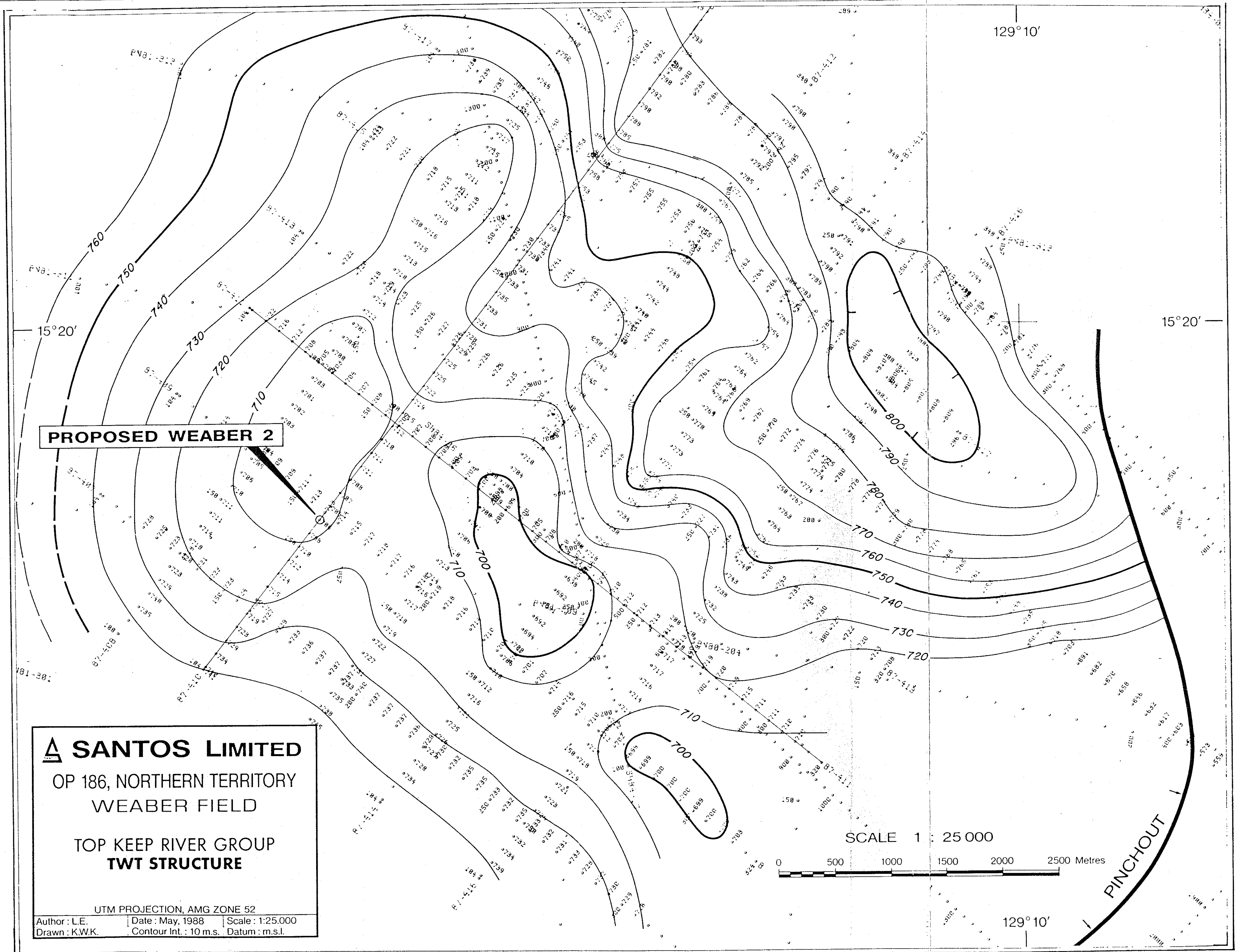

129°
20
0
20
40 KM
15°
15°
BONAPARTE-1
2
NINGBING-1
KEEP RIVER-1
OP 186
SKULL-1
WEABER-1
PROPOSED
WEABER-2
SPIRIT
HILL-1
ORD
KUNUNURRA
RIVER
LOCATION MAP
129°

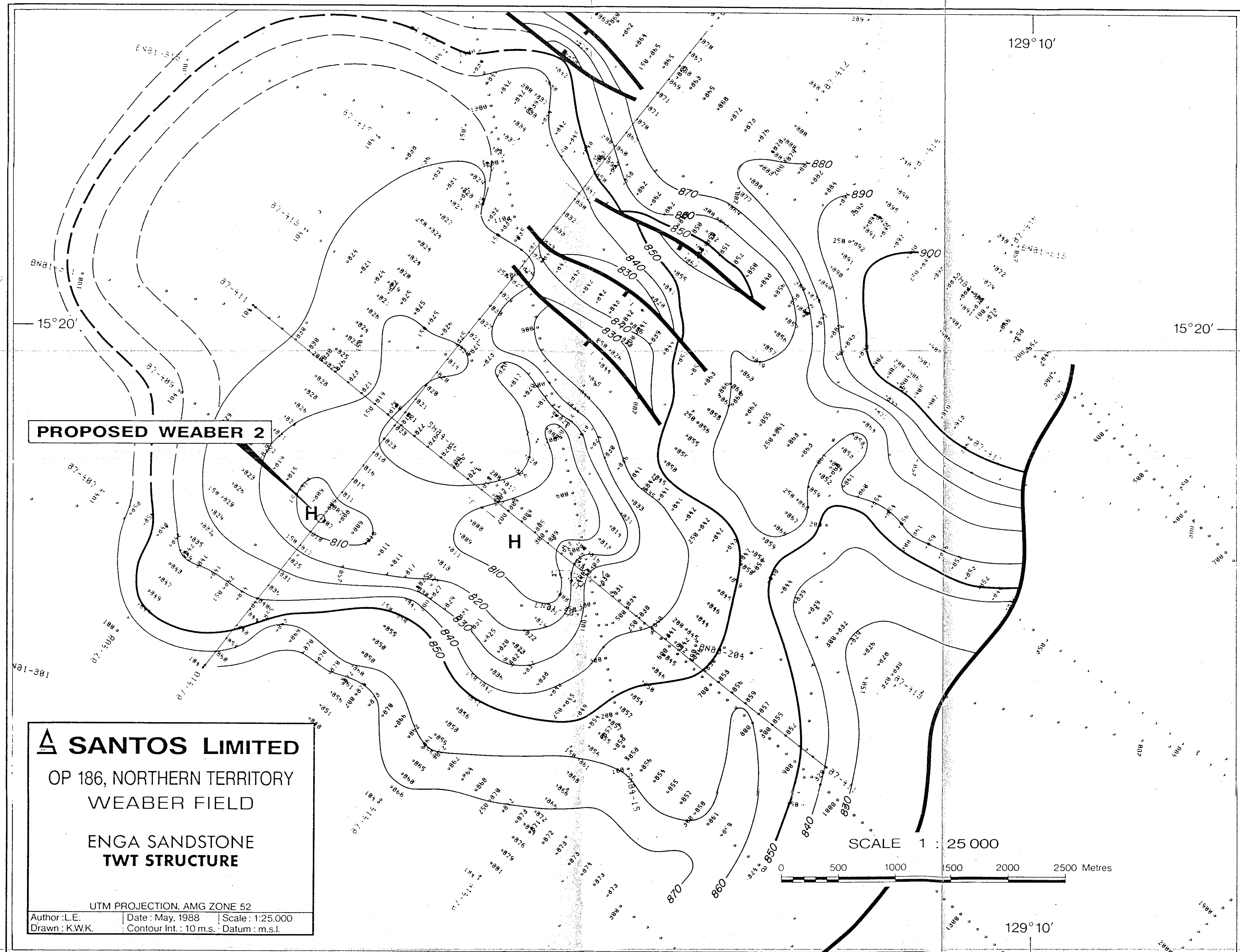
Fig. 1

OP186



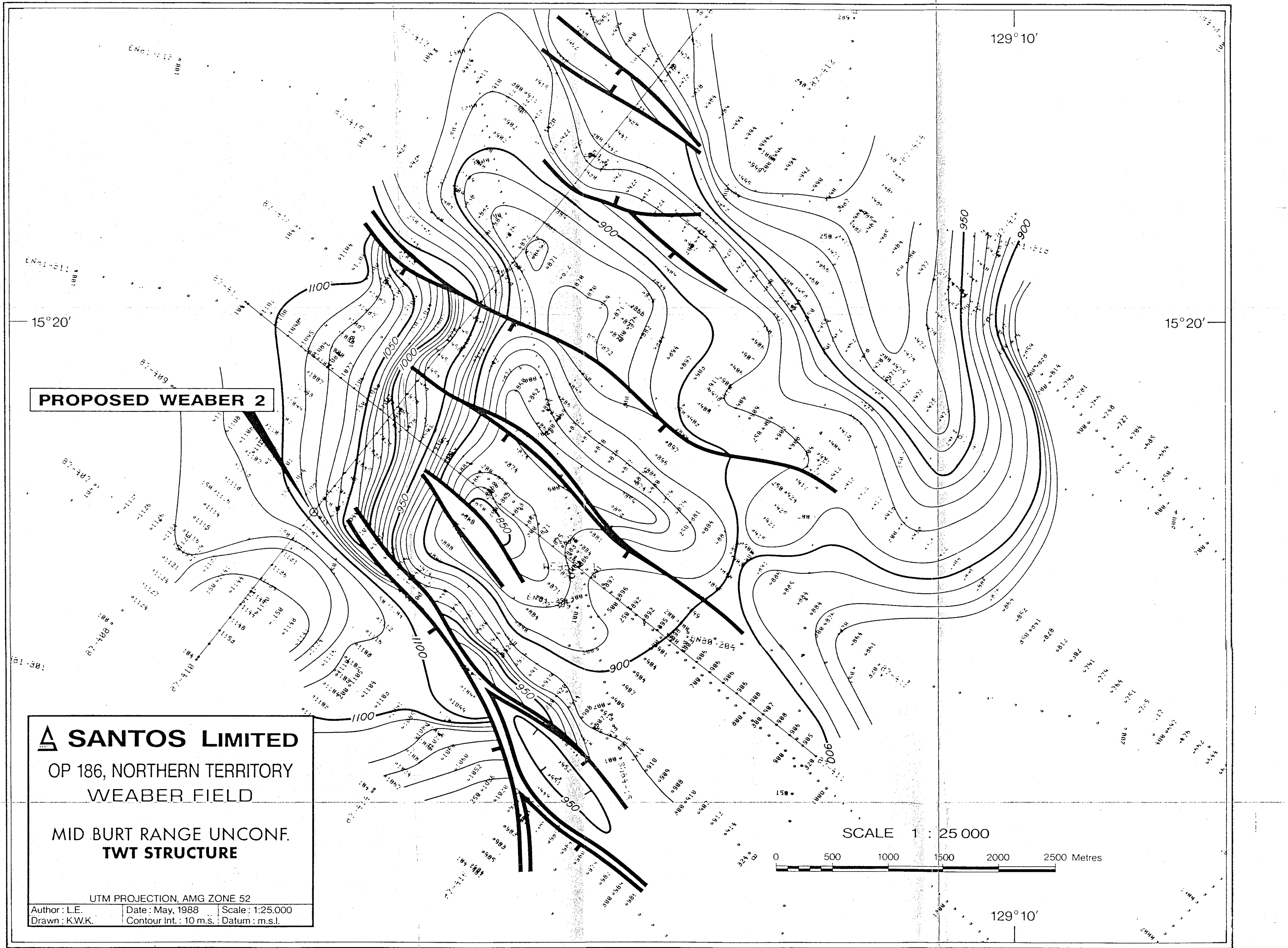
PROPOSED WEABER 2
SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
TOP KEEP RIVER GROUP
TWT STRUCTURE
UTM PROJECTION, AMG ZONE 52
Author : L.E.
Drawn : K.W.K.
Date : May, 1988
Contour Int. : 10 m.s.
Scale : 1:25.000
Datum : m.s.l.
SCALE 1 : 25 000
0 500 1000 1500 2000 2500 Metres
PINCHOUT
129°10'
15°20'
800
790
780
770
760
750
740
730
720
710
700

Fig. 2



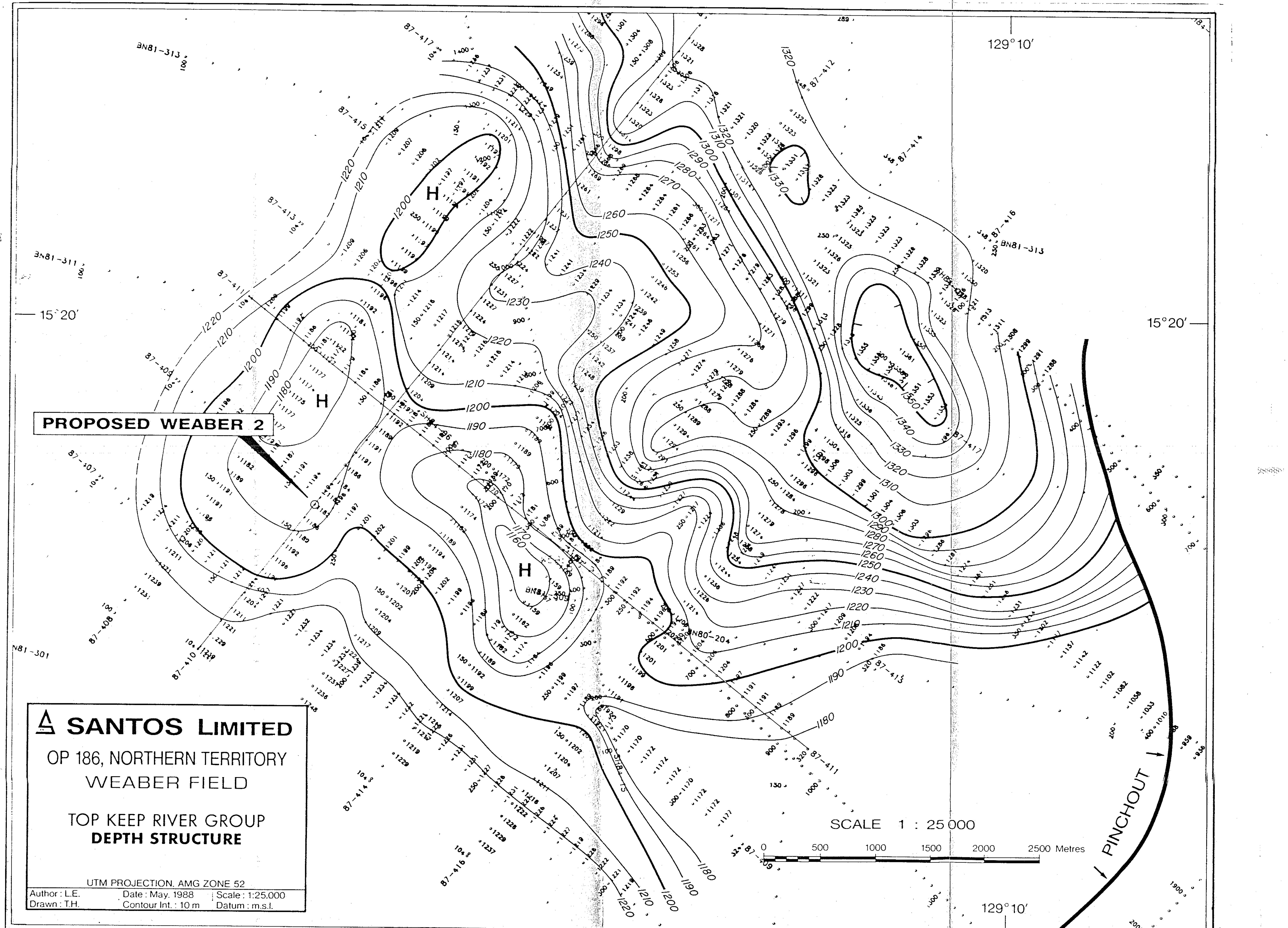
PROPOSED WEABER 2
SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
ENGA SANDSTONE
TWT STRUCTURE
UTM PROJECTION, AMG ZONE 52
Author : L.E.
Drawn : K.W.K.
Date : May, 1988
Contour Int. : 10 m.s.
Scale : 1:25.000
Datum : m.s.l.
SCALE 1 : 25 000
0 500 1000 1500 2000 2500 Metres
129°10′
15°20′

Fig.3



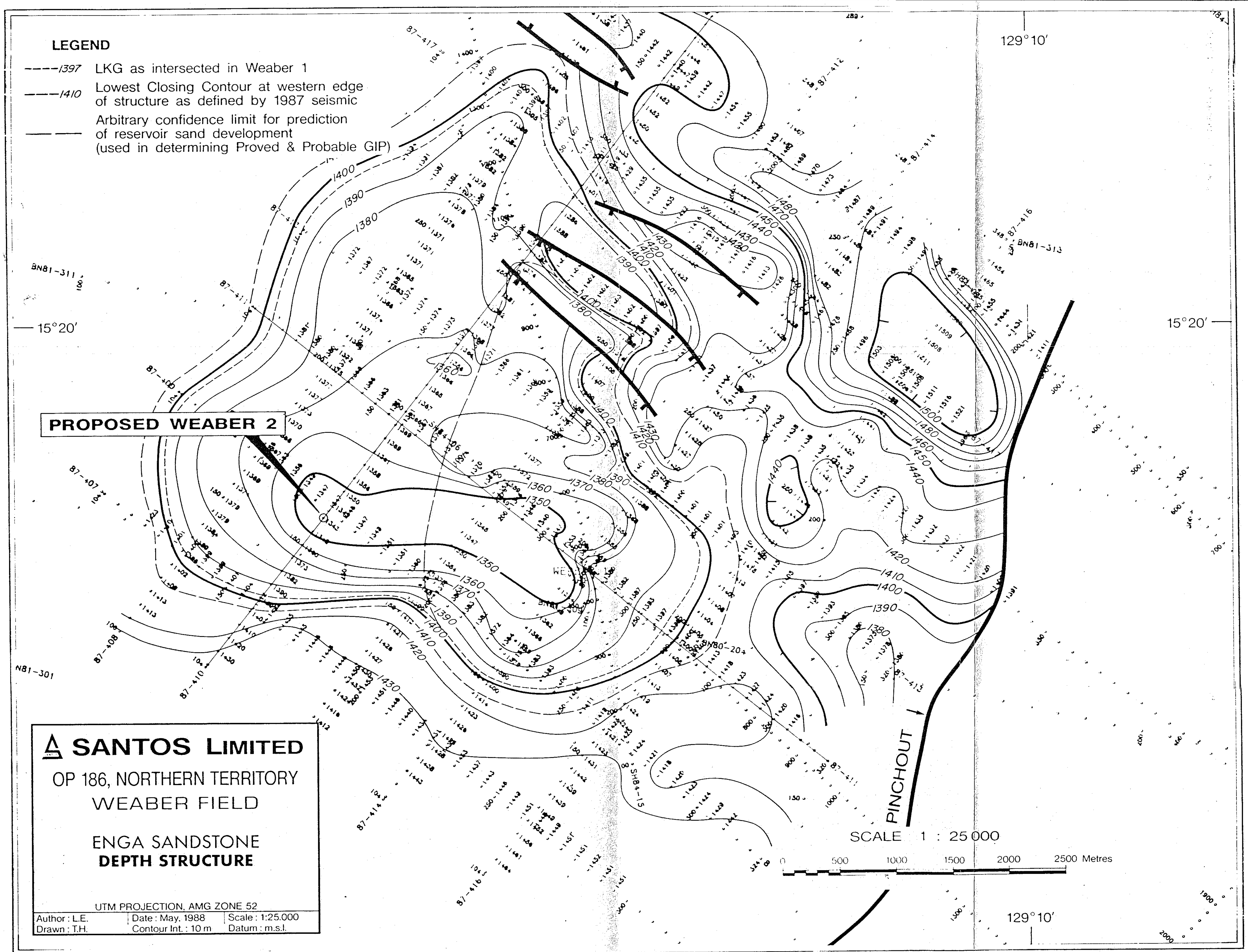
129°10'
15°20'
PROPOSED WEABER 2
1100
1050
1000
950
900
850
SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
MID BURT RANGE UNCONF.
TWT STRUCTURE
UTM PROJECTION, AMG ZONE 52
Author : L.E.
Drawn : K.W.K.
Date : May, 1988
Contour Int. : 10 m.s.
Scale : 1:25,000
Datum : m.s.l.
SCALE 1 : 25 000
0 500 1000 1500 2000 2500 Metres

Fig. 4



SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
TOP KEEP RIVER GROUP
DEPTH STRUCTURE
UTM PROJECTION. AMG ZONE 52
Author : L.E.
Drawn : T.H.
Date : May. 1988
Contour Int. : 10 m
Scale : 1:25.000
Datum : m.s.l.
PROPOSED WEABER 2
SCALE 1 : 25 000
0
500
1000
1500
2000
2500 Metres
PINCHOUT
129°10′
15°20′
H

Fig. 5



LEGEND
1397 LKG as intersected in Weaber 1
1410 Lowest Closing Contour at western edge of structure as defined by 1987 seismic
Arbitrary confidence limit for prediction of reservoir sand development (used in determining Proved & Probable GIP)
PROPOSED WEABER 2
PINCHOUT
129°10'
15°20'
SCALE 1 : 25 000
0 500 1000 1500 2000 2500 Metres
SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
ENGA SANDSTONE
DEPTH STRUCTURE
UTM PROJECTION, AMG ZONE 52
Author : L.E.
Drawn : T.H.
Date : May, 1988
Contour Int. : 10 m
Scale : 1:25.000
Datum : m.s.l.

Fig. 6

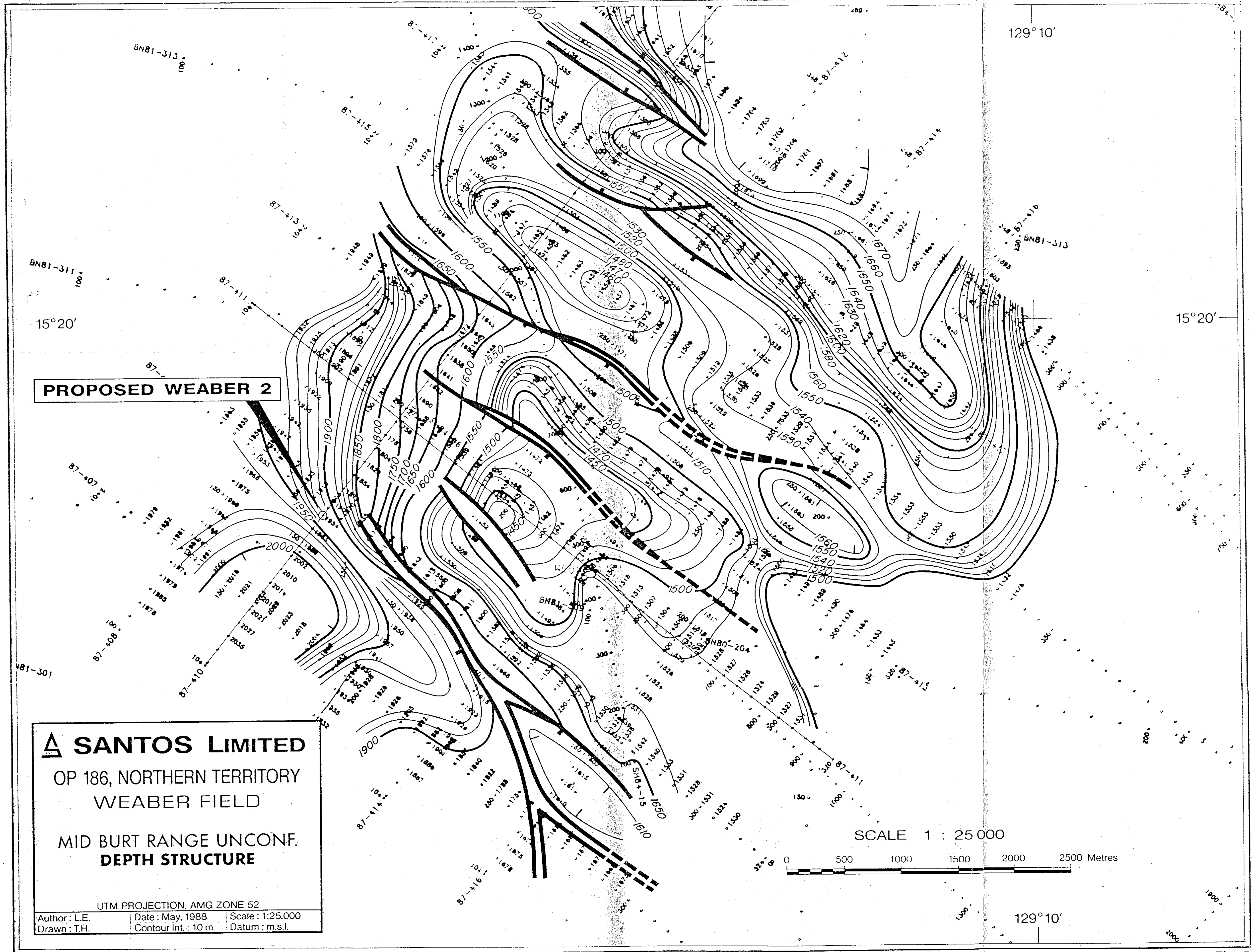
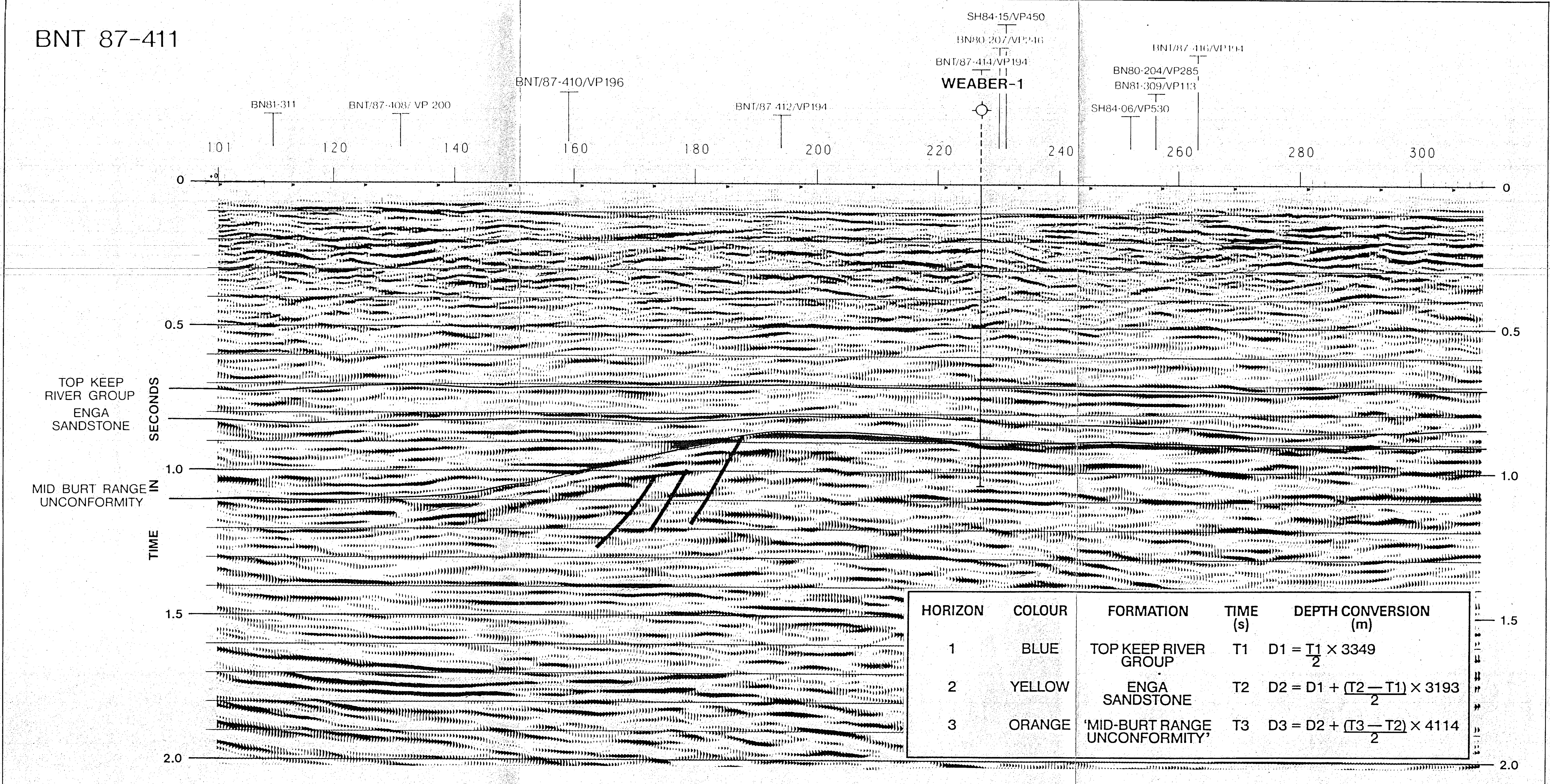
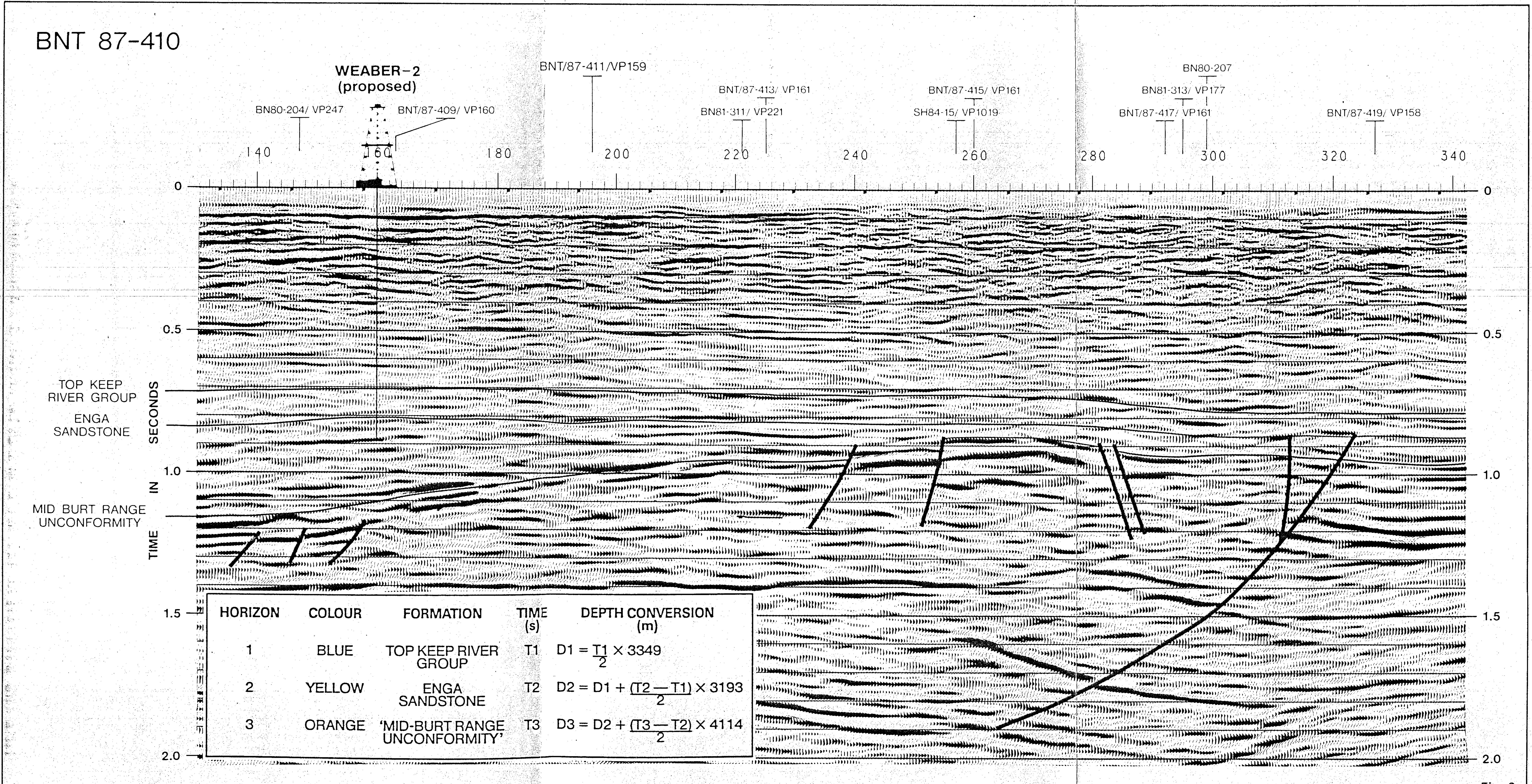

PROPOSED WEABER 2
SANTOS LIMITED
OP 186, NORTHERN TERRITORY
WEABER FIELD
MID BURT RANGE UNCONF.
DEPTH STRUCTURE
UTM PROJECTION, AMG ZONE 52
Author : L.E.
Drawn : T.H.
Date : May, 1988
Contour Int. : 10 m
Scale : 1:25.000
Datum : m.s.l.
SCALE 1 : 25 000
0 500 1000 1500 2000 2500 Metres
129°10'
15°20'
BN81-313
BN81-311
BN81-301
BN80-204
87-407
87-408
87-410
87-411
87-412
87-413
87-414
87-415
87-416

Fig. 7



HORIZON	COLOUR	FORMATION	TIME (s)	DEPTH CONVERSION (m)
1	BLUE	TOP KEEP RIVER GROUP	T1	$D1 = \frac{T1}{2} \times 3349$
2	YELLOW	ENGA SANDSTONE	T2	$D2 = D1 + \frac{(T2 - T1)}{2} \times 3193$
3	ORANGE	'MID-BURT RANGE UNCONFORMITY'	T3	$D3 = D2 + \frac{(T3 - T2)}{2} \times 4114$

Fig. 8



HORIZON	COLOUR	FORMATION	TIME (s)	DEPTH CONVERSION (m)
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2	YELLOW	ENGA SANDSTONE	T2	$D2 = D1 + \frac{(T2 - T1)}{2} \times 3193$
3	ORANGE	'MID-BURT RANGE UNCONFORMITY'	T3	$D3 = D2 + \frac{(T3 - T2)}{2} \times 4114$

Fig. 9

Operations

OPERATIONS REPORT

OF

SEISMIC REFLECTION SURVEY

FOR

SANTOS LIMITED

1987 WEABER SEISMIC SURVEY
OP-186, N.T.

BY

G.E.S. PTY. LTD. - PARTY V1-27

21st September, 1987
to 4th October, 1987

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OPERATIONS

APPENDICES

PLATES

1.1 INTRODUCTION

The Weaber Seismic Survey, situated within OP-186 Northern Territory, was carried out by G.E.S. Pty. Ltd., Party V1-27 for and on behalf of Santos Limited, between 21st September, 1987 and 4th October, 1987.

OP-186 is situated in the Bonaparte Gulf Basin region of the Northern Territory.

The seismic programme consisted of a twelve line detail grid in the 'Weaber Plains' area and a six line pre-detail grid in the adjacent 'Pincombe' area. (See Plate 2).

Santos Limited was represented in the field by Mr. T. Hewitson who remained on the operations site for the duration of the survey.

1.2 ABSTRACT

The Weaber Seismic Survey consisted of 18 lines totalling 140.58 kilometres. The 60-fold data quality was fair to good.

The energy source was provided by three truck-mounted Litton Y1600 Failing vibrators. A conventional 120 channel split-spread recording configuration was used throughout.

Uphole surveys for datum statics were located at regular intervals including line intersections.

The local companies, Kununurra Earthmoving and G. Cooper Drilling were contracted and supervised by Santos Limited.

Recording commenced on 21st September, 1987 and was completed on 4th October, 1987.

1.3 LOCATION, TOPOGRAPHY AND VEGETATION

The Weaber Seismic Survey was located in the south western sector of OP-186 and centred approximately 60 kilometres north-east of the Western Australian township of Kununurra.

The prospect was bounded by longitudes 129° 00' 00" to 129° 15' 00" east and latitudes 15° 17' 00" to 15° 26' 00" south.

The 'Weaber Plains' grid traversed low-lying silt-plains adjacent to the Keep River which bisects permit OP-186 from north to south.

The 'Pincombe' area further to the west was slightly more elevated with rocky outcrops encountered in the vicinity of the Weaber Range.

The 'Weaber Plains' area was well grassed but supported only scattered scrub. Heavier timber lined the banks of the Keep River and its tributaries. The 'Pincombe' area was moderately forested with Eucalypts except towards the southern extent of the grid where vegetation was more scattered.

1.4 WEATHER

Morning rainfall on 1st October resulted in the loss of half a day's production. Otherwise, weather conditions remained hot and dry throughout the survey.

Average daily temperatures ranged from 17°C minimum to 38°C maximum.

1.5 LOGISTICS

1.5.1 Access

The main access to the prospect was provided by the Kununurra-Legune road which was unsealed and in fair condition.

1.5.2 Campsite

The campsite was located approximately 3 kilometres south of the Weaber No. 1 wellsite near the intersection of lines 87-407/416.

1.5.3 Supplies

All food supplies were obtained locally from Kununurra. Water was available from Kneebone bore on Spirit Hills Station. Fuel was delivered to the camp by Coles of Kununurra.

1.5.4 Explosives

Explosives requirements were organised by Santos Limited and delivered to the site by ICI Australia Pty. Ltd. Anzomex 'A' boosters and detonators were used in uphole recording.

1.6 COMMUNICATIONS

A daily radio schedule using Crammond 100W SSB's was conducted with the G.E.S. Brisbane office on a frequency of 13 mHz. This schedule was used to relay progress reports and operational information as well as requisitioning spares and supplies.

Intra-crew communication was by Tait FM radios (recording crew) and VHF Motorola radios (vibrators).

OPERATIONS

2.1 PERMITTING AND DE-PERMITTING

Permitting and de-permitting for the Weaber Survey were carried out by Mr. B. Beer and Mr. T. Hewitson, representatives of Santos Limited.

2.2 LINE CLEARING

Line Clearing contractor:
Kununurra Earthmoving of Kununurra.

Line Clearing equipment:
1 x Caterpillar D6E bulldozer.
1 x Caterpillar D7G bulldozer.
1 x Caterpillar 12G grader.

First Line Clearing commenced	:	26th July, 1987
First Line Clearing completed	:	10th August, 1987
Second Line Clearing commenced	:	11th September, 1987
Second Line Clearing completed	:	15th September, 1987

The second phase of the line-clearing programme was required to extend lines 87-415 and 419.

Line clearing operations were performed satisfactorily and bulldozing was completed well in advance of the recording crew.

2.3 CHAINING AND SURVEYING

Geophone stations and shotpoint intervals were measured along the lines using a calibrated seismic surveying chain (3.5mm [PVC coated] wire).

Geophone stations were marked by wire pins with coloured plastic flagging attached to the top.

A light aluminium tag (Hortico brand Permo-tags) with GES Party 1, line number and shotpoint number inscribed upon it, was attached to some permanent object e.g. tree or fence post in the vicinity of every fourth station wherever possible.

Standard tachymetrical observations using a Wild T1 theodolite, a Sokkisha Red 1A electronic distance measurer (EDM) and a modified Brookeades E staff were used to determine the vertical data. All chained distances were checked by EDM readings to ensure accuracy.

Line start points were taken from previous seismic, topographical or cadastral map data. Line start bearings were deduced from sunshots or from angles turned from previous seismic lines.

Grid bearings of lines were determined from sunshots taken at or near the ends of lines and from horizontal angles observed at significant points along the lines, usually at the bends. Bearing misclosures between the sunshots were adjusted where the error was large enough to warrant such adjustment. Extra sunshots were taken on lines in excess of ten kilometres, usually at intervals of approximately ten kilometres, but dependent on the number of horizontal angles measured. Grid bearings

2.3 CHAINING AND SURVEYING (Cont.)

and EDM distances corrected for slope (where applicable) were used to determine the horizontal data.

The horizontal and vertical origins for the prospect were as follows:-

Vertical - Lines 87-401, 402 : W.A. Department of Works BM 3A. All other lines : BM KR4

Horizontal - All lines: Trig Station S29. (NOTE:This Trig Station has been upgraded to the AGD84 system of horizontal control.)

Vertical data and sunshots were computed in the field with Hewlett-Packard hand-held calculators (type HP11C).

Final adjusted data was computed in the G.E.S. Brisbane office using a Sharp PC5000 computer.

Copies of the survey notes (with provisional elevations computed), were sent to the client (or processing centre) during the survey.

Upon completion of the surveying, the client was sent the following data:-

a. The remaining copy of the survey notes (containing the final elevations).
b. The final adjusted computer printouts listing the locations of the geophone stations, permanent markers, intersections, wells, previous seismic data and survey connections to or from Government survey control stations. Printouts show eastings/ northings, latitudes and longitudes and elevations.

2.3 CHAINING AND SURVEYING (Cont.)

c. A list of permanent markers.
d. The horizontal and vertical origins/misclosure maps.
e. Sunshots computations.
f. The chaining reports.
g. Two magnetic tapes containing the data listed in b. above.

Note: Changes to the provisional elevations (if any) sent previously to the client (or the processing centre) accompanied the survey notes in sub-paragraph a. above.

Surveying accuracies were within the following specification. i.e.:

a. Vertical 10 $(k)^{\frac{1}{2}}$ cm

b. Horizontal 10 $(k)^{\frac{1}{2}}$ m

(where k is the traverse length in kilometres).

Permanent markers consisting of 165cm steel star pickets driven approximately 50cm into the ground and with a wooden dumpy peg alongside the picket, were placed:-

a. At the ends of lines
b. At the intersections with all other lines
c. At major road and/or railway crossings
d. At intervals of 3-5 kilometres where the lines are devoid of other seismic or topographic detail.
e. As requested by the client.

2.3 CHAINING AND SURVEYING (Cont.)

Each permanent marker has an aluminium tag bolted to the top of the picket. Stamped into the tag are GES Party 1, line number, station number, intersection details etc.

One of the surveyors was permanently used for setting off the lines for the line clearing crew and for scouting the prospect.

Chaining commenced on 21st September, 1987 and the surveying was completed by 3rd October, 1987.

All surveying work was supervised by Mr. K. Salter, the G.E.S. Surveyor Supervisor.

Ties to previous seismic work showed several large misclosures. Listed below are the ranges of the misclosures:-

PINCOMBE AREA:					
1) 1981	Three ties	E 4.7	N 7.7	ELEV. 8.83m	
		22.2	47.9	9.34m	
WEABER PLAINS AREA:					
2) 1981	Four ties	E 7.9	N 8.8	ELEV. 4.07m	
		36.6	24.0	4.39m	
3) 1984	Two ties	E 9.0	N 0.6	ELEV. 0.79m	
		6.1	1.2	0.60m	
4) BRI	Four ties	E13.2	N 0.2	ELEV. ?	(No vertical data)
		13.7	1.8	ELEV ?	(No vertical data)

As no origin data for previous work was available it is impossible to deduce the reason for the large misclosures.

2.4 DRILLING

Drill Contractors: G.P. Cooper Drilling, Morley, W.A.

Drilling Equipment

1 x Truck-mounted drilling rig (Midway)
1 x Water tanker (Toyota)
1 x Utility vehicle (Toyota)

Commencement of drilling :	26th August, 1987
Completion of drilling :	17th September, 1987
Number of upholes drilled:	76 (incl. 3 re-drills)
Total metreage drilled :	1,929

Drilling on this prospect was slow in places due to sand and gravel. Mud-pitting was generally required.

2.5.1 EXPERIMENTAL RECORDING

Preliminary parameter experiments were conducted on 21st September, 1987 on line 87-412 under the supervision of Messrs. B. Rumph and T. Hewitson of Santos Limited.

i) Phase Lock

A direct comparison was made between two profiles recorded at VP 183.5 using a full production spread, one with base-plate phase lock and the other with ground-force phase lock.

Processed Displays : Selected-trace power spectra, trace plots

ii) Noise Analysis

Type	: full split-spread, continuous offset.
Location	: line 87-412, Stn 124 to 243.
Spread	: un-gapped production spread, 30m group intervals.
Geophones	: 12/group, #1-60 bunched, #61-120 linearly arrayed over 30m.
Source Location A	: nine V.P.'s spaced between Stn 183 and 184.
Source Location B	: nine V.P.'s spaced between Stn 123 and 124.
V.P. Interval	: 3m
Sweep	: 3 standing sweeps, 8-80Hz linear, ground-force phase lock.
Processed Displays	: continuous offset plots #1-60, #61-120 from source locations A and B.

2.5.1 EXPERIMENTAL RECORDING (Cont.)

iii) Remote Nest with Ground-force Phase Lock

A 'Remote nest' test was performed at VP 182, line 87-412 using a gapped production spread (1845-75-0-75-1845m). Each of the three vibrators recorded a single sweep using ground-force phase lock.
Processed Displays : selected-trace power spectra, trace plots.

iv) Source Array Length/No. of Sweeps/Sweep Length

Using the test (iii) spread configuration and location, three vibrators, 8-80Hz linear sweeps and ground-force phase lock, three profiles were recorded with the following variables applied:-

A) 4 x 6 sec sweeps, 15m pad-to-pad, 7.5m move-up, (52.5m array).
B) 3 x 8 sec sweeps, 20m pad-to-pad, 10m move-up, (60m array).
C) 2 x 12 sec sweeps, 15m pad-to-pad, 15m move-up, (45m array).

Processed Displays : selected-trace power spectra, trace plots.

The above experimental results were analysed in the field by Mr. B. Rumph and the production parameters were selected.

2.5.2 PRODUCTION RECORDING

Instrument Parameters

Recording instruments	:	DFSV/FT-1
Data format	:	SEG-B: 6250 BPI, diversity-stacked, un-correlated SEG-Y: 6250 BPI, diversity-stacked, correlated
No of recording channels	:	120
Aux. Channel #1	:	Radio base plate
Aux. Channel #2	:	Filtered true reference
Aux. Channel #3	:	Radio reference
Aux. Channel #4	:	N/U
Sample Interval	:	4ms
Record length	:	12 sec sweep + 4 sec listen
Record filters	:	Hi-cut 128Hz @ 72 dB/oct. Lo-cut 8Hz @ 18 dB/oct.
Notch filter	:	Out
Type of stacking	:	Diversity
Correlation filter	:	Minimum phase

Spread Parameters

Cable type	:	De-regt
Geophone type	:	GSC-20D/10Hz, 70% damping
Electrical configuration	:	6 elements in series per string, 2 strings in parallel
Geophones per group	:	12
Geophone spacing	:	2.73m
Geophone pattern	:	Linear, 30m array, centred midway between station pegs
Group interval	:	30m
Spread configuration	:	1845-75-0-75-1845m
CDP coverage	:	60-fold

2.5.2 PRODUCTION RECORDING (Cont.)

Polarity (SEG)

Impulse signal	:	Upward ground motion gave negative output signal on tape
Sweep signal	:	Vibrator true reference signal led baseplate vel. phone by 90°.

Source Parameters

Vibrator model	:	Litton-Failing Y1600 (33,500 lbs Peak Force)
Vibrator electronics	:	Pelton Advance 1 Model 5
No. of vibrators	:	3
V.P. interval	:	30m
Sweeps per V.P.	:	2 (Line 87-414 only: 4 swp/vp)
Sweep length	:	12 sec
Pad spacing	:	15m
Move-up	:	15m (Line 87-412 only: 7.5m) (Line 87-414 only: 5.0m)
Source array	:	45m (centred at station peg) (Line 87-412 only:array=37.5m)
Sweep frequency	:	8-80Hz upsweep
Sweep function	:	Linear
Cosine taper	:	0.25 sec
Amplitude control	:	Drive level fixed at 40%
Type of phase lock	:	Ground-force

After-hours demultiplexing using the FT-1 in the recording truck produced diversity stacked correlated SEG-Y data.

Production commenced on the afternoon of 21st September, 1987 immediately following the experimental work and was completed on the morning of 4th October, 1987.

2.5.2 PRODUCTION RECORDING (Cont.)

As four lines crossed the Keep River, long detours were necessary for both vibrators and line vehicles. In spite of the delays associated with these river crossings, the crew achieved an excellent overall production rate of 12 km per day. Instrument downtime was minimal.

No. of lines	:	18
Km recorded	:	140.58
CDP coverage	:	60-fold
Data quality	:	Fair to good

2.5.3 QUALITY CONTROL

The following tests were routinely performed in accordance with client requirements. Recording instrument and vibrator similarity test procedures utilized a Texas Instruments 4.0.4 QC software package.

A) Pre-production Tests

i) Monthly instrument tests: (see description 'B')
ii) Geophone status printouts: All geophones were pre-tested using an I/O Geophone Analyser Mod GA-1 which listed leakage, resistance, distortion, frequency, damping, impedance and polarity.
iii) Hardwire and Vibra-chek similarities: (see description 'C').
iv) Polarity tests: IMPULSE-SIGNAL polarity was such that an upward ground motion produced a negative-going output signal on tape (as per SEG recommendation). SWEPT-SIGNAL polarity was such that the baseplate velocity-phone signal lagged the recorded pilot sweep by 90° (as per SEG specification).

2.5.3 QUALITY CONTROL (Cont.)

B) Monthly Instrument Tests

Calibration and de-gaussing of line filters, DRD, converter noise, input noise, IFP amplifier oscillator, filter pulse, gainstep accuracy, harmonic distortion, crossfeed, converter linearity.

Test specification : T.I.

Data output : SEG-B tape, on-line printer, electrostatic plotter.

C) Daily Tests

i) Hardwire Similarities : comparison of phase relationships between vibrator synthetic "ground-force"signals and wireline reference signals.

Test Specification : Pelton (wireline reference signal in phase "ground-force" signal from vibrator. This 0° phase relationship occurs because the similarity signal is a force signal rather than a velocity signal).

Data Output : SEG-B tape, plotter

ii) Vibra-chek: Comparison of phase and amplitude of signals from each vibrator independently.

Test specification : Pelton

Data output : Vibra chek digital print-out

iii) Instrument tests : DRD, system noise, filter pulse, exponential oscillator tests.

Data Output : SEG-B tape, camera

2.5.3 QUALITY CONTROL (Cont.)

C) Daily Tests (Cont.)

iv) Radio similarities: comparison between radio transmitted synthetic "ground-force" signal from vibrator (aux. Ch. #3) and radio reference signal (aux. Ch. #1).
Test specification : Pelton (true reference signal in phase with "ground-force" signal from vibrator)
Data Output : V.D.U.

v) Line checking : using a Geospace GS900 String Tester and a G.E.S. Spread Checker situated in the recording vehicle.

vi) Data Quality Monitoring :every 5th or 10th V.P. summed, correlated and output to camera for checking by observer.

2.6 IN-FIELD DATA PROCESSING

Technical Equipment:

FT1 - Timap System incorporating R980B CPU, ATP IV array processor, 16 megabyte mass memory. Two STC 1600/6250BPI tape drives. One Gould-5000 electrostatic plotter. One TIPC with TI printer. One Sytech 'Spex' data processing software package.

Off-line Demultiplexing (Demux):

Due to the cumulative time factor involved in on-line demultiplexing (correlation and reformatting from SEG-B to SEG-Y), it was decided to perform this operation after hours in order to optimize the use of available recording time.

Experimental Processing:

The processing of experimental data generally involved the production of Gould plots of field records or ensembles of selected sets of data followed by individual trace analyses (e.g. power spectra) for comparison purposes.

Brute Stacks:

Sections were produced on the following lines:-

Weaber Plains Area	Line 87-412	(60-fold)
Weaber Plains Area	Line 87-414	(60-fold)
Pincombe Area	Line 87-403	(60-fold)

Section quality was generally fair with reasonable reflection continuity in the shallower zones. Due to time constraints, velocity analyses and other analytical processes had to be reduced to a minimum, thus each stack was produced on a one-off basis with no time allocated for further data enhancement. A typical processing sequence was as follows:-

2.6 <u>IN-FIELD DATA PROCESSING</u> (Cont.)

Resequence	: re-numbering of records plus Q.C. displays.
Sort	: edit, spread geometry input, datum statics input, CDP trace gathers.
Scaling	: T.V. equalization.
Deconvolution	: spiking, 130ms operator length, 1% prewhitening.
Velocity Analysis	: constant velocity stacks, 3 per line, 20 CDPs per panel.
Velocity Analysis	: constant velocity gathers, one CDP.
N.M.O.	: Correction using velocity functions picked from constant velocity stacks.
Mute	: 1st arrival mute picked from constant velocity gathers.
Filter	: bandpass, selected from filter scan test, typically 12-24/55-75.
Stack	: 60 fold CDP summing.
Scaling	: T.V. equalization,
Gould plots of section	: as requested by client representative.

2.7 UPHOLE SURVEYS

Technical Equipment

1 x Sercel SN338 48-channel IFP recording system.
1 x SIE ERC-10C camera.
1 x I/O SSS-200 encoder-decoder.
4 x Sensor geophones (8Hz).

Recording Parameters

Tape format	:	SEG-B, 1600 Bpi
Sample interval	:	1 millisecond
Recording filters	:	Hi-cut 250Hz @ 24dB/octave Lo-cut out
Playback filters	:	Hi-cut 125Hz @ 24dB/octave Lo-cut out
Data traces	:	No. 1 - 4
System lag	:	2.0 - 2.5 milliseconds

Quality Control

Geophones	:	Pre-tested using I/O Geophone Analyser Mod. GA-1
Recording Instruments	:	routine start-up tests (monthly test tape), daily tests (system ref, system noise, DRDs, filter pulse, programme), cap-under-geophone test (to check lag, optical alignment)

Recording Procedure

Uphole surveys were recorded at 73 locations including line intersection and at intervals generally not exceeding 1.5km. The locations and proposed depths

2.7 UPHOLE SURVEYS (Cont.)

Recording Procedure (cont.)

were provided by the client representative. Hole depths averaged 24m throughout the Weaber Plains and Pincombe areas.

Explosives were prepared by a licensed pre-loader who attached charges at accurately measured intervals to a weighted harness which was loaded in each hole immediately after drilling. Four single geophones were planted at 1.0m radius from the hole. (See Plate 4 for charge configuration).

After recording, cap wire was removed and holes were backfilled and plugged leaving the environment in its original condition.

Preliminary uphole survey plots were prepared by the observer on site in order to monitor LVL trends and velocities.

Uphole recording commenced on 27th August and was completed on 17th September, 1987.

(See Appendix VI for list of uphole survey locations).

2.8 RESTORATION

G.E.S. personnel plugged all shotholes, and removed station pegs and flagging from lines. At the completion of the survey all campsite litter was disposed of and the area was restored to its original state.

2.9 STATIC CORRECTIONS

The computation method was based on :

$$\text{Static} = \frac{Ed-Es+Ds}{Vr} - Tuh$$

where Ed	=	datum elevation (m ASL)
	=	0m (Sea level)
Es	=	surface station elevation (m ASL)
Ds	=	depth shot (m)
Tuh	=	uphole time at Ds
and Vr	=	correction/replacement velocity (constant for a given area)

Uphole times were linearly interpolated between uphole surveys. The correction velocity, Vr was selected by averaging the uphole subweathering velocities for each area. Velocities (Vr) used for Weaber Plains and Pincombe were 2200 and 2500m/sec respectively.

Statics were computed in the GES Brisbane office and the first shipment, containing finalized uphole plots, uphole records, statics computation sheets and survey notes was despatched to Santos Limited on 9th November, 1987.

APPENDIX I

G.E.S. Personnel

Superviser	:	C. Marshall
Party Manager	:	W. Shallvy
Assistant Party Manager	:	B. Davidson
Instrument Engineer	:	A. Cheshire, J. Eaglesham
Observers	:	S. Finch, W. Moir
		B. Nicholson
Seismologist/Data Processor	:	R. Vincart,
		M. Hogarde
Surveyor	:	E. Amedee
Dozer Pointer	:	J. Flynn
Uphole Observers	:	G. Allan,
		P. Nixon
Preloader	:	C. Lawton
Chainman/Rodman	:	S. McDonald,
		A. Schipp
Vibrator Engineer	:	J. Albright
Vibrator Operators	:	A. Bennett,
		W. Rochford,
		N. McCabe,
		A. Molnar
Vibrator Mechanic	:	L. Finch
Fleet Mechanic	:	B. Wood, K. Teague
Cable Repairman	:	R. Norman
Spread Checker	:	P. Stone
Linesmen	:	P. Hunt, A. Toth
		M. Mellino, J. McEwan
		N. Richards, R. Syme
		G. Hardie, S. Charlton
		A. Davidson, J. Stubbs
Supply Driver	:	L. Burke
Camp Attendant	:	F. Schifoske
Cook	:	W. Chappell

APPENDIX II

G.E.S. Equipment

Vehicles

1 x Toyota Landcruiser S.W.	: Party Manager
1 x Toyota Landcruiser P.C.	: Personnel carrier
1 x Toyota Landcruiser	: Vibrator Mechanic
1 x Toyota Landcruiser	: Spread Checker
1 x Toyota Landcruiser	: Cable repair
1 x Toyota Landcruiser	: Recorder store
1 x Toyota Landcruiser	: Tyre supply
5 x Toyota Landcruisers	: Cables and Geophones
1 x Toyota Landcruiser	: Dozer Pointer
2 x Toyota Landcruisers	: Surveying
1 x Toyota Landcruiser	: Chaining
1 x Toyota Landcruiser	: Preloading
1 x Toyota Landcruiser	: Fuel
1 x Bedford 4x4	: Workshop
1 x Bedford 4x4	: Camp generators
1 x Isuzu 6x6	: Fuel tanker (5000L)
1 x Isuzu 6x6	: Water tanker (5000L)
1 x Isuzu 6x6	: Recorder (production)
1 x International Acco 4x4	: Recorder (upholes)
4 x International Paystar 5000 6x6	: Vibrators
1 x International 4x4	: Vibrator workshop
3 x trailers	: Oil, tyres, pegs

Camp

1 x 9m Portacom caravan	: Kitchen
1 x 9m Portacom caravan	: Diner
1 x 6m Portacom caravan	: Shower
1 x 7m Portacom caravan	: P.M. Office
4 x 6m Portacom caravans	: Sleepers (8 berth)
1 x 6m Portacom caravan	: Sleeper (4 berth)
1 x 6m Viscount	: Cable repair shop

APPENDIX III

List of Tapes (SEG-B)

Tape No.	Line No.	VP - VP	File No.
Weaber Plains Area			
024	87-412	Experimental	241-036
025	87-412	100-288	001-195
026	87-412	289-350	196-257
027	87-414	350-171	001-188
028	87-414	170-100	189-259
029	87-416	100-289	001-190
030	87-416	290-350	191-260
031	87-410	350-156	001-186
032	87-410	155-100	187-242
033	87-407	100-277	001-178
034	87-407	278-330	187-239
035	87-409	325-133	001-193
036	87-409	132-100	195-227
037	87-411	100-283	001-184
038	87-411	284-321	185-230
039	87-413	324-131	001-194
040	87-413	130-101	196-225
041	87-408	098-236/328-364	001-184
042	87-419	128-290	001-163
043	87-419	291-482	164-356
044	87-419	483-613	357-492
045	87-415	604-414	001-184
046	87-415	413-224	185-383
047	87-415	223-100	384-501
048	87-417	300-111	001-199
049	87-417	111-100	199-210
050	87-419	117-100	493-510
051	87-408	316-244	186-258
Pincombe Area			
052	87-405	300-108	001-193
053	87-405	107-100	194-201
054	87-406	244-101	001-153
055	87-403	100-290	001-187

List of Tapes (SEG-B) (Cont.)

Tape No.	Line No.	VP to VP	File No.
Pincombe Area (Cont.)			
056	87-404	534-341	001-190
057	87-404	340-175	191-352
058	87-404	174-100	353-434
059	87-402	105-300	001-194
060	87-401	102-242	001-149
SEG-Y			
Weaber Plains Area			
501	87-412	Experimental	5002-5030
017	87-412	101-350	5001-5251
018	87-408	098-244	5001-5249
019	87-414	350-100	5001-5251
021	87-416	100-350	5001-5251
022	87-410	350-100	5001-5242
023	87-407	100-330	5001-5231
024	87-409	325-100	5001-5226
025	87-411	100-320	5001-5221
026	87-413	324-101	5001-5224
027	87-419	129-369	5002-5242
028	87-419	370-613	5243-5479
029	87-419	117-100	5480-5497
030	87-415	604-350	5001-5248
031	87-415	349-100	5249-5491
032	87-417	300-100	5001-5196
Pincombe Area			
033	87-405	300-100	5001-5201
034	87-406	244-101	5001-5144
020	87-403	100-290	5001-5178
035	87-404	534-341	5001-5190
036	87-404	340-100	5191-5426
037	87-402	105-300	5001-5193
038	87-401	102-242	5001-5141

GES

APPENDIX IV

SANTOS LIMITED

WEABER SEISMIC SURVEY

LIST OF PERMANENT MARKERS

Notes: 1. Permanent markers consist of 165 cm steel star pickets, driven into the ground approximately 50 cm (and concreted in, if client has specified).

2. An aluminium tag stamped "GES PARTY 1 87-..." and data as shown in tag inscription column below is bolted to the top of the picket.

Line	Tag Inscription	AMG Zone 52		Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
		Easting	Northing				
87-401	VP 102 SOL	501 185.5	8299 297.9	15 22 59.060	129 00 39.769	27.36	
	VP 122 XING 87-402	501 773.7	8299 180.1	15 23 02.893	129 00 59.501	22.88	
	VP 166 XING 87-404	503 068.3	8298 924.9	15 23 11.194	129 01 42.930	17.93	
	VP 193 XING BN80-203	503 863.6	8298 767.7	15 23 16.308	129 02 09.612	17.37	
	VP 242 EOL	505 305.4	8298 483.2	15 23 25.556	129 02 57.982	24.61	
87-402	VP 300 EOL	501 793.1	8299 393.0	15 22 55.964	129 01 00.152	22.09	
	VP 200	501 149.2	8296 459.1	15 24 31.454	129 00 38.556	18.08	
	VP 105 SOL	500 537.0	8293 672.8	15 26 02.142	129 00 18.020	19.24	
87-403	VP 290 EOL	504 766.8	8302 358.6	15 21 19.428	129 02 39.888	35.33	
	VP 271 XING BN80-203	504 212.3	8302 490.4	15 21 15.143	129 02 21.286	40.72	
	VP 260 XING 87-404	503 890.3	8302 566.9	15 21 12.654	129 02 10.486	44.37	
	VP 225	502 868.2	8302 810.4	15 21 04.732	129 01 36.203	52.24	
	VP 214 XING BN81-306	502 546.9	8302 887.3	15 21 02.232	129 01 25.425	52.40	
	VP 144 XING BN80-201	500 509.2	8303 373.1	15 20 46.425	129 00 17.079	55.71	
	VP 122 XING BN81-302	499 867.0	8303 525.3	15 20 41.472	128 59 55.540	54.83	
	VP 100 SOL	499 223.6	8303 677.2	15 20 36.527	128 59 33.960	51.58	
87-404	VP 534 EOL	504 739.5	8305 748.3	15 19 29.102	129 02 38.949	23.40	
	VP 524 XING BN81-303	504 660.8	8305 458.3	15 19 38.542	129 02 36.311	23.92	
	VP 485 XING BN80-204	504 354.2	8304 327.9	15 20 15.334	129 02 26.035	25.04	
	PM 441 XING BN81-301	504 009.2	8303 052.3	15 20 56.855	129 02 14.472	39.04	
	VP 216	502 657.5	8296 442.5	15 24 31.993	129 01 29.159	17.25	N side of road
	VP 100 SOL	502 062.5	8293 010.7	15 26 23.687	129 01 09.208	18.36	

Line	Tag Inscription	AMG Zone 52		Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
		Easting	Northing				
87-405	VP 100 SOL	499 680.9	8305 598.5	15 19 33.994	128 59 49.298	34.37	
	VP 134 XING BN80-201 & BN81-302	500 671.4	8305 335.5	15 19 41.902	129 00 22.518	31.75	
	VP 226 XING 87-406 & BN81-306	503 352.3	8304 697.1	15 20 03.323	129 01 52.433	32.45	
	VP261 XING 87-404 & BN80-203	504 373.2	8304 447.7	15 20 11.435	129 02 26.673	25.14	
	VP 300 EOL	505 512.1	8304 173.9	15 20 20.338	129 03 04.872	21.69	
87-406	VP 100 SOL	502 691.8	8302 200.0	15 21 24.601	129 01 30.289	56.48	
	VP 138 XING BN81-301	502 993.4	8303 300.4	15 20 48.786	129 01 40.400	45.75	
	VP 180 XING BN80-204	503 328.3	8304 514.8	15 20 09.257	129 01 51.628	32.88	
	VP 190 XING BN81-306	503 408.1	8304 804.4	15 19 59.831	129 01 54.302	31.58	
	VP 220 XING BN81-303	503 647.6	8305 673.9	15 19 31.529	129 02 02.330	27.74	
	VP 244 EOL	503 840.6	8306 368.8	15 19 08.912	129 02 08.800	24.80	
87-407	VP 100 SOL	509 606.3	8303 413.2	15 20 45.055	129 05 22.199	11.91	
	VP 118 XING BN80-204	510 028.8	8303 075.7	15 20 56.032	129 05 36.374	12.16	
	VP 280 XING BN80-207	513 827.3	8300 041.6	15 22 34.722	129 07 43.841	12.54	
	VP 330 EOL	515 000.2	8299 104.8	15 23 05.190	129 08 23.206	13.22	
87-408	VP 98 SOL	509 808.3	8302 047.4	15 21 29.505	129 05 28.994	12.25	
	VP 129 XING 87-407	510 376.8	8302 783.4	15 21 05.542	129 05 48.052	12.25	
	VP 136 XING BN80-204	510 505.4	8302 949.9	15 21 00.121	129 05 52.363	12.25	
	VP 166 XUNG 87-409	511 056.0	83 03 662.7	15 20 36.915	129 06 10.818	12.22	
	VP 200 XING 87-411	511 680.1	8304 470.2	15 20 10.622	129 06 31.736	11.87	
	VP 210 XING BN81-311	511 863.6	8304 707.7	15 20 02.888	129 06 37.890	11.78	
	VP 228 XING 87-413	512 194.0	8305 135.1	15 19 48.972	129 06 48.961	10.45	
	VP 263 XING 87-415	512 836.5	8305 966.4	15 19 21.905	129 07 10.493	8.05	
	VP 283 XING BN81-313 & SH84-15	513 205.0	8306 440.3	15 19 06.474	129 07 22.845	11.62	
	VP 294 XING 87-417	513 407.9	8306 700.8	15 18 57.992	129 07 29.644	10.61	
	VP 330 XING 87-419	514 071.0	8307 552.0	15 18 30.273	129 07 51.864	8.93	
	VP 343 XING BN80-207	514 310.1	8307 860.9	15 18 20.216	129 07 59.876	7.12	
	VP 364 EOL	514 696.3	8308 359.6	15 18 03.977	129 08 12.814	8.69	

Line	Tag Inscription	AMG Zone 52 Easting	AMG Zone 52 Northing	Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
87-409	VP 100 SOL	510 290.7	8304 297.1	15 20 16.277	129 05 45.141	11.80	
	VP 190 XING BN80-204	512 381.0	8302 586.2	15 21 11.928	129 06 55.278	11.26	
	VP 256 XING BN80-207	513 914.5	8301 331.7	15 21 52.730	129 07 46.741	12.97	
	VP 275 XING SH84-15	514 356.4	8300 970.0	15 22 04.495	129 08 01.572	12.56	
	VP 325 EOL	515 518.0	8300 018.7	15 22 35.433	129 08 40.557	11.21	
87-410	VP 350 EOL	515 165.2	8307 570.6	15 18 29.646	129 08 28.556	9.24	
	VP 326 XING 87-419	514 719.5	8307 004.6	15 18 48.078	129 08 13.623	9.96	
	VP 299 XING BN80-207	514 218.4	8306 366.8	15 19 08.847	129 07 56.831	10.10	
	VP 293 XING BN81-313 & 87-417	514 107.0	8306 225.0	15 19 13.464	129 07 53.098	9.83	
	VP 260 XING 87-415 & SH84-15	513 493.5	8305 448.4	15 19 38.751	129 07 32.539	4.25	
	VP 223 XING 87-413 & BN81-311	512 807.6	8304 576.5	15 20 07.142	129 07 09.552	10.48	
	VP 196 XING 87-411	512 306.6	8303 940.0	15 20 27.867	129 06 52.760	11.56	
	VP 163 XING 87-409	511 692.4	8303 162.1	15 20 53.197	129 06 32.174	12.11	
	VP 147 XING BN80-204	511 395.2	8302 784.3	15 21 05.497	129 06 22.212	12.52	
	VP 126 XING 87-407	511 005.7	8302 289.2	15 21 21.619	129 06 09.152	12.32	
	VP 100 SOL	510 521.7	8301 677.1	15 21 41.548	129 05 52.928	12.49	
87-411	VP 321 EOL	516 106.4	8300 886.6	15 22 07.171	129 09 00.274	10.85	
	VP 313 XING BN81-308	515 919.3	8301 037.3	15 22 02.272	129 08 53.996	10.96	
	VP 254 XING BN80-204 & SH84-06	514 540.9	8302 148.1	15 21 26.147	129 08 07.735	12.63	
	VP 231 XING SH84-15 & BN80-207	514 004.1	8302 581.0	15 21 12.068	129 07 49.721	12.40	
	VP 110 XING BN81-311	511 176.2	8304 861.5	15 19 57.894	129 06 14.831	11.15	
	VP 100 SOL	510 942.1	8305 050.2	15 19 51.754	129 06 06.978	10.28	

Line	Tag Inscription	AMG Zone 52 Easting	AMG Zone 52 Northing	Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
87-412	VP 100 SOL	511 349.6	8301 091.5	15 22 00.594	129 06 20.708	12.67	
	VP 124 XING 87-407	511 803.4	8301 651.2	15 21 42.371	129 06 35.919	12.51	
	VP 160 XING 87-409	512 484.8	8302 491.8	15 21 14.999	129 06 58.763	11.45	
	VP 195 XING 87-411	513 146.6	8303 308.8	15 20 48.397	129 07 20.946	11.01	
	VP 198 XING SH84-06	513 203.2	8303 378.6	15 20 46.124	129 07 22.842	11.00	
	VP 224 XING 87-413	513 695.3	8303 985.7	15 20 26.354	129 07 39.336	9.87	
	VP 236 XING BN81-311	513 922.6	8304 265.1	15 20 17.256	129 07 46.952	11.28	
	VP 246 XING BN80-207	514 112.4	8304 498.5	15 20 09.658	129 07 53.313	11.32	
	VP 259 XING 87-415	514 358.4	8304 801.0	15 19 59.807	129 08 01.558	11.28	
	VP 292 XING 87-417	514 983.0	8305 570.3	15 19 34.755	129 08 22.489	11.14	
	VP 312 XING BN81-313	515 361.7	8306 037.0	15 19 19.557	129 08 35.179	11.08	
	VP 324 XING 87-419	515 589.0	8306 317.2	15 19 10.434	129 08 42.796	10.86	
	VP 350 EOL	516 081.3	8306 924.1	15 18 50.669	129 08 59.293	10.34	
87-413	VP 100 SOL	511 391.1	8305 722.5	15 19 29.867	129 06 22.024	8.86	
	VP 170 XING BN81-311	513 065.3	8304 453.8	15 20 11.130	129 07 18.196	9.07	
	VP 198 XING SH84-15	513 734.3	8303 945.7	15 20 27.656	129 07 40.644	10.39	
	VP 212 XING BN80-207	514 069.0	8303 691.3	15 20 35.928	129 07 51.875	11.53	
	VP 293 XING BN81-308	516 005.2	8302 219.9	15 21 23.779	129 08 56.849	11.30	
	VP 324 EOL	516 746.5	8301 656.6	15 21 42.096	129 09 21.726	10.58	
87-414	VP 350 EOL	516 884.7	8306 255.8	15 19 12.401	129 09 26.250	10.26	
	VP 328 XING 87-419 & BN81-313	516 460.4	8305 749.8	15 19 28.880	129 09 12.031	10.68	
	VP 316 XING BN81-308	516 229.5	8305 472.9	15 19 37.897	129 09 04.297	10.82	
	VP 294 XING 87-417	515 807.0	8304 965.4	15 19 54.424	129 08 50.138	11.07	
	VP 260 XING 87-415	515 153.6	8304 182.9	15 20 19.908	129 08 28 241	11.77	
	VP 254 XING BN81-311	515 038.2	8304 044.9	15 20 24.402	129 08 24.373	11.79	
	VP 224 XING 87-413	514 460.2	8303 353.6	15 20 46.914	129 08 05.003	12.06	
	VP 199 XING BN80-207 & SH84-15	513 980.0	8302 777.1	15 21 05.687	129 07 48.906	12.26	
	VP 195 XING SH84-06 & 87-411	513 902.9	8302 684.5	15 21 08.700	129 07 46.324	12.32	
	VP 179 XING BN80-204	513 595.2	8302 315.7	15 21 20.709	129 07 36.011	12.76	
	VP 160 XING 87-409	513 229.6	8301 877.4	15 21 34.981	129 07 23.754	12.88	
	VP 125 XING 87-407	512 556.2	8301 069.8	15 22 01.281	129 07 01.184	13.14	
	VP 100 SOL	512 075.4	8300 492.9	15 22 20.064	129 06 45.064	13.66	

Line	Tag Inscription	AMG Zone 52		Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
		Easting	Northing				
87-415	VP 100 SOL	512 024.8	8306 544.1	15 19 03.116	129 06 43.263	12.39	
	VP 157 XING SH85-15	513 391.6	8305 516.7	15 19 36.532	129 07 29.118	7.62	
	VP 188 XING BN80-207	514 135.2	8304 959.3	15 19 54.657	129 07 54.069	10.67	
	VP 245 XING BN81-311	515 505.8	8303 935.8	15 20 27.941	129 08 40.060	11.72	
	VP 270 XING BN81-308	516 106.9	8303 487.0	15 20 42.536	129 09 00.231	10.96	
	VP 400 XING BN81-309	519 215.1	8301 126.4	15 21 59.288	129 10 44.545	9.68	
	VP 451 XING SH84-01	520 430.0	8300 197.8	15 22 29.480	129 11 25.325	11.96	
	VP 557 XING SH84-03	522 954.1	8298 262.4	15 23 32.395	129 12 50.059	12.73	
	VP 580	523 498.7	8297 842.3	15 23 46.049	129 13 08.345	13.40	Nw side of road
	VP 604 EOL	524 069.2	8297 402.2	15 24 00.354	129 13 27.498	13.05	
87-416	VP 100 SOL	512 943.8	8299 815.7	15 22 42.091	129 07 14.208	15.95	
	VP 124 XING 87-407	513 404.9	8300 369.1	15 22 24.071	129 07 29.664	12.90	
	VP 150 XING BN80-207	513 904.1	8300 969.6	15 22 04.516	129 07 46.397	12.81	
	VP 160 XING 87-409	514 096.0	8301 200.5	15 21 56.997	129 07 52.831	12.91	
	VP 168 XING SH84-15	514 249.4	8301 384.6	15 21 51.004	129 07 57.972	12.88	
	VP 195 XING 87-411, BN80-204 & SH84-06	514 768.1	8302 007.0	15 21 30.735	129 08 15.359	12.66	
	VP 226 XING 87-413	515 363.5	8302 721.6	15 21 07.464	129 08 35.313	12.25	
	VP 262 XING 87-415 & BN81-308	516 055.9	8303 550.8	15 20 40.461	129 08 58.520	11.45	
	VP 272 XING BN81-311	516 248.6	8303 781.4	15 20 32.952	129 09 04.975	10.68	
	VP 295 XING 87-417	516 691.2	8304 311.2	15 20 15.697	129 09 19.807	10.16	
	VP 326 XING 87-419	517 285.7	8305 025.4	15 19 52.438	129 09 39.730	9.68	
	VP 350 EOL	517 747.1	8305 578.8	15 19 34.414	129 09 55.189	9.30	
87-417	VP 300 EOL	517 448.4	8303 740.5	15 20 34.254	129 09 45.218	9.47	
	VP 248 XING BN81-308	516 191.9	8304 666.3	15 20 04.152	129 09 03.055	10.90	
	VP 166 XING BN 80-207	514 208.8	8306 126.4	15 19 16.670	129 07 56.513	10.43	
	VP 157 XING BN81-313	513 991.2	8306 286.6	15 19 11.461	129 07 49.212	9.38	
	VP 120 XING SH84-15	513 096.7	8306 945.0	15 18 50.048	129 07 19.200	10.57	
	VP 100 SOL	512 613.3	8307 301.0	15 18 38.472	129 07 02.984	12.18	

Line	Tag Inscription	AMG Zone 52		Latitude S	Longitude E	Elevation (Metres AHD)	Remarks
		Easting	Northing				
87-419	VP 100 SOL	513 355.4	8308 106.8	15 18 12.231	129 07 27.855	8.24	
	VP 140 XING BN80-207	514 299.9	8307 366.4	15 18 36.309	129 07 59.544	7.95	
	VP 223 XING BN81-308 & BN81-13	516 261.3	8305 830.3	15 19 26.265	129 09 05.352	10.70	
	VP 296 XING SH84-04	517 986.5	8304 479.7	15 20 10.181	129 10 03.246	9.10	
	VP 376 XING BN81-311	519 892.4	8303 020.7	15 20 57.617	129 11 07.211	8.93	
	VP 454 XING SH84-01	521 751.6	8301 599.3	15 21 43.827	129 12 09.614	10.96	
	VP 567 XING SH84-03	524 443.8	8299 538.1	15 22 50.823	129 13 39.990	11.37	
	VP 613 EOL	525 540.0	8298 697.5	15 23 18.146	129 14 16.796	12.99	

APPENDIX V

Line Lengths

Line No.	VP to VP	km
87-412	100-350	7.50
87-414	350-100	7.50
87-416	100-350	7.50
87-410	350-100	7.50
87-407	100-330	6.90
87-409	325-100	6.75
87-411	100-321	6.63
87-413	324-100	6.72
87-408	098-364	7.98
87-419	100-613	15.39
87-415	604-100	15.12
87-417	300-100	6.00
87-405	300-100	6.00
87-406	244-100	4.32
87-403	100-290	5.70
87-404	534-100	13.02
87-402	105-300	5.85
87-401	102-242	4.20
	TOTAL	140.58

APPENDIX VI

List of Uphole Survey Locations

Weaber Plains Area:

Uphole No.	Line No.	Station
123	87-407	133 + 15m (INT 87-408 STN 129 + 11m)
124	87-408	166 + 23m (INT 87-409 STN 133 + 4m)
125	87-408	199 + 22m (INT 87-411 STN 131 + 8m)
126	87-408	227 + 20m (INT 87-413 STN 133 + 4m)
127	87-408	262 + 4m (INT 87-415 STN 133 + 5m)
128	87-408	294 + 12m (INT 87-417 STN 132 + 24m)
129	87-408	329 + 25m (INT 87-419 STN 130 + 16m)
130	87-410	326 + 26m (INT 87-419 STN 158 + 12m)
131	87-410	293 + 8m (INT 87-417 STN 161 + 9m)
132	87-410	259 + 24m (INT 87-415 STN 161 + 2m)
133	87-410	224 + 19m (INT 87-413 STN 160 + 21m)
134	87-410	196 + 2m (INT 87-411 STN 158 + 17m)
135	87-410	162 + 13m (INT 87-409 STN 160 + 4m)
136	87-410	126 + 5m (INT 87-407 STN 159 + 24m)
137	87-412	124 + 18m (INT 87-407 STN 193 + 26m)
138	87-412	159 + 20m (INT 87-409 STN 194 + 10m)
139	87-412	194 + 2m (INT 87-411 STN 193 + 17m)
140	87-412	224 + 19m (INT 87-413 STN 196 + 4m)
141	87-412	258 + 23m (INT 87-415 STN 197 + 3m)
142	87-412	290 + 28m (INT 87-417 STN 197 + 22m)
143	87-412	325 + 5m (INT 87-419 STN 195 + 11m)
144	87-414	325 + 27m (INT 87-419 STN 229 + 24m)
145	87-414	293 + 19m (INT 87-417 STN 231 + 22m)
146	87-415	230 + 26m (INT 87-414 STN 260 + 13m)
147	87-413	229 + 13m (INT 87-414 STN 225 + 2m)
148	87-414	194 (INT 87-411 STN 226 + 16m)
149	87-414	160 + 11m (INT 87-409 STN 226 + 25m)
150	87-407	225 + 10m (INT 87-414 STN 124 + 20m)
151	87-407	263 (INT 87-416 STN 124 + 8m)
152	87-416	158 + 13m (INT 87-409 STN 263 + 14m)
153	87-411	263 + 6m (INT 87-416 STN 193 + 27m)

List of Uphole Survey Locations (Cont.)

(Weaber Plains Area)

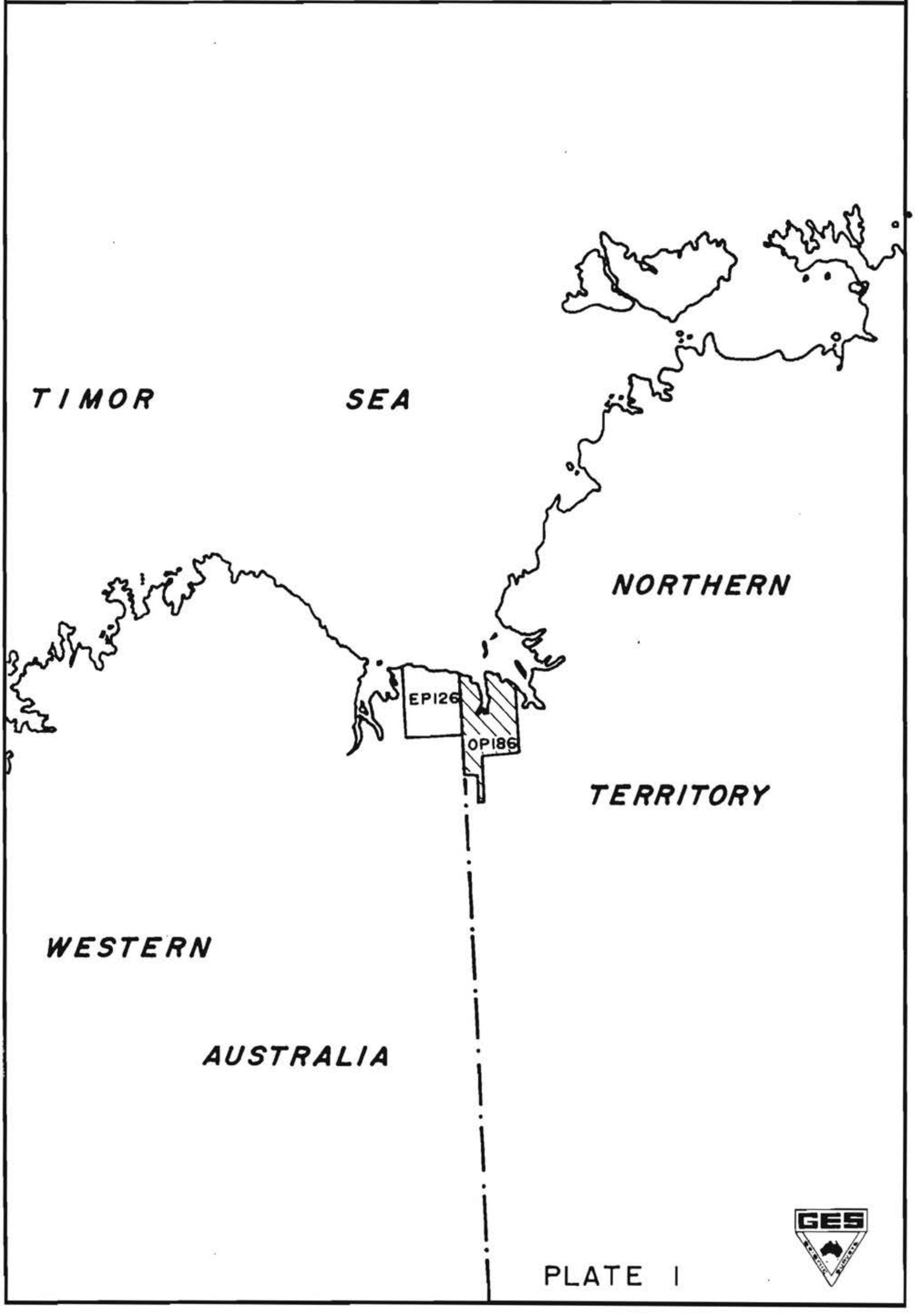
Uphole No.	Line	Station
154	87-416	225 + 23m (INT 87-413 STN 265 + 27m)
155	87-416	261 + 9m (INT 87-415 STN 267 + 10m)
156	87-416	294 + 20m (INT 87-417 STN 268 + 12m)
157	87-416	326 + 3m (INT 87-419 STN 266 + 12m)
158	87-413	298 + 14m
159	87-411	295 + 22m
160	87-409	296 + 24m
161	87-407	299 + 5m
162	87-419	316
163	87-419	367 + 8m
164	87-419	420
165	87-419	472
166	87-419	524 + 6m
167	87-419	574 + 7m
168	87-419	564
169	87-415	513 + 18m
170	87-415	460
171	87-415	408 + 12m
172	87-415	356
173	87-415	312 + 7m
Pincombe Area		
101	87-402	129 + 20m
102	87-402	184 + 24m
103	87-402	237 + 19m
104	87-401	120 + 25m (INT 87-402 STN 292 + 27m)
105	87-404	146
106	87-404	198 + 10m
107	87-404	248 + 27m
108	87-404	299 + 25m (INT 87-401 STN 166 + 20m)
109	87-401	211 + 27m
110	87-404	346

List of Uphole Survey Locations (Cont.)

Pincombe Area (Cont.)

Uphole No.	Line	Station
111	87-404	367 + 19m
112	87-404	424 + 11m (INT 87-403 STN 259 + 18m)
113	87-404	458 + 5m
114	87-404	489 + 1m (INT 87-405 STN 261 + 13m)
115	87-406	120 + 27m (INT 87-403 STN 224 + 20m)
116	87-406	152 + 19m
117	87-406	185 + 24m (INT 87-405 STN 226 + 24m)
118	87-406	218 + 28m
119	87-405	174 + 24m
120	87-405	117 + 18m
121	87-403	117 + 3m
122	87-403	172

LOCATION MAP
WEABER SEISMIC SURVEY
SANTOS LTD.



PROGRAMME MAP
WEABER SEISMIC SURVEY
SANTOS LIMITED

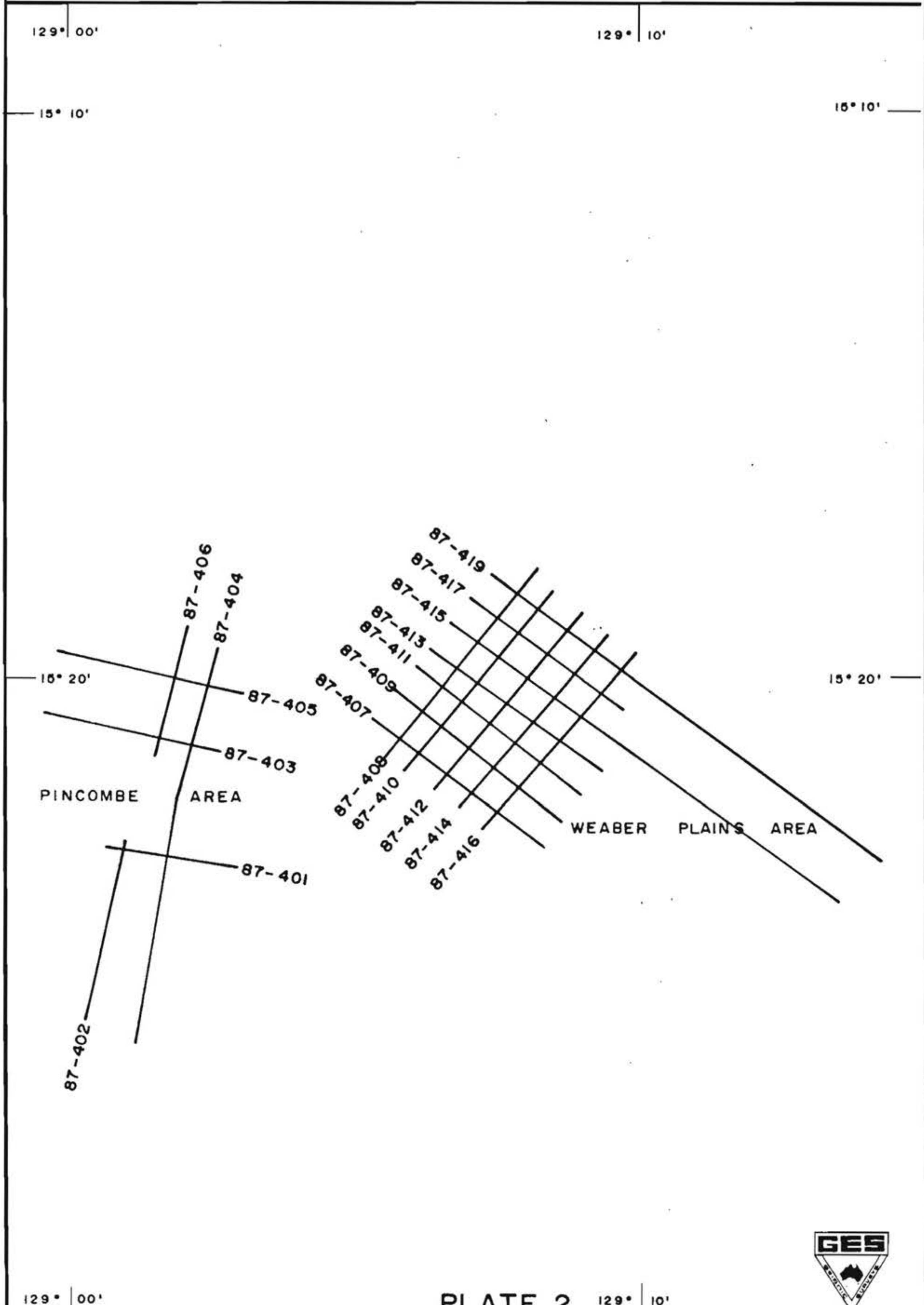
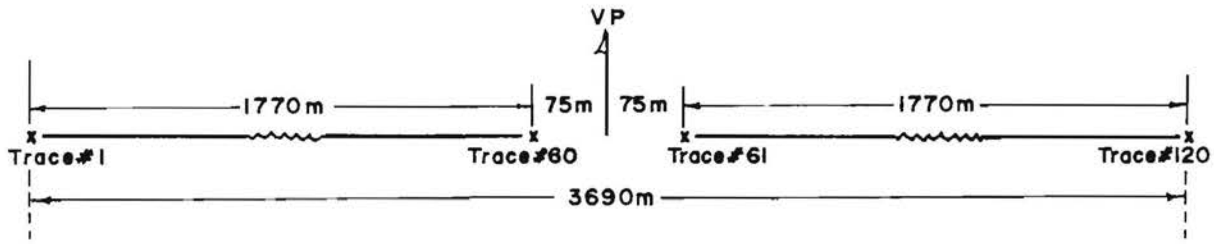


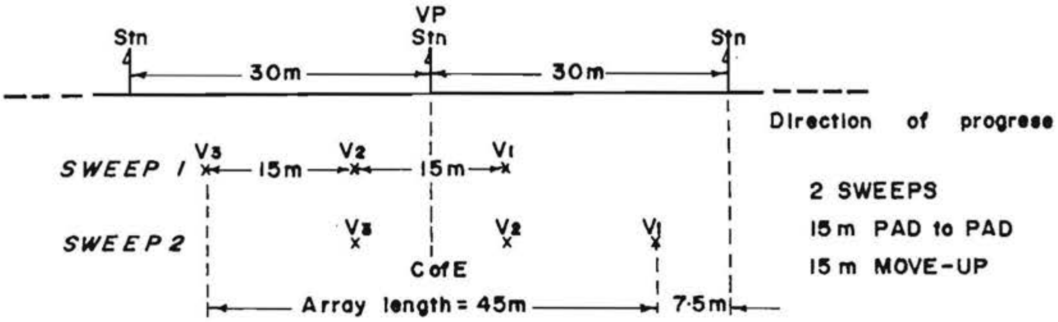
PLATE 2

SPREAD PARAMETERS
WEABER SEISMIC SURVEY
SANTOS LTD.

SPREAD LAYOUT



SOURCE ARRAY



GEOPHONE LAYOUT

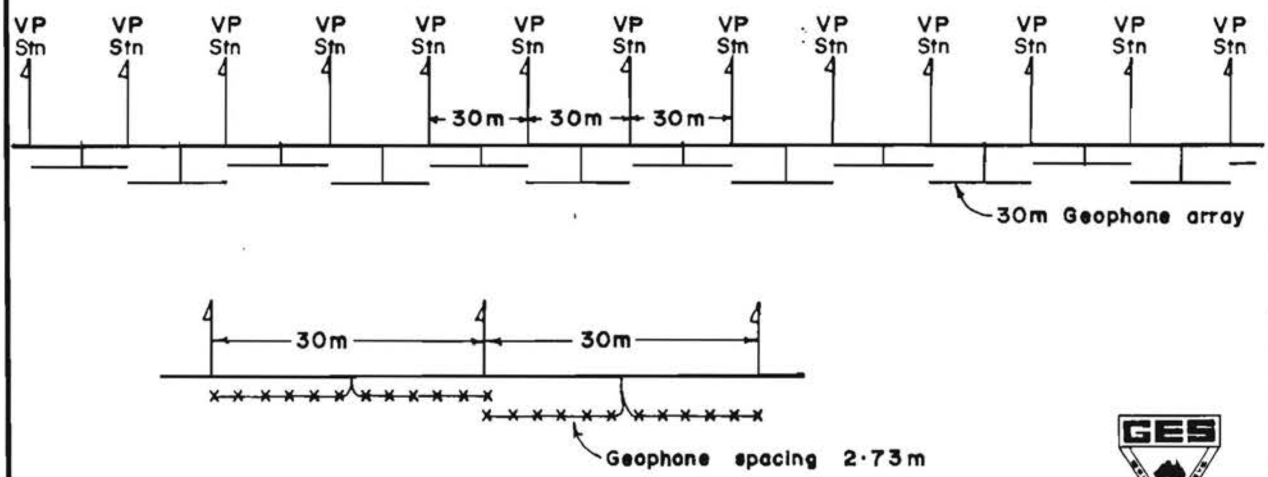


PLATE 3

UPHOLE CONFIGURATION
WEABER SEISMIC SURVEY
SANTOS LTD.

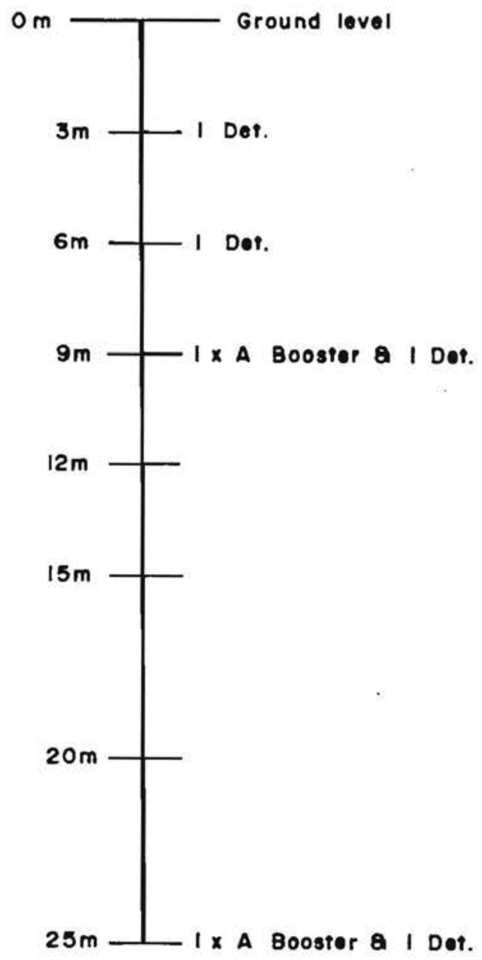


PLATE 4

Processing

DIGITAL PROCESSING REPORT

OF

LAND SEISMIC DATA FROM
OP-186, NORTHERN TERRITORY
1987 WEABER SEISMIC SURVEY

FOR

SANTOS LIMITED

BY

WESTERN GEOPHYSICAL COMPANY
SINGAPORE DIGITAL CENTRE

RPTL02B.SAN

CONTENTS

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VELAN^{R} WG trademark & service mark

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INTRODUCTION

The processing of 140.52 km of seismic data recorded in the OP 186 prospect for **SANTOS LIMITED** was undertaken in the Singapore Digital Centre of WESTERN GEOPHYSICAL COMPANY during the period of October 1987 to March 1988.

The survey was conducted by G.E.S. Pty Ltd from September to October 1987 , utilizing 120 data channel DFS 5 system for 60 fold coverage.

Final processing parameters were approved by Mr Brian Rumph from **SANTOS LIMITED** after studying tests and experimental comparisons. The processing flowchart is given in Appendix 3.

FIELD DATA

The recording parameters for 18 lines dealt with in this report are as follows :

Spread	: Spread Geometry	: 1845-75-0-75-1845 M
Instrument	: Instrument Type	: DFS-V #72424
	No. of Channels	: 120
	Sample Rate	: 4
	Record Length	: 16 sec
	Tape Format	: SEG-Y
	Packing Density	: 6250 BPI
Source	: Source Type	: Vibroseis
	Source Pattern	: Symmetrical split spread
	Source Interval	: 30 m
	Element Spacing	: 15 m
	Move Up	: 15 m
	No. of Vibrators	: 3
	Sweep Start	: 8 Hz
	Sweep End	: 80 Hz
	Sweep Length	: 12 sec
	No. of Sweeps/VP	: 2
Receiver	: Receiver Type	: GSC 200, 10 Hz
	Station Interval	: 30 m
	Receiver Pattern	: In-Series
	Array Length	: 30 m
	Element Spacing	: 2.72 m
	No. of Geophones/Group	: 12

FORMAT CONVERSION

Each field record was converted from SEG-Y to WGC Code 4 format. Full word, 32 bit and floating point data at geophone amplitude were maintained.

Every record was displayed and checked before proceeding to the next process.

PREPROCESSOR

The functions of the preprocessor are described below in the order in which they were applied.

1) Define the line in terms of stations and shotpoints with X-Y coordinates and shot to receiver distances, taking into account any irregular shot-receiver geometry.

2) Trace edit : delete traces exhibiting severe noise problems; and correct traces received from groups of geophones whose polarity are reversed.

3) Assignment of surface elevations, datum statics, X-Y coordinates, and shot-receiver distances to individual trace headers. The datum statics had been computed by G.E.S. PTY LTD in the field.

4) Computation of data start time for each trace.

5) Geometric spreading compensation. This gain function was applied in order to compensate for the decay of seismic wave amplitude due to spreading of the wave front. The gain correction was calculated based on the distance (time) that the wavefront had traveled and the velocity of the medium. The gain function was proportional to V^2T where V = RMS velocity at zero offset time and T = two way travel time.

6) Trace Balance

The data were trace balanced to an RMS level of 2000. The trace balance gain applied a single scalar to every trace which was computed by measuring the RMS of the whole trace and dividing that into 2000. The scaling factor was also stored in the trace header to allow for inverse application, if required by later processing.

FREQUENCY WAVENUMBER (FK) FILTERING

Dipping events crossing each other on seismic records, when transformed into the FK domain, will be separated. With this discrimination, unwanted dipping events and background noise can be filtered out in this domain, thus enhancing the desired dipping events.

In this process, field residual statics in the trace headers were applied to all shot records prior to FK transformation.

A filter designed to pass signals having dips between -9 ms/trace and 9 ms/trace was applied to the FK-transformed record. The filter had a cosine taper of 18 ms/trace. The FK-filtered record was then transformed back to the time domain.

After filtering, the residual field statics applied pre-FK were backed out and inserted into their appropriate trace header locations.

This process was applied to all lines in the Pincombe and Weaber Plains areas.

DECONVOLUTION BEFORE STACK

A Wiener-Levinson least squares prediction filter was applied to all data. The parameters applied were :

Prediction Distance	# of Windows	Operator Length	White Light
4 ms	3	120 ms	0.1%

Autocorrelation windows were designed to bracket data zones with similar character/frequency content. They overlapped to provide for a smooth transition in the shape of the reflection wavelet.

The data were trace balanced, sorted according to common midpoints and output as deconvolved and sorted data sets on which the remainder of the processing sequence is based.

An auxiliary output of 100% data was obtained for quality control of deconvolution performance, and later monitoring of NMO correction.

VELOCITY ANALYSIS - BY VELAN

Velocity analyses were run both before and after automatic residual statics were applied. The VELAN velocity analysis program computed correlation values as a function of stacking velocity and reflection time, by summing the crosscorrelations of all sets of normal moveout (NMO) corrected traces from selected groups of 4 CMP gathers governed by a range of trial velocities (from 1500 m/sec to 6000 m/sec).

WESTERN GEOPHYSICAL's composite velocity analyses include multi-velocity functions applied to increasing offset gathers and CMP stacked gathers, and variable density VELAN plots. Offset gathers and CMP stacked gathers helped to verify velocity picking and the stack response. These were run approximately every 1 km with actual frequency and locations being determined from the data quality and structures observed on the brute stacks.

After automatic residual statics, analyses were obtained approximately every 1/2 km and at line intersections using the same parameters as above, again with actual location being determined by observed data quality. Constant velocity stacks were produced to aid or verify interpretations and solve problem locations.

AUTOMATIC RESIDUAL STATICS - BY REFLECTION MISER

This Modular Iterative Static Evaluation Routine commenced with NMO correction of each CMP gather. Stack monitor and stack were generated and displayed to check for residual NMO. Studying the stack, a window parallel to structure and having high signal to noise ratio was selected. From the stack monitor, the maximum time shift was estimated and varied spatially to conform with variations in residual statics amplitude and complexity.

Seismic trace time deviation (statics) were estimated from common midpoint families by a standard midpoint modeling technique. A table listing the model to model shifts, the accumulated model shifts, the minimum and maximum time deviations and the crosscorrelation coefficients were generated and printed to monitor the time-deviation picking process.

The resulting deviation estimates were thereafter resolved by a general linear least square iterative technique, into surface consistent shot and receiver residual statics. A table listing the shot and receiver statics, structural term and residual NMO with their RMS errors was generated to monitor the performance of the MISER process.

The computed residual statics updated the field statics in trace headers for application to data in final stack.

PRE-STACK GAIN

Pre-stack AGC gain with a 200 ms window was applied to the Pincombe Lines BNT87-401 to 406 as it was found to improve the signal to noise ratio of the stacked data in this area.

NORMAL MOVEOUT CORRECTION

The data were NMO corrected and CMP stacked at several stages in the processing sequence for general QC purposes after preprocessor and deconvolution. The brute stack was first produced as the starting and reference point for all subsequent stacking. Stacks using the most recently updated information were produced following each of the procedures listed below :

- Peliminary velocity analysis
- First pass MISER
- Post MISER velocity analysis
- Revised velocity analysis (where applicable).

Prior to NMO correction the picked velocity functions were adjusted to datum, interpolated in time and space to provide a function for every CMP. They are then shifted back to surface to provide a velocity function for hyperbolic moveout correction of reflection data, consistent with the source to receiver travel path of reflective energy.

Outside trace muting was determined on a line to line basis to remove first arrivals and overstretching of data at early times. Automatic program muting was also used to attenuate signals stretched to twice their original duration after NMO correction. Displays of unsummed, NMO corrected gathers (stack monitors) were output for every 24th CMP for quality control purposes with each stack.

TRIM STATICS

Fine tuning of residual statics was undertaken by the trim statics program.

A model was first constructed from a conventional NMO stack of the traces in a common midpoint and the $\frac{N - 1}{2}$ adjacent CMPs on each side. (N = number of traces to form a model trace).

Crosscorrelation of NMO corrected traces from a common midpoint with its model trace yield time deviations which were applied to the traces before stacking. Higher temporal and spatial resolution were observed from the trim statics stack.

A maximum correlation shift limit of 12 ms was used to reduce the possibility of cycle skipping or ambiguity in selecting the peak correlation. The number of traces used in model building was 11.

Trim statics was applied to all lines in the Pincombe and Weaber Plains areas.

FINAL STACK

NMO corrected data were stacked for 60 fold coverage. For all stacks, the summing procedure was the mean of sample values at each sample time.

Stacks at previous stages were compared for improvements and any deteriorations in stack quality were traced back to the cause for remedial action.

The final stack incorporated optimum parameters with respect to final RMS velocities, residual statics, mute design, etc. These parameters were finally quality controlled via stack monitors, common offset gathers, and visual review of detail stacking response.

MIGRATION

Migration is a process to improve spatial resolution of seismic data. It moves dipping reflectors nearer to their true subsurface positions, collapses diffractions and better delineates fault planes.

All lines were migrated using Kirchhoff summation migration. The input to the migration was the raw structural stack.

The migration velocity field was 100% of stacking velocities, corrected to datum and then smoothed over one cable length.

RADIAL PREDICTIVE FILTER

This program acts as a multichannel filter to enhance the most coherent signal within a range of specified dip angles and suppresses both random noise and coherent energy outside that range. This is accomplished by using weighted summation of adjacent traces that have been time variantly shifted to line up at the angle of maximum coherency.

For each shift the traces are cross-multiplied and summed to yield correlation values. The shift that yields maximum correlation value at any given sample point should be the amount to shift the data at that time in order to align the most coherent event before summation. In order to avoid erratic variations in shifts, however, the correlation values from each shift are determined for specific time gates that overlap one another by 50%. After determination of coherent dip information, the input traces are shifted, weighted and summed to yield the output. This purely filtered output tends to have an artificial appearance and is usually blended with a specified percentage of the original input trace to yield a more familiar seismic quality.

An 11 trace model was used in this project. Coherent reflection energy was scanned within a dip range of +4 to -4 ms/trace. Time variant return percentage of unfiltered traces ranged from 50% at 0 ms to 90% at 4 sec.

POST-STACK FILTERING

A time variant filter was designed and applied to all final and migrated stacks. The filter parameters selected from the tests were as follows :

Time(ms)	Low Cut(Hz)/Slope(dB/oct)	High Cut(Hz)/Slope(dB/oct)
0	15/24	80/48
500	10/24	70/48
1000	10/24	70/48
2500	10/24	60/48
4000	10/24	50/48

POST-STACK SCALING

The filtered data were scaled with the Automatic Gain Control programme. An operator length of 1000 ms was used.

FINAL DISPLAY

Final stack and migrated stack were displayed on film using the following parameters :

Final Stack & Migration (Full Scale)

Mode	:	Variable Area - Wiggle
Horizontal	:	25.6 traces/inch (1:15118)
Vertical	:	3.75 inches/second
Record Length	:	4 seconds

TAPE DISPOSITION

		Qty
1)	Field Tapes	24
2)	No Gain Final Stack Tape	1
3)	Migrated Stack Tape	1

The no gain final stack and migrated stack tapes were concatenated and converted to SEG-Y format.

All of the above tapes and supporting data were shipped to **SANTOS LIMITED** on 10th and 20th July 1988.

* For Line BNT87-411 the field tapes and supporting data were shipped to Horizon Seismic Australia Pty Ltd on 8th March 1988.

COMMENTS

Field data quality is generally poor.

FK filtering and trim statics were found to be necessary to eliminate noise (eg, ground roll), enhance signal content and to improve temporal and spatial resolution in the poor data areas.

Pre-stack gain of AGC 200 ms helped to improve the signal to noise ratio of the stacked data in the very poor Pincombe area.

Velocity variations may be significant and frequent especially on the Weaber Plains area which is characterised by poor, discontinuous reflectors. All lines were very closely analysed to achieve the best stacking response and continuity possible.

All lines were migrated using the Kirchhoff summation algorithm.

Post-stack coherency was improved by the radial predictive filter program and applied to all lines.

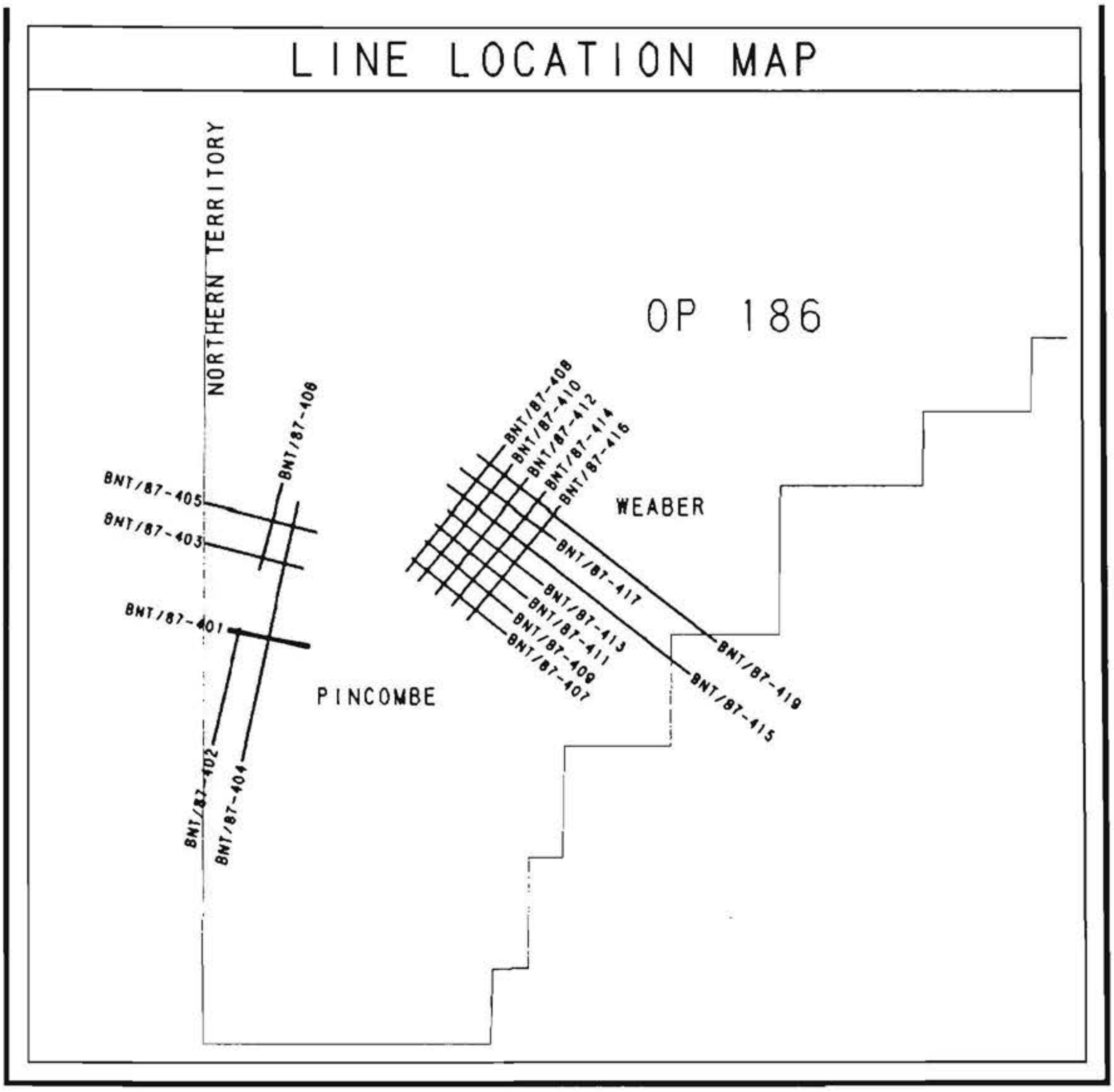
Phan Ying Peng
Geophysical Analyst

Chan See Chin
Land Processing Supervisor

Peter Nuttall
Data Processing Manager

LIST OF APPENDICES

APPENDIX 1


LINE LOCATION MAP
NORTHERN TERRITORY
OP 186
WEABER
PINCOMBE
BNT/87-401
BNT/87-402
BNT/87-403
BNT/87-404
BNT/87-405
BNT/87-406
BNT/87-407
BNT/87-408
BNT/87-409
BNT/87-410
BNT/87-411
BNT/87-412
BNT/87-413
BNT/87-414
BNT/87-415
BNT/87-416
BNT/87-417
BNT/87-419

APPENDIX 2

LIST OF LINES PROCESSED

PROSPECT	LINE NO.	VP - VP	KM
OP 186 (Pincombe)	BNT 87-401	102 - 242	4.20
	BNT 87-402	105 - 300	5.85
	BNT 87-403	100 - 290	5.70
	BNT 87-404	534 - 100	13.02
	BNT 87-405	300 - 100	6.00
	BNT 87-406	244 - 101	4.29
OP 186 (Weaber Plain)	BNT 87-407	100 - 330	6.90
	BNT 87-408	98 - 364	7.98
	BNT 87-409	325 - 100	6.75
	BNT 87-410	350 - 100	7.50
	BNT 87-411	100 - 321	6.63
	BNT 87-412	100 - 350	7.50
	BNT 87-413	324 - 101	6.69
	BNT 87-414	350 - 100	7.50
	BNT 87-415	604 - 100	15.12
	BNT 87-416	100 - 350	7.50
	BNT 87-417	100 - 300	6.00
	BNT 87-419	100 - 613	15.39
	18 lines		140.52 km

APPENDIX 3

PROCESSING SEQUENCE FLOWCHART