FIRST ANNUAL REPORT
EXPLORATION LICENCE 40/83
(STRATHBLANE)
FOR PERIOD ENDING 21.9.84

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DATE: AUGUST 1984

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REPORT NO. 1984/31

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1.0 INTRODUCTION

This report covers exploration work carried out by Marathon Petroleum Australia, Ltd. (MPAL) on E.L. 40/83 Strathblane.

MPAL initially applied for 490km^2 on July 27, 1982. However due to landowner objections resulting in several warden court hearings, granting of the E.L. was delayed. During this period MPAL undertook a geological reassessment of the application area. This resulted in the reduction of the application area to 195km^2. This area was granted on September 22, 1983 as E.L. 40/83 Strathblane.

Several small coal mines have been reported within the E.L. and this area was considered very prospective after work undertaken within E.L. 6/79 Catamaran (also held by MPAL) which lies to the south of E.L. 40/83.

Work carried out to date includes a Landsat Study, an Aeromagnetic Survey and ground follow up.

2.0 LOCATION AND ACCESS

E.L. 40/83 Strathblane is located at approximately 43°15'S, 147°E and is 60km by road south-southwest of Hobart near the southeast coast of Tasmania (Figure 2.1).

Access to the area from Hobart is by sealed road which passes through Huonville, Geeveston and Dover. Many main forestry roads branch off this road providing good access to most of the E.L. Movement off these forestry roads is extremely difficult due to the steep slopes and dense vegetation on the hills and the soft swampy ground and thick grasses on the lowland.

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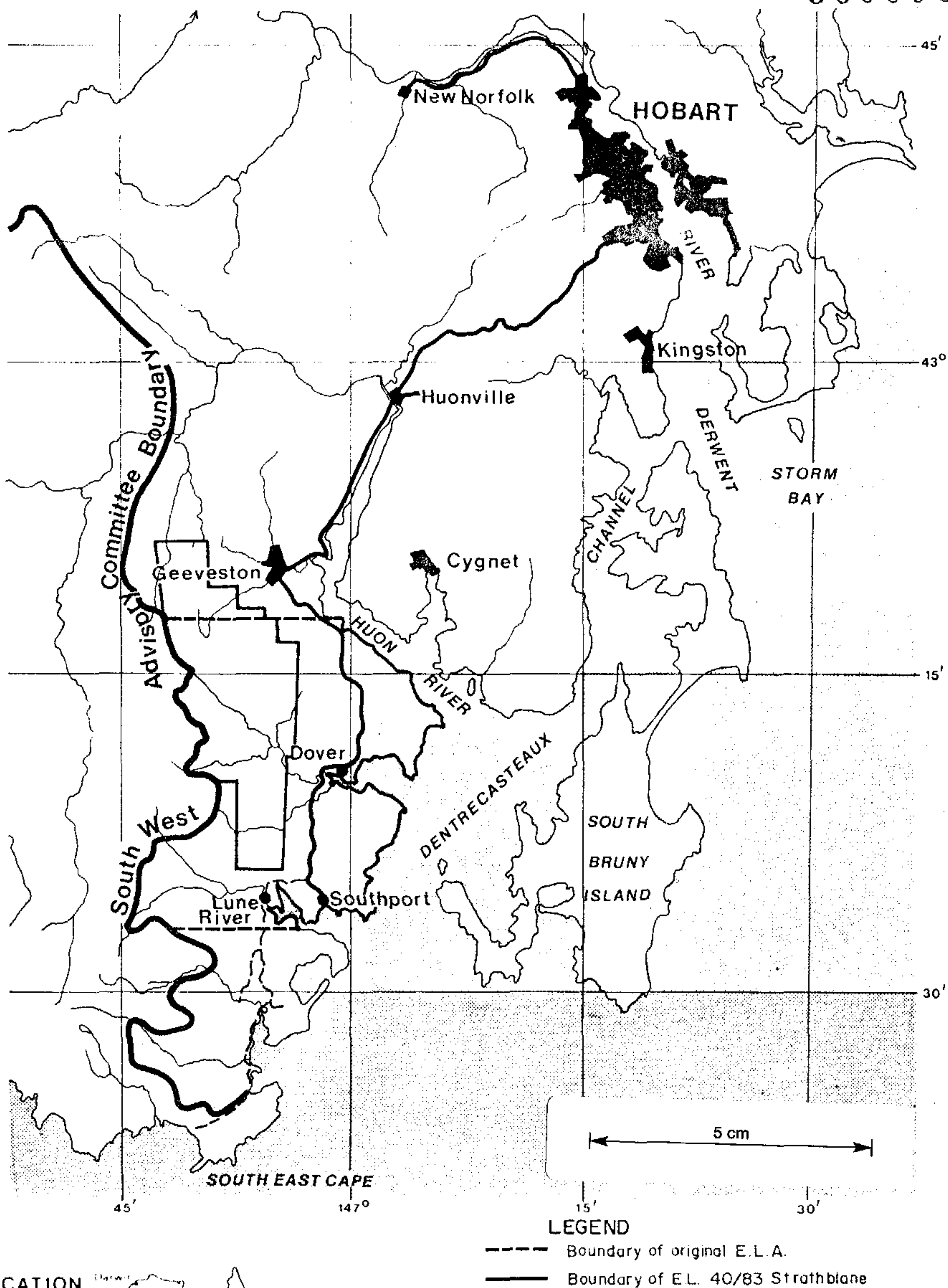

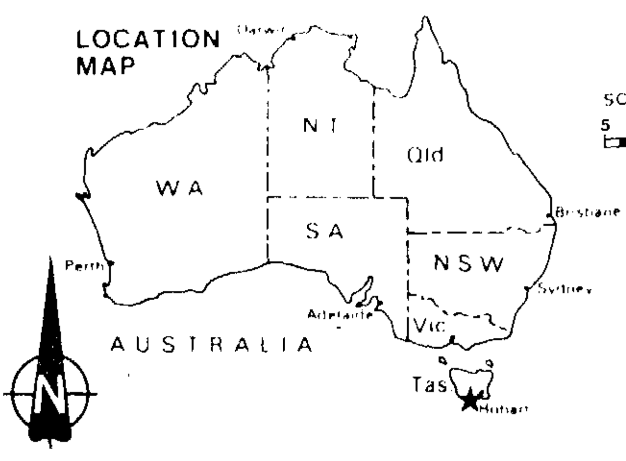

SCALE 1:500 000

5 0 5 10 15 20 25 Km

FIGURE 2.1

Marathon Petroleum Australia, Ltd.

BRISBANE AUSTRALIA

Hobart SK55-8 Tasmania

TASMANIA PROJECT

Plan Showing

LOCATION OF
E.L. 40/83 STRATHBLANE

Mapped by *Tas. Lands* Plan No. CIC 89

Drawn by *L.P.* Date Nov. '84

3.0 PHYSICAL SETTING

3.1 Relief and Drainage

The regional topography rises from 80m to 720m within the E.L. and again further to the west to approximately 1200m (Figure 3.1).

Generally the area is a deeply dissected and densely timbered region of rugged topography. However small low lying swampy plains vegetated with cutting grass and button grass occur throughout the area.

Three main water courses drain the area. The Kermandie River in the northern part of the E.L., Esperence River in the central part and Creekton Rivulet in the south. The Esperence River is by far the most important of these streams and is used as the town water supply at Dover.

3.2 Land Usage

Most of the forests within the area have at one time or another undergone intensive sawmilling operations. These operations are continuing today with the Forestry Department revegetating areas to ensure further adequate timber supplies for future use.

Major population centres are located nearby at Geeveston (centre for a large timber and orchard industry) and Dover (centre for a large fishing industry).

3.3 Vegetation

The vegetation of the area is typical of the coastal region of the Tasmania Basin, that is dry and wet Schlerophyll forest, temperate rainforest and swampy grasslands (Figure 3.2). The different types of vegetation seem to correlate roughly with the lithological types. The forest type vegetation seems to be found associated with Jurassic dolerite and Tertiary basalts, while low swampy grassland is associated with Triassic sediments.

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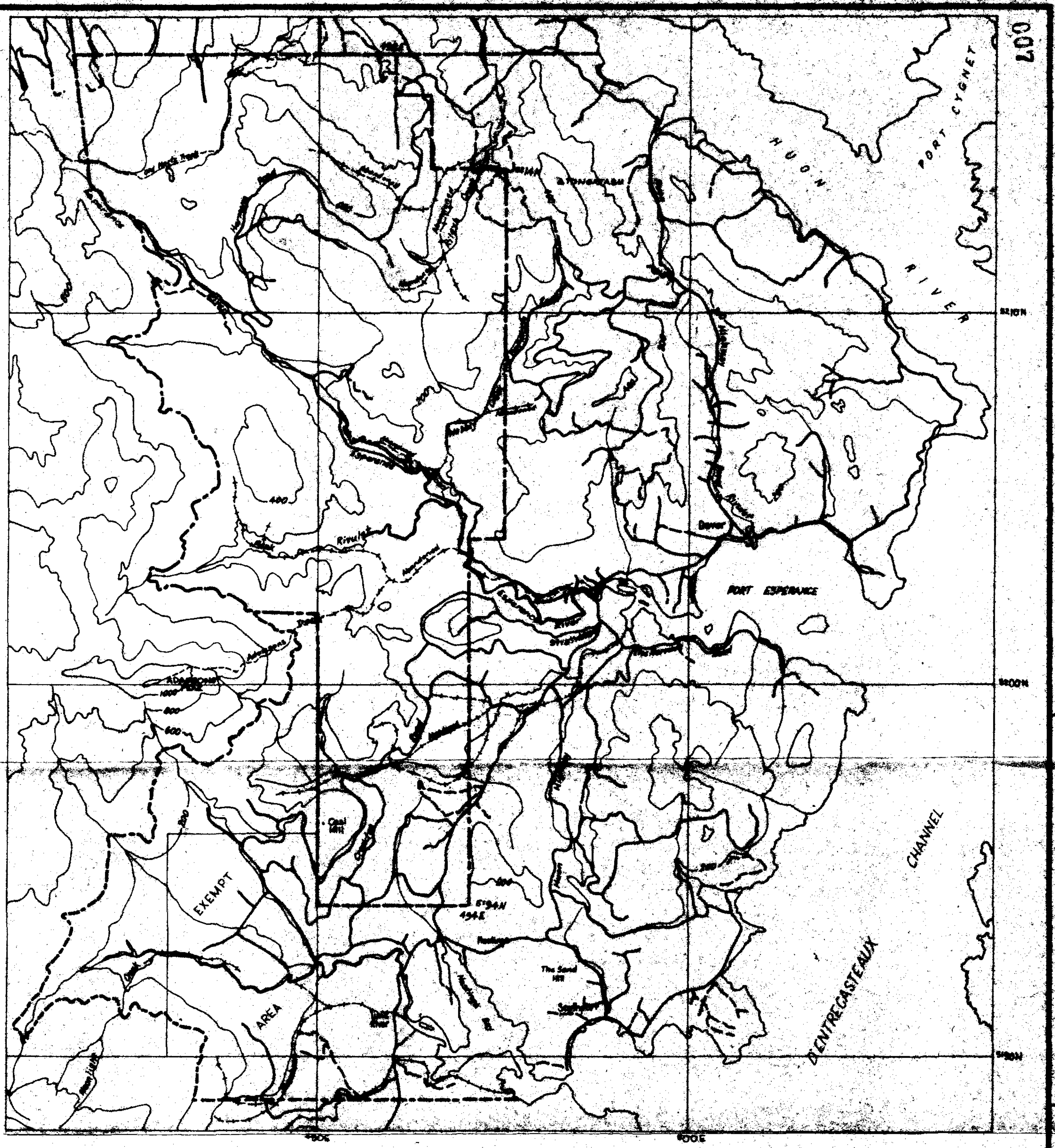
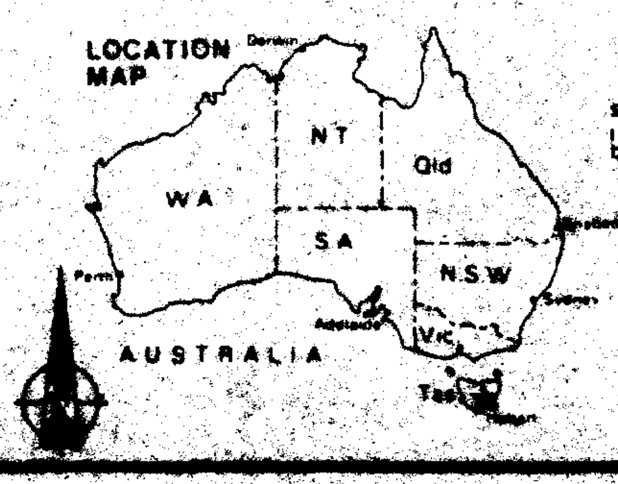


LEGEND

- Boundary of ELA 28/83
- Boundary of granted EL 40/83

LOCATION MAP



5 cm

SCALE 1:100 000
0 1 2 3 4 5 Km

FIGURE 3.1

Marathon Petroleum Australia, Ltd.

SK 55 - 8 Hobart, Tasmania

EL. 40/83 STRATHBLANE

TOPOGRAPHY MAP

Date NOV. '83 Plan No C1A3/T5-16

36000 8

007 A

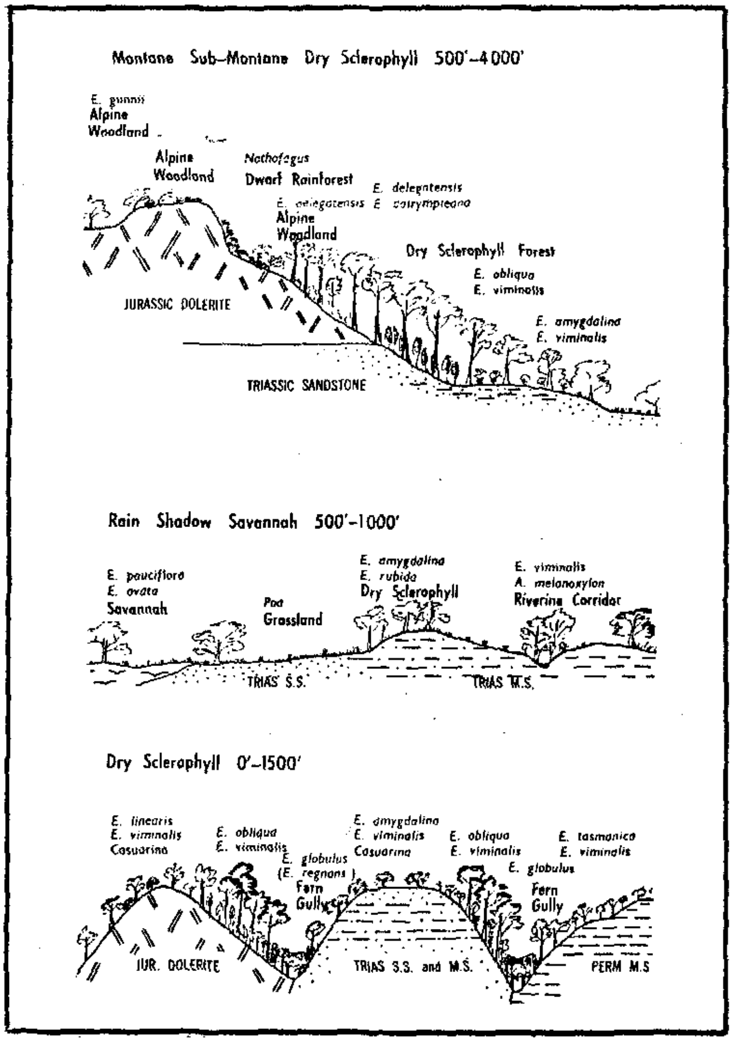


FIGURE 3.2 REPRESENTATIVE VEGETATION TYPES

(Jackson, 1956)

3.4 Climate

The climate of the area is typical of coastal Tasmania with an average daily temperature maxima of 18.9°C in summer and 11.7°C in winter. Average minimum night-time temperatures are 9.1°C in summer and 3.1°C in winter. Frosts often occur during the winter months and snowfalls have been reported.

Annual rainfall in the region is 1420mm with the majority of the rain received between May and September.

4.0 REGIONAL GEOLOGICAL SETTING

E.L. 40/83 Strathblane is situated within the Tasmania Basin which covers an area of approximately 20,000 square kilometres and contains over 1000m of Permo-Triassic intruded and faulted clastic continental and paralic sediments. These sediments overlie Ordovician marine sediments of the Junee Group and have been intruded by sills of Jurassic dolerite (Spry and Banks, 1962). The regional geology of the relevant portion of the Tasmanian Basin is shown in Figure 4.1. A representative stratigraphic column is shown in Figure 4.2.

4.1 Regional Stratigraphy

4.1.1 Ordovician

The Ordovician Junee Group is believed to form the basement to the Tasmanian Basin and is known from a number of widely scattered localities along the western margin of the basin including a few isolated inliers near Hastings and Ida Bay.

The Group consists of limestone and sandstone with subordinate conglomerate which is believed to have been deposited in a shallow marine or tidal environment.

The Junee Group underwent deformation during the Middle Devonian Taberabberan Orogeny and is unconformably overlain by rocks from the Parmeneer Supergroup.

4.1.2 Permian

The Lower Parmeneer Supergroup of Permian age outcrops over a large part of the Tasmanian Basin. These rocks consist of a variety of sediment types e.g. tillite, mudstone, sandstone and conglomerate. The environment of deposition ranges from glacio-marine during the Upper Carboniferous and Lower Permian through shallow marine, estuarine and minor glacial conditions in the Middle Permian and fluvial in the Upper Permian.

4.1.3 Triassic

The Upper Parmeneer Supergroup of Triassic Age is not as areally extensive as the Lower Parmeneer Supergroup.

Rocks of the Upper Parmeneer Supergroup contain the prospective coal measures which occur towards the top of the Triassic Sequence. Attempts have been made to sub-divide the Upper Parmeneer Supergroup into units, but due to lack of continuous marker horizons and poor outcrop only a limited subdivision into a basal quartzose sandstone with minor mudstone and upper prospective coal measures has been possible by MPAL. /The sequence within the basin is between 60 and 400m in thickness.

4.1.4 Jurassic Dolerite

During the Jurassic, large bodies of dolerite were intruded into both Permian and Triassic sediments. These intrusives take the form of large transgressive sheet-like bodies with minor dykes. These sheets form resistant capping on topographic highs throughout the Tasmanian Basin.

4.1.5 Cainozoic

Tertiary basalts are widespread in the Tasmanian Basin. These basalts are believed to be the remains of incised valley fills.

Soil horizons, unconsolidated alluvial sediments, dolerite scree and glacial debris can be recognised over the basin and these have been attributed to both the Teriary and Quaternary.

4.2 Tectonic History

The Tasmanian Basin has undergone at least two major tectonic events. The first occurred during the Jurassic when large bodies of dolerite were intruded into the Permian and Triassic sediments. The magma rose up through the basement until it reached the Permo-Triassic sediments, where it spread out laterally, lifting or floating the roof of sediments.

The second major tectonic event occurred during the Tertiary when horst and graben structures of major dimensions were developed. Basaltic volcanism was a feature of this event.

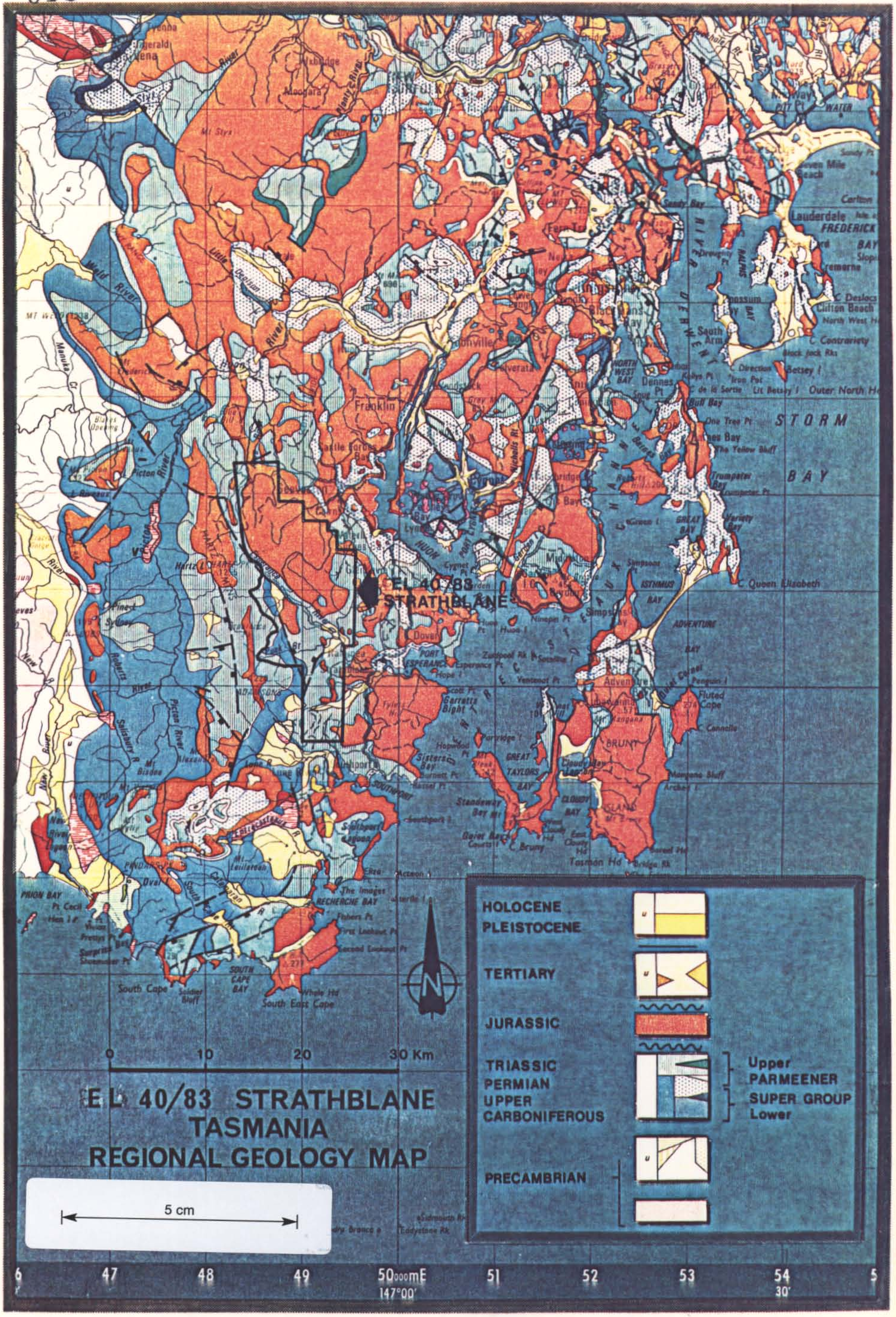

EL 40/83 STRATHBLANE
TASMANIA
REGIONAL GEOLOGY MAP
0 10 20 30 Km
5 cm
HOLOCENE
PLEISTOCENE
TERTIARY
JURASSIC
TRIASSIC
PERMIAN
UPPER
CARBONIFEROUS
Upper
PARMEENER
SUPER GROUP
Lower
PRECAMBRIAN
EL 40/83
STRATHBLANE
STORM
BAY
47
48
49
50000mE
147°00'
51
52
53
54
30'

FIGURE 4.1

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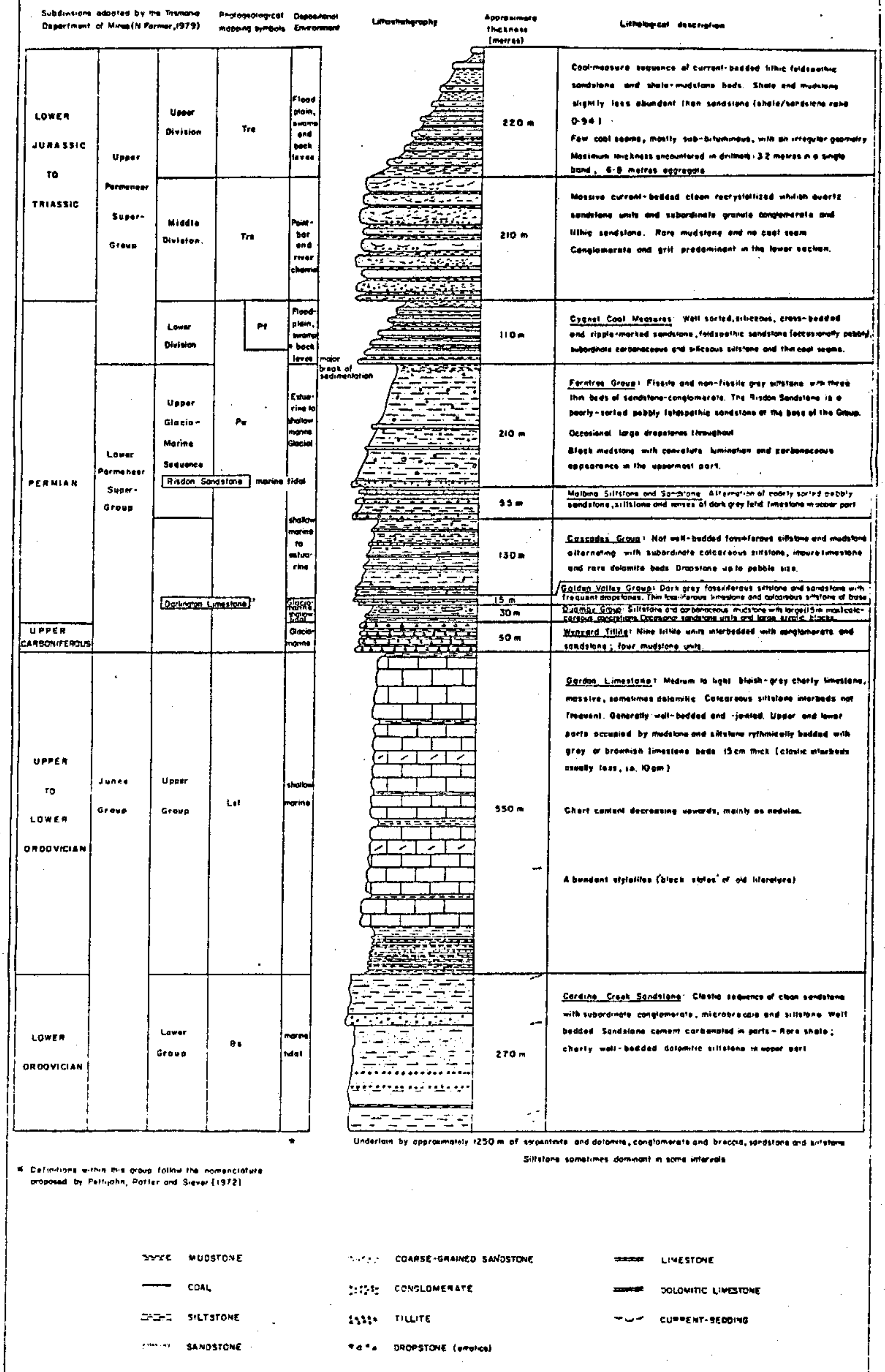
FIGURE 4.2

Summary of the stratigraphy in the Catamaran - Mount La Perouse Area, Southern Tasmania



Hunting Geology and Geophysics (Australia) Pty Ltd

Canberra June 1980 Job No GA 6/80

5.0 TARGET AND MODEL

MPAL's target within E.L. 40/83 Strathblane is the Triassic Coal Measures. This is a fluvitile sequence of sediments of approximately middle Triassic age. The coal seams are believed to have been deposited in backswamps in an upper delta plain environment. Typical washed coal quality characteristics are set out in Table 5.1. Coal of this quality would be suitable for a domestic power station.

Table 5.1
Washed Coal Quality Characteristics
(db)

Moisture	5 - 8%
Ash	20 - 30%
Volatile Matter	20 - 30%
Specific Energy	21 - 25 MJ/kg
Total Sulphur	<0.5%

The Tasmanian Hydro-Electric Commission has indicated that a thermal fired power station is likely to be of 2 x 200 MW size. Based on typical Tasmanian coal quality characterisitics, approximately 34 million tonnes (1.13 Mtpa) of saleable coal would be required over the usual 30 year power station life span.

- underground mineable target 112Mt in situ (assumption of 50% mining recovery and 60% preparation plant yield), i.e. assuming a single workable 2m thick seam, a total areal requirement of 35 sq. km.

- opencut mineable target 64Mt in situ (assumption of 90% mining recovery and 60% preparation plant yield), i.e. assuming a single workable 2m thick seam, a total areal requirement of 20 sq. km.

MPAL's model within E.L. 40/83 Strathblane for underground coal reserves is flat or shallow dipping coal measures protected beneath a dolerite sill, similar to the Mt. Nicholas deposit in north-east Tasmania. Open cut coal reserves would be contained in down-faulted Permo-Triassic blocks.

6.0 EXPLORATION

An aeromagnetic survey and landsat study were carried out in an attempt to delineate broad structural features including faulting and dolerite intrusions. It was also hoped that areas of Triassic Coal Measures covered wiuth dolerite scree that had previously been mapped as dolerite could be outlined. These reports are included in Appendices 1 and 2. on 1:500000 map of Tas !!!

Follow up field mapping was undertaken. The mapping was carried out by MPAL staff using 1:25,000 scale base maps. Road cuttings were geologically assessed using the parameters set out in "A Field Guide to the Identification of Rock Units in Southern Tasmania" by Dr. D. Leaman (Appendix 3).

7.0 RESULTS AND INTERPRETATION

7.1 Landsat Interpretation

Digital data from the Landsat 2 Satellite was analysed using programmes developed by M.J. Longman and Associates. Two techniques were used in the study: thematic mapping in which rock types were identified on the basis of their contained vegetation species and visual interpretation of the linear features shown on the imagery.

Thirteen different signatures were classified using this method into three levels of priorities.

7.2 Aeromagnetic Interpretation

A preliminary interpretation of the aeromagnetic data is included in Appendix 2.

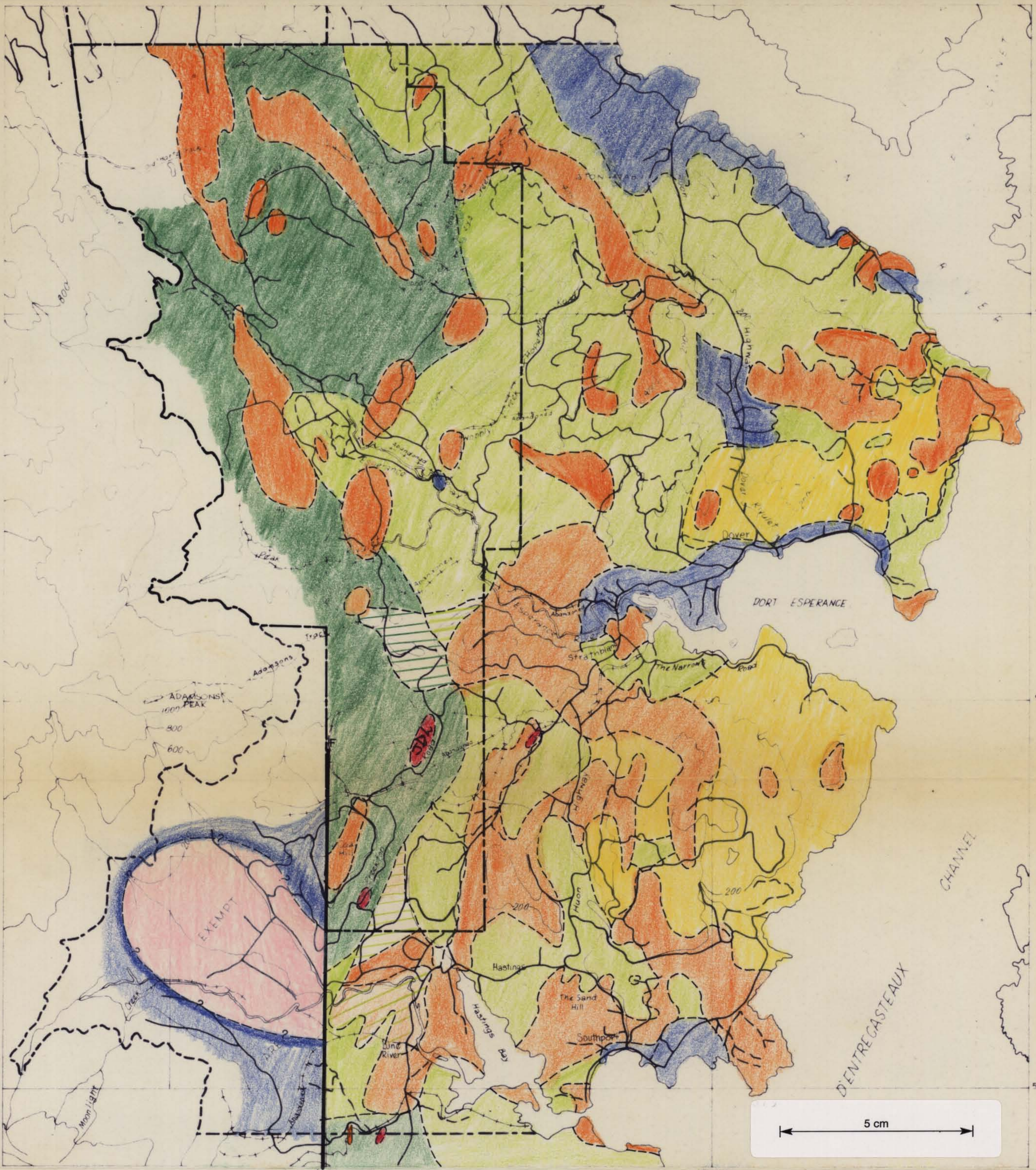
From the data provided it would appear that the areal extent of the dolerite is not as great as shown in the published mapping. The aeromagnetics outlined areas where dolerite occurs close to the surface however detailed structural interpretation of the data is not possible due to the spacing of the flight lines. The aeromagnetic survey has been shown to be a very useful mapping aid. As more geological information becomes available it will be able to be fine tuned allowing much more interpretation of the data.

7.3 Geological Mapping and Ground Follow-up

This method proved to be a cost effective procedure for identifying areas which are the most prospective.

The eastern and southern sections of the E.L. were found to be underlain by barren Permian sediments and Triassic Sandstone intruded by Jurassic Dolerite. The bulk of the south-western section of the area was contained within a government reserve and the rest was found to be underlain with Ordovician limestone and Pre-Cambrian dolomite. The sites of the old Strathblane and Hastings coal fields were located and these have been retained in E.L. 40/83. Outcrops of coal were found in the northwest of the area in what had been described on the published maps as outcropping dolerite. These outcrops were on average 0.5m thick and were found in road cuttings on new forest roads.

A provisional geology map is shown in Figure 7.1.



geology grossly incorrect

KEY

- SCREE
- TERTIARY BASALT
- JURASSIC DOLERITE
- TRIASSIC COAL MEASURES
  - THICK SEQUENCE
  - THIN COVER ON DOLERITE
- TRIASSIC SANDSTONE
  - THICK SEQUENCE
  - THIN COVER ON DOLERITE
- PERMIAN SEDIMENTS
- PRE PERMIAN SEDIMENTS

LEGEND

- ELA 28/82 STRATHBLANE
- EL 40/83 STRATHBLANE
- F——F FAULT
- GEOLOGICAL BOUNDARY

LOCATION MAP

SCALE 1:100 000
1 0 1 2 3 4 5 Km.

FIGURE 7.1

Marathon Petroleum Australia, Ltd.
BRISBANE AUSTRALIA
SK 55-8 Hobart Tasmania
ELA 28/82, EL 40/83 STRATHBLANE
Plan Showing
GEOLOGY

Mapped by N.T.P.
Drawn by L.PETERSON Date Feb.'84
Plan No. CIA3/T5-17

BASE CIA3/T6-13

017

360019

APPENDIX 1

Landsat Study by Longman and Associates

8?-019 360021

M. J. LONGMAN & ASSOCIATES

LANDSAT PROCESSORS AND INTERPRETERS

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PHONE (09) 322 2739
AFTER HOURS (09) 385 9469

LANDSAT INTERPRETATION

OF THE

MT LLOYD - CATAMARAN AREA

SOUTHERN TASMANIA

USING

THEMATIC

CLASSIFICATION

TECHNIQUES

by

M.J. Longman

January, 1983

Perth, W.A.

Map Sheet SK 55-8

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PLATES (at 1:25,000 scale)

1.0 SUMMARY

In the Mt. Lloyd, Catamaran and Geeveston areas of Southern Tasmania, computer processing of digital Landsat data and thematic classification techniques has been used in an attempt to distinguish between outcropping Tertiary basalt, Jurassic dolerite and Triassic coal measures, transported scree, talus and rocks of doleritic origin, and alluvial areas underlain by Permian and Triassic sediments.

A cloud free digital Landsat image No 2255-023085 acquired on 15th January 1982 by the Landsat 2 satellite was used in the computer processing. Geological ground control in the Catamaran district was provided by drill hole information and a geological map at 1:25,000 scale.

Fifteen signature classes totalling thirty three separate signatures, arranged in three reliability groups were developed in the control area containing the geological information. These signatures were then used to produce nine thematic maps at 1:25,000 scale outlining the distribution of these signatures in the Mt. Lloyd, Geeveston and Catamaran districts.

Ground checking of these areas are required to verify the distribution, as the thematic mapping technique assumes that the response of the vegetation cover directly correlates with the underlying rock type.

To accompany the digital classification maps, visual interpretation of the linear features shown on the Landsat image has been undertaken. This interpretation has been produced on five separate map sheets at 1:25,000 scale.

2.0 CONCLUSION

A thematic classification technique based on computer processing of digital landsat image No 2255-023085 in the Catamaran district of Southern Tasmania has shown that in the control area, where drill hole and geological information is available, dolerite, basalt, dolerite scree, and talus can be identified and distinguished from the Permo-Triassic Coal Measures and other Permo-Triassic rocks.

Nine thematic maps at 1:25,000 scale have been produced showing the distribution of these signatures in the Mt. Lloyd and the Catamaran - Geeveston district.

To accompany the thematic maps, a visual lineament interpretation of the same Landsat digital data has been produced.

3.0 INTRODUCTION

3.1 Location

The area mapped, approximately 2,100 sq kilometres, is located in two areas in southern Tasmania. The larger area, 1700 sq kilometers in size, is located between Geeveston and Catamaran and the smaller area, 400 sq kilometres in size, is located at Mt Lloyd, south-west of New Norfolk. It is covered by the Landsat image, Hobart No 2255-023085 and is included by the southern portion of the 1:250,000 map sheet Hobart (SK 55-8) The permanent settlements in the area are Geeveston, Strathblane, Hastings, Lune River and Catamaran.

3.2 Physiography

The area studied is mountainous with a relief of up to 1500 metres. In the western areas where the pre-Permian rocks form residuals, the ranges tend to be ridge-like, while areas in the east tend to be covered by flat lying Jurassic dolerite. These ranges tend to be plateau-like with deeply dissected valleys and sharp scarps where the underlying Triassic and Permian rocks are exposed. Adjacent to the coastline, narrow coastal plains occur, but these are of limited extent.

3.3 Vegetation

The areas are occupied by two major forest types, a typical rainforest in the north and west, and a dry sclerophyll forest in the Southport area.

Due to the dissected and hilly topography which covers most of the study area, and the rapid changes in rock type and parent rock material, the vegetation appears to form local environments within the broader forest types.

In the dry sclerophyll forest, well defined species definition occurs on the western and eastern slopes of the hills and classification techniques must develop signatures for the environments.

Typically on Jurassic dolerite soils the western slopes are composed of a Eucalyptus linearis, E. viminalis cover while the eastern slopes are covered with E. obliqua and E. viminalis.

In Triassic Sandstone areas, the western slopes have an E. globulus cover, the hill crests an E. amygdalina, E. viminalis cover and the eastern slopes an E. obliqua, E. viminalis cover while in Permian areas E. tasmanica and E. viminalis are the dominant species.

In the wetter rainforest areas, the distinction between the parent rock types becomes less distinct with Notofagus sp. tending to dominate in the moister areas.

The natural patterns have been modified by forestry and agriculture activities and frequent fire burns. In these areas classification techniques reflect surface changes rather than the underlying rock type.

3.4 Climate

The area of interest is between latitude 42^{o} 45'S and 43^{o} 45'S. The climate is temperate marine dominated by westerly winds. Thus on a broad basis the climate is predictable with similar patterns from year to year. This regular pattern influences the vegetation which under natural conditions tends to be stable showing only seasonal variations.

In the study area the annual rainfall varies from 100 - 200 mms. spread throughout the year, but with the main period between April and November.

The mean temperature range varies from 17^{o}C in January to 7^{o}C in July, with peak temperature in January reaching 40^{o}C and minimum temperature in July falling to minus 12^{o}C.

4.0 GEOLOGY

4.1 Regional Geology

In the area of interest Jurassic dolerite, intruded as flat lying sills into both the Permian and Triassic rocks is the dominant rock unit.

The oldest rocks exposed on the western margin of the area are limestones of Ordovician age unconformably overlain by Permain rocks of glacial origin. Overlying the Permian rocks with a major disconformity is the lacustrine Triassic succession.

During a period of block faulting in the Late Cretaceous and Early Tertiary, basalts has been intruded along major fault zones.

4.2 Detailed Geology

4.2.1 Ordovican

Exposed in the west of the area, these rocks are composed dominantly of well bedded limestone with minor chert horizons.

4.2.2 Upper Carboniferous-Permain

These rocks are composed of glacial marine sequence of interbedded basal pebbly tillite overlain by siltstone and mudstone, with rare limestone horizons. This unit is overlain disconformably by an erratically developed fresh water sequence, locally carbonaceous, which in turn again is overlain by a monotonous sequence of siltstone and mudstone.

4.2.3 Triassic

The Triassic rocks are composed of lacustrine and fluviatile deposits of quartzite, lithic arenites, minor conglomerate and coal beds. Sandstone dominates in the lower part of the succession being quartzose in the basal units with increasing feldspathic contact in the higher portion of the succession.

In the upper coal bearing portion of the succession, feldspathic sandstone dominates, and lutites become more common forming up to half the succession in selected areas. Coal is restricted to the upper portion of the succession closely related to the feldspathic sandstone units.

4.2.4 Jurassic

During the middle Jurassic widespread intrusion of tholeiitic magma took place forming dyke like bodies in the pre-Permian rocks and sills parallel to bedding in the Permian and Triassic rocks.

These sills, up to 500 metres thick, dominate in the area. Multiple sills have been observed in the one stratigraphic succession and interpretation suggests that two sills are present south of Catamaran.

The contact with the adjacent sediments are sharp and only a narrow chilled margin is present. No large scale assimilation of the country rock has been observed. One local variant of the tholeiitic suite is a granophysic differentiate which tends to occur above feeder dykes.

4.2.5 Cainozoic

During the late Mesozoic and Early Tertiary, widespread normal faulting produced the graben or step fault structures throughout the area. In these depressions under lacustrine conditions clays and silts were deposited. At major fault intersections, olivine basalt lavas were extruded together with the associated tuffaceous sediments.

Widespread lateritisation occurred during the late Tertiary followed by a period of glaciation in the Pleistocene.

5.0 LANDSAT INVESTIGATIONS

5.1 Landsat Data

Digital data from the Landsat 2 Satellite has been used to process the area covered by the Hobart Landsat image. This image was sensed on the 15th January 1982. It is cloud free and the sun elevation was at a maximum.

5.2 Analysis Method

The digital Landsat data was analysed using programmes developed by our organization to operate on our PDP11-44 computing system.

Two main programmes are used, the first an interactive programme which allows the digital data to be processed in small blocks up to a maximum of 6000 acres, 50 x 120 pixels, and individually display the response of each pixel on each band.

The second programme which takes these selected responses and produces and plots maps at any selected scale and projection.

In addition to the two main programmes, subsiduary programmes read the data from the Landsat data tapes, perform various statistical smoothing operations to remove noise and sensor inbalance. Other programmes automatically classify the data and produce classifications which are statistically valid.

Subsiduary programmes are used to establish geographical control and adjust the data to match the required map projection.

5.3 Geographical Control

One of the greatest problems associated with the interpretation of Landsat data is to obtain accurate ground control and relate the Landsat digital image to the existing data bases.

Although actual Latitude and Longitude are provided with the Landsat data, these have been calculated from the theoretical orbit of the satellite and as such have little reference to the actual area sensed on the ground.

To provide accurate ground control, to within 200 metres or better, data points which are visible on the digital data and can be accurately located on the ground must be used. These points are determined using the pixel grid for reference in the Landsat data and Latitude and Longitude from the ground control maps.

By statistical analysis of this data, making due allowance for variations in the mirror scan rate, pitch and height variations in the satellite itself and corrections for the earth's rotation, an accuracy of 150-200 metres could be expected in an individual area on the final maps.

Variation in the control points used to correct the digital data to the Transverse Mercator Base map, the residual error after the above corrections had been applied varied between 8 and 112 metres.

6.0 CONTROL FOR THEMATIC CLASSIFICATION

As the ground or vegetation response for the various rock types could not be determined by either ground radiometer traverses or aircraft scans, the sensor responses had to be calibrated by accurately locating known geological features on the digital image data and determining the actual responses of each sensor in that area.

To provide the most accurate ground data, the location of each of the drill holes in the area, Holes No CA 101 to 120 inclusive were plotted on the satellite pixel grid and the sensor response of the surrounding 4 pixels was determined. As this accuracy is at the limit of reasonable ground control using 1:25,000 scale base maps, the values of the response of the pixels corresponding to a 5 x 5 pixel block (25 acres) were also determined to augment the signatures existing in the smaller area.

To provide correlation throughout the mapped region, these twenty areas were analysed using an automatic classification technique and the responses graded as to reliability, on a pixel by pixel basis, of characterising each rock type. The response range of each pixel was then increased in unit values on a band by band basis until a compromise was reached between an increased coverage of the control areas with increased false responses from rock units unassociated with the control unit.

Even in the relatively small area occupied by the control drill holes, each rock type could not be characterised by one signature without considerable false responses, so in all cases multiple signatures were used to characterise each unit, in an attemp to minimise false responses.

To provide ground control in areas away from the drill hole locations, the geological maps, one at 25,000 scale provided by Marathon and one at 1:250,000 scale produced by the Geological Survey of Tasmania were used.

Again as with the drill hole information, areas were selected which were composed of the one rock type and an automatic classification technique was used to extract those responses which could be used to characterise that area.

Where these signatures corresponded to those derived from the drill hole data, greater reliability could be placed on these signatures than those which had no direct correlation.

During this phase of the development, it was noted that certain responses were widespread and appeared to be independent of rock type. These areas could not be classified using this technique and appear as blank areas on the final maps.

In all, in excess of 2,000 classification signatures were tested and finally 33 signatures were selected which appeared to have specific responses, particularly within the control areas. These 33 signatures were combined into groups and presented on the final maps as fifteen groups in three reliability categories.

The first priority signatures were eight in number, composed of four dolerite, one basalt and three sandstone signatures. These signatures had minimal false responses in the control areas, but due to the restricted range of responses in each band, tended to be restricted in coverage.

The second priority signatures were twelve in number, and composed of two dolerite, four dolerite talus and scree, two basalt talus and three sandstone signatures. These signatures were less reliable in the control area, but again had restricted responses and ground coverage.

The third category signatures were twelve in number and were composed of two dolerite signatures, four dolerite talus signatures and six signatures which appeared to correspond to soils overlying sandstone in the control area. These signatures as a group are less reliable, tend to have wider responses and more widespread coverage.

A water signature, corresponding to clear water was determined to provide in addition to the geographic grid, details for location in the southern areas.

6.1 Final Map Production

Sixteen maps at 1:25000 scale have been produced. Eight maps cover the Catamaran Geeveston area, five digital classification maps and three lineament maps, while in the Mt Lloyd area four digital classification and two lineament maps were plotted.

In all cases, due to the oblique path of the satellite more area was processed than was actually contained within the Exploration Areas to assure that the area was adequetely covered. This was particularily true in the case of the lineament maps where many of the lineaments were major trends extending throughtout the southern portion of the State.

7.0 DISCUSSION OF RESULTS

The thematic classification mapping technique relies on the fact that an identical response from each of the Landsat sensors represents a unique situation and it is assumed that all areas with that identical response will also be identical.

However, there are many exceptions to this assumption and the interpretation of thematic maps must in many areas be treated with caution.

The commonest cause of false responses is the averaging effect of between two extreme responses, e.g. a sandy beach and water where intermediate responses composed of all variations between the responses for sand and water can be obtained. This effect is generally restricted to small areas of a few pixels in size and can be visually isolated.

The other false response which is more difficult to identify is when the vegetation cover does not reflect the underlying rock type. This response can be due to many causes. Seasonal conditions tend to have an overriding effect on vegetation cover. The most obvious cases can be seen after heavy rainfall where variations in the response tends to be minimised, while at the other extreme, in drought conditions almost no variation can be detected.

Another feature that affects the reliability of the classification is the distance from the control area, particularly where climatic patterns undergo rapid change. In these situations, signatures developed in one area have almost no possibility of being applied on a regional basis.

The following comments can be applied to the signatures developed in the Catamaran area.

1. Signature A - Dolerite Outcrop

   This is a composite signature composed of four sub-divisions and is the broadest signature response plotted. The composite theme has a variation of 2% in brightness on band 4, 2% on band 5, 5% on band 6 and 6% on band 7.

   Because of the wide response on bands 6 and 7 the signature could be expected to have wide coverage, but would tend to have false responses associated with its distribution. Reducing the responses on bands 6 and 7 resulted in restricted area coverage without significantly reducing the false responses.

2. Signature B - Basalt Outcrop

This signature developed in the vicinity of drill hole No CA106 is a single signature with a reflective range of 3% on each band. This signature would be expected to have minimal false responses, but from its distribution there appears to be an overlapping response with that of fine grained dolerite.

No combination of signatures were able to eliminate this dual response, so association of signatures would be needed to verify the distribution. Small areas closely associated with dolerite and sandstone signatures would probably represent fine grained contact zones, while isolated larger areas would represent basalt.

3. Signature C - Triassic Coal Measures

This is a composite signature of two sub-signatures developed in the Catamaran area from drill hole locations and known outcrops. The range of response is 1% on band 4, 3% on band 5, 3% on band 6 and 2% on band 7.

With such restricted tolerances the signature would be expected to be very specific and could be interpretated with reasonable reliability. Other rock units composed of sandstone and shale sequences could be expected to provide false responses.

4. Signature D - Dolerite Sub-outcrop

This is a composite signature composed of three sub-signatures. The range of responses are 3% on band 4, 3% on band 5, 7% on band 6 and 2% on band 7. With the wide range of response on band 6, false identifications could be expected. When this range was reduced, very scattered coverage was obtained in the type area.

5. Signature E - Dolerite Scree

This signature was developed from the drill hole data in the Catamaran area and is composed of two sub-signatures. It is quite a specific signature with response ranges of 2% on band 4, 2% on band 5, 3% on band 6 and 2% on band 7. With this response range, false identifications should be minimal.

6. Signature T - Dolerite Talus and Soil

This is a composite signature composed of two sub-signatures developed in the Catamaran area. The signature has a response range of 2% on band 4, 2% on band 5, 4% on band 6 and 3% on band 7. Due to the relatively wide range on bands 6 and 7 some false identification could expected, however when the response range was restricted scattered areas were obtained.

7. Signature G - Basalt Talus and Soil

This is a composite signature developed near drill hole No CA106 and has a response range of 3% on all bands. It is always closely associated with Signature B and could be associated with soils derived from chilled dolerite margins as well as basalt outcrop.

8. Signature H - Triassic Coal Measures

This is a composite signature composed of three sub-signatures, developed from the drill hole data in the Catamaran area. The signature should be quite specific as the response ranges were 2% on all bands.

As the signatures were developed over an alternating sandstone and shale succession, other sandstone and shale sequences could provide a similar response.

9. Signature I - Dolerite Weathered insitu

This signature has been developed in areas of known dolerite outcrop with a heavy forest cover. It is a composite signature composed of two sub-signatures. The signature ranges are 1% on band 4, 2% on band 5, 3% on band 6 and 2% on band 7.

This limited response range suggests that the signature should be quite specific, but as it has been developed in heavy forest cover, this may dominate in the classification rather than the underlying rock type.

10. Signature X - Dolerite Talus and Soil

This is a composite theme composed of the sub-signatures with an overall response range of 1% on band 4, 2% on band 5, 1% on band 6 and 2% on band 7. With this response range it is anticipated that the signature should be quite specific and false responses would be minimal.

11. Signatures K, L, N, and P - Triassic Rocks - Soil covered

These signatures have been developed in areas mapped as Triassic sandstone or Triassic coal measures on the geological map and modified to provide minimal false responses. This group of signatures have the widest responses, and as such would tend to be the least reliable of the signatures developed.

Interpretation of the areas covered by these signatures must be treated with caution. Six sub-signatures have been used to produce the range of responses with signature L with a response range of 3% on all bands, being typical of the developed signatures.

12. Signature W - Water

This signature has been developed to assist in location of the areas of interest. The response has been restricted to areas of deeper water and tidal areas, mud flats, swamps, etc. have not been covered by the classification. This signature shows a normal response range for thematic classification techniques of 14% on band 4, 12% on band 5, 12% on band 6 and 10% on band 7.

13. Unclassified Areas

These areas have been plotted as areas without distinguishing symbols. They are outside the range of the classification used or are composed of areas which have no diagnostic features. In general they correspond to ground that has been altered by agriculture or forestry activities, road construction or recent fire burns.

8.0 REFERENCES

FARMER N, 1979, Geological Atlas, 1:250,000 Series, Sheet SK 55-8 Hobart, Explanatory Report, Geological Survey, Tasmania.

LEAMAN D, 1981, Interpretation of Geophysical Surveys, Catamaran Area [EL 6/79] Unpublished.

APPENDIX 2

Airborne Magnetic Survey by Geophysical Exploration Consultants

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360040

GEOPHYSICAL EXPLORATION CONSULTANTS PTY. LTD.

Suite 106, 104 Mount Street, Heidelberg, Victoria 3084 Telephone (03) 459 0533

REPORT ON

THE AIRBORNE MAGNETIC SURVEY OF

EL STRATHBLANE, TASMANIA

FOR

MARATHON PETROLEUM AUSTRALIA LTD

BY

GEOPHYSICAL EXPLORATION CONSULTANTS PTY. LTD.

HUGH RUTTER MARCH 1983.

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TOTAL MAGNETIC INTENSITY PLANS; 1:25,000 (9 plans)

STOCKED PROFILES OF TOTAL MAGNETIC INTENSITY; 1:25,000 (6 plans)

INTERPRETATION OF TOTAL MAGNETIC INTENSITY; 1:25,000 (2 plans).

1. INTRODUCTION

The Strathblane exploration licence is on the eastern shore of the Huon River, approximately 65 km south south-east of Hobart in Tasmania. The northern boundary is almost to Geeveston and the southern boundary includes the small town of Southport. The coastline marks the eastern boundary and the 200m elevation contour marks the western limit.

The 1:250,000 geological map indicates the presence of the upper glacio-marine sequence from the Lower Parmeener Super-Group with more extensive beds of the coalbearing fresh water sequence above.

However, much of the more prospective coal bearing sequences are obscured by Triassic dolerites. It is considered that there is one major dolerite sill with a thickness of 100m to 150m; plus several other thinner sills intruded into the sequence. The purpose of the airborne magnetic survey is to locate the boundaries of the various sills and therefore delineate areas free of major dolerites that can be explored for coal. Whenever possible, structural detail such as faulting, dips and folds, are extracted from the data.

2. DATA ACQUISITION

The airborne magnetic survey was contracted to Geoterrex Pty. Ltd. and full survey specifications are included in their logistics report. The more relevant details can be summarised. The flight line spacing is 500m with lines orientated in an east west direction: tie lines are flown north-south with a maximum separation of 3000m. The aircraft flew with a mean terrain clearance of 90m. In some locations this was exceeded because of topographic relief. The survey was originally specified to cover the exploration licence as far west as the boundary, which is the 200m topographic contour. It was found impossible to maintain an east-west flight direction at 90m along this boundary. One alternative was a revised flight plan with north south lines; or, secondly, to fly parallel to the elevation contours. Both alternatives increased the overall survey cost. However, after an examination of the field data records it was decided not to fly this western strip of high relief; there was no magnetic activity and it was concluded there was an absence of dolerite; in all probability the northern extension of the Lune River Fault had been crossed. An examination of the final data shows this decision to have been correct.

Subsequent to the presentation of preliminary contour plans and magnetic profiles a choice final processing and presentation details was made. The contour interval of 5nT is used on the final plans. These plans are in the standard format of 7.5 by 7.5 minutes at a scale of 1:25,000: both latitude, longitude and AMG coordinates are shown on each map.

The flight lines are superimposed on the magnetic contour plans so that data reliability can be gauged at a glance.

The stocked profiles of total magnetic intensity have a horizontal scale of 1:25,000 and a vertical scale of 50 nT/CM; each profile is separated in a northerly direction by a factor of 3 to enable the data to be more easily used.

A cesium vapour magnetometer was used throughout the survey and a total of 1260.5 km of data were collected.

3. INTERPRETATION

The Strathblane survey is the third of three airborne magnetic surveys in south-eastern Tasmania: the other being Mt Lloyd and Catamaran. All surveys were flown for the same reason, ie location and delineation of dolerite sill in order to direct efficient coal exploration; and were flown in similar geological invironments. The comments and references which are contained in the interpretation section of the two previous reports also apply here.

Strathblane is the largest area and abuts Catamaran in the south. Some features which are more regional can be derived from the data. The major sill is more in evidence towards the west with an increasing number of smaller sills outcropping towards the shoreline.

Faulting appears to be more intensive in the west, possibly due to the influence of the Lune River Fault, or its northern extension. The dolerite sills in the west have a blocky distribution whereas those along the coast have strike continuation over greater distance.

Dips are not easily determined because of the disruptive nature of the faults and the interaction of the magnetic anomaly from one sill with that from another. However in a number of locations the direction of dip is obtainable and has been marked on the interpretation plan. The overall dip is to the west but local variations are common.

At Swearing Bobs Plain on the northern sheet the dips indicate a broad, gently dipping syncline: this feature may extend southwards towards Storm Hill but the evidence is not clearly discernible from the magnetics.

West of Swearing Bobs Plain, towards Ti-Tree Hill there appears to be a narrow anticline which reverts the dip to that of a westerly attitude. There is supporting evidence of the anticline 2-3 km to the north and slightly west. The dips appear to be gentle, in the range of 5º-15°.

It is possible that folding exists towards the south west but it cannot be extracted from the data with any degree of certaintly.

The thicker sills can be identified by the higher amplitude of the magnetic anomaly, and their outcrop is marked on the interpretation plans. The thin sills may not always be what their name suggests. A thin sill marked as outcropping may in fact be a thicker unit at a greater depth. Magnetic susceptibility and thickness, the two critical parameters for a depth interpretation, are known to vary. This ambiguity, coupled with the close interplay of shallow dip and topography will undoubtably lead to a few misinterpretations. However, maximum care has been taken to minimise these errors by comparing the interpretation of each magnetic anomaly with those along strike and across dip.

4. CONCLUSION

There appears to be little doubt that dolerite sills occur throughout the area somewhere in the upper 300m. But in many instances these will be thin sills which should not detract from successful coal exploration and subsequent mining. The thicker sills are more apparent in the magnetic and can be avoided when planning drill holes. If the westerly dip is confirmed in the field, then there is a greater likelyhood of there being fewer thick dolerites in the east. If there coal-bearing sediments occur in the east, then exploration may have a higher rate of success here, than towards the Lune River Fault.

Perhaps of more concern is the apparent number of faults. But if the throw is small they should not seriously effect the operation of an open cut coal mine. The determination of throw is complicated by the presence of many dolerite sills in the sequence. But if the throw was of any magnitude one would expect a large lateral displacement. If the faults are transverse in nature, then again, a large displacement of the magnetic anomaly would be expected if the movement was great.

There are many areas in Strathblane where the presence of dolerite is not detrimental and the structure is acceptable: it now remains to locate exploitable coal in these areas.

Hugh Rutter

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CONSULTANT GEOPHYSICIST

HR/bg

APPENDIX 3

A Field Guide to the Identification of Rock Units in Southern Tasmania

by

Dr. D. Leaman

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A FIELD GUIDE FOR THE IDENTIFICATION OF ROCK UNITS IN SOUTHERN TASMANIA

Prepared for Marathon Petroleum Australia Ltd.,

By D.E.Leaman B.Sc., Ph.D

INTRODUCTION:

The notes are intended to guide mappers unfamiliar with post-Carboniferous units in Southern Tasmania. Those properties which facilitate redognition or which should be recorded are emphasized. The descriptors outlined ignore the many subtleties and facies variants which complicate very detailed mapping and are selected to permit sub-Group rather than Formation or Member identifications. This is a realistic simplification for a region (especially south of Hobart) where minimal exposure prohibits rapid, highly detailed mapping; but one which allows all salient features of stratigraphy or structure to be recognised or inferred.

Situations will undoubtedly arise where a rare facies variant at an isolated exposure will create problems. Use of the field book descriptor list and comparison of notes from adjacent exposures will usually resolve the problem - at the end of the day. The notes are a distillation of nearly twenty years experience and no newcomer can expect them, as words, to convey the nuances of colour or texture which the eye assimilates and needs for intuitive recognition. The rocks involved are not easy since they exhibit limited property ranges, but these notes will certainly provide a rapid, on site reference of high probability from the start of work.

The notes are in six parts plus an appendix.

STRATIGRAPHIC NOTES - SUMMARY:

FORMATION GUIDE:

Precambrian:

Dolomite, Hastings Region only.

Ordovician:

Limestone. Gordon Limestone correlate, Junee Group. Dover west - Hastings region.

Can only be distinguished from older dolomite on the basis of calcite shell replacement and from younger limestones on the basis of folding, consolidation, very high quality and fauna. This limestone is very fossiliferous and carries both solitary and colonial corals but few bryozoans. Colour, dark grey.

Upper Carboniferous - Lower Permian:

All units younger than Late Carboniferous are essentially sub-horizontal. Deformations are restricted to intrusion margins or fault zones. Warps or domes do occur but the wavelength exceeds several kilometres. Rocks of this age form the Lower Marine Sequence of the Parmeener Super-Group.

Tillite: Patchy, basal unit. Very pebbly with a matrix of fine silt, clay or frock flour. Steel grey when fresh, buff when weathered. Matrix breaks down to cuboidal fragments. Cannot be confused with any other unit.

Woody Island Siltstone: Massive, monotonous siltstone-mudstone. Colouring and weathering properties identical to tillite matrix. Pebbles rare; fossils rarer. Thickness may exceed 200 m. The weathering of grey mudstone to cuboidal fragments is distinctive. Only Triassic mudstones exhibit similar properties.

Bundella Mudstone/Darlington Limestone: Essentially the upper members of the previous unit although the development may be of comparable (> 100 m) scale. Marked by increased silt, sand content and patchy calcareous units. Quite fossiliferous, extensive brachiopod-bryozoan population. Commonly weathers to an off cream/off white colour (if fine-grained) and can then only be distinguished from Cascades Group by detailed faunal examination.

Middle Permian:

Faulkner Group: Lower Freshwater Sequence, Lower Parmeener Super-Group.

Very patchy unit, includes a range of siltstone, sandstone, conglomerate members. It is rarely well developed and is quite thin (< 50 m). There are no marine fossils but the sandstones occasionally carry wood fragments. Well sorted (often arkosic) sandstone in a Permian sequence are definitive. The unit is often absent south of Hobart.

Middle - Upper Permian:

Upper Marine Sequence, Lower Parmeener Super-Group.

Cascades Group: Very fossiliferous mudstone and limestone. The mudstone is often pebbly and the limestone silty and impure. The mudstone is often calcareous and weathers to a characteristic cream-off white colour. The group is rarely less than 60-90 m thick and is the most consistently fossiliferous unit in the Lower Parmeener Super-Group.

If a unit is fine-grained, richly fossiliferous with sheafs of bryozoans and low profile brachiopods (Strophalosids) with few sandy intercalations it is probably this group, rather than Bundella Mudstone. Limestone members of this, or the Bundella Formation, are rarely found south or west of Mt. Wellington.

Caution: The two units may be paraconformably combined if the Faulkner Group is absent.

Recommendation: Consider mapping as one unit; "Bundella-Cascades".

Malbina Group: A relatively patchy, variable unit dominated by the typical Upper Permian siltstones. (The typical siltstone is invariably hard, with surface weathering only, coarse and poorly sorted; grey when fresh but broken surfaces are always textured (bioturbate?, castings?) and often pebbly. Fossils are extremely rare.) The Malbina Group can be identified in two ways - by stratigraphic relationship to the very different Cascades Group beneath and the Risdon Sandstone marker above - or by the only fossiliferous sandstone in the sequence. The sandstone (Member A) often has a burnt brick appearance and contains thick-shelled brachiopods only. A thin fossiliferous upper member (E) with properties comparable to the Cascades Group is rarely seen. The group is rarely more than 60 m thick, except in the type area near New Norfolk.

Risdon Sandstone: A five metre thick, poorly sorted, arkosic, pebbly, massive sandstone offers the only chance for splitting the siltstone sequence. Unfortunately the sandstone is not well exposed in high rainfall areas. A sequence of siltstone - thin fossiliferous mudstone - massive sandstone - sitstone is definitive of the Malbina-Risdon-Ferntree boundary. The visual trigger is always the sandstone. There are very few sandstone/siltstone interfaces and only this one overlies a fossiliferous (if hard to find) mudstone. Note that the Risdon Sandstone is not fossiliferous and cannot be confused with the base of the Malbina Group.

Ferntree Group: A thick (>150-180 m) predominantly siltstone series. Up to three conglomerates (< 50 cm) may be observed but these and a single fossiliferous unit have little mapping significance. The fossils are brachiopods and are restricted to one thin zone rich in mud rolls which on exposure are etched to yield small rounded caves up to a metre across. These structures are found nowhere else in the section.

Upper Permian:

Upper Freshwater Sequence, Upper Parmeener Super-Group.

Cygnet Coal Measures: An extremely patchy, variable unit containing carbonaceous mudstones, coal and variably sorted sandstones. Sandstones are usually feldspathic and rich in heavy minerals, including garnets. As a result they often have a red, 'spotty' appearance and are quite distinct from the overlying pure quartz sandstones.

Quartz sandstone: (= Ross, Rhyndaston Sandstone??). Formation names have no relevance. Massive quartz sandstone, very minor shale. Beds often graded and re-cemented. Includes the Permo-Triassic boundary.

Triassic: Upper Freshwater Sequence, Upper Parmeener Super-Group.

Normally only two divisions are made. These are based on sandstone lithology and the presence of coal. Several other divisions are possible based on the proportion and type of lutite.

Quartz succession. Sandstones dominant near base. Shale, then massive mudstone content increases upward. Mica content also increases upward and maximises near the introduction of the lithic sandstones. The feldspar content is variable but may also increase upward. Clay pellet conglomerates are common.
Many lithological associations are difficult to map due to variable exposure and some may not always be recognisable. For example, the massive sandstones at the base may be absent. If massive mudstones have been observed then the succession is at least Late Triassic and potentially coal bearing.

Lithic succession. Lithic sandstones and mudstones. Often carbonaceous. Quartz rich units are interleaved in many areas.

Jurassic:

Dolerite.

Cretaceous:

Syenite dyke swarm centred on Cygnet. Large sanidine crystals and deep white clay weathering typical.

Tertiary:

Basalt. Separable from dolerite on structural grounds or if vesicles, amygdales, pillows, olivine, iddingstite are present (and obvious) and if too coarse grained. The best grain size indicator is the etched length of pyroxene crystals.

Sediments. Tuffs, clays, sands. Ubiquitous but relatively unconsolidated and rarely recognised at first sight.

Pleistocene-Recent:

Talus. Composed mainly of dolerite; the oldest deposits are usually reddest in colour reflecting deeper, humic weathering pre-glacial activity. The most recent deposits have little matrix.

Alluvium. Includes gravels.

SUGGESTED MAP UNITS:

1. BASEMENT. Precambrian dolomite (A), Ordovician limestone (B).

2. LOWER PARMEENER SUPER GROUP.

   A: Lower Marine siltstone,mudstone, tillite. Unfossiliferous.

   B: Lower-Upper Marine fossiliferous & calcareous siltstones.

   (Presumes Lower Freshwater sequence absent or not found).
   Otherwise map B1: Lower Marine fossiliferous mudstone
   B2: Lower Freshwater sequence
   B3: Upper Marine fossiliferous mudstone

   C: Upper Marine siltstone. Essentially unfossiliferous siltstone. Malbina unit A or Risdon Sandstone may be noted.

3. UPPER PARMEENER SUPER GROUP.

   A. Carbonaceous, arkosic, sandstone, shale.

   B. Quartz succession - sandstone, shale, mudstone. No lithic content.

   C. Lithic succession - sandstone, mudstone, coal. Quartz content common.

4. DOLERITE.

5. BASALT (A) (and sediments (B) if observed).

6. TALUS.

7. ALLUVIA.

MAPPER'S GUIDE:

1. IF IN DOUBT - WHAT TO RECORD FROM AN EXPOSURE

(a) Is the rock pebbly? No need to detail size, composition etc.

(b) Does the rock contain clay pellets?

(c) Is the rock fossiliferous?

If yes, note the lithology, rock colour, whether pebbly, and general fossil types (population), i.e. brachiopods only, bryozoans only, bryozoans and strophalosids etc.

(d) Is the rock calcareous?

(e) What is the lithology and colour?

(f) Is the rock thick/thinly bedded? Is the bedding graded? Are there current structures?

(g) Is the rock homogeneous?

(h) If fine-grained what is the texture? Is it massive or shaly? Is it uniform in colour or spotted? Is it micaceous?

(i) If coarse-grained what can be seen with a hand lens? Heavy minerals, rock fragments, primary mineralogy, coal or wood fragments etc.

(j) Is the rock weathered? What colours are evident. Is the cementing sound? Are there holes?

(k) If igneous, note texture, mineralogy, grain size and joint/fracture types and separation.

Single word notes in reply to these questions will usually allow later correlations and judgments on most materials even if recognition on site is uncertain. Familiarity with the possible combinations will ultimately permit quite certain field identifications from very few, or small, exposures.

2. IDENTIFICATION GUIDE

This is a condensed inversion of the stratigraphic description in a field usable form. The guide is designed to permit reliable sub-Group identification and to reveal those facies variants which may be ignored and indicate where adjacent observations are essential to the identification. Refer page 5 for map unit code.

1. The rock is pebbly. Definitive. Unit 2.

2. The rock contains clay pellets. Definitive. Unit 3B, not near base.

3. The rock is fossiliferous.
   a) plant fossils. Units 2B2, 3A, 3B, 3C
   b) dominance of bryozoans. Units 2B1 upper, 2B3 lower (some pebbles, cream mudstone)
   c) large pectenids present. Unit 2B1 (definitive) (usually calcareous, buff siltstone)

d) thick shelled simply ribbed brachiopods. Unit 2C basal (in pebbly sandstone - Malbina A - definitive)
e) significant proportion strophalosid brachiopods. Units 2B1 upper, 2B3 lower, 2C occasional (Malbina E). Actual genera recognition definitive.

4. The rock is a limestone.
a) folded, unfossiliferous: Precambrian. Unit 1A, definitive.
b) folded, fossiliferous: Ordovician. Unit 1B, definitive.
c) light grey, dirty, fossils: Permian. Unit 2B (see notes 3c, 3e above for identification)

Confusion may arise where dips do not exceed 10-15°, but fossil types are definitive.

5. The rock is calcareous. Normally unit 2B. Parts of 2C (Malbina E) may be confused but the scale of deposition is such that the unit is rarely seen outside road cuttings where the relationships with other units is evident.

6. The rock is a conglomerate.
a) if localised or a single bed. Part of 2B2 or 2C
b) poorly consolidated. Unit 5B
c) if dolerite boulders dominant. Unit 6
d) whole rock mass pebbly, conglomeratic. Unit 2A (base)

7. The rock is a sandstone.
a) quartz dominant, with or without feldspar. Units 2B2, 2C, 3A, 3B.
b) pebbly, even if rare (see d). Unit 2C(base). Malbina A or Risdon Sandstone.
c) 7a plus heavy minerals (garnets etc). Unit 3A, upper part 3B
d) fossiliferous (definitive). Unit 2C (base) Malb A
e) well sorted, micaceous/graphitic. Unit 3B (upper)
f) lithic fragments, spotty appearance. Unit 3C

8. The rock is a siltstone.
a) uniform texture. Probably Unit 2A
b) complex texture. Often sandy. Rough feel. Unit 2C
c) fossiliferous Unit 2B

9. The rock is a mudstone.
a) massive
(i) grey, some rare pebbles Unit 2A
(ii) red, green, spotty (fresh colours). Unit 3B (upper), 3C (lower)
(iii) fossiliferous (marine) Unit 2B

b) shaly
(i) black, no mica. Units 2B2(rare), 3B (base, usual)
(ii) fossiliferous (marine) Unit 2B (prob, 2B3)
(iii) fossiliferous (plant) Unit 3B
(iv) micaceous Unit 3A(rare),3B(upper)

10. The bedding is
a) massive
(i) sandstone, pebbles. Unit 2C(Risdon Ss)
(ii) sandstone (quartz/lithic) Unit 3B or 3C
(iii) mudstone Unit 2A

b) graded; sandstone, grit to fine ss	Unit 3B (usual)
c) current structured	Units 2B2, 3A, 3B
d) fine	Unit 3A(rare),3B upper
11. The rock is homogeneous	
a) tillitic	Unit 2A
b) grey mudstone	Unit 2A
c) turbate siltstone	Unit 2C
12. There are wood, coal fragments.	Units 2B2,3A,3B(upper) -3C
13. The weathered surface colour is	
a) white	Unit 2C
b) cream	Unit 2B
c) buff	Virtually everything
14. The weathered rock	
a) contains large rounded holes	Unit 2C (upper)
b) is hard, flinty.	Unit 2C
c) collapses to cuboidal fragments	Units 2A, 3B-C
(i) sandstone	Unit 3C(usual), rare 2C(Risdon Ss)
(ii) grey even mudstone,occas pebbles	Unit 2A
(iii) coloured mudstones	Units 3B, 3C
d) lacks cement, sandstone	Unit 3B (usual)
15. The rock is igneous	
a) vesicular, olivine-iddingsite bearing	Unit 5A
b) fine-grained	Units 4, 5A
c) sheet, platy jointing	Unit 4

REGARDING DOLERITE:

Dolerite generates many of the mapping problems in this area. It does this in 3 ways.

1) By concealment; either <u>in situ</u> or as debris.
2) By description; either by pre-intrusion or concomitant faulting or by large scale intrusion dilation effects.
3) By confusion; at contacts or fault boundaries.

To the regional mapper the problems may be academic, to the economic mapper they are crucial. The exact nature of a boundary, its location, or its attitude may affect his assessment of material volumes, workability or prospect. Several features should be defined wherever possible. These are

a) Boundary position
b) Boundary type
c) Scale of intrusion
d) Intrusion complications

Precise location of a boundary is basic to a good map. It is often difficult due to talus cover. On a slope, the point of steepening is the <u>upper</u> limit for the position. These gradient changes are often recognisable on contour maps or slope profiles. when seen side on. If there is no talus the boundary will be found at this level. Where talus is present it is often useful to examine the texture and grainsize of both suspected or certain outcrop <u>and</u> the talus fragments. Glass or fine dark (black) dolerite indicates an intrusive boundary ($\pm$ 5m). Fault boundaries compound the problem but the textures should still be noted. Soil type is a further useful indicator. A grey (especially if sandy) loam will not be dolerite-derived. Dolerite soils are usually clay-based loams which are grey-yellow or more normally yellow-brown to red in colour.

Note dolerite textures and grain size wherever the rock is fresh or a change is evident. An outcrop or traverse map showing the variations in these properties is as useful as a traced-formation map since it carries considerable structural implication. A useful classification is grainsize,

(f) - fine $<$ 0.5mm
(f-m) - fine-medium 0.5 - 2mm
(m) - medium 2 - 4mm
(c) - coarse $>$ 4mm (f to c) equigranular

and texture,

(p) - pegmatitic long needles $>$ 5-6mm, much plagioclase, light colour.
(g) - granophyric usually $>$ 4mm, little pyroxene, light colour, granitic.

Fine or coarse equigranular materials must be noted; some uncertainty will always attach to fine/medium rock. Any textural variant (pegmatite, granophyre) is very important since feeder systems may be identified. Alternations of fine and coarse exposures may define intra-intrusional or multiply injected intrusives. Each form has relevance to the ultimate structural understanding of the area, or intrusion scale.

Jointing or fracture density or form may be a useful guide to boundary position or type. Large columns are only found in the heart of large masses. Sheet or platy joints with many incipient features almost always indicate an intrusive contact; the size of the plates is inversely proportional to the distance from the contact. Plates are rarely obvious more than 25-40 metres from a contact. The long axes of a plate are parallel and/or perpendicular to the contact surface. The long axis is perpendicular if prismatic. A fault-induced fracture system is usually weathered with lack of incipient fractures. Joints of thermal origin are rarely persistent over large areas and contribute much to the overall joint variability seen in dolerite masses. Major joint consistency is an in-situ guide but care must be taken since many talus blocks are large and the sampling may be poor.

The appendix provides an expansion of the above notes. Since the appendix material was prepared greatly improved magnetic understanding and methods means that the gravity and magnetic methods are on an equal footing; each possessing distinct advantages (refer appendix page 16).

STRUCTURAL NOTES:

Mapping of the Parmeener Sub-Groups should, where present provide reasonable definition of fault systems (throw and trend). Coupled with dip measurements all first order structures can be identified. Where relief or exposure conditions, or presence of dolerite, precludes such definition other methods must be used. Geophysical surveys and, if relevant, careful mapping of dolerite textures or joint systems can yield comparable information. Both classes of data (structural-stratigraphic and dolerite character) with or without superimposed geophysics are essential to comprehensive understanding. Carey (1958), Leaman (1975) and Leaman and Naqvi(1968) - see Appendix references - have discussed the structural dilation problem and its relevance to unit continuity in concealed conditions.

No detailed discussion of structural interpretation methods is provided here since these lie beyond the scope of a field mapping guide.

APPENDIX:

Some thoughts on dolerite intrusions with particular reference to marginal features.

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1978/30. Some thoughts on dolerite intrusions with particular reference to marginal features

D.E. Leaman

Abstract

The fine-grained rocks at the margins of Jurassic dolerite intrusions have been generally regarded as crucial to any understanding of magma composition, temperature conditions and intrusion forms. These rocks have also been used for age and magnetic pole determinations. While much relevant material can be provided it is often easily misread and must be carefully integrated. Several examples of major demonstrably invalid conclusions are included.

INTRODUCTION

Observations based on contact rocks on both sides of Jurassic dolerite intrusion margins have been used in several fields; these are discussed in order of practical relevance.

Understanding of margins is essential to the formulation of structural interpretations in mapping, hydrogeology and engineering projects, where it is necessary to establish the character of the margin - contact or fault or spatial orientation of the intrusive body - dyke, sill, sheet, wedge or transgression.

Marginal rocks have been frequently sampled for palaeomagnetic studies because of their even properties, rapid passage through the Curie Point and presumed originality and lack of contamination.

Age determinations from such rocks are preferred on the basis that the chilled rock is free of argon loss and representative of the original melting pulse.

Magma composition may be deduced if it is presumed that the chilled margin represents a leading fluid edge which is singular and continuously typical. This implies no contamination.

Temperature conditions at the time of intrusion may also be deduced by consideration of either mineral species and proportions or from the scale and nature of the metamorphic aureole.

Conclusions of a structural nature are the most important and the most confusing and these are emphasised in the discussion below. However, it will be noted that the latter four classes mentioned above depend on the same basic presumption, namely that the samples are derived from the same material, uniformly sampled at both source and in the field, and which were injected in a short time after a rapid unadulterated passage. This may be referred to as the uniform leading edge theory.

LEADING EDGE THEORY

Appreciation of the ramifications of the leading edge theory has never been discussed in the literature, although there is a general presumption of its truth. Early petrologic studies of the Tasmanian dolerites (*e.g.* Edwards, 1942) were predicated at a time when a simple differentiation theory was commonly accepted. The relationships between analyses of dolerite at Mt Nelson and Mt Wellington tended to support this concept. Subsequent physical and petrographic observations on the same intrusions provided substantial concurrence. A measure of agreement was also given by work on the Great Lake intrusions (McDougall, 1964). Given that no other detailed petrologic work had been undertaken, it was reasonable in the circumstances to presume single pulse intrusion followed by simple differentiation. A corrollary of this presumption was then to examine and compare the marginal materials with a view to the establishment of the properties of the magma. The idea of a single intrusion is an old one in Tasmanian geology and may be inferred in the works of Hills *et al.* (1922) and Carey (1958). It was held until Bradley (1965), Leaman (1970, 1975) and Leaman and Naqvi (1968) demonstrated that it could not be so if several sheets occurred in the same section. Hydraulically this is no different to multiple intrusion of a 'single' sheet. Hale (1953) and McDougall (1959) had suggested sections with two sheets, but Leaman (1970) and Leaman and Naqvi (1968) proved that they were general.

Over the years, most field mappers have ignored the rich detail often available in areas of dolerite outcrop and the relevance such detail has for interpretation of the structure of the intrusion (*see* Leaman, 1975). In most cases, the dolerite boundaries are accurately mapped but the area between has only been cursorily examined. Textural variations, internal contacts and 'xenoliths' have thus been missed. Indeed, few dolerite cores have been examined in detail although many kilometres are available. In 1971 a deep hole was drilled in Glenorchy (*see* Leaman 1972*a*) and a previously unsuspected intrusion was drilled in its entirety. A detailed petrography of the core revealed that the body was not simply intruded or differentiated and its properites did not approximate the concept of Edwards or McDougall. This was in agreement with more frequent notings in other provinces of layered and clearly multiple intrusions.

Careful examination of many local masses of dolerite reveals that these observations may be more common than the past record would suggest. Multiple intrusions can be demonstrated within a few metres of the intrusion margin in several localities, notably Single Hill, along the Southern Outlet Road, Black Charlies Sugarloaf and Battery Point. Some of the subsequent injections are fine-grained, while some are granophyric and thus imply a very late stage introduction.

Since there have been few studies of the petrology of dolerite and no comparative or lateral examination of variations, it is not possible to state how common each of the two intrusion regimes may be. It is likely that multiple, rather than single pulse intrusion is in fact the normal condition. There are many ramifications to such a conclusion. Sampling of marginal rocks may not consistently represent material of the same pulse, even in the same intrusion and, depending on the period between injections, may reflect various palaeomagnetic and petrologic properties.

The latter is a key question in the simplistic view of the leading edge in any event, since it is assumed that the first pulse of the magma from the magma 'pool' is representative of the magma fraction which will form the entire intrusive mass. This argument is tenuous since it presumes a fraction, probably already differentiated, of sufficient volume to supply the province, or a large part of it, coherently and uniformly over a relatively short period. The ultimate requirement is just as important; that the leading edge material remain uncontaminated at high level during injection where it is cooled rapidly and fresh material is continually introduced. If it could be shown that the composition of the chilled margin was consistent in a number of localities and in a number of intrusions, the theory might be established. Such determinations would allow detection of an intermediate chamber where additional differentiation might have occurred and whether there are systematic variations in a contact zone of a 'single' intrusion. No answers are available to these questions since the necessary reseach has not been done. However assertions have been made.

Edwards (1942) noted a uniformity in the few analyses at his disposal. Subsequent work by McDougall (1962, 1964) followed Edwards' approach, was selective in distribution, and included averages of the contact rocks. No close examination has been made of the analyses available.

Consider the treatment of this key question in the latest work (McDougall, 1964). On page 116, he discusses undifferentiated magma and notes that his two analyses from Great Lake differ significantly from each other, but that their average does not differ markedly from the average of thirteen other analyses. Table 1 reproduces his figures (p. 117) and inspection shows that the differences between averages are as major as those between the two analyses, particularly in respect of the major elements iron, calcium and magnesium. These results throw considerable doubt on the leading edge hypothesis but cannot invalidate it. Comparisons by average have confused the issue.

Table 1. ANALYSIS OF GREAT LAKE DOLERITES (AFTER McDOUGALL, 1964)

Analysis	1	2	3	4
SiO_2	53.32	53.04	53.18	53.18
TiO_2	0.70	0.77	0.74	0.65
Al_2O_3	14.18	14.74	14.46	15.37
Fe_2O_3	0.97	1.64	1.31	0.76
FeO	8.54	7.43	7.99	8.33
MnO	0.18	0.17	0.18	0.15
MgO	7.23	6.88	7.05	6.71
CaO	11.22	10.29	10.75	11.04
Na_2O	1.38	1.75	1.57	1.65
K_2O	0.87	1.56	1.21	1.03
P_2O_5	0.20	0.13	0.16	0.08
H_2O^+	1.00	1.13	1.07	0.67
H_2O^-	0.64	0.96	0.80	0.45
Total	100.43	100.49	100.46	100.07

1. DDH 5002, depth 42 m (138')
2. DDH 5084, depth 360.5 m (1183')
3. Average of analyses 1 and 2
4. Average of 13 analyses of chilled Tasmanian dolerites (McDougall, 1962)

Given that the dolerite intrusions are not the result of simple intrusion or single pulse injection, a significant time scale may be implied. The assumption that the marginal material for a given intrusion, or averaged for many, represents the basic matter for that intrusion or for the province is clearly not justified. This observation may well account for the anomalies noted in the palaeomagnetic results and the wide range of K-Ar dates now implied. Questions of the weathering state may be irrelevant for point sampling on a state-wide basis unless comparable values are available along intrusion or through it. As there is a preference for contact or fine-grained rocks in the work of Irving (1956) and Schmidt and McDougall (1977) this matter has not been resolved.

At the present state of research on the Tasmania dolerites, it cannot be validly claimed that the slight sampling of the marginal rocks is representative of that particular intrusion and much may be concealed in their averages across the province.

ROCKS OF THE MARGIN

Before considering the particular uses to which observations on the contact rocks may be put, it is necessary to describe the actual materials.

All marginal rocks, unless faulted, are fine-grained, often glassy with fine, intense and often incipient jointing. It is common for the metamorphosed host rocks to be hardened and jointed. The high joint frequency in both the chilled dolerite and the intruded rocks allows ready access for circulating groundwater and deeper and more extreme weathering. The mineral species produced at the contact are commonly less stable and this exacerbates decomposition. These effects are most pronounced in respect of discordant boundaries. The obvious effects may extend several metres on either side of the contact and may exceed 25 m. It is also common for the actual contact to be difficult to discern, since many mudstone and siltstone units metamorphose to a dark-coloured chert which is very similar to dolerite glass in appearance.

Metamorphism and alteration of the intruded rocks is a further area requiring research. In a few localities, some cursory studies have been undertakenand temperatures of up to 550°C inferred. Readily apparent and obviously interesting mineral species are usually related to calcareous rocks, *e.g.* CascadesGroup of the Hobart area, but even these have not been examined in detail. It is likely that the effects of metamorphism may be more pervasive than realised. Certainly large parts of the Triassic section in the Midlands area reveal thermally altered spore cases when the lithology offers no obvious indication of metamorphism.

STRUCTURAL DETERMINATION

Field workers have always regarded the margin as crucial to their understanding of dolerite intrusions if conclusions or predictions of their form were to be made. Many have recognised that undue emphasis on small, detached non-coastal exposures may be misleading.

General mapping, with its conclusions based on boundary - topography relationships, may be uncertain. A first but sometimes minor problem is accurate placement of the boundary. Due to the topographic dominance of dolerite, many boundaries are concealed by soil creep and talus deposits. Only dissections across slope reveal true form and position.

It is common to map a margin along contour (and many can be relatively straight) and consider the intrusion to be concordant when a section may reveal extreme discordancy. Similarly, intrusions which show overall concordancy, such as the Wellington sheet, may have local margins which are discordant (as near the University of Tasmania sign). This paradox and the extent of deviancy from expectation cannot be resolved by geological means, since mapping merely locates the margin and rarely includes direct or continuous observations of it. Exceptions occur only in coastal exposures.

Recent major road and railway projects have tended to improve this situation. A random scattering of new exposures is available, often more than 25 m high and 300 m long. Examination of these has reinforced concerns only suspected in previous exposures;

a) The base of many concordant bodies may be very irregular.

b) The roof may be even more irregular.

c) Adjacent exposures may be apparently conflicting in interpretation.

d) A significant proportion of contacts are compound.

e) Jointing need not be a reliable guide to intrusion form.

f) Many discordant margins are related to, or include, faults.

Basal margins

Few basal margins of dolerite sheets have ever been naturally exposed. Coastal exposures are rare and inland exposures are limited to a few cuttings. Most margins are concealed by talus or vegetation. In normal circumstances, the mapper suspects significant variations but cannot confirm them and the resultant map is often at a scale which smooths them. Basal margins in Permian rocks are extremely rarely observed and the comments below relate to intrusion in Triassic rocks.

Useful exposures are now available in the Midlands and north of Launceston. These show margins with several metres of undulation and some abrupt steps (plate 1). Unweathered material can be seen, it can be shown that some steps are original variations; most are subsequent faults with small throws. These variations are somewhat unexpected and suggest that the bedding parting was unable to exert control on the initiating wedge, either by termination or irregularity. Both effects are common in all Triassic rocks since the materials are heterogeneous, both laterally and vertically. Such heterogeneity includes such properties as jointing and bedding.

A key question posed by all similar two dimensional exposures is the problem of source direction; was the magma pushed up and down through irregular partings or was it injected laterally in a planar way into a crinkled set of disrupted partings? The latter is more likely and may be directly supported in exposures and general distribution at Antill Ponds. It is unclear at Mt Direction (Tamar) and along the East Derwent Highway at Mt Direction (Derwent).

Roof margins

Intrusion roofs present an alternative position. Classic dilation theory would imply that roof margins should exactly mirror base margins. However few roofs are to be seen in Triassic rocks and few bases are to be seen in Permian rocks. Some of the roof exposures seen in Permian rocks are superbly exposed. In those cases where the exposure is extended, occasional bends and warps may be seen in the roof rocks. In general, the scale is very small; two clear examples are exposed at Mt Nelson. In general, the disruption or warping in the roof rocks, if Permian, is very slight. Examples at Nelson Saddle form part of small monoclines with a total width of about 25 m and maximum relief of 1.5 m. The main zone of curvature is often less than 1.5 m wide and 0.5 m high, indicating that the causal irregularity is quite minor. There is no ground for expecting a similar contortion or bulbous remnant at the base of the intrusion since all beds remain traceable, if compressed, and forcible injection, in part, is indicated. This may well occur at a much larger scale at National Park and Dromedary, where an entire formation shows moderate relief folding (plate 4). Although faults are related to these structures, simple drag dips cannot wholly account for the features.

In one rare, small scale example at Mt Nelson, a small monocline

Plate 1. *Jurassic dolerite/Triassic mudstone contact, Antill Ponds.*

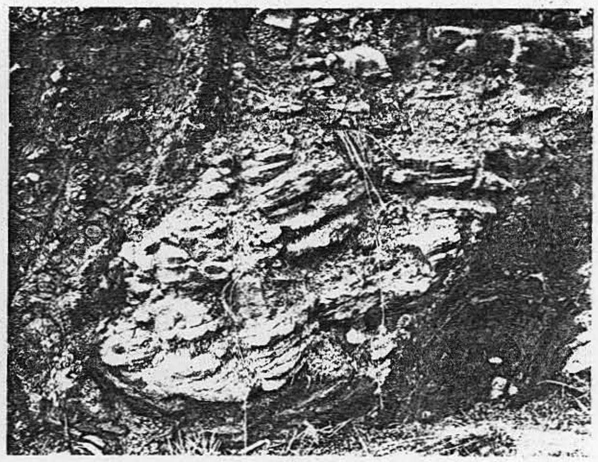

Plate 2. *Irregular intrusion, Little Swanport.*

Plate 3. *Minor irregular intrusion, Little Swanport.*

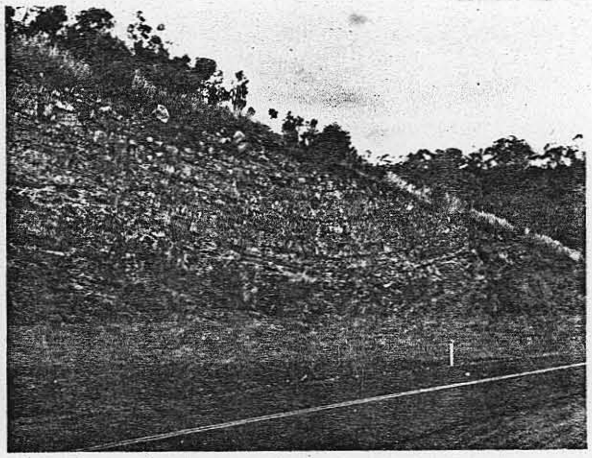

Plate 4. *Warped upper Cascades Group rocks, Boyer Road.*

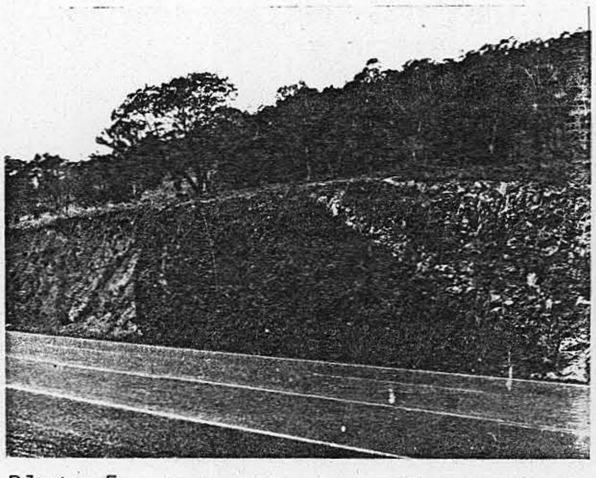

Plate 5. *Dolerite contact, southern side, Eastern Outlet Road, Cambridge.*

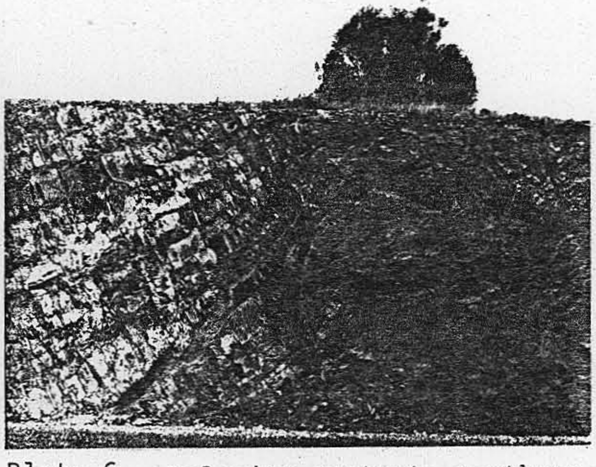

Plate 6. *Dolerite contact, northern side, Eastern Outlet Road, Cambridge.*

distortion can be related to a small bulbous feeding wedge. The dolerite has been frozen and the space in front filled with now highly weathered debris. This intrusion is the same as that seen in Plate 8.. Where small intrusions are visible both surfaces are regular and matching. Since it could be considered, at worst, that the roof is more disrupted than the base, the more regular nature of intrusions in Permian rocks must reflect better compaction, more regular stratification and higher confinement loadings. Small detached intrusions may be found in those cases where intense metamorphism has occurred.

Roofforms in Triassic rocks are very irregular and can range from stongly disrupted (Little Swanport) to domelike (Colebrook). Figure 1 and Plates 2 and 3 indicate something of the situation at Little Swanport. There are several irregular roof blocks, one fault, and at least two dolerite protruberances into the sediments of a very disrupted roof. Marginal features such as fine grain, fine jointing, hornfelsing and delicate weathering all attest to the original character of the roof. The bulk of the disruption visible appears to have been original. Small glimpses of dipping margins have often been regarded as providing a definite indication of the inclination of the sheet. While this may be generally true, sufficient exceptions can be cited to make such interpretation risky without independent supporting evidence (e.g. magnetic or gravity survey). An excellent example of this may be seen on the Eastern Outlet Road near Cambridge.

On the northern side of the road, a contact appears to dip steeply eastward while on the southern side of the road it is concordant but dipping westward. All rocks are chilled or metamorphosed and the presence of a fault in the region complicates interpretation (plates 5, 6). Beside the Tasman Highway in the same area, there is a small quarry where jointing suggests a steep dip to the west. Surface mapping is quite inconclusive, but suggests a major discordance since any concordance appears minimal and does not recur on the hillside. Gravity evidence confirms an overall dip to the west. Allowing for all factors, including some small scale faulting, only one piece of geological observation yielded a true indication, the jointing in the quarries. The localised eastward dips are misleading. The mixed pattern of anomalous observation is consistent only with a source to the north-west as suggested by Leaman (1972a; 1975, section 11) with intrusion to the south-east. In this way, all aspects can be produced without complex flow dynamics.

RECOGNITION OF MARGIN TYPE

It was indicated in the introduction that mapping considerations require the determination of the actual character of the margin and identification of any complex interaction. Margin here refers to the boundary between the dolerite of one intrusion and other rocks, including dolerite, of a separate intrusion. Several conditions may arise.

a) Dolerite chilled, intruded rocks not obviously metamorphosed.

b) Dolerite not obviously chilled, intruded rocks metamorphosed.

c) Neither dolerite nor intruded rocks show thermal effects.

d) Key exposures or information absent in region of the margin.

e) Thermal effects obvious but intruded rocks deformed.

f) Dolerite chilled, intruded rocks deformed but unmetamorphosed.

g) Dolerite and intruded rocks show thermal effects.

Type (g) may be regarded as the normal contact margin, but it is not always certainly recognised. In order of frequency of occurrence in normal mapping these conditions may be listed as (d), (b), (c), (g), (f), and (e). Cases (d) and (b) account for about 80% of all boundaries with (c), (a) and (g) accounting for most of the remainder. Cases (a) and (d) include the situation where the chilled dolerite is an obvious margin to a discrete body within another dolerite intrusion. It must also be recognised that certain units weather readily after metamorphism and appear less cohesive than when unmetamorphosed causing some confusion. This situation is included in (a).

Interpretation of the listed conditions could be:-

(a) Dolerite chilled, intruded rocks not obviously metamorphosed

Post intrusion fault; Where the fault surface is slightly oblique to a discordant and dislocated contact so that the chilled margin remains on one wall. Various exposures along the boundary could reveal very different information.

Weathering; As mentioned above certain sedimentary units, especially in the Triassic rocks, decompose or alter rapidly upon exposure when metamorphosed. All traces of obvious hornfelsing can thus be destroyed. Various exposures can conflict.

Intra-intrusion; Where one dolerite has intruded another there may be little or no alteration in the intruded dolerite. The principal problem in this case arises where the grain size variation in the respective bodies is not great.

Normal post-intrusion fault; Where the detail of mapping permits reliable mapping of a boundary and where its structural character is deducible, any offsets physically and thermally may be visible. This is usually only true of sub-concordant intrusions.

(b) *Dolerite not obviously chilled, intruded rocks metamorphosed*

Post intrusion fault, normal post intrusion fault. As for (a) but where the opposite characters are observed. This is the normal state in field mapping. A major problem exists, however, in relation to the adequacy of observation of the dolerite margin due to weathering. In many instances the fine-grained marginal rocks are altered or decomposed. Where the glassy verge is thin, as in the case of discordant intrusions, observations may be uncertain. Quite often weathering and discolouration effectively conceal the true textural appearance and only fresh kernels or thin sections may resolve the question. Experience has shown this condition to be very common.

(c) *Neither dolerite nor intruded rocks show thermal effects*

Post-intrusion fault. Provided there are no complications due to weathering, this is a straightforward conclusion. There will be no conflicting evidence from any available exposures.

(d) Key exposures or information absent in region of the margin

In this case doubt remains. It will be evident from the discussion related to types (a) and (b) above how uncertainties arise where data are poor or misleading. As for cases (e) and (f) below, resolution is often only possible where cuttings or sections are available and a degree of three dimensionality is possible. In normal field mapping this is not possible and many boundaries are presumed normal although substantiative evidence may be lacking. In most cases this will be a valid conclusion.

(e) *Thermal effects obvious, but intruded rocks deformed*

Pre-intrusion fault. Where a fault previously mating sedimentary rock faces has been occupied by dolerite, previous drag dip and bed contortions will be preserved on the unoccupied side of the fault. The effect of intrusion may involve further deformation but it usually metamorphoses the intruded materials. Normal exposures are rarely good or frequent enough to identify all the features needed to establish this situation. However, its frequency of occurrence in coastal and road sections is such as to imply that many boundaries have this form. Certainly one should suspect near straight 'margins' as being of this type.

Concomitant fault. Concomitant faults are largely a matter of structural semantics since their properties can be identical with those of the pre-intrusion fault. The concomitant fault is a conceptual feature presumed necessary as part of the intrusion process. The only way such faults may be segregated is by inspection of the overall structural layout of faulting within a region and comparing it with the distribution of dolerite margins.

Post-intrusion fault. Where subsequent movement has occurred on an angular margin, materials may be recorded which include chilled dolerite, metamorphosed country rock with either or both deformed. Deformation of the dolerite may not be readily recognised due to lack of reference features. Slickensides may be observed but these must be sighted across a range of materials at the site to be definitive. Natural exposure is rarely adequate.

Note that slickensides are commonly seen along joint surfaces in dolerite intrusions where they are related to settling movements, presumably in the later stages of solidification and consolidation. Rarely can movements in excess of several centimetres be demonstrative in relation to these features.

Note also that post-intrusion faults discussed in context of properties (e) may be of two types. The first simple displacement, not adding extensive new deformation, and the second where most of the disruption relates to new movements. These may only be assessed in section.

(f) *Dolerite chilled, intruded rocks deformed but not metamorphosed*

Post-intrusion fault. This situation is similar in many respects to field situations noted for types (a), (b) and (e) where observations are limited and relate to (a) in particular. Where the boundary was discordant and has suffered disruption, considerable deformation may occur with a display of fine-grained dolerite but no evidence of metamorphism. Exposure will determine whether any disruption is noted. This situation is probably most common within intrusion marginal zones.

It will be clear from the foregoing discussion that interpretation of boundaries is often suspect and dependent on observations of variable quality. An additional problem which may compromise or aid interpretation depending on the topography-structure function is the fact that many boundaries display very rapid changes from concordance or gentle transgression to discordance and yet maintain the appearance of concordance. This results from the erosional resistance of dolerite and hence it tends to dominate landscape. Thus an extended dyke-discordant boundary can appear concordant. This type of interpretation can easily be mixed with fault interpretations where outcrops are restrictive.

The effect of secondary intrusions, whatever their scale, and although mentioned in (a), pose the entire spectrum of problems stated in (e) - (f). The history of events during the intrusion cycle becomes very important. Structures related to one intrusion may be considered post-intrusive, yet to another the same features may be pre-intrusive or concomitant. These issues become important when an apparently single mass of dolerite is composed of two sheets or an apparently staightforward margin is found to include an insert of potentially major proportion.

An example of this is shown in Plates 7 and 8. Selective weathering has done much to pick out multiple injections near the margin of the Nelson intrusion at Nelson Saddle. These variations may be systematically traced around the many quarries and cuts of the region. A further example was described by Edwards (1942), but it is not certain how this relates to the other intrusions in the same area. However, the intrusion of Plate 7 clearly transects the main Nelson mass. Plate 9 provides a contrasting example in 'upper' zone dolerite where inclusions and dykes of granophyre have been introduced. The margin is less than 5 m away. Various sets of joints may be observed indicating a complex history for joint development. Some features clearly predate the granophyre and some post-date it. More typical banding layers which parallel the roof of the intrusion are shown in Plates 10 and 11 from Black Charlies Saddle near Runnymede. Similar structures can also be seen 1 km south of Nelson Saddle on the Southern Outlet Road. Clear displacements are visible and a range of joint characteristics vary from material to material. Thermal jointing is clearly less regular. Forceful separation of non-viscous slabs of material is indicated in Plate 12 where some highly hornfelsed mudstone is preserved in small dyke cores.

As interpretation of structure within intruded areas is often considered to depend on margin observations, it is important that the variable and observation deficiencies be appreciated. Quite often there is no way intrusion form may be determined from surface field observation and some geophysical approach or drilling is necessary. Neither of the latter approaches can relate intrusions to each other and a detailed consideration of the margins remains essential.

STRUCTURAL FEATURES NEAR MARGINS

A number of features directly related to the boundary have been discussed in the previous section. Many subsidiary features have been alluded to (jointing, degree of concordance, discordance, doming, etc.) but none have been specifically examined.

Consider jointing; two prinicpal aspects of jointing around intrusion margins, frequency and orientation, have been utilised in structural assessments. Most observations are restricted to consideration of the dolerite side of the margin, although frequency determination is relevant in the intruded rocks as well. Joint frequency, both real and incipient, increases near normal intrusive boundaries and near faulted boundaries. However, in the former case it is normal for the joints to be persistently platy over a

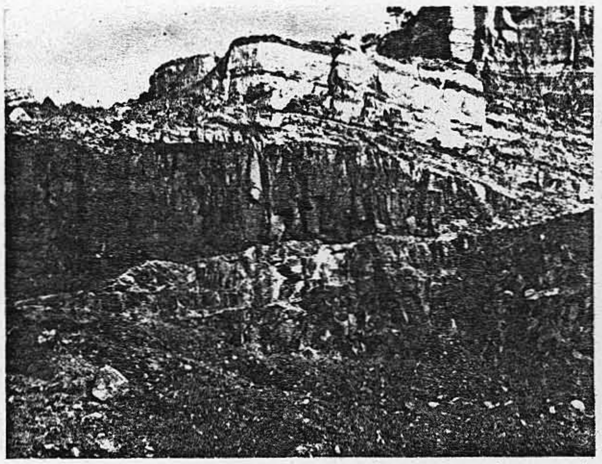

Plate 7. *Intrusion contacts, Nelson Saddle.*

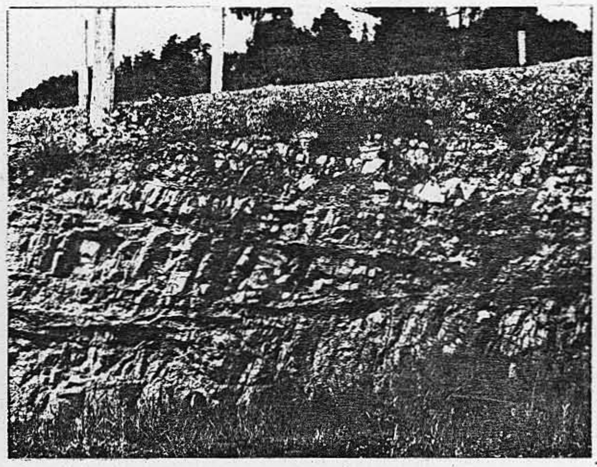

Plate 8. *Multiple contacts in roof of dolerite mass, Nelson Saddle.*

Plate 9. *Granophyre dyke, Single Hill.*

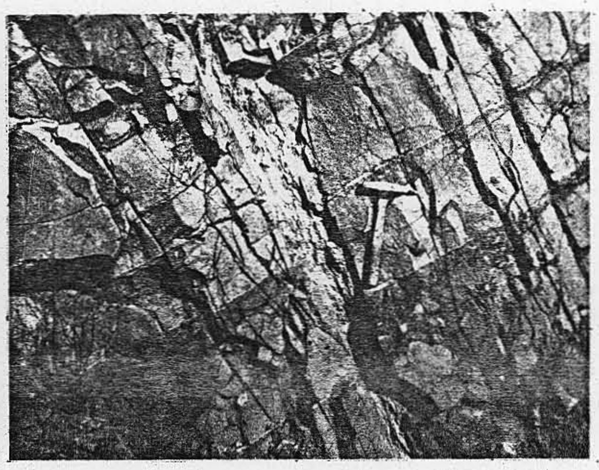

Plate 10. *Multiple intrusion inclusions, Black Charlies Sugarloaf.*

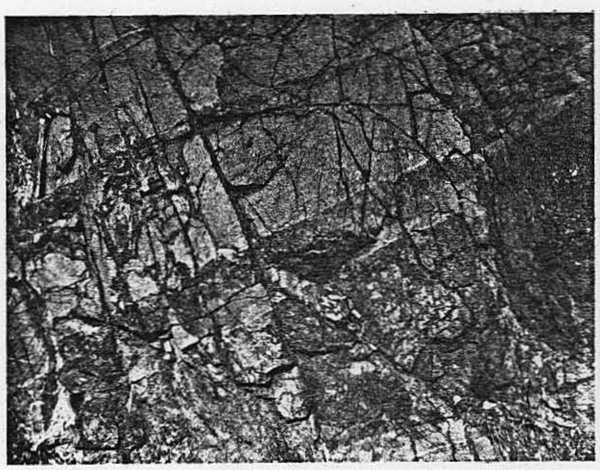

Plate 11. *Multiple intrusion granophyric inclusions, Black Charlies Sugarloaf.*

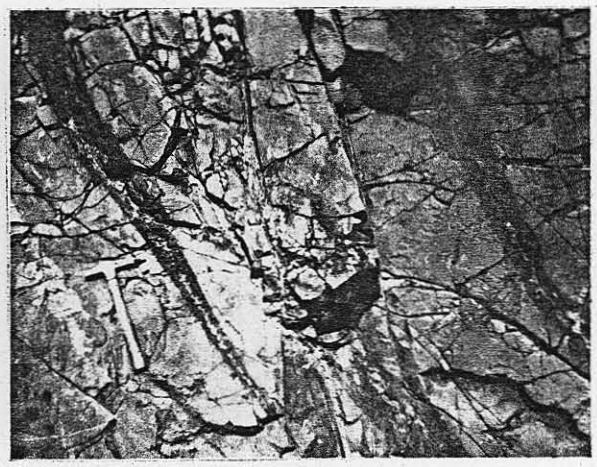

Plate 12. *Neptunian dykes, Black Charlies Surgarloaf.*

variable but often wide zone near the margin. If the orthorhombic (approx.) axes are a<b<c, then the boundary parallels the Planes b-c if jointing is associated with steeply dipping boundaries.

The other principal joint class, also thermal, is that of columns and these may occur at various scales. Polygon base size may range from a few centimetres to several metres and may at times be very obvious. Columns may also be strongly prismatic. Good examples may be seen at Mt Wellington, Cape Raoul and Tasman Island. Plate 13 provides an example of platy-jointing at a contact exposed in a road cutting at Ravensdale River Bridge, Little Swanport. Although the structural situation is complex (refer fig. 1), the band of platily jointed dolerite relates to the principal discordant edge. At this site it is possible that the plane a-b parallels an upper surface exposed near the old roadway and that the reason for the especially strong development here (and at Lovely Banks, Spring Hill; Stony Bridge, Swansea) is that these joints also represent fine columns. It will be noted that normal prismatic columns may thus be confused with platy joints related to discordant edges since the effect is the same and cannot be separated unless independent information is available about the margin. Jointing need not be a reliable indicator to intrusion form within 50 m of a margin. The large columns within intrusions are, however, reliable indicators, the long axis being perpendicular to the plane of the margin. It is generally noted that the plane perpendicular to the long axis of the column approximately parallels the intrusion boundary. Most columnar jointing appears to be related to essentially concordant intrusions.

Other joints are tectonic and usually form three sets. The two principal sets, usually nearly perpendicular, are extensive and common but may be locally confused with columnar jointing. Aerial photography, especially over the Central Plateau, can usually reveal the status of joints by showing extent, continuity and relative importance. These features are not always distinct or recognised at ground level yet they are very common joint features (*e.g.* Southern Outlet).

Nearly all joint types discussed above show evidence of movement in any given location. Inspection of relationships, especially where more than one injection is involved or where significant tilting has occurred will show that the movement is slight, being rarely more than 1 - 2 cm. However, in even those cases where the movement is virtually undiscernable, a chloritic paste covers the joint surfaces and shows clear polishing and slickensides. Quite often, as in drill core, these effects may give the impression of severe movement.

The final joint type, rarely seen but probably very common, is the sub-horizontal and sub-parallel slope sheet joint, often called a sheet or topographic elastic release joint, produced by surface unloading. These joints may be clearly seen at North Sorell, Oatlands, Southern Outlet and are often visible due to their control of weathering by groundwater. Such joints are commonly curved and transect other joint sets. A good example is shown in Plate 20 from the Southern Outlet about 1 km south of Nelson Saddle. The upper portion of the exposure is strongly discoloured and noticeably weathered and there is a sharp boundary with less weathered material at the upper sheet joint which clearly controls near surface groundwater circulation.

Degree of concordance

Few dolerite intrusions are truly concordant. Close examination of margins show that slight oscillations from bed to bed are common, especially in fine-grained, thinly bedded units. However the overall effect is one of

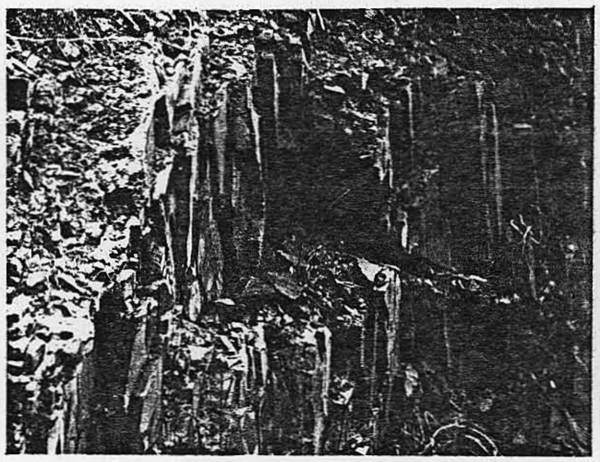

Plate 13. *Prismatic joints, Little Swanport.*

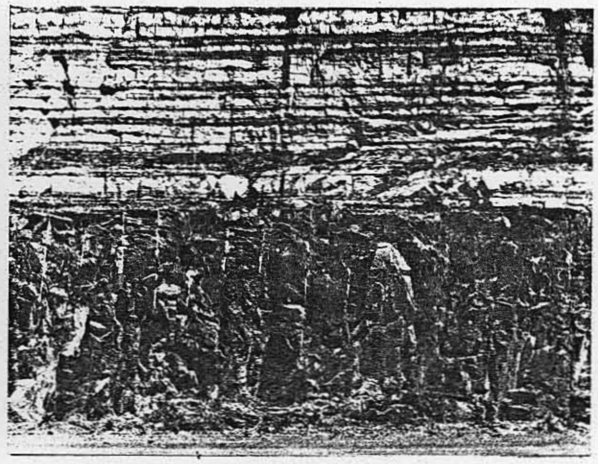

Plate 14. *Planar concordant contact, Southern Outlet.*

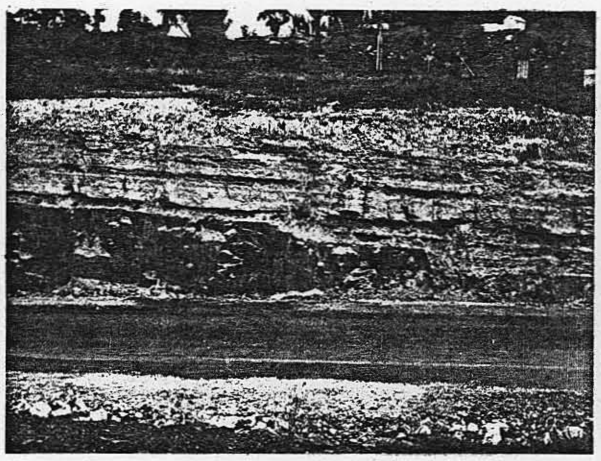

Plate 15. *Transgressive steps in generally concordant intrusion, Nelson Saddle.*

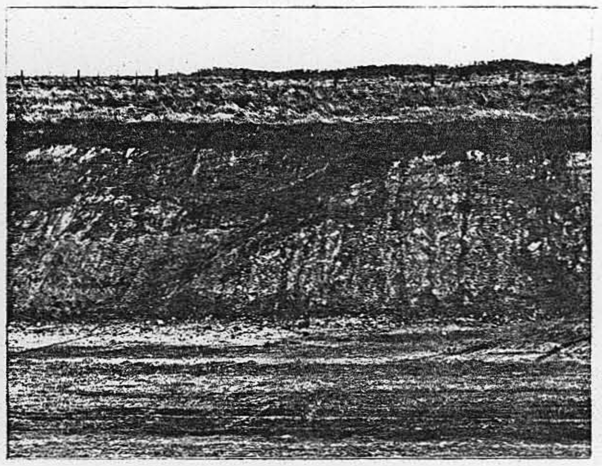

Plate 16. *Faulting in Triassic rocks, Northern Outlet Road, Granton.*

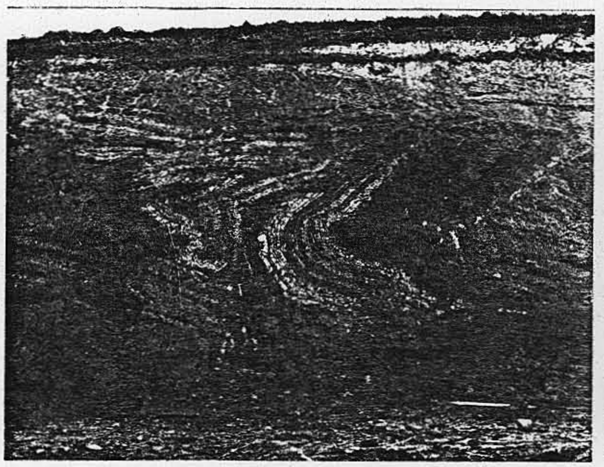

Plate 17. *Severely contorted Triassic rocks, Northern Outlet Road, Granton.*

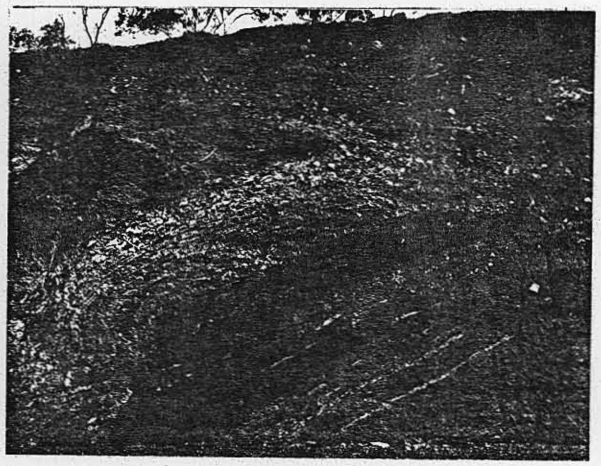

Plate 18. *Thrust in Triassic sediments, East Derwent Highway, Otago Bay.*

concordance since the variation is rarely more than 10 cm. Another common observation is that of risers up to one metre between concordant stages of the type mentioned above. The steps may be one metre to 1 km long and the overall effect may remain one of concordance, even though the intrusion margin is consistently stepping through the beds of the intruded formation. This effect is usually referred to as gentle transgression. It is most common in Permian rocks. Plates 14 and 15 indicate this type of structure. In some rare cases it is possible to view the detailed characteristics of the contact within the transgressed bed. In the first long cut on the Southern Outlet south of Nelson Saddle it is possible to observe compressions of up to 20% in the beds directly overlying the nick point of the transgression. Compressions persist for up to one metre and are of similar lateral extent to those about the monocline described on p. 5. Many of these observations suggest an intrusion process that is not wholly gentle and greater disruptions could be expected in rocks of the Upper Triassic nearly a kilometre higher stratigraphically. Thus the domes and disruptions noted in earlier sections probably similarly reflect forcible intrusion but under possibly negligible roof loadings. Many low angle disruptions seen in Triassic rocks (discussed by Leaman, 1976; Plates 16 - 19) may thus be related to such intrusion. However as noted in the above reference, near surface failure is an alternative solution that can rarely be differentiated. Exposure of steps and risers may often be such as to offer misleading conclusions about a margin. A good example occurs on Mt Wellington at the sign describing the Wellington Sill. The exposure is too small to offer a firm confirmation of marginal form since it reveals a riser and part of a step. The well-mapped extent of the body, possible here but not generally so, indicates overall concordance. Gravity coverage provides additional information and suggests a dome-like intruded structure with the dolerite thinning slightly under the pinnacle. Such a structure, as discussed by Leaman (1970, 1975), implies multi source injection for the Wellington body.

Discordance

Clear, continuous transgression where the overall angle of transection of bedding exceeds 20 - 30° may be termed as discordant. Every intrusion includes several stages of this behaviour which is related to local faulting, bedding continuity, formation homogeneity and source position (see Leaman, 1975). Discordant intrusions may occur at any scale (*e.g.* Black Creek Quarry, Orford). Plate 21 shows an intrusion in granite at Cape Surville. The intrusion shows a dip that is unusual in any stratified material since in latter cases it is either very nearly horizontal or vertical. Even on a small scale (Plates22, 23, Leaman, 1976) the angle is steep and overall averages 70°, although the portion photographed indicates a shallower dip.

Xenoliths are an additional complication near dolerite margins. The basic implication of xenoliths has been discussed by Leaman (1975). However a high proportion of xenoliths do not escape the chilled zone near the base of an intrusion to float toward the top where they are usually seen. Some irregular forms are visible near the roof of many intrusions in which a ragged piece of intruded rock is surrounded by glassy dolerite. In some exposures the roof may be traced completely and the fragment shape can be seen to exactly match an irregularity in the roof. In such a case, a parting fracture irregularity has been utilised but not expanded; the split fragment being 'frozen' in the margin. Should this process be reversed the fragment may either remain in the basal margin or float through the intrusion. In such a case there is no matching irregularity in the roof.

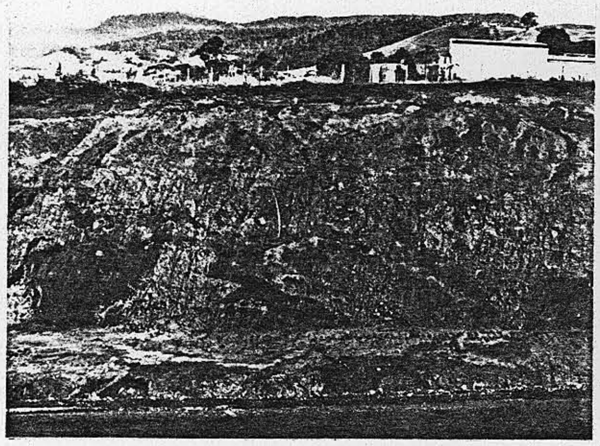

Plate 19. *Disturbed mudstone and talus, Midland Highway, Dysart.*

Plate 20. *Dolerite with horizontal weathering zones, Southern Outlet.*

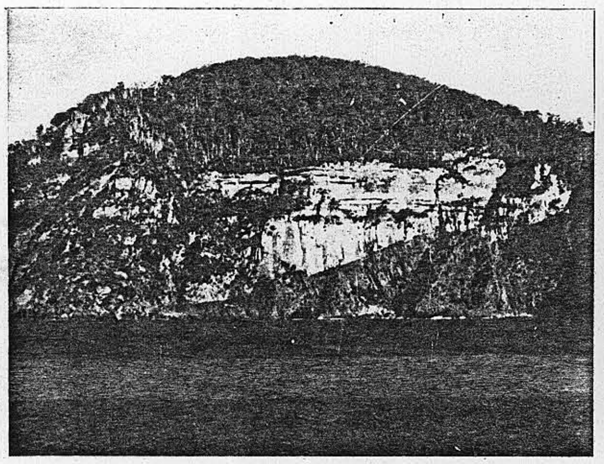

Plate 21. *Jurassic dolerite/Devonian granite, Cape Surville.*

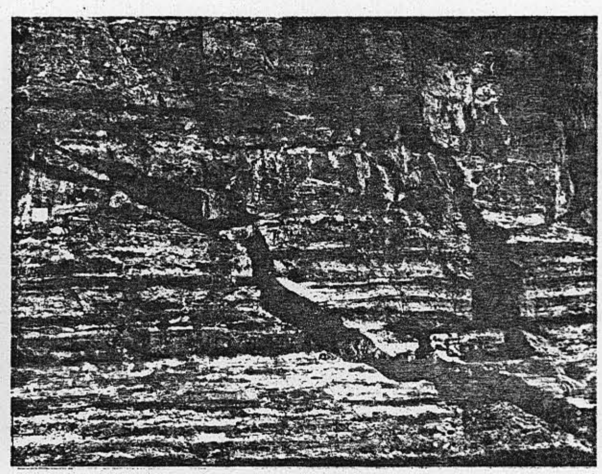

Plate 22. *Small transgressive sheet displaying dilation, Single Hill.*

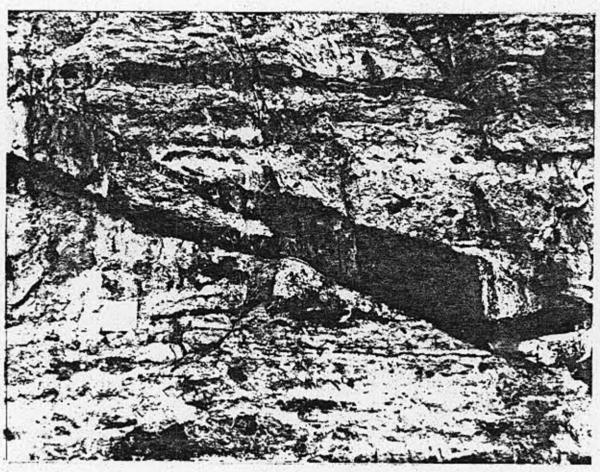

Plate 23. *Detail of Plate 22, showing granite erratic cut by intrusion.*

Role of geophysics in studies of margins

Some uses of geophysical studies have already been alluded to in the foregoing discussion. Nearly all references have been to gravity surveys, which are the most direct and the only currently reliable way of examining dolerite intrusions. Gravity surveys may not reveal fine details about margin distribution and orientation but they do permit integration of the confusing fine details to a whole interpretation. Electrical surveys may be directed at boundary tracing and assessment of jointing and weathering conditions, but as such they are awkward and shallow. Seismic refraction methods are also clumsy and not suited to structural investigations. Seismic reflection methods may be extremely useful, but considerable refinement of technique is necessary before they can be widely used (Leaman, 1978). Magnetic methods offer an obvious means of mapping intrusion margins and while good results may be achieved there are several pitfalls.

The problems relating to the use of magnetic methods derive from the variation of magnetic properties within the intrusion itself. An example of misleading observations at a margin is offered by Leaman (1972*b*) at Rosny College where the deduced position of the boundary was in error. Several possible explanations may be offered; multiple intrusion near margin, one body far less magnetic, faulted intrusion, coarser material to west more magnetic, variations in remanence or orientation, variations due to layers (basal) of differentiation, variations due to marked discordance and sectioning of body. These explanations imply that the state of the boundary is wholly unknown. The overall form deduced from a gravity survey is one of moderate transgression with some slight faulting. The exact nature of the particular boundary remains uncertain and its fit into the overall structure is unknown.

A study of the properties of dolerite magnetism currently underway indicates that substantial variations exist and that many parts of intrusives may yield anomaly patterns and levels comparable with those of the intruded sequence. This clearly shows that care is necessary when using magnetic methods and unless the survey spacing is such as to reveal the high frequency variations definitive of dolerite, they may be most misleading. The methods may locate definite dolerite areas but not always reliably map the margin, even allowing for remanence and orientation effects. A forthcoming report will discuss this subject in detail.

Multiple contacts

In the preliminary discussion relating the implications of simple leading edge theories it was noted that multiple intrusion is commonly observed. In Proctors Road below the Nelson Saddle, a dyke of dolerite is intruded into quite coarse dolerite. Nearby in the saddle area the margin of the main intrusion and another small dyke, visible in the upper quarry, are both composite. In one instance in the low cut on the eastern side of the saddle, a definite wedge may be observed above the main intrusion but in contact with it. The beds of mudstone are bent monoclinally over it and are continuous, but a significant space in front of the wedge is filled with a mush of weathered unrecognisable material (plate 8).

Other large scale examples may be quoted and one of the best exposed occupies the fault zone along the Southern Outlet Road north of Kingston. The fine dolerite interfingers with very coarse dolerite and has also metmorphosed the siltstone. However the section was previously faulted to juxtapose coarse dolerite and siltstone.

PALAEOMAGNETISM

Two major studies of the palaeomagnetic properties of dolerite have been undertaken (Irving, 1956; Schmidt and McDougall, 1977). There have been some minor studies and some are included in the references given by the above authors. Irving's basic study listed some thirty sample sites and concluded with a field inclination of 85°, declination of 325° for the Jurassic pole. However Schmidt and McDougall noted that the data contained some anomalies. Firstly, the pole position did not agree well with other Jurassic poles and secondly, some measurements had an eastward orientation. Since it was thought that inadequate magnetic treatment may have been applied in the older study, the dolerite was resampled. The older results were confirmed and Irving's conclusion found to be in error, but only as a result of averaging two distinct data sets (Declination 63°, dip 81°; 304°, 79°). In each case the bulk of the samples came from marginal or near-marginal dolerite (as far as can be determined by analyses of descriptions and likely localities). This was done presumably to ensure a rapid passage through the Curie Point.

It is interesting to note that neither study observed any reverse magnetisation, but this is doubtless a result of the relative rarity of reversely magnetised dolerite and selection of nearly identical sites. Reversely magnetised dolerite has been observed (Jaeger and Joplin, 1955) and by the author.

Schmidt and McDougall (1977) considered two possible solutions for the determined poles. Firstly, that some unknown magnetic component has not been removed or secondly that an excursion was sampled. The present author believes the latter to be the case in view of the occasionally recorded reversal.

The work done to date leaves many questions unanswered. There is a regular distribution of the dolerite with eastward poles, although the state coverage is poor. There is no convincing study of the variations to be found through a body or along a margin and no detailed analysis has been made of bodies in the same region in order to establish a consistent individual pattern. If it were shown that a particular intrusion reflected the anomalous pole, then clearly age differences would be established. The present level of palaeomagnetic effort is quite inadequate.

It is interesting to speculate that the younger intrusions of the Hobart area, as deduced by the author, north of the River Derwent and exposed up the Derwent Valley show the anomalous pole and that the age determinations of dolerite at Devonport with the same pole are also significantly younger. However some of the older dates are also so correlated. There is inadequate dating to establish periods of excursion, since the period of intrusion could be quite short (<10 Ma) even if multiple. The best means of resolving this matter would be a detailed examination by intrusion. Care must be taken in the case of marginal rocks to ensure that the samples selected relate to the appropriate main intrusion.

AGE DETERMINATIONS

All relevant age determinations on Tasmanian dolerite intrusions are presented in table form by Schmidt and McDougall (1977). Datings range from 152 to 181 Ma but due to various factors are believed to represent a date of about 170 Ma. The ten published results are considered by the writer to be too few and too disparate to have any relevance to arguments on the real age of individual intrusions or pulses of intrusion within the province. Only five bodies have been sampled and a range of materials utilised for dating. In view of the problems of sampling, leakage and general resolution, all fully discussed by Schmidt and McDougall, it would appear that palaeomagnetic studies offer the best approach to separation of intrusion by age.

CONCLUSIONS

Studies of marginal rocks around dolerite intrusions are quite crucial to an understanding of structure, age, petrology and sampling for temperature, dating or palaeomagnetic data. Marginal zones are often compound in terms of either; structures
intrusions
structures and intrusions
and should not be treated lightly. The range of possibilities is such that all possible criteria should be employed in determining whether problems exist around the boundary and it must also be recognised that many criteria may be ambiguous (*e.g.* jointing, chill factors), depending on the quality and quantity of exposure.

A number of matters need urgent research:

a) detailed comparative petrology of margins and related intrusions where age differences are suspected

b) detailed examination of metamorphic effects

c) detailed magnetic analysis of the properties of dolerite and the relationship of these properties to residual magnetisation

d) large scale palaeomagnetic sampling of margins and related intrusions, especially where age differences are suspected

e) full examination of the use of reflection methods to examine dolerite structures

f) a more adequate dating coverage governed by the results of (a), (c) and (d) in particular.

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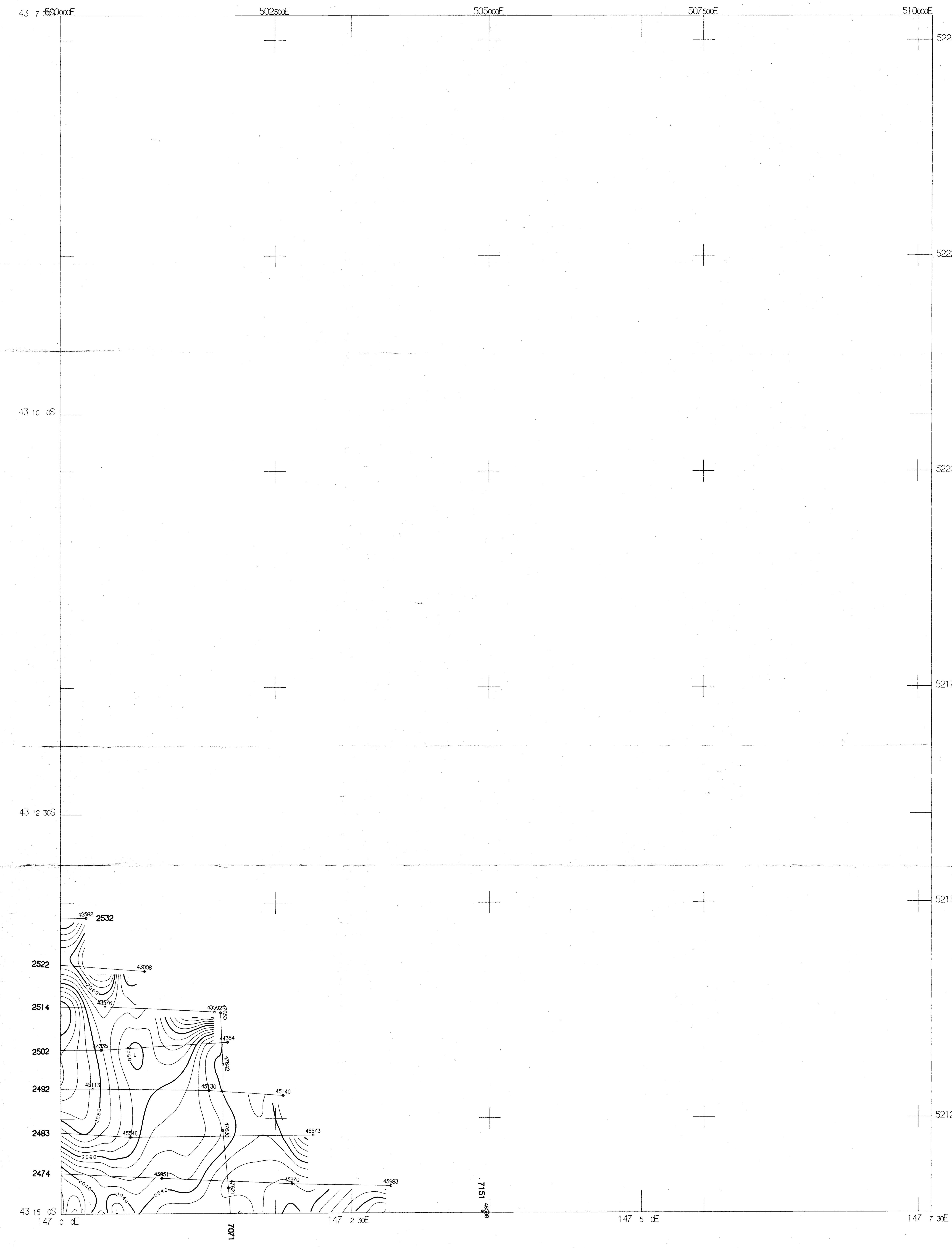

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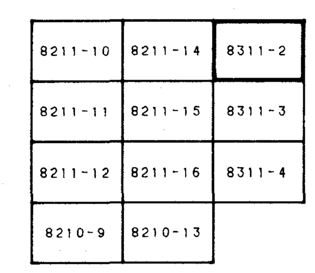

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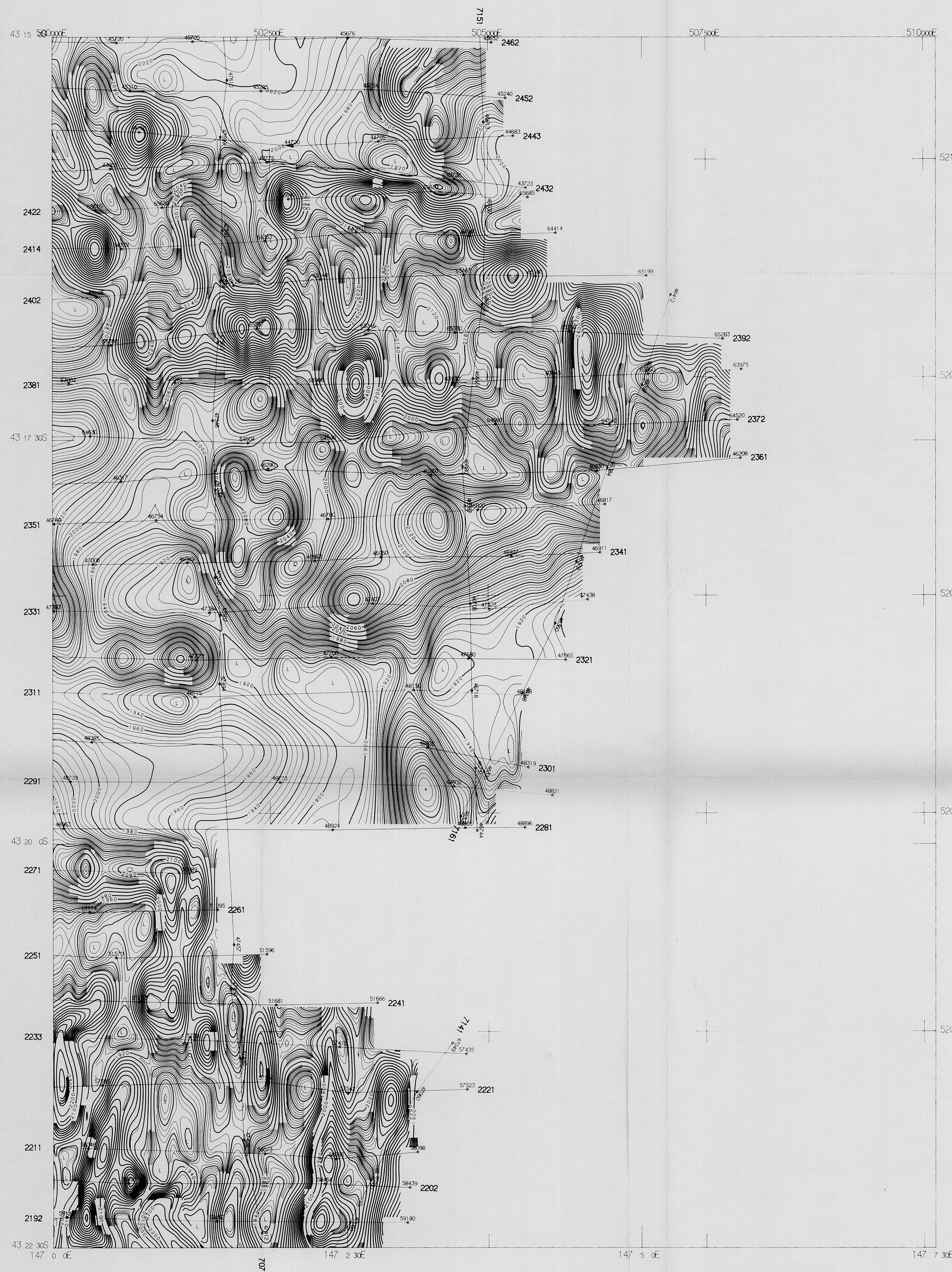

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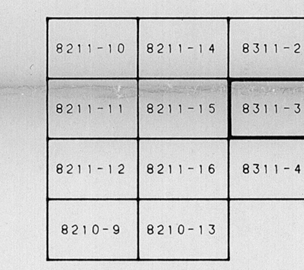

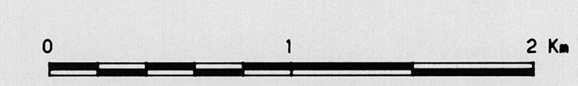

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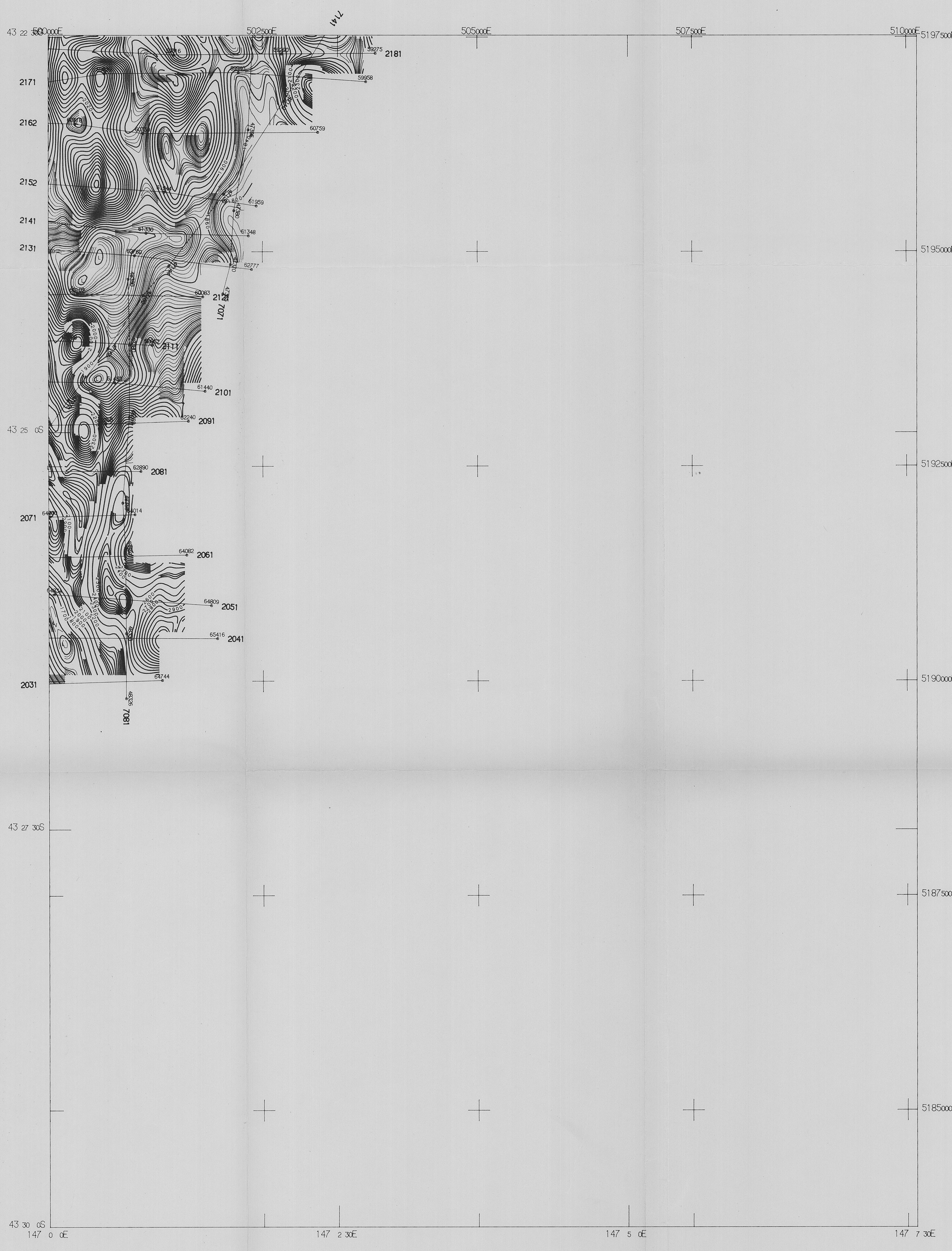

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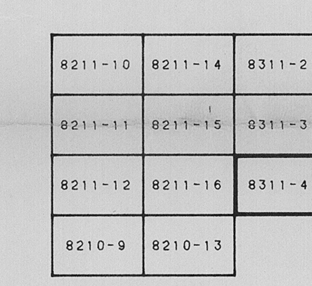

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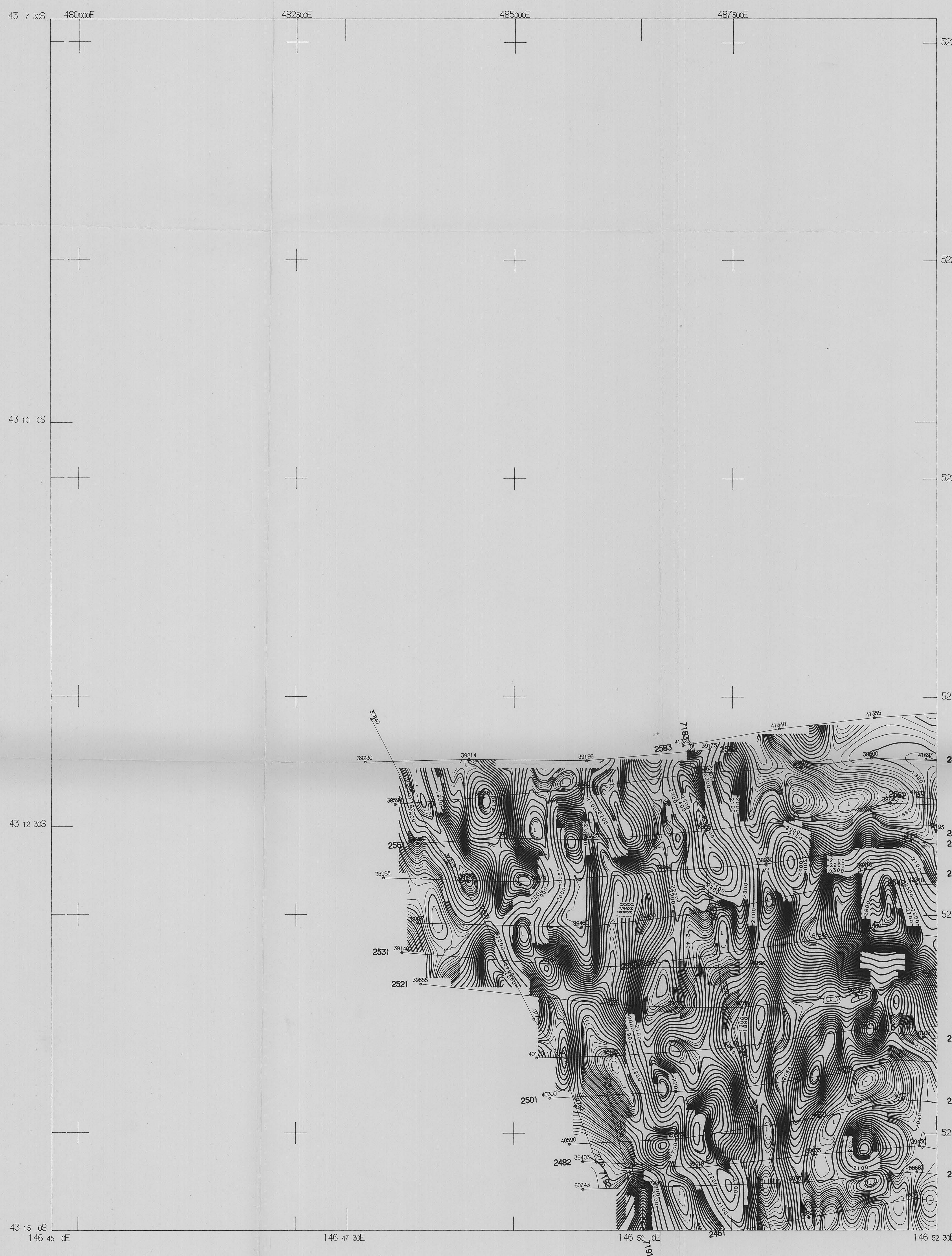

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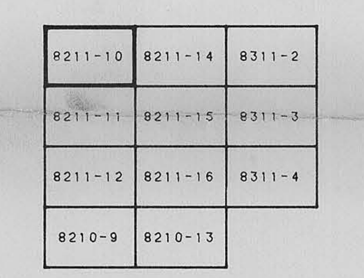

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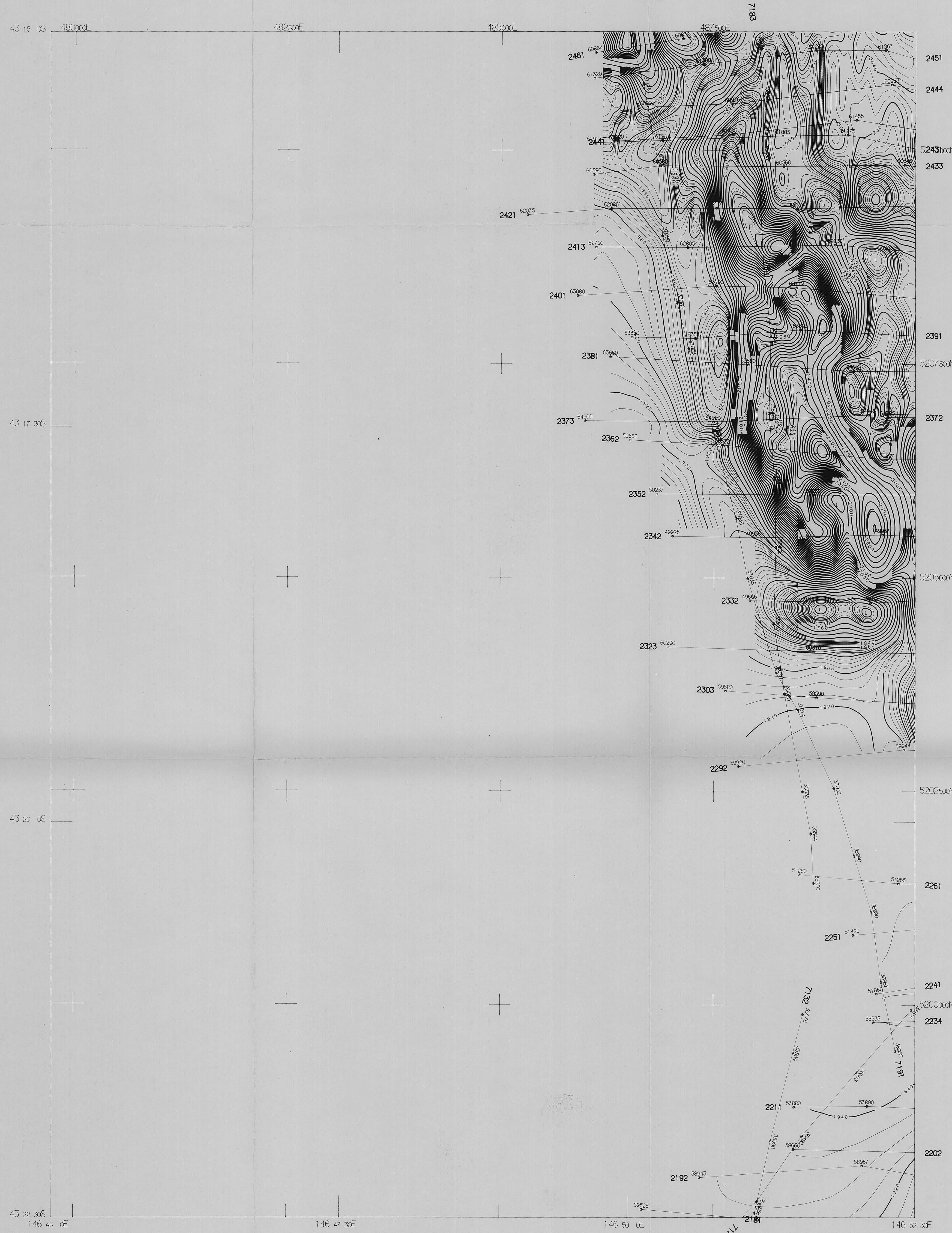
7136

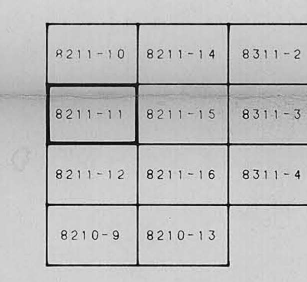


AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system, Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

RESIDUAL MAGNETIC CONTOURS
SHEET 8211-11
Grid Notation Refers to Australian Map Grid
Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed, Datum 2000nT added.
Contour Interval	:5,20,100,500,1000 and 2000 nanoteslas.



0 1 2 Km

SCALE 1:25000

5 cm

360084

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services, Bowral, NSW.

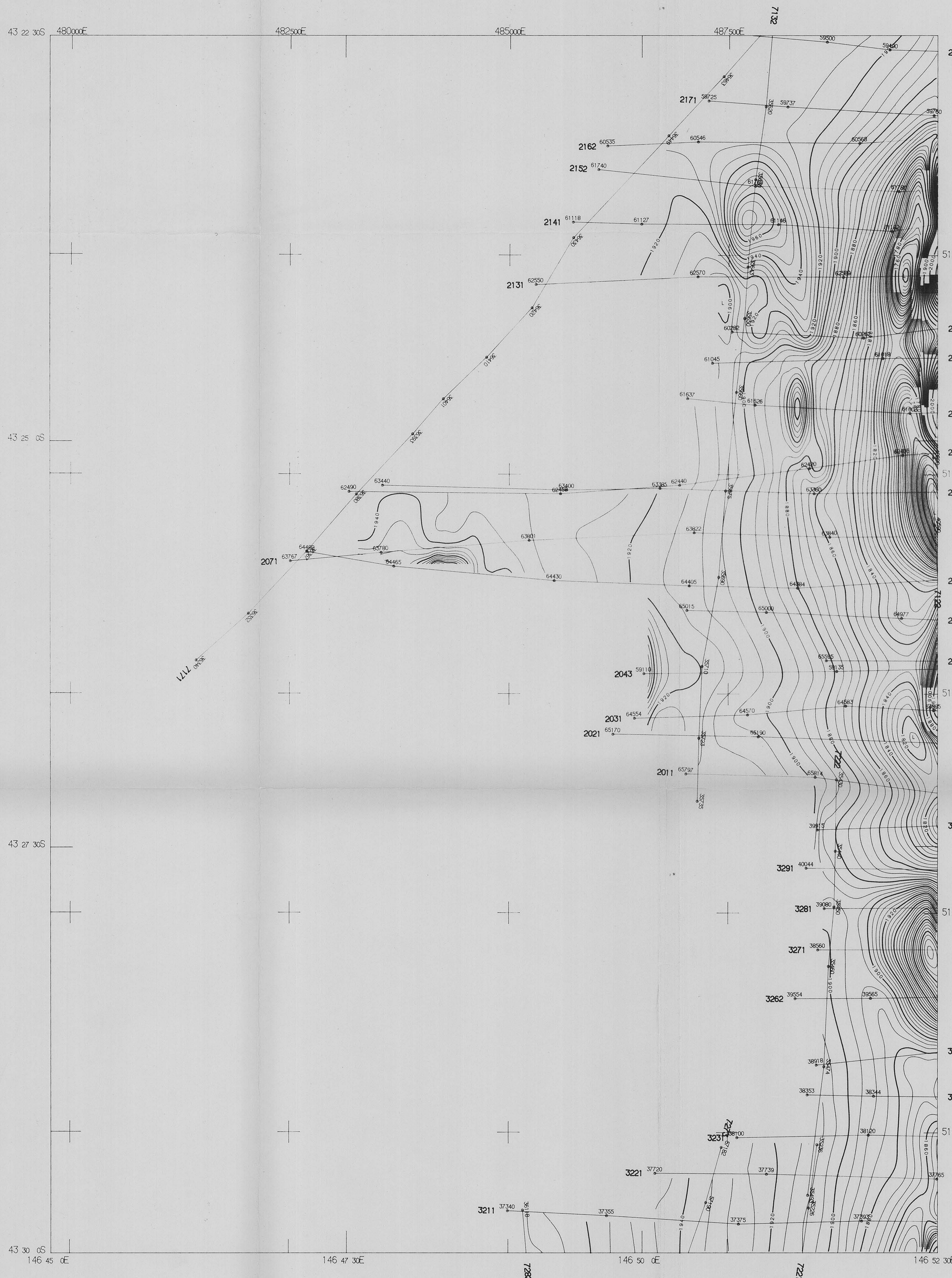
MARATHON PETROLEUM
AUSTRALIA, LTD.

EL 28/82 STRATHBLANE TAS.
RESIDUAL MAGNETIC CONTOURS
SHEET 8211-11

84-2200

PROJ NO.	DATE: 24-DEC-82

7137



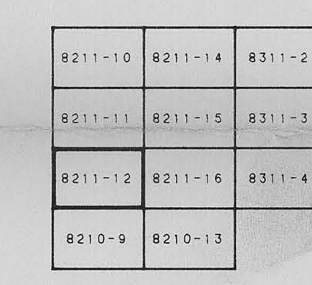
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

RESIDUAL MAGNETIC CONTOURS
SHEET 8211-12

Grid Notation Refers to Australian Map Grid
Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed, Datum 2000nT added.
Contour Interval	:5, 20, 100, 500, 1000 and 2000 nanoteslas.



0 1 2 Km
SCALE 1:25000

5 cm

360085

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services, Bowral, NSW.

MARATHON PETROLEUM
AUSTRALIA, LTD.

EL 28/82, EL 6/79 TAS.
RESIDUAL MAGNETIC CONTOURS
SHEET 8211-12

84-2200

PROJ NO.	DATE: 24-DEC-82

7138

AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER : Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL : 0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING : Geoterrex MADACS acquisition system, Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :Detector in aircraft at 90 m.
NOMINAL LINE SPACING : Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD : Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY : Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

RESIDUAL MAGNETIC CONTOURS

SHEET 8211-16
Grid Notation Refers to Australian Map Grid
Digitised from 1:25000 controlled photographs.
Magnetics :Tie Line Levelled.
Diurnal :Removed.
IGRF :Removed, Datum 2000nT added.
Contour Interval :5, 20, 100, 500, 1000 and 2000 nanoteslas.

8211-10	8211-14	8311-2
8211-11	8211-15	8311-3
8211-12	8211-16	8311-4
8210-9	8210-13	

N

0 1 2 Km
SCALE 1:25000

5 cm

360086

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services, Bowral, NSW.

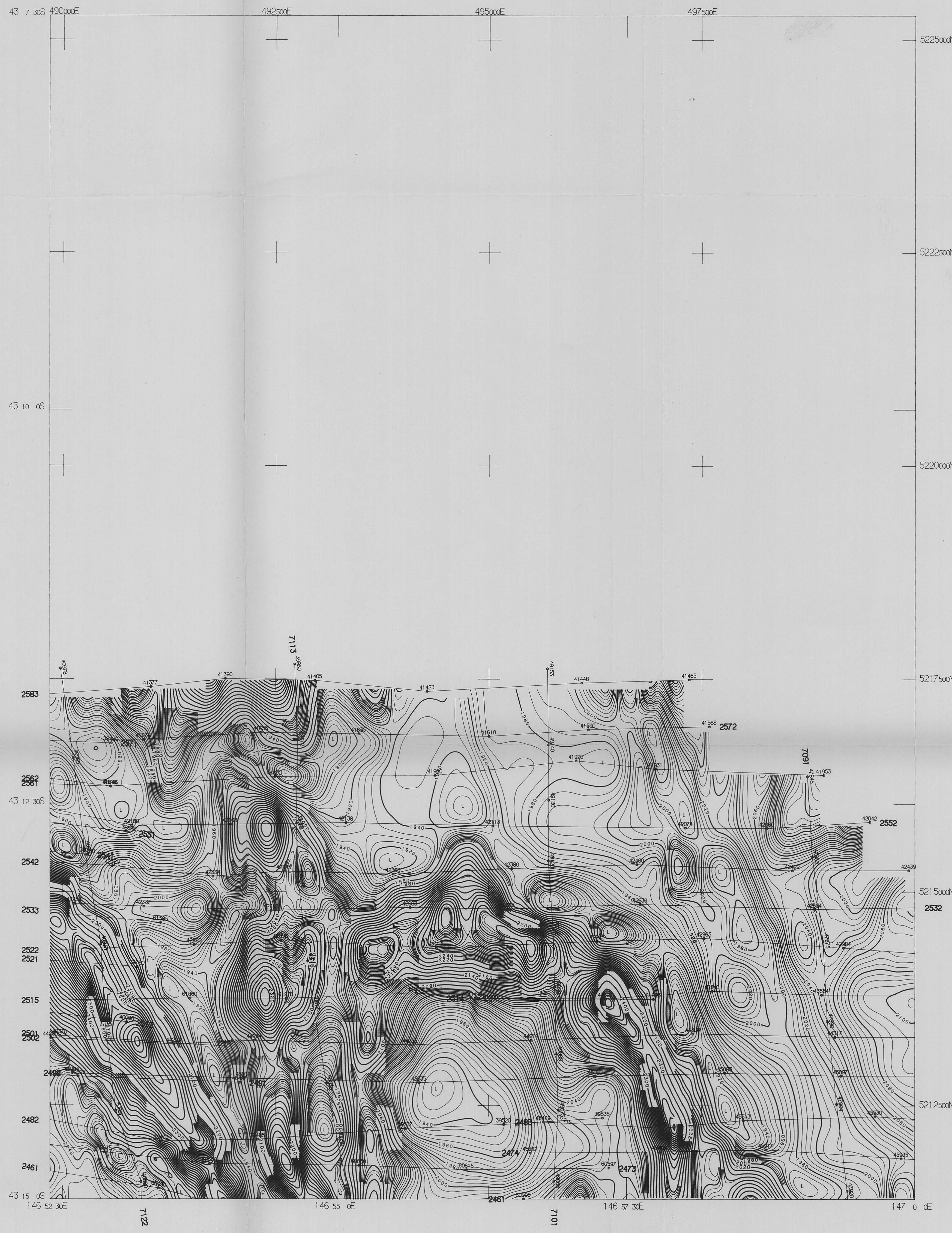
MARATHON PETROLEUM
AUSTRALIA, LTD.

EL 28/82, EL 6/79 TAS.
RESIDUAL MAGNETIC CONTOURS
SHEET 8211-16

84-2200

PROJ NO. | DATE: 24-DEC-82

7141



AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

RESIDUAL MAGNETIC CONTOURS
SHEET 8211-14
Grid Notation Refers to Australian Map Grid
Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed. Datum 2000nT added.
Contour Interval	:5.20.100.500.1000 and 2000 nanoteslas.

8211-10	8211-14	8311-2
8211-11	8211-15	8311-3
8211-12	8211-16	8311-4
8210-9	8210-13	

N

0 1 2 Km
SCALE 1:25000

5 cm

360087

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

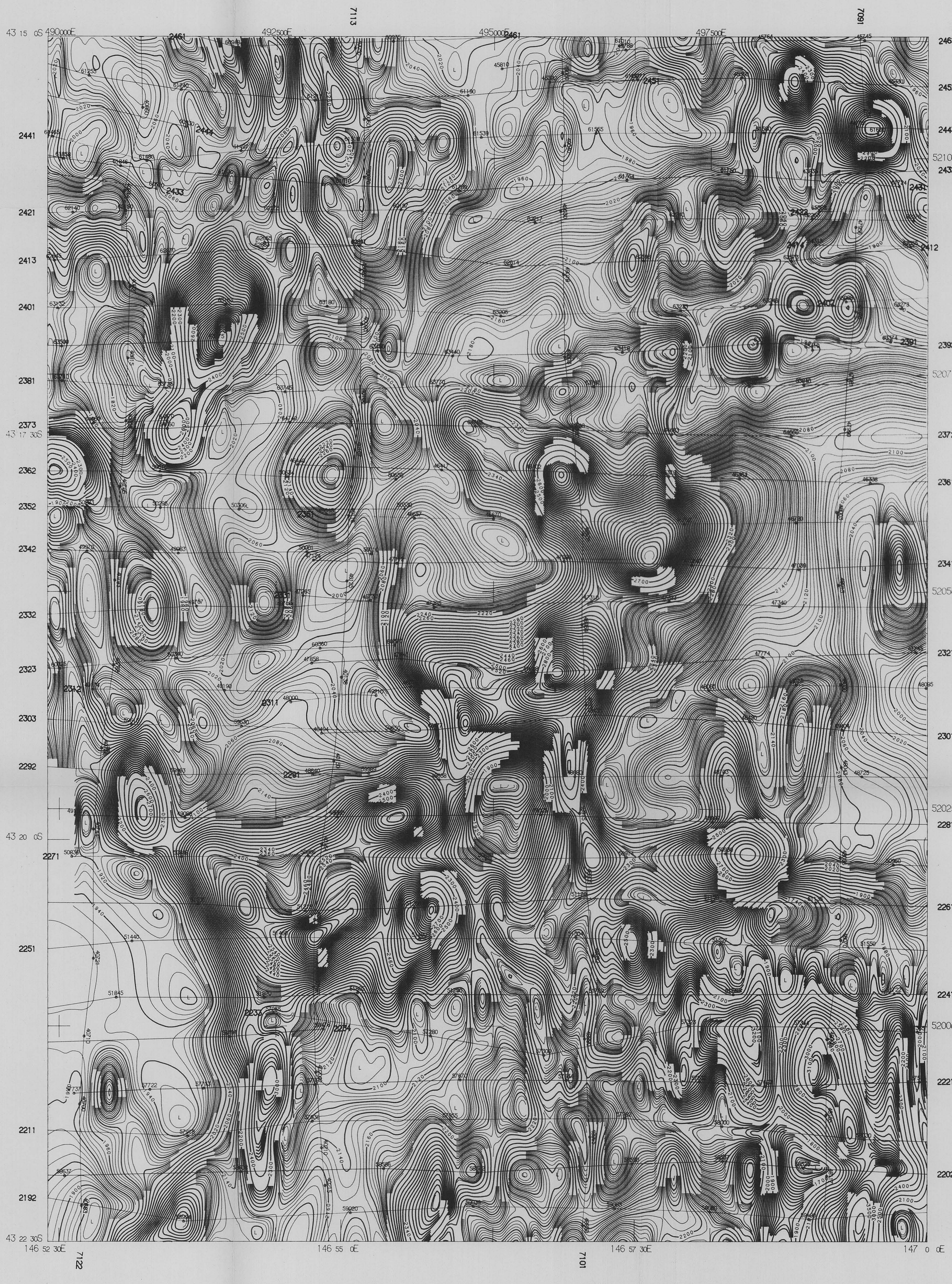
MARATHON PETROLEUM
AUSTRALIA, LTD.

EL 28/82 STRATHBLANE TAS.
RESIDUAL MAGNETIC CONTOURS
SHEET 8211-14

84-2200

PROJ NO. DATE: 24-DEC-82

7139



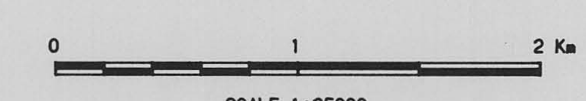
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

RESIDUAL MAGNETIC CONTOURS
SHEET 8211-15
Grid Notation Refers to Australian Map Grid
Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed, Datum 2000nT added.
Contour Interval	:5, 20, 100, 500, 1000 and 2000 nanoteslas.

8211-10	8211-14	8311-2
8211-11	8211-15	8311-3
8211-12	8211-16	8311-4
8210-9	8210-13	



5 cm

360088

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services, Bowral, NSW.

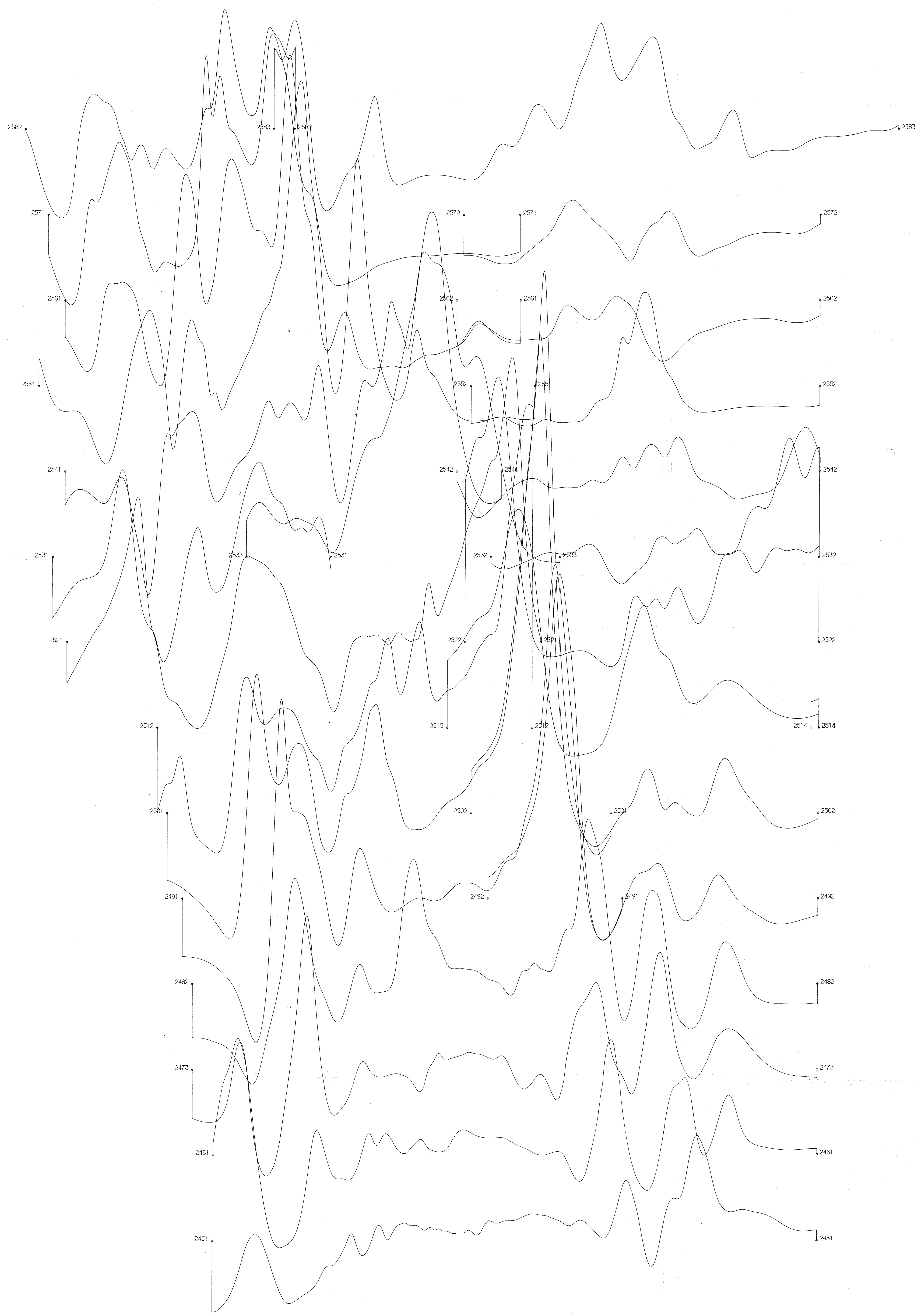
MARATHON PETROLEUM
AUSTRALIA, LTD.

EL 28/82 STRATHBLANE TAS.
RESIDUAL MAGNETIC CONTOURS
SHEET 8211-15

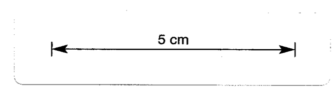
84-2200

PROJ NO.	DATE: 24-DEC-82

7140



360089



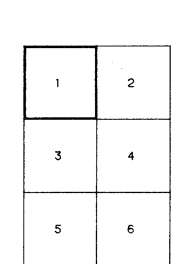
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

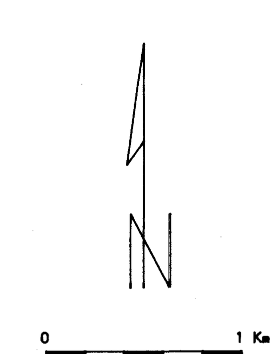
SEPARATED MAGNETIC PROFILES
SHEET 1

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed. Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM



14645E 1465615E 1470730E



JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

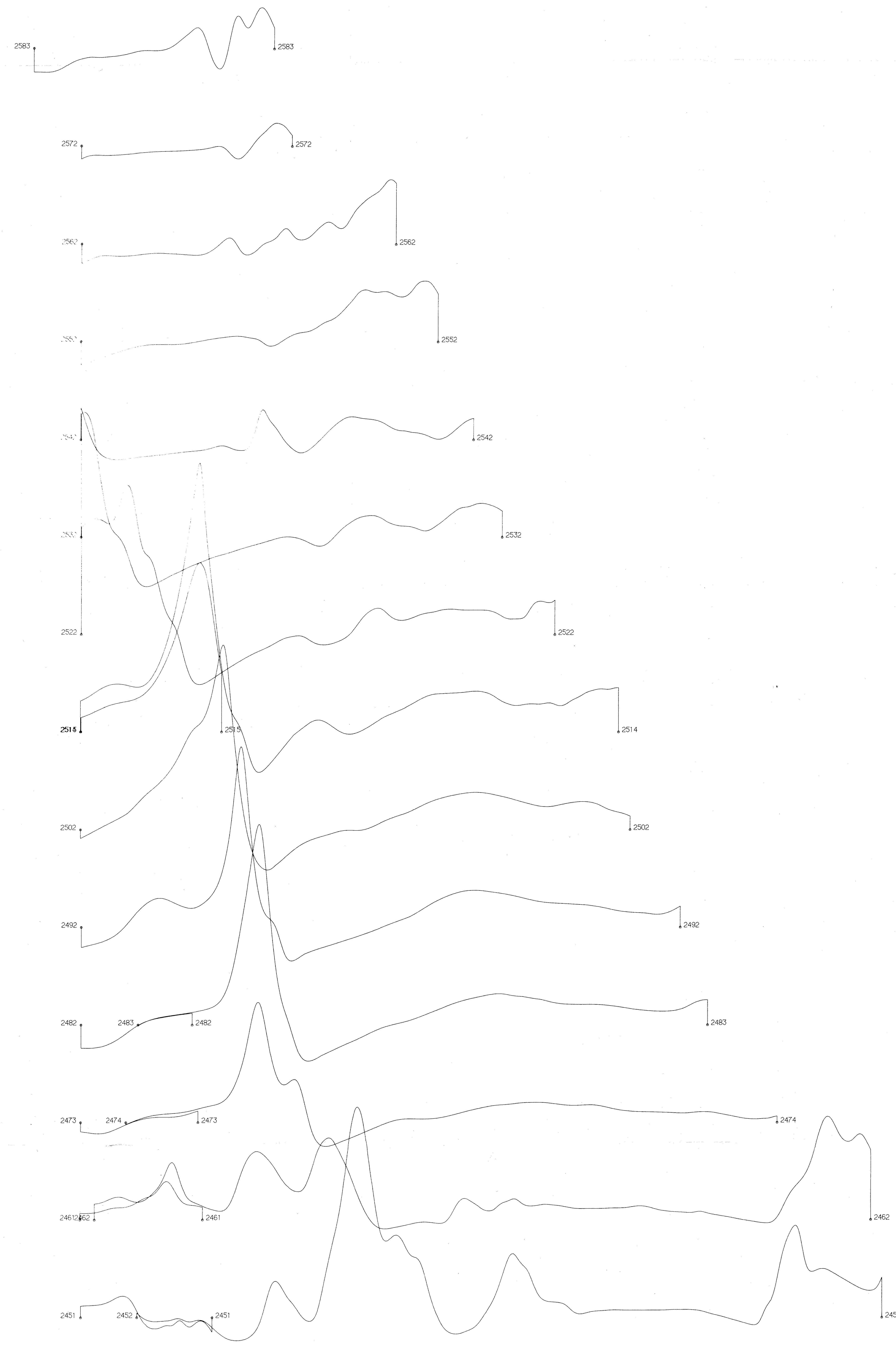
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 1

84-2200

PROJ NO.	DATE: 6-JAN-83

7126



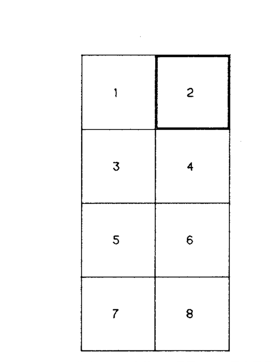
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25.000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 2

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed.Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM



0 1 Km
SCALE 1:25000

360090

5 cm

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd.,Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

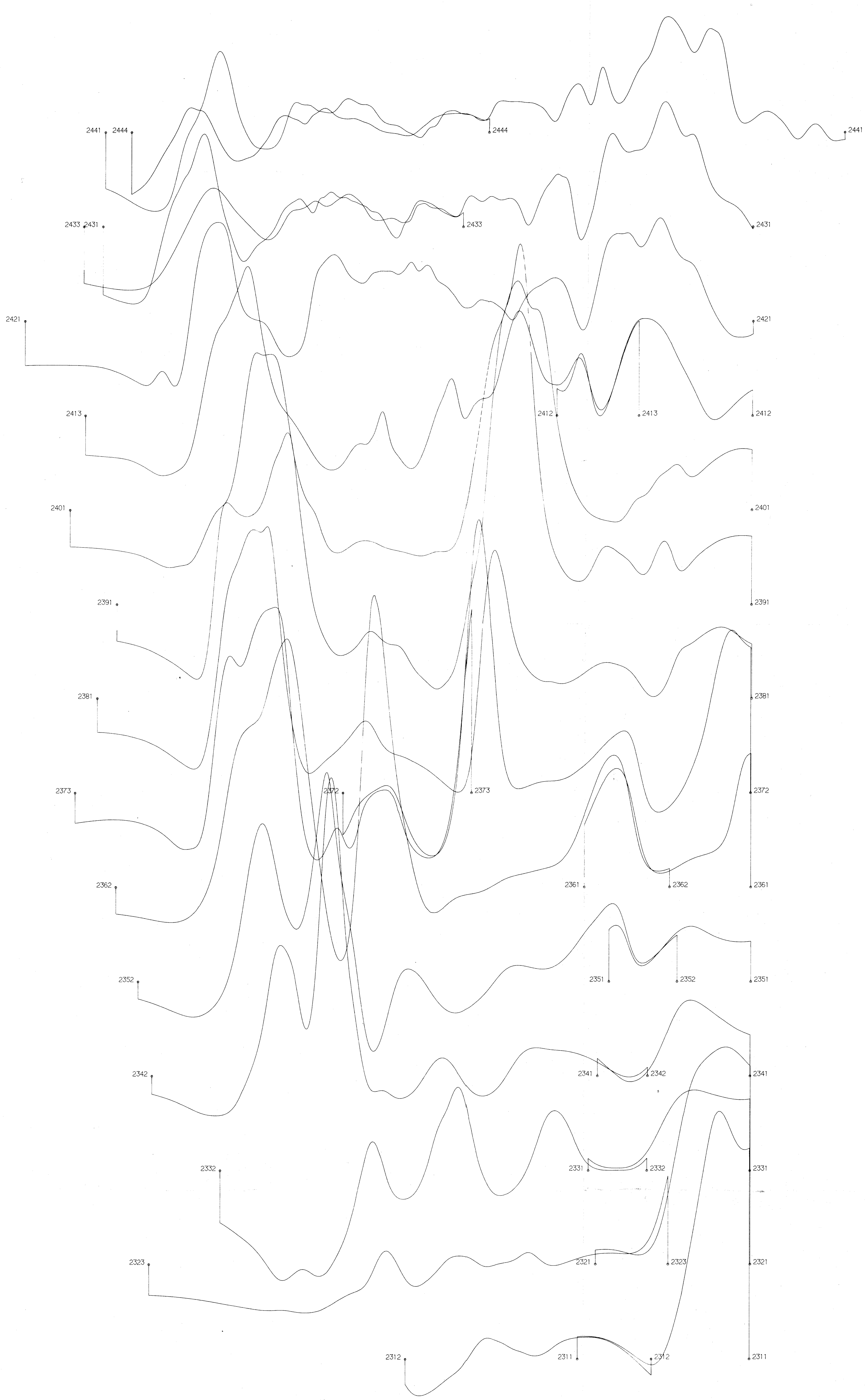
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 2

86-2200

PROJ NO.	DATE: 6-JAN-83

7127



360091

5 cm

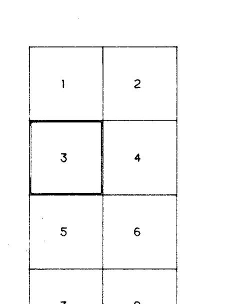
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 3

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed, Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM



14645E 1465615E 1470730E

N

0 1 Km
SCALE 1:25000

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services, Bowral, NSW.

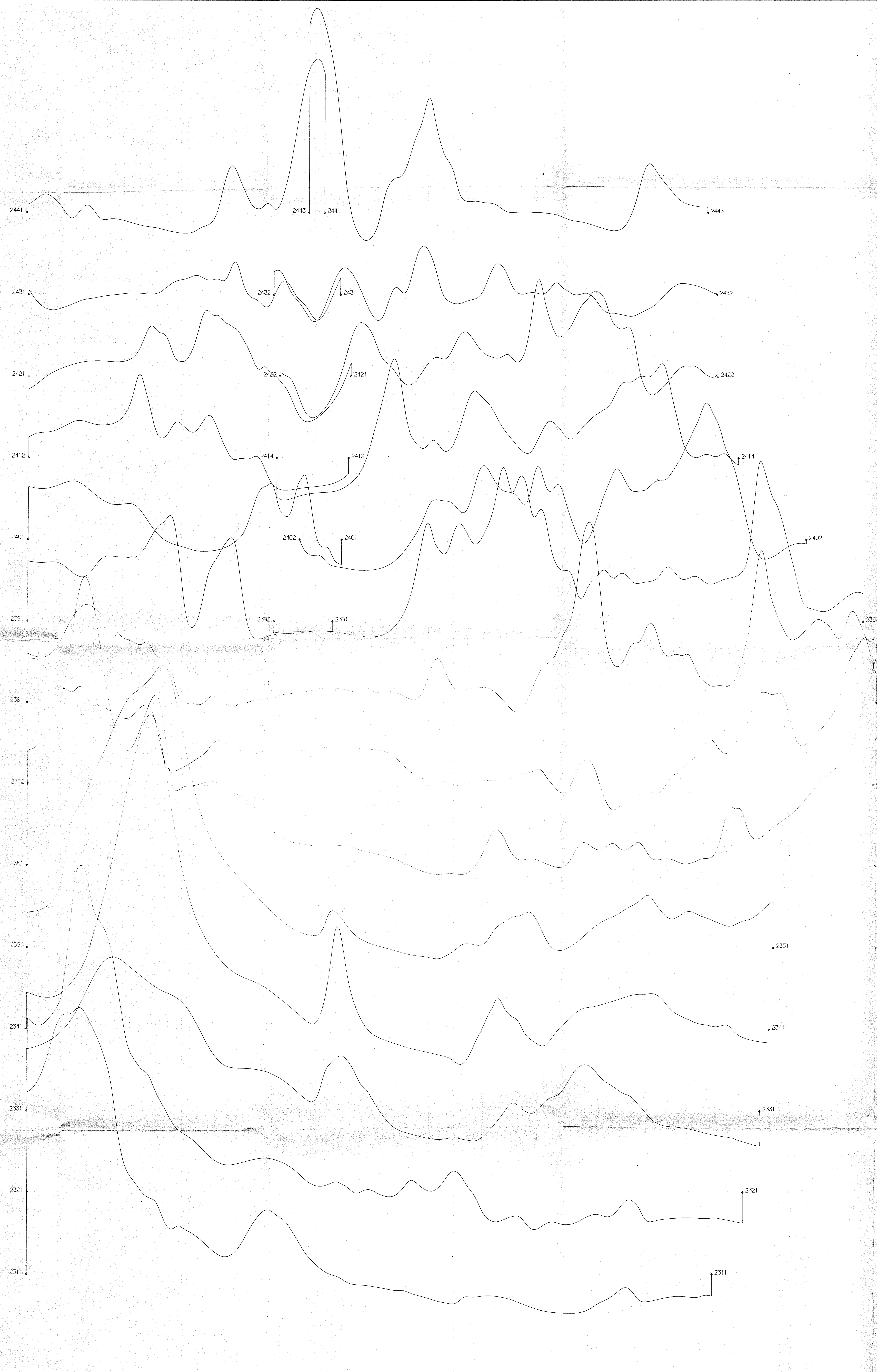
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 3a

84-2200

PROJ NO.	DATE: 6-JAN-83

7129



360092

5 cm

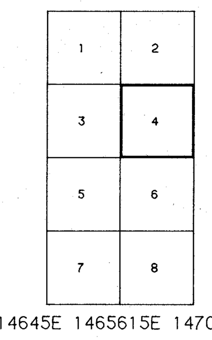
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

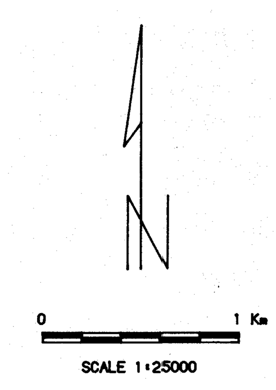
SEPARATED MAGNETIC PROFILES
SHEET 4

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed.Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM



14645E 1465615E 1470730E



JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd.,Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

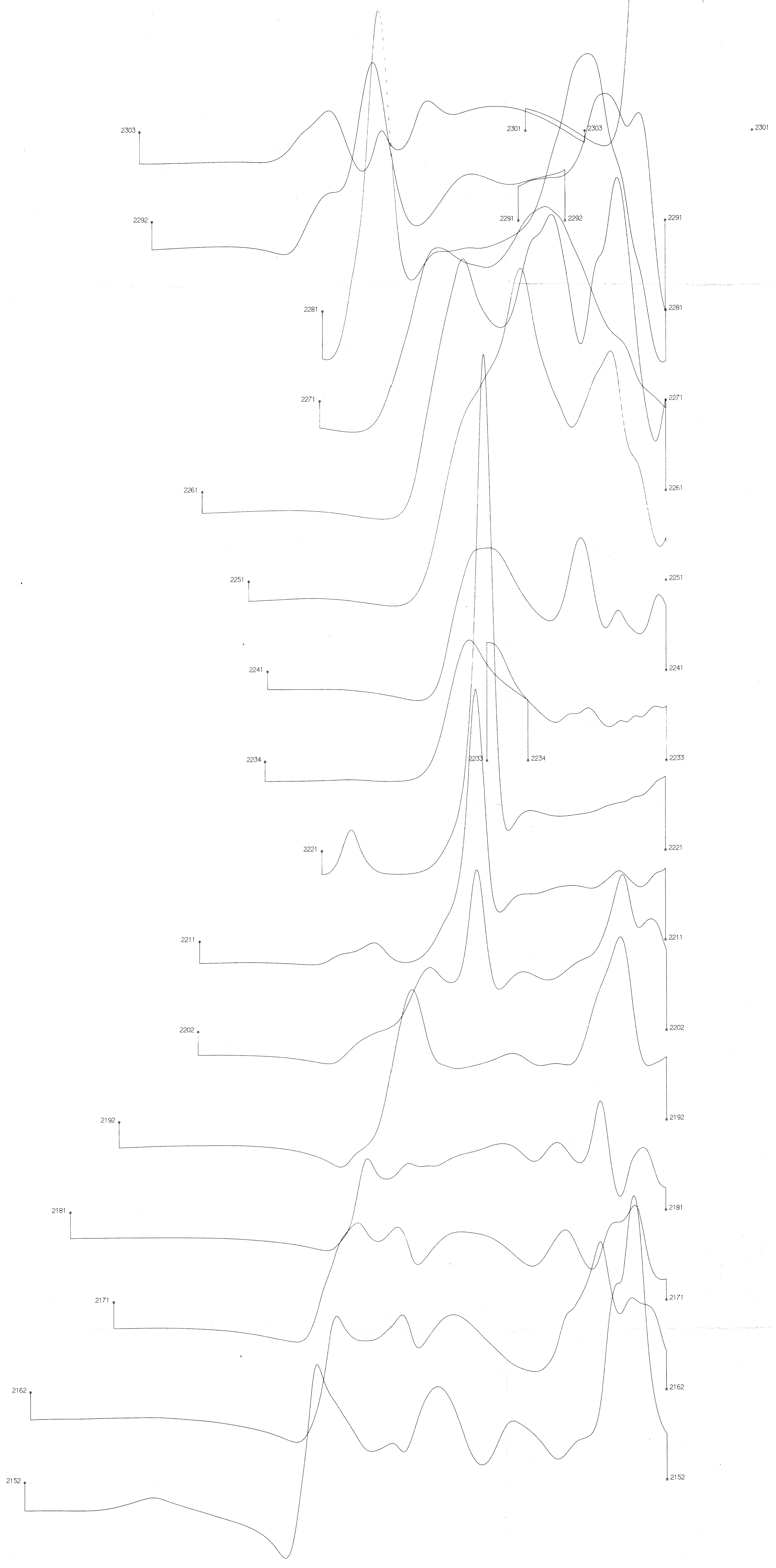
MARATHON PETROLEUM AUSTRALIA, LTD.

STRATHBLANE TAS. SEPARATED MAGNETIC PROFILES SHEET 4a

84-2200

PROJ NO.	DATE: 6-JAN-83

7131



360093

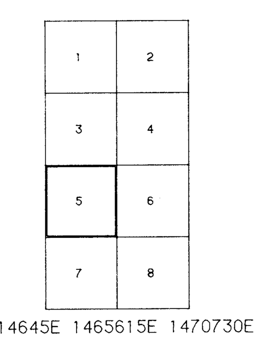
AIRBORNE SURVEY SPECIFICATIONS

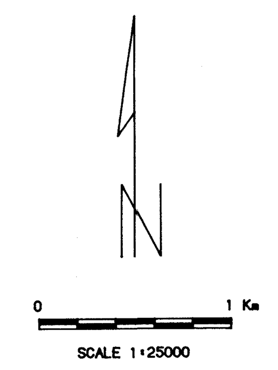
MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 5

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed, Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM





JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

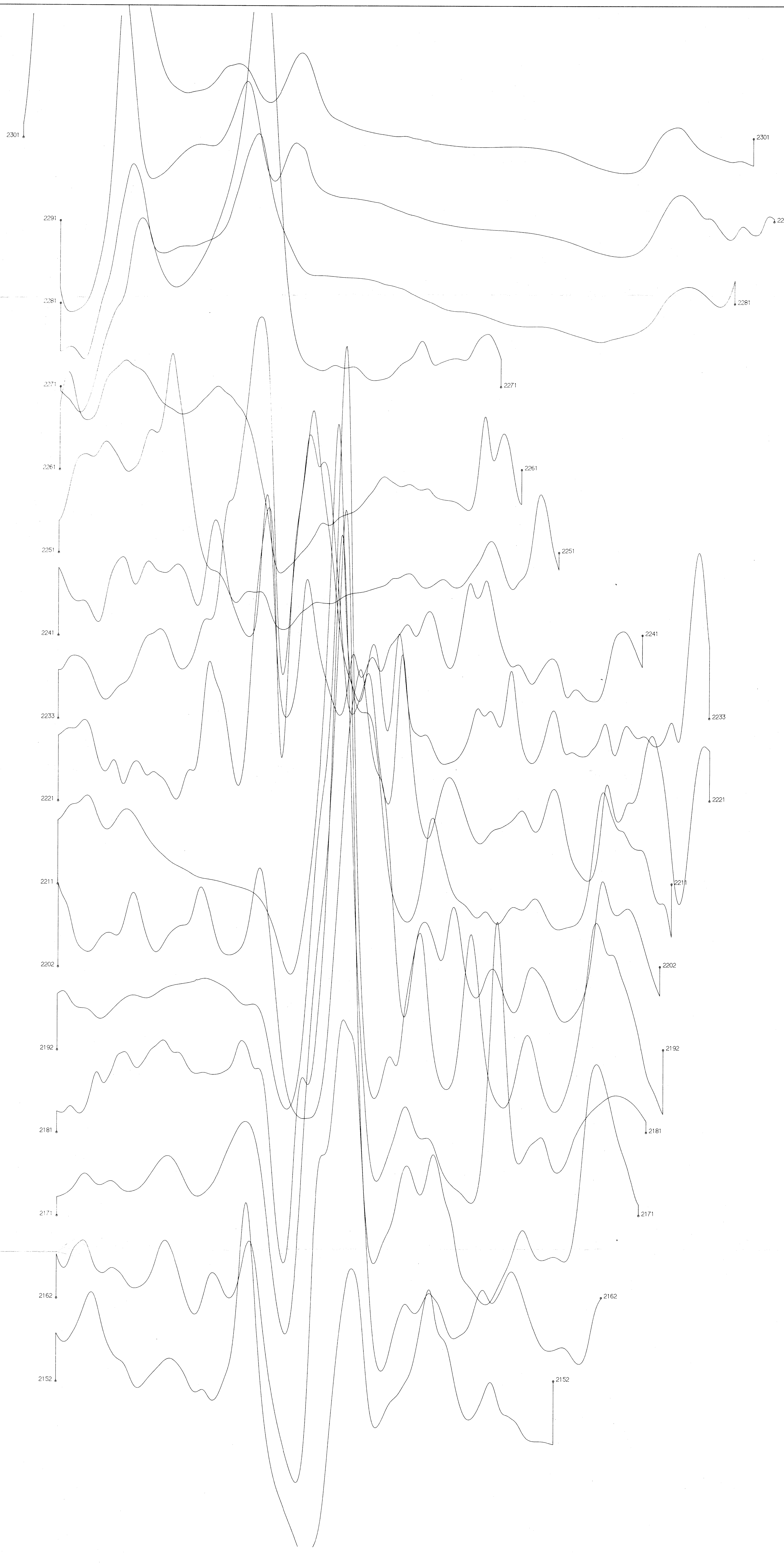
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS. SEPARATED MAGNETIC PROFILES SHEET 5

84-2200

PROJ NO.	DATE: 6-JAN-83

7132



360094

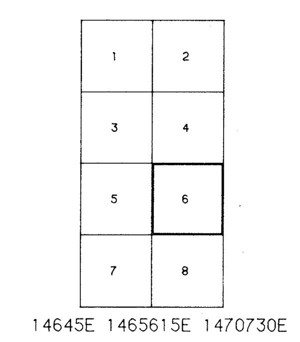
AIRBORNE SURVEY SPECIFICATIONS

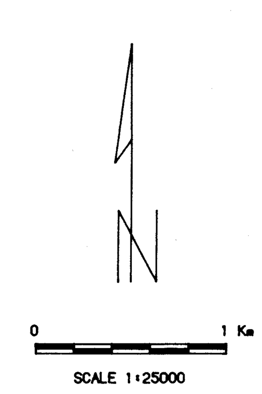
MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 6

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed.Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM





5 cm

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd., Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

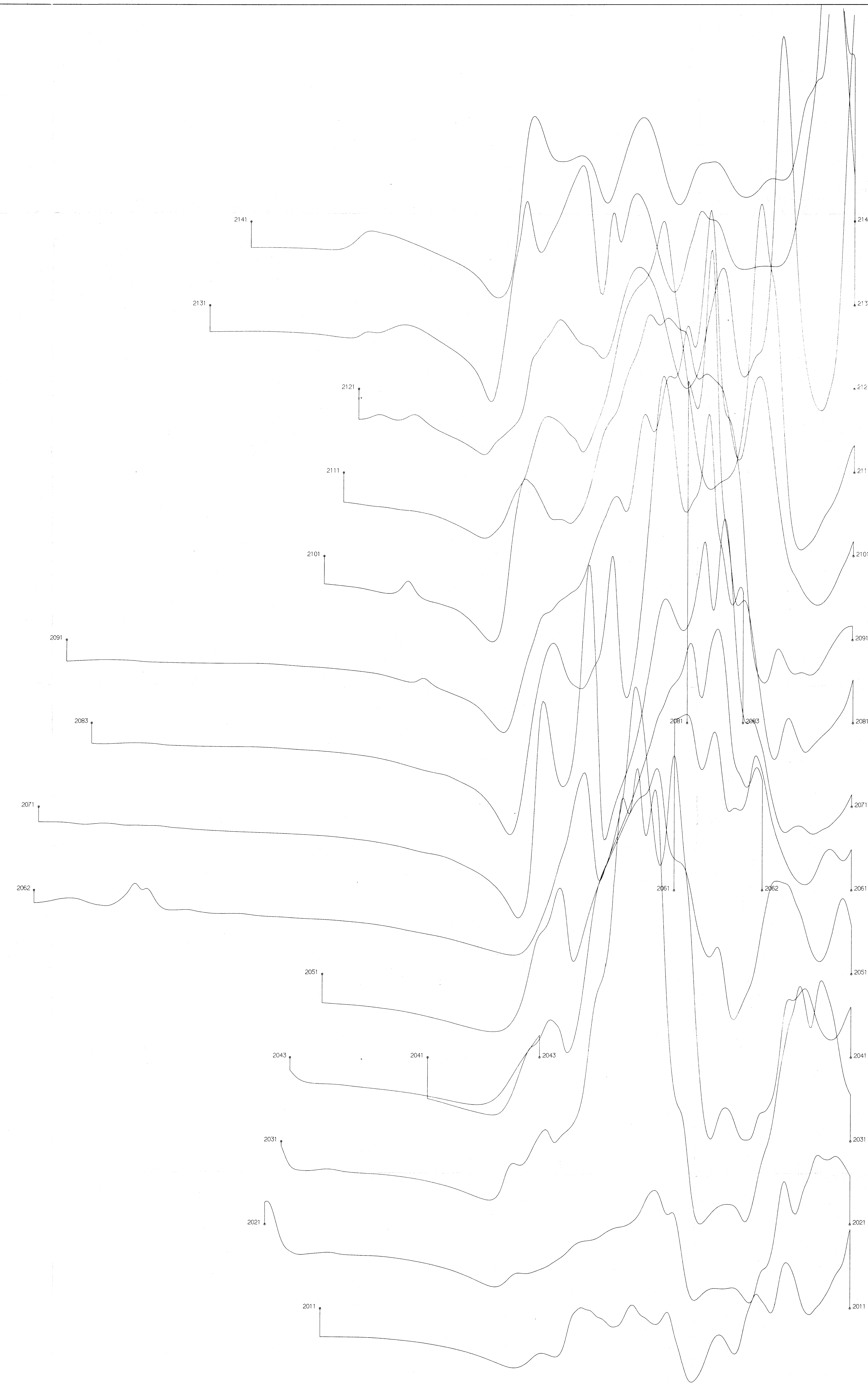
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 6

84-2200

PROJ NO.	DATE: 6-JAN-83

7133



360095

5 cm

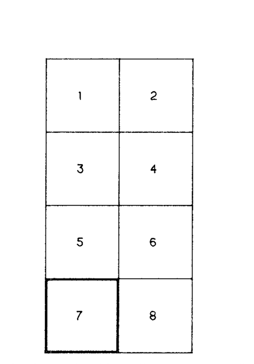
AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 7

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed.Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM



N

0 1 Km
SCALE 1:25000

JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd.,Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

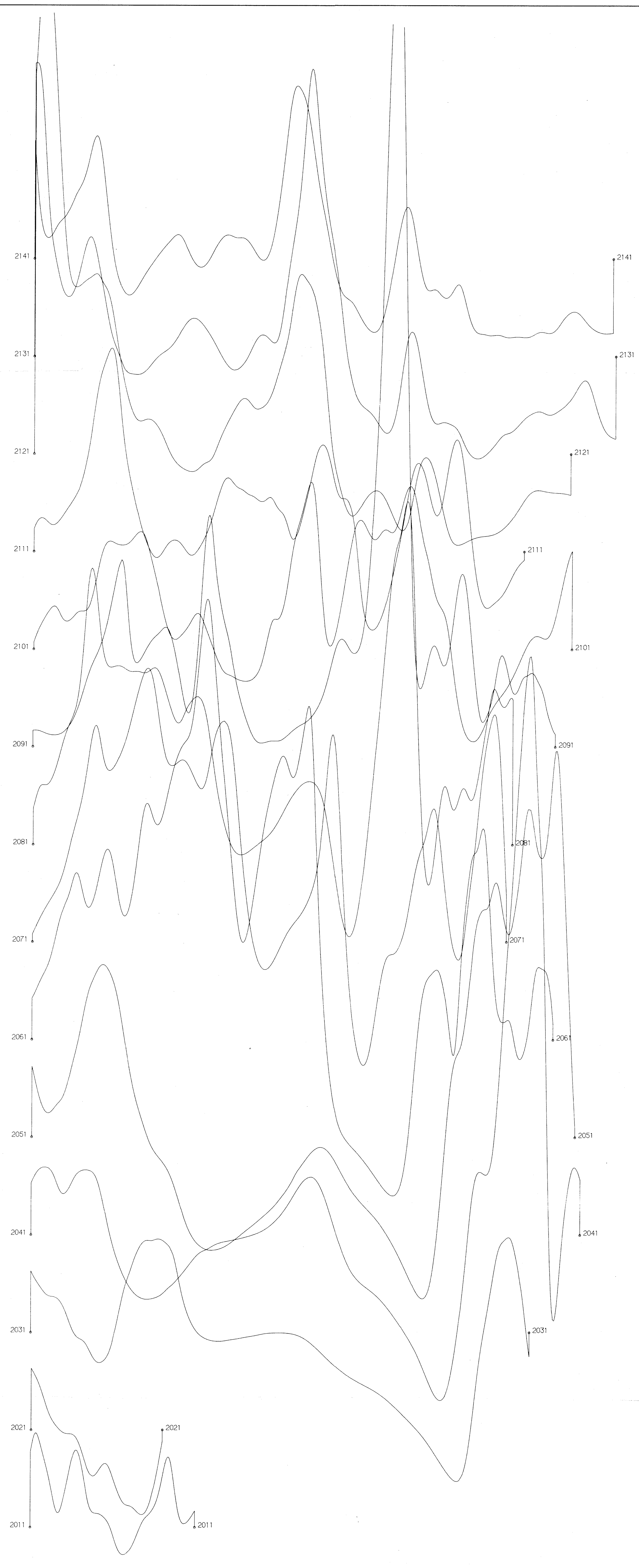
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 7

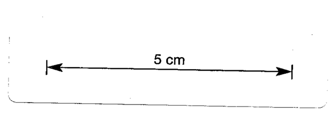
84-2200

PROJ NO.	DATE: 6-JAN-83

7134



360096



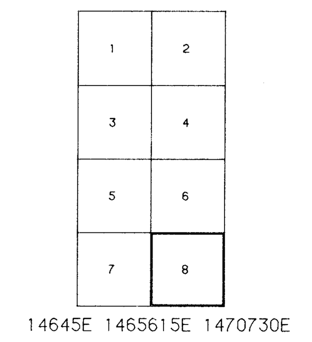
AIRBORNE SURVEY SPECIFICATIONS

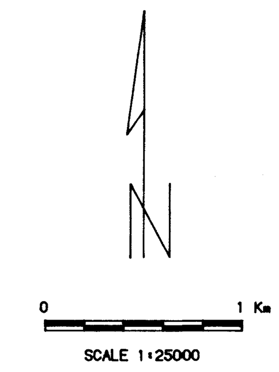
MAGNETOMETER :	Cesium Vapour optical absorption. Sensitivity : 0.04 nT
RECORDING INTERVAL :	0.2 sec (approx 13m sampling) at mean ground speed of 220 km/hour.
DATA RECORDING :	Geoterrex MADACS acquisition system. Digital to magnetic tape.
NOMINAL TERRAIN CLEARANCE :	Detector in aircraft at 90 m.
NOMINAL LINE SPACING :	Traverse lines 500 metres. Tie lines 3.0 km.
FLIGHT PATH RECORD :	Geocam 35mm continuous tracking camera.
FLIGHT LINE RECOVERY :	Visually to 1:25,000 enlargements of Tas Lands Dept. black & white photography.

SEPARATED MAGNETIC PROFILES
SHEET 8

Digitised from 1:25000 controlled photographs.

Magnetics	:Tie Line Levelled.
Diurnal	:Removed.
IGRF	:Removed.Datum 2000nT added.
Base Value	:2000 nT
Vertical Scale	:50 nT/CM





JOB NO : 87-259
Flown by GEOTERREX PTY LTD : DECEMBER 1982
Compiled by Geoterrex Pty Ltd.,Sydney, NSW.
Processed by Engineering Computer Services , Bowral, NSW.

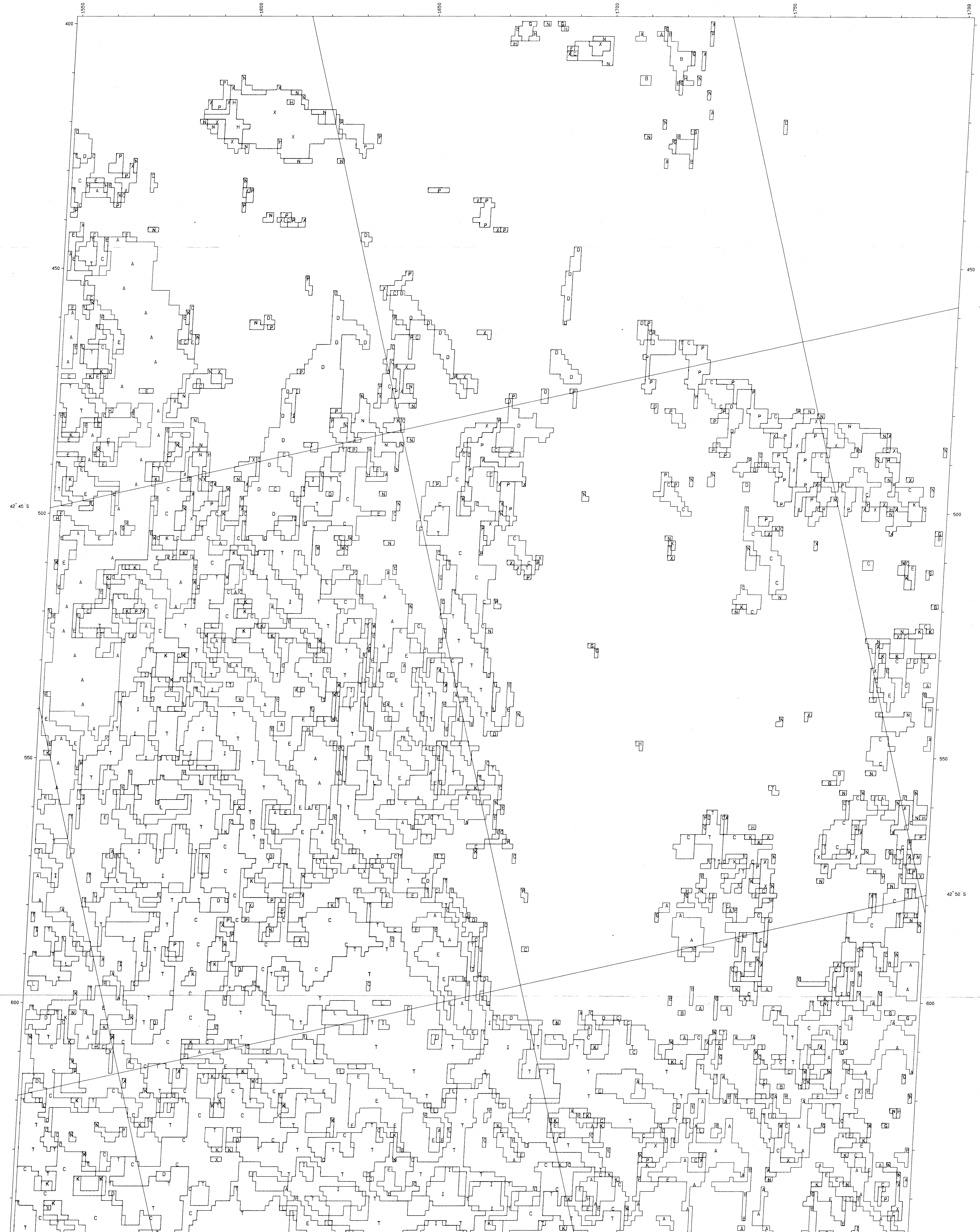
MARATHON PETROLEUM
AUSTRALIA, LTD.

STRATHBLANE TAS.
SEPARATED MAGNETIC PROFILES
SHEET 8

84-2200

PROJ NO.	DATE: 6-JAN-83

7135



LEGEND

FIRST PRIORITY SIGNATURES

- A — DOLERITE: mainly outcrop with minor talus and scree
- B — BASALT: outcrop with minor talus and soil cover
- C — TRIASSIC COAL MEASURES: outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

- D — DOLERITE: sub-outcrop covered with thin talus and scree
- E — DOLERITE SCREE: associated with minor talus
- T — DOLERITE TALUS AND SOIL: in part overlying Triassic Coal Measures
- G — BASALT TALUS AND SOIL
- H — TRIASSIC COAL MEASURES: soil covered

THIRD PRIORITY SIGNATURES

- I — DOLERITE: weathered insitu, overlain by deep soils
- X — DOLERITE TALUS AND SOIL: usually thin, developed over dolerite
- K — CLAYEY SOILS: overlying Triassic Coal Measures
- L — CLAYEY SOILS: overlying Triassic Coal Measures
- N — CLAYEY SOILS: overlying Triassic Coal Measures
- P — CLAYEY SOILS: overlying unassigned Triassic rocks

SUNDRY

- W — WATER: does not include tidal flats or swampy ground

360097

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE	16TH JANUARY, 1983
IMAGE ID	22550 - 23085
IMAGE DATE	15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

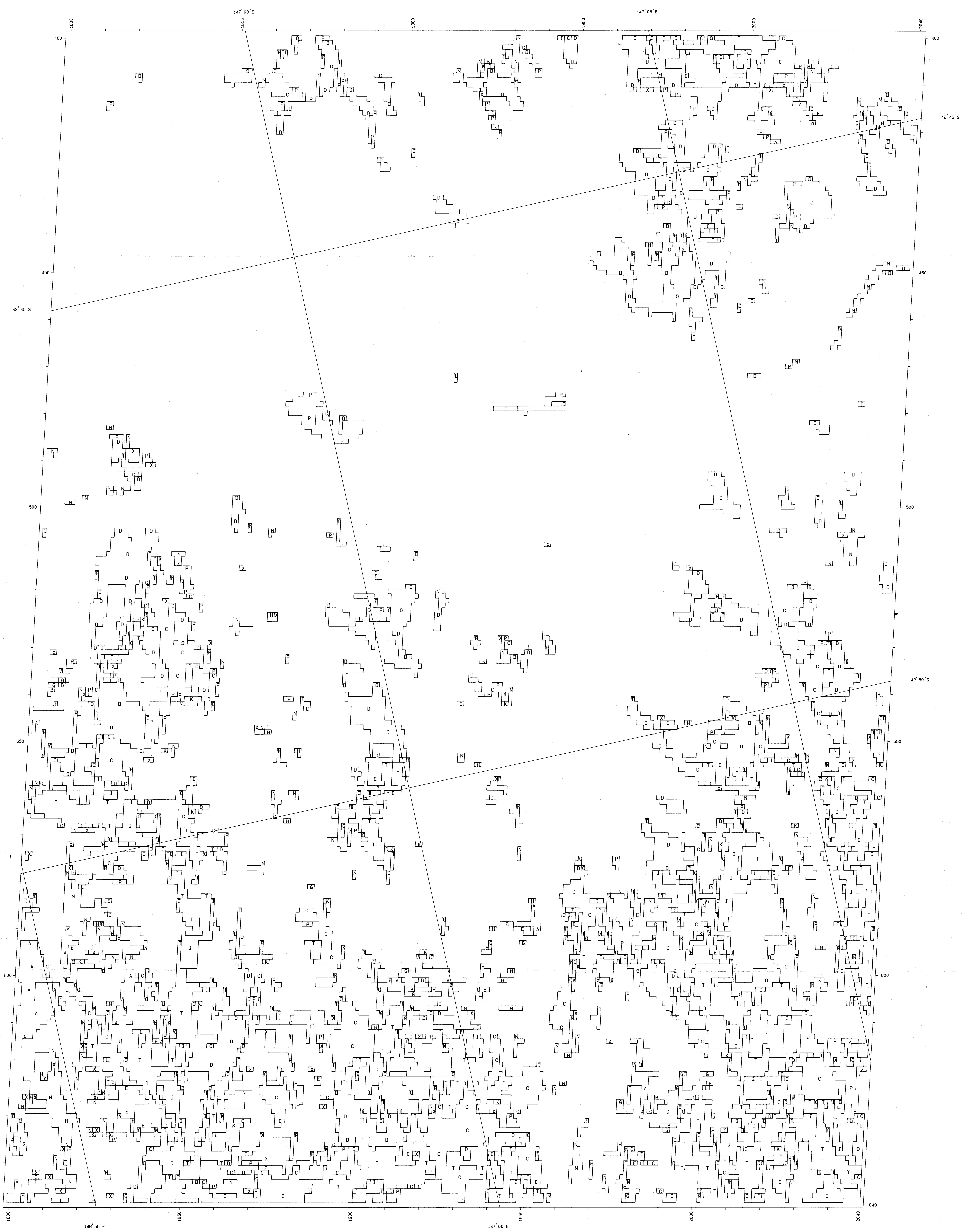
0 0.5 1.0 2.0 KM
SCALE 1: 25000

5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS
(Mt Lloyd)

PLATE 1

Good copy



LEGEND

FIRST PRIORITY SIGNATURES

A	DOLERITE mainly outcrop with minor talus and scree
B	BASALT outcrop with minor talus and soil cover
C	TRIASSIC COAL MEASURES outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

D	DOLERITE sub-outcrop covered with thin talus and scree
E	DOLERITE SCREE associated with minor talus
T	DOLERITE TALUS AND SOIL in part overlying Triassic Coal Measures
G	BASALT TALUS AND SOIL
H	TRIASSIC COAL MEASURES soil covered

THIRD PRIORITY SIGNATURES

I	DOLERITE weathered insitu, overlain by deep soils
X	DOLERITE TALUS AND SOIL usually thin, developed over dolerite
K	CLAYEY SOILS overlying Triassic Coal Measures
L	CLAYEY SOILS overlying Triassic Coal Measures
N	CLAYEY SOILS overlying Triassic Coal Measures
P	CLAYEY SOILS overlying unassigned Triassic rocks

SUNDRY

W	WATER does not include tidal flats or swampy ground

360098

84-2200 (A)

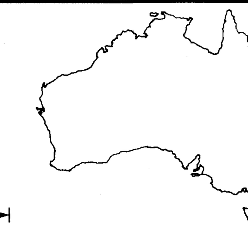
FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE	16TH JANUARY, 1983
IMAGE ID	22550 - 23085
IMAGE DATE	15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

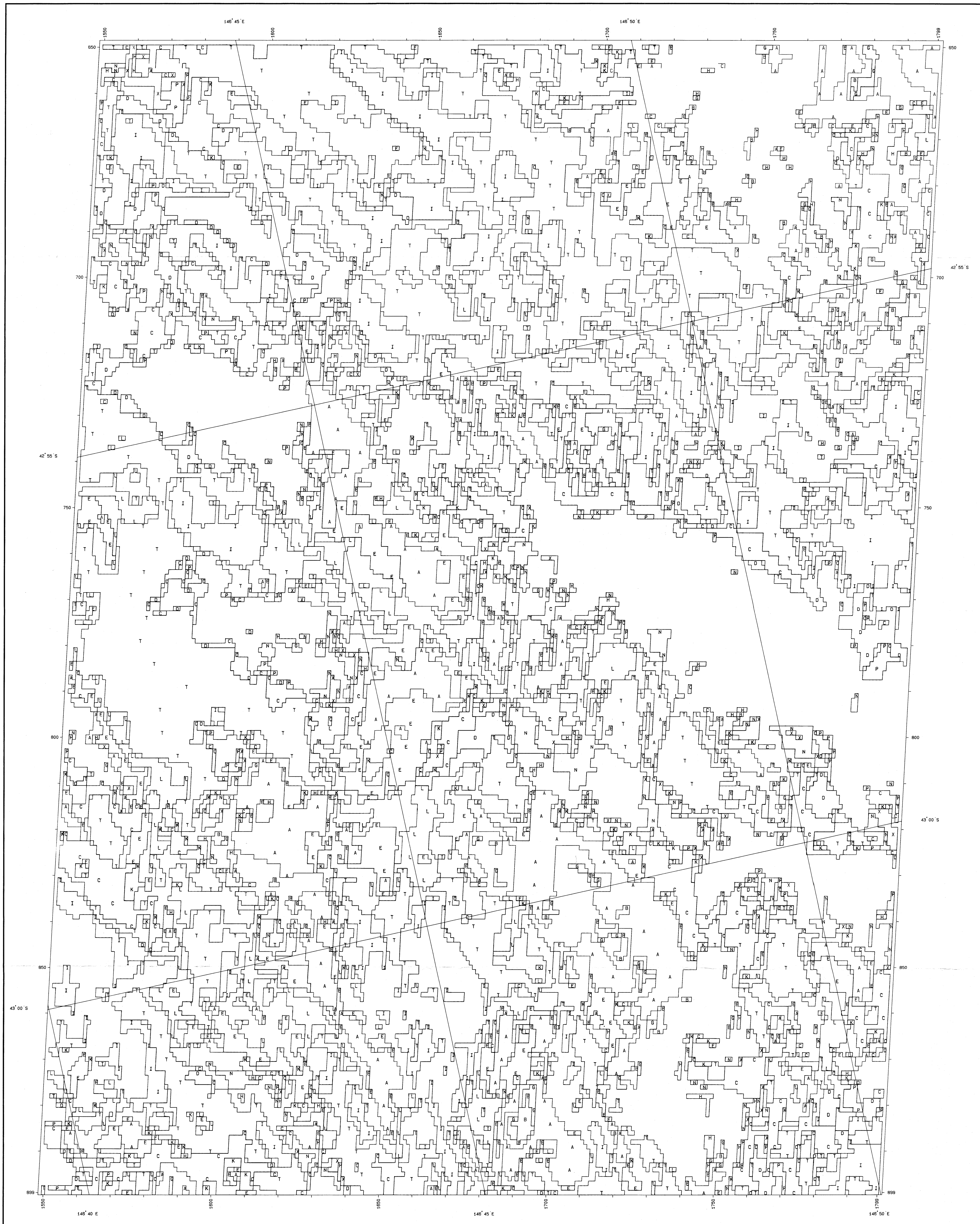
0 0.5 1.0 2.0 KM
SCALE 1: 25000



5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

(Hardcopy) PLATE 2



LEGEND

FIRST PRIORITY SIGNATURES

- A — DOLERITE — mainly outcrop with minor talus and scree
- B — BASALT — outcrop with minor talus and soil cover
- C — TRIASSIC COAL MEASURES — outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

- D — DOLERITE — sub-outcrop covered with thin talus and scree
- E — DOLERITE SCREE — associated with minor talus
- T — DOLERITE TALUS AND SOIL — in part overlying Triassic Coal Measures
- G — BASALT TALUS AND SOIL
- H — TRIASSIC COAL MEASURES — soil covered

THIRD PRIORITY SIGNATURES

- I — DOLERITE — weathered insitu, overlain by deep soils
- X — DOLERITE TALUS AND SOIL — usually thin, developed over dolerite
- K — CLAYEY SOILS — overlying Triassic Coal Measures
- L — CLAYEY SOILS — overlying Triassic Coal Measures
- N — CLAYEY SOILS — overlying Triassic Coal Measures
- P — CLAYEY SOILS — overlying unassigned Triassic rocks

SUNDRY

- W — WATER — does not include tidal flats or swampy ground

360099

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

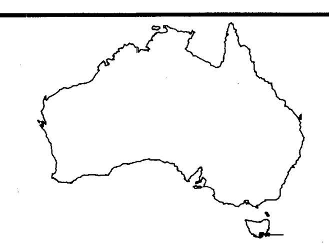
DATE 16TH JANUARY, 1983
IMAGE ID 22550 - 23085
IMAGE DATE 15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

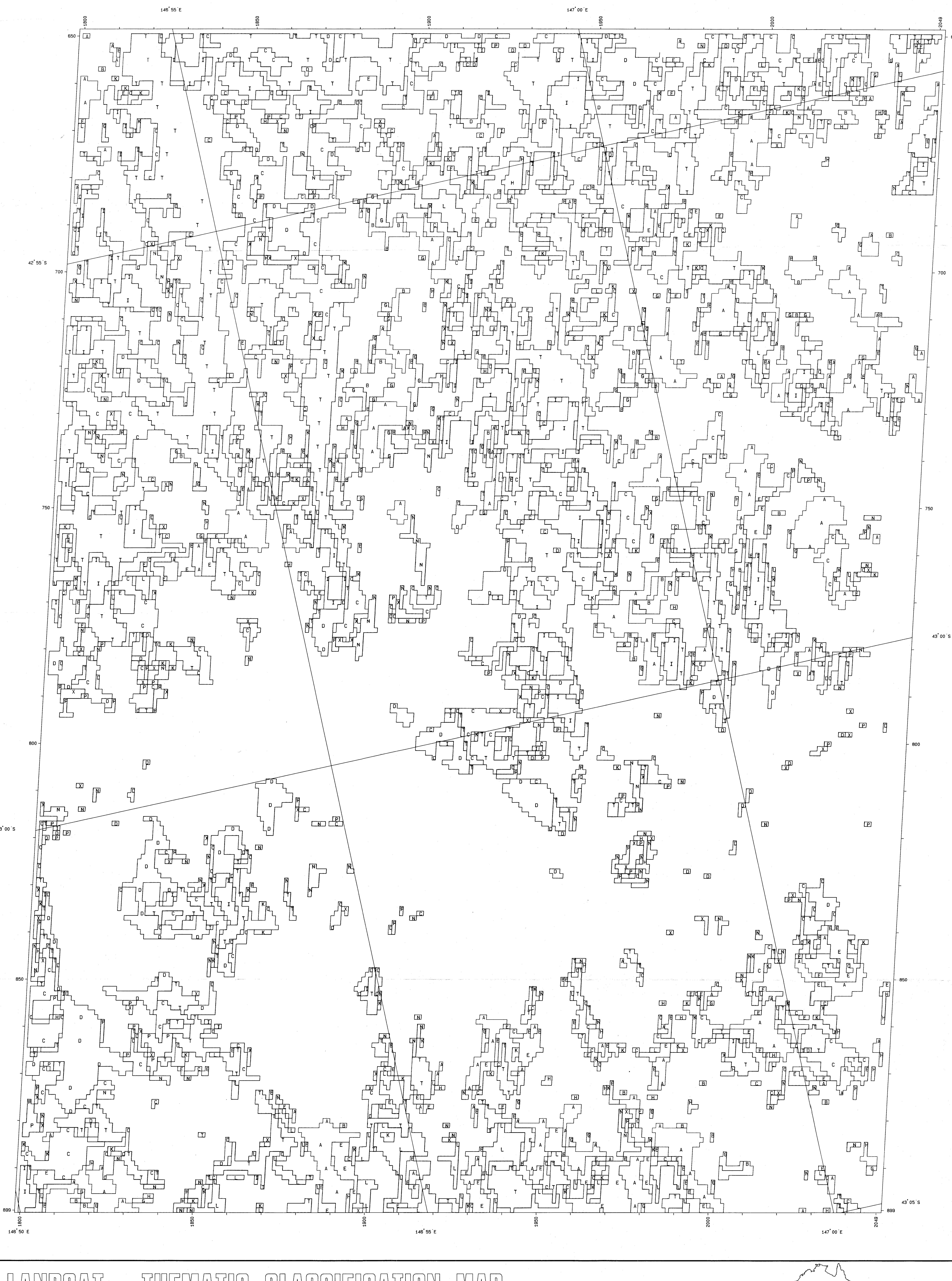
0 0.5 1.0 2.0 KM
SCALE 1: 25000

5 cm



M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 3



LEGEND

FIRST PRIORITY SIGNATURES

A	DOLERITE	mainly outcrop with minor talus and scree
B	BASALT	outcrop with minor talus and soil cover
C	TRIASSIC COAL MEASURES	outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

D	DOLERITE	sub-outcrop covered with thin talus and scree
E	DOLERITE SCREE	associated with minor talus
T	DOLERITE TALUS AND SOIL	in part overlying Triassic Coal Measures
G	BASALT TALUS AND SOIL	
H	TRIASSIC COAL MEASURES	soil covered

THIRD PRIORITY SIGNATURES

I	DOLERITE	weathered insitu, overlain by deep soils
X	DOLERITE TALUS AND SOIL	usually thin, developed over dolerite
K	CLAYEY SOILS	overlying Triassic Coal Measures
L	CLAYEY SOILS	overlying Triassic Coal Measures
N	CLAYEY SOILS	overlying Triassic Coal Measures
P	CLAYEY SOILS	overlying unassigned Triassic rocks

SUNDRY

W	WATER	does not include tidal flats or swampy ground

360100

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE 16TH JANUARY, 1983
IMAGE ID 22550 - 23085
IMAGE DATE 15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

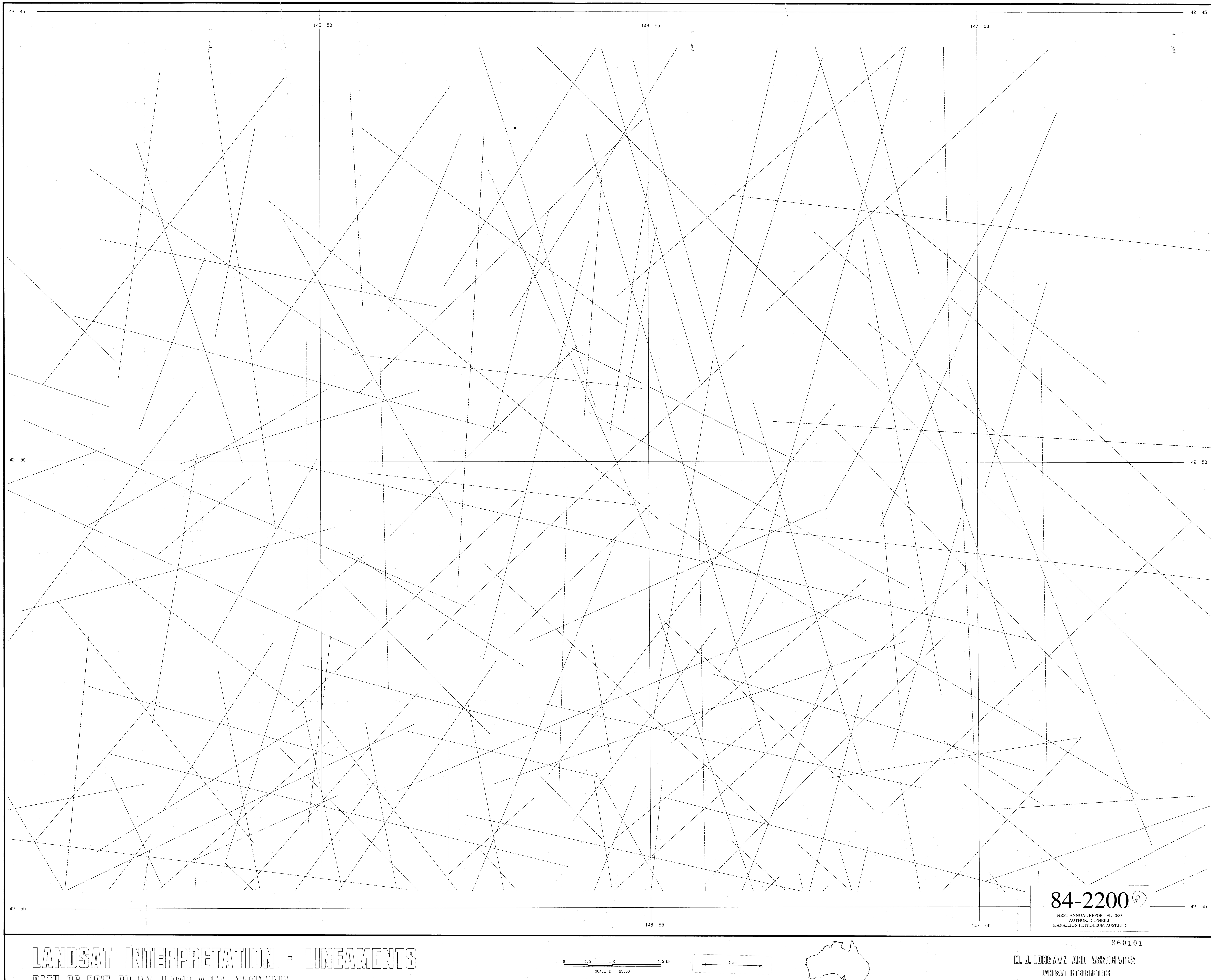
PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

0 0.5 1.0 2.0 KM
SCALE 1: 25000
5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

(and copy)

PLATE 4



84-2200 (A)
FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

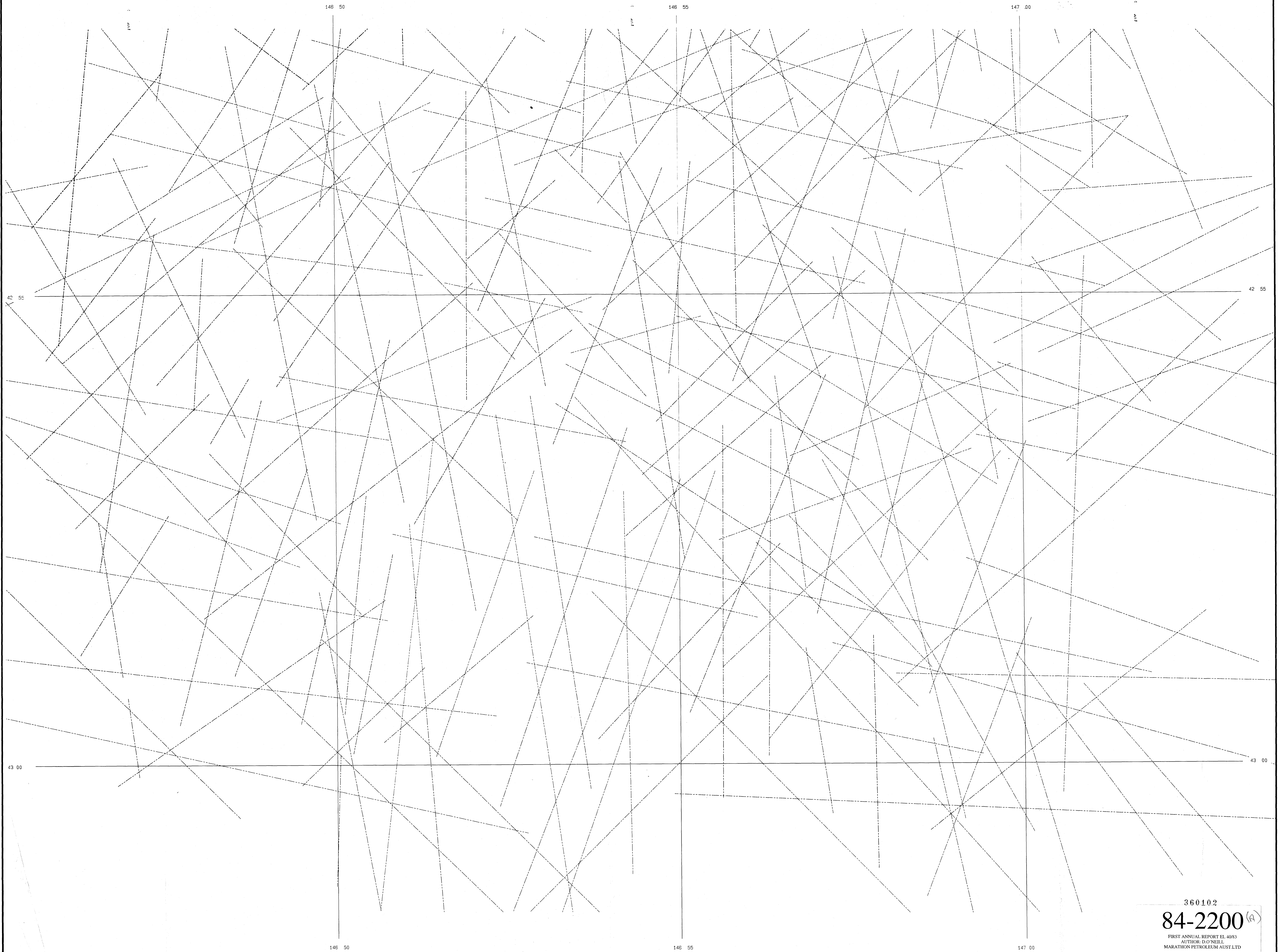
360101

LANDSAT INTERPRETATION - LINEAMENTS

PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 5



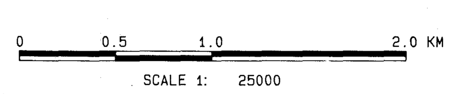
360102

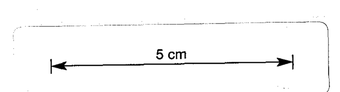
84-2200 (A)

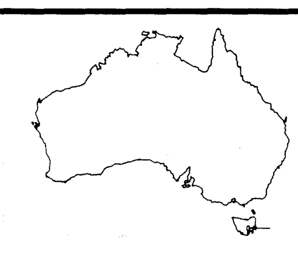
FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

LANDSAT INTERPRETATION - LINEAMENTS

PATH 96 ROW 90 MT LLOYD AREA, TASMANIA

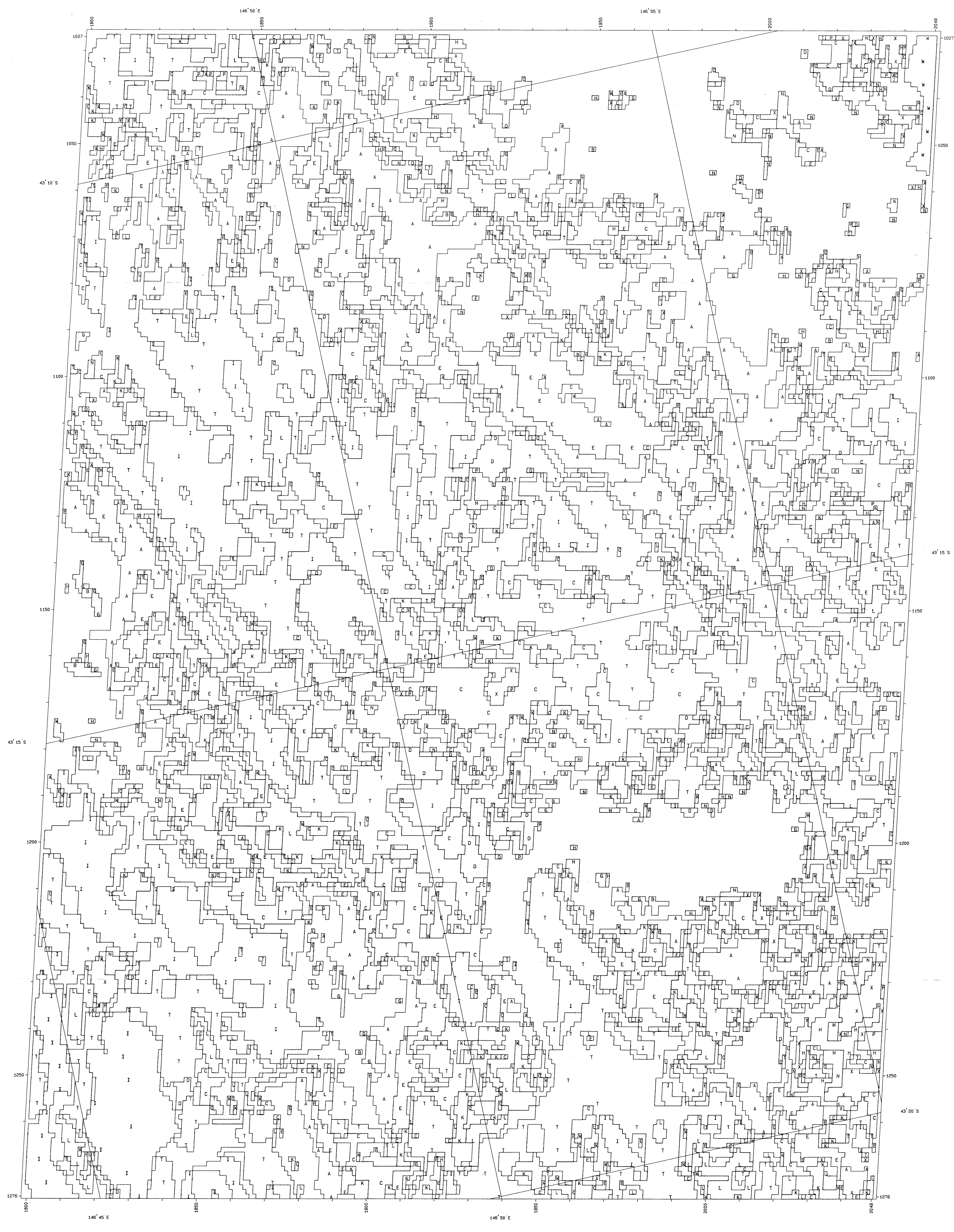






M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 6



LEGEND

FIRST PRIORITY SIGNATURES

- A — DOLERITE: mainly outcrop with minor talus and scree
- B — BASALT: outcrop with minor talus and soil cover
- C — TRIASSIC COAL MEASURES: outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

- D — DOLERITE: sub-outcrop covered with thin talus and scree
- E — DOLERITE SCREE: associated with minor talus
- T — DOLERITE TALUS AND SOIL: in part overlying Triassic Coal Measures
- G — BASALT TALUS AND SOIL
- H — TRIASSIC COAL MEASURES: soil covered

THIRD PRIORITY SIGNATURES

- I — DOLERITE: weathered insitu, overlain by deep soils
- X — DOLERITE TALUS AND SOIL: usually thin, developed over dolerite
- K — CLAYEY SOILS: overlying Triassic Coal Measures
- L — CLAYEY SOILS: overlying Triassic Coal Measures
- N — CLAYEY SOILS: overlying Triassic Coal Measures
- P — CLAYEY SOILS: overlying unassigned Triassic rocks

SUNDRY

- W — WATER: does not include tidal flats or swampy ground

360103

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE	18TH JANUARY, 1983
IMAGE ID	22550 - 23085
IMAGE DATE	15TH JANUARY, 1982

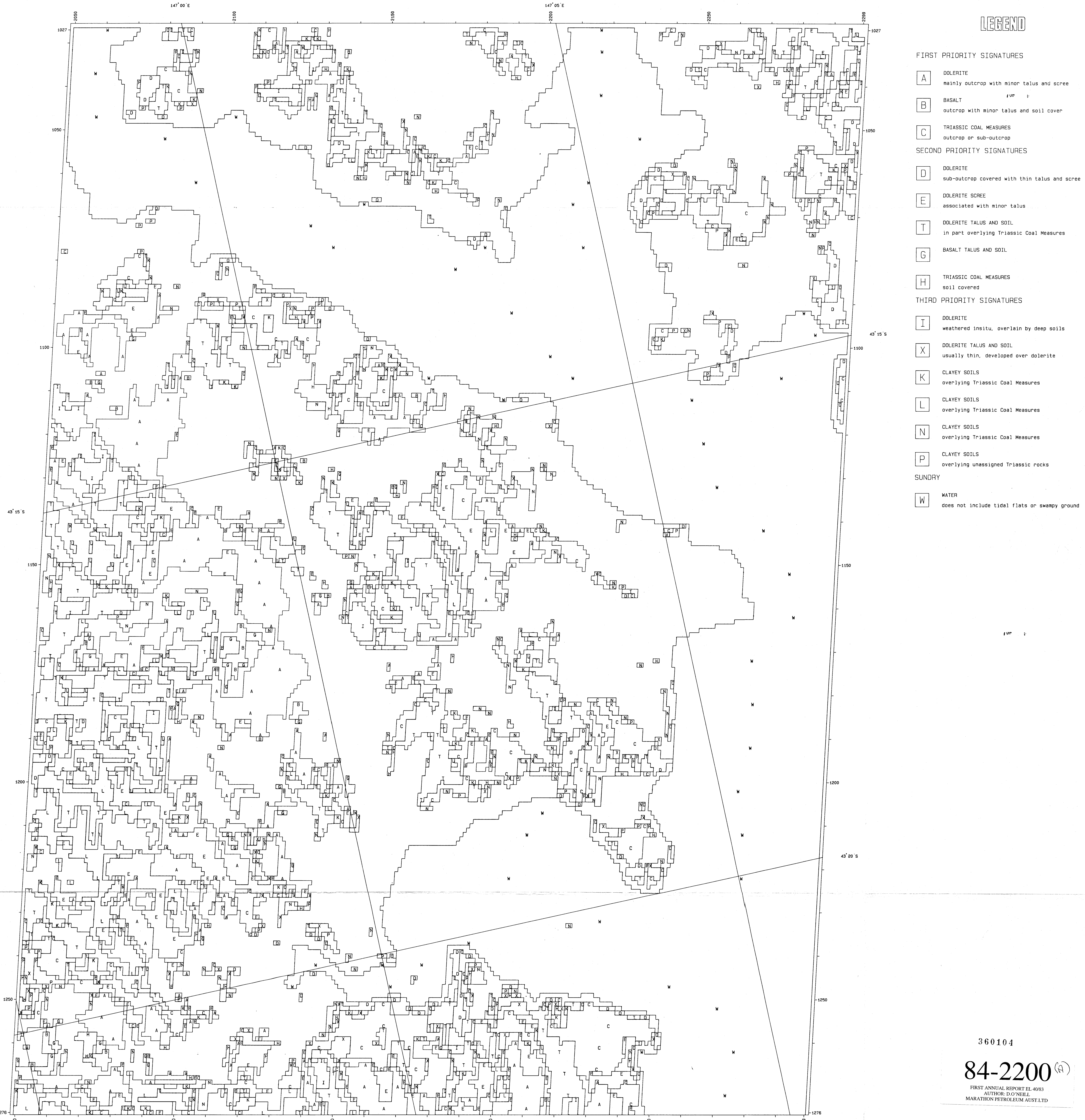
LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM
SCALE 1: 25000
5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS
(Geeveston)

PLATE 1



DATE 16TH JANUARY, 1983
IMAGE ID 22550 - 23085
IMAGE DATE 15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

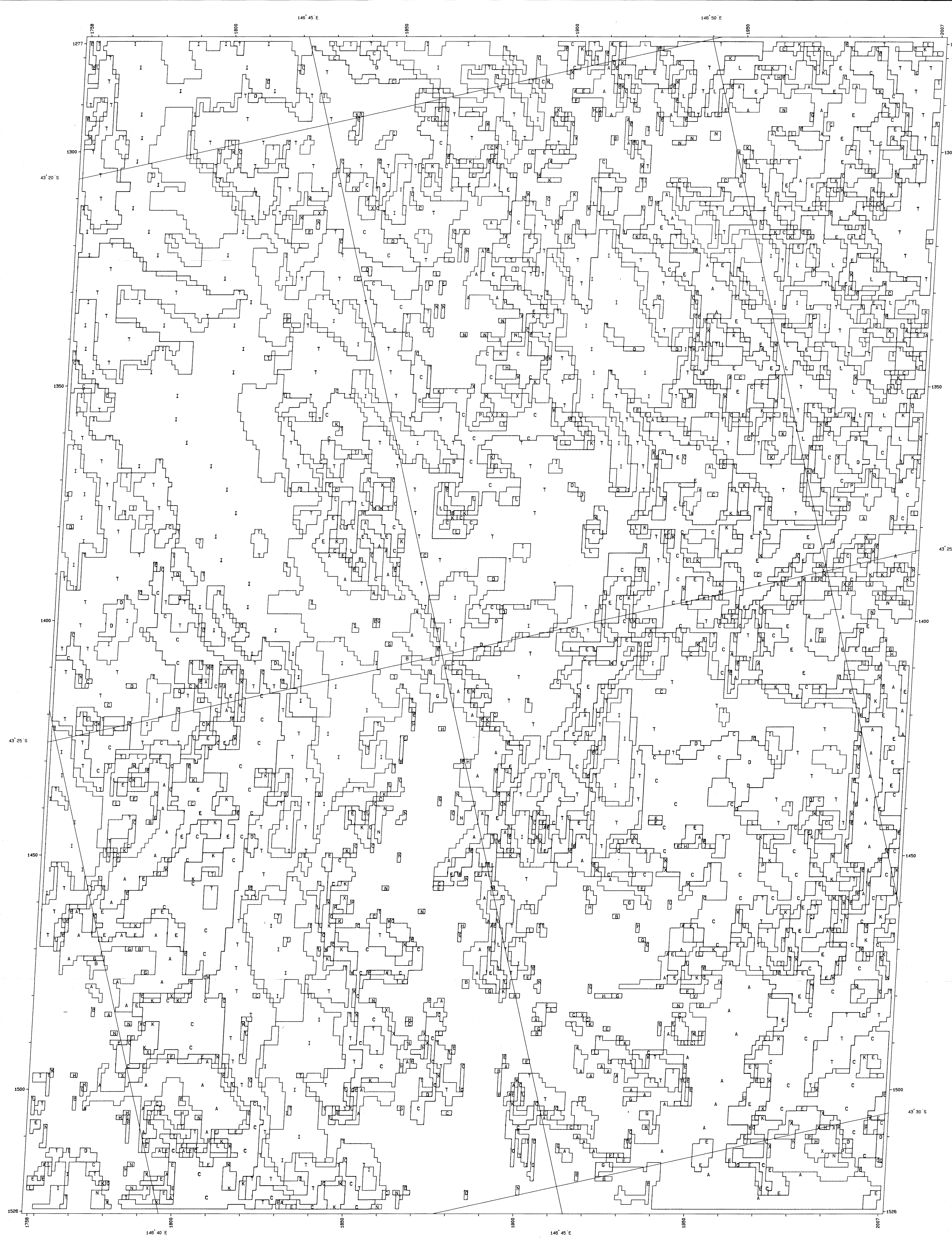
PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM
SCALE 1: 25000

5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 2



LEGEND

FIRST PRIORITY SIGNATURES

- A — DOLERITE: mainly outcrop with minor talus and scree
- B — BASALT: outcrop with minor talus and soil cover
- C — TRIASSIC COAL MEASURES: outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

- D — DOLERITE: sub-outcrop covered with thin talus and scree
- E — DOLERITE SCREE: associated with minor talus
- T — DOLERITE TALUS AND SOIL: in part overlying Triassic Coal Measures
- G — BASALT TALUS AND SOIL
- H — TRIASSIC COAL MEASURES: soil covered

THIRD PRIORITY SIGNATURES

- I — DOLERITE: weathered insitu, overlain by deep soils
- X — DOLERITE TALUS AND SOIL: usually thin, developed over dolerite
- K — CLAYEY SOILS: overlying Triassic Coal Measures
- L — CLAYEY SOILS: overlying Triassic Coal Measures
- N — CLAYEY SOILS: overlying Triassic Coal Measures
- P — CLAYEY SOILS: overlying unassigned Triassic rocks

SUNDRY

- W — WATER: does not include tidal flats or swampy ground

360105

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE 16TH JANUARY, 1983
IMAGE ID 22550 - 23085
IMAGE DATE 15TH JANUARY, 1982

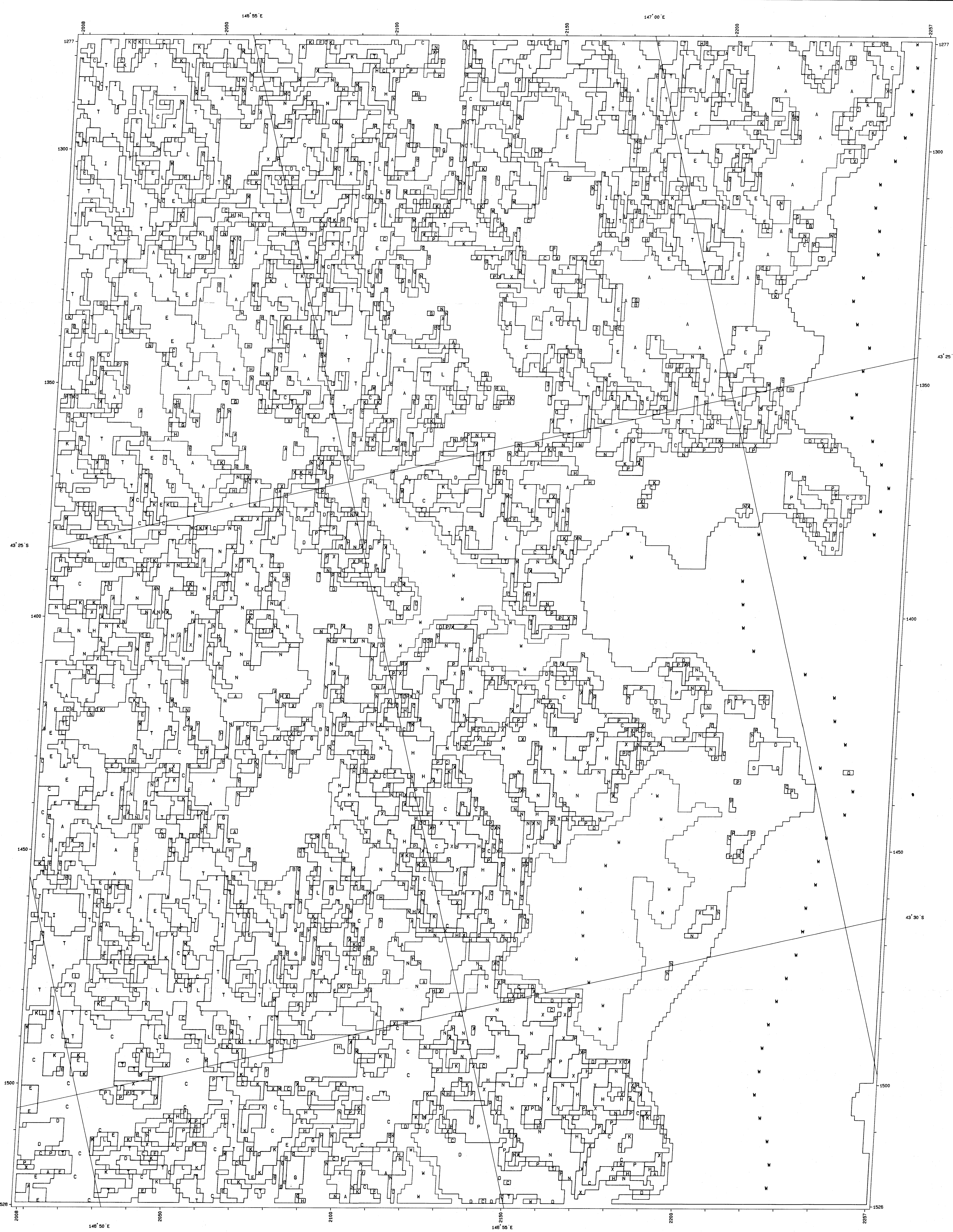
LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM
SCALE 1: 25000
5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 3



LEGEND

FIRST PRIORITY SIGNATURES

A	DOLERITE mainly outcrop with minor talus and scree
B	BASALT outcrop with minor talus and soil cover
C	TRIASSIC COAL MEASURES outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

D	DOLERITE sub-outcrop covered with thin talus and scree
E	DOLERITE SCREE associated with minor talus
T	DOLERITE TALUS AND SOIL in part overlying Triassic Coal Measures
G	BASALT TALUS AND SOIL
H	TRIASSIC COAL MEASURES soil covered

THIRD PRIORITY SIGNATURES

I	DOLERITE weathered insitu, overlain by deep soils
X	DOLERITE TALUS AND SOIL usually thin, developed over dolerite
K	CLAYEY SOILS overlying Triassic Coal Measures
L	CLAYEY SOILS overlying Triassic Coal Measures
N	CLAYEY SOILS overlying Triassic Coal Measures
P	CLAYEY SOILS overlying unassigned Triassic rocks

SUNDRY

W	WATER does not include tidal flats or swampy ground

360106

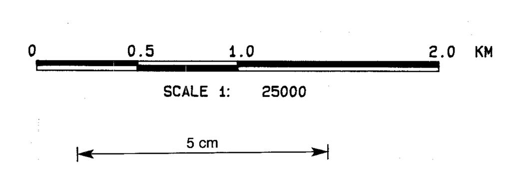
84-2200 (A)

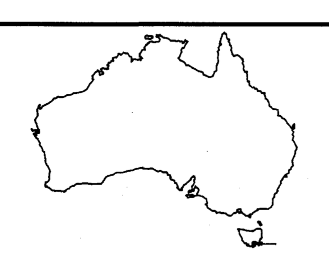
FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

DATE	16TH JANUARY, 1983
IMAGE ID	22550 - 23085
IMAGE DATE	15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA





M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 4

LEGEND

FIRST PRIORITY SIGNATURES

- A — DOLERITE: mainly outcrop with minor talus and scree
- B — BASALT: outcrop with minor talus and soil cover
- C — TRIASSIC COAL MEASURES: outcrop or sub-outcrop

SECOND PRIORITY SIGNATURES

- D — DOLERITE: sub-outcrop covered with thin talus and scree
- E — DOLERITE SCREE: associated with minor talus
- T — DOLERITE TALUS AND SOIL: in part overlying Triassic Coal Measures
- G — BASALT TALUS AND SOIL
- H — TRIASSIC COAL MEASURES: soil covered

THIRD PRIORITY SIGNATURES

- I — DOLERITE: weathered insitu, overlain by deep soils
- X — DOLERITE TALUS AND SOIL: usually thin, developed over dolerite
- K — CLAYEY SOILS: overlying Triassic Coal Measures
- L — CLAYEY SOILS: overlying Triassic Coal Measures
- N — CLAYEY SOILS: overlying Triassic Coal Measures
- P — CLAYEY SOILS: overlying unassigned Triassic rocks

SUNDRY

- W — WATER: does not include tidal flats or swampy ground

DATE	16TH JANUARY, 1983
IMAGE ID	22550 - 23085
IMAGE DATE	15TH JANUARY, 1982

LANDSAT - THEMATIC CLASSIFICATION MAP

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM

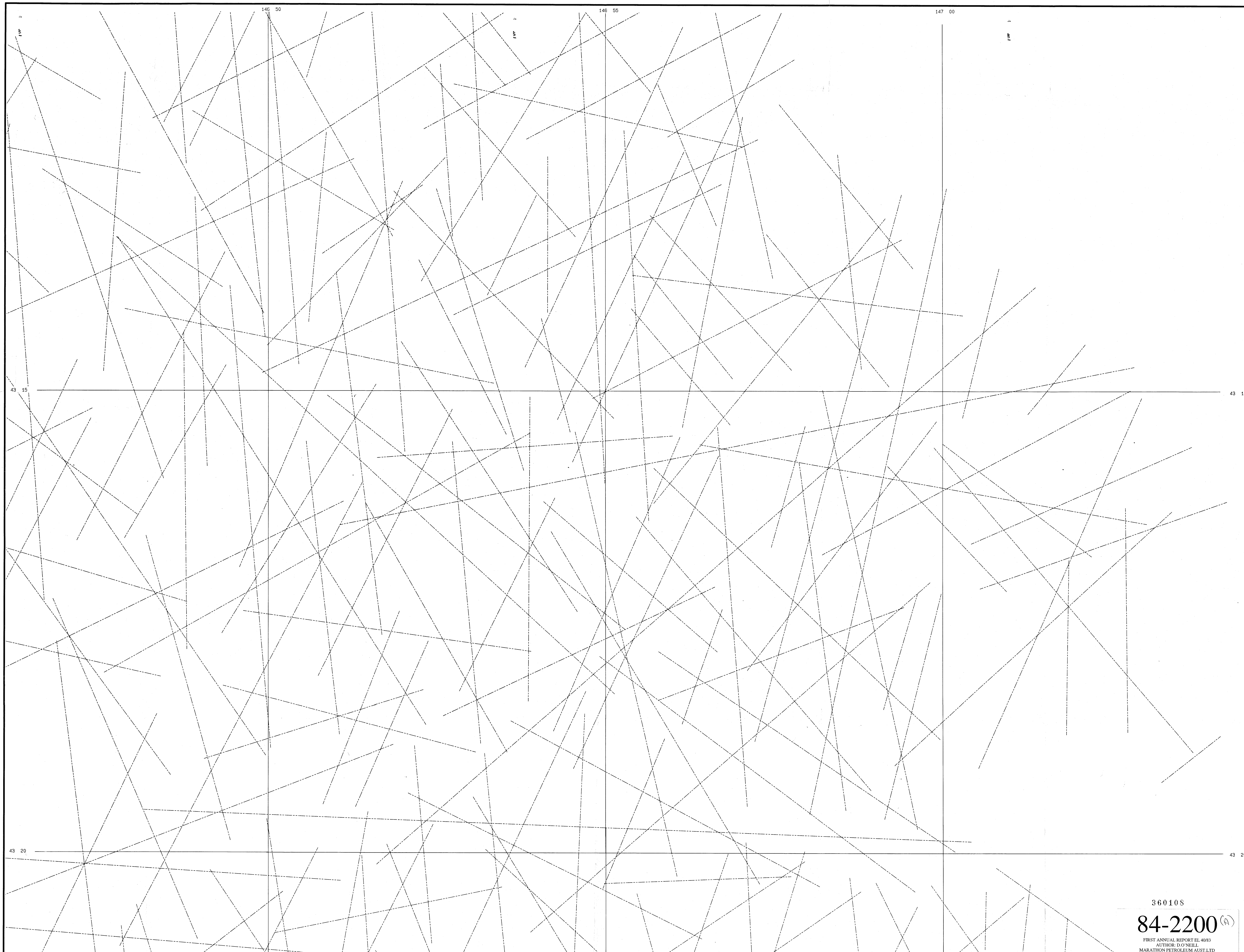
SCALE 1: 25000

5 cm

M. J. LONGMAN AND ASSOCIATES

LANDSAT INTERPRETERS

PLATE 5



360108

84-2200 (A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

LANDSAT INTERPRETATION - LINEAMENTS

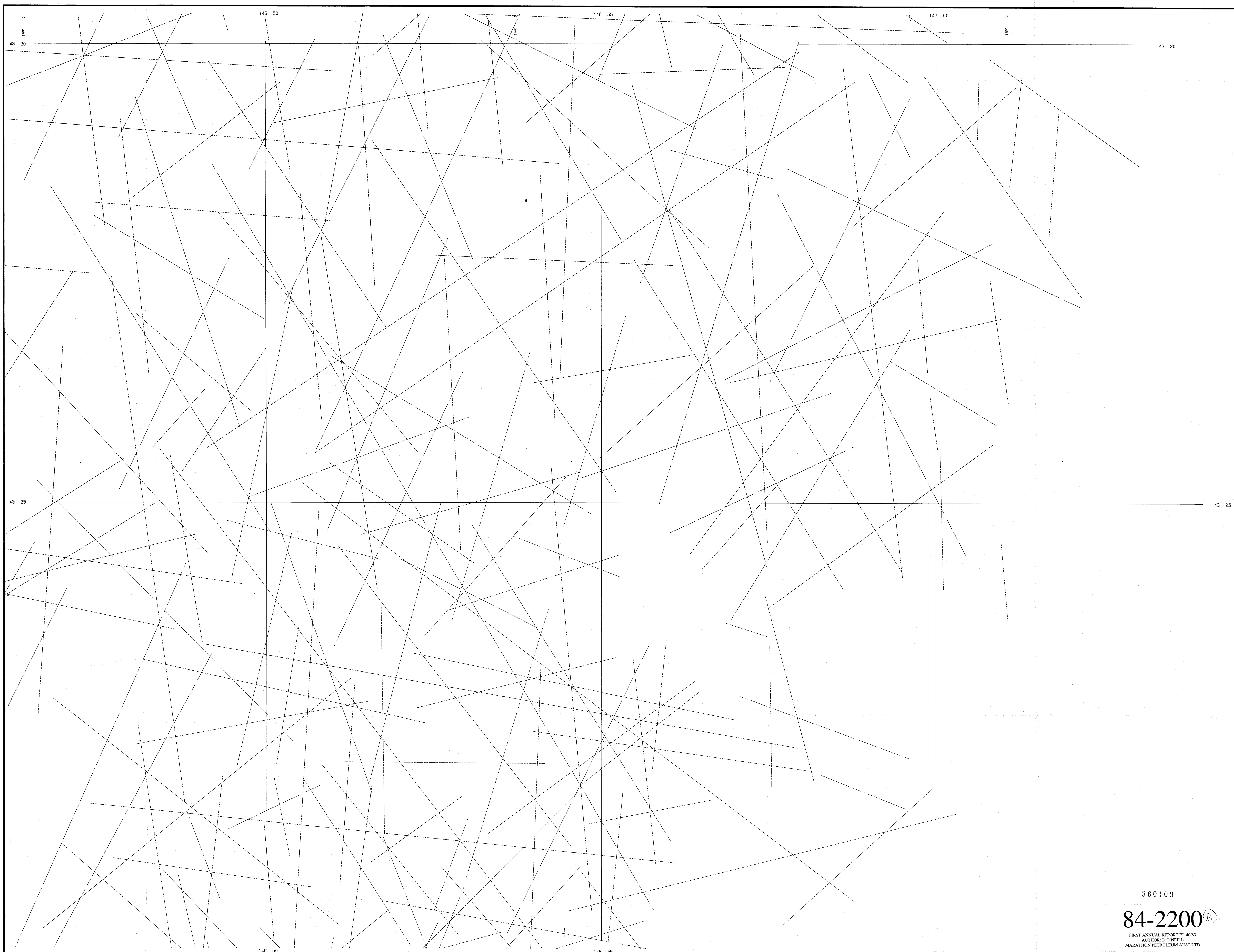
PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM
SCALE 1: 25000

5 cm

M. J. LONGMAN AND ASSOCIATES
LANDSAT INTERPRETERS

PLATE 7



360109

84-2200(A)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

LANDSAT INTERPRETATION - LINEAMENTS

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM

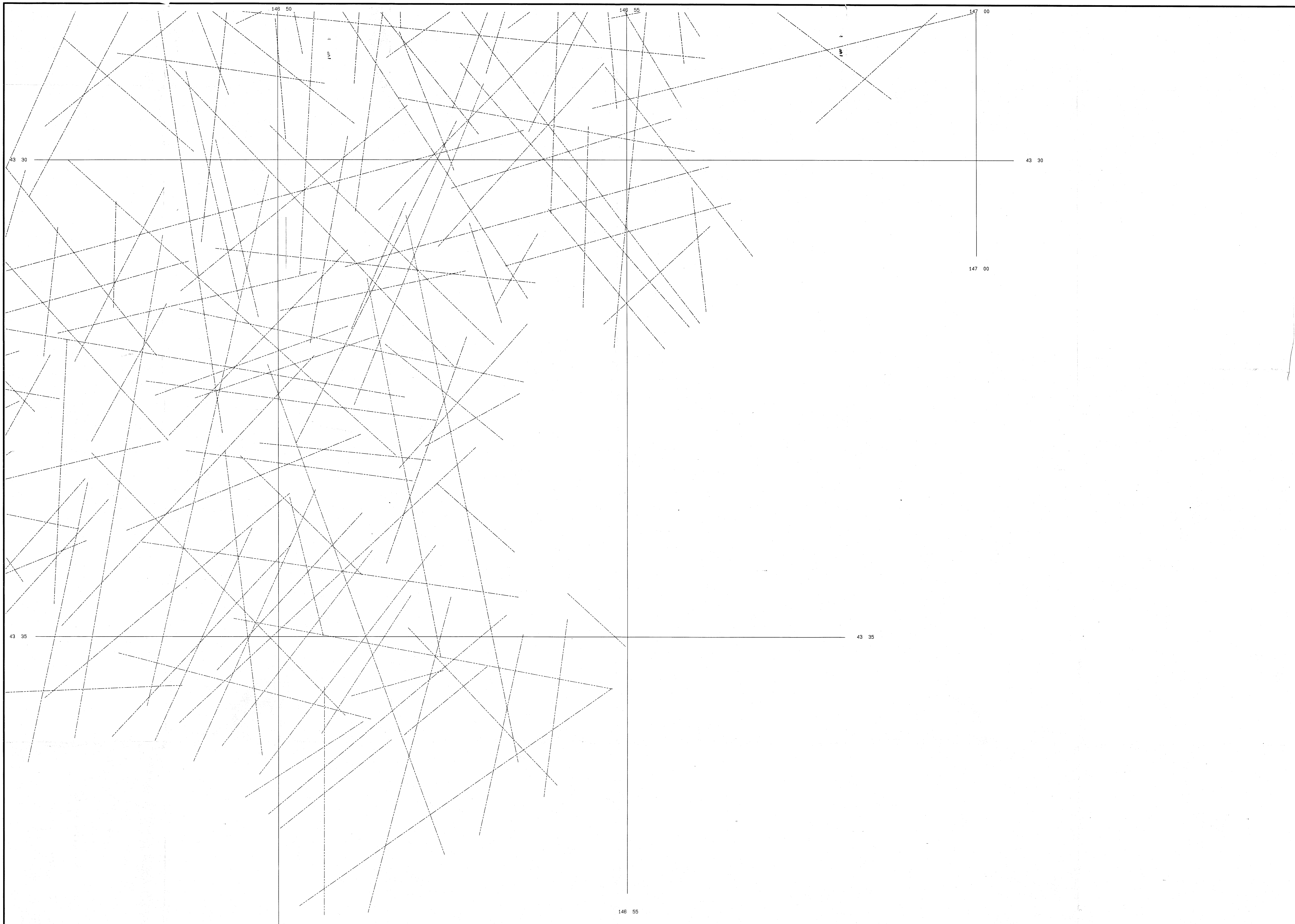
SCALE 1: 25000

5 cm

M. J. LONGMAN AND ASSOCIATES

LANDSAT INTERPRETERS

PLATE 8



360110

84-2200 (a)

FIRST ANNUAL REPORT EL 40/83
AUTHOR: D.O'NEILL
MARATHON PETROLEUM AUST.LTD

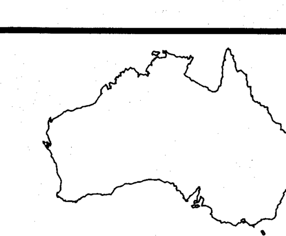
LANDSAT INTERPRETATION - LINEAMENTS

PATH 96 ROW 90 CATAMARAN - GEEVESTON AREA, TASMANIA

0 0.5 1.0 2.0 KM

SCALE 1: 25000

5 cm



M. J. LONGMAN AND ASSOCIATES

LANDSAT INTERPRETERS

PLATE 9