

059001 OFFSHORE 37
PART 1

Bass Basin part XV

" FLINDERS SEISMIC SURVEY "

HEMATITE PETROLEUM PTY. LTD.

7th March, 1974.

OR-015

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SEISMIC SURVEY

1. Bass or J55-14 OG 3185
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Abstract

The Flinders Seismic Survey was shot by G.S.I. for Hematite in the Bass Basin in September and November 1973.

Shooting used an airgun energy source to record 48 traces, 3 x 24 CDP, with a trace interval of 66.67 metres and a shot interval of 22.22 metres for the September shooting, and 48 CDP with a trace interval of 50 metres and shot interval of 25 metres in November. A total of 370 miles was shot, 311 in September and 59 in November. Navigation was by Satellite sonar doppler.

Processing was 24 fold, with either a 3:1 or 2:1 vertical stack and using continuous velocity analysis.

Two horizons were mapped, and six structural leads were detailed. The record quality was improved over previous shooting, but not to the extent expected.

1. General Data

The Flinders Seismic Survey was carried out for the operator, Hematite Petroleum Pty. Ltd., by Geophysical Service International, in the central Bass Basin area, in permits T/3P and T/4P.

The seismic interpretation was undertaken by J.I. Denham, Senior Geophysicist, M. McNicol, Geophysicist, and E. Urschel, Geophysicist, and the section on regional geology was written by J. Smith, Geologist, and B.R. Brown, Senior Geologist.

The survey was shot from 3rd September 1973 to 11th September 1973 and an extension was shot on the 9th and 10th of November 1973. Further details are given in the contractor's reports which appear as Appendices 1, 2 and 3 to this report.

(a) Regional Geology

The Bass Basin occurs wholly on the Continental Shelf of south eastern Australia beneath the waters of Bass Strait. It is located north of Tasmania in the partial enclosure formed by King Island, the coast of Victoria and Flinders Island.

The Bass Basin is a north-west to south-east trending basin lying at the southern end of the Palaeozoic Tasman Geosyncline. Completely folded, intruded and metamorphosed Palaeozoic rocks are seen on the Mornington Peninsula to the north and in Tasmania to the south. Similar Palaeozoic rocks are believed to comprise economic basement in the Bass Basin. The basement extends from shallow depths at the basin edge, in the vicinity of Bass 2 and 3 wells, and is in excess of 12,000 feet in the central part.

The Bass Basin is a Cretaceous-Tertiary basin although it may contain earlier Mesozoic and late Palaeozoic rocks between the relatively undisturbed Cretaceous and Tertiary above and the complex Palaeozoic rocks below.

Basin formation probably commenced in the Cretaceous with major faulting aligned north-west to south-east on the north-east and south-west flanks, accompanied by significant block tilting. During the Palaeocene and Eocene gentle regional downwarping with some faulting was accompanied by widespread swamp conditions under which peat, clay, sand, silt and gravel, comprising the Eastern View Coal Measures, were deposited.

The basement blocks such as the one on which Bass-2 is located had a strong local influence on the sedimentation during this period, the bulk of the sediment being deposited round the flanks of the feature. Occasional thin marine sediments were intercalated with the non-marine rocks during Lower and Mid Eocene time in the Bass-3 area. Sparse microplankton noted in cores from the Bass-1 and Pelican-3 sections also indicate slight marine incursions into the non-marine environment prevailing in the basin.

The deltaic sequence is essentially similar throughout the basin; fewer coals developed in the Bass-3 area and wells nearer to the centre of the basin, Bass-1, Cormorant-1, Poonboon-1 contain a higher proportion of argillaceous material. Relatively rapid facies changes occur laterally within this section in the eastern part of the basin where a coarse sandy facies encountered in the Bass-2 and Durroon-1 may reflect the proximity of a provenance area.

Upper Eocene time saw a change in conditions from dominantly continental to restricted marine. Siltstone and mudstone of the Demons Bluff Formation overlie the deltaic complex over most of the basin.

During the Palaeocene/Eocene period of active basin subsidence the depositional units pinched out along the flanks. The adjustment faults mapped in the basal Tertiary sections die out in the younger beds; Oligocene time saw the framework of the basin become more stabilised and although maximum deposition continued within the original confines of the basin, later units spread beyond the basin margin and truncate and overlap older beds.

The predominantly argillaceous sediments of the Oligocene Jan Juc Formation were deposited in a more open marine environment.

The remainder of the section is represented by argillaceous siltstone, mudstone and shale with localized dolomite bands; minor sands thicken in an easterly direction. Mixed fossil assemblages occurring spasmodically in the sediments indicate a continuance of periodic inundations from the open seas to the west into the generally more restricted environment prevailing in the east.

Tuffite cones of Upper Oligocene and Lower Miocene age in the northern half, Bass-1 area, and the south western part of the basin indicate tectonic activity during this period.

In mid and Upper Miocene times a carbonate facies replaced the marls, shales and calcareous mudstones of lower Miocene age. Significant quartzose sands encountered in the calcarenite of the Bass-2 and Durroon-1 sections again reflect the proximity of southerly and easterly provenance.

(b) Previous Geophysical Work

Following preliminary aeromagnetic surveys, the Bass Basin was covered by the Bass Strait Seismic Survey in 1962/63 by Hematite, and subsequently there were six subsidized surveys shot by Esso from 1965 to 1969. Unsubsidised work has also been carried out. Until 1967 the surveys used a dynamite energy source and up to sixfold coverage. In 1968 and 1969 "Aquapulse" was used with up to 48 fold cover, processed 12 fold and since then airguns have been used, shot 24 fold, increasing to 48 fold in 1972. Also in 1972 the cable length was increased from 2400 to 3200 metres, and 48 traces were processed instead of 24. In 1971 the airgun array capacity was increased from 860 to 1300 cubic inches.

Even the earliest work gave quite good results down to the upper part of the Eastern View Coal Measures, but it was not until 1972 that even poor results were obtained below this level.

The area of the survey has reconnaissance lines from 1963, extended to a grid averaging about 5 miles spacing in 1970 and 1971. Several lines from 1967-1968 detailing anomalies extend into the area, as do several 1972 lines.

(c) Survey Objectives

The objective of the survey was to provide a closer coverage of high grade data to enable mapping of possible deep structures, and to detail the leads "Aroo", "Jerra Jerra", "Toolka", "Kalperri", "Paipan" and an anomalous area west of Cormorant-1.

3. Methods Used

(a) Shooting

Noise limits for the entire survey were set at a maximum of 2 μ bar averaged over 5 sec. which is more stringent than is normally specified in the Bass Strait, in an attempt to record deep reflections. A 3200 metre cable was originally used with a shot interval of 22.2 metres to give 3 x 24 fold data. The short shot interval was used to increase energy input to enhance deep data.

For the extension a 2400 metre cable with a shot interval of 25 metres to give 48 fold data was used, as this cable was on the boat at the time, and it was not considered necessary to change the cable for the 59 miles as the deep data was not the primary aim in this area.

Three sonobuoy refraction probes were attempted, on Lines HB73A-135, 137 and 143. On Lines HB73A-135 and 143 the first buoy used caught on the streamer and stopped transmitting and a second one was used. However, in both cases results were poor, and no high velocity arrivals were recorded. On Line 137, the maximum offset recorded was about 26,300 feet, and a refractor of about 12,000 ft/sec was recorded as a second arrival.

Navigation was by G.S.I. Geonav satellite/sonar doppler system, which was satisfactory in the Portland-King Island Survey in 1972.

(b) Processing

(i) Reflection

Details of processing are shown in the contractor's report (Appendix 2).

Processing methods largely followed the methods used by Esso in the 1972 survey, but several changes were made. The bulk of the survey (3200 m. streamer) used a 3:1 vertical stack to give 24 fold data, as Esso had in 1972 shown that there was no noticeable difference between data processed 48 fold and the same data with a 2:1 stack and processed 24 fold except for very shallow reflections. The lines shot with a 2400 m. streamer had a 2:1 vertical stack to give 24 fold data.

The continuous velocity analysis was used to give control over velocity variations and to ensure optimum stack. Previous experience showed that using alternate depth points gave adequate results in this area.

The data with a 3:1 mix showed a marked noise problem, which is referred to on page 18 of the Appendix 2. It was found that this could be overcome by a small (15%) two-way mix of adjacent traces.

A major change from previous processing methods is that no time variant scaling or trace normalisation was used.

One line, HB73A-143 was migrated, to assist in interpreting the deep structure in the Aroo area.

(ii) Refraction

The refraction records were processed to enhance high velocity refractors and simplify interpretation by producing double delay time displays with a 3:1 trace sum. Velocities used were 12,000 ft/sec and 18,000 ft/sec.

(c) Interpretation

(i) Reflection

The methods of interpretation used varied slightly across the area, but followed the general outline given below.

In using velocity data for a depth interpretation there is the problem that the reflection times are much more accurate than velocity data, so that it is desirable to smooth the velocity data, or average it over a number of shotpoints. Since the velocity is known to vary with depth, this cannot be done directly. However, the variation with depth can be predicted, at least approximately, and can be allowed for by subtracting from the velocity value for each reflection given by the velocity analysis the velocity value from a "standard" velocity function, in this case that from the well survey at Cormorant No. 1 extrapolated to 5 sec., to give a residual referred to as a "velocity anomaly" (this is done in terms of R.M.S. velocity). The velocity anomaly may then be smoothed, and this was done using a nine point weighted running average along each line. To avoid the effects of widely varying points, each point making up an average was tested for deviation against the average, and if it exceeded a specified maximum deviation it was excluded and the average recalculated.

This gave a smoothed velocity anomaly, which was then added to the velocity from the standard function to give a smoothed R.M.S. velocity. Sufficient horizons were picked above those mapped to give a reasonable approximation to average velocity by calculating interval velocities and thicknesses, which were summed to give depth.

The velocity anomaly for each horizon was generally mapped both to give a picture of velocity variations and to enable average velocities to be found for older data which did not have continuous velocity control. In a few cases average velocity was mapped instead.

Despite the smoothing of velocities mentioned above, it was frequently necessary to edit the velocities manually and to repick the velocity analyses, particularly at and near line ties. No correction to R.M.S. velocity was made for dip.

No "onset correction" correction was made, so that where a map horizon can be identified with a geological horizon the map values will be deep by about 100 feet.

(ii) Refraction

Refraction interpretation was carried out only for Line HB73A-137 as this was the only profile which recorded a high velocity refractor.

The delay time method was used (refer Gardner, L.W., Seismic Refraction Prospecting, S.E.G., 1967) with modifications to use data from the reflection shooting on the same line. The velocity distribution of the overburden was derived from the reflection velocity analyses. Depths and offsets were calculated using the assumed refractor velocity of 12,000 ft/sec, and then this velocity was corrected using the dip shown from the reflection profile, and recalculated after correcting the delay times for the difference in velocity. Delay times were partitioned between shot and detector using the reflection record dip.

The results are presented in tabular form and as a profile plotted against the reflection depth section for the same line. The refractor appears to be the top Eastern View Coal Measures, but the irregularities are probably not real, being due to the later arrival event interpreted being distorted by the crossing of lower velocity events. The correction back to first break was an arbitrary .050 sec.

4. Interpretation(i) General

Two horizons were generally mapped, the shallower one being the "Yellow Horizon". This is a marker throughout the area, and, although weak has a distinctive character and little trouble was encountered in tying loops. The horizon correlates with the top of the "Eastern View Coal Measures".

The second "Red Horizon" is a marker within the coaly section of the "Eastern View Coal Measures" but its character varies, often quite rapidly. Despite this it is relatively easy to map, and misties on loops are usually easily resolved. It is the deepest regional event which can be confidently mapped.

The "Blue Horizon", which was mapped in the "Aroo" area, is the deepest event which could be mapped over the lead. Its stratigraphical position is uncertain.

(ii) Toolka

The survey over the Toolka area was intended to provide closer control over a known structural lead, and in particular to determine the extent to the Northwest of the feature.

Record quality was very good, and the effects of velocity changes on structure were slight. Maps of the area on "Red" (plate IV) and "Yellow" (plate III) horizons are enclosed. The "Yellow horizon" shows a closed structure, but with the southern part of it distorted by a presumed volcanic body mapped at the level of the "Yellow horizon."

The "Red horizon" map shows a similar structure, but with less closure, as a result of the increase with depth of the regional southeast dip. Some minor faulting is apparent at this level.

(iii) Aroo

Previous work gave an indication of structure at depth in the Aroo area. Lines HB73A-147 and 142 were designed to test closure to the southwest and the two cross lines HB73A-145 and 144 were to provide closer control over gaps in the older grid of lines.

Record quality was good over the area. An auto-migrated section was made for line HB73A-143, and this assisted in interpretation. As mentioned above the refraction probe was not successful.

The survey established that closure existed at the depth of "Blue horizon" (plate V). To the northeast beyond a northwest-southwest fault there are four small isolated highs which are mainly fault controlled. The structure is not dependent on faulting or lateral changes in velocity for closure. The culmination on the "Red" and "Yellow horizons" are offset to the north of the deeper closure mapped on the "Blue horizon." There are no faults in the immediate area of Aroo at the "Red" and "Yellow horizons" and velocity anomaly gradients are reasonably gentle.

(iv) Kalperri

The survey over the Kalperri feature was designed to investigate the reversal on Line B72A-93 which gave closure and to tie into the new lines over the Aroo prospect to the northeast.

Record quality was not as good as at Aroo, and deep reflections could only be seen in a few areas. Closure at both the "Red" and "Yellow horizons" (plates) was found to exist close to the intersection of Lines HB73A-153, 155 and 87.

At the "Red horizon" there is a broad closure which is independent of faulting and lateral velocity changes for closure. The "Yellow horizon" displays a sharp structure elongated northwest-southeast.

(v) Jerra Jerra

The survey over this area was intended to investigate a small fault controlled closure previously mapped, the three short lines filling gaps in the existing grid.

Record quality was good, but deep reflections were not recorded.

The structure previously mapped was confirmed at the "Red horizon" level, but is a nose on the "Yellow horizon."

(vi) Paipan

The eleven short lines of the extension were shot over a known lead, in an area where the records are greatly affected by irregular volcanic bodies in the upper section. The programme was not planned to attempt to avoid the worst of these.

The record quality was much improved over previous work, but the volcanic core like bodies remain a major problem. The problem is to accurately allow for velocity effects rather than one of picking the records. The close line spacing helped the interpretation.

The velocity analyses are affected by the irregular volcanics in the upper section, and much editing of the velocities was needed.

A closed structure was mapped at both levels, the size and amount of closure increasing with depth.

(vii) Other areas

The four lines shot in the area west of Cormorant 1 were intended to investigate a terrace previously mapped in an area of relatively open coverage.

Record quality is good, and although deep reflections are absent, this is probably due to relatively shallow basement. A feature of the area is a number of discontinuous, very high amplitude reflections within the "Eastern View Coal Measures. These are thought to be from igneous intrusive sills based on our knowledge of the regional geology and the character of the reflection events.

At the "Red horizon" level dip reversals on HB73A-159 and B72A-92 give a closure controlled by a northwest-southeast fault. The closure does not extend up to the "Yellow horizon" which only show regional southeast dip.

The six lines (HB73A-125, 126, 135-138) were intended to map the deeper section. The results of the survey provided evidence of only occasional dip segments below the coaly section. Down to the coaly section the record quality was very good. The principal cause of the failure to get deep data probably relates to the thick coaly section which reflects most of the incident energy as some of our unpublished theoretical studies have shown.

The "Red horizon" map shows several reversals and the "Yellow horizon" is similar but with subdued relief.

The one moderately successful sonobuoy refraction probe was on Line HB73A-137, and the interpretation is given below. Another probe on HB73A-135 was not successful. The refractor mapped is the top Eastern View Coal Measures.

Refraction Interpretation

X = Offset

H = depth to refractor

hi = thickness of overburden with velocity Vi

Vr = refractor velocity

$$\beta_i = \frac{h_i}{H}$$

H = t R

$$R = \left[\sum \frac{\beta_i \cos \sin^{-1} \left(\frac{V_i}{V_r} \right)}{V_i} \right]^{-1}$$

$$X = H \left[\sum \beta_i \tan \sin^{-1} \left(\frac{V_i}{V_r} \right) \right] = H.S.$$

For Shot point 14682, hi, H, Vi from reflection data.

Refractor velocity = 11,810 Ft/sec

hi	$\beta_i = \frac{h_i}{H}$	Vi	$\frac{\beta_i}{V_i} \sqrt{1 - \left(\frac{V_i}{V_r} \right)^2}$	$\beta_i \sqrt{\frac{V_i^2}{V_r^2 - V_i^2}}$
286	•03883	4900	•0000072	•017706
2071	•28119	6644	•0000349	•191134
2176	•29545	8371	•0000248	•29687
1636	•22213	9349	•0000145	•37285
1195	•16225	9145	•0000112	•24298
<u>H = 7365</u>			<u>$\Sigma = \cdot 0000926$</u>	<u>$S = \Sigma = 1 \cdot 121746$</u>

$$R = \Sigma^{-1} 10,797$$

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SONOBUOY REFRACTION INTERPRETATION

Line HB73A - 137

Dist.	SP	TA 12,000 1/sec	T .0005 ms/ft	T 11,810 1/sec	T - = 50	t ts=.561 T-ts-	H R=10,797.9 t . R	X S=1.12174 H . S	SP Offset
<hr/>									
26301	14862								
26086	14859	1.335	136	1.199	1.149	.588	6349	7122	14760
25781	14856	1.331	135	1.196	1.146	.585	6317	7086	14758
25655	14853	1.328	134	1.194	1.144	.583	6295	7061	14755
25440	14850	1.322	133	1.189	1.139	.578	6241	7001	14753
25225	14847	1.320	132	1.188	1.138	.577	6230	6988	14750
25009	14844	1.319	131	1.188	1.138	.577	6230	6988	14747
24794	14841	1.315	130	1.185	1.135	.574	6198	6953	14744
24579	14838	1.315	129	1.186	1.136	.575	6209	6965	14741
24364	14835	1.311	128	1.183	1.133	.572	6176	6928	14739
24148	14832	1.310	127	1.183	1.133	.572	6176	6928	14736
23933	14829	1.304	125	1.179	1.129	.568	6133	6880	14733
23718	14826	1.300	124	1.176	1.126	.565	6101	6844	14731
23502	14823	1.300	123	1.177	1.127	.566	6112	6856	14728
23287	14820	1.293	122	1.171	1.121	.560	6047	6783	14726
23072	14817	1.291	121	1.170	1.120	.559	6036	6771	14723
22856	14814	1.291	120	1.171	1.121	.560	6047	6783	14720
22642	14811	1.291	119	1.172	1.122	.561	6058	6796	14717
22426	14808	1.290	118	1.172	1.122	.561	6058	6796	14714
22210	14805	1.288	116	1.172	1.122	.561	6058	6796	14711
21995	14802	1.288	115	1.173	1.123	.562	6068	6807	14707
21780	14799	1.285	114	1.171	1.121	.560	6047	6783	14705
21564	14796	1.282	113	1.169	1.119	.558	6025	6758	14702
21350	14793	1.281	112	1.169	1.119	.558	6025	6758	14699
21134	14790	1.281	111	1.170	1.120	.559	6036	6771	14696
20919	14787	1.279	110	1.169	1.119	.558	6025	6758	14693
20707	14784	1.278	109	1.169	1.119	.558	6025	6758	14690
20495	14781	1.280	107	1.173	1.123	.562	6068	6807	14686
20283	14778	1.285	106	1.179	1.129	.558	6025	6758	14684
20071	14775	1.280	105	1.175	1.125	.564	6090	6831	14680
19859	14772	1.278	104	1.174	1.124	.563	6079	6819	14677
19647	14769	1.277	103	1.174	1.124	.563	6079	6819	14674
19435	14766	1.276	102	1.174	1.124	.563	6079	6819	14671
19223	14763	1.270	101	1.169	1.119	.558	6025	6758	14669
19011	14760	1.270	100	1.170	1.120	.559	6036	6772	14666
18799	14757	1.270	99	1.171	1.121	.560	6047	6783	14663
18587	14754	1.270	97	1.173	1.123	.562	6068	6807	14659
18375	14751	1.270	96	1.174	1.124	.563	6079	6819	14656
17904	14748	1.270	94	1.176	1.126	.565	6101	6844	14653

Fig. 2

14808

14772

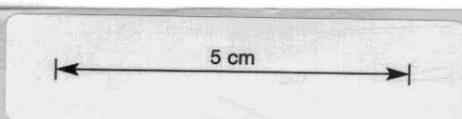
14736

14700

14664

14628

059016



0 Depth ft.

Refraction Profile
HB73A-137

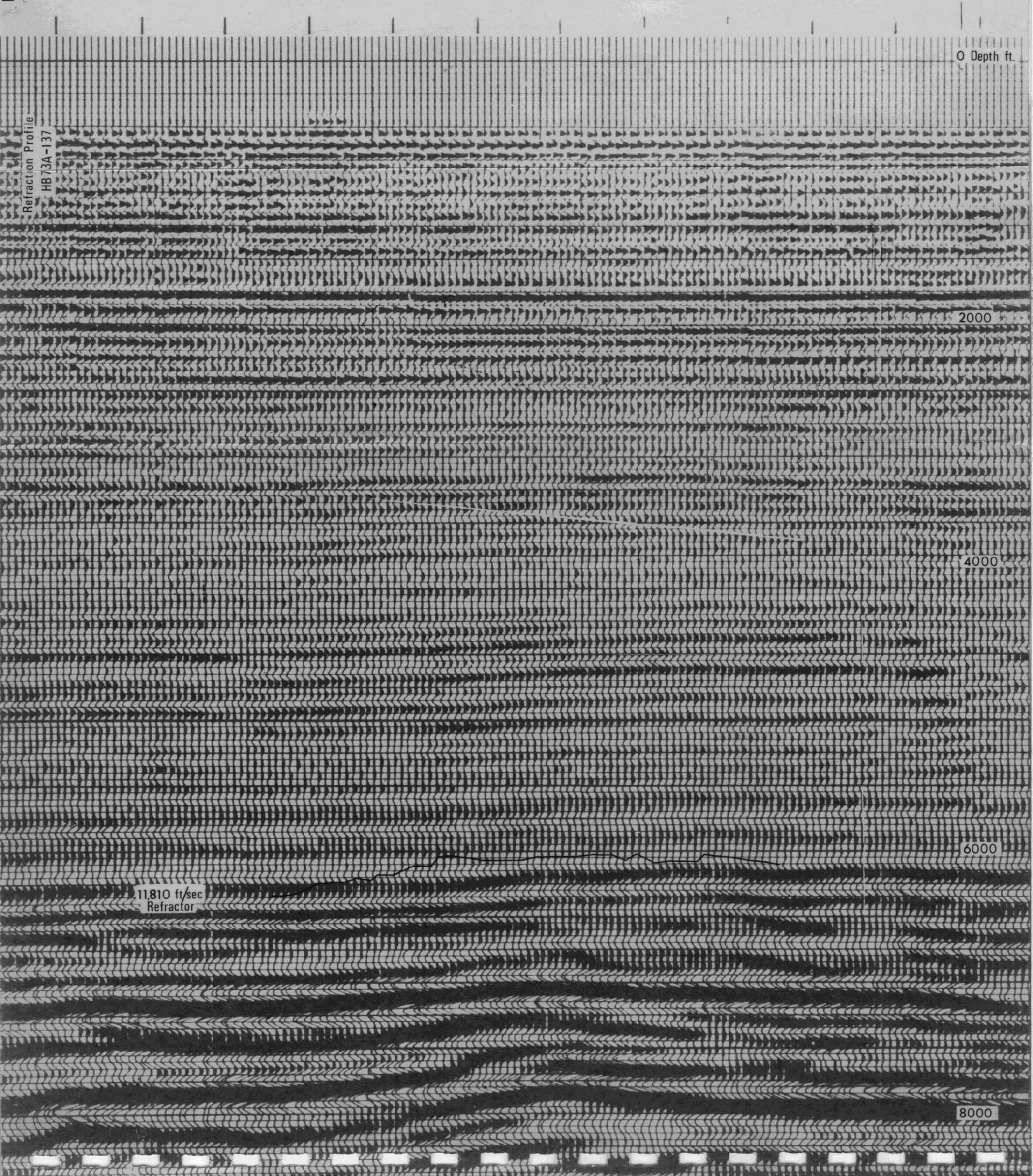
2000

4000

6000

11,810 ft/sec
Refractor

8000



5. Conclusions

We employed the most advanced shooting and processing techniques on this survey in order to obtain deep data in areas where only fragmentary data had been previously acquired. In spite of this only fragmentary deep data was obtained as the desired improvement in deep reflections was not attainable with the methods used.

Further improvements in record quality probably depend on improvements in equipment, especially the foreshadowed increase from 48 to 96 channel recording. Decreasing the shot interval further is not practical, and it is not considered practical to further reduce the maximum noise level. There are no immediate prospects of significant improvements in energy sources.

The deep reflections were generally best where their dip is different to that of the multiples from the coaly section, and this indicates that best results should be obtainable from dip lines.

An unexpected problem was the noise resulting from the constant offset vertical stack, but this was effectively overcome by the mix.

The objectives of mapping known leads were successful, the programmed lines being sufficient to define these in all cases. The area covered west of Cormorant No. 1 disclosed leads which may need further evaluation.

APPENDIX 1

OPERATIONS REPORT



OPERATIONS REPORT

FLINDERS SEISMIC SURVEY

For

HEMATITE PETROLEUM PROPRIETARY LIMITED
G.P.O. BOX 86A, MELBOURNE. VIC. 3001

Client Representative : Mr. E. Urschel

By

GEOPHYSICAL SERVICE INTERNATIONAL
P.O. BOX 437, CROWS NEST. N.S.W. 2065

Party 931 : M.V. "Eugene McDermott II"
Operations Supervisor : G. Shilliday
Quality Control Seismologists : J. Butler, B. Nelson

SEPTEMBER/NOVEMBER, 1973



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SECTION I

INTRODUCTION

A marine seismic reflection survey was conducted by the M.V. "Eugene McDermott II" in the Bass Strait for Hematite Petroleum Proprietary Limited between 3rd September and 11th September, 1973 and 9th to 10th November, 1973.

Approximately 500 kilometres of 72-fold reflection coverage were shot during September using a 3200 metre streamer and 95.4 kilometres of 48-fold reflection during November utilizing a 2400 metre streamer. These streamers were used under continuous tow in conjunction with a Pneumatic Acoustic Energy Source (Airguns), generally operating 24 hours per day.

Recordings were made using two sets of 24 trace DFS III's, with 3 tape transports recording on 1" magnetic tape in 21 track TIAC* Binary Gain Digital Format. The record length was 5 seconds and the sample rate was 4 milliseconds.

The ship's location was determined by Geonav II*.

* Trademark of Texas Instruments Inc.



SECTION II

OPERATION PROCEDURES

A. RECORDING :

A Texas Instruments Digital Field System III (DFS III) with 3 tape transports was used for all recording. A Servo-Writer Profiler was utilized to obtain 100% (Near Trace Gather) subsurface coverage (uncorrected section) of 5, 6 and 10 seconds duration, directly from monitor recording, up to Line HB-73A-158.

Direct Read After Write (RAW) monitors were generated approximately every 20 shotpoints for quality control purposes during September and every 1.5 shotpoints during November.

B. STREAMER :

The 3200 metre, neutrally buoyant, continuous tow streamer consisted of 48 live sections each 50 metres in length; 47 dead sections each 16.67 metres in length and 5 Waterbreak/Depth Transducer sections each 1.52 metres in length, placed immediately in front of group 48 and between groups 30 dead and 30 live, 20 dead and 20 live, 10 dead and 10 live, 2 dead and 2 live.



The 2400 metre streamer used during November consisted of 48 live sections and 6 Waterbreak/Depth Transducer sections located in front of group 48 and between groups 40 and 41, 30 and 31, 20 and 21, 10 and 11, 3 and 4.

Five nylon stretch sections were placed between group 48 and the recording vessel to attenuate ship generated noise during the September recording; seven stretch sections were in use during the extension programme. Eight Condep** cable depth controllers were placed between the depth transducers on the streamer at the centre of dead groups 47, 40, 34, 28, 22, 16, 10 and 3 where the hydrophone spacing is the greatest during the September period. Four Condeps** were employed during November on the dead sections of groups 3, 10, 20 and 30.

Three nylon stretch sections followed group 1 in September and four during November; they were joined to the tailbuoy by 122 metres of nylon rope. Tail-buoy bearings were taken by radar when weather conditions permitted to ensure that maximum feathering angle was not exceeded.

The average streamer depth was 18.29 metres during September and 16.76 metres during November.

** Trademark of Continental Oil Company



C. ENERGY SOURCE (AIRGUNS) :

An Electro-Pneumatic Acoustic Energy Source known as "Airguns" was used for all reflection work.

The airgun has basically two moving parts, the shuttle and the solenoid. Compressed air is supplied to this unit at a pressure of 13,780 Kilopascals. The shuttle is forced to close on initial application of pressure. Compressed air fills the reservoir chamber through a central orifice in the shuttle. To discharge the gun an electrical current activates the solenoid and retracts a plunger, thus enabling compressed air to pass through a port hole to the underside of a flange at the top of the shuttle. The pressure difference above and below the shuttle then thrusts it open. The air from the chamber then escapes through four port holes near the centre of the gun and expands rapidly through the water, producing a single bubble and resultant shock wave. The air bubble collapses in a manner similar to that caused by explosives with one notable exception in that its period is controllable and is placed in the desired seismic frequency band.

There are three variables used to control the frequency content of the shock waves. These are:-

- (i) depth of the airgun in the water,
- (ii) pressure at which the gun is operated,
- and
- (iii) size of the chambers used on the gun.



Using different guns of various chamber sizes broadens and flattens the frequency spectrum of the pulse (Plate 3).

The depth of the airguns was 11 metres and they were operated at a pressure of 13,780 Kilopascals with the pressure never falling below 12,746.5 Kilopascals. The individual airguns were arranged to produce a 19.665 litre array. This array consisted of :

- (i) 1 x 3.933 litres (3 x 1.311 litre guns separate)
1 x 3.278 litres (2 x 1.639 litre guns separate)
 - (ii) 2 x 1.639 litre guns.
2 x 1.311 litre guns.
 - (iii) 6 x 0.655 litre guns.
 - (iv) 6 x 0.328 litre guns.
 - (v) 4 x 0.164 litre guns.
- 10.489 litres Spare

These arrays were arranged and spaced so as to operate as a tuned array which yields a flat frequency spectrum. (Plate 3.)



The time co-ordinator unit triggered the Digital Field System which in turn discharged the Texas Instruments Airgun Control Unit (Blaster), causing a current to flow simultaneously through all solenoids, resulting in the guns firing. The guns were fired every 22.22 metres giving 72-fold coverage during the September work and 25 metres giving 48-fold coverage during November. The airgun array was mounted on two Gun Strings, one port astern and the other starboard astern and towed behind the recording vessel at a distance of 27.4 metres from the stern to the centre of the array.

D. INSTRUMENT AND NOISE TESTS :

Instrument tests were carried out prior to each day's operations and the results were examined in an analogue form in the field. These tests consisted of Dynamic Range Determination, Amplifier Noise Test and Automatic Gain Control (AGC) Test. Frequent checks on tape speed and skew were made.

A set of monthly tests were carried out prior to commencement of operations. These tests included Harmonic Distortion, Gain Linearity, Periodic Calibration checks, skew checks and the above-mentioned tests.

The tests were analysed in the Sydney, Australia, Processing Centre using TIAC routines.



A streamer noise analysis was made at the beginning of each line shot. Some of these tests were recorded on tape.

E. FATHOMETER :

A Ross, Model 400A, fathometer and an Elac Deneb, Model LAZ-17DDL, AGN8 fathometer were used.

The Ross fathometer operated at 50 KHz and the Elac fathometer at 15-20 KHz. Each fathogram was identified by line number, direction shot, time and date of first shotpoints and scale. The fathograms were marked every 12 'pops' and labelled every 50 'pops' during September and marked every 40 'pops' and labelled every 40 'pops' during November. The zero line for the fathograms was not corrected for the ship's draught.

F. REFRACTION SURVEY :

Some refraction recording was performed during September and was obtained with the use of six Teleseis STR-70-2F Sonobuoys and an Aquatronics Sonobuoy receiver. When these were in operation, the data was displayed on the Servo-Profiler unit set with filters 18 and 66 out and recorded via waterbreak channel 5 onto tape channel 27.



G. SURVEY :

The positioning system used was Geonav II, a wholly integrated Satellite and Sonar Doppler navigation system owned and operated by Texas Instruments Incorporated. A separate report has been prepared.

H. PERMITTING :

The necessary permits were obtained by Hematite Petroleum. The Marine Operations Centre, Canberra, was advised as to the ship's location throughout the survey to enable the necessary navigation warning to mariners to be issued.

059030



APPENDICES



APPENDIX A

KEY PERSONNEL

	<u>September</u>	<u>November</u>
Supervisor	G. Shilliday	G. Shilliday
Party Manager(s)	J. McGrath M. McLean	J. McGrath
Administrator	W. Pettigrew	M. McLean
Quality Control Seismologists	J. Butler B. Nelson	J. Butler B. Nelson
Instrument Engineer	S. Clutter	S. Clutter
Observer(s)	B. Lyon T. Morgan	T. Morgan
Instrument Engineer Trainees	S. Griffin K. Karlson	A. Bagley K. Karlson
Airgun Mechanics	P. Reichle S. Martin L. Campbell R. Howell	P. Reichle S. Martin L. Campbell R. Howell
Captain	M. Gustersen	I. Jones
Geonav Operators	J. Jesske M. Cormier	J. Jesske M. Cormier

APPENDIX BEQUIPMENTa) Recording

i) 3200 Metre Streamer (Plate 2)

Type Cable : 48 live group, neutrally buoyant,
universal gland streamer.

Length of Live Section : 50 metres

Length of Dead Section : 16.67 metres

Length of Depth
Transducer Section : 1.52 metres

Distance Group 1 to 48
(centres) : 3133.33 metres

Group Interval : 66.67 metres

Seismometer Type : Pavey Acceleration Cancelling

Seismometers per Group : 30

Seismometer Interval : Linear, 1.14 metres except centre
two which are 8.33 metres apart.

Sensitivity : 6.0 uV/uBar



ii) 2400 Metre Streamer (Plate 2A)

Type Cable : 48 live group, neutrally buoyant,
universal gland streamer.

Length of Live Section : 50 metres

Length of Dead Section : Nil (all live sections)

Length of Depth
Transducer Section : 1.52 metres

Distance Group 1 to 48
(centres) : 2350 metres

Group Interval : 50 metres

Seismometer Type : Pavey Acceleration Cancelling

Seismometers per Group : 30

Seismometer Interval : Linear, 1.14 metres except centre
two which are 8.33 metres apart.

Sensitivity : 6.0 $\mu\text{V}/\mu\text{Bar}$



iii) Recording Parameters

Amplifiers : TI DFS III Binary Gain

Gain Mode : Binary Gain

Record Length : Normal 5.0 seconds

Sample Rate : 4 milliseconds

Gain Constant : 30 db

Attack Rate : 1500 db/sec.

Final Gain : 90 db

Total Gain : September: 90 + 30 = 120 db
: November : 120 db

Trip : As necessary

Initial Gain : September: 30 - 36 db
: November : 24 - 30 db

Upper Set Limit : 62.5%

Lower Set Limit : 25%

Filter -

 Low Cut : 8 Hz, 18 db/octave

 High Cut : 62 Hz, 72 db/octave

Release Rate : Fast 94 db/sec.

Delay time for RAW
Monitors caused by
displacement of RAW
and record heads : 26.7 milliseconds



iv) Data Channel Allocations - 3200 Metre Streamer : September.

<u>Function</u>	<u>Monitor Trace No.</u>	<u>System</u>	<u>Tape Channel</u>
Timing	-	Both	0
Streamer Odd Groups 1 - 47	1 - 24	System I	1 - 24
Streamer Even Groups 2 - 48	31 - 54	System II	1 - 24
Waterbreak 1 (between groups 2L & 2D)	49	Both	31
Waterbreak 2 (between groups 10L & 10D)	48	Both	28
Waterbreak 3 (between groups 20L & 20D)	50	Both	29
Waterbreak 4 (between groups 30L & 30D)	49	Both	31
Waterbreak 5 (between groups 40L & 40D) or Sonobuoy data	50	Both	27
Waterbreak 6 (in front of group 48)	48	Both	28
Field Timebreak	4	System I	-
Field Timebreak	28	System II	-
DFS Synthetic Timebreak	8	System I	-
DFS Synthetic Timebreak	32	System II	-



v) Data Channel Allocations - 2400 Metre Streamer : November.

<u>Function</u>	<u>Monitor Trace No.</u>	<u>System</u>	<u>Tape Channel</u>
Timing	-	Both	0
Streamer Odd Groups 1 - 47	1 - 24	System I	1 - 24
Streamer Even Groups 2 - 48	31 - 54	System II	1 - 24
Waterbreak 1 (between groups 1 & 2)	27	Both	31
Waterbreak 2 (between groups 9 & 10)	26	Both	28
Waterbreak 3 (between groups 19 & 20)	28	Both	29
Waterbreak 4 (between groups 29 & 30)	27	Both	31
Waterbreak 5 (between groups 39 & 40)	25	Both	27
Waterbreak 6 (in front of group 48)	26	Both	28
Field Timebreak	4	System I	-
Field Timebreak	34	System II	-
DFS Synthetic Timebreak	8	System I	-
DFS Synthetic Timebreak	38	System II	-

b) Survey VesselM.V. "Eugene McDermott II"

Flag	: Bahamas
Homeport	: Nassau
Trade	: Foreign Going, Seismic Exploration
Owners	: Worldwide Surveys Limited
Call Sign	: ZQA-2012
Length	: 52.73 metres
Breadth	: 12.19 metres
Depth	: 4.27 metres
Draught	: 3.05 metres
Official Number	: 343728
Gross Tonnage	: 929.89 tonnes
Net Tonnage	: 249.09 tonnes
Engine Horsepower	: 2 x 839.25 KW engines



APPENDIX C

OPERATION STATISTICS

Prospect	: Flinders and Extension	
Operational period	: 3rd - 11th September, 1973	
	: 9th - 10th November, 1973	
	<u>September</u>	<u>November</u>
Time spent on recording	: 6 days	1 day
Time lost due to bad weather	: 2 days	¼ day
Time lost due to other reasons, (includes supplies, equipment and survey failures)	: ½ day	Nil
Field tapes used	: 111	20
Water depth range	: 40 - 50 fathoms	
Total production mileage	: 312 miles 502.12 Kms.	59.4 miles 95.6 Kms.
Production shotpoints	: 22604	478
Autofires	: 48	Nil
Delay due to streamer noise levels	: 2 hrs.	



APPENDIX D

FIELD TAPE LOG

FLINDERS

<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>			
			<u>Odd</u>	<u>Even</u>		
7/9/73	HB73A-143	1-228	544-	544-		
		1-441	002	001		
		229-665		003		
		442-665	004			
		666-881		004		
		666-1114	005			
		882-1242		006		
		1115-1242	007			
			HB73A-145	1243-1506	008	
				1243-1665		009
				1507-1665	010	
			HB73A-144	1666-1929		010
				1666-2085	011	
		1930-2138		012		
		2086-2138	013			
	HB73A-152	2139-2365		012		
		2139-2365	013			
		2366-2519		013		
		2366-2668	014			
		2520-2668		015		



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
7/9/73	HB73A-155	2669-2804	544-014	544-
		2669-2963		015
		2805-2963	016	
		2964-3248		016
		2964-3277	017	
		3249-3277		018
	HB73A-142	3278-3397	017	
		3278-3654		018
		3398-3654	019	
		3655-3831		019
		3655-4085	020	
		3832-4263		021
		4086-4263	022	
		4264-4290		022
8/9/73	HB73A-87	4291-4494		022
		4291-4686	023	
		4495-4914		024
		4687-4914	025	
		4195-5038		025
		4915-5038	026	
	HB73A-151	5039-5122		025
		5039-5350	026	
		5123-5566		027
		5351-5566	028	
	5567-5602		028	
	5567-5602	029		



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
8/9/73	HB73A-153	5603-5758	544-	544-
		5603-5974	029	028
		5759-6190		030
		5975-6190	031	
		6191-6406		031
		6191-6542	032	
		6407-6542		033
	HB73A-154	6543-6626	032	
		6543-6818		033
		6627-6818	034	
		6819-7034		034
		6819-7265	035	
		7035-7319		036
		7266-7319	037	
	HB73A-136	7320-7465		036
		7320-7465	037	
		7466-7690		037
		7466-7904	038	
		7691-8137		039
		7905-8137	040	
		8138-8349		040
		8138-8571	041	
		8350-8771		042
		8572-8771	043	
		8772-8841		043
		8772-8841	044	



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
8/9/73	HB73A-126	8842-8993	544-	544-
		8842-9211	044	043
		8994-9427		045
		9212-9427	046	
		9428-9641		046
		9428-9726	047	
		9642-9726		048
9/9/73	HB73A-125	9727-9846	047	
		9727-10074		048
		9847-10074	049	
		10075-10278		049
		10075-10371	050	
		10279-10371		051
	HB73A-138	10372-10575		052
		10372-10815	053	
		10576-11019		054
		10816-11019	055	
		11020-11247		055
		11020-11444	056	
	HB73A-140	11248-11444		057
		11445-11672		057
11445-11672		058		
11673-11876			058	
11673-11987		059		
	11877-11987		060	



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
9/9/73	HB73A-139	11988-12095	544-059	544-
		11988-12287		060
		12096-12287	061	
		12288-12481		061
		12288-12481	062	
	HB73A-141	12482-12723	062	
		12482-12772		063
		12724-12772	064	
	HB73A-135	12809-12931		063
		12809-12931	064	
		12932-13176		064
		12932-13342	065	
		13177-13610		066
		13343-13610	067	
		13611-13786		067
13611-14054		068		
13787-14223			069	
14055-14223		070		
10/9/73	HB73A-137	14483-14650	071	
		14483-14925		072
		14651-14925	073	
		14926-15094		073
		14926-15370	074	
		15095-15526		075
		15371-15526	076	
		15527-15802		076



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
10/9/73	HB73A-137 (Cont'd)	15527-15970	544-	544-
		15803-16156	077	078
		15971-16156	079	
	HB73A-157	16157-16240		078
		16157-16240	079	
		16241-16384		079
		16241-16660	080	
		16385-16763		081
		16661-16763	082	
	HB73A-156	16764-17030		082
		16764-17207	083	
		17031-17472		084
		17205-17472	085	
		17473-17647		085
	17473-17866	086		
	17648-17866		087	



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
10/9/73	HB73A-159	17867-17918	544-086	544-
		17867-18087		087
		17919-18087	088	
		18088-18364		088
		18088-18469	089	
		18365-18469		090
	HB73A-158	18470-18526	089	
		18470-18797		090
		18527-18797	091	
		18798-18896		091
		18798-18896	092	
	HB73A-147	18897-18965		091
		18897-19232	092	
		18966-19400		093
		19233-19400	094	
19401-19440			094	
		19401-19440	095	



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
11/9/73	HB73A-148	19441-19656	544-	544-
		19441-19836	095	094
		19657-20052		096
		19837-20052	097	
	HB73A-149	20053-20268		097
		20053-20484	098	
		20269-20700		099
		20485-20700	100	
		20701-20764		100
		20701-20764	101	
	HB73A-150	20765-20821		100
		20765-20821	101	
		20822-20917		100
		20822-21133	101	
		20918-21337		102
		21134-21337	103	
		21338-21553		103
	HB73A-146	21338-21553	104	
		21554-21779	104	
		21554-21989		105
		21780-21989	106	
21990-22227			106	
21990-22430		107		
22228-22667			108	
22431-22667		109		
22668-22697			109	
22668-22697	110			



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
9/11/73	HB73A-165	1-31	544- 852	544- 853
		1-31		853
		32-36	853	
		32-36		854
	HB73A-166	37-55	853	
		37-71		854
		55-71	855	
	HB73A-167	72-84		854
		72-84	855	
		85-109		855
		85-117	856	
		110-117		857
	HB73A-168	118-135	856	
		118-163		857
136-163		858		
164-167			858	
164-167		859		
9/11/73	HB73A-168R	168-182 168-182		858 859
10/11/73	HB73A-169	183-188 183-216 189-236 217-236		858 859 860 861



<u>Date Shot</u>	<u>Line Number</u>	<u>List of Shotpoints</u>	<u>Field Tape Numbers</u>	
			<u>Odd</u>	<u>Even</u>
10/11/73	HB73A-170	237-241	544-	544-
		237-241	861	860
		242-269		861
		242-276	862	
		270-276		863
	HB73A-164	277-294	862	
		277-322		863
		295-322	864	
		323-328		864
		323-328	865	
	HB73A-163	329-346		864
		329-369	865	
		347-369		866
	HB73A-162	370-376	865	
		370-400		866
		377-400	867	
		401-404		867
		401-404	868	
	HB73A-161	405-430		867
		405-454	868	
431-458			869	
455-458		870		
HB73A-160	459-484		869	
	459-484	870		
	485-493		870	
	485-493	871		
		D-10		

059049



PLATES

059050

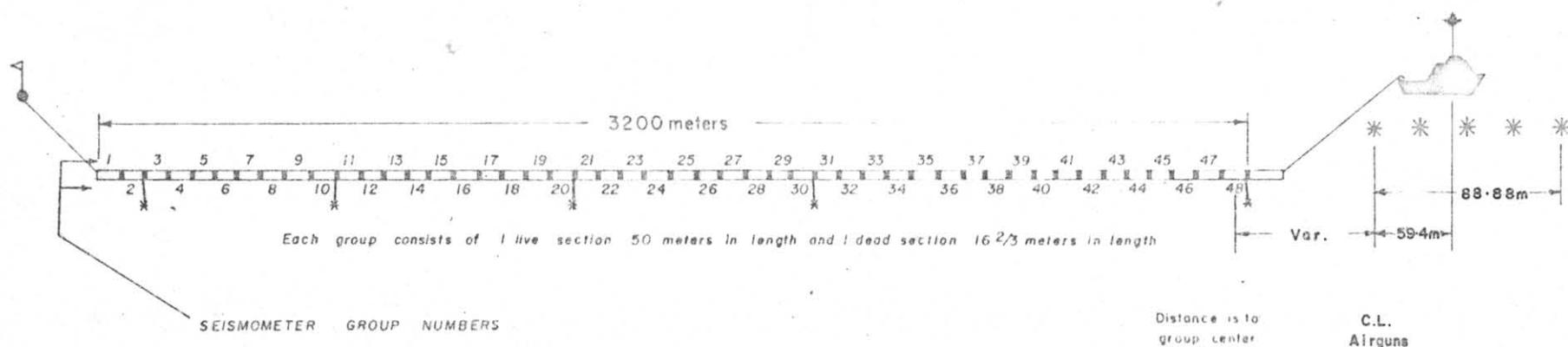


HEMATITE PETROLEUM PTY. LTD.
LOCATION OF PROSPECT
GEOPHYSICAL SERVICE INTERNATIONAL PARTY 931

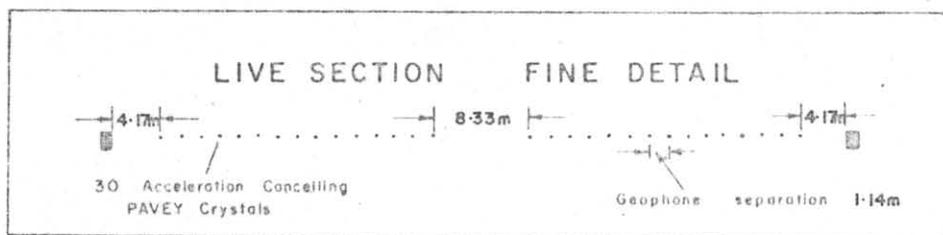
5 cm

PLATE 1

059051



* STREAMER DEPTH TRANSDUCER AND WATER BREAK PHONE LOCATION



WATER BREAKS	DISPLAYED ON SEISMOGRAM TRACES	RECORDED ON TAPE CHANNELS
1	49	31
2	48	28
3	50	29
4	49	31
5	50	27
6	48	28

5 cm

MARINE CABLE DIAGRAM
3200 METER

(OFF END SPREAD - 48 GROUPS)

G. S. I. Party 931

Ship EUGENE McDERMOTT II

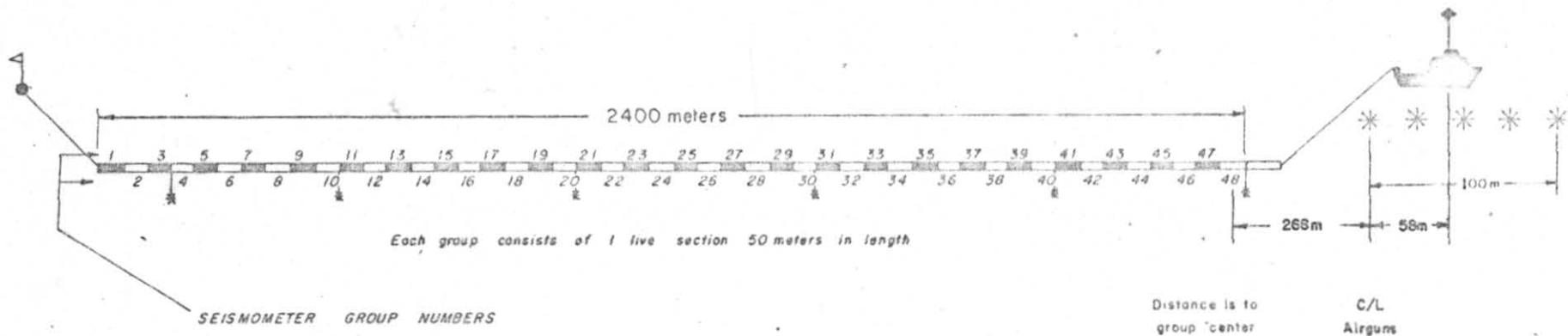
Client HEMATITE PETROLEUM P/L

Area BASS STRAIT FLINDERS

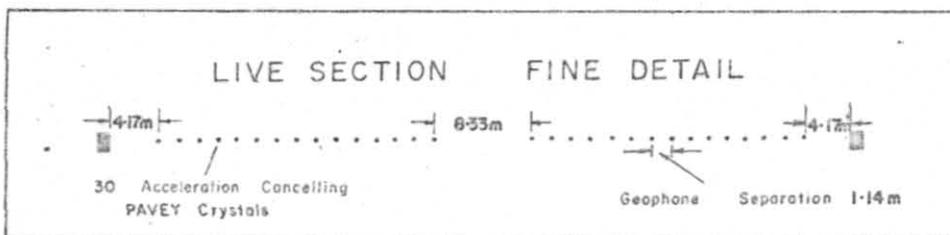
Date SEPTEMBER, 1973

PLATE 2

059052



■ STREAMER DEPTH TRANSDUCER AND WATER BREAK PHONE LOCATION

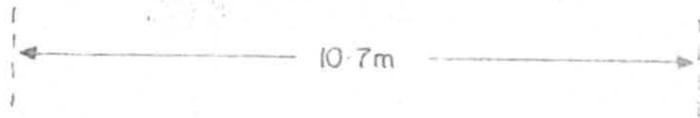


WATER BREAKS	DISPLAYED ON SEISMOGRAM TRACES	RECORDED ON TAPE CHANNELS
1	27	31
2	26	28
3	28	29
4	27	31
5	25	27
6	26	28

MARINE CABLE DIAGRAM
2400 METER
(OFF END SPREAD - 48 GROUPS)
G.S.I. Party 931
Ship McDERMOTT II
Client HEMATITE PETROLEUM P/L
Area BASS STRAIT FLINDERS EXT.
Date NOVEMBER, 1973

PLATE 2A

5 cm



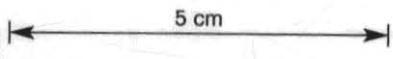
PORT				STARBOARD			
N ^o	GUN	SIZE	Distances		N ^o	GUN	SIZE
1	●	1-311 litres	— 0m —		17	●	1-639 litres
Z 2	●	1-311	0-46		Z 18	●	1-639
3	●	1-311	0-91		X 19	●	1-639
ZX 4	●	1-311	1-37		ZX 20	●	1-639
5	●	1-639	3-20	3-28	21	●	1-639
X 6	●	1-639	3-66	3-73	X 22	●	1-639
7	●	1-311	5-49	5-64	Z 23	●	1-311
ZX 8	●	1-311	5-94	6-10	ZX 24	●	1-311
9	●	0-655	7-77	8-00	25	●	0-655
10	●	0-655	8-99	9-30	26	●	0-655
11	●	0-655	10-21	10-59	27	●	0-655
12	●	0-328	11-43	11-89	28	●	0-328
13	●	0-328	12-65	13-11	29	●	0-328
14	●	0-328	13-87	14-33	30	●	0-328
15	●	0-164	15-09	15-54	31	●	0-164
16	●	0-164	16-31	16-76	32	●	0-164

m/v EUGENE Mc DERMOTT II

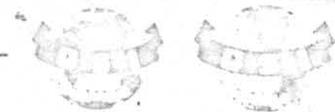
Z = Spare guns until Line 73A-151

X = Spare guns after Line 73A-151

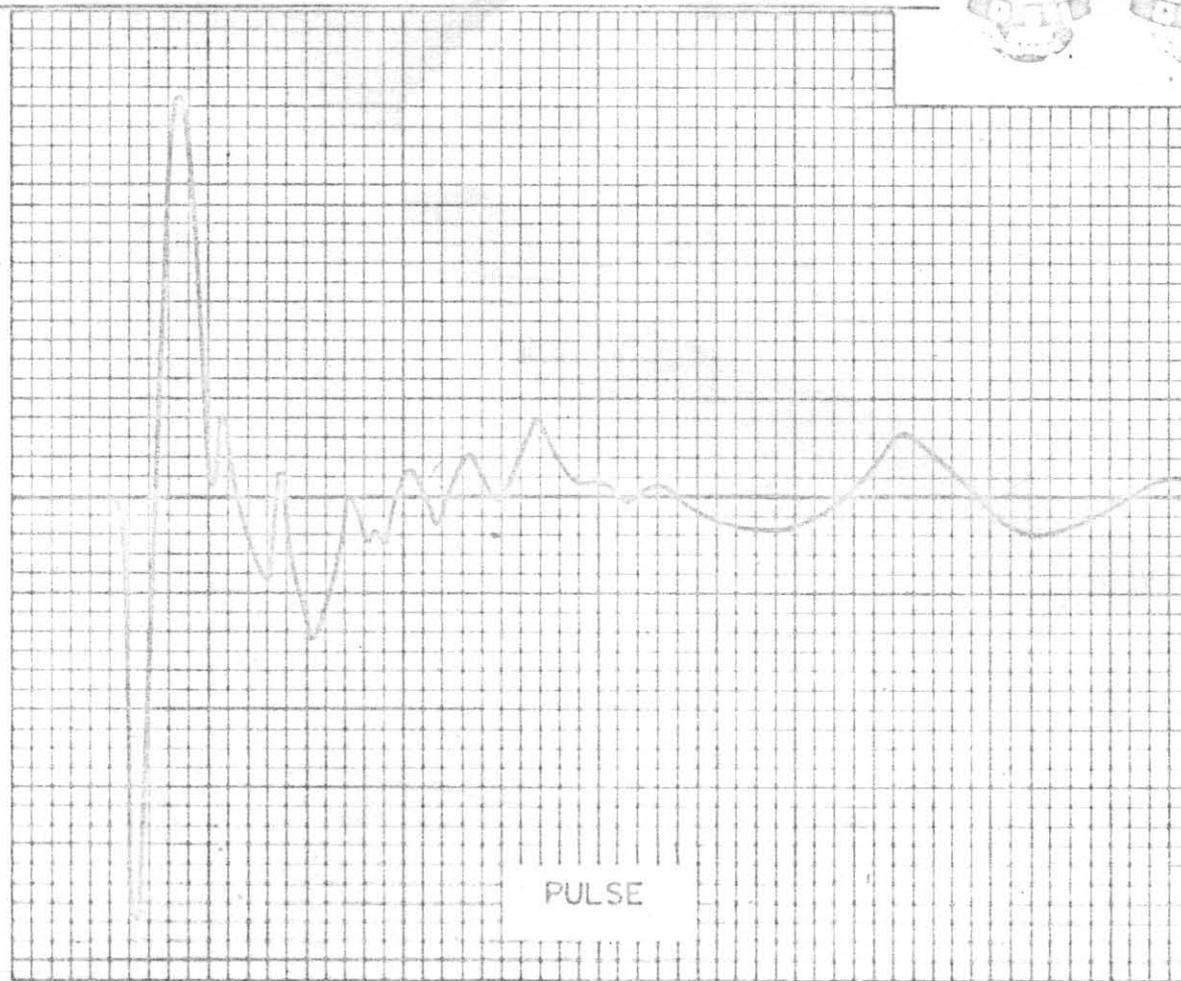
AIR GUN ARRAY



SEPTEMBER 1973



AMPLITUDE

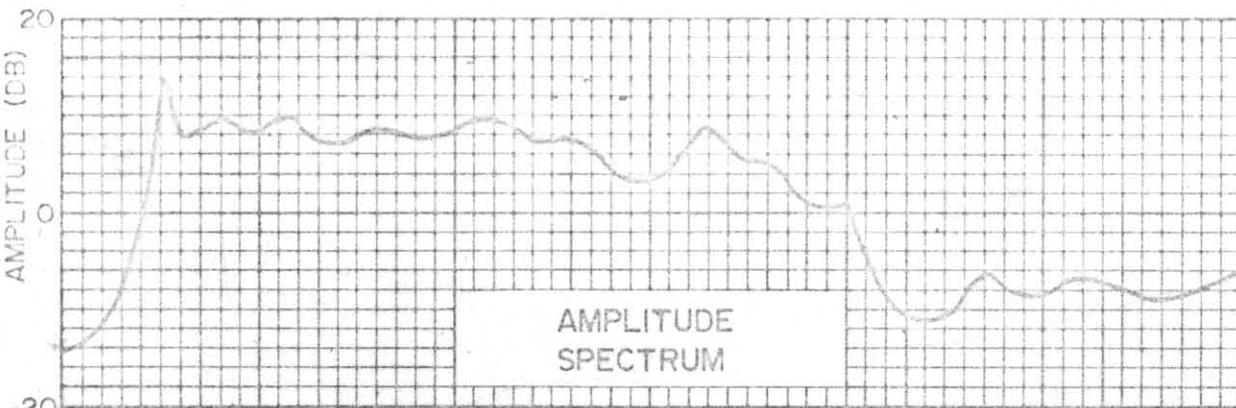


0 100 200
MILLISECONDS

PULSE

RELATIVE

AMPLITUDE (DB)



0 20 40 60 80 100
FREQUENCY (HZ)

AMPLITUDE SPECTRUM

GUN	SIZES
4X0-164 litres	2X1-311 litres
6X0-328 "	2X1-639 "
6X0-655 "	1X3-278 "
	1X3-933 "

AIRGUN ARRAY PULSE AND SPECTRUM

Vessel	EUGENE MCDERMOTT II
Array Capacity	19-655 litres
Recording Filter	OUT - 248 Hz
Date	MARCH 1973

APPENDIX 2

PROCESSING REPORT



PROCESSING REPORT
MARINE SEISMIC SURVEY
BASS STRAIT
FLINDERS SEISMIC SURVEY
1973

For

HEMATITE PETROLEUM PROPRIETARY LIMITED
140 WILLIAM STREET,
MELBOURNE. VICTORIA 3000

By

GEOPHYSICAL SERVICE INTERNATIONAL
120 CHRISTIE STREET,
ST. LEONARDS. N.S.W. 2065

PARTY 103-HEM-1

SEPTEMBER/DECEMBER, 1973.

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<u>APPENDIX</u>	<u>TITLE</u>
A	LINE AND SHOTPOINT INDEX
B	PARAMETERS FOR 700 PACKAGE

PLATE NO. 1 - LOCATION MAP



SECTION I

INTRODUCTION

A marine seismic reflection survey was conducted by the M.V. "Eugene McDermott II" in the Bass Strait for Hematite Petroleum Proprietary Limited between 3rd September and 11th September, 1973 and again on 9th and 10th November, 1973.

Flinders Survey:

Approximately 501 kilometres of "72-fold" reflection coverage were shot during September using a 48 trace, 3200 metre, acceleration cancelling streamer under continuous tow in conjunction with a Pneumatic Acoustic Energy Source, a 19.655 litre tuned airgun array.

Flinders Extension Survey:

Approximately 95 kilometres of 48-fold reflection coverage were shot during November using a 48 trace, 2400 metre streamer with the same airgun array as above. Field and survey operations are fully discussed under separate covers.

Refraction:

Three marine seismic refraction lines were included in the Flinders survey. These lines were recorded at the same time as production lines. Teleseis Sonobuoys were used to record and transmit the signals to an Aquatronics Sonobuoy receiver on board ship. The data was recorded using waterbreak channel 5 onto tape channel 27.



Digital data processing was performed in the Sydney and Singapore offices of Geophysical Service International. All data were vertically stacked and processed as 24-fold CDP, 48 trace data. Continuous Velocity Analysis was effected by the 700 Package event detection module at our Singapore office.



SECTION II

DIGITAL PROCESSING

The following processing sequence was applied to the data. All data were processed to a record time of 5.0 seconds at a sample period of 4 milliseconds.

A. SEQUENCE

1. Vertical Stack :
 - a. True Amplitude Recovery.
 - b. Vertical Stack (as required).

2. Pre-processing :
 - a. Trace Edit.
 - b. Pre-deconvolution Ramp Scaling.
 - c. Static Corrections.
 - d. Deconvolution.
 - e. Common Depth Point Gather.
 - f. Annotation of Water Depth and Offset Information.
 - g. Preliminary Stack.



3. Velocity Processing :

Full 700 Package Continuous Velocity Analysis
on alternate depth points.

- a. Moveout Scan, Dip Search and Reflection Identification.
- b. Plot of picked events as a function of Velocity, Amplitude and Dip.
- c. Primary Segment Display.

4. Post-processing :

- a. Normal Moveout Correction.
- b. Single-fold Display.
- c. Common Depth Point Stack.
- d. Time Variant Deconvolution (TVD).
- e. Time Variant Filtering (TVF).
- f. Cross Record Mix (3200 m. cable).
- g. Display.



B. PROGRAM AND PARAMETER DETAILS

1. Vertical Stack :

a. True Amplitude Recovery (TAR)

TAR was applied to all field records. This process removed the gain imposed by the DFS III Binary Gain Control System and corrected for inelastic attenuation and spherical divergence losses.

b. 3 on 1 Vertical (Flinders)

The "72-fold" shooting was reduced to 24-fold, 48 trace by stacking the 48 traces of three contiguous shots. This summing produces a depth point smear but maintains correct offsets. The main advantage of Vertical Stack is the cancellation of random noise and the reinforcing of primary data.

Even/Odd Vertical Stack (Flinders Extension)

Even/Odd Vertical Stack was performed reducing the 48-fold common depth point coverage to 24-fold. The Even 24 groups were stacked with the Odd 24 groups of the succeeding shot. Although an offset mix was involved, by using the Even and Odd groups from consecutive shots, any depth point smear was eliminated. Tests have indicated this method of Vertical Stack produces the best results in the deeper zones of interest. Using the field Q.C. reports as a guide, as well as on a random basis, the Vertical Stack records were displayed for further editing.



2. Pre-processing :

a. Trace Edit

Trace editing was performed based on the Vertical Stack displays. This consisted primarily of zeroing noisy field traces.

b. Pre-deconvolution Ramp Scaling

Pre-deconvolution ramp scaling was designed to suppress direct arrival energy. This was to prevent the high amplitude direct arrivals from being "blown-up" when the deconvolution operator was applied.

c. Static Corrections

Static corrections were applied to correct for a sea level datum. A positive static correction was applied to compensate for the depth of the airgun array and streamer below sea level. A water velocity of 4900 ft./sec. was assumed when making these corrections. At the same time a correction of 12 milliseconds was removed for the airgun delay.

d. Deconvolution

The approximate deconvolution was accomplished by the application of a whitening filter designed from auto-correlation functions, which were derived from the trace to be deconvolved. Two filters were designed per trace and applied with a 50% overlap, such



that the first filtered tapered off while the second filter tapered on. The operators were designed as double section operators; i.e., to dereverberate the first and second water bottom reverberations.

e. Common Depth Point (CDP) Gather

All data were output from the Pre-processing Module in CDP format. For the data now reduced to 24-fold, each 24 trace output record represented one CDP point.

f. Annotation

The offset and the shot plus receiver water depth for each trace were annotated in channel 25 of the CDP gather record.

g. Preliminary Stack

Velocities obtained from previous years' processing were applied to one system (usually evens) after CDP gather and the data stacked. This post-processing sequence omitted deconvolution. Velocities from this year's work were used if available.



3. Velocity Analysis :

1. Program 700-2 provides a continuous velocity analysis technique which was used to determine the complete velocity field along a line.

Inputs to this program are pre-processed CDP gather records. Only data from one system (Evens) were submitted, resulting in alternate depth point processing.

On these CDP records the following processes were performed:-

- o Moveout and Dip Scan Building -

A Moveout Scan is generated for each depth point and is formed by the application of a constant shift to each trace in proportion to the square of the offset of the trace and then stacking by mixing together all the traces in the gather to form a scan trace. The moveout applied is then incremented by a constant amount and the process repeated until the range of moveout applied exceeds the expected seismic range.



Dip scans are built by stacking together series of moveout scans from consecutive depth points along linear planes of dip which are automatically incremented within a specified dip aperture designed to cover the expected range of dips on the seismic section. Dip apertures for each processing time gate were determined from the preliminary stack sections. The number of consecutive moveout scans stacked to form a dip scan is termed the SMASH rate and may also vary with the time gates.

- o Interpretation of Moveout/Dip Scans to detect valid events with time, amplitude and moveout, and dip information -

The automatic interpretation is based on the fact that any coherent event on the gather record will stack at the optimum moveout value to a maximum (or minimum for negative values) in the two-dimensional time moveout plane of the scan. When stacking again takes place along the dip plane, which most approximates the true geological time-dip, maximum dip scan response will be achieved. The dip scan domain is a three-dimensional one in which every coherent event from the input gather records will be represented by a maximum or minimum at that time, moveout and dip which correctly describes the original seismic event.



The resulting "TAMD picks" represent the mean time, amplitude, moveout and dip of the seismic event over a space gate of width SMASH depth points. The move-up rate is another important consideration. It refers to the number of depth points between the centre of each successive dip scan set and for these lines was made equal to the SMASH rate to give a continuous suite of dip scan sets.

- o Output to magnetic tape are the event files for each Space/Time gate -

After the event detection is performed for all space points in each time gate the Event files are written on magnetic tape.

- o Extensions of the Event files in each time gate to produce Work files -

Using search windows in time, amplitude, moveout and dip, the picked seismic events from neighbouring dip scan files can be correlated and those evolving from the same seismic horizon identified and connected. This process is called Extension and the set of connected seismic horizon events are termed Segments which are output as Work (Segment) files.



o Summary Files and Consolidation Files -

After all time gates have been processed, the program outputs Summary and Consolidation files in the following manner.

- Hook-up of segments between time gates to allow continuous segments across time gates.
 - Output Summary Files.
 - Consolidation of Summary files into continuous segments with time, amplitude and moveout at every depth point.
 - Output of Consolidated Segment files on magnetic tape to be submitted for display on analysis routines.
2. Program 701 - Velocity Analysis Module - provides statistical displays (scattergrams) of velocity, amplitude and dip as a function of time over the entire space and also over specified space gates. The RMS velocities are computed from the segment times and moveouts averaged over each space gate and plotted as a coded symbol for each segment. The symbols



are coded according to segment length within each space gate or according to the relative length in the entire Consolidated file. The highest amplitude segment within each 100 msec. gate is also shown by circling the rank or grading symbol. Dip and amplitude information is plotted on the right-hand side of the velocity versus time plot.

A scattergram with a listing was generated for the entire space and for each individual space gate.

3. Program 602 - Segment Sort and Display - displays the Consolidated file in a fashion suitable for section overlay. Various sorting and annotation techniques are available to aid in the interpretation of the file.

Initially, the total file was displayed as a quality control measure. Only segments greater than 12 depth points were plotted with segment numbers annotated on segments longer than 24 depth points.

The final displays (segments ≥ 6 d.p.).

- a) Primary Peaks with RMS velocities averaged and annotated every 12 depth points.



- b) Primary Troughs with RMS velocities averaged and annotated every 12 depth points.
- c) Primary Peaks and Troughs with segment numbers annotated on any segment, > 24 d.p.

Input to Program 602 was the Consolidated file and output was on 5" CRT frame. These were enlarged to a horizontal scale of the section to be overlain (see "Display").



4. Post-processing :

The CDP gather records were input to the Post-processing Module and the following processes applied:-

a. Normal Moveout Correction

The Normal Moveout Correction was performed utilizing the velocity functions interpreted from the scattergrams. A velocity function was input at the location of each velocity module. A linear interpolation was performed between these functions and a velocity function calculated for and applied to each of the intermediate depth points. All velocity functions are referenced to the water top.

b. Single-fold Display

A single-fold section with the final stacking velocities applied was generated from the normal moveout program. This section was filtered and displayed on paper.

c. Common Depth Point Stack

Common Depth Point Stack was performed with a scaling response equal to the reciprocal of the number of live traces contributing after first break suppression. The first break suppression ramps were derived from single-fold records, to remove unwanted water-borne energy, refractions and low frequencies due to stretching in the moveout process.



d. Time Variant Deconvolution (TVD)

Time Variant Deconvolution is a multiple operator, whitening, deconvolution designed from and applied to each trace in a series of overlapping gates. Two operators were used on all lines. The TVD operators were designed from two 50% overlapping gates extending from 200 msec. below the water bottom to 4900 msec.

e. Time Variant Filtering (TVF)

A time variant, zero phase, digital filter was applied as shown on the side panel of each record section.

f. Cross Record Mix (Flinders 3200 m. cable)

This process does a weighted trace mix on the final output sections. The weighting used was 15%, 70%, 15%.

The first output trace of a record would have 15% contribution from input trace 1, 70% from input trace 2 and 15% from trace 3.

The second output trace would have 15% from input trace 2, 70% from trace 3 and 15% from trace 4. This process continues for the entire line.



Various tests were run on Line HB-73A-151 to ensure the percentages of the mix were optimum. (25%, 50%, 25%; 20%, 60%, 20%.)

g. Display

All plotter displays were in a wiggle trace/variable area format at a horizontal scale of approximately .5 mile/inch and a vertical scale of 3.75 inches/second.

For the 3200 metre, 48 trace streamer, this resulted in trace spacing of 10 traces/Cm. (0.53 miles/inch).

For the 2400 metre, 48 trace streamer, 36 traces/inch were used (0.56 miles/inch).



C. REFRACTION

The refraction lines were gathered from the field tapes such that recordings from successive shots could be displayed adjacent to each other on the final plot.

These refraction profiles were then filtered. The filters were determined from filter analyses run on Line HB-73A-137.

The filtered, refraction profiles were then corrected to give two delay-time profiles (12,000 ft./sec. and 18,000 ft./sec.). After shifting, each three adjacent traces were summed before final display (10 traces/cm., 3.75 inches/sec.).



SECTION III

DISCUSSION

Data quality from the Flinders survey was not quite as good as expected due to the presence of high amplitude reflected refractions. This energy, sometimes called "leaking P-Mode" energy, cannot be accounted for by simple ray path theory; but is explained by wave theory, based on the constructive interference of plane waves totally reflected in a waveguide. This phenomenon produced high amplitude noise trains on the field records. A vertical stack of consecutive field records tended to reinforce this coherent, shot-generated noise. Because this leaking P-Mode energy was offset dependent, some attenuation could be obtained by mixing traces of different offsets (i.e. #47 and #48). Test showed that a Cross Record Mix on the final sections effectively attenuated the majority of this interference. A Cross Record Mix was not necessary on the Flinders Extension survey because Odd and Even traces (#1 & #2; #3 & #4 .. #47 & #48) were vertically stacked before Pre-processing.



Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

S. Jeffrey

Steve Jeffrey,
Assistant Party Chief.

Bill Pailthorpe

Bill Pailthorpe,
Party Chief.

Ken Graybill

Ken Graybill,
Processing Supervisor.



APPENDIX A

LINE AND SHOTPOINT INDEX



FLINDERS SURVEY

<u>LINE</u>	<u>SHOTPOINTS</u>	<u>MILES</u>
HB-73A-143	1-1242	17.14
-145	1243-1665	5.84
-144	1666-2138	6.53
-152	2139-2668	7.31
-155	2668-3277	8.40
-142	3278-4290	13.97
- 87	4291-5038	10.32
-151	5039-5602	7.78
-153	5603-6542	12.97
-154	6543-7319	10.72
-136	7320-8841	21.01
-126	8842-9726	12.22
-125	9727-10371	8.92
-138	10372-11444	14.80
-140	11445-11987	7.49
-139	11988-12481	6.82
-141	12482-12772	4.01
-135	12809-14482	23.11
-137	14483-16156	23.11
-156	16764-17866	15.22
-159	17867-18469	8.33
-158	18470-18896	5.90
-147	18897-19440	7.51
-148	19441-20052	8.45
-149	20053-20764	9.83
-150	20822-21553	10.10
-146	21554-22697	15.78
-157	16157-16763	8.09

A-2



FLINDERS EXTENSION SURVEY

<u>LINE</u>	<u>SHOTPOINTS</u>	<u>MILES</u>
HB-73A-165	1-36	4.47
-166	37-71	4.35
-167	72-117	5.72
-168	118-167	6.22
-169	183-236	6.72
-170	237-276	4.97
-164	277-328	6.46
-163	329-369	5.10
-162	370-404	4.35
-161	405-458	6.71
-160	459-493	4.35

FLINDERS REFRACTION

<u>LINE</u>	<u>SHOTPOINTS</u>	<u>MILES</u>
HB-73A-143	1-433	5.9
-135	13044-13288	3.4
-137	14483-14866	5.3



APPENDIX B

PARAMETERS FOR 700 PACKAGE

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
HB-73A-125	9728-10295	190	11200	0	100	0	0	0	ALT	3001 3005 3011 3015	10001	1	10041	
				100	500	4	-7	7						
				500	1400	3	-8	7						
				1400	2400	4	-9	11						
				2400	3500	4	-14	19						
				3500	5000	6	-17	13						
HB-73A-126	8843-9578	246	11200	0	100	0	0	0	ALT	3021 3025 3031 3035	10031	31	10071	
				100	500	4	-10	9						
				500	1400	3	-10	9						
				1400	2400	4	-11	8						
				2400	3500	4	-12	14						
				3500	5000	6	-17	19						
HB-73A-126	9563-9650	30	11200	0	100	0	0	0	ALT	3041 3045 3051 3055	10061	61	10121	
				100	500	4	-8	9						
				500	1400	3	-8	10						
				1400	2400	4	-12	8						
				2400	3500	4	-13	16						
				3500	5000	6	-14	13						
HB-73A-136	7321-8056	246	11200	0	100	0	0	0	ALT	3101 3105 3111 3115	10141	141	10201	
				100	500	4	-7	8						
				500	1400	3	-10	12						
				1400	2400	4	-11	13						
				2400	3500	4	-13	17						
				3500	5000	6	-15	13						
HB-73A-136	8041-8767	243	11200	0	100	0	0	0	ALT	3101 3105 3111 3115	10141	141	10201	
				100	500	4	-8	7						
				500	1400	3	-11	10						
				1400	2400	4	-12	16						
				2400	3500	4	-12	18						
				3500	5000	6	-15	20						

NOTE

DUPLICATE RECORDS

280650

BI.

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
HB-73A-137	14484-15219	246	11200	0	100	0	0	0	ALT	3201 3205 3211 3215	10301	301	10341	
				100	500	4	-8	8						
				500	1400	3	-10	7						
				1400	2400	4	-15	12						
				2400	3500	4	-13	15						
				3500	5000	6	-15	14						
HB-73A-137	15204-15939	246	11200	0	100	0	0	0	ALT	3221 3225 3231 3235	10331	331	10371	
				100	500	4	-8	8						
				500	1400	3	-8	8						
				1400	2400	4	-13	13						
				2400	3500	4	-12	14						
				3500	5000	6	-15	15						
HB-73A-137	15924-16080	53	11200	0	100	0	0	0	ALT	3241 3245 3251 3255	10361	361	10421	
				100	500	4	-10	9						
				500	1400	3	-11	12						
				1400	2400	4	-11	8						
				2400	3500	4	-15	14						
				3500	5000	6	-18	15						
HB-73A-138	10373-11108	246	11300	0	100	0	0	0	ALT	3261 3265 3271 3275	10411	411	10451	
				100	500	4	-8	9						
				500	1400	3	-11	6						
				1400	2400	4	-15	13						
				2400	3500	4	-15	17						
				3500	5000	6	-15	16						
HB-73A-138	11093-11369	93	11300	0	100	0	0	0	ALT	3301 3305 3311 3315	10441	441	10501	
				100	500	4	-7	6						
				500	1400	3	-7	7						
				1400	2400	4	-11	11						
				2400	3500	4	-12	13						
				3500	5000	6	-13	14						

039083

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
HB-73A-139	11989-12406	140	11300	0	100	0	0	0	ALT	3401 3405 3411 3415	10601	601	10641	
				100	500	4	-6	7						
				500	1400	3	-6	8						
				1400	2400	4	-12	11						
				2400	3500	4	-11	15						
				3500	5000	6	-13	15						
HB-73A-141	12483-12696	72	11300	0	100	0	0	0	ALT	3421 3425 3431 3435	10631	631	10671	
				100	500	4	-7	9						
				500	1400	3	-8	7						
				1400	2400	4	-12	14						
				2400	3500	4	-13	15						
				3500	5000	6	-14	17						
HB-73A-140	11446-11911	156	11300	0	100	0	0	0	ALT	3441 3445 3451 3455	10661	661	10721	
				100	500	4	-7	6						
				500	1400	3	-7	12						
				1400	2400	4	-14	12						
				2400	3500	4	-14	14						
				3500	5000	6	-14	18						
HB-73A-147	18898-19366	157	11300	0	100	0	0	0	ALT	3461 3465 3471 3475	10711	711	10751	059084
				100	500	4	-7	8						
				500	1400	3	-10	12						
				1400	2400	4	-11	15						
				2400	3500	4	-13	19						
				3500	5000	6	-15	19						
HB-73A-148	19442-19976	179	11300	0	100	0	0	0	ALT	3501 3505 3511 3515	10741	741	11001	
				100	500	4	-7	7						
				500	1400	3	-12	13						
				1400	2400	4	-14	19						
				2400	3500	4	-16	18						
				3500	5000	6	-16	18						

LINE	SP's	DP's	XREF	TIME		SMASH	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
				GATE										
HB-73A- 149	20054- 20690	213	11300	0	100	0	0	0	ALT	3001 3005 3011 3015	10001	1	10041	
				100	500	4	-3	3						
				500	1400	3	-8	12						
				1400	2400	4	-10	8						
				2400	3500	4	-12	15						
				3500	5000	6	-15	15						
HB-73A- 156	16765- 17500	246	11300	0	100	0	0	0	ALT	3021 3025 3031 3035	10031	31	10071	
				100	500	4	-3	3						
				500	1400	3	-8	8						
				1400	2400	4	-8	8						
				2400	3500	4	-10	8						
				3500	5000	6	-12	8						
HB-73A- 156	17485- 17791	103	11300	0	100	0	0	0	ALT	3041 3045 3051 3055	10061	61	10121	
				100	500	4	-3	3						
				500	1400	3	-8	8						
				1400	2400	4	-8	8						
				2400	3500	4	-10	8						
				3500	5000	6	-12	8						
HB-73A- 157	16158- 16689	178	11300	0	100	0	0	0	ALT	3061 3065 3071 3075	10111	111	10151	
				100	500	4	-3	3						
				500	1400	3	-4	6						
				1400	2400	4	-10	10						
				2400	3500	4	-10	10						
				3500	5000	6	-12	12						
HB-73A- 159	17868- 18393	176	11300	0	100	0	0	0	ALT	3101 3105 3111 3115	10141	141	10201	
				100	500	4	-2	2						
				500	1400	3	-2	2						
				1400	2400	4	-8	10						
				2400	3500	4	-12	12						
				3500	5000	6	-15	12						

059085

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
HB-73A-135	12810-13545	246	11300	0	100	0	0	0	ALT	3301 3305 3311 3315	10301	301	10341	
				100	500	4	-6	7						
				500	1400	3	-9	11						
				1400	2400	4	-12	13						
				2400	3500	4	-12	15						
				3500	5000	6	-19	13						
HB-73A-135	13530-14265	246	11300	0	100	0	0	0	ALT	3321 3325 3331 3335	10331	331	10371	
				100	500	4	-5	6						
				500	1400	3	-6	6						
				1400	2400	4	-7	10						
				2400	3500	4	-16	12						
				3500	5000	6	-13	14						
HB-73A-135	14250-14406	53	11300	0	100	0	0	0	ALT	3341 3345 3351 3355	10361	361	10421	
				100	500	4	-5	6						
				500	1400	3	-7	8						
				1400	2400	4	-8	7						
				2400	3500	4	-16	12						
				3500	5000	6	-13	12						
HB-73A-146	21555-22290	246	11300	0	100	0	0	0	ALT	3361 3365 3371 3375	10411	411	10451	059086
				100	500	4	-7	7						
				500	1400	3	-9	11						
				1400	2400	4	-14	11						
				2400	3500	4	-13	10						
				3500	5000	6	-18	13						
HB-73A-146	22275-22623	117	11300	0	100	0	0	0	ALT	3401 3405 3411 3415	10441	441	10501	B5
				100	500	4	-5	5						
				500	1400	3	-11	11						
				1400	2400	4	-10	11						
				2400	3500	4	-16	12						
				3500	5000	6	-14	12						

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP			ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
				0	100		0	0	0						
HB-73A-150	20823-21477	219	11300	0	100	0	0	0	ALT	3421 3425 3431 3435	10471	471	10531		
				100	500	4	-8	5							
				500	1400	3	-11	9							
				1400	2400	4	-15	13							
				2400	3500	4	-18	16							
	3500	5000	6	-15	20										
HB-73A-158	18471-18822	118	11300	0	100	0	0	0	ALT	3441 3445 3451 3455	10521	521	10561		
				100	500	4	-6	5							
				500	1400	3	-9	11							
				1400	2400	4	-11	9							
				2400	3500	4	-14	10							
	3500	5000	6	-14	13										
HB-73A-				0		0	0	0	ALT						
					500	4									
				500	1400	3									
				1400	2400	4									
				2400	3500	4									
	3500	5000	6												
HB-73A-				0		0	0	0	ALT						
					500	4									
				500	1400	3									
				1400	2400	4									
				2400	3500	4									
	3500	5000	6												
HB-73A-				0		0	0	0	ALT						
					500	4									
				500	1400	3									
				1400	2400	4									
				2400	3500	4									
	3500	5000	6												

059087

LINE	SP's	DP's	XREF	TIME		SMASH	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
				GATE										
HB-73A-144	1667-2063	132	11100	0	100	0	0	0	ALT	3001 3005 3011 3015	10001	1	10041	
				100	500	4	-6	7						
				500	1400	3	-12	9						
				1400	2400	4	-8	10						
				2400	3500	4	-17	15						
				3500	5000	6	-30	18						
HB-73A-143	2-737	246	11100	0	100	0	0	0	ALT	3101 3105 3111 3115	10031	31	10071	
				100	500	4	-9	10						
				500	1400	3	-7	15						
				1400	2400	4	-13	10						
				2400	3500	4	-21	17						
				3500	5000	6	-21	22						
HB-73A-143	722-1166	149	11100	0	100	0	0	0	ALT	3121 3125 3131 3135	10061	61	10121	
				100	500	4	-6	8						
				500	1400	3	-15	17						
				1400	2400	4	-19	13						
				2400	3500	4	-23	21						
				3500	5000	6	-20	18						
HB-73A-142	3279-4014	246	11100	0	100	0	0	0	ALT	3141 3145 3151 3155	10111	111	10151	
				100	500	4	-8	10						
				500	1400	3	-13	14						
				1400	2400	4	-11	13						
				2400	3500	4	-22	20						
				3500	5000	6	-22	22						
HB-73A-142	3999-4215	73	11100	0	100	0	0	0	ALT	3161 3165 3171 3175	10141	141	10201	
				100	500	4	-7	7						
				500	1400	3	-13	12						
				1400	2400	4	-11	13						
				2400	3500	4	-24	17						
				3500	5000	6	-25	19						

059088

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
				0	100		0	0						
HB-73A-145	1244-1604	116	11000	0	100	0	0	0	ALT	3201 3205 3211 3215	10201	201	10241	
				100	500	4	-9	6						
				500	1400	3	-9	8						
				1400	2400	4	-8	10						
				2400	3500	4	-15	14						
				3500	5000	6	-15	17						
HB-73A-155	2670-3210	178	11000	0	100	0	0	0	ALT	3301 3305 3311 3315	10301	301	10341	
				100	500	4	-9	10						
				500	1400	3	-12	10						
				1400	2400	4	-13	10						
				2400	3500	4	-16	20						
				3500	5000	6	-20	20						
HB-73A-153	5604-6339	246	11000	0	100	0	0	0	ALT	3401 3405 3411 3415	10401	401	10441	
				100	500	4	-6	6						
				500	1400	3	-11	9						
				1400	2400	4	-12	11						
				2400	3500	4	-16	11						
				3500	5000	6	-16	14						
HB-73A-153	6324-6468	49	11000	0	100	0	0	0	ALT	3421 3425 3431 3435	10431	431	10471	
				100	500	4	-5	6						
				500	1400	3	-9	11						
				1400	2400	4	-7	9						
				2400	3500	4	-18	9						
				3500	5000	6	-17	14						
HB-73A-87	4292-4964	225	11200	0	100	0	0	0	ALT	3501 3505 3511 3515	10501	501	10541	R-L N
				100	500	4	-6	8						
				500	1400	3	-10	7						
				1400	2400	4	-12	11						
				2400	3500	4	-13	15						
				3500	5000	6	-17	17						

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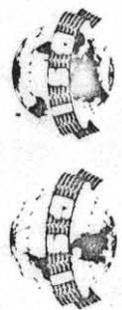
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HB-73A- 165	1 36	136	8550	0	100	0	0	0	ALT	3001 3005	11001	1001	11041	
				100	800	4	-3	3						
				800	2000	4	-5	5						
				2000	3500	4	-7	7						
				3500	5000	6	-7	10						
HB-73A- 166	37 71	130	8550	0	100	0	0	0	ALT	3021 3025	10031	31	10071	
				100	800	4	-3	3						
				800	2000	4	-7	7						
				2000	3500	4	-10	7						
				3500	5000	6	-10	10						
HB-73A- 167	72 117	172	8550	0	100	0	0	0	ALT	3041 3045	10061	61	10121	
				100	800	4	-4	4						
				800	2000	4	-8	8						
				2000	3500	4	-8	8						
				3500	5000	6	-9	9						
HB-73A- 168	118 167	190	8550	0	100	0	0	0	ALT	3061 3065	10111	111	10151	059091
				100	800	4	-3	3						
				800	2000	4	-10	10						
				2000	3500	4	-10	10						
				3500	5000	6	-8	8						
HB-73A- 169	183 236	210	8550	0	100	0	0	0	ALT	3121 3125	10171	171	10231	BIO
				100	800	4	-3	3						
				300	2000	4	-5	5						
				2000	3500	4	-10	10						
				3500	5000	6	-10	10						

LINE	SP's	DP's	XREF	TIME GATE		SMASH RATE	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS GATHERS	REMARKS
HB-73A-170	237 276	152	8550	0	100	0	0	0	ALT	4101 4105	10301	301	10341	
				100	800	4	-3	3						
				800	2000	4	-5	7						
				2000	3500	4	-12	+12						
				3500	5000	6	-12	+12						
HB-73A-164	277 328	198	8550	0	100	0	0	0	ALT	4121 4125	10331	331	10371	
				100	800	4	-3	3						
				800	2000	4	-7	5						
				2000	3500	4	-10	10						
				3500	5000	6	-10	10						
HB-73A-163	329 369	156	8550	0	100	0	0	0	ALT	4141 4145	10361	361	10421	
				100	800	4	-3	3						
				800	2000	4	-8	8						
				2000	3500	4	-8	8						
				3500	5000	6	-8	8						
HB-73A-162	370 404	132	8550	0	100	0	0	0	ALT	4161 4165	10411	411	10451	059092
				100	800	4	-3	3						
				800	2000	4	-8	6						
				2000	3500	4	-10	6						
				3500	5000	6	-11	6						
HB-73A-161	405 458	210	8550	0	100	0	0	0	ALT	4201 4205	10441	441	10501	BII.
				100	800	4	-3	3						
				800	2000	4	-5	5						
				2000	3500	4	-5	5						
				3500	5000	6	-6	6						

LINE	SP's	DP's	XREF	TIME		SMASH	DIP		ALT EVY	WORK FILES	SUMMARY FILES	CONSOL FILES	HEADER RECORDS & GATHERS	REMARKS
				GATE			RATE							
HB-73A- 160	459 493	128	8550	0	100	0	0	0	ALT	4221 4225	10471	471	10531	
				100	800	4	-4	4						
				800	2000	4	-7	7						
				2000	3500	4	-10	7						
				3500	5000	6	-10	10						
HB-73A-			8550	0	100	0			ALT					
	100	800		4										
	800	2000		4										
	2000	3500		4										
	3500	5000		6										
HB-73A-			8550	0	100	0			ALT					
	100	800		4										
	800	2000		4										
	2000	3500		4										
	3500	5000		6										
HB-73A-			8550	0	100	0			ALT					
	100	800		4										
	800	2000		4										
	2000	3500		4										
	3500	5000		6										
HB-73A-			8550	0	100	0			ALT					
	100	800		4										
	800	2000		4										
	2000	3500		4										
	3500	5000		6										

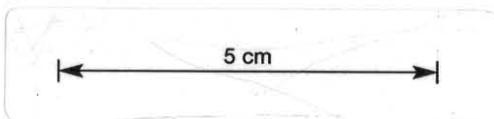
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HEMATITE PETROLEUM PTY. LTD.
LOCATION OF PROSPECT
GEOPHYSICAL SERVICE INTERNATIONAL PARTY 931

-1-



PLATE

059095

APPENDIX 3

NAVIGATION REPORT

059096



GEONAV SURVEY
BASS STRAIT
FLINDERS SEISMIC SURVEY

For

HEMATITE PETROLEUM PROPRIETARY LIMITED

Prepared by

GEOPHYSICAL SERVICE INTERNATIONAL

JANUARY, 1974.

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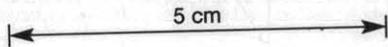
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OBSERVATIONS FOR DATUM SHIFT	4
LOCATION DIAGRAMS - PORTLAND (PLATE 2)	5
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HEMATITE PETROLEUM PTY. LTD.
LOCATION OF PROSPECT
GEOPHYSICAL SERVICE INTERNATIONAL PARTY 931

-1-

PLATE



059098





INTRODUCTION

During the periods 3rd - 11th September and 9th - 10th November, 1973, G.S.I. Party 931, aboard the M.V. "Eugene McDermott II", conducted a marine geophysical survey for Hematite Petroleum Proprietary Limited in the Bass Strait area of Australia and known as the Flinders Seismic Survey. Figure 1 shows the survey's approximate location.

Geonav, an Integrated Satellite Positioning System (described in Appendix A) was the primary navigation system used and provided horizontal position and shotpoint spacing control. No secondary system was utilized.

Final base maps, using Australian National Spheroid and Standard Australian Map Grid Universal Transverse Mercator Projection parameters, were generated in the course of processing. These were then plotted on a stable polyester-based drawing film at scales of 1:50,000*, 1:100,000 and 1:250,000. Shotpoint positions were based on the Australian National Datum.

* Only 70% of the prospect was mapped at 1:50,000.



SUMMARY OF OPERATIONS

The seismic surveys were conducted with a 3200 metre streamer in the September period and a 2400 metre streamer during the November period. Shotpoint spacing was maintained at 22.22 metres and 25 metres producing 72-fold and 48-fold coverage, respectively.

Shotpoint positions represent the centre of the airgun array at the instant of its discharge.

The Geonav system performed well throughout the surveys with the greatest update being 230 metres and 80% being 90 metres or less.

All shotpoint positions were adjusted in post-processing by applying a datum shift based on observations at Portland Harbour, Victoria.

The projection used in post-plotting has the following defining values :-

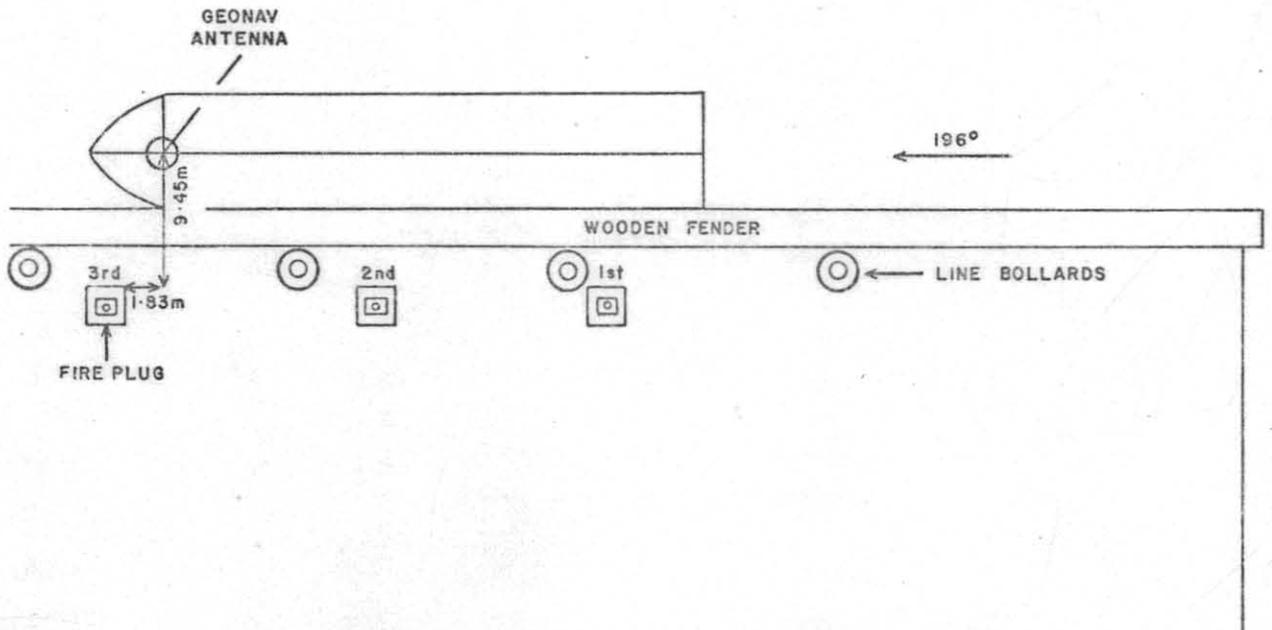
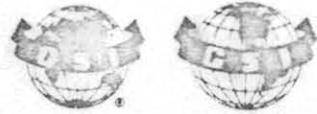
Spheroid Semi-Major Axis	:	6378160.00 metres
Semi-Minor Axis	:	6356774.72 metres
Latitude of Origin	:	0 ⁰ South
Central Meridian	:	147 ⁰ East
Central Scale Factor	:	.9996
False Easting	:	500,000 metres
False Northing	:	10,000,000 metres



OBSERVATIONS FOR DATUM SHIFT

On the 3rd, 12th and 13th September, 1973 the M.V. "Eugene McDermott II" was berthed at the K.S. Anderson Wharf, Portland, Victoria. During these periods a number of stationary satellite fixes were taken. The resulting co-ordinates of the Geonav antenna were then used to co-ordinate a point on the jetty relative to the satellite (A.P.L.) datum. After the completion of additional observations this point was further co-ordinated on the Australian National Datum. The results were :-

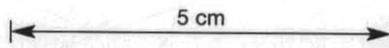
	Latitude	Longitude
Australian National Datum	38 ⁰ 21' 08.2" S	141 ⁰ 37' 09.4" E
A.P.L. Datum	38 ⁰ 21' 03.5" S	141 ⁰ 37' 13.4" E
Shift A.P.L. to A.N.D.	4.7" S	4.0" W



AUSTRALIAN NATIONAL DATUM COORDINATES

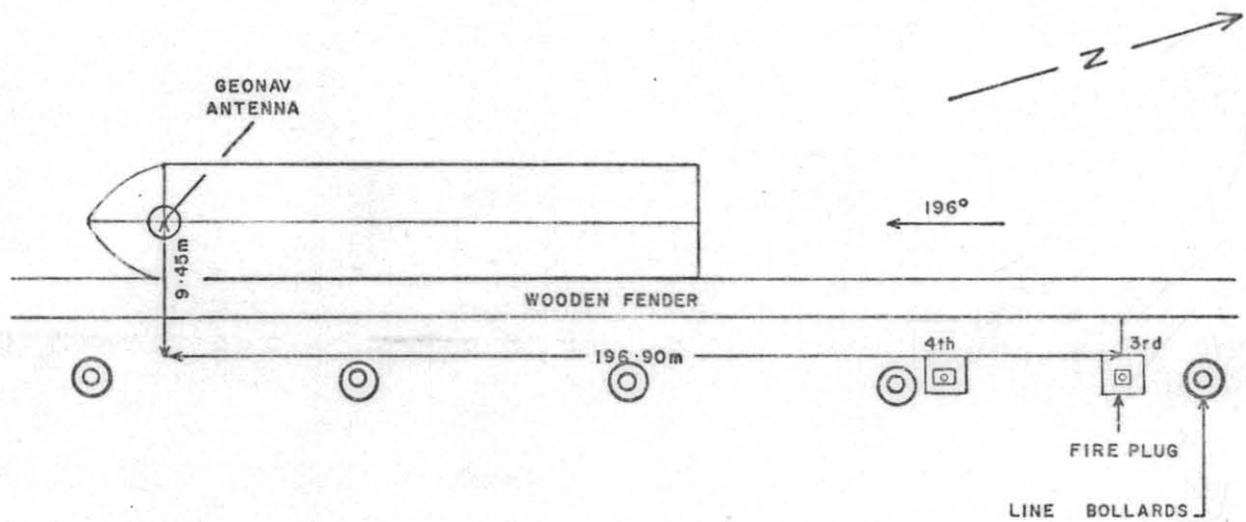
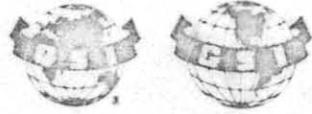
LATITUDE	LONGITUDE
----------	-----------

3rd FIRE PLUG	38° 21' 08.2" S	141° 37' 09.4" E
---------------	-----------------	------------------



LOCATION DIAGRAM AT K.S. ANDERSON WHARF
PORTLAND

3rd SEPTEMBER 1973



AUSTRALIAN NATIONAL DATUM COORDINATES

LATITUDE LONGITUDE

3rd FIRE PLUG 38° 21' 08.2" S 141° 37' 09.4" E

5 cm

LOCATION DIAGRAM AT K.S. ANDERSON WHARF
PORTLAND

12-13th SEPTEMBER 1973



APPENDIX A
GEONAV POSITIONING SYSTEM



APPENDIX A
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APPENDIX A*

GEONAV** POSITIONING SYSTEM

A. INTRODUCTION

The GeoNav integrated marine navigation system records and displays continuous position computed from U.S. Navy navigation satellite, doppler sonar, gyrocompass, attitude control, and velocimeter data. The system performs automatic line and shot control based on distance-measured equal shotpoint spacing along the great circle path between the end positions of a seismic line.

B. FIELD OPERATION

The GeoNav system computes the great-circle path for a seismic line based on end points input as geographical positions by the GeoNav operator. While on-line, the vessel's deviation from the great-circle path is plotted on a pair of track plotters to a preset scale (normally 200 m/in). One of these plotters is on the bridge, where the helmsman steers the vessel to minimize deviations as they are plotted.

Automatic shot control is obtained by measuring the distance traveled on the surface. Each time the required pop interval is traversed the digital field system and the shot relay for the seismic energy source are activated automatically. The required pop interval is computed from group and coverage information input by the operator.

* This appendix is adapted from a paper entitled, "Self-contained Quality Control in Marine Satellite Navigation," by John M. Hughes and Rudolf Unger, presented at the 27th Annual Meeting of the Institute of Navigation, June 29, 1971 in Pasadena, California.

**A Geophysical Service Inc. service mark.



The line and shot control module allows for extensions at either end of a line, line deflections (doglegs), and circling. In all these cases, continuity of shotpoint spacing along the great-circle path is preserved automatically. Subsurface coverage at the beginning and end of a line is guaranteed by taking into account possible position shifts due to satellite fix corrections and by computing the appropriate lead-in and lead-out. The track-plotters output a special lead-in display for each line and annotates line parameters, shotpoints, and satellite fixes.

All shotpoint positions, line parameters, position fixes, and other relevant navigation data are recorded on magnetic tape. Hardcopy redundancy of this recorded data is provided by teletype printout and track-plotter annotation.

C. POST MISSION PROCESSING

The navigation accuracy obtainable in real time is improved in post mission processing by infinite time smoothing of the recorded navigation data. Shotpoint and satellite fix positions are weighted against "past" and "future" position information using statistical filtering parameters based on satellite variance estimates and velocity and heading calibration factors output at each satellite fix.

Post mission processing also computes the position shift from satellite receiver antenna position to any desired offset position (seismic source, common depth points, etc.), and the position shift due to conversion from the APL* satellite system reference ellipsoid to a given local datum.

*Applied Physics Laboratory, Johns Hopkins University.



The post mission processing end product is the computerized map and listing of transverse Mercator projected positions.

D. SYSTEM DESCRIPTION

1. General

The GeoNav system establishes its absolute geographical location from information transmitted by satellites of the U.S. Navy Navigational Satellite System. The vessel's continuous path of travel is computed by a dead reckoning system consisting of a velocity measurement system (VMS) and an azimuth measurement system (AMS). The VMS derives its values from four-beam independent doppler sonar velocity measurements compensated for the ship's pitch and roll, and for variations in the sound propagation velocity. The AMS consists of a gyrocompass externally compensated for the ship's dynamics.

At intervals averaging approximately 1.5 hours at the equator and less at higher latitudes, the dead reckoned position is corrected by a satellite position fix. Each satellite fix printout contains an estimate of fix accuracy and provides calibration factors for the dead reckoning system. In this manner, a self-contained quality control is established.

The Navy currently has five satellites in non-synchronous, circular, polar orbits of about 600 mi. altitude. A core memory onboard the satellite contains its orbital position information which is updated approximately every 12 to 18 hours from ground tracking and injection stations. The satellite continuously transmits this data as its navigation message phase encoded onto two carrier frequencies.

The vessel's satellite receiver automatically locks onto the satellite signals when it appears in sight. A satellite pass may have a



duration of up to 20 minutes during which period the satellite navigation message is redundantly received, and a number of integrated doppler frequency shift (doppler count) measurements are acquired. From the navigation message the satellite positions along its orbit are derived. The doppler counts yield measures of range difference between the vessel position and the satellite positions along its orbit. Comparing the doppler shifts of the two carrier frequencies permits elimination of the ionospheric refraction influence. Automatic data editing and an iterative process of fitting computed and measured range differences ultimately result in a correction to the dead reckoned position.

Besides the tasks of navigation and data quality control, the GeoNav computer performs the line and shot control as described in Section B.

2. Detailed Description

Figure 1 is a block diagram of the GeoNav system as configured for GSI. The system employs a Magnavox MX702CA satellite receiver configured for the transfer of doppler counts synchronized with the completion of each line of the satellite message (a line takes 4.6 sec of the 2-min cycle). This permits implementation of the so-called "short doppler" satellite solution whereby the doppler counts are integrated over segments corresponding to an integer multiple of satellite lines.

The satellite receiver also receives both of the two transmitted satellite frequencies, demodulates the signals, and organizes the demodulated bits into 12-bit data words for transfer to the computer. Each 12-bit data word is accompanied by three bits of code which identify the nature of the data being transferred. Also a part of the satellite receiver is a 5-MHz oven-stabilized crystal oscillator which is the reference oscillator for the

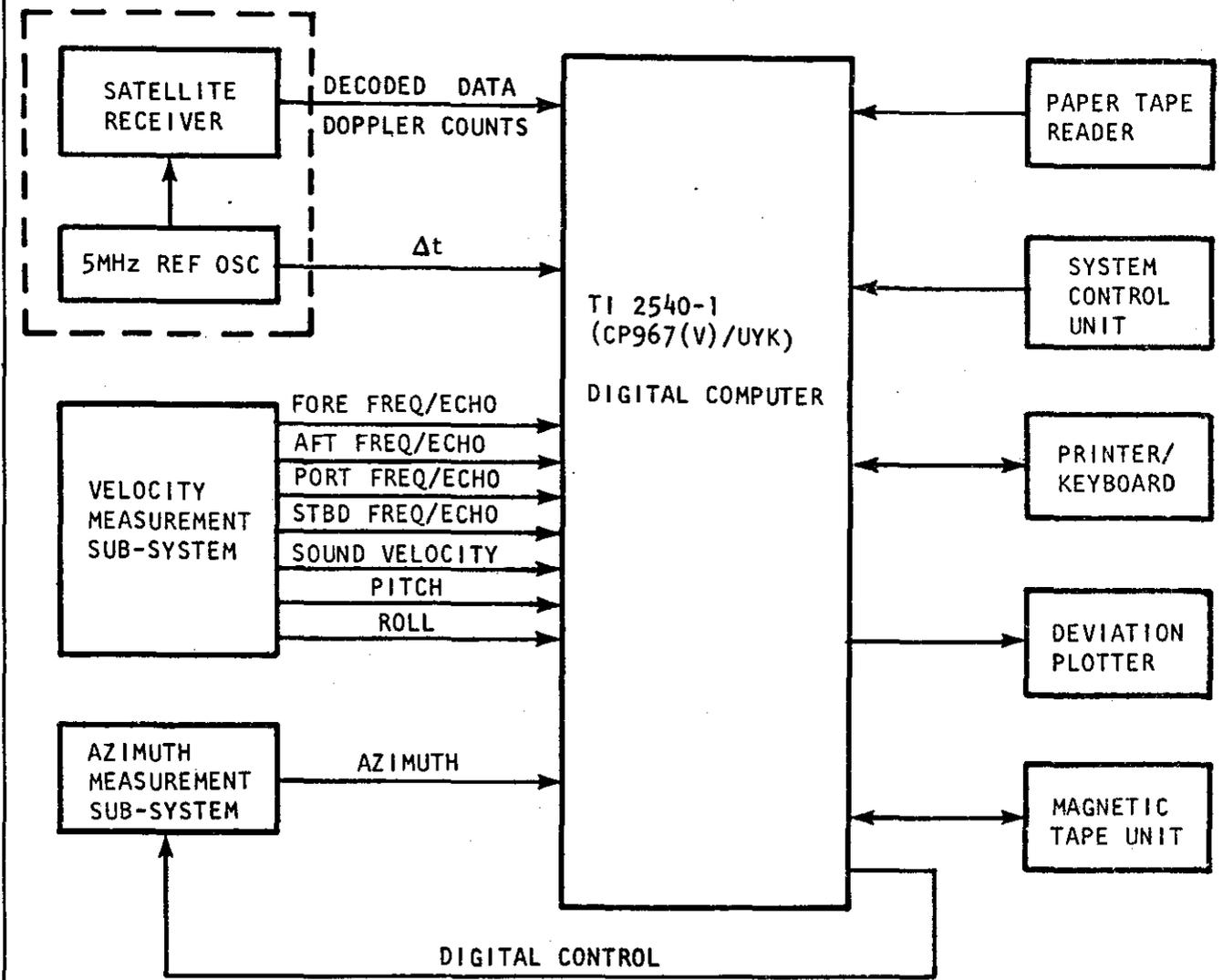


Fig. 1. GeoNav System Block Diagram.



satellite receiver in addition to being the relative time reference for the GeoNav system.

Figure 2 is a block diagram of the GeoNav velocity measurement subsystem. The sonar transducer and associated electronics are the Edo Western 435C pulse-frequency tracking system modified by Texas Instruments to yield only the frequencies of the four sonar beams (Figure 2 shows only one channel) and the time of arrival of their echoes.

The GeoNav velocity measurement subsystem provides parameters for computing the vessel's velocity in a plane tangent to the earth's surface. Components of this velocity are the projections of the ship's fore-aft and port-starboard axes on this tangent plane. To permit navigation from these data, these velocity vectors must be resolved into velocity components in northerly and easterly directions.

Figure 3 is a block diagram of the GeoNav azimuth measurement subsystem. Basic to it is the Sperry MK227-0 gyrocompass which provides X1 and X36 synchro outputs of vessel azimuth in addition to a 400-Hz reference, the amplitude of which is modulated by control from the computer, utilizing an amplitude modulator built by Texas Instruments. This external control from the computer is derived from an algorithm which compensates the gyrocompass for the effects of vessel dynamics on the compass.

A synchro-to-digital converter, Astrosystems A603-5-S149, translates the X1 and X36 information from the gyrocompass to digital form for transfer to the computer. Now available is the information necessary to resolve the data from the velocity measurement subsystem into components of velocity in northerly and easterly directions in the local earth-tangent plane. Basic instrument accuracies are shown in Table I.

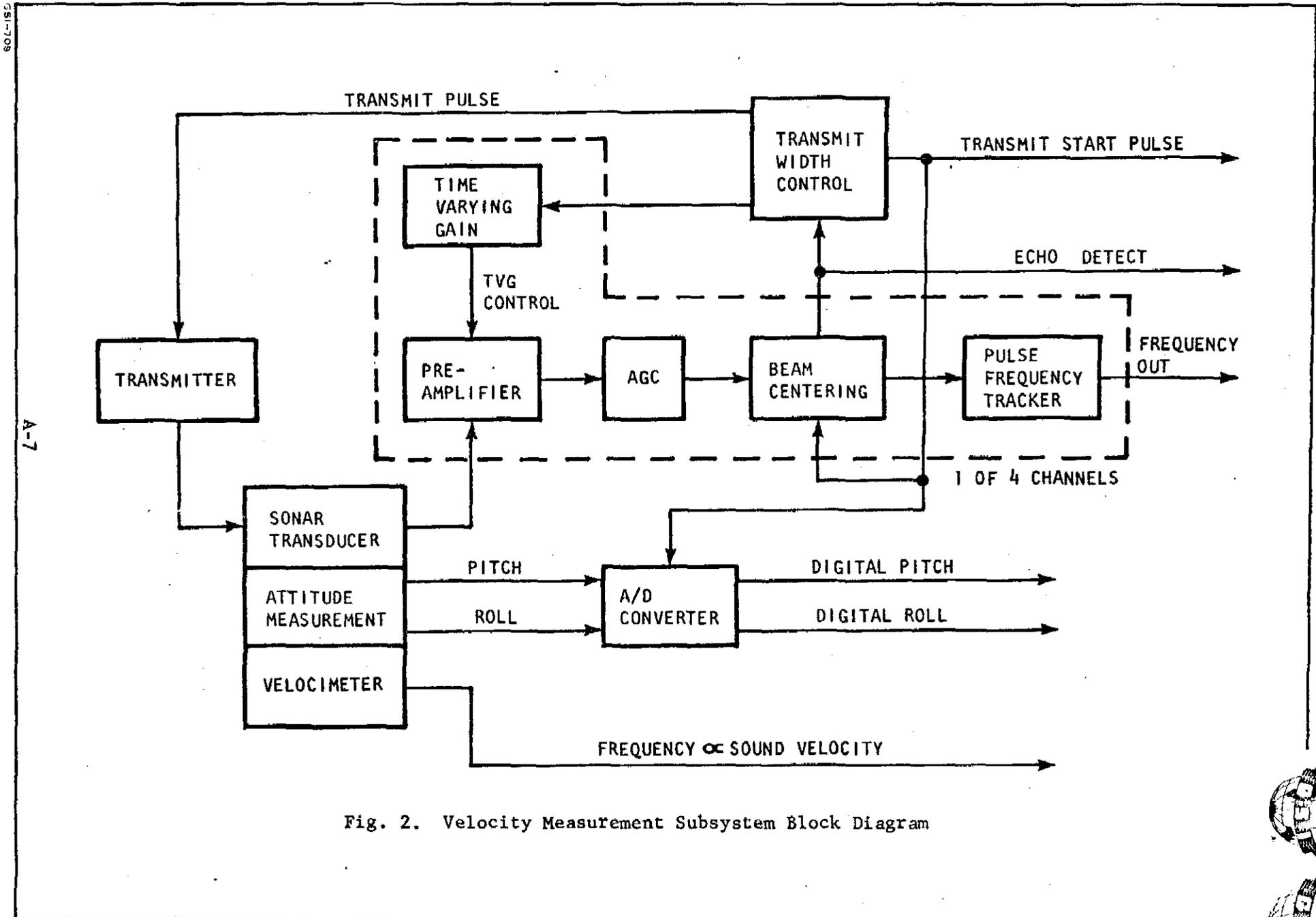


Fig. 2. Velocity Measurement Subsystem Block Diagram



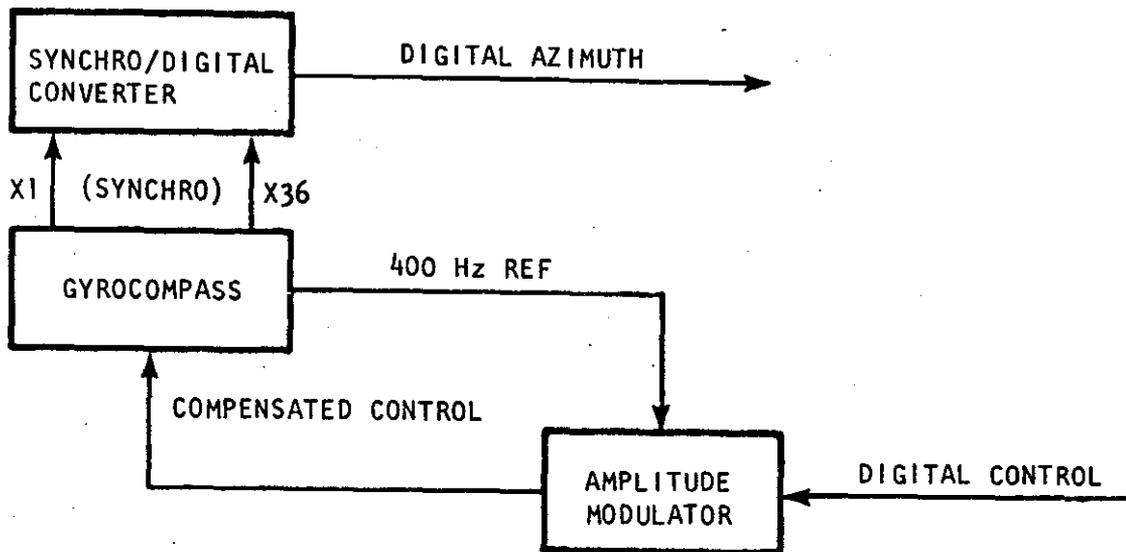


Fig. 3. Azimuth Measurement Subsystem Block Diagram.



Table I. Instrument Accuracy

Unit	Accuracy
Gyrocompass (with compensation)	0.2°
Doppler Sonar	
<100 Ftm	0.2%
100-160 Ftm	0.5%
Inclinometer	0.1°
Velocimeter	0.01%

Focal point of the GeoNav system is the TI 2540-3 (CP967(V)/UYK) digital computer; all sensor data must pass through the computer, and consequently, can be monitored by it. The GeoNav operating system software performs the satellite-fix solution and supplies velocity and azimuth measurement subsystem data to the dead reckoning system. The computer also performs position filtering, quality control of all sensors, and seismic-line and shot control. In this manner, data from all sensors are integrated to provide optimum continuous navigation, guidance, and shot control. In addition, data from the velocity measurement subsystem are used to compute the water depth for each sonar transmit/receive cycle. An extension of this technique permits using the system in bottom topography studies.

The system control panel, digital plotter, and printer/keyboard permit effectively using system outputs and system communications. A magnetic-tape unit is included for hardcopy data recording to permit post mission analysis.

The computer monitors the basic measurement processes of the various sensors. Anomalous measurements are noted and compensated for. The following paragraphs detail the techniques employed.



E. GEONAV SELF CONTAINED QUALITY CONTROL

1. Continuous Sensor Quality Control

The doppler sonar and associated parameters necessary for velocity measurement are of foremost importance. The basic sonar measurement provides a component of frequency from each of the four sonar axes (fore, aft, port, and starboard). These measurements are relative to the plane to which the sonar transducer is attached. Since this plane is normally free to roll and pitch with the vessel, vessel attitude must be measured. For similar reasons, the velocity of the vessel must be measured normal to the sonar transducer mounting plane. These sonar frequency measurements must be corrected for the velocity of sound in water. To complete the data set, the frequency of the transmitted sonar energy is required to resolve the velocity component normal to the sonar mounting plane.

In all cases, the basic measurement data are examined by the computer for reasonableness and rate of change; if found anomalous, the GeoNav operating system alerts the operator to the error condition. This is the most basic level of system quality control.

Another ancillary item of data measured by GeoNav is the time of arrival of the echoes from the four sonar beams with respect to the transmitted energy pulse. These measurements permit extension of GeoNav sonar quality control to include reasonableness of the locale of the sonar echoes. When combined with sound velocity data, these measurements extend GeoNav's usefulness as a depth-controlling device. The four sonar echoes per transmitted pulse also provide a powerful tool for bottom topography studies.

Likewise, data from the azimuth measurement subsystem are examined for reasonableness of magnitude and rate of change. The operator is informed of anomalies.



The value of this method of quality control is limited, however, since the rate of change of the variables can legitimately vary over a large range depending on the vessel's design and sea conditions. Hence, a wide range of variation must be permitted. Similarly, individual anomalous values are useful only in detecting obvious hardware malfunctions. What is required is an alternative means of verifying a sensor's performance by comparing its data with data from another source. The following paragraphs describe how GeoNav does this.

2. Quality Control on Satellite Position Fixes

Digital data received from the orbiting satellites are independent of the velocity and azimuth measurement subsystems comprising the dead reckoning system. Since the vessel's velocity and azimuth do affect the doppler count, fixes derived from the decoded data and associated doppler counts are not independent of the dead reckoning system. The following describes the quality control that verifies incoming satellite data, quality assurance during computation, and interpretation of results, all of which permits use of satellite fixes as independent references.

All data received from a satellite observation are preserved in the computer's memory. At the end of a satellite pass, the software performs a validation sequence verifying the quality of incoming data. Since the same data is received several times during one pass of the satellite, one validity test is to see whether repeated data bits actually appear identical in the computer. This bit majority voting is performed on like bits of like parameters over the entire range of redundant satellite messages stored in memory. In the event the bit error rate is excessive, the entire satellite observation is invalidated and the operator informed of the excessive error rate. When



this occurs, it is highly probable that there is a noisy receiver channel requiring repair or, less likely, a bad satellite being observed.

The two frequencies transmitted by the satellite are received by GeoNav, and the doppler counts received from the two receiver channels are preserved in memory. These data are reduced to refraction counts and compared against preset limits to insure reasonable refraction data. In case the refraction counts are not reasonable, the pass is rejected and the operator alerted that the receiver should be verified for proper operation of the doppler counters. All data are validated automatically in preparation for entering the satellite solution.

The bit majority voting scheme is altered when a satellite injection is detected. In this instance, the system attempts to utilize only data received following the injection to insure that the most current data and the best prediction of the satellite's orbit is used in the position-fix solution. Data received before the injection is ignored and replaced as necessary by extrapolating back based on parameters received after the injection, using curve-fitting techniques. Similar techniques are used to interpolate for parameters which may have been missed due to poor signal quality, fade, etc., or for parameter points at the short doppler intervals selected by the software system. The choice of whether to extrapolate is based on whether the following conditions (arranged in decreasing importance) can be achieved.

- A data set of valid fixed parameters
- A minimum range requiring extrapolation of variable parameters yet still coinciding with the maximum range of good doppler counts



- Maximum range of valid variable parameters
- Most recent data

This concludes the preprocessing of satellite data. The resulting data set is free of erroneous message data and invalid doppler counts.

Further quality control of satellite fixes is handled as an editing function. Inasmuch as satellite doppler and, more especially, the refraction count are known to degrade when the satellite is near the horizon, doppler counts received below 7.5° are rejected.

Another quality control tool available to GeoNav operators is a constant which specifies the minimum number of short doppler intervals on both sides of the satellite's closest approach which the software (GNSDOP) will demand before computing a fix. This constant insures symmetry of the data (same number of short doppler counts on each side of closest approach) and is an indirect control of the minimum satellite elevation angle acceptable to the system. If, after checking the aforementioned editing criteria the system determines that there is the required symmetry but not enough data above 7.5° (at least 10 short doppler intervals), the editing software will accept just enough short doppler segments below 7.5° (maintaining symmetry) to meet minimum requirements.

Additional control permits rejection of an entire satellite observation if any portion of the data was collected while the observation angle exceeded some angle selected by the operator. This angle is typically 70° to 75° and is adjusted according to satellite alerts for the area of operation.

The preceding paragraphs describe some major elements of editing included in the GeoNav satellite software package. Together, all of these insure a high degree of quality for the data entering into a satellite-fix



solution and intermediate to the solution. To use the resulting fix effectively as a measure of the quality of the GeoNav sensor subsystem data, the quality of a given fix solution must be measured. The GeoNav system does this with a unique, proprietary algorithm that estimates statistical variances north and east for the satellite fix. These estimates are not derived from a priori statistics of satellite fixes versus elevation angle but from only the incoming satellite data set. Figure 4 is a bull's-eye of satellite-fix distribution from a set of 100 fixes received in GSI's Dallas laboratory. These data were recorded with a minimum requirement of five short doppler segments on both sides of closest approach and with a maximum elevation angle of 75° .

The foregoing discussion covers the condition in which the satellite receiver is stationary. To obtain experimental data, a week of satellite observations were recorded on magnetic tape using a GeoNav system operating with the standard operating software. The resulting satellite fixes were tabulated, and known velocity and heading errors were introduced into the dead-reckoning or navigator's estimates. The satellite fixes were then recomputed and compared with the previously tabulated data and plotted. The resulting curves are those shown in Figures 5 and 6. It is noteworthy that the major component of satellite-fix error versus velocity error is that previously published in numerous journals. However, the smaller component of fix error shows a tendency to split, depending on the direction of satellite travel with respect to the observer, e.g., clockwise or counter-clockwise. These errors are as shown for 1 knot north in Figure 5 and 1 knot east in Figure 6 at latitude 32° N. These curves would converge to zero at the equator and be in reversed orientation in the southern hemisphere. In either

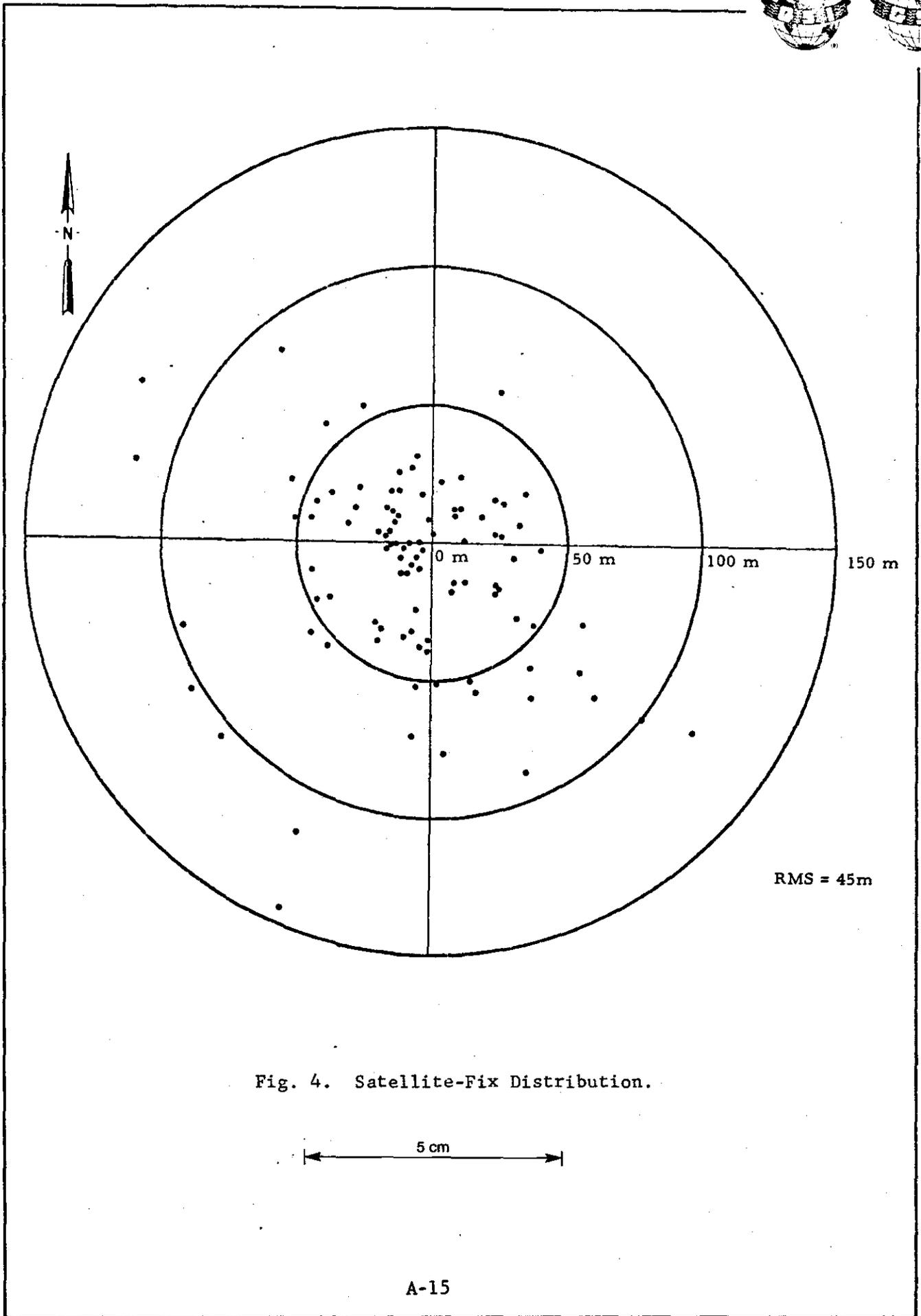


Fig. 4. Satellite-Fix Distribution.

5 cm

5 cm

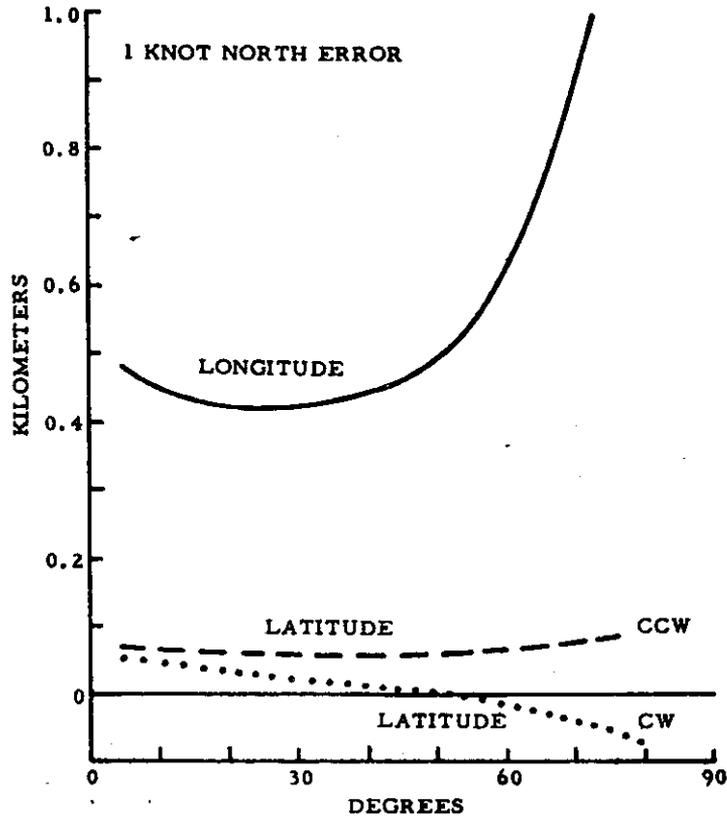
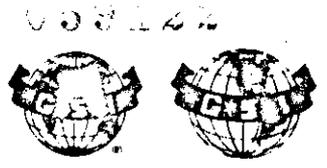


Fig. 5. Satellite Fix errors at Latitude 32°N, Due to Forced Dead Reckoning Errors.

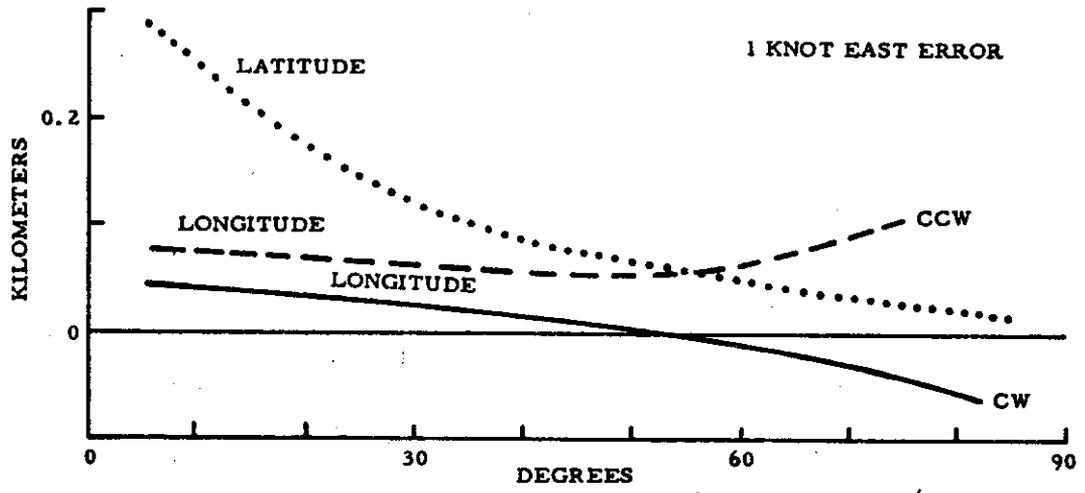


Fig. 6. Satellite Fix Errors at Latitude 32°N, Due to Forced Dead Reckoning Errors.



hemisphere, the magnitude of the error diverges as the pole is approached. In short, major satellite-fix errors are caused by dead-reckoning error, but the magnitude of these errors is such that they should be readily recognized. Hence, the problem reverts to one of identifying quality in a satellite-fix computation.

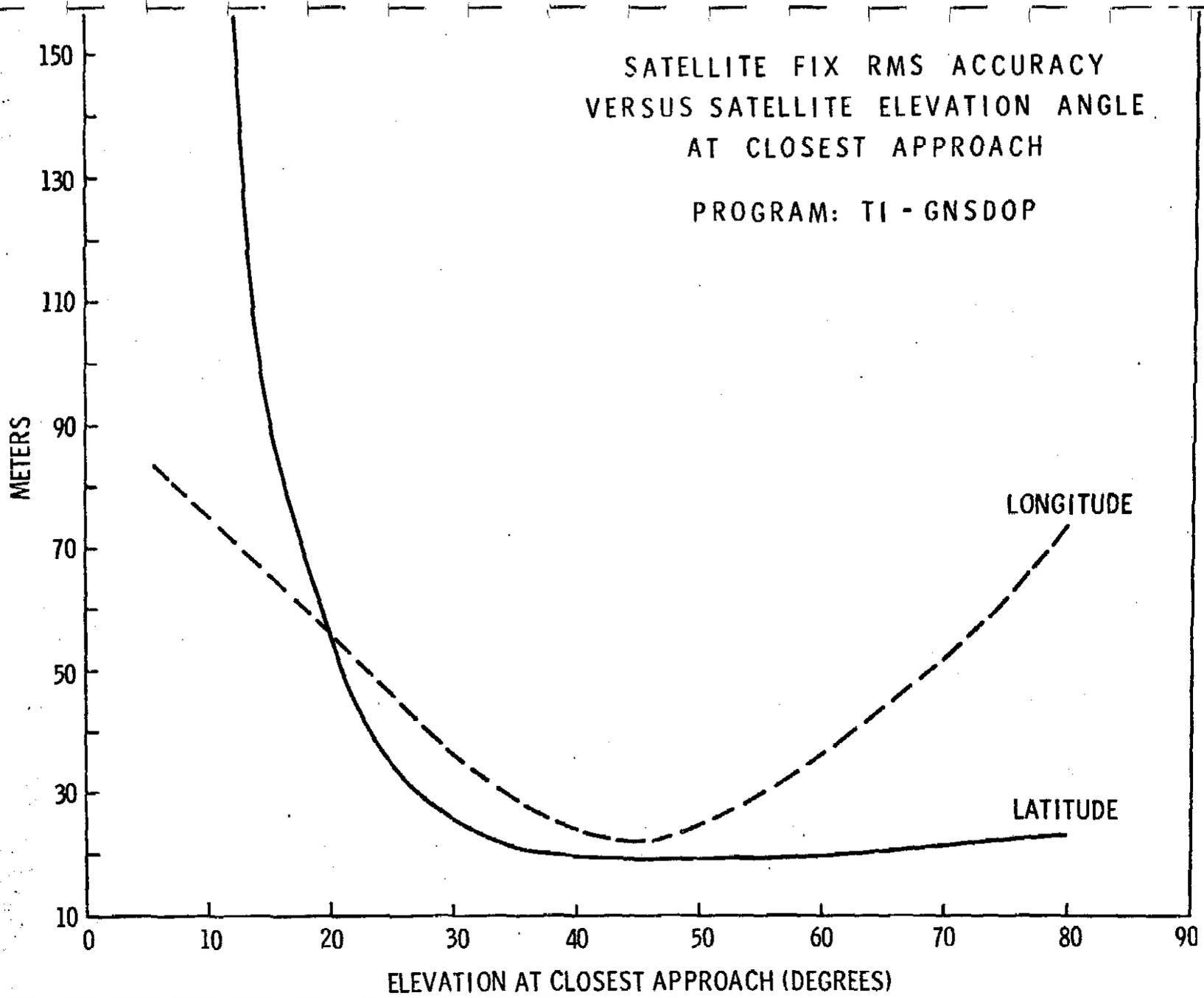
The previously described variances provided as part of the satellite-fix solution are independent of dead-reckoning error. To obtain a measure of the reliability of the variance computation, a set of satellite fixes was tabulated in the laboratory and each result and its variance estimates compared with the known antenna location. The curves shown in Figure 7 were obtained where the data were plotted as standard deviation versus satellite elevation angle. Figure 8 shows the same type of data recorded in the Far East while operating at approximately 40° S latitude. Figure 9 shows the difference between the variance estimate in the laboratory and the actual position error. This curve shows that the reliability of the variance estimate decreases at low elevation angles but that the estimate is reliable for satellites in the range 15° to 70° . Note that the error estimate tends to exceed the actual error, thereby avoiding an over-dependence on the satellite fix results. Hence, we have a reference with a reliable estimate of its accuracy which we can now use as a tool for verifying the quality of the velocity and azimuth measurement subsystems.

3. Velocity/Heading Quality Control

Velocity and azimuth subsystem performance can be evaluated by relating the position correction resulting from a satellite position fix to the distance between fixes. See Figure 10.

Fig. 7. Standard Deviation Versus Satellite Elevation Angle.

A-18



059124



5 cm

5 cm

059125

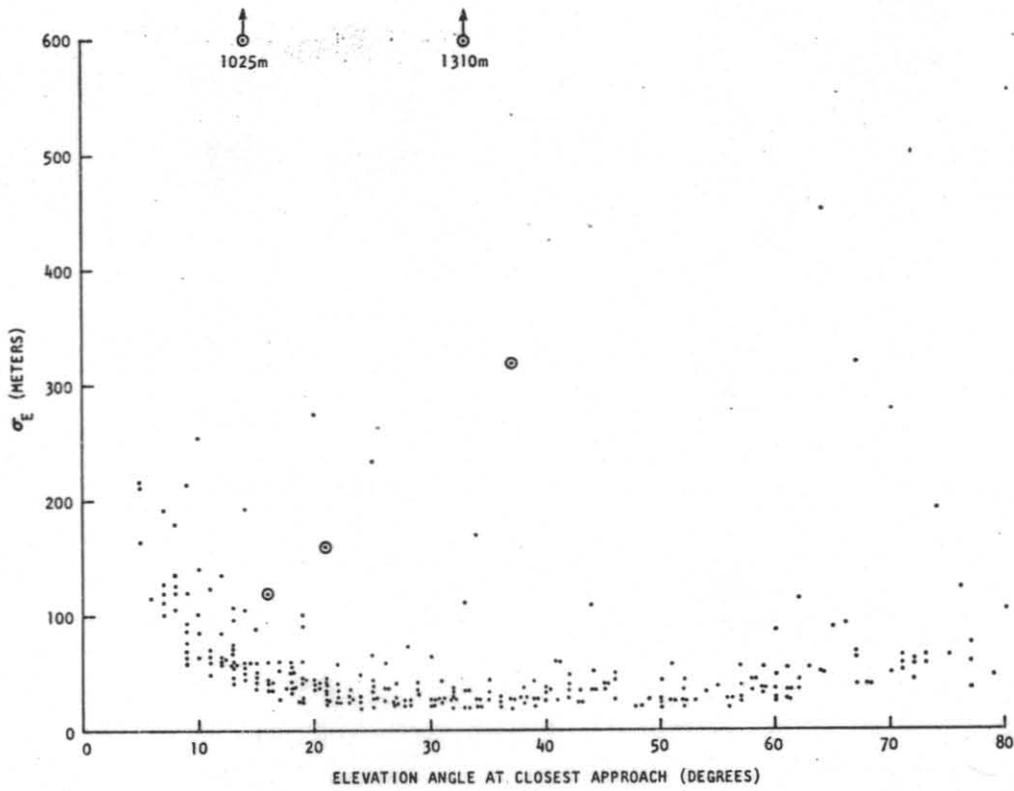
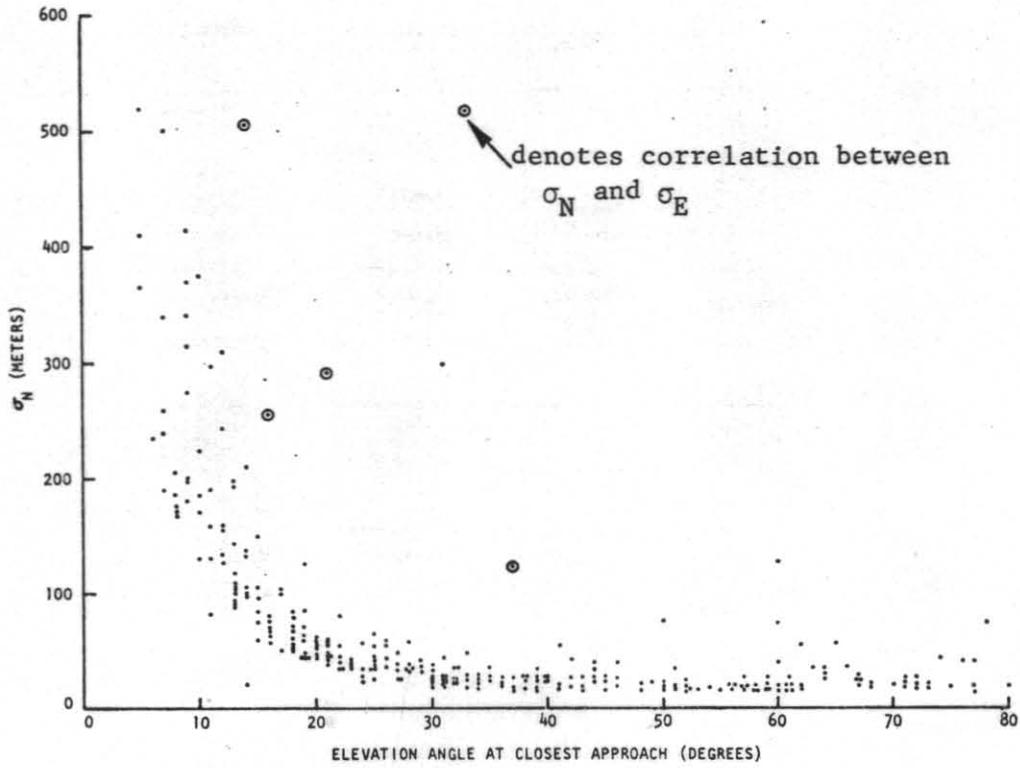


Fig. 8. Satellite-position Fix Standard-Deviation Estimate, Far East.

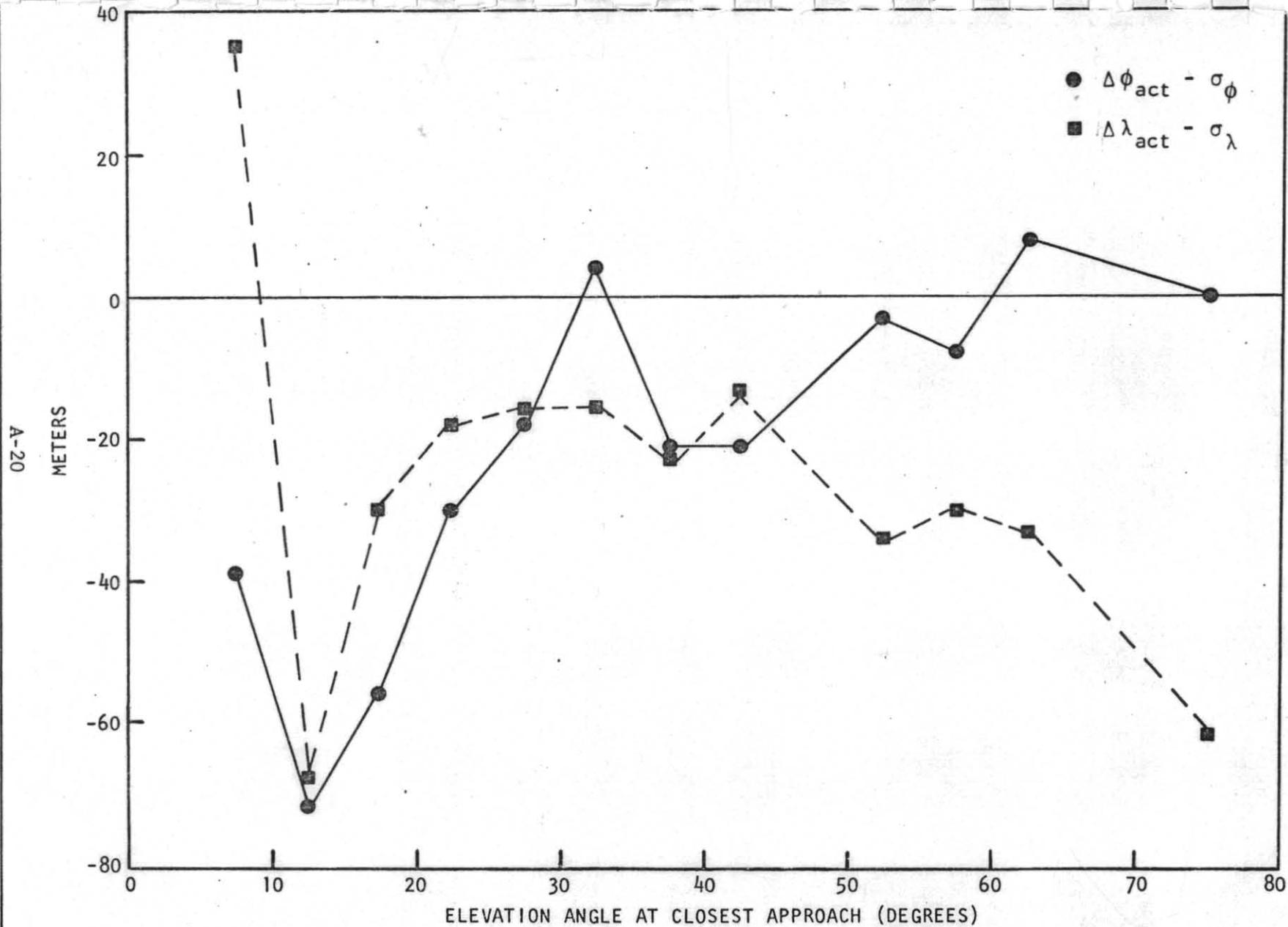


Fig. 9. Differences Between Variance Estimate In Laboratory and Actual Position Error.

5 cm



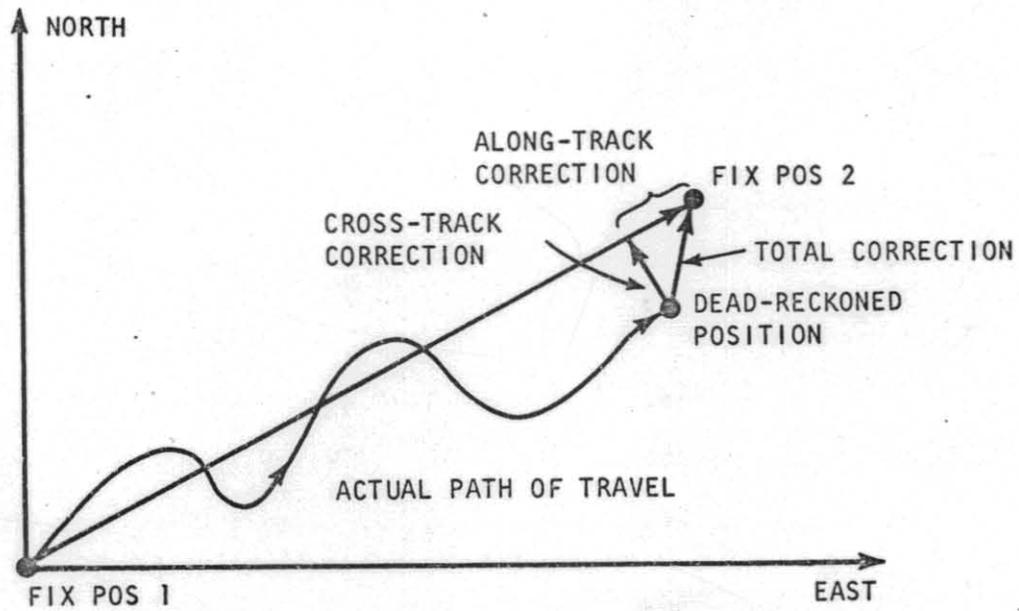


Fig. 10. Calibration Principle.



The total dead-reckoning error accumulated during the time between position fixes (fix interval) is a result of errors in along-track and cross-track velocity measurement and the error in azimuth measurement. Geometrically, this total error comprises two orthogonal error vectors. One vector is colinear with the direction of the shortest distance between each pair of position fixes. This component is basically the result of the error in the fore-aft or along-track velocity measurement. The orthogonal component combines the error in the port-starboard or cross-track velocity measurement and the error in measurement of the ship's azimuth. The heading error expresses any misalignment between the gyrocompass and the fore-aft direction as determined by the sonar beams. Thus, the error components are a direct and separate measure of average along-track and cross-track velocity errors. By prorating the vector magnitudes to the direct distance between fixes, we obtain relative or percent error factors.

Analytically, the total dead-reckoning error can be separated into total velocity error and heading error. In this, it is assumed that the relative errors in all velocity measurements are caused by the same sources, and higher-order cross-terms between velocity and heading error are ignored. The assumption is correct as far as the doppler sonar instrumentation is concerned and is plausible with respect to any environmental error sources.

Let

K = relative error in velocity measurements

θ_e = absolute heading error

Then

$$V_{\text{true}} = (1 - K)V_{\text{meas}}, \quad \text{true velocity}$$

$$\theta_{\text{true}} = \theta_{\text{meas}} - \theta_e, \quad \text{true heading}$$



In dead reckoning, the fore-aft, port-starboard, and up-down velocities about the measured azimuth are resolved into velocity-north and velocity-east components, which are subsequently integrated over time:

$$\phi = \phi_0 + \int_T \frac{VN}{R_N(\phi)} dt, \text{ latitude}$$

$$\lambda = \lambda_0 + \int_T \frac{VE}{R_E(\phi)} dt, \text{ longitude}$$

where (ϕ_0, λ_0) is an initial position, VN and VE are the velocity-north and -east components, and R_N and R_E are the radii of the earth's curvature in north and east directions.

Each velocity component contains an error which is a function of both the relative velocity error, K, and the heading error, θ_e . Therefore, dead-reckoned latitude and longitude also contain errors which are (different) functions of the error parameters, K, θ_e :

$$\phi_e = f(K, \theta_e)$$

$$\lambda_e = g(K, \theta_e)$$

A position fix, if sufficiently accurate, immediately yields the position error (ϕ_e, λ_e) . By neglecting second- and higher-order cross-terms as mentioned, the error parameters or "calibration factors" K and θ_e can be found directly.

Two requirements must be met for satisfactory calibration:

- The fixes at either end of the dead-reckoning interval must be sufficiently accurate
- The direct distance between fixes must be sufficiently large



For example, for a distance of 10 km between lines, a 100-m radial fix error causes an error of 1% in velocity calibration or $0.01 \text{ rad} = 0.57^\circ$ in heading calibration.

The calibration method is independent of the actual travel path between fixes because deterministic errors compensate when traveling in opposite directions. In this respect, closed-loop navigation never reflects deterministic error, and the error at loop closure results from accumulated random errors. Thus, separate measurement of deterministic velocity and heading errors derived from position fixes of known accuracy have been established. At each satellite fix GeoNav prints out the estimated fix accuracy, the distance between fixes, and the calibration factors, plus all other necessary position update information, therefore providing continuous performance evaluation.

This velocity/heading calibration principle has been exercised extensively: first, in testing doppler sonar and gyrocompass instrument errors in the Gulf of Mexico in March 1970 by sailing between oil rigs, where the accurately known positions were substituted for satellite fixes; second, in the same period with a simulated seismic survey performed against electronic positioning; and third, by continuous data collection from actual worldwide field operations. Table II shows that the calibration factors obtained from the test run between known, fixed positions agree with the instrument errors specified.



Table II. Velocity-Heading Error Statistics

Distance Traveled (km)	Heading Error (m)	Velocity Error (m)	Total Error RMS (m)
24.1 (E→W)	-4.2	24	24
24.1 (W→E)	≈ 0.0	0	0
24.1 (E→W)	16.8	-24	29
24.1 (W→E)	29.4	0	29
24.1 (E→W)	4.2	-24	24
24.1 (W→E)	16.8	+48	51
44.5 (NE→SW)	96.0	-89	131
44.5 (SW→NE)	8.0	0	8

TPR OR-015

VOL. 2

TPR
OR-015

OFFSHORE
BASS BASIN
PART 15 Vol 2/2

FLINDERS SEISMIC SURVEY
HEMATITE PETROLEUM PTY. LTD.

MARCH 7, 1974

059132

DOCUMENT WALLETS No.2

PLATES

- I Yellow Horizon
7918; 8017; 8018; 8117; 8118
- II Red Horizon
7918; 8017; 8018; 8117; 8118
- III Yellow Horizon Toolka Area
- IV Red Horizon Toolka Area
- V Blue Horizon Area
- VI Red Horizon Velocity Anomaly
7918; 8017; 8018; 8117; 8118
- VII Yellow Horizon Velocity Anomaly
7918; 8017; 8018; 8117; 8118
- VIII Refraction Delay Time Profile
HB73A-137

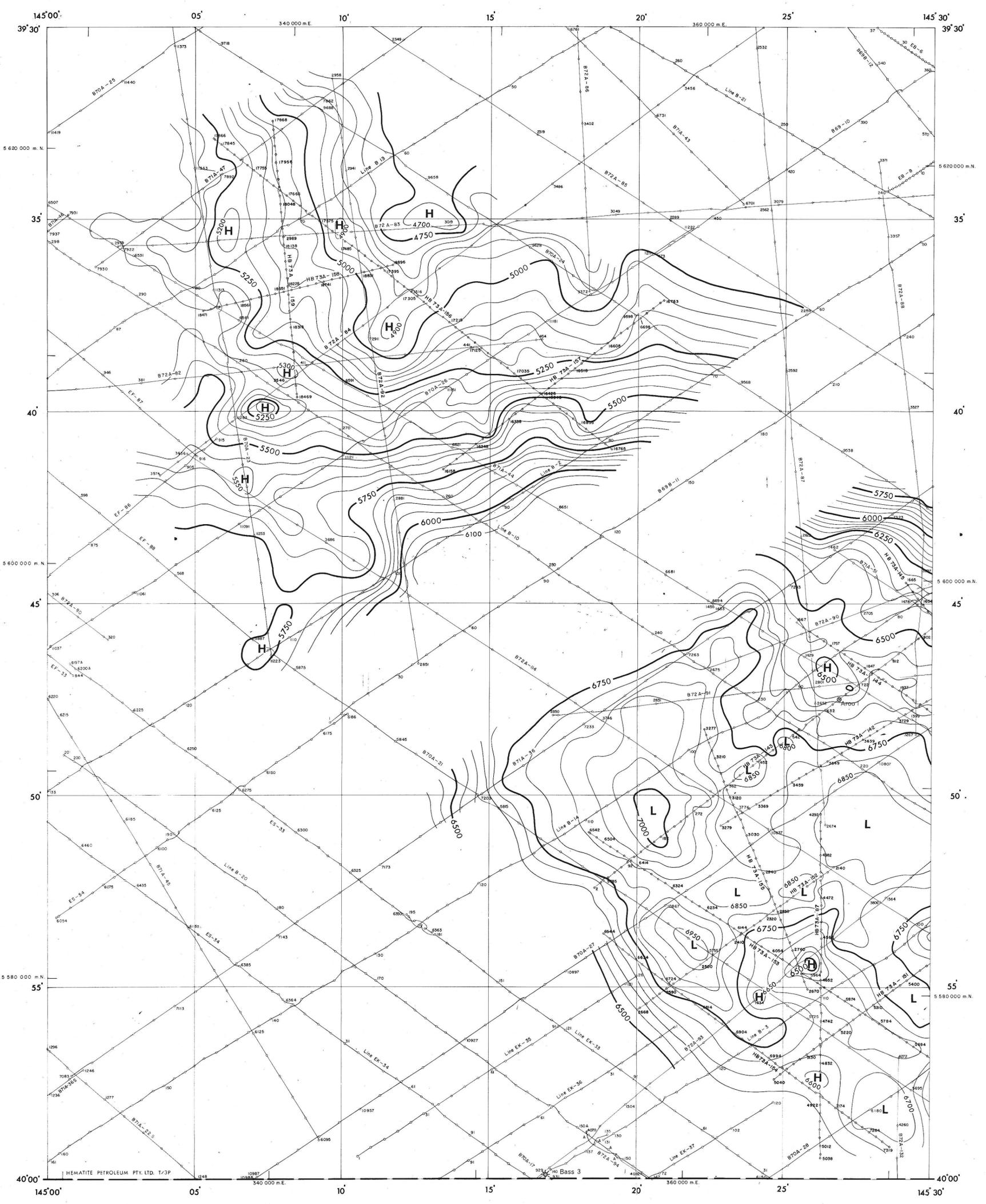
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- 2. Wynyard or K55-2 OG 3185-1
- 3. King or J55-13 OG 3185-2

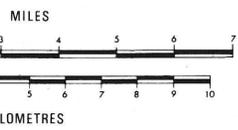
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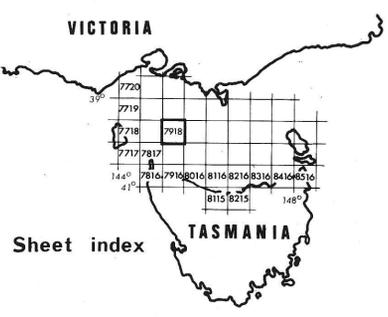
PLEASE



Scale 1:100,000



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Revised, February 1974

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

FLINDERS SEISMIC SURVEY
YELLOW HORIZON

5 cm

- LEGEND**
- --- Oil Well
 - * --- Gas Well
 - * --- Oil & Gas Well
 - --- Oil show
 - * --- Gas show
 - * --- Oil & Gas shows
 - --- Drilling
 - --- Dry hole (Abandoned)

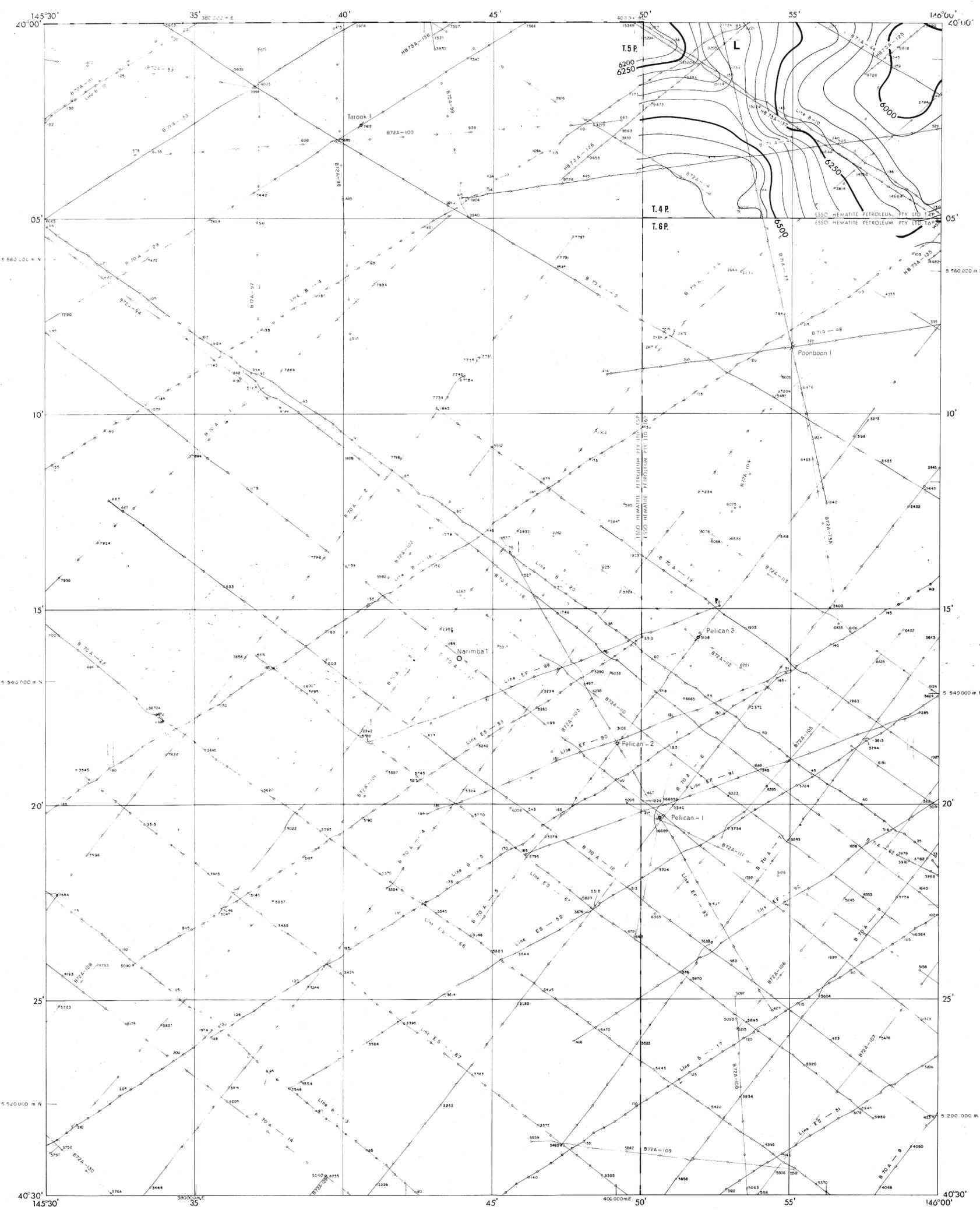
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Author: M. McNichol Drawn by: J. Bloye
Date: February 1974 Checked by: G. Hosking

Plate 1

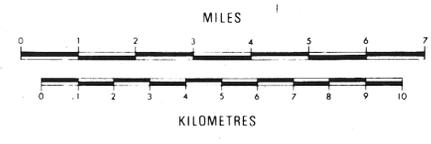
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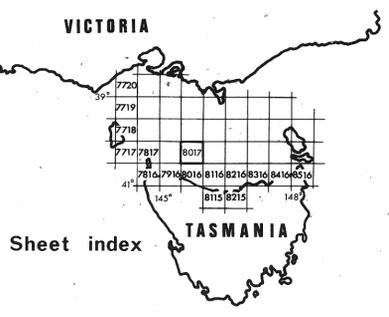
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Scale 1:100,000



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Projection, UTM Zone 55 C.M. 147E



- LEGEND**
- --- Oil Well
 - --- Gas Well
 - ⊛ --- Oil & Gas Well
 - --- Oil show
 - --- Gas show
 - ⊛ --- Oil & Gas shows
 - --- Drilling
 - ⊘ --- Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN
FLINDERS SEISMIC SURVEY
YELLOW HORIZON

Contour interval: 50 feet (B.S.L.) Datum: Sea Level
Author: M. McNicol Drawn by: B. Hale
Date: February 1974 Checked by:

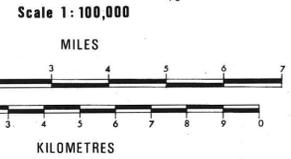
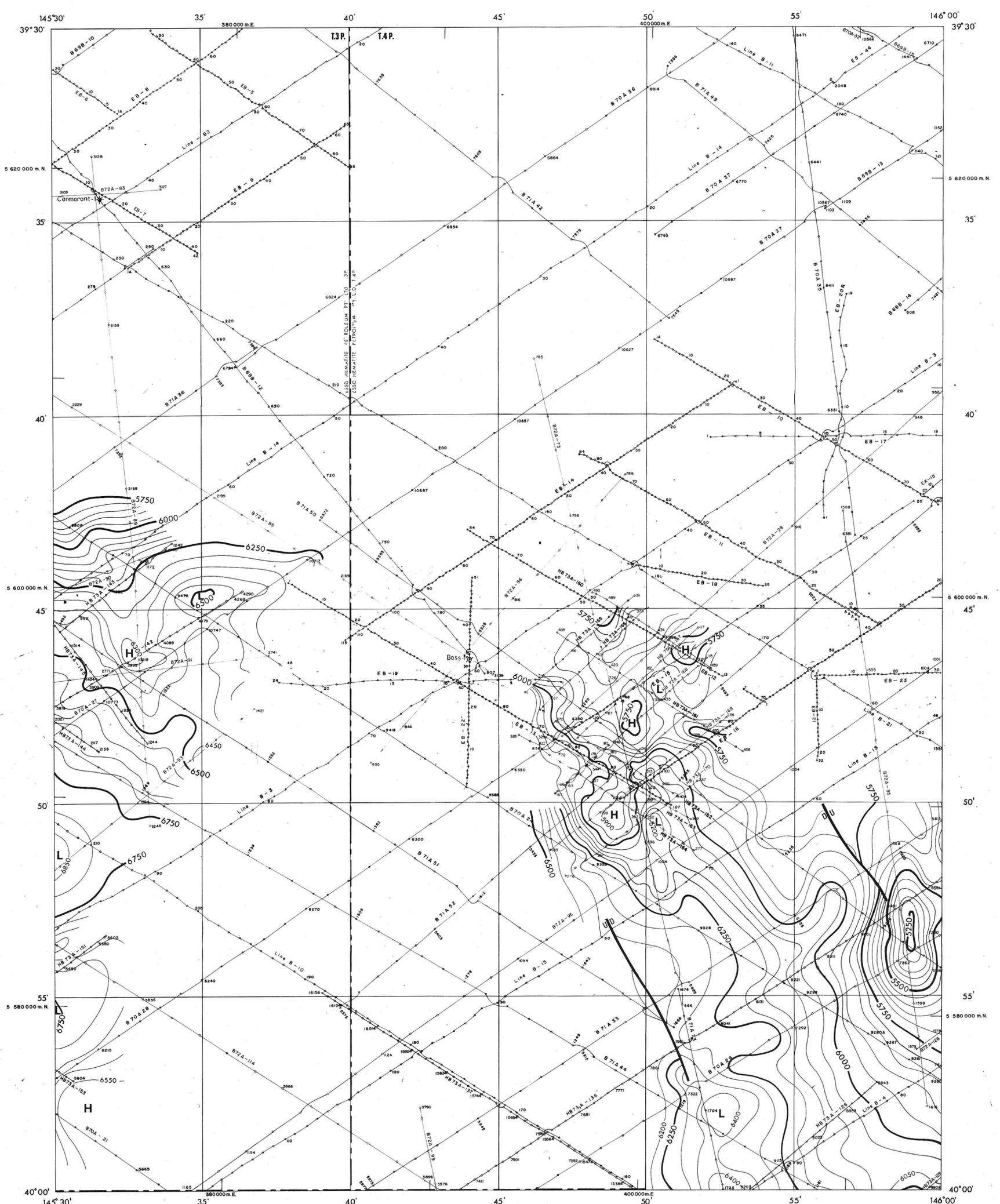
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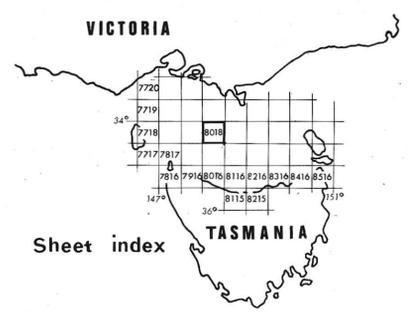
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OR-015

Bass Basin part XV



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 BASS BASIN

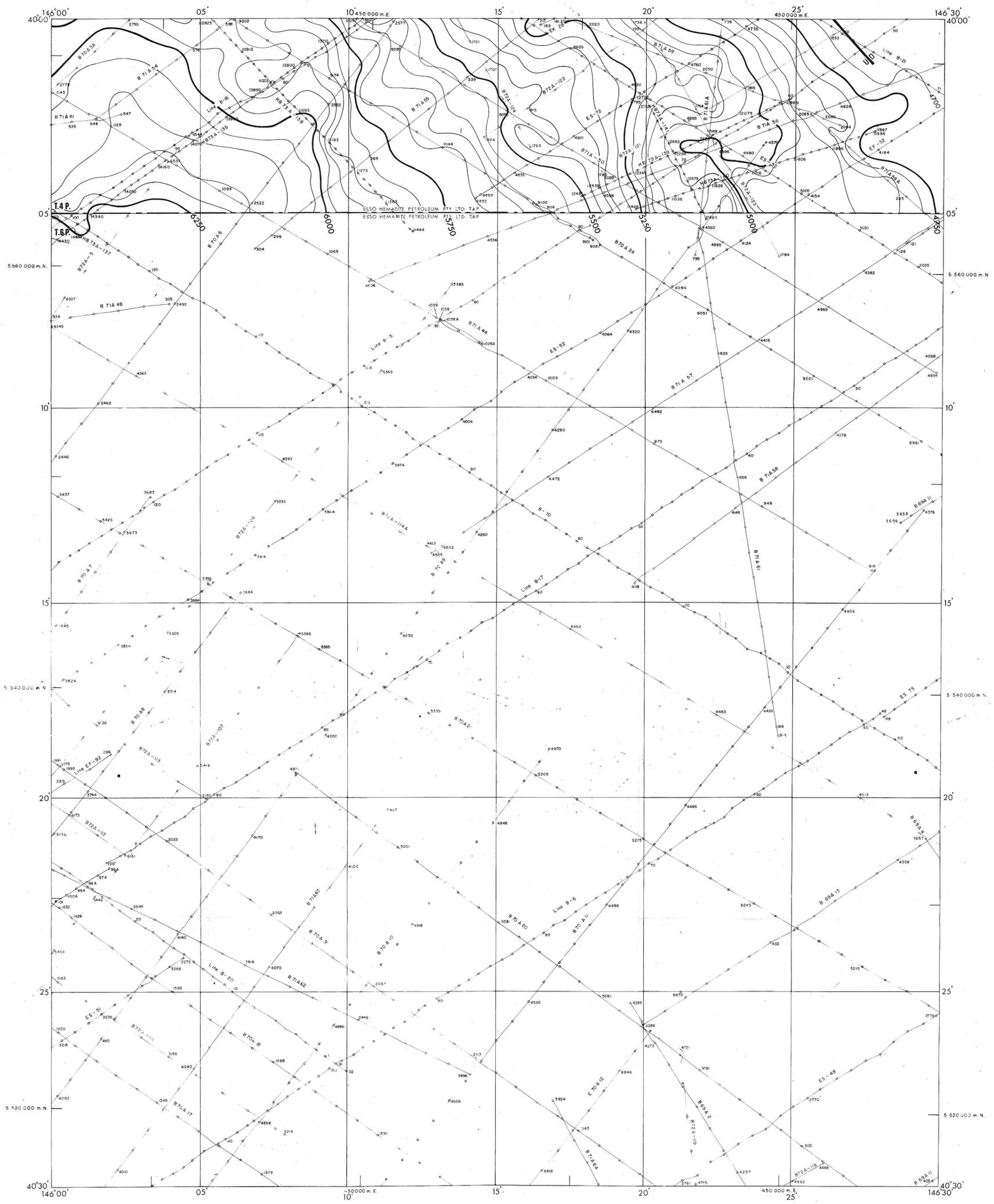
FLINDERS SEISMIC SURVEY
YELLOW HORIZON

Contour interval 50 feet (B.S.L.) Datum Sea Level
 Author M. McNicol Drawn by B. Hale
 Date February 1974 Checked by

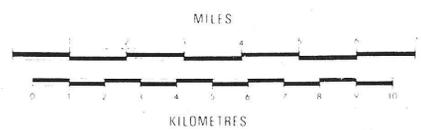
- LEGEND**
- Oil Well
 - ⊙ Gas Well
 - ⊙ Oil & Gas Well
 - Oil show
 - ⊙ Gas show
 - ⊙ Oil & Gas shows
 - Drilling
 - ⊙ Dry hole (Abandoned)

Plate I 059135

SHEET 8018



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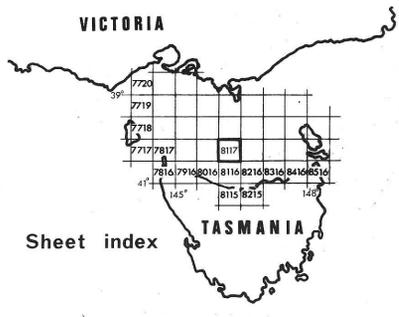


HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

FLINDERS SEISMIC SURVEY
YELLOW HORIZON

5 cm

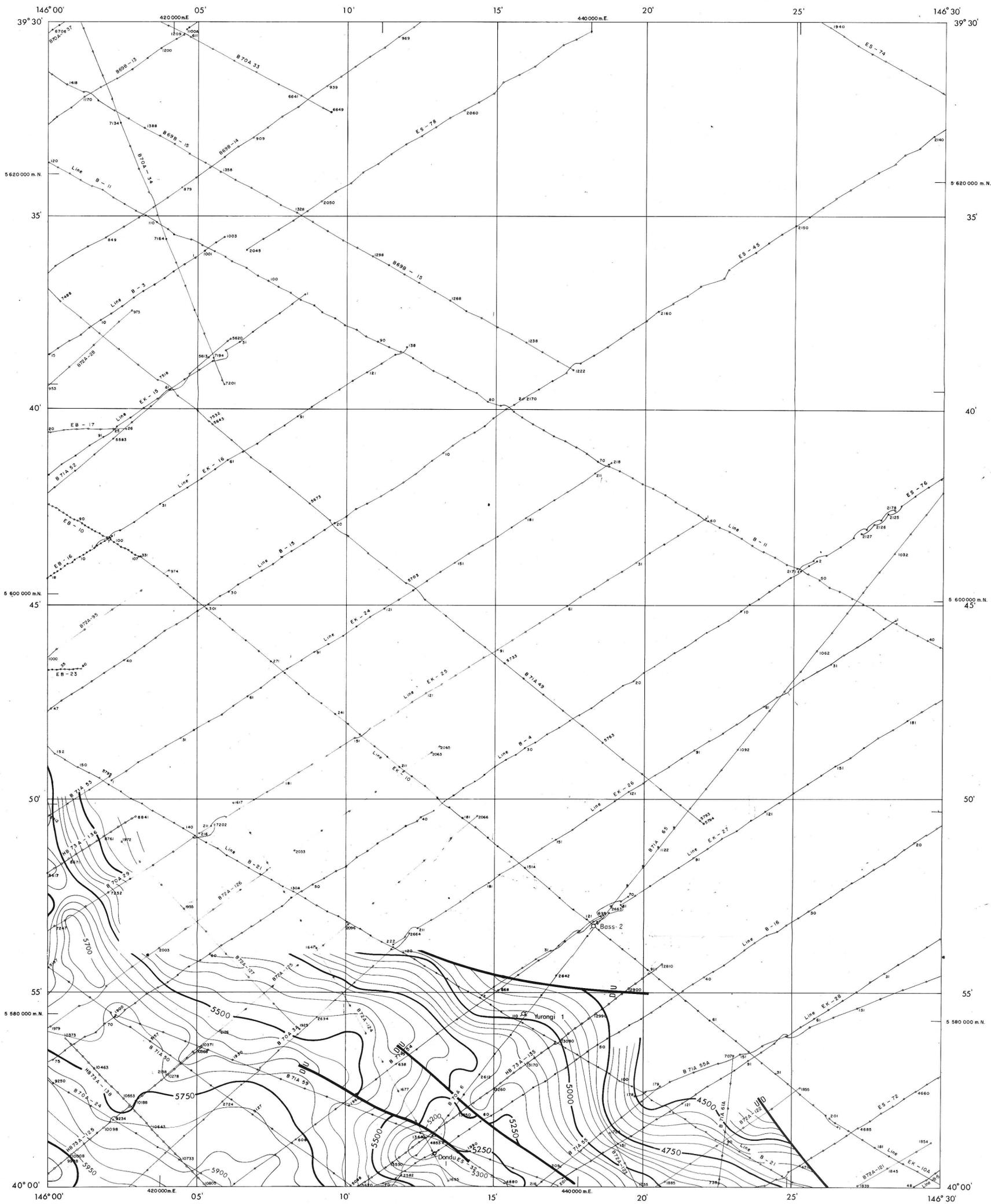
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Author: M. McNicol Drawn by: B. Hale
Date: February 1974 Checked by:



- LEGEND**
- Oil Well
 - ⊙ Gas Well
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 - ⊙ Gas show
 - ⊙ Oil & Gas shows
 - Drilling
 - ⊙ Dry hole (Abandoned)

Plate 1
SHEET 8117

Bass Basin part XV



Scale 1:100,000

MILES



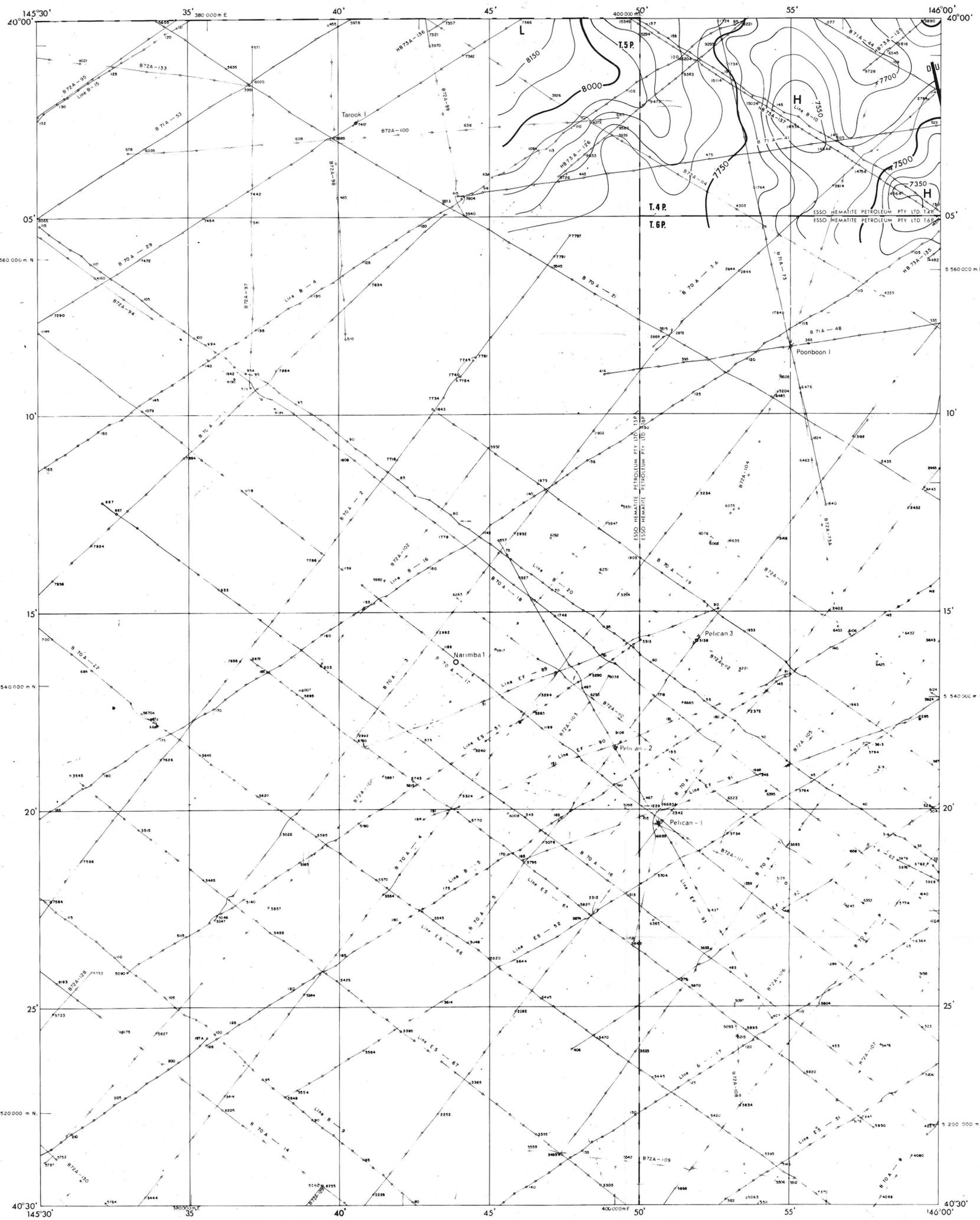
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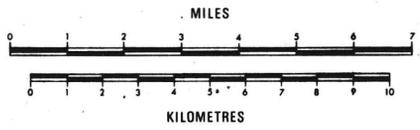
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Projection UTM Zone 55 C.M. 147° E.

LEGEND

- --- Oil Well
- ★ --- Gas Well
- ★ --- Oil & Gas Well
- --- Oil



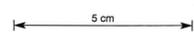
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HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

FLINDERS SEISMIC SURVEY

RED HORIZON



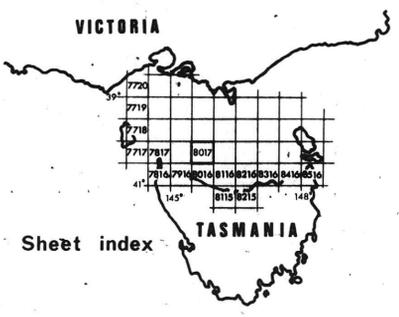
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Author M. Mc Nicol
Date February 1974
Drawn by B. Hale
Checked by G. Hosking

Contour values shown in feet below datum

Plate II 059139

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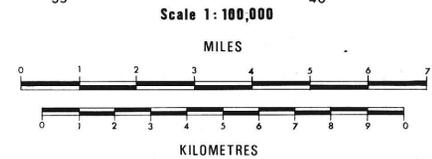
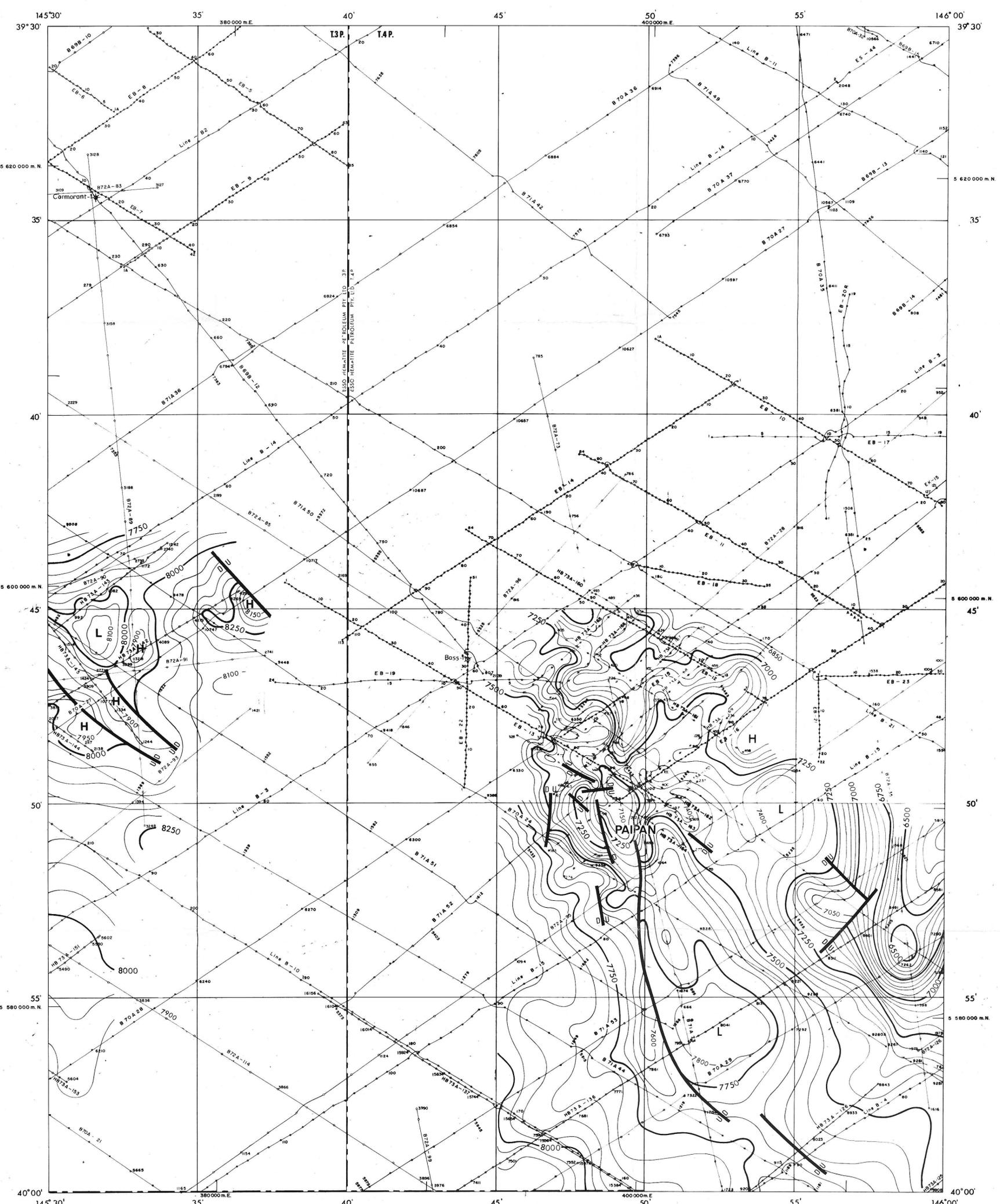
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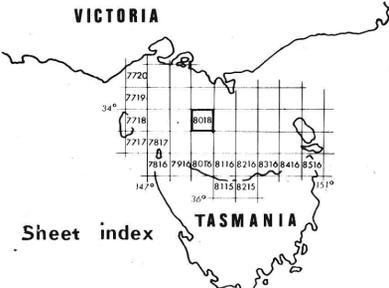
LEGEND

- Oil Well
- Gas Well
- ⊛ Oil & Gas Well
- Oil show
- Gas show
- ⊛ Oil & Gas shows
- Drilling
- ⊘ Dry hole (Abandoned)

Compiled by Hematite Petroleum Pty. Ltd.
Projection UTM Zone 55 C.M. 147°E.



Compiled by Hematite Petroleum Pty. Ltd.
 Projection, UTM, Zone 55, C.M. 147°E



HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN

FLINDERS SEISMIC SURVEY

RED HORIZON



- LEGEND**
- --- Oil Well
 - ⊙ --- Gas Well
 - ⊙ --- Oil & Gas Well
 - --- Oil show
 - --- Gas show
 - ⊙ --- Oil & Gas shows
 - --- Drilling
 - ⊙ --- Dry hole (Abandoned)

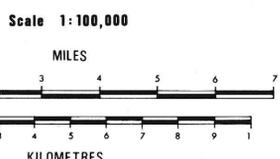
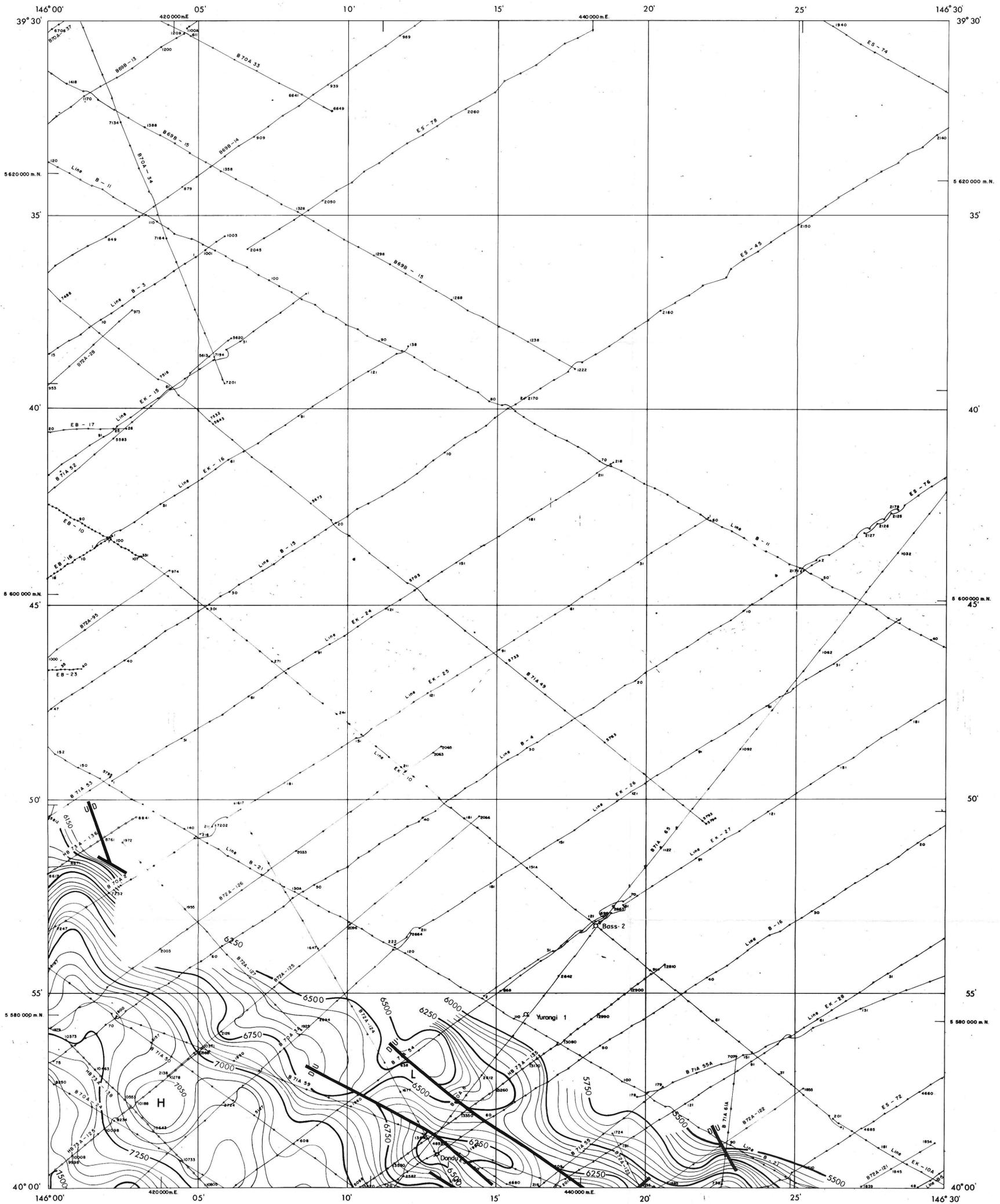
Contour interval - 50 feet Date - February 1974
 Datum - Sea level Drawn by B. Hale
 Author - M. Mc Nicol Checked by G. Hosking

Contour values shown in feet below datum

Plate II 059140

SHEET 8018

OR 015

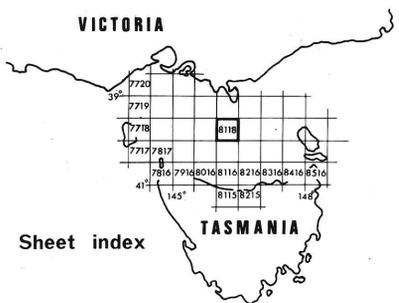


HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN
 FLINDERS SEISMIC SURVEY
RED HORIZON

Contour interval: 50 feet
 Datum: Sea level
 Author: M. McNicol

Date: February 1974
 Drawn by: B. Hale
 Checked by: G. Hosking

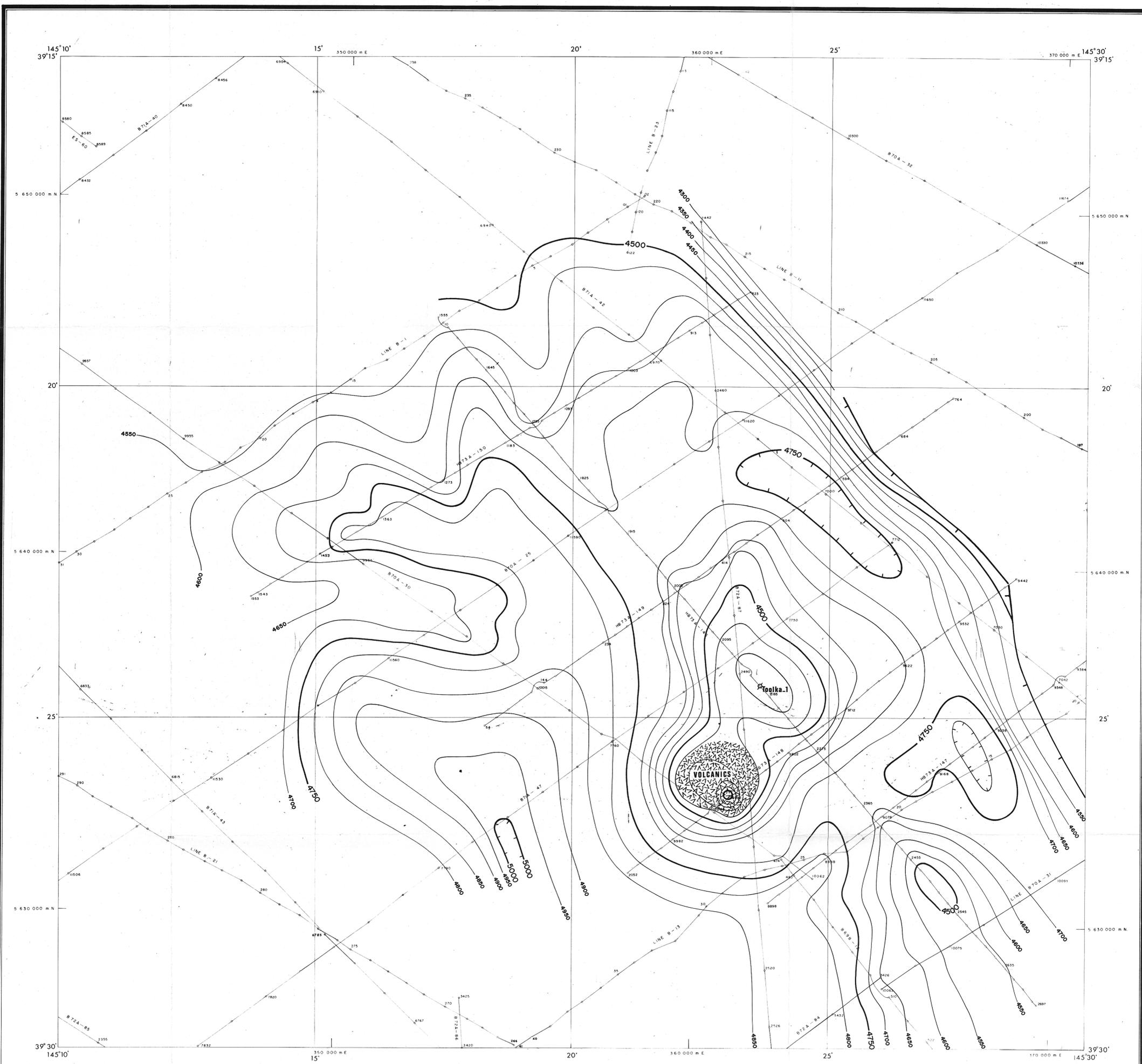
Contour values shown in feet below datum



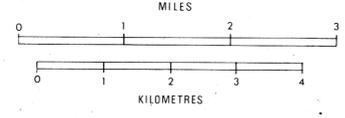
Compiled by Hematite Petroleum Pty. Ltd.
 Projection UTM Zone 55 C.M. 147° E.

- LEGEND**
- Oil Well
 - ☼ Gas Well
 - ☼ Oil & Gas Well
 - Oil show
 - Gas show
 - ☼ Oil & Gas shows
 - Drilling
 - ∅ Dry hole (Abandoned)

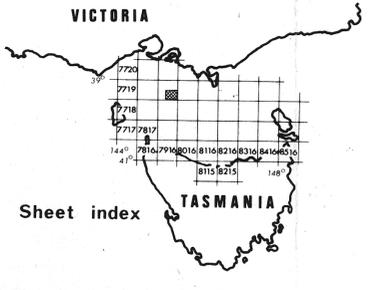
Plate II
SHEET 8118



Scale 1: 50,000



Compiled by Hematite Petroleum Pty Ltd.
Projection: UTM Zone 55 C.M. 142°E

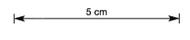


LEGEND

- --- Oil Well
- ★ --- Gas Well
- ✱ --- Oil & Gas Well
- --- Oil show
- ✱ --- Gas show
- ✱ --- Oil & Gas shows
- --- Drilling
- ∅ --- Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

TOOLKA PROSPECT



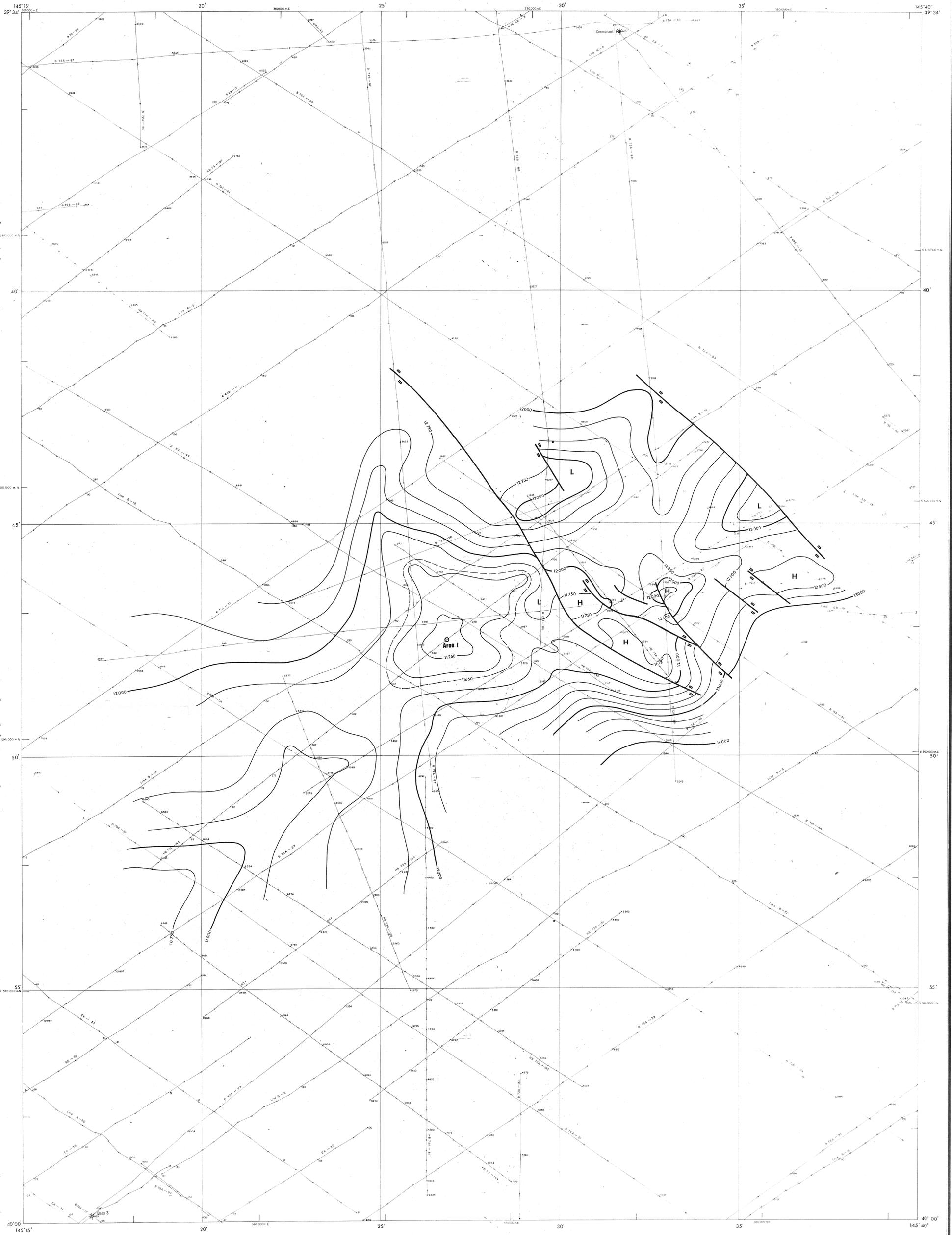
YELLOW HORIZON

Contours in feet below sea level. Contour interval 50 feet
Author: J. Denham Date: November 1973

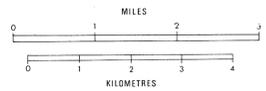
Plate III

059243

OR 015
OG 3256



Scale 1 : 50 000



Compiled by Hematite Petroleum Pty Ltd
Projection UTM Zone 55 CM 142°E

LEGEND

- Oil Well
- Gas Well
- Oil & Gas Well
- Oil show
- Gas show
- Oil & Gas shows
- Drilling
- Dry hole (Abandoned)

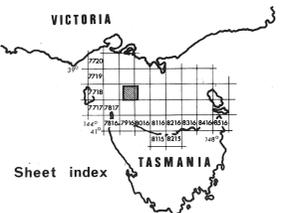
HEMATITE PETROLEUM PTY. LTD
BASS BASIN
ARCO PROSPECT



BLUE HORIZON

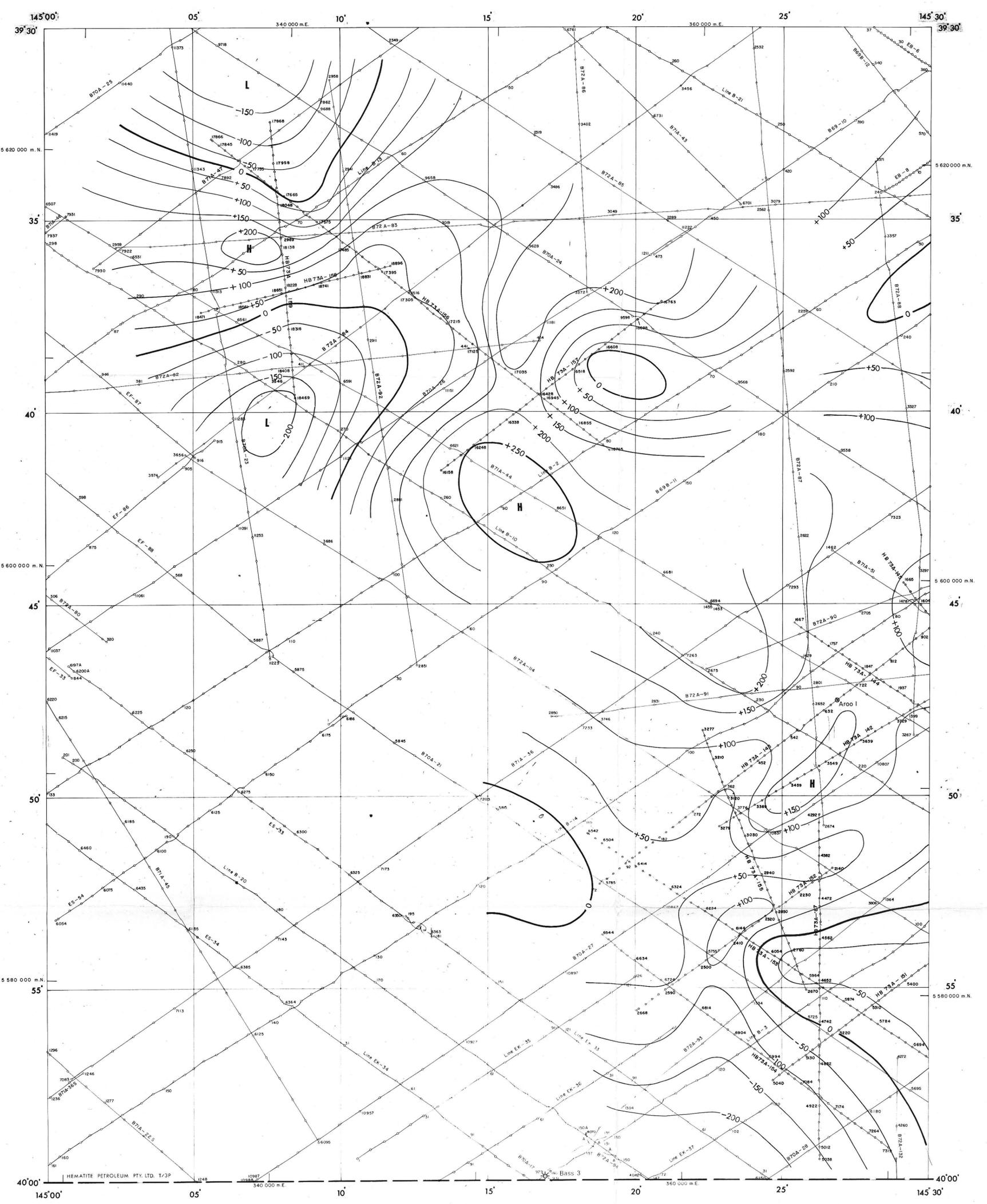
Contour interval: 250 feet Datum: Sea level
Author: J. Denham M. McNeil E. Urschel Date: November 1973

Plate V

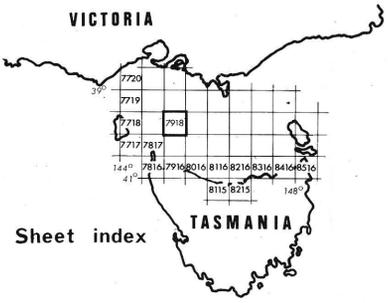
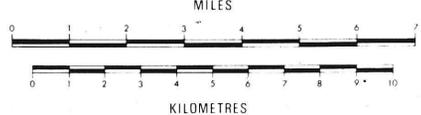


Sheet index

Encl. 5 CR 015
06 3254



Scale 1:100,000



Compiled by Hematite Petroleum Pty Ltd
 Projection UTM Zone: 55 C M 147°E.

- LEGEND**
- Oil Well
 - Gas Well
 - ⊛ Oil & Gas Well
 - Oil show
 - ⊛ Gas show
 - ⊛ Oil & Gas shows
 - Drilling
 - ⊛ Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN

**FLINDERS SEISMIC SURVEY
 RED HORIZON
 VELOCITY ANOMALY**

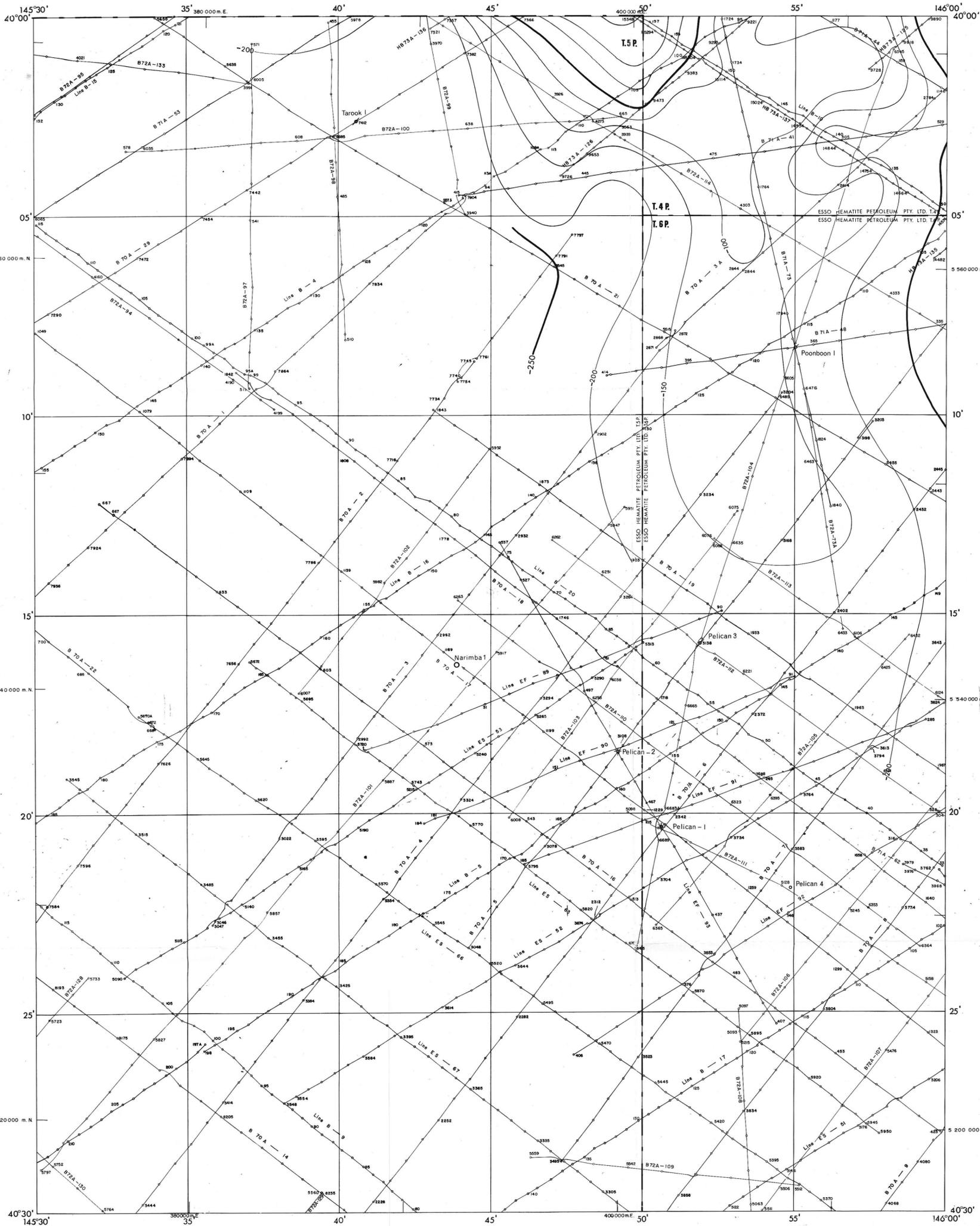
059146
 Contour intervals: 50 feet Datum: Sea level

Author: M. McNicol Date: 22nd February, 1974

Plate VI

SHEET 7918

OR 015



Scale 1:100,000

MILES



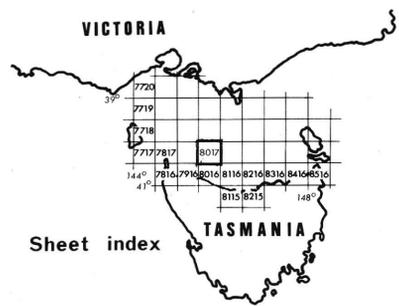
KILOMETRES



Compiled by Hematite Petroleum Pty. Ltd.
Projection, UTM, Zone 55, C.M. 147°E

LEGEND

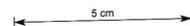
- --- Oil Well
- --- Gas Well
- ⊛ --- Oil & Gas Well
- --- Oil show
- --- Gas show
- ⊛ --- Oil & Gas shows
- --- Drilling
- --- Dry hole (Abandoned)



Sheet index

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

**FLINDERS SEISMIC SURVEY
RED HORIZON
VELOCITY ANOMALY**



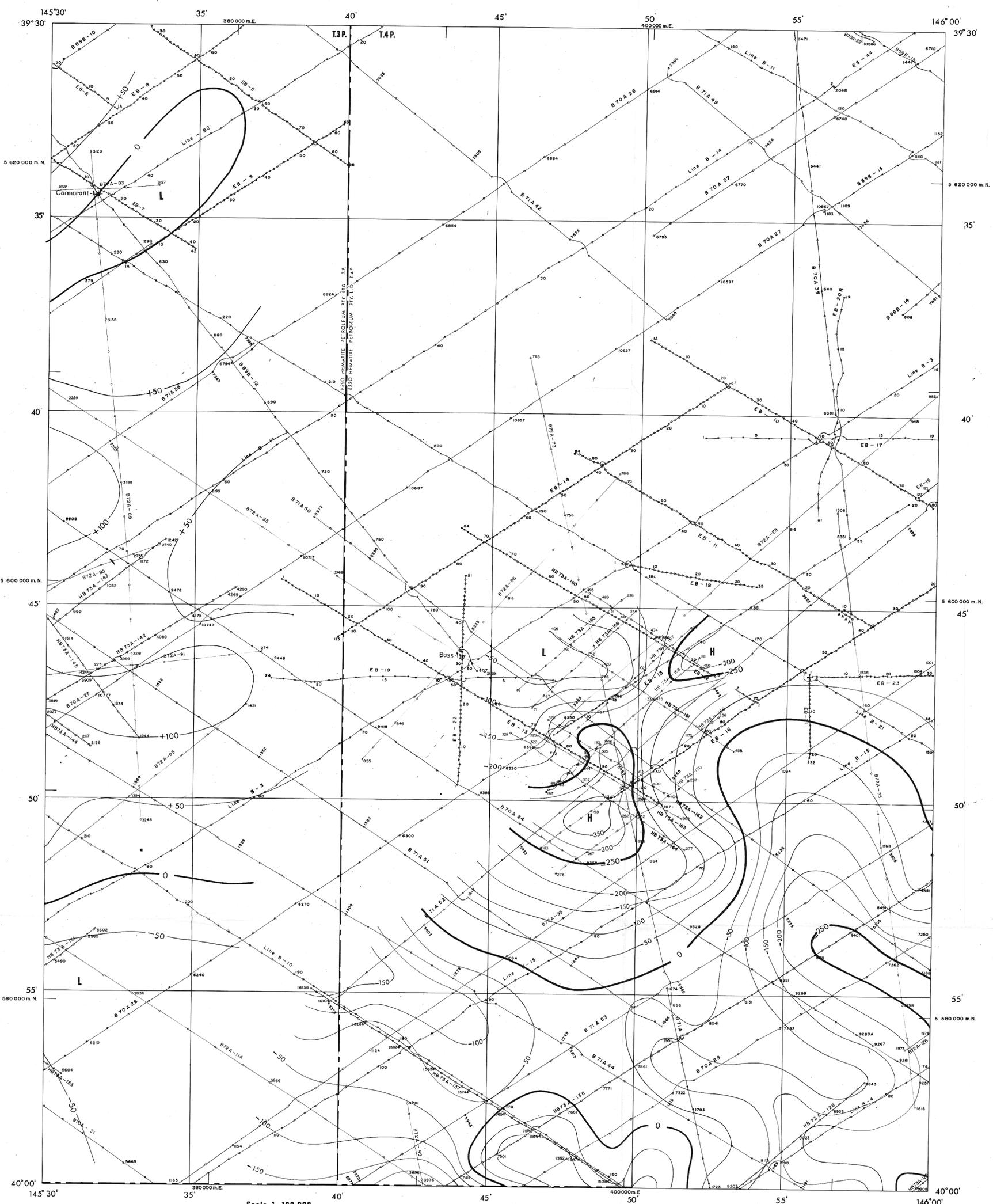
Contour intervals: 50 feet Datum: Sea level

Author: M. Mc Nicol Date: 22nd January, 1974

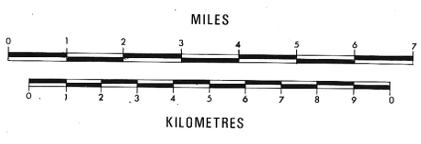
Plate VI 059147

SHEET 8017

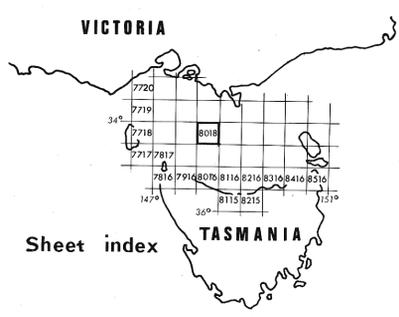
OR C15



Scale 1:100,000



Compiled by Hematite Petroleum Pty. Ltd.
Projection, UTM, Zone 55, C.M. 147°E



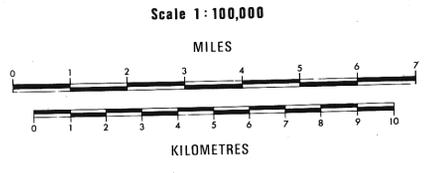
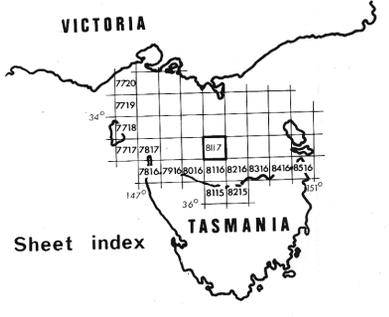
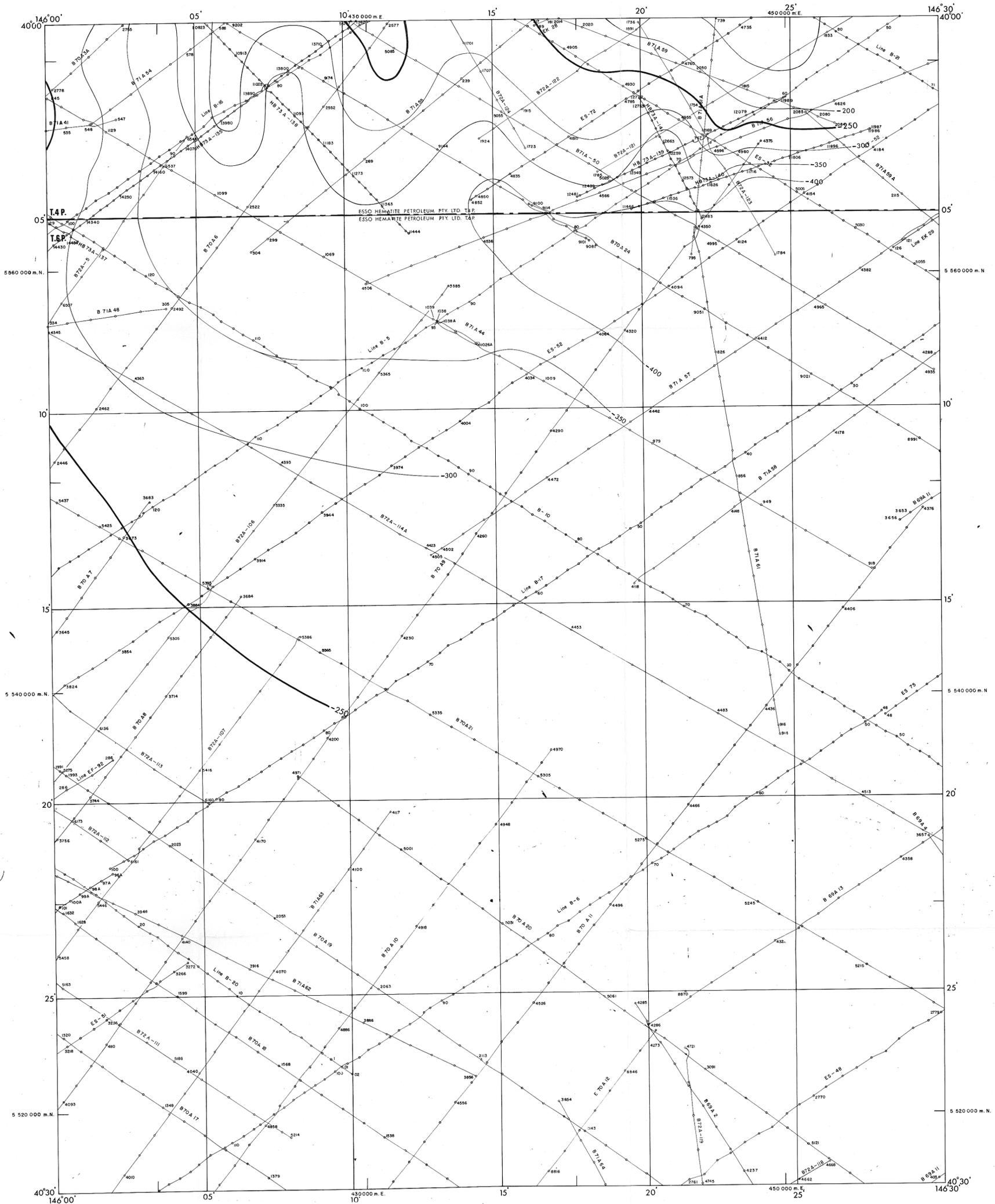
HEMATITE PETROLEUM PTY. LTD.
BASS BASIN
FLINDERS SEISMIC SURVEY
RED HORIZON
VELOCITY ANOMALY

Contour intervals: 50 feet Datum: Sea level
Author: M.Mc Nicol Date: 22nd January, 1974

Plate VI 050148

- LEGEND**
- --- Oil Well
 - --- Gas Well
 - ★ --- Oil & Gas Well
 - --- Oil show
 - --- Gas show
 - ★ --- Oil & Gas shows
 - --- Drilling
 - ∅ --- Dry hole (Abandoned)

SHEET 8018



Compiled by Hematite Petroleum Pty. Ltd.
 Projection, UTM, Zone 55, C.M. 147E

- LEGEND**
- Oil Well
 - Gas Well
 - ✱ Oil & Gas Well
 - Oil show
 - Gas show
 - ✱ Oil & Gas shows
 - Drilling
 - Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN
FLINDERS SEISMIC SURVEY
RED HORIZON
VELOCITY ANOMALY

Contour intervals: 50 feet Datum: Sea level

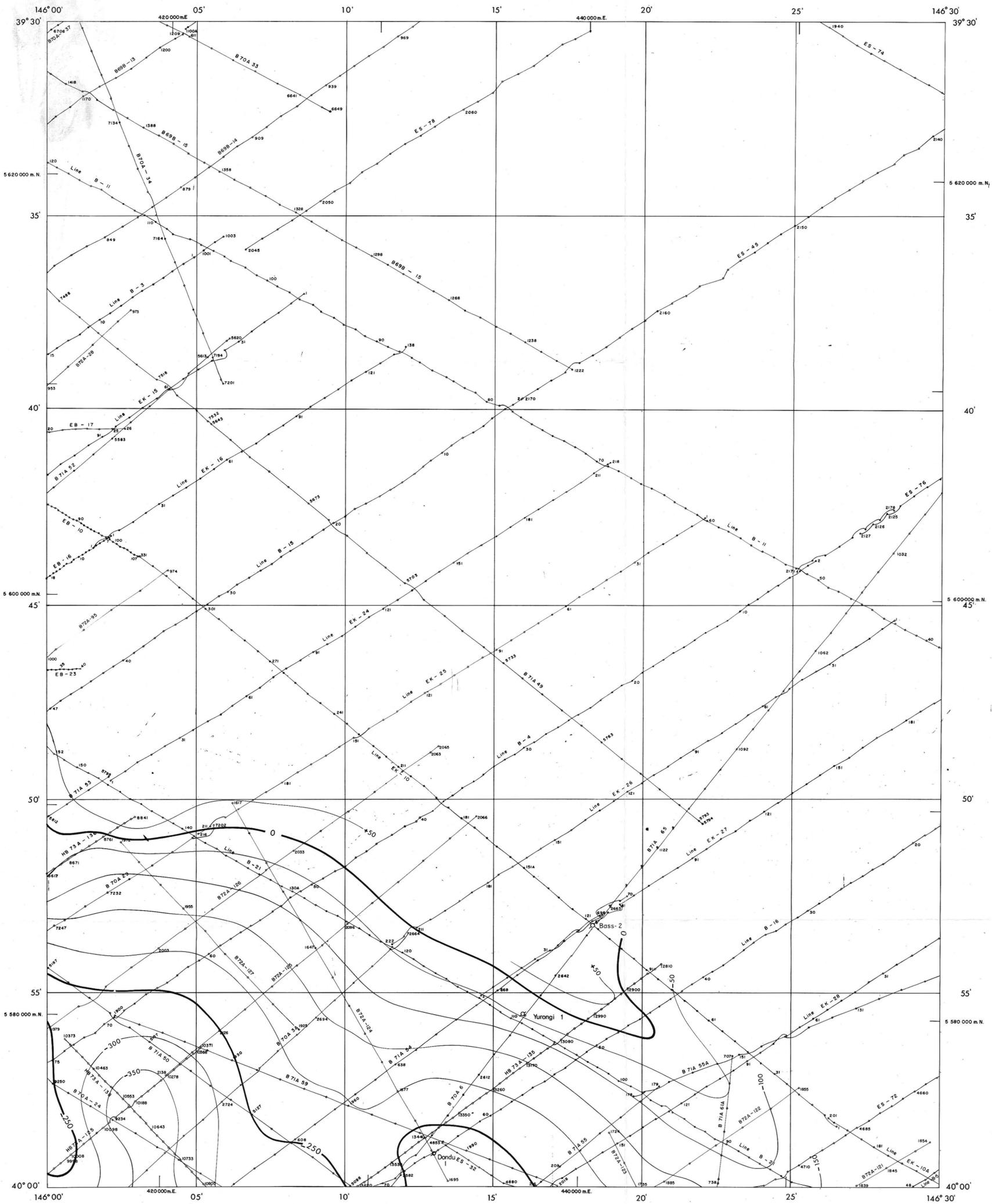
Author: M. Mc Nicol Date: 22nd January, 1974

Plate VI

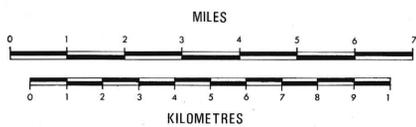
SHEET 8117

050149

OR 015



Scale 1:100,000



HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

**FLINDERS SEISMIC SURVEY
RED HORIZON
VELOCITY ANOMALY**

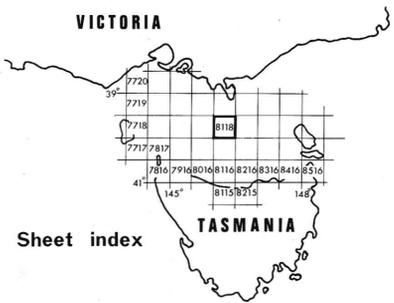
Contour intervals: 50 feet Datum: Sea level

Author: M. McNicol Date: 22nd January, 1974

Plate VI 059150

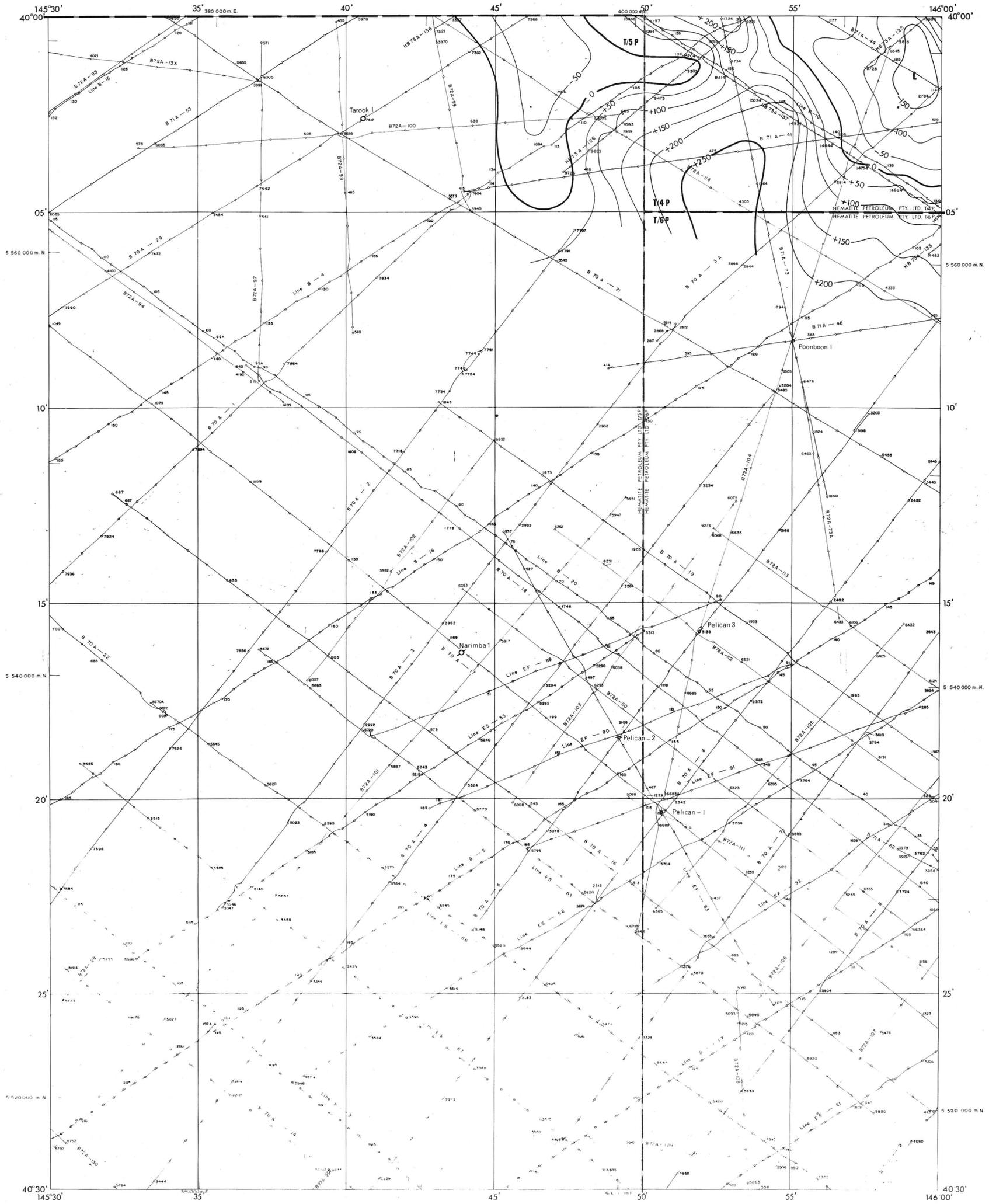
SHEET 8118

CR 015



LEGEND

- --- Oil Well
- ⊙ --- Gas Well
- ⊙ --- Oil & Gas Well
- --- Oil show
- --- Gas show
- ⊙ --- Oil & Gas shows
- --- Drilling
- --- Dry hole (Abandoned)



Scale 1:100,000

MILES



KILOMETRES



Compiled by Hematite Petroleum Pty. Ltd.
Projection: UTM Zone 15, Datum: G.M. 1974

LEGEND

- Oil Well
- ☆ Gas Well
- ⊛ Oil & Gas Well
- Oil show
- ⊙ Gas show
- ⊛ Oil & Gas shows
- Drilling
- ⊙ Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

**FLINDERS SEISMIC SURVEY
YELLOW HORIZON
VELOCITY ANOMALY**

5 cm

Contour interval: 50 ft./sec.
Author: M. McNicol

Date: February 1974
Drawn by: E. Celisse
Checked by: G. Hosking

059152

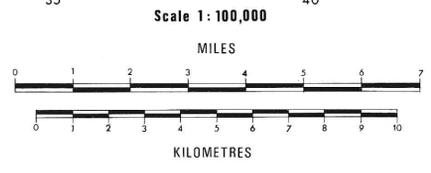
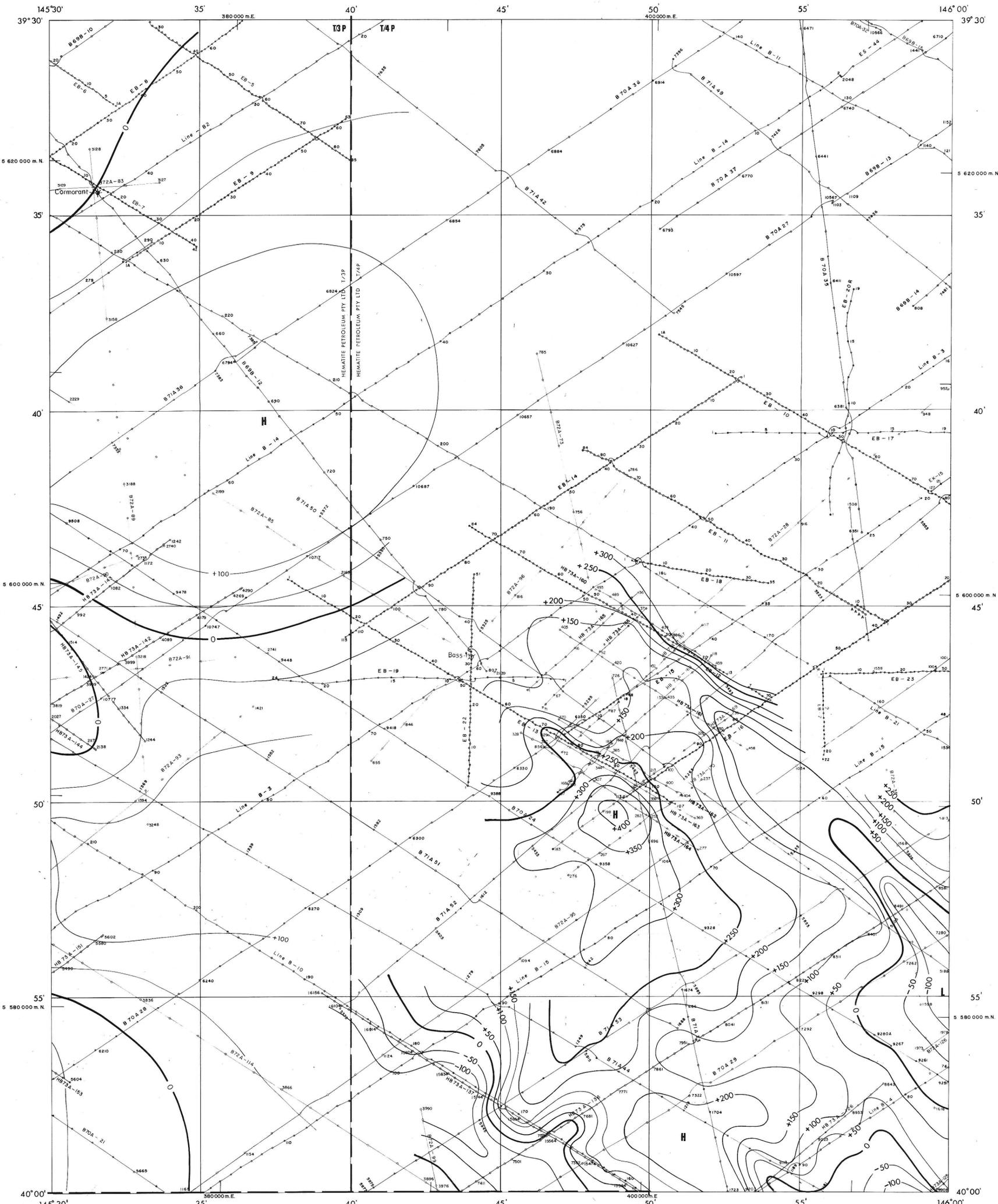
SHEET 8017 Plate VII

OR 015



Sheet index

Revised: February 1974



Compiled by Hematite Petroleum Pty. Ltd.
 Projection, UTM, Zone 55 C.M. 147°E

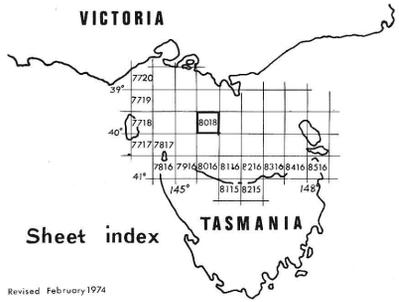
HEMATITE PETROLEUM PTY. LTD.
BASS BASIN
FLINDERS SEISMIC SURVEY
YELLOW HORIZON
VELOCITY ANOMALY

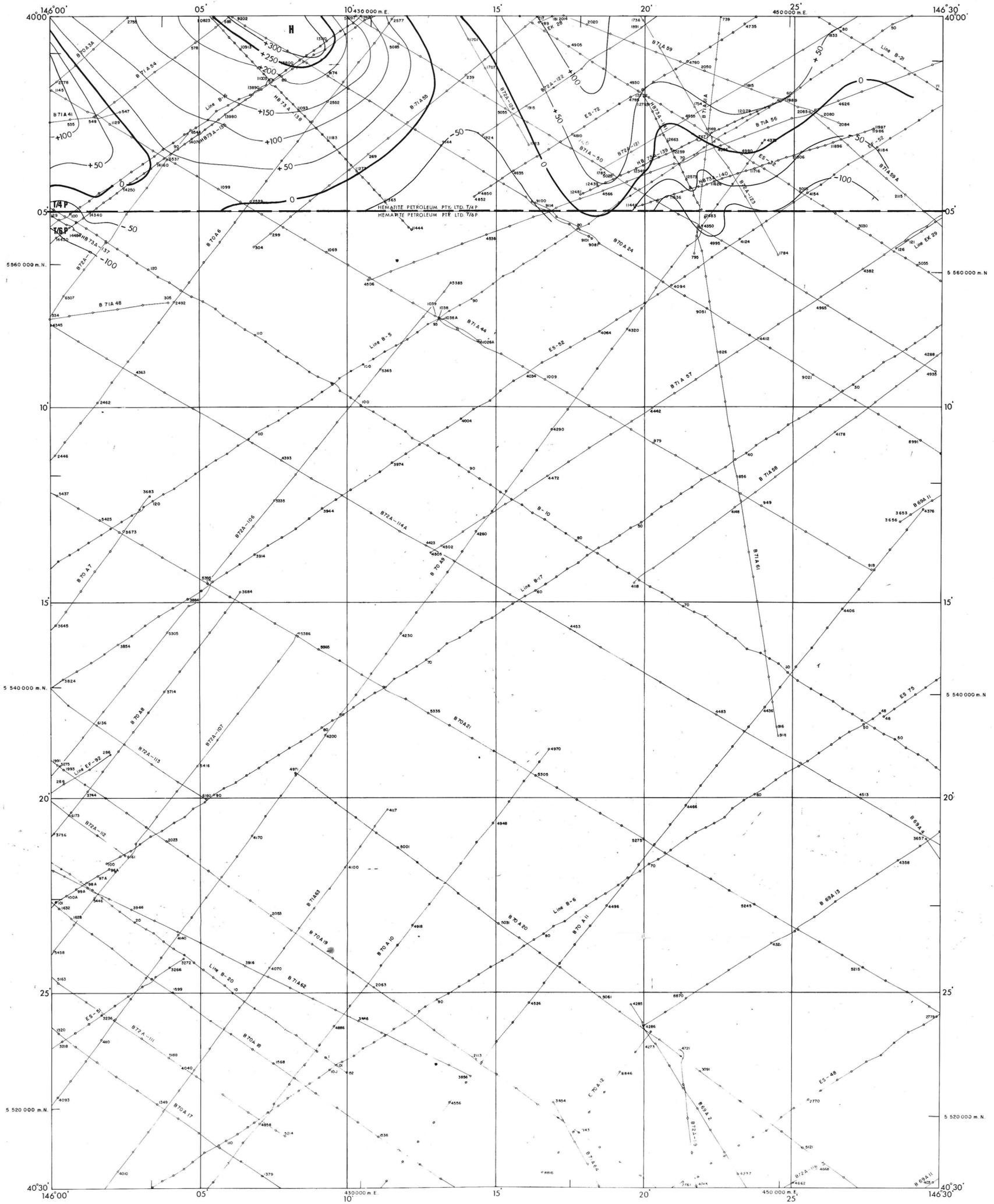
059153

Contour interval 50 ft/sec
 Date February 1974
 Author: M. McNicol
 Drawn by: E. Celisse
 Checked by: G. Hosking

- LEGEND**
- --- Oil Well
 - --- Gas Well
 - ⊙ --- Oil & Gas Well
 - ⊙ --- Oil show
 - ⊙ --- Gas show
 - ⊙ --- Oil & Gas shows
 - --- Drilling
 - ⊘ --- Dry hole (Abandoned)

SHEET 8018 OR OS Plate VII





Scale 1:100,000

MILES



KILOMETRES

Compiled by Hematite Petroleum Pty Ltd
Projection UTM Zone 55 CM 147 E

LEGEND

- --- Oil Well
- --- Gas Well
- ★ --- Oil & Gas Well
- --- Oil show
- --- Gas show
- ★ --- Oil & Gas shows
- --- Drilling
- --- Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

059154

**FLINDERS SEISMIC SURVEY
YELLOW HORIZON
VELOCITY ANOMALY**



Contour interval = 50 ft./sec.

Date: February 1974

Author: M McNicol

Drawn by E. Celisse

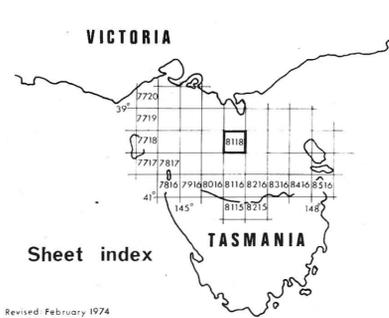
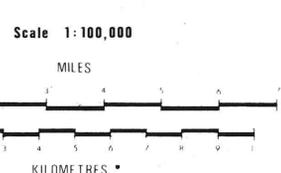
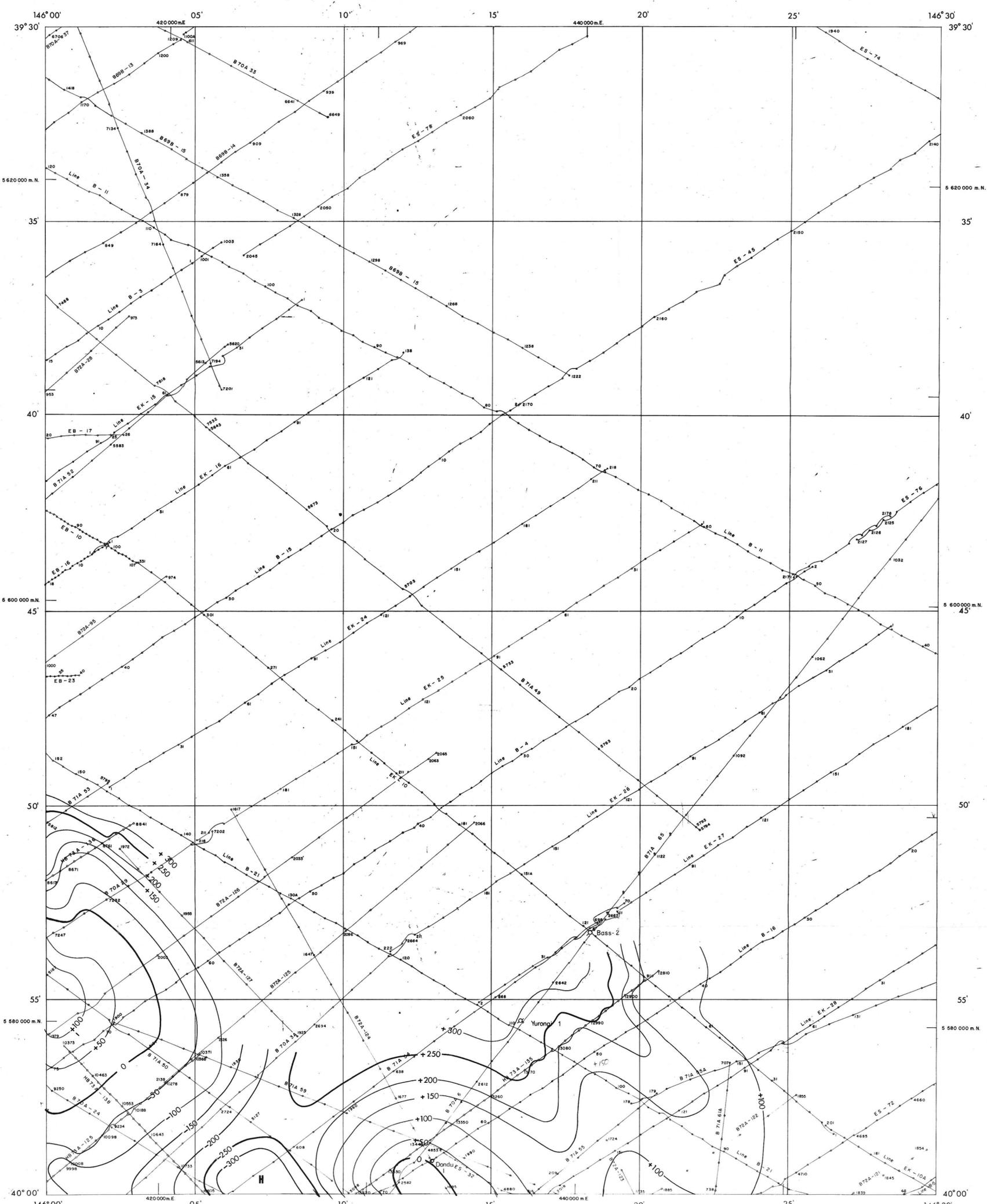
Checked by G. Hosking

SHEET 8117

Plate VII



Revised: February 1974



- Compiled by Hematite Petroleum Pty Ltd
Projection UTM Zone 55 CM 14°E
- LEGEND**
- Oil Well
 - ⊛ Gas Well
 - ⊛ Oil & Gas Well
 - Oil show
 - ⊛ Gas show
 - ⊛ Oil & Gas shows
 - Drilling
 - ⊘ Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN

FLINDERS SEISMIC SURVEY 059151

YELLOW HORIZON VELOCITY ANOMALY

5 cm

Contour interval: 50 ft./sec. Date: February 1974
Author: M. McNicol Drawn by: E. Celisse
Checked by: G. Hosking

SHEET 8118 Plate VII
OR C15

5 cm

HEMATITE PETROLEUM PTY. LTD 059156
LINE HB 73A-137
12000 ft/sec and 18000 ft/sec DELAY TIME PROFILE
WITH 3-ON-1 TRACE MIX
5-40HZ DGF APPLIED BEFORE SHIFT and MIX

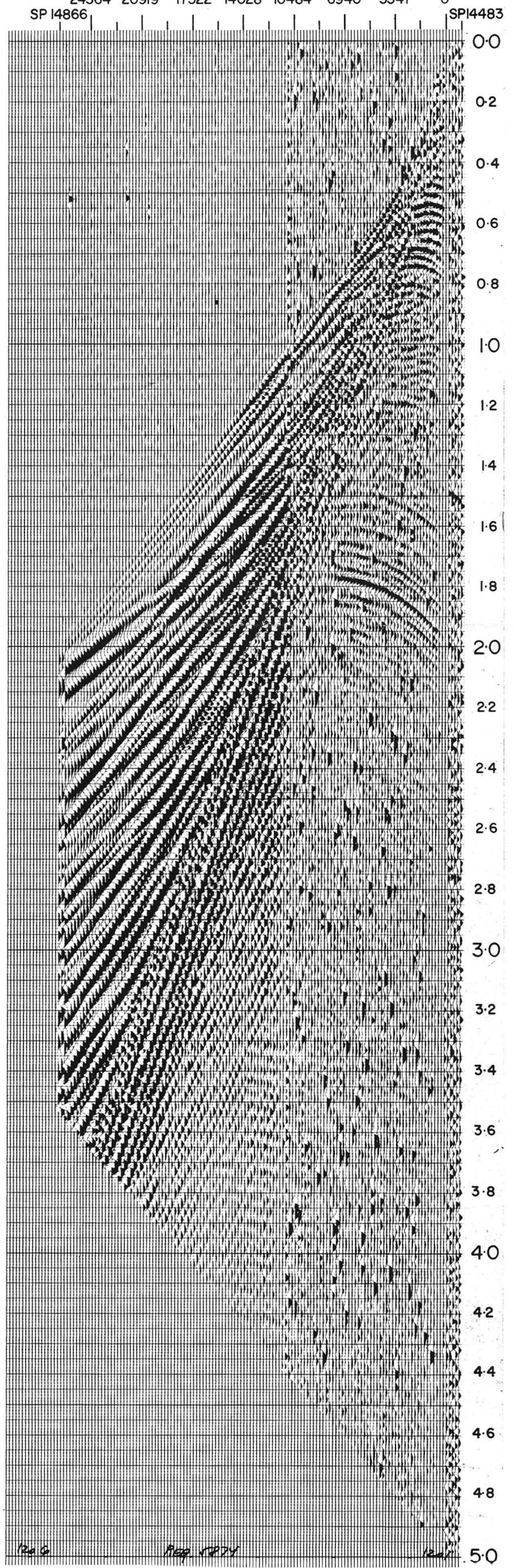
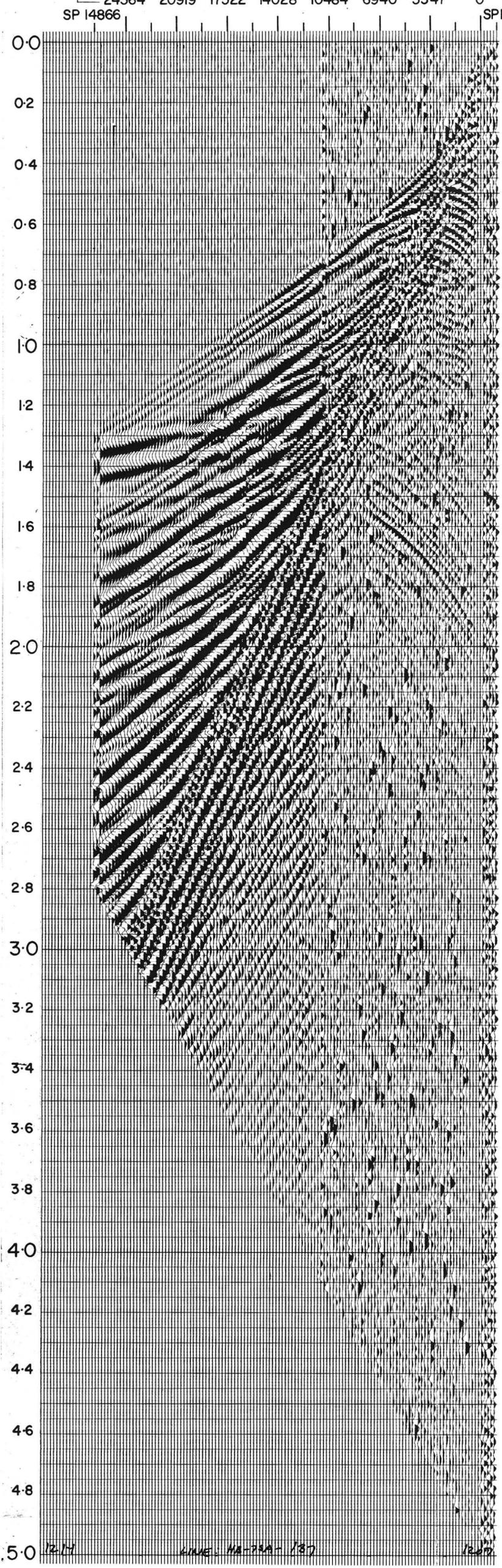
Plate VIII

Bass Basin part XV

18000/SEC PROFILE

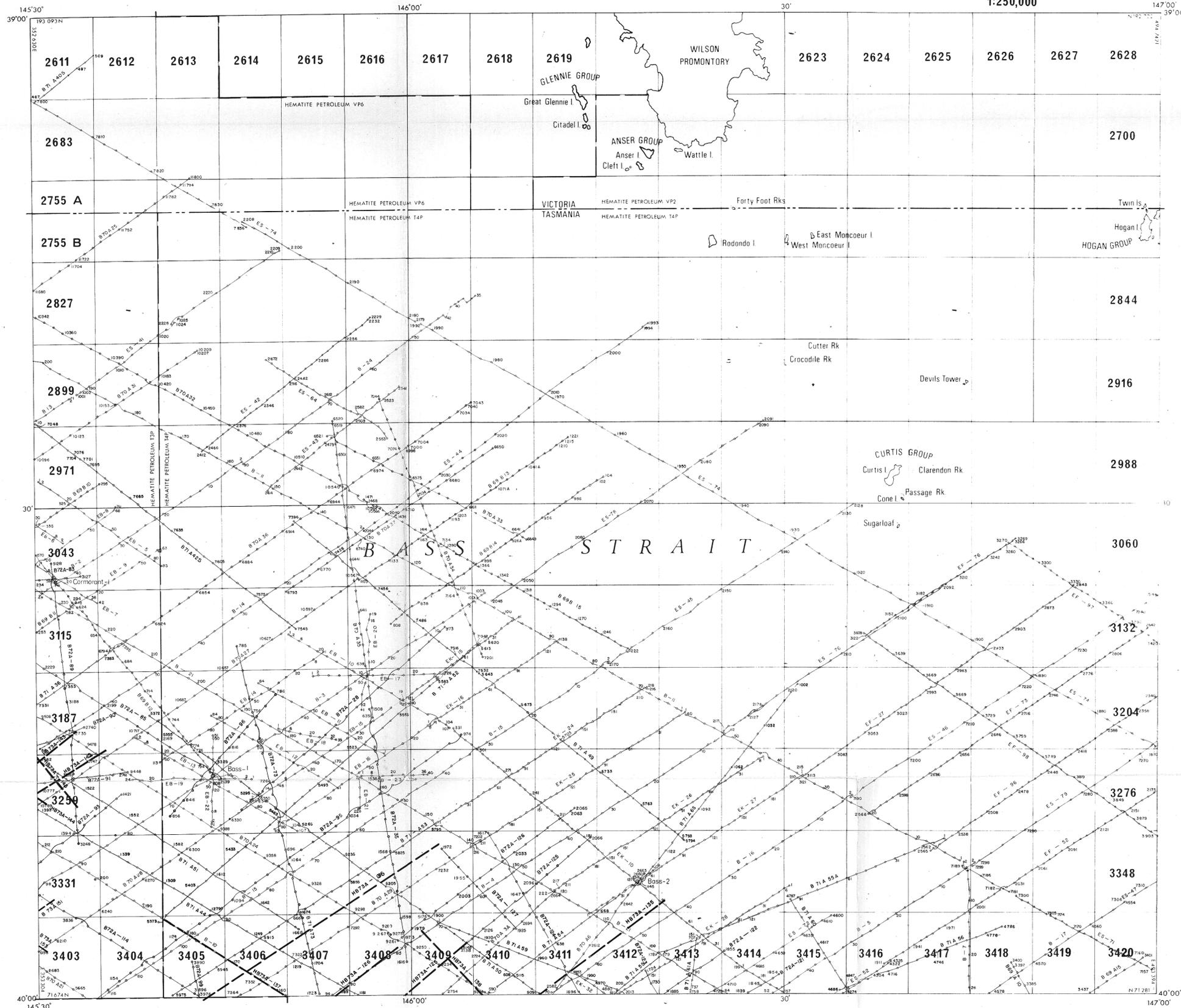
OFFSET DETERMINED FROM FIRST BREAK
OFFSET ASSUMING 72' SHOT INTERVAL 12000/SEC PROFILE
24192' 20736' 17280' 13824' 10368' 6912' 3456'
24364' 20919' 17522' 14028' 10484' 6940' 3347' 0'

24192' 20736' 17280' 13824' 10368' 6912' 3456'
24364' 20919' 17522' 14028' 10484' 6940' 3347' 0'



BASS

1:250,000



INDEX TO ADJOINING SHEETS

QUEENSLAND	WARRAGUL	SALE
KING	BASS	FLINDERS
HUNTER	WYNARD	CAPE BARREN

Compiled by the Exploration Drawing Office of Hematite Petroleum Pty Ltd in conformity with and as an extension to the topographic series prepared by the Royal Australian Survey Corps and the Division of National Mapping. This plan is drawn according to the zone numerical system and therefore disregards irregularly placed sheets. Transverse Mercator Projection.

The five minute Graticular Sections are shown thus 1777

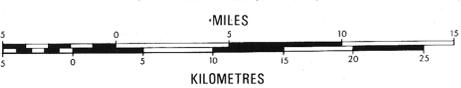
They are designated by:

- The name of the Map Sheet 1:1000,000 series.
- The block number.
- The Longitude and Latitude of the North West corner.

e.g. MELBOURNE 1777 Long. 148°00' E. Lat. 38°00' S.

Reference: Petroleum (Submerged Lands) Act 1967-68 of the Commonwealth of Australia.
Petroleum (Submerged Lands) Act 1967-68 of the State concerned.

Scale 1:250,000



- LEGEND**
- --- Oil
 - ☼ --- Gas
 - ☼ --- Oil & Gas
 - --- Oil show
 - ☼ --- Gas show
 - ☼ --- Oil & Gas shows
 - --- Drilling
 - ⊘ --- Dry hole (Abandoned)
 - Proposed seismic.

HEMATITE PETROLEUM PTY. LTD.

BASS BASIN

PROPOSED PROGRAMME

FLINDERS SEISMIC SURVEY
(August 1973)

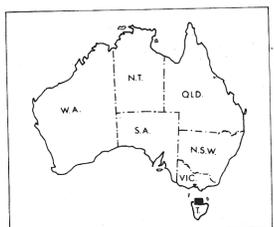
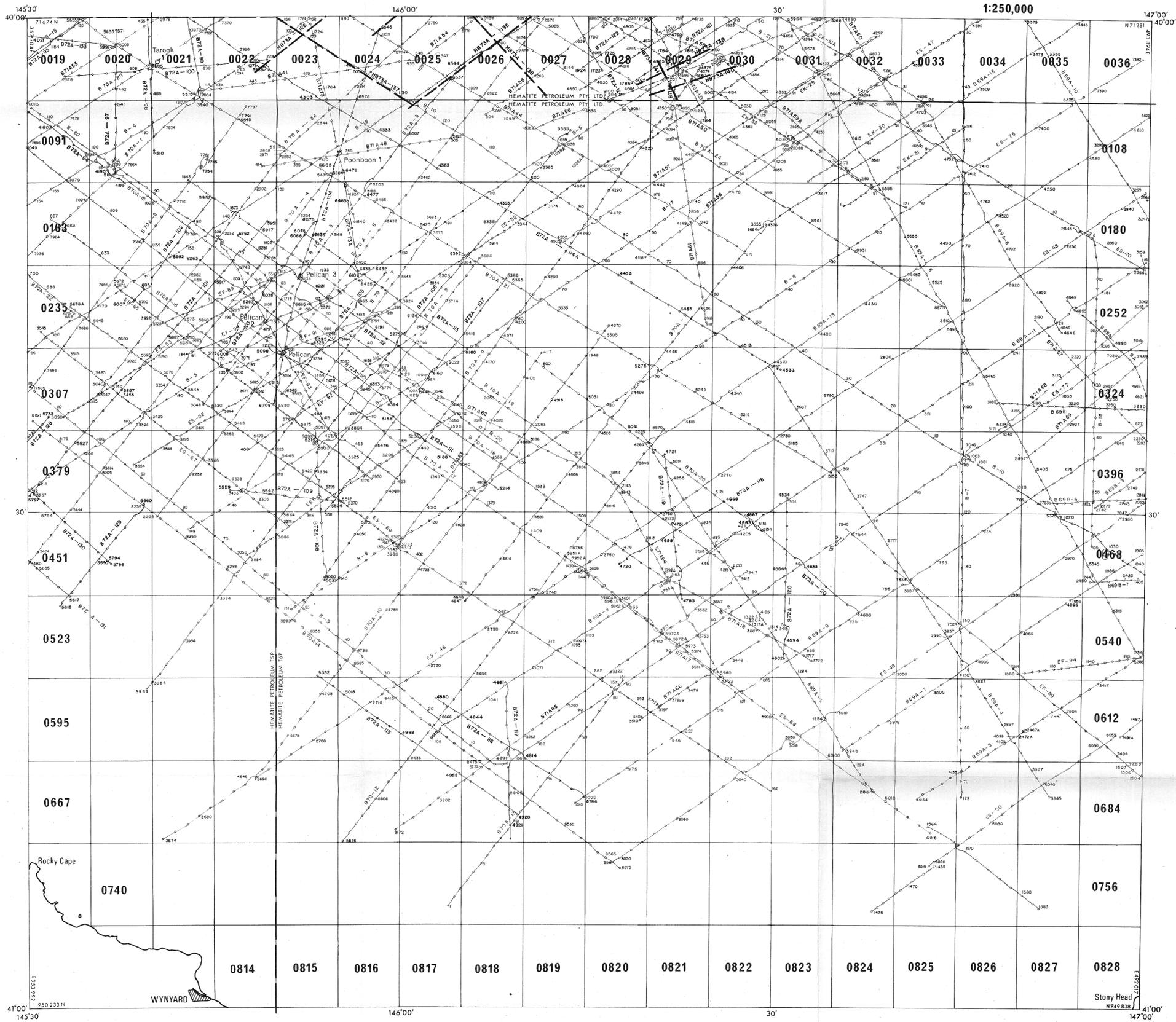
059157

BASS or J55-14



06 3185

WYNYARD



INDEX TO ADJOINING SHEETS

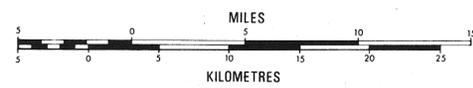
KING	BASS	FLINDERS
HUNTER	WYNYARD	CAPE BAREN
SMITHTON	DEVONPORT	LAUNCESTON

Compiled by the Exploration Drawing Office of Hematite Petroleum Pty. Ltd. in conformity with and as an extension to the topographic series prepared by the Royal Australian Survey Corps and the Division of National Mapping. This plan is drawn according to the zone numerical system and therefore disregards irregularly placed sheets. Transverse Mercator Projection.

The five minute Graticular Sections are shown thus 1777
 They are designated by:
 1. The name of the Map Sheet 1:100,000 series.
 2. The block number.
 3. The Longitude and Latitude of the North West corner.
 e.g. MELBOURNE 1777 Long 148°00' E. Lat. 38°00' S.

Reference: Petroleum (Submerged Lands) Act 1967-68 of the Commonwealth of Australia.
 Petroleum (Submerged Lands) Act 1967-68 of the State concerned.

Scale 1:250,000



- LEGEND**
- --- Oil
 - ★ --- Gas
 - ✱ --- Oil & Gas
 - --- Oil show
 - ⊙ --- Gas show
 - ✱ --- Oil & Gas shows
 - --- Drilling
 - ∅ --- Dry hole (Abandoned)
 - Proposed seismic.

HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN

PROPOSED PROGRAMME
FLINDERS SEISMIC SURVEY
 (July 1973)

059158

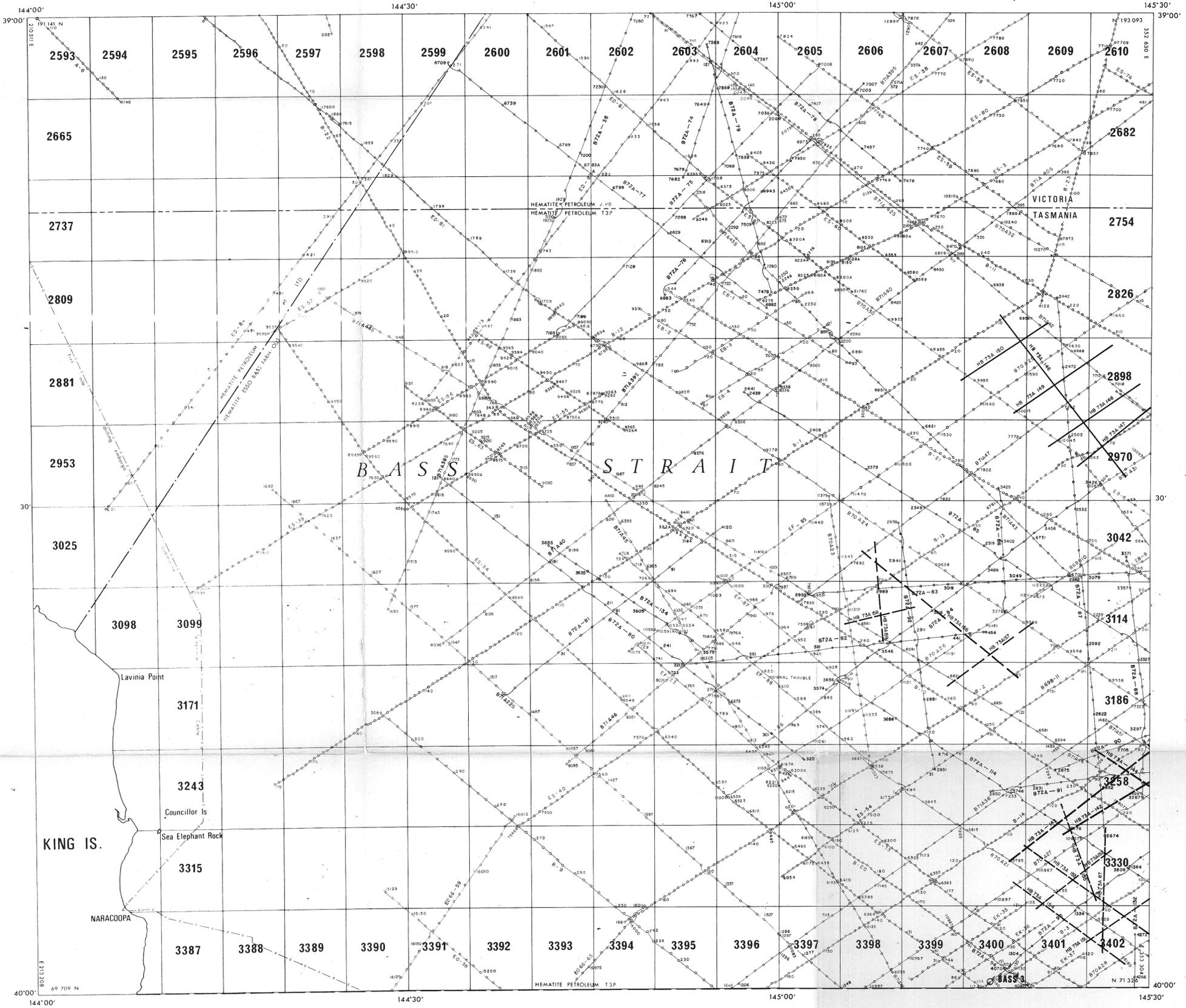
WYNYARD or K55-2



06 3185-1

KING

1:250,000



INDEX TO ADJOINING SHEETS

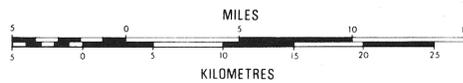
COLAC	QUEENSLIFF	WARRAGUL
WICKHAM	KING	BASS
STOKES	HUNTER	WYNARD

Compiled by the Exploration Drawing Office of Hematite Petroleum Pty Ltd in conformity with and as an extension to the topographic series prepared by the Royal Australian Survey Corps and the Division of National Mapping. This plan is drawn according to the zone numerical system and therefore disregards irregularly placed sheets.
Transverse Mercator Projection

The five minute Graticular Sections are shown thus 1777
They are designated by:
1. The name of the Map Sheet 1:100,000 series.
2. The block number.
3. The Longitude and Latitude of the North West corner.
eg MELBOURNE 1777 Long 148° 00' E Lat 38° 00' S

Reference Petroleum (Submerged Lands) Act 1967 68 of the Commonwealth of Australia
Petroleum (Submerged Lands) Act 1967 68 of the State concerned

Scale 1:250,000



LEGEND

- --- Oil
- ☼ --- Gas
- ★ --- Oil & Gas
- --- Oil show
- ☆ --- Gas show
- ⊛ --- Oil & Gas shows
- --- Drilling
- ⊘ --- Dry hole (Abandoned)

HEMATITE PETROLEUM PTY LTD
BASS BASIN

PROPOSED PROGRAMME

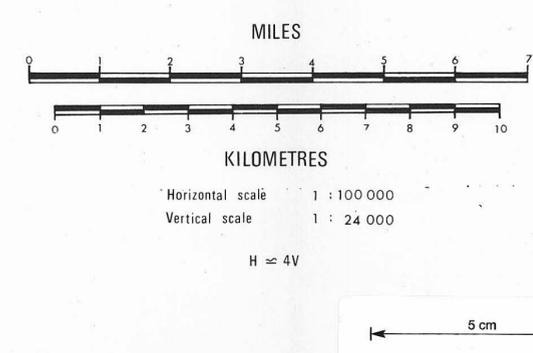
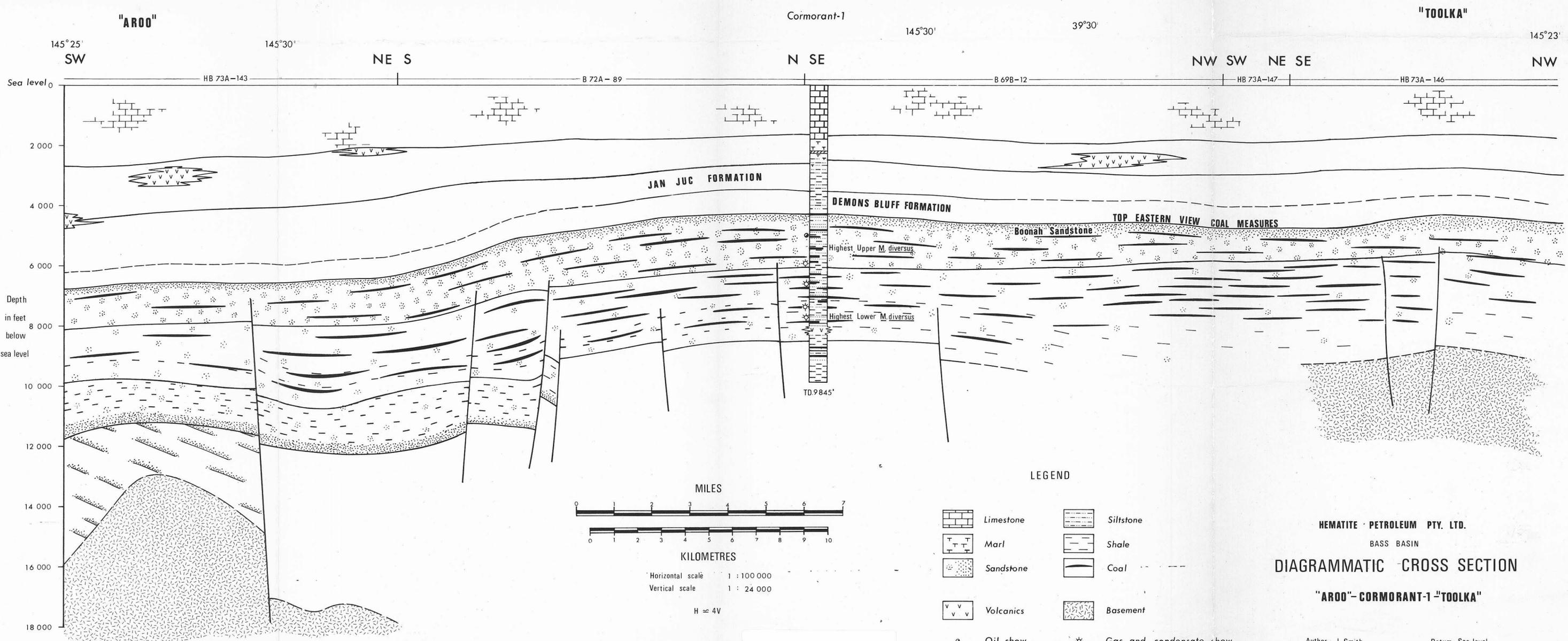
FLINDERS SEISMIC SURVEY
(August 1973)



059159

KING or J55-13

06-3185-2



LEGEND

	Limestone		Siltstone
	Marl		Shale
	Sandstone		Coal
	Volcanics		Basement
	Oil show		Gas and condensate show

HEMATITE PETROLEUM PTY. LTD.
 BASS BASIN
 DIAGRAMMATIC CROSS SECTION

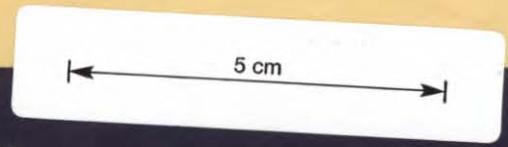
"AROO"-CORMORANT-1-"TOOLKA"

Author: J. Smith Datum: Sea level
 Date: November 1973

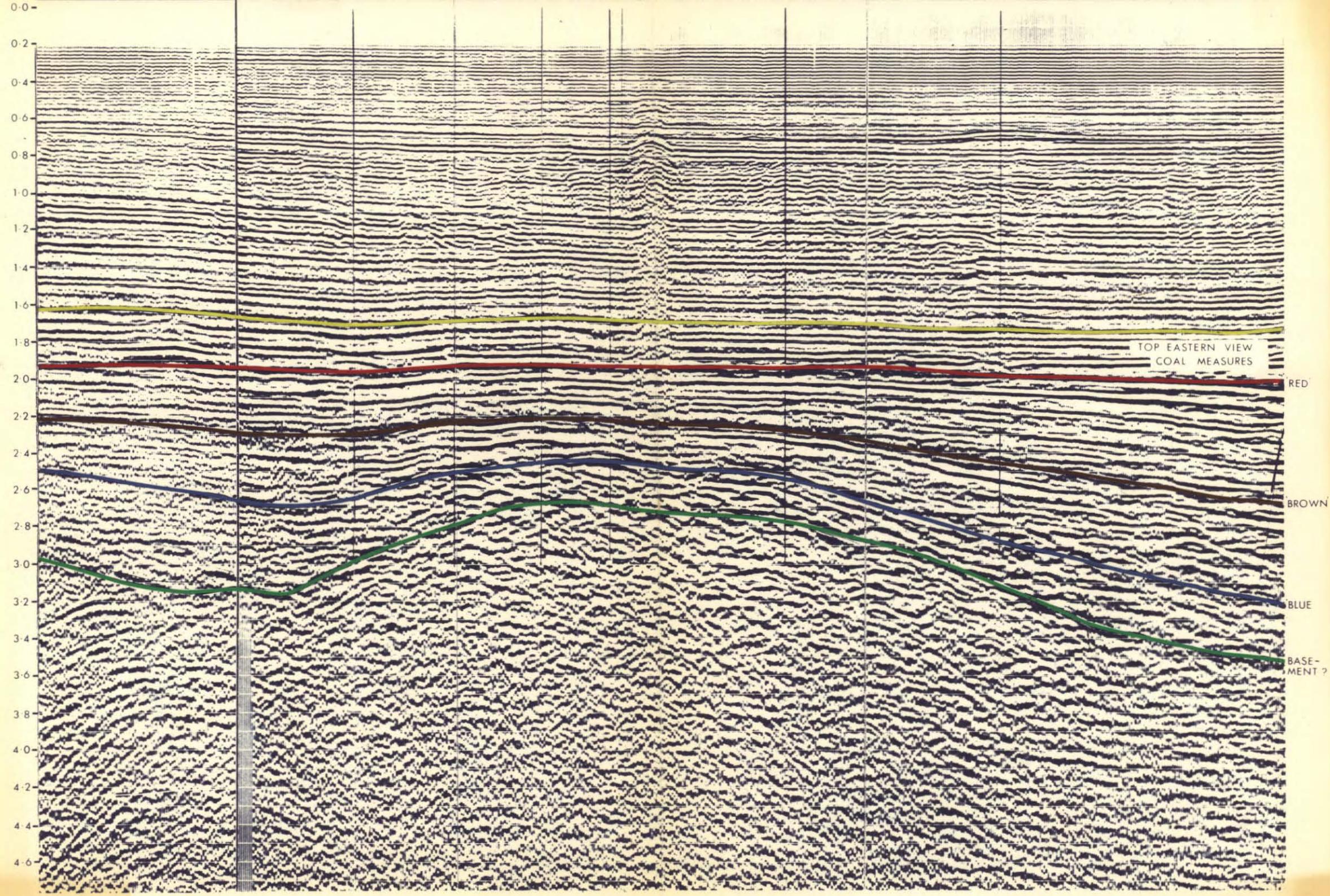
Encl. I
 06 3260

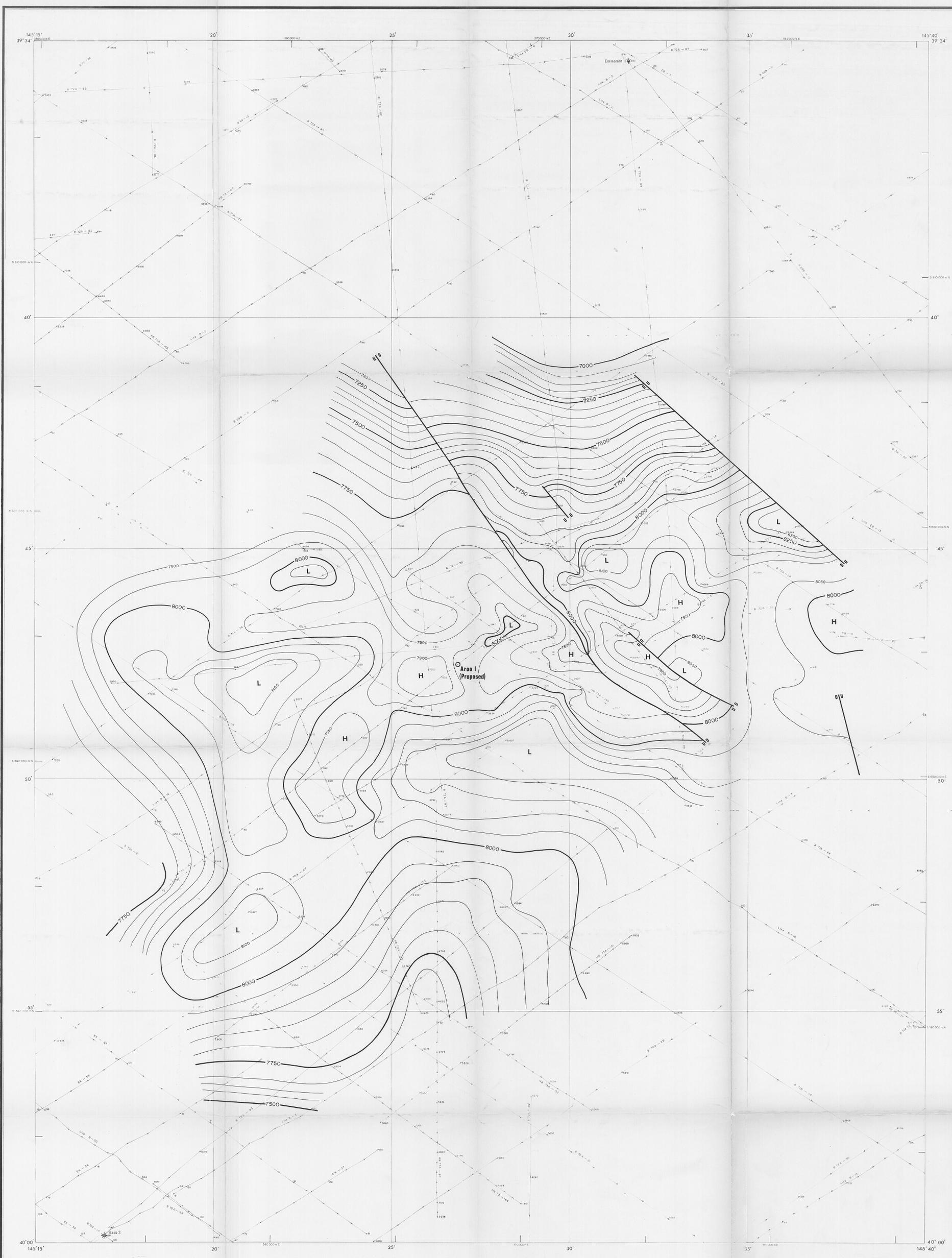
OR-0015

02-0015



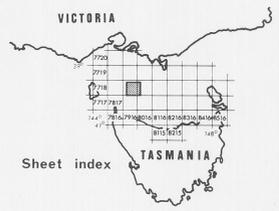
SE \rightarrow E B71A-44 HORIZONTAL SCALE: 1 TRACE = 50 METRES
 E. RATIO = 2.8:1 AT 1.5 SEC.  Proposed AROO - 1 (Projected) \leftarrow SE





Compiled by Hematite Petroleum Pty Ltd
 Projection UTM Zone 55 CM 147°E

- LEGEND**
- Oil Well
 - Gas Well
 - ⊛ Oil & Gas Well
 - Oil show
 - Gas show
 - ⊛ Oil & Gas shows
 - Drilling
 - Dry hole (Abandoned)



HEMATITE PETROLEUM PTY. LTD
 BASS BASIN

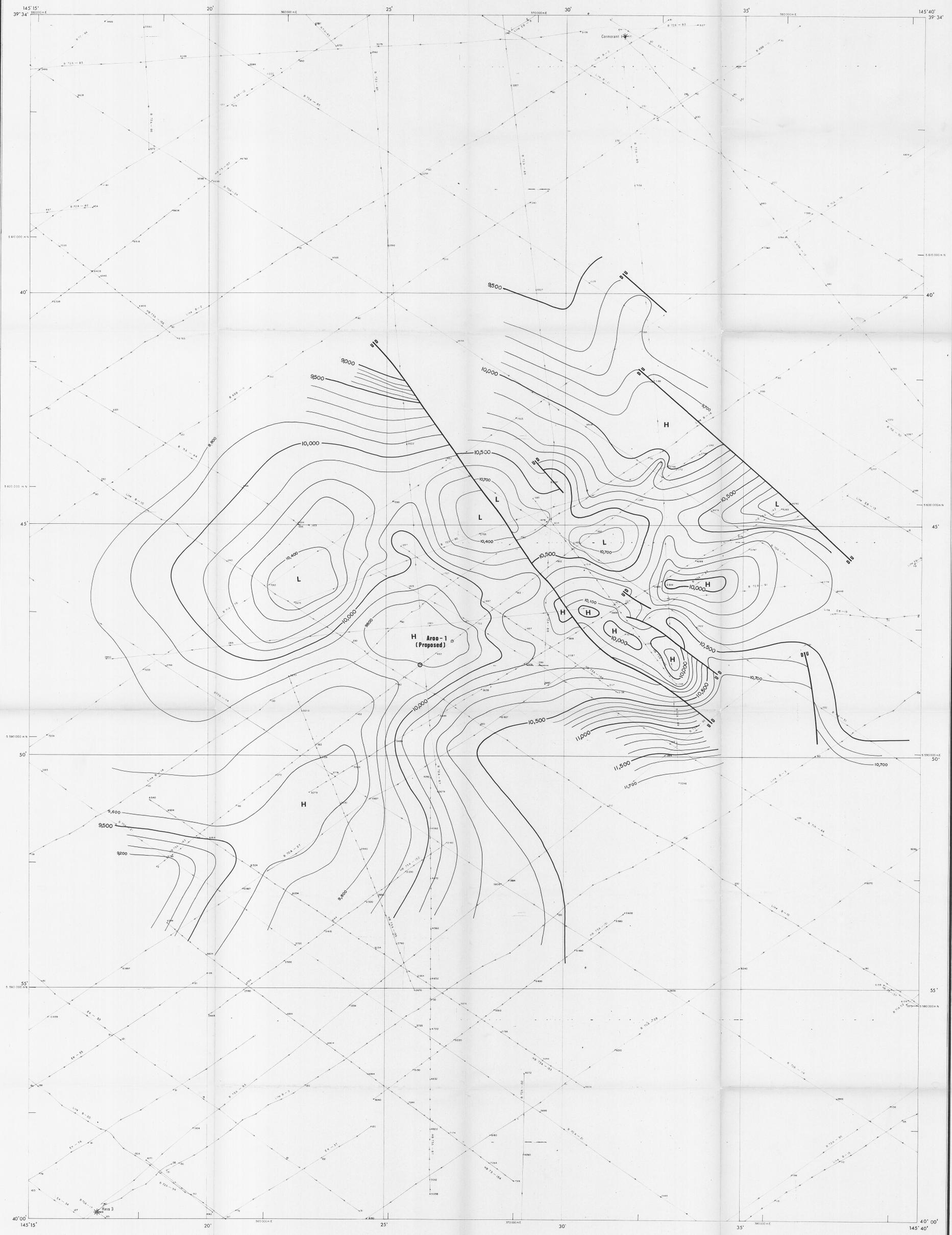
ARO O PROSPECT

RED HORIZON

Contours in feet below sea level Contour Interval 50 feet
 Author E Urschel Date November 1973



CR 005

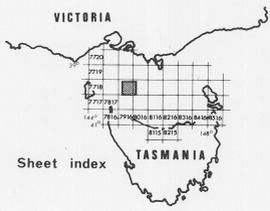


Scale 1: 50 000



Compiled by Hematite Petroleum Pty Ltd
Projection UTM Zone 55 CM 147°E

- LEGEND**
- Oil Well
 - Gas Well
 - ⊙ Oil & Gas Well
 - ⊙ Oil show
 - ⊙ Gas show
 - ⊙ Oil & Gas shows
 - Drilling
 - ⊙ Dry hole (Abandoned)

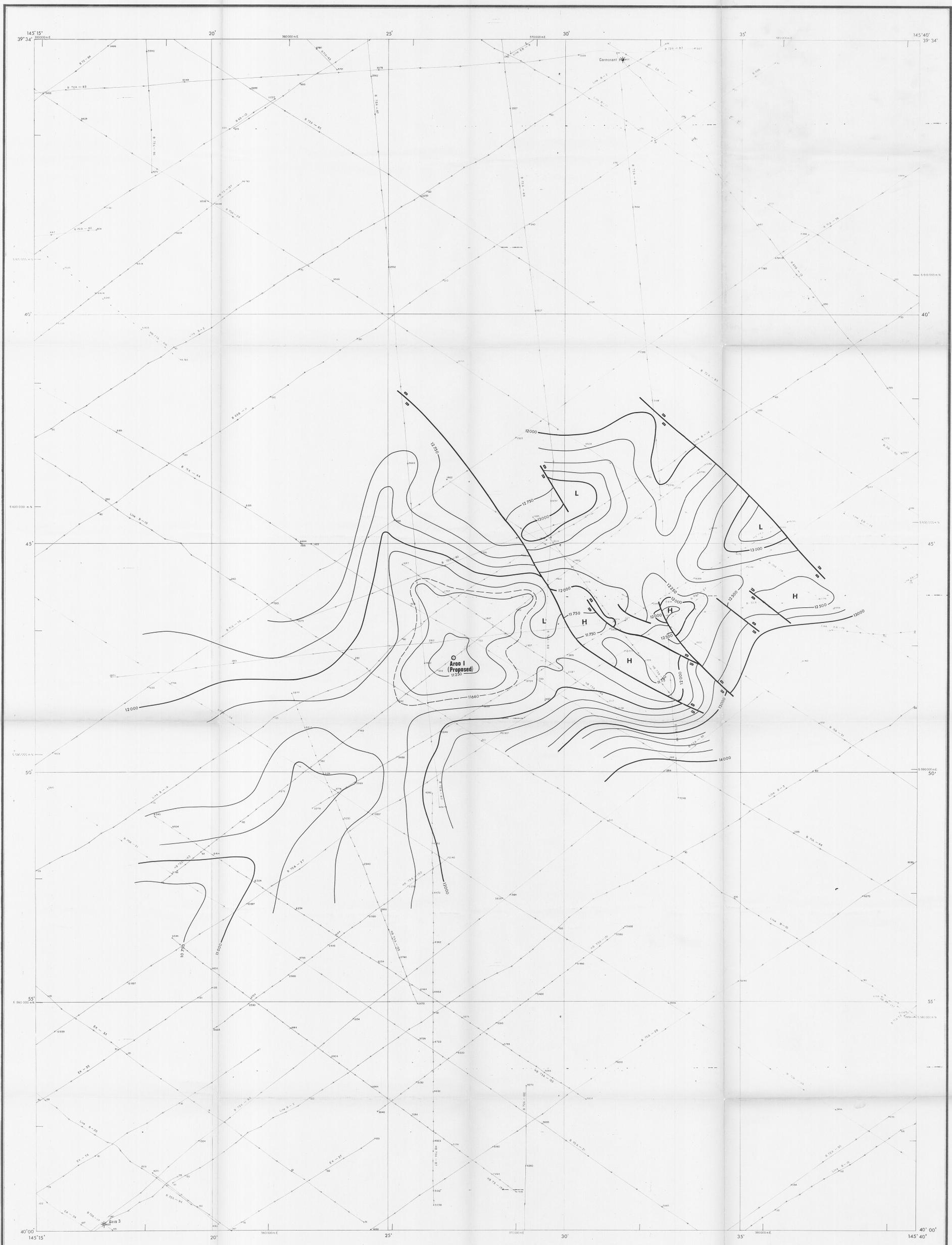


HEMATITE PETROLEUM PTY. LTD
BASS BASIN
AROO PROSPECT
BROWN HORIZON

Contours in feet below sea level Contour Interval 100 feet
Author: E. Urschel Date: November 1973



CR-005



Scale 1 : 50 000



Compiled by Hematite Petroleum Pty. Ltd.
Projection UTM Zone 55 CM 147°E

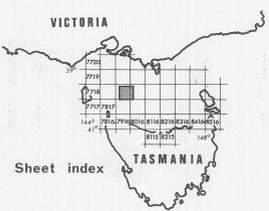
LEGEND

- Oil Well
- Gas Well
- ✱ Oil & Gas Well
- Oil show
- Gas show
- Oil & Gas shows
- Drilling
- Dry hole (Abandoned)

HEMATITE PETROLEUM PTY. LTD.
BASS BASIN
AROO PROSPECT

BLUE HORIZON

Contour interval 250 feet Datum Sea level
Authors J. Denham, M. McNeil, E. Urschel
Date November 1973



AR 005