DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1977/27

GALILEE BASIN SEISMIC AND GRAVITY SURVEY, QUEENSLAND, 1976

OPERATIONAL REPORT

PENTLAND - HUGHENDEN AREA

by

D.L. Schmidt, A. Nelson*, and W. Anfiloff

*Geological Survey of Queensland, Brisbane.

Record 1977/27

GALILEE BASIN SEISMIC AND GRAVITY SURVEY, QUEENSLAND, 1976

OPERATIONAL REPORT

PENTLAND - HUGHENDEN AREA

by

D.L. Schmidt, A. Nelson*, and W. Anfiloff

*Geological Survey of Queensland, Brisbane.

CONTENTS

SUMMARY

The Bureau of Mineral Resources conducted a seismic and gravity survey from August to December 1976 near the eastern margin of the Galilee Basin to investigate the structure of the northeastern and eastern margins of the basin, and the extent and relations of the older, underlying Drummond and Adavale Basins.

Traverses 1 and 2 were recorded during August and September in the Pentland-Hughenden area. Both were recorded digitally with Texas Instruments DFS IV equipment using 6-fold common depth-point recording techniques.

Geophysical Service International, Sydney, has been contracted to digitally process the data and final interpretation awaits the completion of processing, although preliminary results are available from field records and intermediate stage processing.

These results indicate that thick sediments in the survey area are more extensive than previously thought, particularly along Traverse 2 to the northeast of Hughenden. The petroleum potential of the area may be upgraded on the basis of this. Traverse 1 crossed an anticlinal structure that may be prospective. Knowledge of the distribution and configuration of the Upper Permian coal measures in the Pentland-Hughendenarea has increased as a result of the survey.

INTRODUCTION

The Bureau of Mineral Resources (BMR) recorded four seismic traverses in the eastern Galilee Basin from August to December 1976 to investigate the nature of the basin margin and the relations between the Galilee and older underlying Drummond and Adavale Basins. The investigations will assist the understanding of the geological evolution, regional structure and hydrocarbon prospectivity of the eastern Galilee Basin.

The first two traverses were recorded in the northeastern area of the basin, in the Pentland-Hughenden area, from August to mid-September. The remaining traverses were recorded farther south around the Clermont-Alpha area and are discussed in a separate operational report on that area by Brassil & Anfiloff (1977).

Gravity interpretation of the White Mountains Gravity Gradient associated with the White Mountains structure (Fig. 1) suggests that thick sediments are faulted against Precambrian metamorphics and Ordovician and Silurian granites of the Lolworth-Ravenswood Block (Vine, Jauncey, Casey, & Galloway, 1965). Structural and stratigraphic traps have been proposed at the basin margin in this area (Vine & Paine, 1974, p. 33) and if present would be prospective. Vine & Paine (1974) further suggest a marked thinning or truncation of the Upper Carboniferous or Lower Permian sequence against a possible basement scarp which extends northeast from Hughenden (Fig. 1). The only oil and gas shows in the northeastern Galilee Basin have been in the Koburra Trough (Flinders, 1970; Exoil, 1965) and as the proposed scarp could form the northwest margin of this trough, it may be prospective if present. The proposal was based on gradients in the magnetic field and a thinning of Upper Carboniferous to Permian sediments between Koburra No. 1 well (Flinders, 1970) and the Glenalvon Homestead Bore, 100 km west of Hughenden. The widespread Upper Permian coal measures which crop out along the eastern margin are strong seismic reflectors and can be easily identified in the survey area.

Traverses 1 and 2 were recorded to test these proposals, although Traverse 2 was not part of the initial program. Traverse 1 was recorded from Torrens Creek, the junction of Lines N16 and N12 of the Bowen Downs Seismic Survey (Amerada, 1965) eastwards to near Pentland andonto the granite outcrop. This traverse passed over Geological Survey of Queensland (GSQ) Hughenden 3-4R stratigraphic bore, which intersects Drummond Basin sediments, thereby providing further information on the distribution of Drummond Basin sediments

in the survey area. Traverse 2, recorded northwest of Prairie, extends Line N2 of the Bowen Downs Seismic Survey to tie into GSQ Hughenden 5 stratigraphic bore.

Detailed gravity readings were taken along both traverses to enable combined seismic and gravity modelling.

This report presents details of operations and preliminary results based on field interpretations. Further data processing and detailed analysis of the seismic and gravity data will be required before a final interpretation report is completed.

SEISMIC OPERATIONS

The locations of Traverses 1 and 2 are shown in detail in Figures 2 and 3 respectively. Production statistics are given in Appendix 1, DFS IV equipment settings are listed in Appendix 2, and personnel and survey equipment in Appendix 3.

Traverse 1

Recording on Traverse 1 commenced on 5 August at Torrens Creek and finished on 27 August near Pentland.

The field crew operated from a camp near Warrigal Creek. The traverse followed the Flinders Highway to Burra, 18 km east of Torrens Creek, whence it swung east-southeast to the old highway and then northeast to tie into GSQ Hughenden 3-4R. Surveying began a week ahead of recording, and drilling of shot-holes two days ahead. The 12 km from Burra to the old highway required much bulldozing to clear thick scrub and to cross two deep gravel-filled river gulleys. A local bulldozer and operator were hired for this work. Several corners along the old highway were bulldozed to minimize traverse bends and the most eastern 2 km were bulldozed through moderate scrub. A total of 15 km of the 56.5 km traversed was bulldozed.

Although the thick bush and broken country along sections of the traverse slowed progress, the recording was not delayed by the drills and, likewise, the drills were not delayed by the bulldozing. The seven rig-days lost on Traverse 1 were due to mechanical failures and four of the seven specifically to breakages sustained on the journey from Canberra to the field.

Recording was 24-channel, 6-fold CDP with a 1000 m-0-1000 m double

centre-gap split-spread, and with the shot between traces 12 and 13, initially. Spread configuration was changed for Stations 1456 through 1662 to 1000 m-0-916 2/3 m, single centre-gap shot on trace 12 in order to record an uphole-time as the first break on trace 12. The Input/Output radio firing unit was faulty throughout the survey and gave erroneous uphole times. Stacking diagrams for these two spread configurations are illustrated in Figure 4(a). A station interval of 83 1/3 m was selected after considerations of desired rate of progress, spread cable dimension, and desired multiple-fold coverage of shallow events. Calculations showed that at least single-fold coverage could be maintained on events as shallow as 300 ms two-way travel-time. A fair continuity of coverage was thus expected of the strong reflections from the top of the Permian (P-horizon), the shallowest event of interest, which was adequately covered by single-fold in other surveys in the area. The deeper reflectors required, however, multiple-fold coverage as their quality was generally poor on single-fold records. Six-fold CDP coverage could be maintained on events as shallow as 650 ms two-way travel-time.

After experimenting, a single charge of 30 kg at a depth of 36 m was selected as energy source, with 16 geophones in-line per trace. Hole depths varied from 36 m to 20 m and charge sizes from 30 kg to 16 kg along the traverse. The larger and deeper charges generally coincided with patches of deeper weathering along the traverse.

An expanded spread with a 5 km offset and centred at Station 1068 was recorded to provide velocity information by T^2-X^2 analysis for normal move-out corrections to the data and time-depth conversions.

Equipment settings of the DFS IV are tabulated in Appendix 2. The Geospace 1801 camera broke down after the first day's recording and was eventually sent to Seismic Supply International, Brisbane, for repairs. A broken input plug on the TRO-6 camera caused several intermittent dead and reversed traces on the field records, although not on tape. This fault, however, concealed another equipment fault which intermittently phase - shifted trace 10 roughly 150°. Playbacks of selected oscillator tests by Geophysical Service International (GSI), Sydney confirmed that this phase shift was recorded on tape but it is expected that digital processing will remove the effective static error so produced on trace 10. The cause of this fault was not detected in the field. In addition, the radio firing unit produced an intermittent variable delay of 2 to 8 ms on the time break, but again, it is expected that digital processing will correct the static errors created.

The new 48 conductor-pair spread cables seemed to be of fragile construction and broke at an average rate of one every two days.

Traverse 2

The camp shifted to near Glendower homestead (Fig. 3) on 30 August and recording on Traverse 2 began on 1 September at GSQ Hughenden 5. A detailed location map of Traverse 2 is presented in Figure 3. North of the Flinders River the traverse crossed mainly flat open grasslands except across the foothills of Mount Wongalee where steep-sided gulleys and large basalt boulders impeded progress. The traverse was bulldozed from the north end of the line to the top of the scarp on the south side of the Flinders River, a distance of 17 km. South of the Flinders River the traverse followed the existing dirt road.

Surveying was relatively straightforward over the traverse except for the steep rocky scarp, south of the Flinders River, which slowed operations. Drilling was slow north of the river owing to a hard near-surface clay layer and discontinuous gravel beds.

Recording was 24-channel, 6-fold CDP, initially with spreads of 500 m-0-458 1/3 m in order to detect the expected shallow reflection from the P-horizon at the depth indicated by GSQ Hughenden 5. This reflection was, however, recorded from a greater depth, and from Station 1040 onwards, a spread of 1000 m-0-916 2/3 m was used. Not only did this accelerate production coverage but velocity calculations from moveout are more reliable. Shots were on trace 12 with no centre gap. The stacking diagram in Figure 4(b) illustrates the effect of the spread change. Initial testing set optimum hole depth at 27 m and charge size at 16 kg in a single hole. Geophone patterns started as 2 rows of 8 in-line/trace but were changed to 1 row of 16 in-line from Station 1040 onwards. While hole depth remained constant over the length of the traverse, charge size was reduced to 9 kg after a series of tests and comparisons midway along the traverse. One recording day was lost owing to slow drilling caused by unconsolidated sand and gravel beds near Flinders River. An expanded spread with a 5 km offset was centred at Station 1600 and three uphole shoots were conducted. Other relevant statistics are given in Appendix 1.

GRAVITY OPERATIONS

During the period from 14 October to 22 October, gravity observations were made at every half-kilometre along the seismic traverses. W. Anfiloff made 140 observations along Traverse 1 and D. Schmidt made 90 observations along Traverse 2 using Worden gravity meter W169 (C.F. = 0.10114 mgal/div.).

Traverse 1 was tied to base 6305.0235 which is situated at benchmark 49/35 near Pentland, and Traverse 2 was tied to base 6305.0204, which is situated at benchmark 49/4, on the Hann Highway (Fig. 4). The two traverses were tied together at benchmark 40/48 at Torrens Creek. This common tie allowed the two traverses to be processed as one. The discrepancy between the given interval between the two gravity bases, and the interval measured in the survey is 0.02 mGal. These data are given in Table 1. The results of the survey are given as Figures 5 and 6 in the form of elevation, observed gravity, and Bouguer anomaly profiles for a range of densities between 2.0 and 3.0 t/m^3.

TABLE 1 - Connections to gravity base stations

BASE	OBSERVED GRAVITY (1963)	OBSERVED GRAVITY (1976)	DIFFERENCE (mGal)
6305.0204	978596.08	978596.08	0.00
6305.0235	978603.82	978603.80	0.02

SEISMIC DATA PROCESSING

Refraction interpretation of production shots and uphole shoots was used to determine velocities and configurations of the near-surface low-velocity layers as a basis for static calculations. One major problem was the variable and intermittent delay on the timebreak, as described in the chapter on seismic operations, but it is expected that autostatics will remove the residual statics in the final stages of processing. Traverses 1 and 2 were both corrected to a datum of 400 m with a replacement velocity of 2600 m/s. GSI Sydney have been contracted to digitally process the survey data and have produced a brute stack on both Traverses 1 and 2. Further processing will likely entail further velocity analyses, filter analyses, deconvolution tests, autostatics, and a final stack. The final stacks are expected to be improve-

ments on the brute stacks because of more precise velocity control, auto-statics, and more careful trace editing.

PRELIMINARY RESULTS

Record quality on Traverse 1 is variable but generally poor. A strong reflection from the P-horizon is visible on most field records and a preliminary interpretation (Fig. 7) shows that the P-horizon rises from a depth of 1200 m (0.75 s reflection time) at Torrens Creek to near the surface at GSQ Hughenden 3-4R. Around Station 1226 there is an anticlinal structure that could be faulted. At the east end granite crops out and sediments most likely lap onto the basement as it rises to the margin. The gravity results (Fig. 5), in addition to confirming regional gravity trends, reveal possible basin margin faulting near Station 1520.

Deeper reflections have been identified on the brute stack section and tentatively labelled as Top of Drummond and Basement (Fig. 7). Final interpretation awaits further processing.

Record quality on Traverse 2 is generally better than on Traverse 1 and the P-horizon gradually shallows from a depth of 1100 m (0.7 s reflection time) at the Prairie end to 800 m (0.55 s reflection time) at GSQ Hughenden 5 (Fig. 8). GSQ Hughenden 5 was drilled to 446 m and initially interpreted to penetrate 3 m of Upper Permian rocks. This interpretation has been revised on the basis of this survey (Gray, in prep.). Neither the seismic results nor the gravity results show any evidence for the steep northwest margin of the Koburra Trough that was proposed by Vine & Paine (1974).

The preliminary interpretation along Traverse 2 (Fig. 8) indicates that Drummond Basin sediments extend farther west and north than previously thought. As oil and gas shows have been recorded in the Galilee Basin and pre-Galilee Basin sediments in Lake Galilee No. 1 and Koburra No. 1 wells, a wider distribution of Drummond Basin sediments is significant in upgrading the petroleum potential of the area.

REFERENCES

AMERADA PETROLEUM CORP. LTD, 1965 - Bowen Downs Seismic Survey, ATP 76P, Qld. Bur. Miner. Resour. Aust. Petrol. Search Subs. Acts Rep. 65/11034 (unpubl.).

BRASSIL, F., & ANFILOFF, W., 1977 - Galilee BasinSeismic Survey, Queensland, 1976 Operational Report - Clermont-Alpha area. Bur. Miner. Resour. Aust. Rec. 1977/26 (unpubl.).

EXOIL (N.L.), 1965 - Well completion report, Lake Galilee No. 1, ATP 76P, Qld, by R.L. Pemberton. Bur. Miner. Resour. Aust. Petrol. Search Sub. Acts Rep. 64/4076 (unpubl.).

FLINDERS, 1970 - Well completion report, FPN Koburra No. 1, ATP 76P, Qld, by R.L. Pemberton and J. de Gray Brereton. Bur. Miner. Resour. Aust. Petrol. Search Subs. Acts Rep. 70/453 (unpubl.).

GRAY, A.R.G., in prep. - Stratigraphic drilling in the Hughenden 1:250 000 Sheet area, 1974-75.

VINE, R.R., JAUNCEY, W., CASEY, D.J., & GALLOWAY, M.C., 1965 - Geology of the Longreach-Jericho-Lake Buchanan Area, Qld. Bur. Miner. Resour. Aust. Rec. 1965/245 (unpubl.).

VINE, R.R., & PAINE, A.G.L., 1974 - Hughenden, Qld. - 1:250 000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes SF/55-1.

APPENDIX 1

OPERATIONAL STATISTICS

	Traverse 1	Traverse 2
Sedimentary basin	Galilee Basin	
Camp site	Warrigal Creek	Glendower H.S.
Recording commenced	6 Aug	1 Sept
Recording completed	27 Aug	14 Sept
Length of traverse	56.5 km	35.3 km
Total no. of shots	347	240
no. of production shots	328	217
maximum no. of shots in one day	35	42
Maximum no. of production shots in one day	35	36
No. of recording days	17	10.5
Recording days lost	0	1
Av. no. shots/recording day	20.4	22.9
Av. no. production shots/recording day	19.3	20.9
Av. surface coverage/recording day	3.24 km	3.36 km
Topographic survey control	Dept. Admin. Services Bench marks	
Total no. of metres drilled	9880 m	6013 m
Total no. of rig-days	57	34.5
Total no. of rig-days lost	7	2
Explosives used	6911 kg	2906 kg
Detonators used	616	296
Spread geometry	split	split
Station interval	83 1/3 m	41 2/3 m or 83 1/3 m
Geophone pattern	16 in-line per trace	2 rows of 8 or 16 in-line/tr.
Geophone Spacing	5 m	5 m
Normal hole pattern	single hole	single hole
Average hole depth	30 m	27 m

Shot on trace	Between 12/13 or on 12	on 12
CDP coverage	6-fold	6-fold
Station Range	996-1673	988-1835
Distance bulldozed	15 km	17 km
Record quality	poor-fair	fair

APPENDIX 2

DPS IV INSTRUMENT SETTINGS

Parameter	Setting
Sample rate	2 ms
Record length	6 s (some 10-second records)
Recording filters; hi-cut	124 hz
lo-cut	12 hz
hi-cut slope	72 dB/octave
lo-cut slope	36 dB/octave
Gain constants	36 dB
(Input module)	(effective 42 dB)
Tape format	SEG B 800 b.p.i.
	½" 9 track
	NRZI
Notch filters	in
(centre 50 hz)	

APPENDIX 3

PERSONNEL AND EQUIPMENT

Personnel

Party Leader		J. Pinchin
Geophysicists		J.A. Bauer
		D.L. Schmidt
		P. Petkovic (11.8.76 on)
		A.R. Nelson (GSQ) (25.8.76 on)
Party Clerk		W.E. Gunner
Technical Officers		G.L. Abbs (27.8.76-13.9.76)
		J.K. Grace (4.8.76-3.9.76)
		G.S. Jennings (8.9.76 on)
Field Assistants		R.D.E. Cherry (5.8.76-27.8.76)
		L. Rickardsson
Surveyor	Supplied by Dept. of Admin. Services.	P. Boersma
Surveyor T.O.		I. Kaczerepa (18.8.76 on)
Chairmen		G. Strickland
		G. Paynter
Toolpusher		E.H. Cherry
Drillers		T. Shanahan
		K. Huth
		J. Kearney
Drill Assistants		J. Henry
		J. Mesics
		W. McDermott
Mechanics		T. Johnson
		J. Keyte
Wages Hands		fifteen

Equipment

Recording system	TI DFS IV
Camera	SIE TRO-6
	Geospace 1801 part-time
Geophones	GSC 20D 8 hz, 1280 units
Cables	SCG-5, 265 m, 14 units

Transceivers	Codan, 6924 SSB, 4 units
	Pye Cambridge, FM 100, 6 units
Radio-shooting equipment	I/O R.F.U.

Vehicles

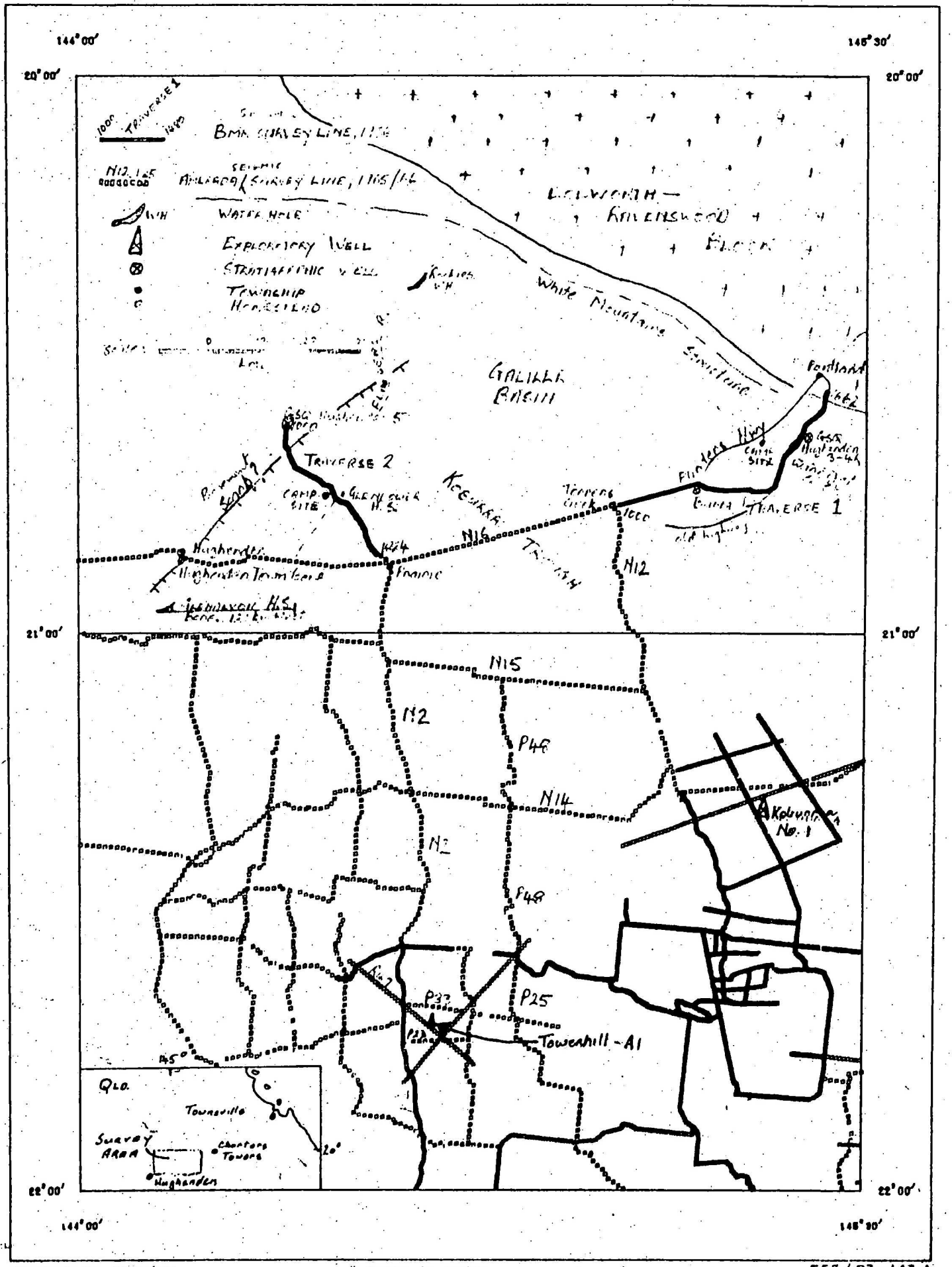
Recording truck	1 x Bedford 3 tonne 4 x 4
Shooting truck	1 x " " " "
Workshop	1 x International D1610 3 tonne 4 x 4
Flat tops	2 x " " " " "
Water tankers	2 x " " " " "
Personnel carriers	1 x Landrover SWB, 1 x Toyota SWB
	1 x Toyota Landcruiser, 1 x Landrover LWB
Geophone carriers	3 x Landrover LWB
Stores truck	1 International D1310 30 cwt 4 x 4
Surveyors' vehicles	2 x Landrover LWB (supplied by Australian Surveying Office)
Drills	3 x Mack 8 x 6; Mayhew 1000
Tankers	3 x AEC Militant 6 x 6

Trailers

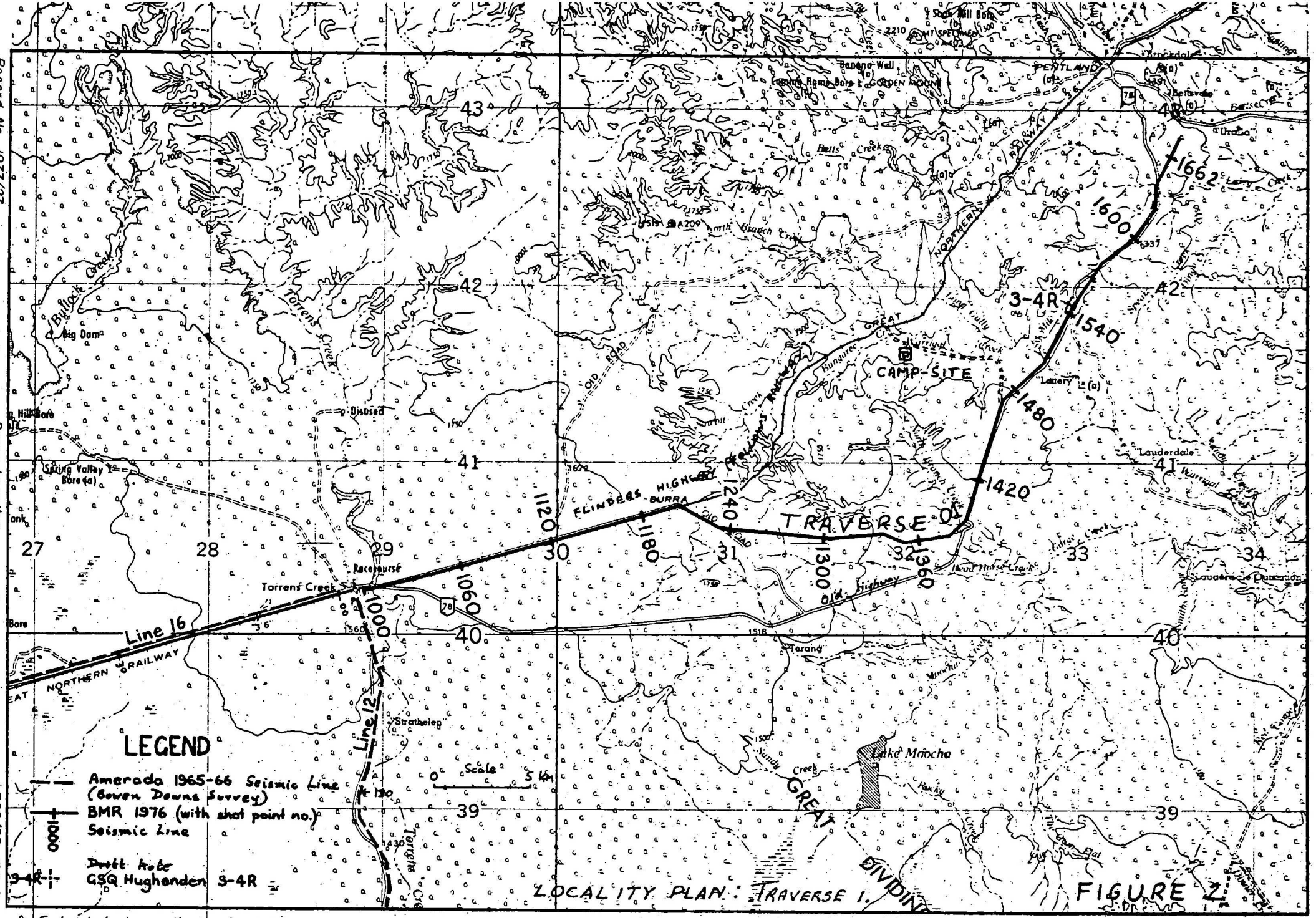
Officer caravan	4-Wheel
Kitchen "	"
Ablutions "	"
Explosive magazine	"
Workshop trailer	"
Stores "	2 x 4 Wheel
Drill	4-Wheel
Generator	2 " (hired from Les Brown Hire Service, Townsville)
Welding Trailer	2 "

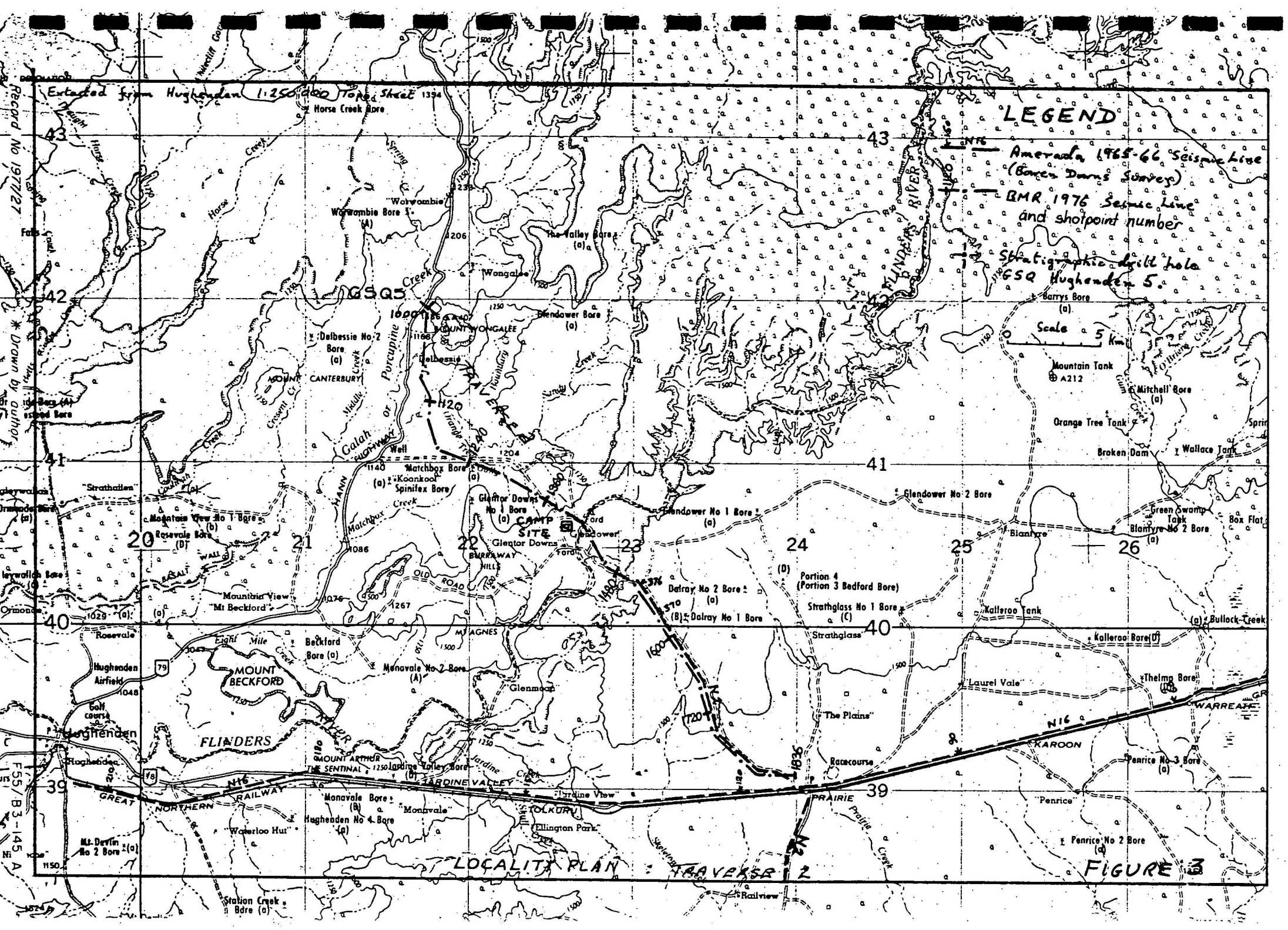
SCALE 1 1000000.

FIGURE 1: LOCATION MAP



Record No. 1977/27 * Drawn by author F55/83-143 A


Record No. 1977/27
Drawn by author
F55/B3-144 A
LEGEND
Amerada 1965-66 Seismic Line (Bowen Downs Survey)
BMR 1976 (with shot point no.) Seismic Line
1000
Drill hole
3-4R
GSQ Hughenden 3-4R
Scale
5 Km
Extracted from Hughenden 1:250 000 topo sheet.
LOCALITY PLAN: TRAVERSE 1.
FIGURE 2.
TRAVERSE 01
CAMP-SITE
FLINDERS HIGHWAY
NORTHERN RAILWAY
GREAT DIVIDING
Line 16
Line 12
Torrens Creek
Strathsleg
Terang
Lake Mooche
Lauderdale
Big Dam
Racecourse
Old Highway
1000
1060
1120
1180
1240
1300
1360
1420
1480
1540
1600
1662


Extracted from Hughenden 1:250 000 Topo Sheet
LEGEND
Amerada 1965-66 Seismic Line (Bowen Downs Survey)
BMR 1976 Seismic Line and shotpoint number
Stratigraphic drill hole GSQ Hughenden 5.
Scale 5 Km
LOCALITY PLAN
TRAVERSE 2
FIGURE 3
Record No 1977/27
Drawn by author
F55/B3-145 A
GSQ5
CAMP SITE
Glentor Downs
Glendower
Dalray No 2 Bore
Dalray No 1 Bore
Portion 4 (Portion 3 Bedford Bore)
Strathglass No 1 Bore
Strathglass
Glendower No 1 Bore
Glendower No 2 Bore
Blantyre
Blantyre No 2 Bore
Mountain View
Mt Beckford
Beckford Bore
Monavale No 2 Bore
Monavale
Monavale Bore
Hughenden No 4 Bore
Hughenden
Hughenden Airfield
MOUNT BECKFORD
MOUNT ARTHUR
THE SENTINAL
MOUNT WONGALEE
MOUNT CANTERBURY
Wongalee
Wolwombie
Wolwombie Bore
Horse Creek Bore
The Valley Bore
Glendower Bore
Dalbessie
Dalbessie No 2 Bore
Matchbox Bore
Koonkool Spinifex Bore
Rosevale
Rosevale Bore
Mountain View No 1 Bore
Mt Devlin No 2 Bore
Waterloo Hut
Station Creek Bore
Jardine Valley Bore
Jardine View
Tolkuru
Ellington Park
Railview
Barrys Bore
Mountain Tank
A212
Mitchell Bore
Orange Tree Tank
Broken Dam
Wallace Tank
Green Swamp Tank
Box Flat
Bullock Creek
Kalleroo Tank
Kalleroo Bore
Laurel Vale
Thelma Bore
The Plains
Racecourse
Penrice
Penrice No 3 Bore
Penrice No 2 Bore
Prairie
Warreah
Karoon
Flinders River
Porcupine Creek
Horse Creek
Eight Mile Creek
Matchbox Creek
Jardine Creek
Prairie Creek
Calah Outstation
Basalt Wall
Old Road
Burraway Hills
Great Northern Railway
N16
79
78
1600
1720
1835

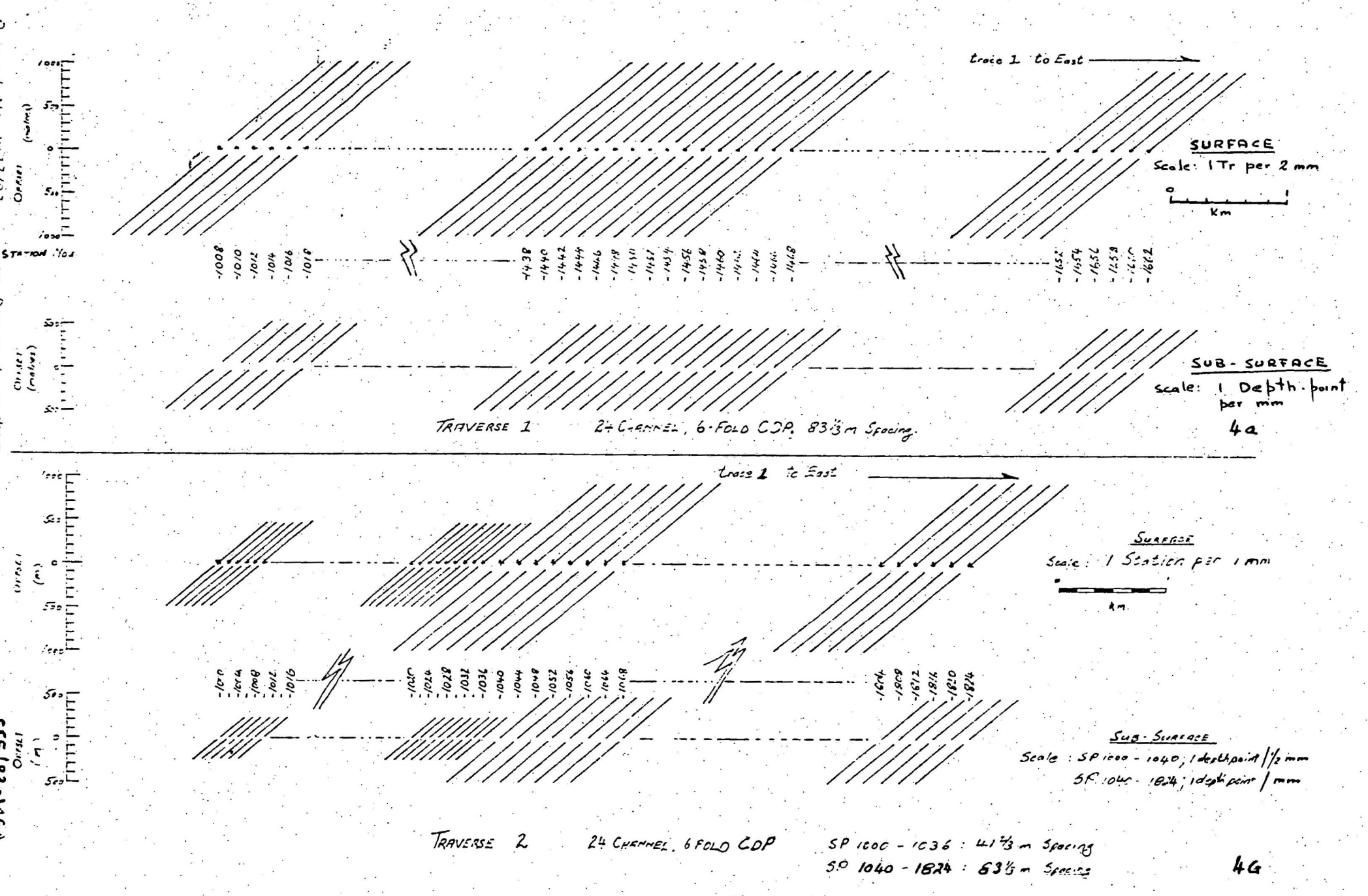
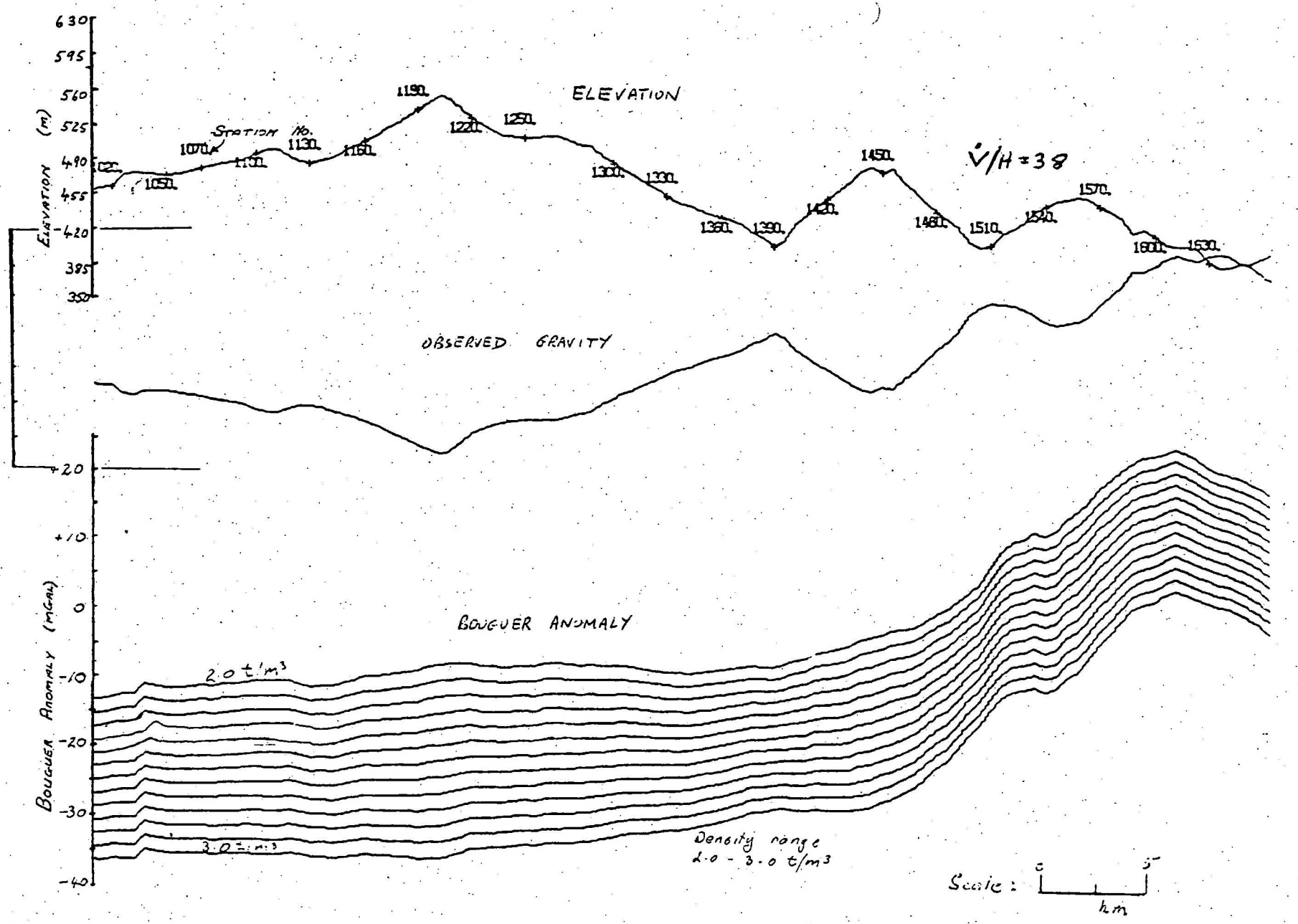


Fig. 4 COP STACKING DIAGRAMS

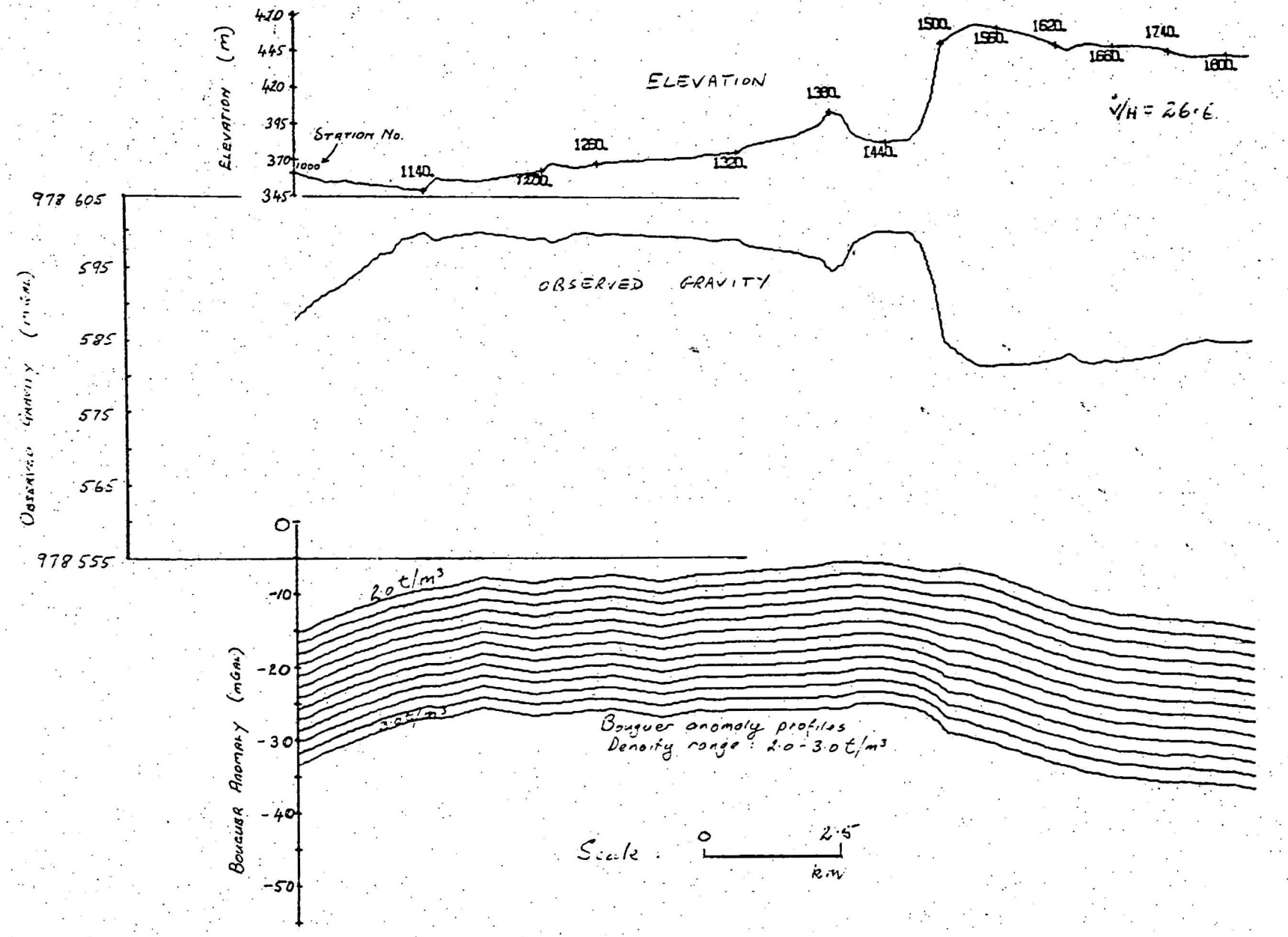


BOUGUER ANOMALY PROFILE : TRAVERSE 1

FIGURE 5.

Record No. 1977/27

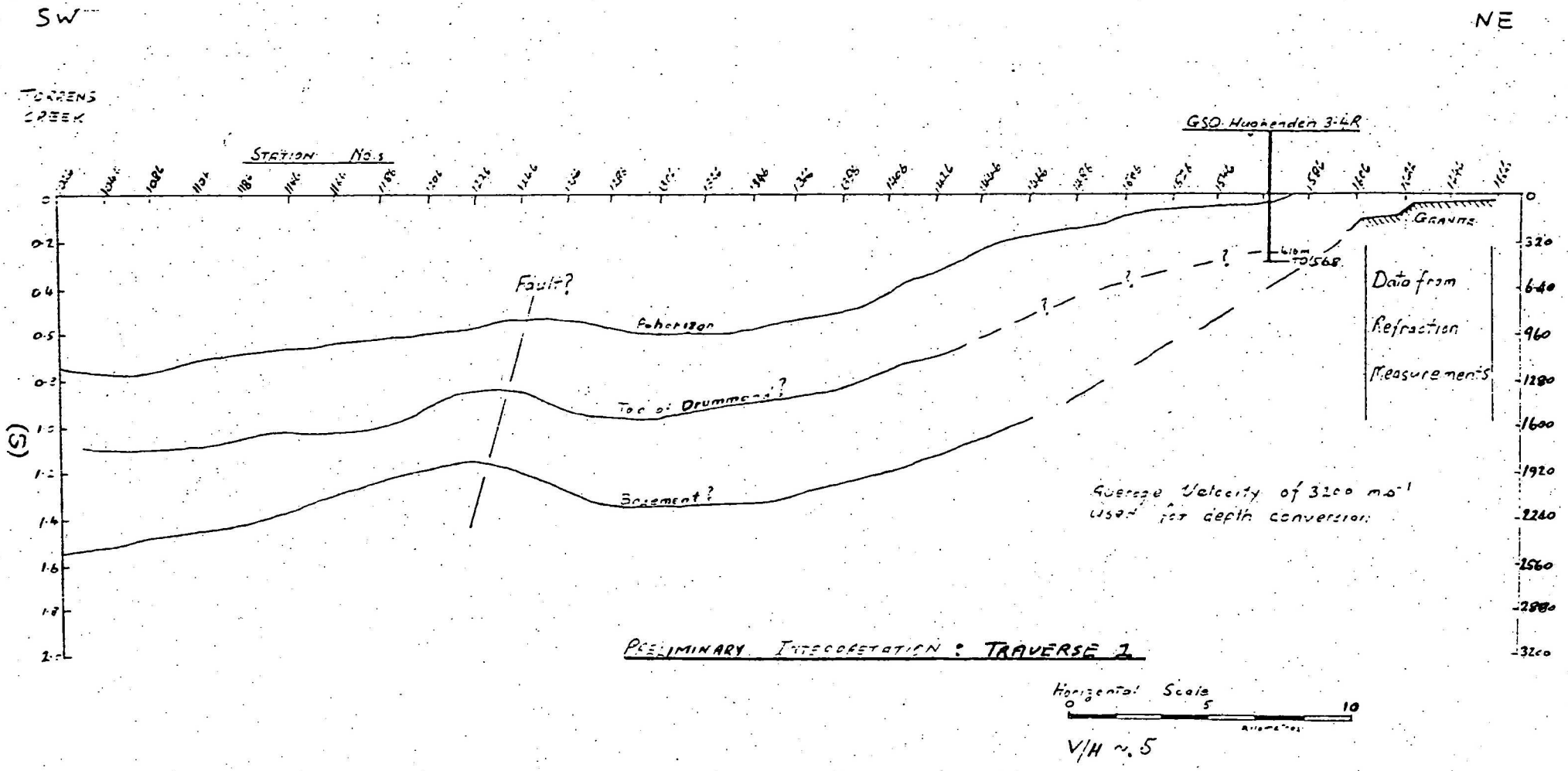
* Drawn by author



BOUGUER ANOMALY PROFILE : TRAVERSE 2

FIGURE 6

F55/B3-148A



Average Velocity of 3200 m.s^{-1} used for depth conversion.

PRELIMINARY INTERPRETATION : TRAVERSE 2

Horizontal Scale
0 5 10
Kilometres

V/H ~ 5

FIGURE 7

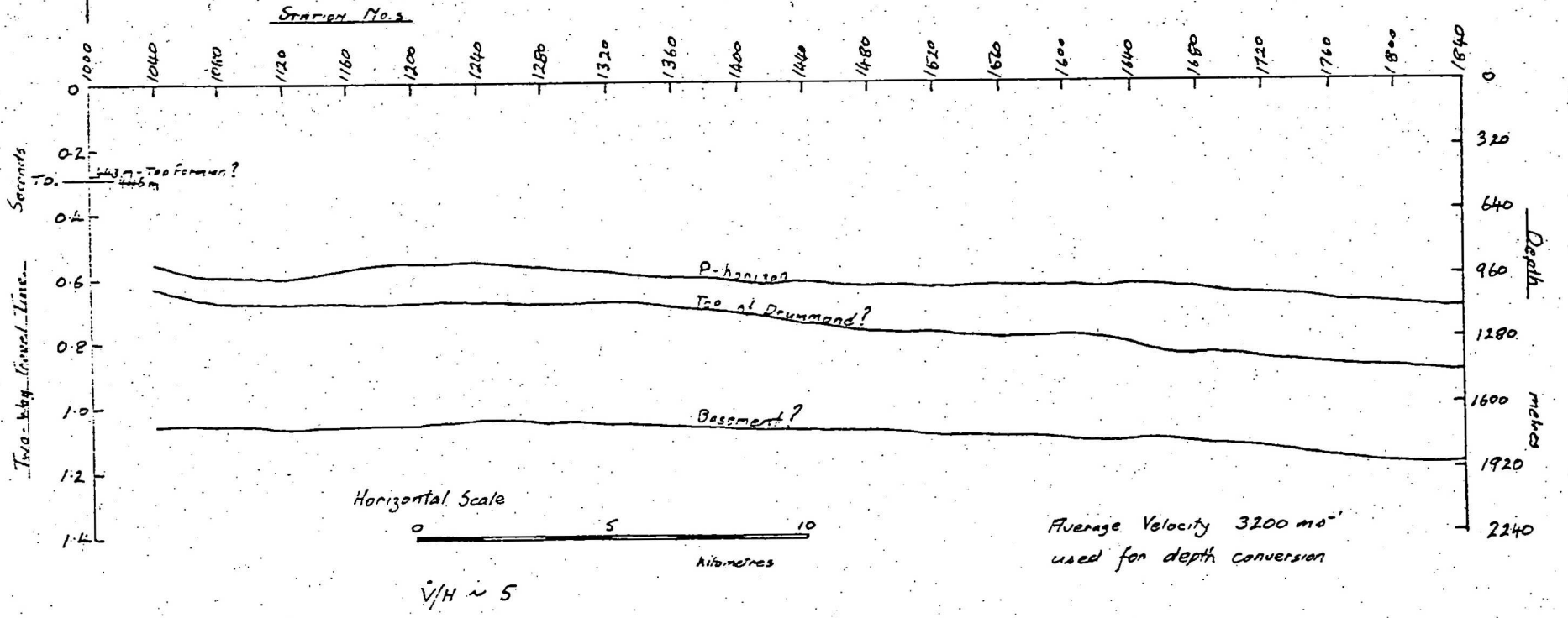
Record No. 1977/27

NW

SE

GSQ Hughenden E

PRAIRIE



V/H ~ 5

PRELIMINARY INTERPRETATION : TRAVERSE 2

FIGURE 8.

*Drawn by author

F55/83-150A