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ANNUAL REPORT FOR EL 3478 "WOOLNER" FOR

THE 12 MONTHS TO JUNE 17, 1983

VOLUME 1

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SUMMARY

Exploration Licence 3478 of 494.7 square kilometres was granted to Mobil Energy Minerals Australia (M.E.M.A.) on June 18, 1982, with a first year expenditure commitment of $38,000. The area is about 60 kilometres east of Darwin, and wholly within the Woolner pastoral lease. The licence was obtained to seek Alligator Rivers type uranium-gold deposits, which occur in Lower Proterozoic metasediments near the margins of an Archean granite.

Previous exploration in EL 1642 by CRAE, and a CRAE/Peko-EZ joint venture, had established the existence of the Woolner Granite, of probable Archean age. This was shown to be overlain by graphitic and chloritic schists (the Fish Creek Schists), correlated with the Cahill Formation, and by the Coomalie Dolomite - both of Lower Proterozoic age. All the Precambrian rocks are obscured by an average of 57 metres of Recent and Cretaceous soft sediments. This prior work included drillhole traverses to elucidate the regional geology, and detailed drilling of an area of Fish Creek Schists, as first located by their strong Airmagnetic response. However, the granite margins elsewhere were largely not prospected.

The first year M.E.M.A. exploration programme was planned to confirm the favourable geological setting, and to define the geophysical signature of the schists so that they could be located (under the cover sequence) by ground geophysical surveys. Orientation magnetic and electromagnetic (E.M.) surveys were run on two traverses across the known subcrop of the Fish Creek Schists, and these techniques were then used as a mapping tool over previously untested granite areas, which were then examined by drilling.

The first 12 months work, to July 17, 1983, is reported in three volumes (text, plates and appendices) and includes:

- An evaluation of prior exploration

- Enhancement of the EL 1642 Airmagnetic Survey data

- 17 lines of ground magnetic and Gem 8 E.M. surveys, of total length 29.5 kilometres

- One seismic line of length 4 kilometres

- Drilling 5 rotary/percussion holes, each cored for a short length below the cover sequence, for a total of 491.2 metres.

- The determination of the age of the Woolner Granite, by uranium:lead ratio's in zircons, as 2675±14 million years.

It was found that the known graphitic beds were weakly indicated by the lowest frequency (32 Hz) radio waves available with the Gem 8 (E.M.) equipment. Reconnaissance magnetic and E.M. traverses located weak anomalies near the Granite rim, which were not found (where drilled) to be due to metasediments.

Further regional geophysical mapping along the Granite margins is planned for the second licence year, using ground magnetic, seismic, gravity, E.M. and downhole E.M. methods.

Expenditure during the first 12 month term, to 17th. June 1983, was $137,788.

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INTRODUCTION

GENERAL

Exploration Licence 3478 is located approximately 60 kilometres east of Darwin, lying within latitudes 12°15' and 12°27' S and longitudes 131°17' and 131°34' E. Figure 1 shows the location of the exploration licence and its boundaries.

Access to the area is by the sealed Arnhem Highway, then by a graded road to Woolner Station homestead, or by air to the station airstrip.

Roughly 70 percent of the area is black soil plains, swamps and coastal salt pans, subject to seasonal flooding, and to tidal inundation in parts, the remainder being open savannah woodland with some areas of dense scrub. Field work on the black soil plains section is limited to a few months each year.

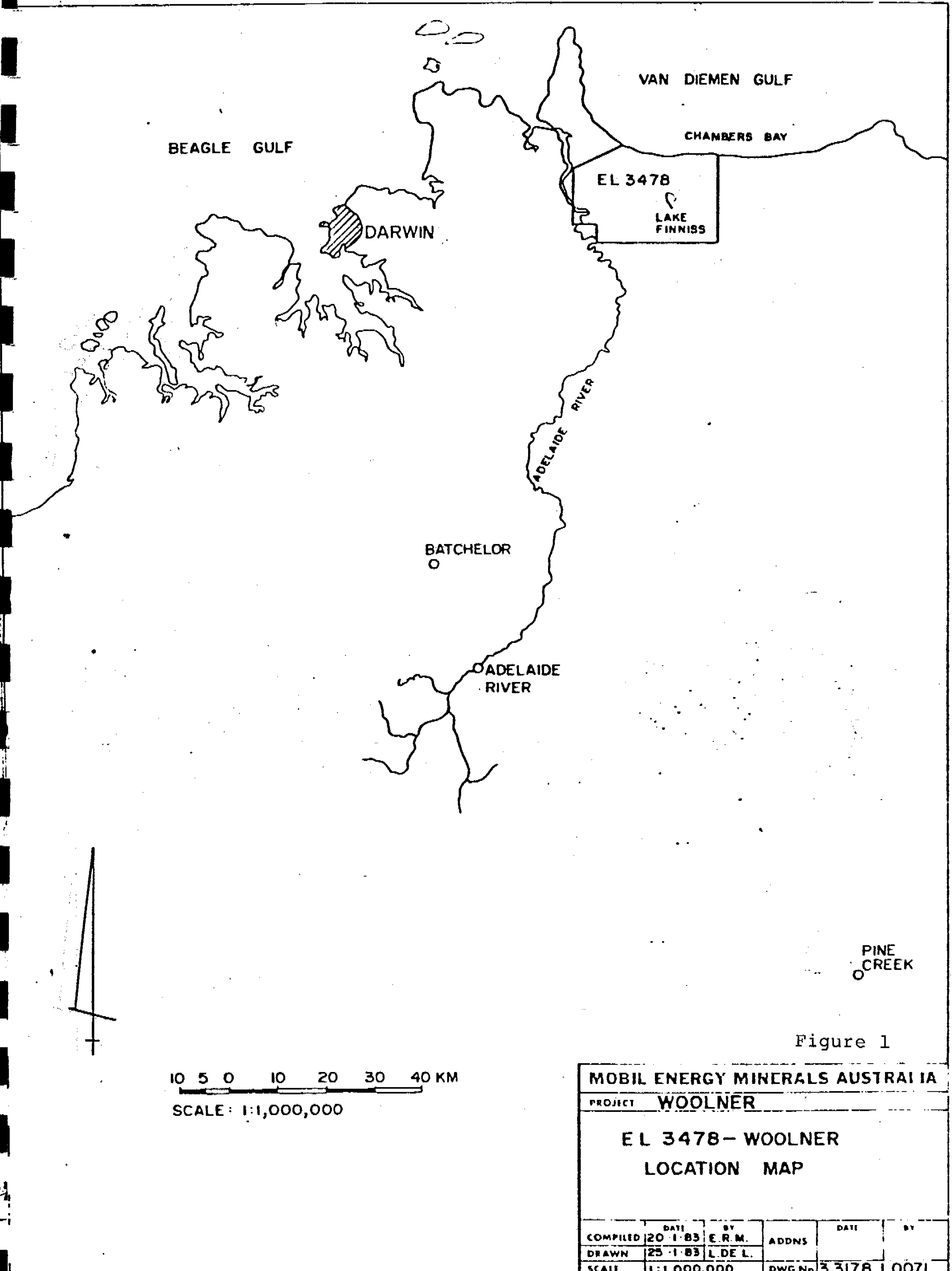
The whole of the licence area falls within PL 793, and it includes a small area of freehold land along the north eastern margin of Lake Finniss. The only prior Mining Title is ML 1298B, which covers a deposit of shell grit.

TENEMENT

EL 3478 was granted to Mobil Energy Minerals Australia Incorporated on June 18, 1982 for a period of twelve months. The area covered is 494.7 square kilometres (191 square miles) with an expenditure commitment of $38,000.

OBJECTIVES

The licence area was thought to be broadly similar to the geological setting of the Alligator Rivers Uranium Field having a granite complex which was inferred to be Archean, flanked by graphitic and chloritic metasediments with a strong magnetic signature.


VAN DIEMEN GULF
BEAGLE GULF
CHAMBERS BAY
EL 3478
LAKE FINNISS
DARWIN
ADELAIDE RIVER
BATCHELOR
ADELAIDE RIVER
PINE CREEK
10 5 0 10 20 30 40 KM
SCALE: 1:1,000,000
MOBIL ENERGY MINERALS AUSTRALIA
PROJECT WOOLNER
EL 3478 – WOOLNER
LOCATION MAP
COMPILED 20·1·83 E.R.M.
DRAWN 25·1·83 L.DE L.
SCALE 1:1,000,000
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DWG No 3.3178.1.0071

Figure 1

Previous exploration by CRAE and a CRAE/Peko-EZ joint venture (in EL 1642) left large gaps, particularly at the base of the metasediments which have not been prospected. A methodical exploration programme was therefore proposed, with three definitive tests to be carried out in the first year.

(a) Determination of the age and fertility of the granite domes.

(b) Definition of the magnetic stratigraphy throughout the area, but particularly in the Lower Proterozoic rocks near their base.

(c) An appraisal of E.M. systems, by which graphitic beds may be detected using conductivity measurements, through the Phanerozoic cover.

Successful completion of these three tests would then lead on to exploration of the granite margins by E.M. surveys followed by drilling to test selected conductive horizons.

PREVIOUS EXPLORATION

Previous exploration by CRAE and a CRAE/Peko-EZ joint venture (in EL 1642) included a detailed airmagnetic survey, close grid ground magnetic and gravity measurements, an unsuccessful trial of ground EM methods, and a major drilling programme, comprising 134 holes for a total of 10059.64 metres.

The drilling defined two granite domes similar to the Nanambu Complex, possibly with a rim of gneisses equivalent to the Kakadu Group. A zone of graphitic and chloritic schists, containing disseminated magnetite and BIF bands, on the western rim of the western dome was thoroughly tested by drilling.

No anomalous radioactivity was found in the 54 holes drilled here, but low grade gold mineralisation (maximum 1.67 parts per million gold over 60 centimetres) was identified in the BIF horizons. These schists are correlated on mineralogy and stratigraphic position with the Cahill Formation. Regional drillhole traverses show that most of the non-granite area is foliated dolomite, probably equivalent to the Coomalie Dolomite. No anomalous radioactivity or metalliferous mineralisation was found in any of these holes.

GEOLOGICAL SETTING

Since the area has a cover, averaging 57 metres thick, of Cretaceous Bathurst Island Formation unconsolidated clayey sands and Recent silt, information on the Lower Proterozoic rocks has been derived from gravity and magnetic characteristics, and on (generally) widely spaced drill holes (see Plate 1).

STRATIGRAPHY

Granites

Three domes of granitoid rocks were recognised by CRAE-Peko-EZ . Subsequent examination of drill core (held at the Department of Mines and Energy) by Dr. John McAndrew of the CSIRO led to the following observations.

(i) Drill core from the Northwest Dome does not contain any granitic rock, only psammitic schist.

(ii) Both the West Dome and the East Dome contain foliated to gneissic granites in their central northern parts, a weakly gneissic dark red granite in their adjoining central parts and younger unfoliated two mica granites in their southern parts. These unfoliated granites are pink in the East Dome but grey in the West Dome.

(iii) Pink pegmatites and associated feldspathization in the older granites may be genetically associated with the younger granites. However, albitisation observed in core of DDH P11/1 (West Dome) may be a separate event.

A copy of Dr. McAndrew's report on this work can be found in the section on Petrology.

The West Dome appears to have a rim of interbanded quartz-feldspar-mica gneisses (meta-arkoses) and chlorite-calcite-quartz schists, which may be transitional, with diminishing metamorphic rank, into the overlying Fish Creek Schists and probably correlate with the Kakadu Group in the Alligator Rivers Uranium Field.

A breccia unit, containing clasts of all of the Lower Proterozoic metasediments and the granites, has been described from hole P4/21 on the southern tip of this dome. Examination of cored sections indicates a conglomerate rather than a breccia, with similarities to the Crater Formation of the Rum Jungle area.

Fish Creek Schists

These occur as an isoclinal syncline (see Plate 1) on the western flank of the West Dome, and contain several magnetite rich horizons - thus they have a strong magnetic signature.

The Fish Creek sequence is generally quartz-mica schists, with muscovite and biotite, the latter often altered (by retrograde metamorphism) to chlorite. Plagioclase-rich and calcite-rich bands occur. Some members have fine disseminated graphite, others disseminated magnetite; pyrite is fairly common, while pyrrhotite and chalocopyrite occur occasionally. The sequence includes major amphibolite (hastingsite-albite-epidote-quartz-carbonate) bands, formed by metamorphism of an original carbonate rich sediment.

There are at least six bands of iron formation (BIF) comprising layered magnetite-calcite metaquartzites, in varying thicknesses from 15 centimetres to 1½ metres - these, with the zones of disseminated magnetite, are the source of the prominent and complex magnetic anomaly.

Based on the presence of graphite, disseminated and banded magnetite, carbonate rich bands, and their general pelitic nature, the Fish Creek Schists are correlated with the Cahill Formation.

However, Johnston (1981) has listed the following differences between the Fish Creek Schists and the Cahill Formation:

(i) There is no basal carbonate unit in the Schist sequence.

(ii) The Schists contain calcite bands, while the Cahill contains dolomite as the major carbonate. — no Mg. metasomatis

(iii) Graphite is disseminated through major thicknesses in the Schists, and not present as finely banded graphite rich and graphite poor beds as in the Cahill.

(iv) Widespread chlorite in the Schists is the result of retrograde metamorphism of biotite, and not the product of magnesium metasomatism (as in the Cahill ore host).

These differences may explain (at least in part) the lack of uranium mineralisation in the Fish Creek beds.

<u>Coomalie Dolomite</u>

The regional drilling intersected sub-horizontal dolomite in most of the fenceline traverses. A typical section comprises a silicified and cavernous regolith (with highly ferruginous sections and numerous vugs and cavities) in which the effects of weathering diminish with depth to fresh dolomite. This is brecciated in part, but otherwise has a prominent foliation depicted by impure or chloritic dolomite bands. It is correlated with the Coomalie Dolomite. The underlying contact between the dolomite and the Fish Creek Schists is shown by seismic work and two drill holes to be generally horizontal, but locally dipping away from the domes.

The dolomite is generally pale grey to cream coloured, with blobs of fuchsite scattered throughout. It is well foliated, with minor interbeds to about 20 centimetres thickness of talc-chlorite schist. Silicified bands or zones are common throughout; these are not consistently conformable with the foliation, and are all that remains of the dolomite in the weathered zone.

Core samples of dolomite from three MEMA holes were analysed at Australian Laboratory Services Pty. Ltd. in Brisbane, results are:

Hole No.	% Cao	% Mgo	% Si02	% L01	TOTAL
WD1	27.0	19.9	7.99	42.5	97.39
WD2	27.3	20.3	6.59	42.7	96.89
WD2	28.3	20.8	4.54	43.8	97.44

These compare closely with the stoichiometric formula for dolomite (which has 19 to 22 percent Mgo), and indicate that magnesium metasomation has not occurred.

Wildman Siltstone

Previously drilled holes in the far southeast of EL 1642 (and outside the area of EL 3478), intersected colour banded phyllite correlated with the Wildman Siltstone. Cretaceous/Recent cover thickness here is about 100 metres, or more.

Phanerozoic Cover

Bathurst Island Formation forms a capping on all of the older rocks in EL 3478, and is generally unconsolidated clayey sands, which become feldspathic sands at depth. The "porcellanite" claystone bed typical of this Formation is thin - a metre or two - or missing. Correlation with the (Cretaceous) Bathurst Island Formation seems unequivocal. The base of this unit frequently contains a pebble bed, in which the pebbles can be recognised as silicified dolomite.

The unit is variable in thickness - from nil to 138 metres, with average 41 metres.

Recent alluvium comprising a layer of black mud, laterite and dune sands containing shells and plant remains, up to 44 metres thick, is the uppermost bed in this area. The average thickness is 16 metres.

The total cover thickness ranges from 15 to 140 metres, with an average of 57 metres. Weathering in the preCambrian rocks averages about 10 metres. Plate 2 shows rough isopachs of cover thickness, and indicates the granites are topographic highs, with a narrow valley along the granite-dolomite margins, somewhat similar to the present surface topography in the Rum Jungle district.

STRUCTURE

Little precise information can be derived for the pre-Coomalie Dolomite Lower Proterozoic beds. The layering of the BIF units, the formation contacts, and the schistosity all appear to dip steeper than 70°, and all are probably isoclinally folded.

METAMORPHISM

The gneisses of the Woolner Domes are of epidote - amphibolite facies, and commonly show two deformations: the first producing the mineral assemblage, and the second the gneissic fabric. On the margins of the Domes, in the transitional area, the gneisses are of upper greenschist rank.

The Fish Creek Schists and Coomalie Dolomite are mildly metamorphosed sediments, initially chemical sediments and siltstones. Biotite is incompletely altered to chlorite in some cases, and there is no evidence of magnesian metasomatism in the schists.

GRANITE STUDIES

Small sections of drill core from the EL 1642 (CRAE and CRAE/Peko-EZ) holes were collected (from the N.T.G.S. core reference store in Darwin) by Dr. John McAndrew of the CSIRO Institute of Energy and Earth Resources. This material was then used for studies on the petrology, fertility (i.e. the potential of the granite as a source of uranium for redistribituion or enrichment into adjacent ore deposits), and the age of the granite. The results of these studies are reported below.

PETROLOGY

These cores consist of a short length (½ to 2m) of granitic rock from the subcrop of a dome. A few longer cores through the metamorphic rocks were briefly examined. Overall, core was examined from 28 drill holes, and small samples taken for further study from 22 of these, 19 being of granitoids and pegmatites and 3 of metamorphic rocks (Table 1). The granite samples are adequate for study of the composition of accessory zircon, and to search for accessory uraninite in an assessment of their potential as source rocks for uranium mineralization. A number are of sufficient size for meaningful chemical analysis.

None of the core examined contained more than 2kg of granitoid. With half the core being available for study, no more than 1kg is available from any single core, and for most cores less than 3/4kg.

Granites

The drill core from the "Northwestern Woolner Dome" does not contain any granitic rock. The grey psammitic schist of this dome is notable for an extensive length with red-brown hematitic staining in DDH P10/8 on the NW of this dome.

The Woolner West Dome and Woolner East Dome drill cores contain a number of types of granite with pegmatite. These may include granites of two ages; however, age dates (this study) indicate no distinguishable age differences in the limited sampling.

The central northern parts of both domes contain foliated to gneissic granites. A connection between the two domes is provided by a distinctive weakly gneissic dark red brown granite, which forms the central western margin of the Woolner East Dome, and on the adjoining central eastern margin of the Woolner West Dome.

The southern part of each of these domes contains granites with little foliation. These, by inference from this feature, are somewhat younger than the northern granites. In both domes they are two-mica granitoids, with the grey granitoid of the souther Woolner West Dome being distinctive from the pink granitoid of the southern Woolner East Dome.

Pink pegmatites and associated feldspathization in the "older" foliated granites may be genetically associated with "younger" granites. However, the albitization observed in core of DDH P11/1 may be a separate event.

There is appreciable sericitization in some core along shears or parallel fractures. While such muscovite is unambiguously secondary, it is not yet clear if the two-mica granites in the southern part of the two domes contain primary as well as secondary muscovite.

Woolner West Dome

Drill cores from the northern part consist of foliated to gneissic grey granite, intruded by pink potash feldspar pegmatite with associated development of potash feldspar in the adjoining granite. Distinct to the latter is the irregular albitization of foliated grey biotite granite in the northern drill hole P11/1.

While the south central drill hole WORD 1 penetrated pink feldspar pegmatite, drill holes south-west and east of this are in grey two-mica granite. The lack of foliation in this granite suggests it is younger than gneissic granites in the northern part of the dome.

The most easterly drill hole P13/6 is in deformed pink granite correlated with that in the adjoining part of the Woolner East Dome.

Woolner East Dome

The most northerly drill core examined, P14/7, is in pink feldspar pegmatite intruding pelitic schist.

Two cores in the eastern part consist of biotite-muscovite schistose granite or granite-like psammitic schist. Disseminated pyrite crystals are present. A third drill core (P14/6) is sheared granite with abundant sericite along parallel shear planes.

The western part is also an "older" granite, being more melanocratic, relatively dark red brown, and having a slightly gneissic texture. As noted above, this may correlate with granite in the adjoining part of the Main Dome.

In contrast, the southern part of the Woolner East Dome is apparently a younger granite, having but slight foliation. It is a two-mica granite, generally with a substantial proportion of pink feldspar.

Description of Drill Core

TABLE 1 (from Woolner domes, N.T., examined at Darwin core store of NTGS, 19th-20th July 1982, and core samples obtained).

DDH	Location in dome	Samples Depth (m)	CSIRO No.	Comments
NORTHWESTERN WOOLNER DOME				
P10/8	N	57.9	70496	hematite-stained psammitic schist
		59.4	70497	hematite-stained psammitic schist
P10/9	NE	-		two-mica psammitic schist
P10/18	E	56.8	70498	grey psammitic schist with small white albite porphyroblasts
P10/7	S	-		grey psammitic schist
WOOLNER WEST DOME				
P11/1	NC	70.0	70478	irregularity albitized foliated biotite granite, with sericitic shears
P6/3	NW	-		feldsparthized biotite gneiss
P7/1	WNW	66.7	70495	dark grey psammitic schist intruded by quartz pink Kspar pegmatite with Kspar augen adjoining the pegmatite
P1/3	W	55.8	70474	dark grey feldspathized gneiss (? deformed granite) cf WP2/S1
WORD 9	W	58.3	70475a)	medium grey sheared gneissic granite with quartz pink microcline pegmatite and local irregular pink feldspathization of granite
		58.8	70475b)	
		59.3	70475c)	
P13/6	E	67.7	70477	melanocratic pink biotite granite, deformed and ? porphyritic.
WP2/S1	WSW	293	70490)	dark grey quartz white-feldspar meta-arkose to psammitic schist with irregular bands and patches of metasomatic pink feldspar
		299.8	70491)	
WORD 1	SC	51.0	70473	pink feldspar pegmatite with quartz veins

Description of Drill Core

TABLE 1 (Cont.)

DDH	Location in dome	Samples Depth (m)	CSIRO No.	Comments
WB2	SE	50.0	70476	grey two-mica granitoid with but slight foliation or deformation
P4/5	S	49.0	70472	weathered schist and weathered grey sheared granite
P4/2	S		-	light grey weathered granite
P4/1	S	37.5	70471	weathered light grey two-mica granite
WOOLNER EAST DOME				
P14/7	N	77.6	70493	quartz pink-felspar pegmatite intruding pelitic schist
		80.6	70494	quartz pink-albite pegmatite
P14/1B	NW	76.50	70492	gneissic melanocratic granite similar to P13/6 with some pink felspar adjoining psammitic schist
P14/3	WNW	64.80	70485	light grey psammitic muscovite-biotite schist (cf. 70478) which could be schistose granite. Has euhedral pyrite (cube + octahedron)
		69.30	70486	do
P14/4	ENE	59.0	70487	well foliated to schistose relatively fine grained granite schist with more biotite than 70485
P14/6	E	54.6	70484	sheared pink leycocratic granite with sericitized shear planes
p14/11	SW	72.7	70488	red-brown two-mica granite, slightly gneissic, cf 70492
		73.6	70489	similar gneissic dark red-brown granite with occasional white feldspar
P14/8	SE	52.20	70482	weakly foliated off white two-mica granite with some pinkish brown feldspar (cf WB/2 as well as 12/11)
		53.50	70481	weakly foliated relatively fine grained granite

Description of Drill Core

TABLE 1 (Cont.)

DDH	Location in dome	Samples Depth (m)	CSIRO No.	Comments
P12/1	SW	55.5	70480	very leucocratic pink sheared granite with sericitic shears
P12/7	S	-		fractured sheared slightly weathered pink leucogranite
P12/10	S	-		fractured quartzite
P12/11	S	52.6	70489a	unfoliated pink two-mica granite
		53.1	70479b	do

FERTILITY INVESTIGATION

The Woolner domes were thought to be possible sources of uranium which may have been subsequently transported and concentrated in Carbonaceous Lower Proterozoic hosts. The potential fertility of these granitic domes has been evaluated by Dr. John McAndrew; the following interpretations and comments are those of MEMA utilizing the results of Dr. McAndrew, and do not necessarily reflect his thoughts.

The northern granites, types A and B, are most metamorphosed to schistose granite. The central red granite, type C, has thorough alteration of potash feldspar to granular albite and quartz. This albite is red from hematite dust and lacks muscovite to saussurite alteration of magmatic plagioclase.

The Southern granites, types D and E, are microgneiss and lack the stronger dynamic deformation of northern granites. There are occasional residuals of more calcic unsaussuritzed plagioclase within some of this magmatic feldspar, otherwise they are now albite with muscovite with minor eipdote.

Zircon is mainly very fine grained, prismatic to elongate prismatic (early zircon habit) with strike zoning throughout. They are magmatic, and included in felsic minerals without any concentration into biotite. This resembles the occurrence in the Nanambu Complex, and are different to those in the Litchfield Complex granitoids. Most specimens are low in the phosphate accessory minerals, apatite and monazite.

The Woolner granites were originally peraluminous ilmenite-series granitoids, very low in opaque accessory minerals. There is occasional pyrite. Ilmenite is absent except for residuals in the southern granites which have less metamorphism and metasomatism. However, leucoxene pseudomorphs, with biotite, representing altered ilmenite, is present.

The relatively high uranium in zircons suggest some granites may have crystallized as fertile source rocks. The low overall whole rock uranium (except for Word 9, and to a lesser extent in P4/1. P14/1) may also suggest potentially labile uranium may have been mobilized during metamorphism and metasomatism. Schemes are plausible:

1. The postulated mobilising fluids may have been oxidising, a judgement possible from the oxidation of ilmenite to leucoxene.

2. An alternative possibility suggested by pyrite and leucoxene after ilmenite is an extended "pronto reaction" under reducing conditions. Unfortunately there is no mention of trace brannerite in the petrographic reports. The suggested reaction (not balanced) is:

$$S + Fe\ Ti\ O_3 = Fe\ S + TiO_2$$
$$UO_2 + 3\ Ti\ O_2 = U\ Ti\ O_8 \text{ (brannerite)}$$

   The corollary to the latter reducing style alteration is the uranium should have been retained in the system.

3. One may also question if the high uranium content of some zircons is an inherited trait, and bears no relation to the moderately low uranium content of host granitic rocks.

4. Finally, there may have been little uranium lost from the system. The estimated partition coefficient of uranium into zircon, using bulk rock uranium as an approximation of the magma uranium content, is roughly 250-1000. This is not exceptionally high, particularly in the absence of other concentrating accessory minerals such as apatite and monazite.

The Woolner Granite may differ from the Nanambu Complex, where metamorphism under reducing conditions is evident by overall retention of ilmenite, with only slight development of rutile together with retention of accessory uraninite through the metamorphism.

Table 2: Uranium, thorium and zirconium content of granites from the Woolner domes (ppm)

Type	Location (DDH)	U	Th	Zr
A	P 11/1 a	3	4	72
	P 11/1 b	4	3	64
A	Word 9	11	13	149
B	P 14/2	2	5	102
C	P 13/6	2	3	106
C	P 14/1	5	5	64
C	P 14/11	2	4	193
D	WB 2	3	8	101
D	P 4/1	6	6	90
E	P 14/8 a	2	2	32
	P 14/8 b	2	6	120
E	P 12/11	2	4	55

Table 3: Uranium content of zircons, Woolner granitoid A

Crystal	DDH P11/1 Uranium Content (%)		Word 9 Uranium Content (%)	
	interior	outer part	interior	outer part
1	.030	.246	.305	.240
2	.190	.078	.254	.155
3	.078	.062	.439	.407
4	.205	.045	.102	.104
5	.033[1]	.069	1.021	.164
6	.154	.143	.554	.164
7	.035	.148	.279	.225
8	.148	.153	.333	.324
9	.200	.206	.406	.270
10	.151	.097	.485	.203
11	.109	.094	.146	.171
12			.912	.910
			.179	.237
			.181	.270

[1]Intermediate part .024

Table 4: Uranium content of zircons, Woolner granitoid C

Crystal	DDH P 13/6 Uranium Content (%) interior	DDH P 13/6 Uranium Content (%) outer part	DDH P 14/1B Uranium Content (%) interior	DDH P 14/1B Uranium Content (%) outer part	DDH P 14/11 Uranium Content (%) interior	DDH P 14/11 Uranium Content (%) outer part
1	.030	.104	.073	.044	.146	.306
2	.082	.121	.036	.063	.075	.034
3	.117	.126	.045	.059	.041	.034
4	.178	.305	.103	.030	.076	.196
5	.211		.059[1]	.066	.047	.038
6	.109	.144	.083	.065	.383	.302
7	.149	.125	.051	.030	.110	.095
8	.120		.259	.188	.214	.097
9	.104	.790	.052	.030	.204	.182
10	.088	.133	.067	.086	.181	.053
11	.056	.106	.049	.116	.082	.110
12	.246	.129	.031	.030	.072	.078
13			.049	.069	.166	.271
14					.068	.162
15					.102	.098

[1] Intermediate part .030

Table 5: Uranium Content of zircons, Woolner granitoid D

Crystal	DDH WB2 Uranium Content (%) interior	DDH WB2 Uranium Content (%) outer part	DDH P4/1 Uranium Content (%) interior	DDH P4/1 Uranium Content (%) outer part
1	.089	.096	.206	.190
2	.203	.080	.249	.246
3	.063	.117	.234	.208
4	.131	.092	.262	.277
5	.230	.110	.142	.208
6	.093	.119	.172	.332
7	.161	.205	.030	.065
8	.055	.030	.365	.193
9	.082	.095	.155	.243
10	.087	.079	.277	.678
11	.055	.030	.180	.235
12	.198	.261	.194	.209
13	.084	.114	.189	.141
14	.369	.392	.184	.133

Table 6: Uranium content of zircons, Woolner granitoid E

Crystal	DDH P14/8 Uranium Content (%) interior	DDH P14/8 Uranium Content (%) outer part	DDH P12/11 Uranium Content (%) interior	DDH P12/11 Uranium Content (%) outer part
1	.033[1]	.153	.063	.207
2	.321[2]	.139	.116	.282
3	.194[3]	.213	.103	.111
4	.042	.041	.030	.032
5	.217	.072	.035	.084
6	.179	.336	.129	.030
7	.453	.366	.079	.320
8	.314	.240	.296	.657
9	.356	.240	.439	.270
10	.202	.250	.122	.175
11	.143	.077		
12	.364	.366		
13	.046	.178		

[1] Intermediate part .030

[2] Intermediate part .193

[3] Intermediate part .129

AGE DETERMINATION

Individual zircon grains were separate from the granite matrix from (drillcore holes P4/1. P11/1, P 12/11 and P14/1) by Dr. McAndrew. The isotopic composition of the lead, and the lead/uranium ratio in the zircons, were then measured by Dr.'s I.S. William and W. Compston of the Australian National University, using the "SHRIMP" ion microscope. Their report is attached as appendix 2, the results of this work are summarised below.

Two of the samples, P12/11 and P14/1. contained zircon with U-Pb compositions suitable for precise age measurements. These gave ages of 2660 ± 20 and 2690 ± 20 Ma, respectively. The compositions of the zircons from the other two samples were not suitable for measuring an age independently but were wholly consistent with these ages. As there is no evidence for a significant difference in age between the samples, the best estimate of the age of all is the mean of the above, 2675 ± 14 Ma.

AIRMAGNETIC DATA

The airborne magnetic survey has been enhanced to give added knowledge of the Woolner Dome. A special analysis of the data was carried out and matched filter designed to display the regional and residual components. These maps were then reduced to the pole to remove lows produced by the low angle of the earths magnetic field.

OBSERVED MAGNETIC TOTAL INTENSITY CONTOUR PLAN (Plate 3)

The most pronounced magnetic feature of the map is a north to north easterly trending magnetic high of 20 to 60 nanoteslas extending from the SW corner of the data sheet M0403 to offshore.

Less pronounced features are two north easterly trending magnetic highs situated on map sheets M0601 and M0603.

The least pronounced feature of the plan is the change of magnetic character on the northwest portions of maps sheet M0405 and M0304. This pattern extends northeast out into Van Dieman Gulf.

The southern portion of the plan is dominated by a regional gradient increasing by 6 nanotesla (nT) per kilometre to the southwest.

RESIDUAL MAGNETIC TOTAL INTENSITY CONTOUR PLAN (Plate 5)

The Residual Magnetic Total Intensity Contour Plan has four anomaly zones similar to the observed magnetic contour plan.

The first zone is located along the western boundary of map sheet M0403. The readings range from a background of -10 to -80 nanoteslas (nT) away from the feature to 0 to 140 nanoteslas over the feature.

The second and third zones are located on map sheets M0601 and M603. These anomalies trend north east and have limited lateral extent.

The fourth zone is positive magnetic anomaly of 60-120 nT located in the north west corner of the sheet. The anomaly of large surface extent extends out into Van Dieman Gulf.

REGIONAL MAGNETIC TOTAL INTENSITY CONTOUR PLAN (Plate 4)

The regional map has outlined a central magnetic low (769E 8638N) surrounded on the southern and western edges by magnetic positive values. A pronounced regional magnetic high is located at the junction of the two trends (e.g. 758E 8620N).

A distinguishable deviation of the magnetic contour can be seen over the residual magnetic anomaly zone on the western boundary of map sheet M0403.

REGIONAL MAGNETIC TOTAL INTENSITY POLE REDUCED TO THE POLE (RTP) CONTOUR PLAN (Plate 6)

This contour plan is the reduction to the Pole of the regional magnetic data using the Pole formula (Syberg, 1972).

The transformation moves the main magnetic feature south to 769E 8634N. The elongation to the east on the original map is not apparent on the RTP map with the feature becoming more circular with a positive value of 6 nanoteslas. The presence of the limb to the south east is noticable on this plan. The small anomaly on the west side of the dome has been suppressed.

The magnetic rim features are also moved south with a value minima of -8 nanoteslas.

REGIONAL MAGNETIC DIPOLE REDUCED TO THE DIPOLE CONTOUR PLAN (Plate 7)

This transformation has moved the central magnetic feature further south to 760N 8630E. The intensity of the anomaly is -7 nanoteslas.

A small deep seated magnetic feature is located on the western edge of the anomaly. The rim features are not clearly outlined. The strongest anomalies of +11 nanoteslas in the north west corner and 9 nanoteslas in the south west corner which indicate change of basement magnetic susceptibility.

GROUND GRAVITY SURVEY

OBSERVED BOUGUER GRAVITY CONTOUR MAP (Plate 9)

The Observed Bouguer Contour Map has been constructed from 131°15'E to 131°36'E from 12°19'S to 12°34'S from data in open file.

The dominant feature on this plan is a gravity low consisting of two minima. The major minima is centred on 764E 8628N with the smaller feature centred at 771E 8624N. The steepest gradient of its fracture is located on the western edge.

The gravity pattern around the central gravity low of -11 milligals has different characteristics to the east and to the west. The eastern portion is a plateau gravity high with a number of small gravity closures. The western boundary gradually decreases in gravity value and has a small number of noticable gravity features.

REGIONAL BOUGUER GRAVITY CONTOUR PLAN (Plate 10)

The principal feature of the Regional Bouguer Gravity Contour Plan is the central gravity low which has partly removed the distortion produced by a second minimum to the south west of the major minimum. This map indicates that the feature has its deepest section below the western gravity minimum and plunges south east. This pattern is very similar to the Regional Dipole RTP Total Intensity Contour map with the magneitc pattern displaced to the north east by 3.5 kilometres.

RESIDUAL BOUGUER GRAVITY CONTOUR PLAN (Plate 11)

A residual plan was constructed by subtracting the regional value at the station from the observed gravity value.

The most significant features are two residual gravity lows of 3.0 and 3.5 milligals centred at 8623N 762E and 8622N 772E.

These two features are separated by and surrounded by gravity highs ranging in intensity from 1 to 4.5 milligals. The strongest intensity gravity highs are located along the southern boundary of the central gravity lows.

The regions to the north east corner and western boundary of the sheet exhibit small positive and negative gravity residuals.

Low order north south trending zones are located to the south of the ring gravity highs on the southern boundary of the area.

GROUND ELECTROMAGNETIC (E.M.) SURVEYS

These surveys are covered by Appendix 1. The Gem 8 E.M. method proved capable of penetrating the conductive overburden with the lowest frequencies 41 HZ and 82HZ. The Fish Creek schists graphitic areas and pyritic units on the north western edge of the dome could be located.

SEISMIC SURVEY

A limited seismic refraction/reflection survey of 4 kilometres in length was conducted along the northern edge of Lake Finniss. The purpose of this survey was to provide an estimate of the thickness of carbonate rocks lying between the Woolner East and Woolner West granite domes.

Carbonate sequences are not good transmitters of energy and have high velocity which shield structure below the sequence from being mapped by this method.

The sequence at Woolner has proved to be the normal case and clear evidence of reflections and deep refraction layers has not yet be achieved.

The Seismic data has been filtered with 100 cps band pass filter and normal move out conversions have been applied. A band of reflections with a two way time of up to approximately 200 milliseconds has been located.

It is considered that this reflector is the basement/Proterozoic contact. If a velocity of 3 kilometers per second is assumed for the section. A depth of 350 metres is estimated in the sedimentary section of the Embayment.

The results of the seismic survey are presented in Volume II.

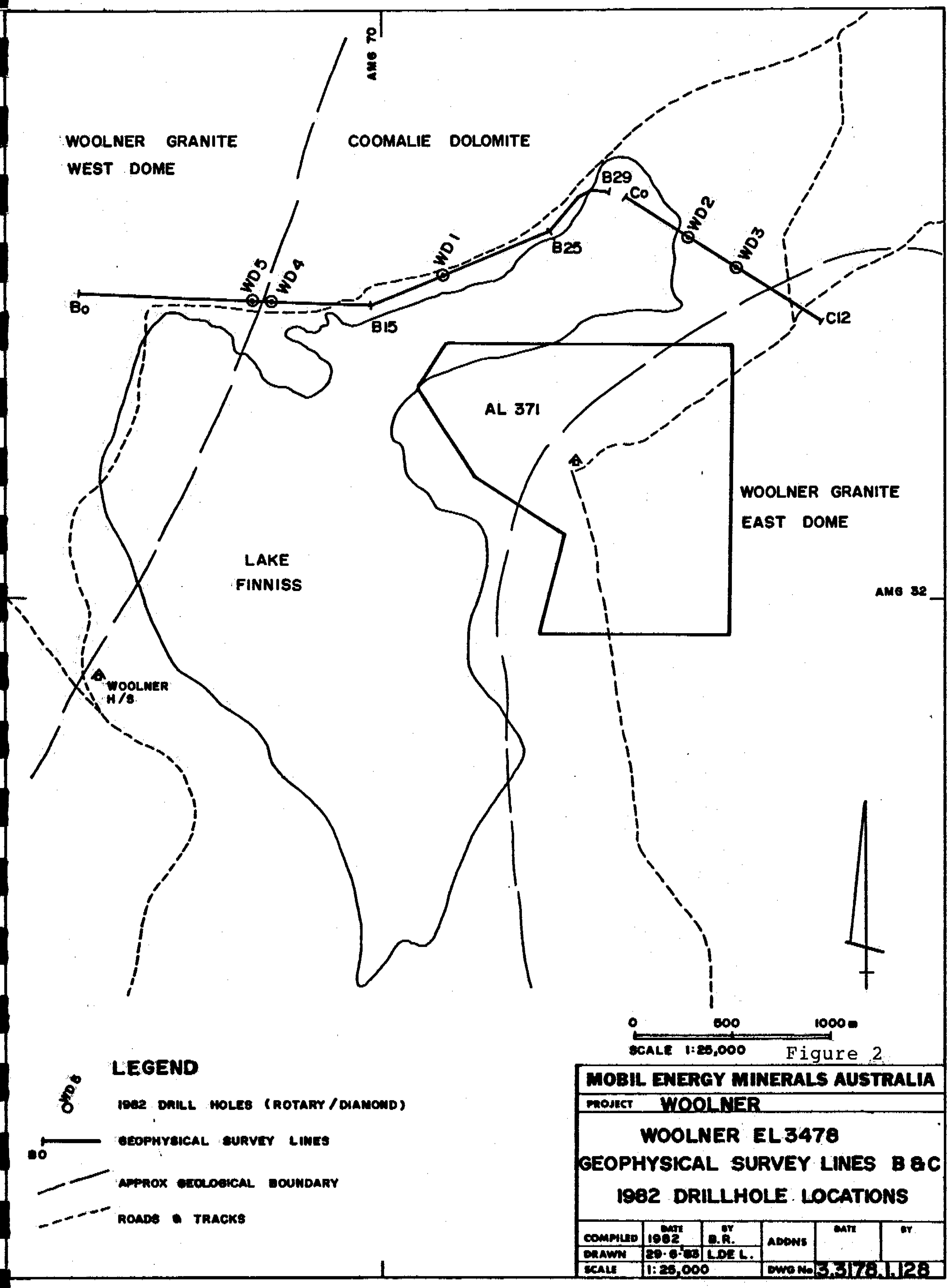

AMG 70
WOOLNER GRANITE
WEST DOME
COOMALIE DOLOMITE
B29
Co
WD2
WD3
WD1
B25
WD5
WD4
Bo
B15
C12
AL 371
WOOLNER GRANITE
EAST DOME
LAKE
FINNISS
AMG 32
WOOLNER
H/S
0
500
1000 m
SCALE 1:25,000
LEGEND
WD 6
1982 DRILL HOLES (ROTARY / DIAMOND)
BO
GEOPHYSICAL SURVEY LINES
APPROX GEOLOGICAL BOUNDARY
ROADS & TRACKS
MOBIL ENERGY MINERALS AUSTRALIA
PROJECT WOOLNER
WOOLNER EL 3478
GEOPHYSICAL SURVEY LINES B & C
1982 DRILLHOLE LOCATIONS
COMPILED
DATE 1982
BY B.R.
DRAWN
29-6-83
L.DE L.
SCALE
1:25,000
ADDNS
DATE
BY
DWG No 3.3178.1.128

Figure 2

DRILLING

The drilling programme was designed to test below the Phanerozoic cover for the prospective Fish Creek Schists in the corridor of metasediments between the East and West granite domes. Five rotary/diamond holes were drilled on geophysical or stratigraphic targets, but only Coomalie Dolomite and Woolner Granite were intersected (Figure 36). Each hole was precollared through the Phanerozoic sediments (40 metres) and the four holes intersecting dolomite were cored (83 metres) (Figure 3 and Table 7). The core was tested every 50 centimetres using an URTEC spectrometer and no anomalous radioactivity was recorded.

A ground magnetic and EM survey was conducted along drill lines B and C and the holes WD2, 3, 4 were sited on resulting EM anomalies, WD 1 on a weak magnetic anomaly and WD5 positioned between WD4 and the then known eastern boundary of the Woolner Granite.

The Coomalie Dolomite is generally pale grey to cream coloured, weakly foliated and contains thin schist interbeds. The foliation dips between 10° and 30° to the axis of the core and the dolomite is partially silicified. In WD5 over 10 metres of weathered granite was intersected.

The thickness of the Phanerozoic cover varies between 56 and 83 metres and consists of the Recent dune, beach and lake deposits with underlying kaolinitic sands, clays and minor carbonates of the Bathurst Island Formation. The full sequence of coastal sands, estuarine organic muds and shell fragments, the laterite profile and the Bathurst Island Formation is best shown in hole WD4 (see drill log in Appendix 3).

Table 7 Summary of Rotary/Diamond Drilling - Woolner EL 3478

Commencement Date : November 10, 1982
Completion Date : November 24, 1982

Hole No	Local Co-ord	AMG Co-ord	Depth Drilled (m) Rotary	Diamond(NQ)	Lithological Summary
WD1	B19	33.68N/70.30E	0-62	62-82.2	Phanerozoic sediments over-lying Coomalie Dolomite
WD2	C4	33.85N/71.60E	0-57	57-81.3	Phanerozoic sediments overlying Coomalie Dolomite
WD3	C7	33.72N/71.82E	0-56	56-75.3	Phanerozoic sediments overlying Coomalie Dolomite
WD4	B10	33.55N/69.45E	0-83.2	83.2-102.4	Phanerozoic sediments overlying Coomalie Dolomite
WD5	B9	33.55N/69.35E	0-150	-	Phanerozoic sediments overlying Woolner Granite
			408.2	83	

CONCLUSIONS

The age of the Woolner granites has been evaluated at 2675 ± 14 Ma. This compares favorably with the age of the Nanambu Complex. The fertility study is inconclusive as to whether labile uranium was present or was remobilized during the events of metamorphism and metasomatism.

Study of the drill core available at the Department of Mines and Energy in Darwin has established a band of interbanded quartz-feldspar -mica gneiss and chlorite-calcite-quartz schist which may be equivalent of the Kakadu Group of the Alligator Rivers Uranium Field.

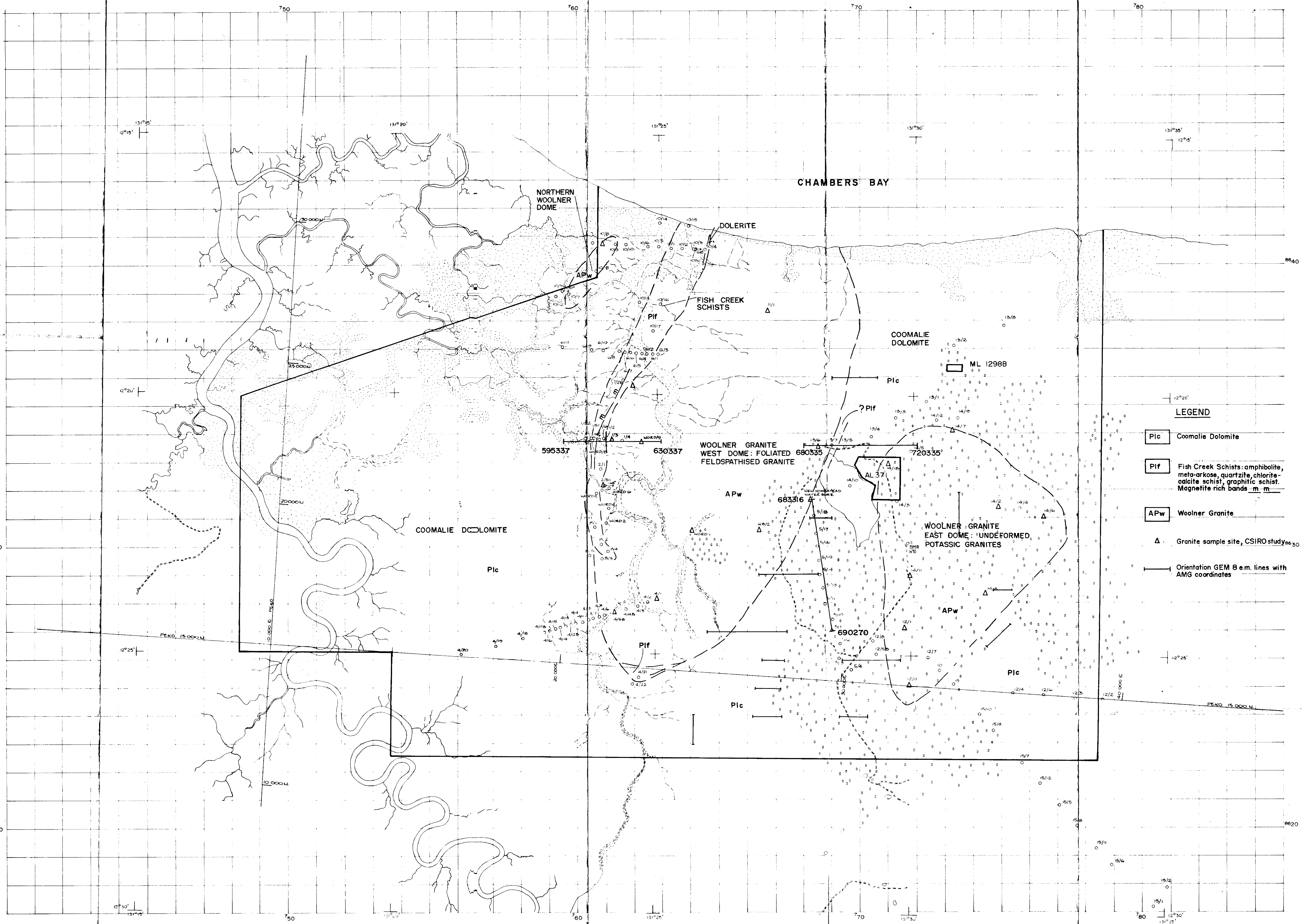
No indication of magnesium alteration has been located by the MEMA drilling and the differences between the Fish Creek Schists and the Cahill Formation (Johnson 1981) still apply.

The enhanced treatment of the airborne magnetic survey has indicated only small discontinuous magnetic features associated with the embayment area between the Woolner West Dome and the Woolner East Dome. It is therefore considered unlikely that any large area of B.I.F. sediments occurs around the contact zone. However the magnetic treatment does not rule out the possiblitiy of a non-magnetic equivalent of the Fish Creek schist being present.

The ground EM surveys have been located on the eastern edge of the Woolner West Dome. However no major EM conductor has been delineated. The EM conducted over the known geology indicated that the granite schist contact could be mapped. However no major anomaly was associated with a graphite zone located by drilling. This indicates that the Fish Creek Schists are possibly different facies to the Cahill Formation where the EM conductors are more clearly defined.

It is recommended that no further investigation be carried in the Embayment area as EM anomalies are poorly defined and there was no continuous magnetic anomaly. The seismic survey also indicates a sedimentary sequence of possible 350 metres above the granite which could consist completely of Coomalie Dolomite. There is no suggestion from the seismic survey of a section of Fish Creek Schists located below the dolomite.

Additional exploration should consider testing the relationship of the proposed Crater Formation at the southern tip of Woolner West Dome to the basement by detailed magnetic and gravity traversing. It would be of benefit to carry out complex resistivity and CSMAT methods to obtain a clearer definition of the Fish Creek Schists and discern how they are related to the basement complex and how they compare to the Manton Group in the Rum Jungle area.



LEGEND

- Sand and Claypans
- Forest
- Swamp

0 1 2 3 4 5 Kilometres

Scale 1:50,000

Plate No. 1

CR 83/231

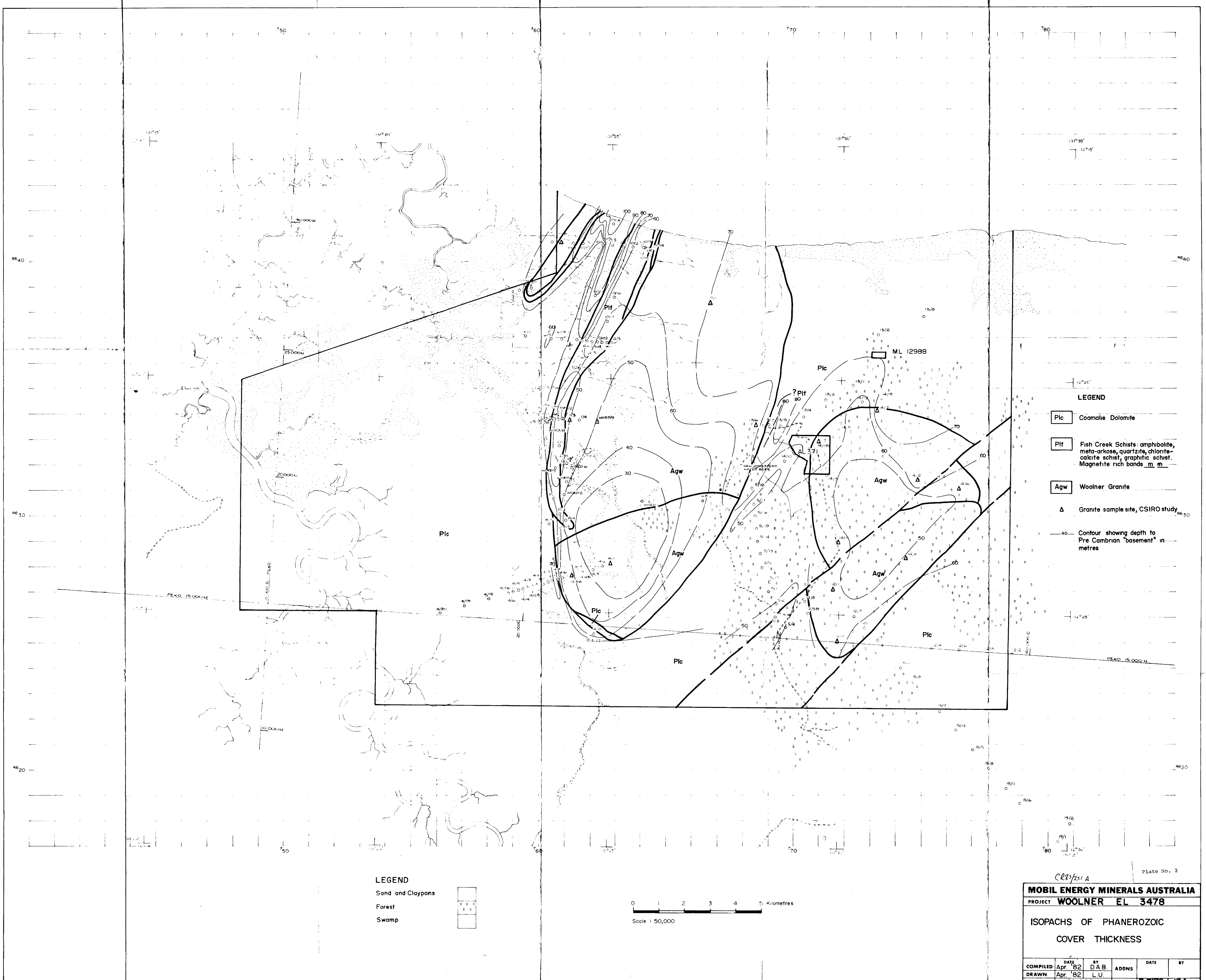
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT **WOOLNER EL 3478**

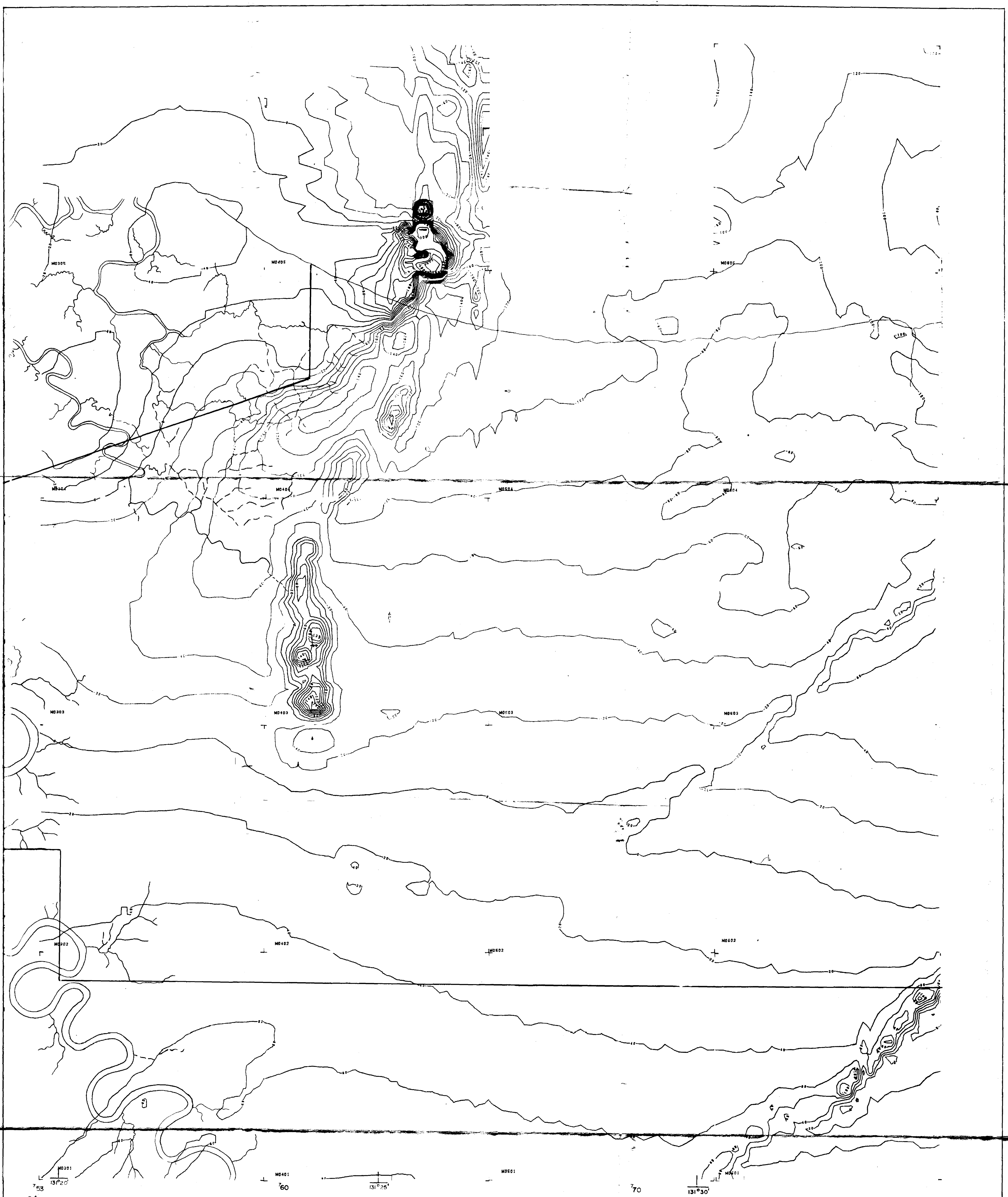
TOPOGRAPHY AND DRILLHOLES

PRELIMINARY GEOLOGICAL MAP

	DATE	BY		DATE	BY
COMPILED	Apr. '82	D.A.B.	ADDNS	28-7-82	
DRAWN	Apr. '82	L.U.			
SCALE	1:50,000		DWG No	3·6136·1·0004	



LEGEND
Plc Coomalie Dolomite
Plf Fish Creek Schists: amphibolite, meta-arkose, quartzite, chlorite-calcite schist, graphitic schist. Magnetite rich bands m m
Agw Woolner Granite
Granite sample site, CSIRO study
Contour showing depth to Pre Cambrian "basement" in metres
ML 12988
AL 371
PEKO 15 000 N
LEGEND
Sand and Claypans
Forest
Swamp
0 1 2 3 4 5 Kilometres
Scale 1:50,000
Plate No. 2
CR83/231 A
MOBIL ENERGY MINERALS AUSTRALIA
PROJECT WOOLNER EL 3478
ISOPACHS OF PHANEROZOIC COVER THICKNESS
COMPILED Apr. '82 D.A.B.
DRAWN Apr. '82 L.U.
SCALE 1:50,000
ADDNS
DWG No 3.3178.1.134



ORP3/231A

Plate No. 3

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER EL 3478

AIRBORNE TOTAL MAGNETIC INTENSITY CONTOUR MAP

CONTOUR INTERVAL = 20 nanoTeslas

	DATE	BY	ADDNS	DATE	BY
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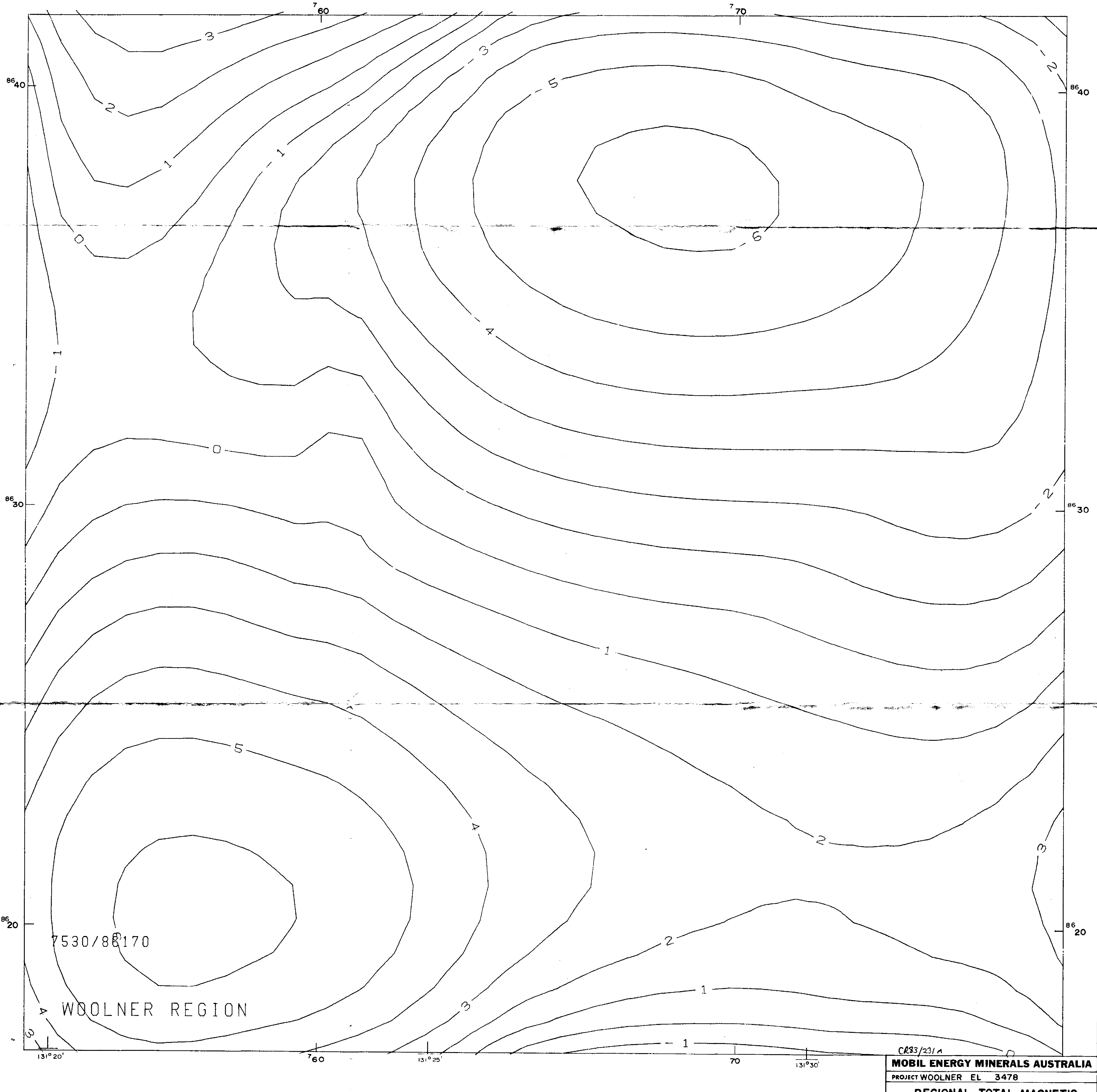
DRAWN	"	HS			
SCALE	1:50,000		DWG No	3·6136·1·0005	



CR83/231A

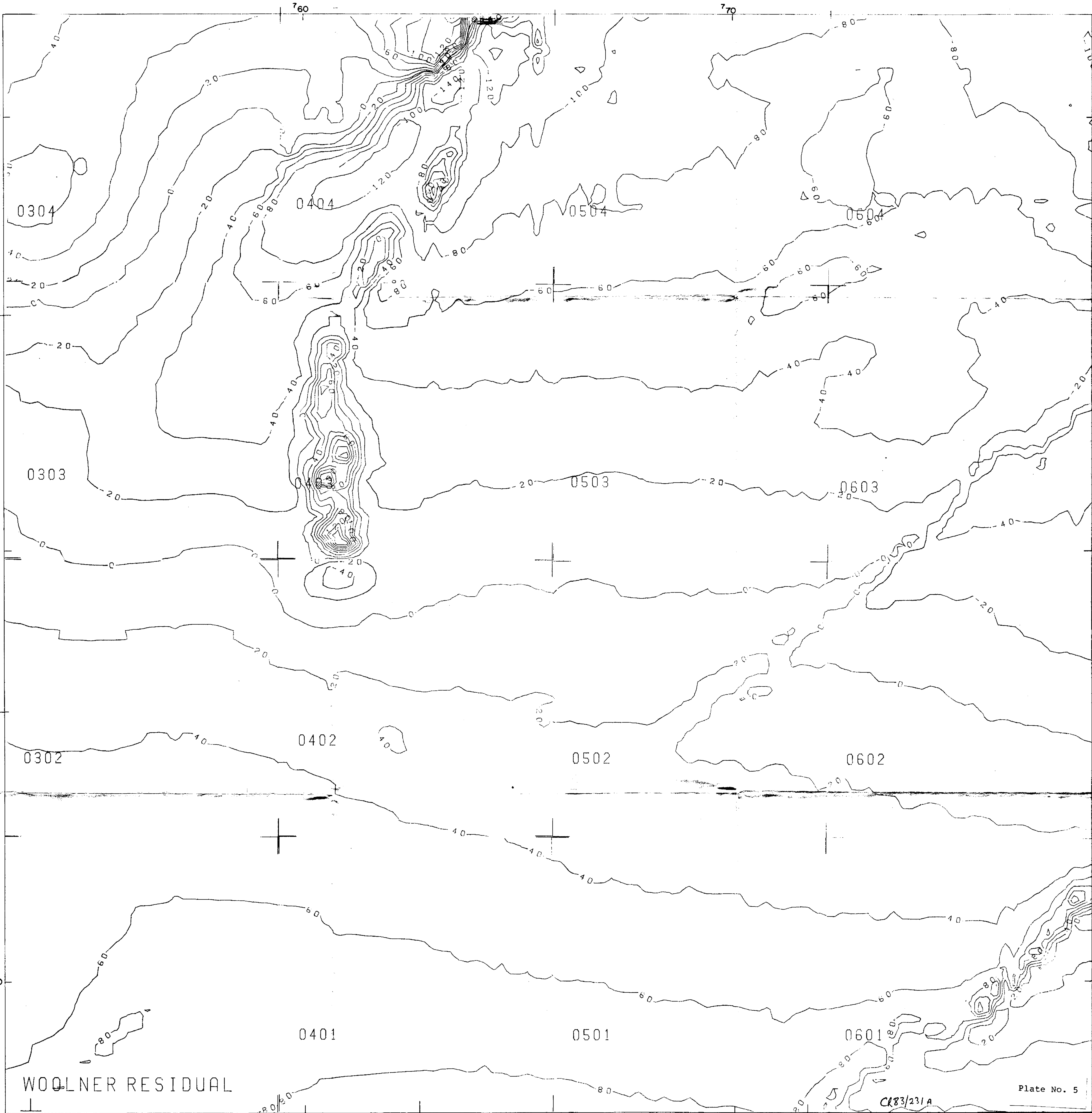
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER EL 3478

REGIONAL TOTAL MAGNETIC INTENSITY CONTOUR PLAN

	DATE	BY		DATE	BY
COMPILED	APRIL '82	D.A.B.	ADDNS	17 8 82	P.B.
DRAWN	APRIL '82	L.U.			
SCALE	1 50,000		DWG No	3·3178·1·0027	

Plate No. 4



LEGEND

Magnetic Contour Interval — 20 gammas

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER EL 3478

WOOLNER RESIDUAL
MAGNETIC CONTOUR PLAN

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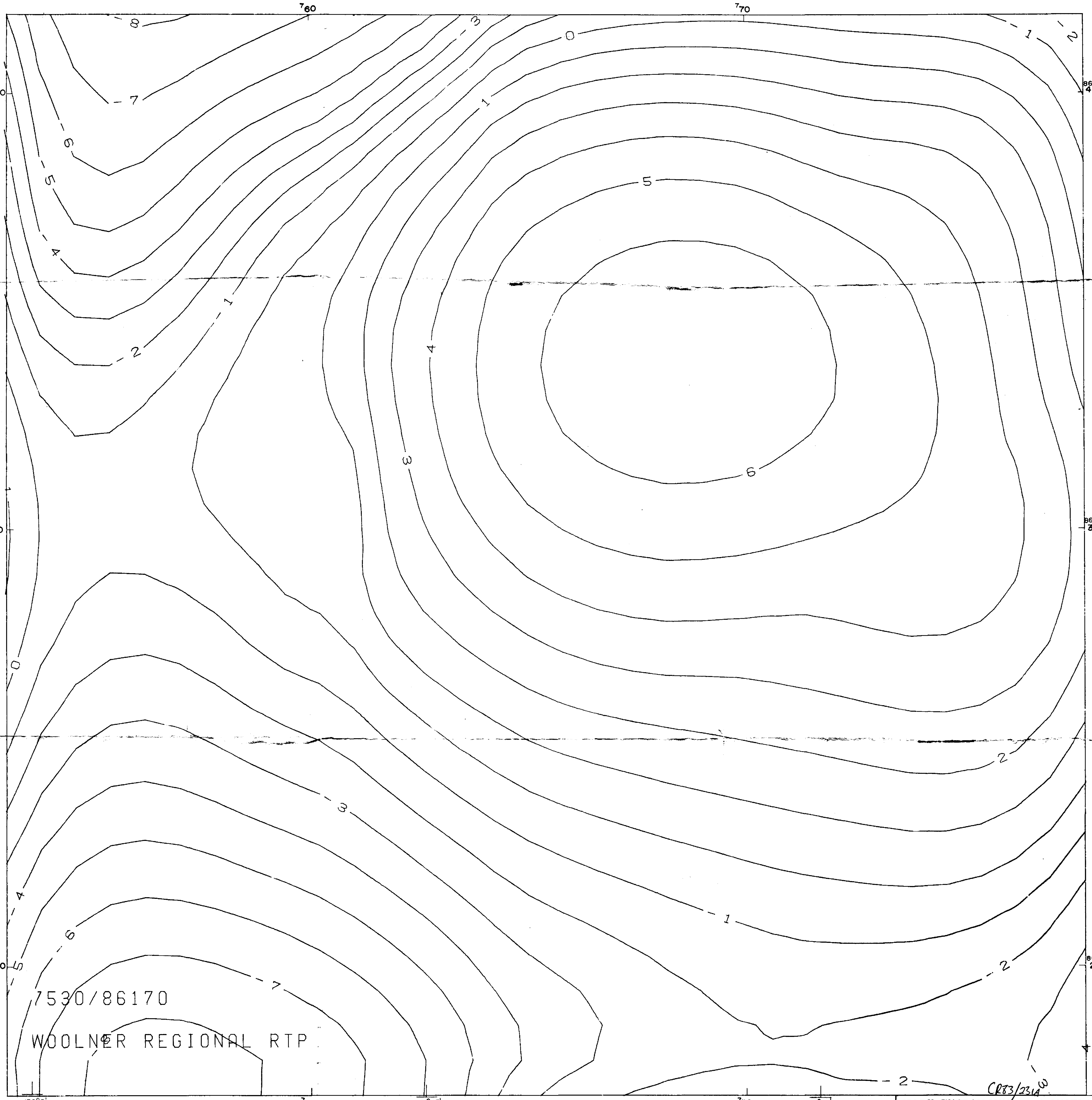
DRAWN					
SCALE	1: 50,000		DWG No	3·6136·1·0012	



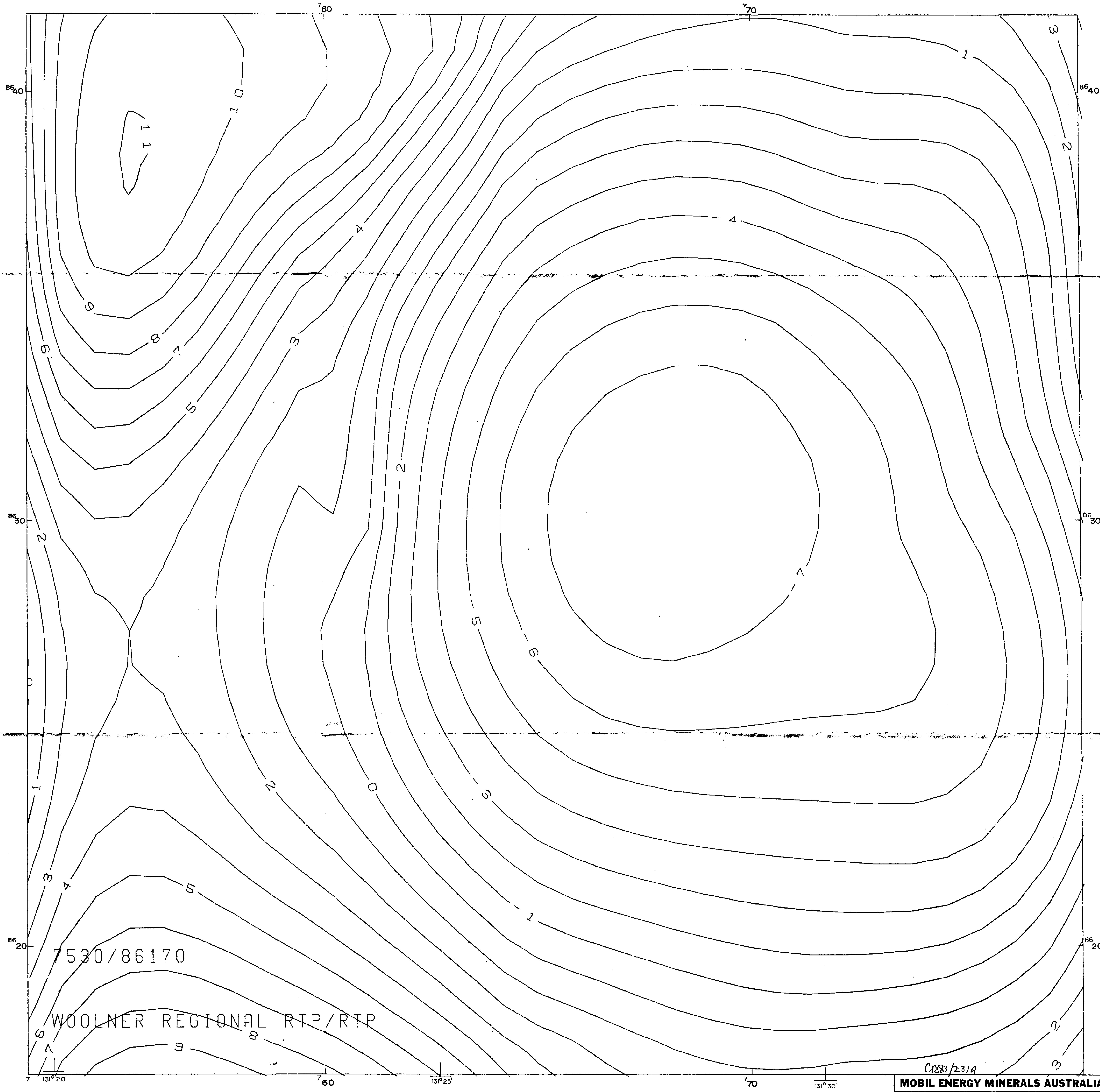
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER EL 3478

REGIONAL RTP
TOTAL MAGNETIC INTENSITY
CONTOUR PLAN

	DATE	BY		DATE	BY
COMPILED	APRIL '82	D.A.B.	ADDNS	16 8 82	P B
DRAWN	APRIL '82	L.U.			
SCALE	1:50,000		DWG No	3·3178·1·0028	

Plate No. 6



CR83/231A

MOBIL ENERGY MINERALS AUSTRALIA					
PROJECT WOOLNER EL 3478					
REGIONAL DIPOLE RTP TOTAL MAGNETIC INTENSITY CONTOUR PLAN					
	DATE	BY		DATE	BY
COMPILED	APRIL '82	D.A.B.	ADDNS	17·8·82	P.B.
DRAWN	APRIL '82	L.U.			
SCALE	1:50,000		DWG No	3·3178·1·0026	

Plate No. 7

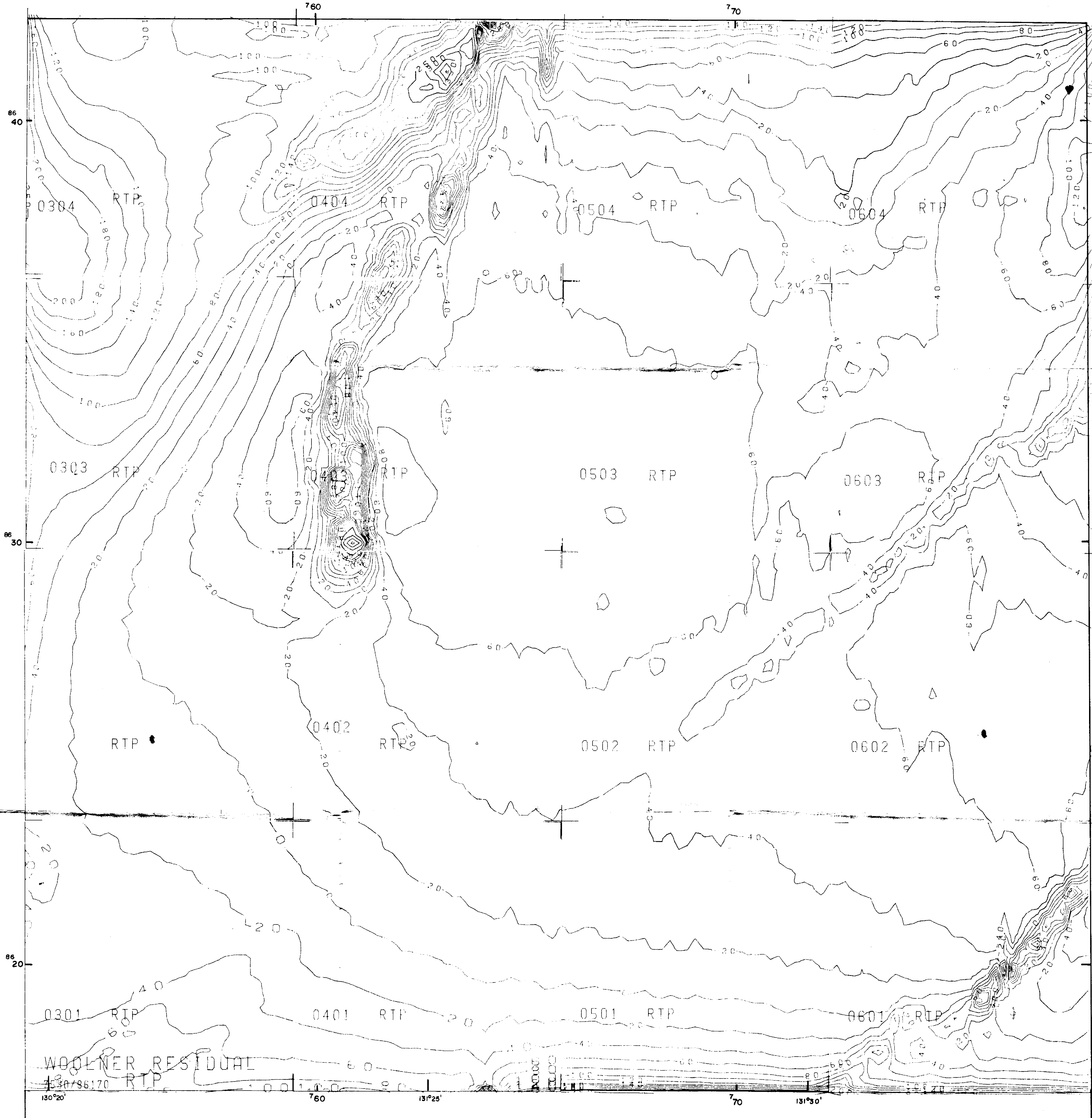


Plate No. 8

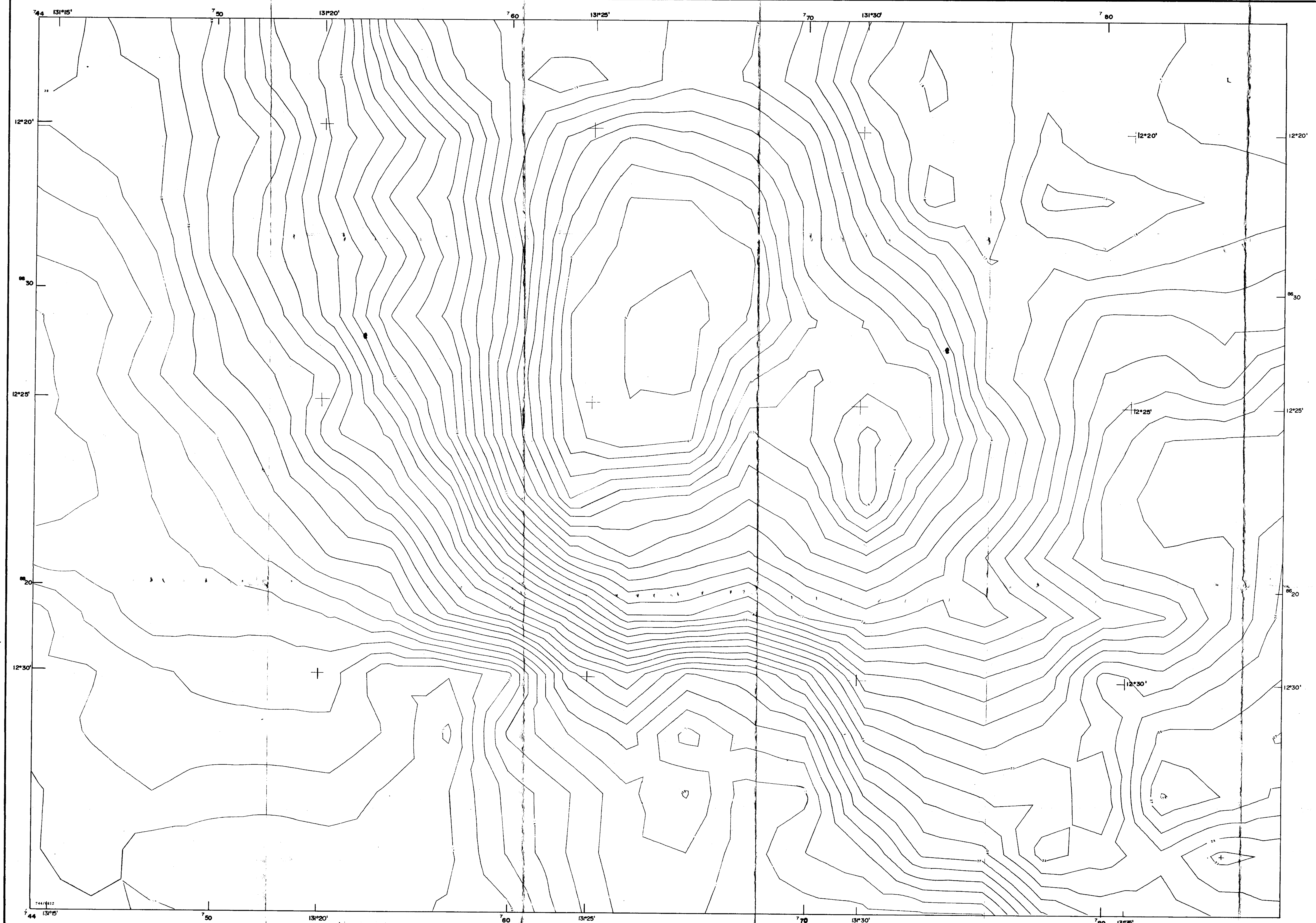
CR83/231A

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

RESIDUAL TOTAL MAGNETIC INTENSITY
CONTOUR PLAN

	DATE	BY	ADDNS	DATE	BY
COMPILED	OCT '82	L.S.			
DRAWN	OCT '82	R.G.H.			
SCALE	1:50,000		DWG No 3·3178·1·0025		



WOOLNER E L 3478

OBSERVED BOUGUER GRAVITY
CONTOUR MAP
CONTOUR INTERVAL = 2 mgals

1:50,000

3·6136·1·0006

CR83/231 A

Plate No. 9

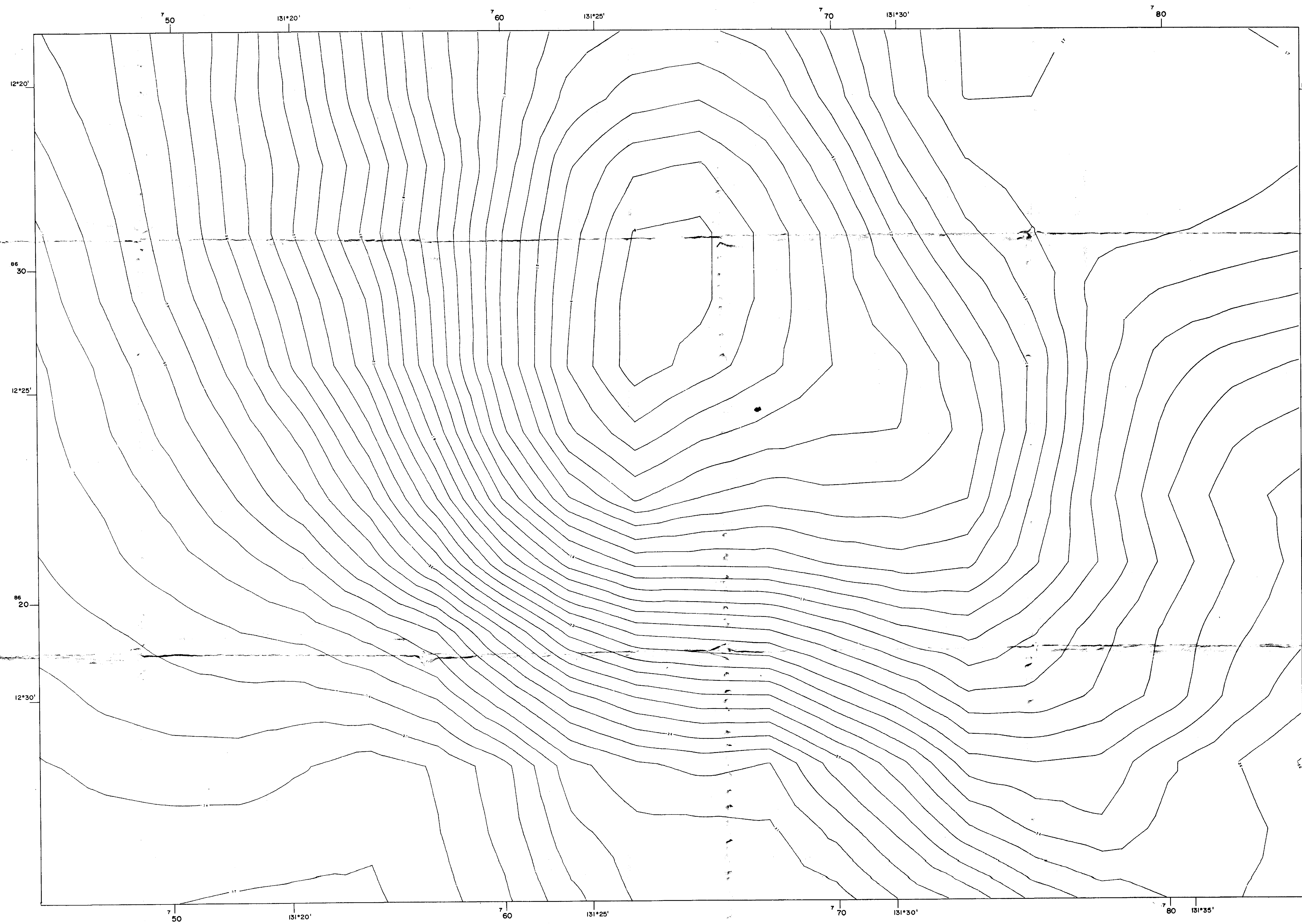


Plate No. 10

CR83/231A

MOBIL ENERGY MINERALS AUSTRALIA					
PROJECT WOOLNER					
WOOLNER EL3478 REGIONAL GRAVITY CONTOURS CONTOUR INTERVAL 1 Milligal					
COMPILED	DATE SEPT '82	BY TvS	ADDNS	DATE	BY
DRAWN					
SCALE	1:50,000		DWG No	3·6136·1·008	

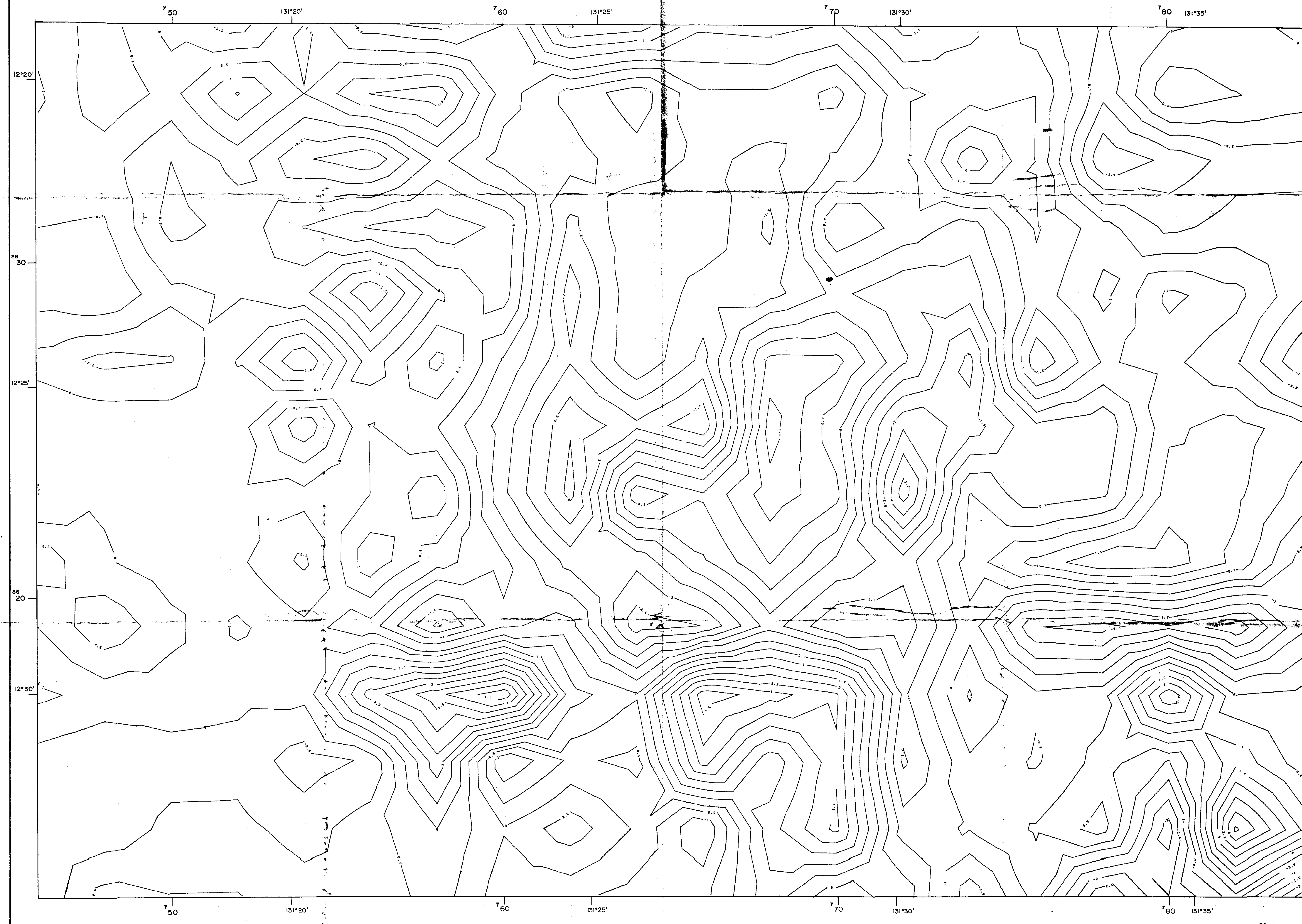


Plate No. 11

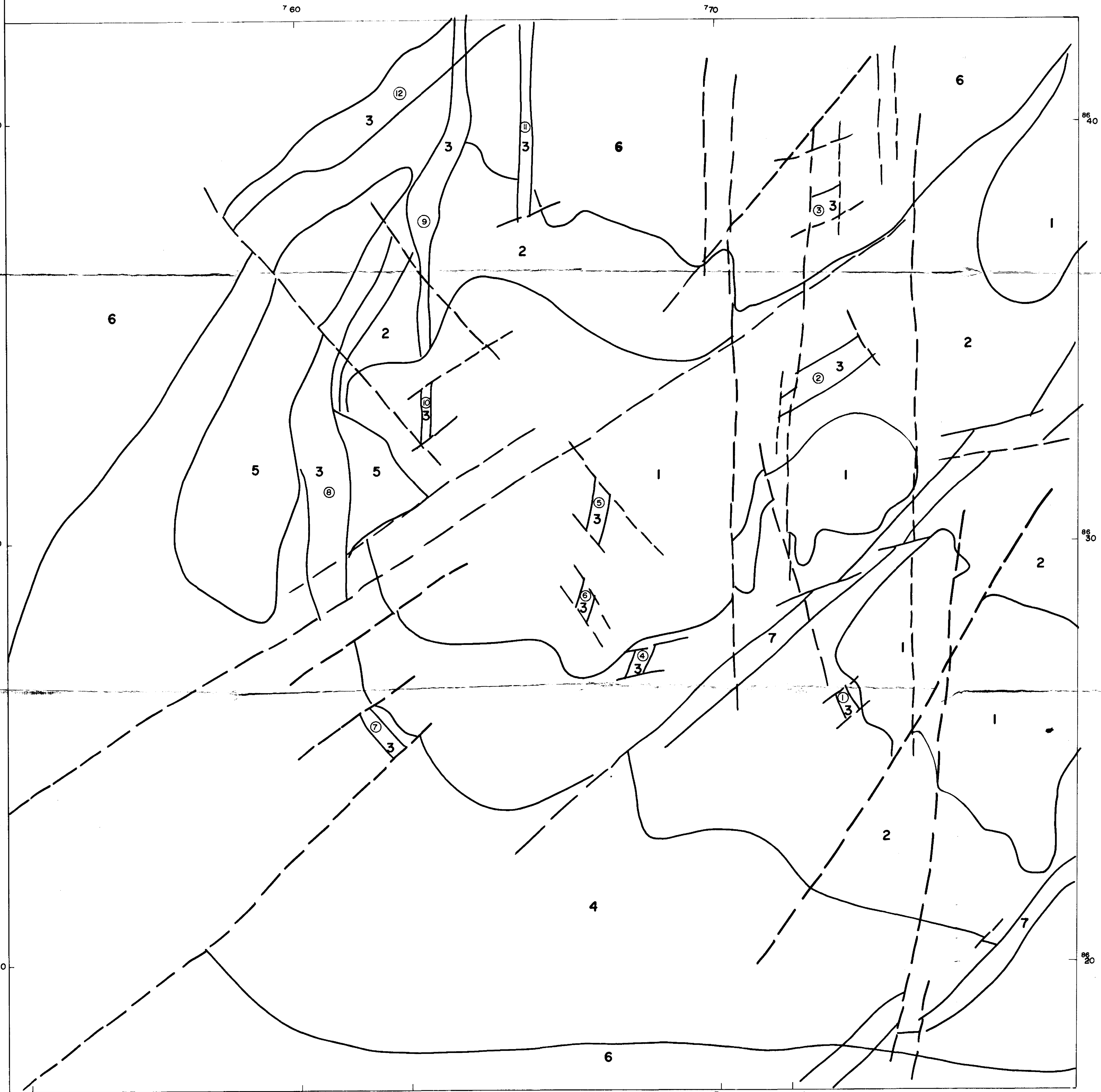
CR83/231A

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT **WOOLNER**

WOOLNER EL3478
RESIDUAL GRAVITY CONTOURS
CONTOUR INTERVAL 0·5 Milligals

	DATE	BY	ADDNS	DATE	BY
COMPILED	SEPT '82	TvS			
DRAWN					
SCALE	1:50,000		DWG No	3·6136·1·007	



1 SHALLOW GRANITE
2 BURIED GRANITE
3 LOWER PROTEROZOIC SEDIMENTS
4 UPPER LOWER PROTEROZOIC SEDIMENTS
5 INTRUSIVE GRANITE
6 THICKENING LOWER PROTEROZOIC SEDS./GRANITE
7 DOLERITE DYKE
MAGNETIC LINEAMENT
MAGNETIC BOUNDARY

Plate No. 12

CR83/231A

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

INTERPRETATION PLAN
RESIDUAL MAGNETIC RTP
CONTOUR PLAN

	DATE	BY	ADDNS	DATE	BY
COMPILED	OCT.'82	L.S.			
DRAWN	NOV.1'82	R.G.H.			
SCALE	1:50,000		DWG No 3·3178·1·0031		

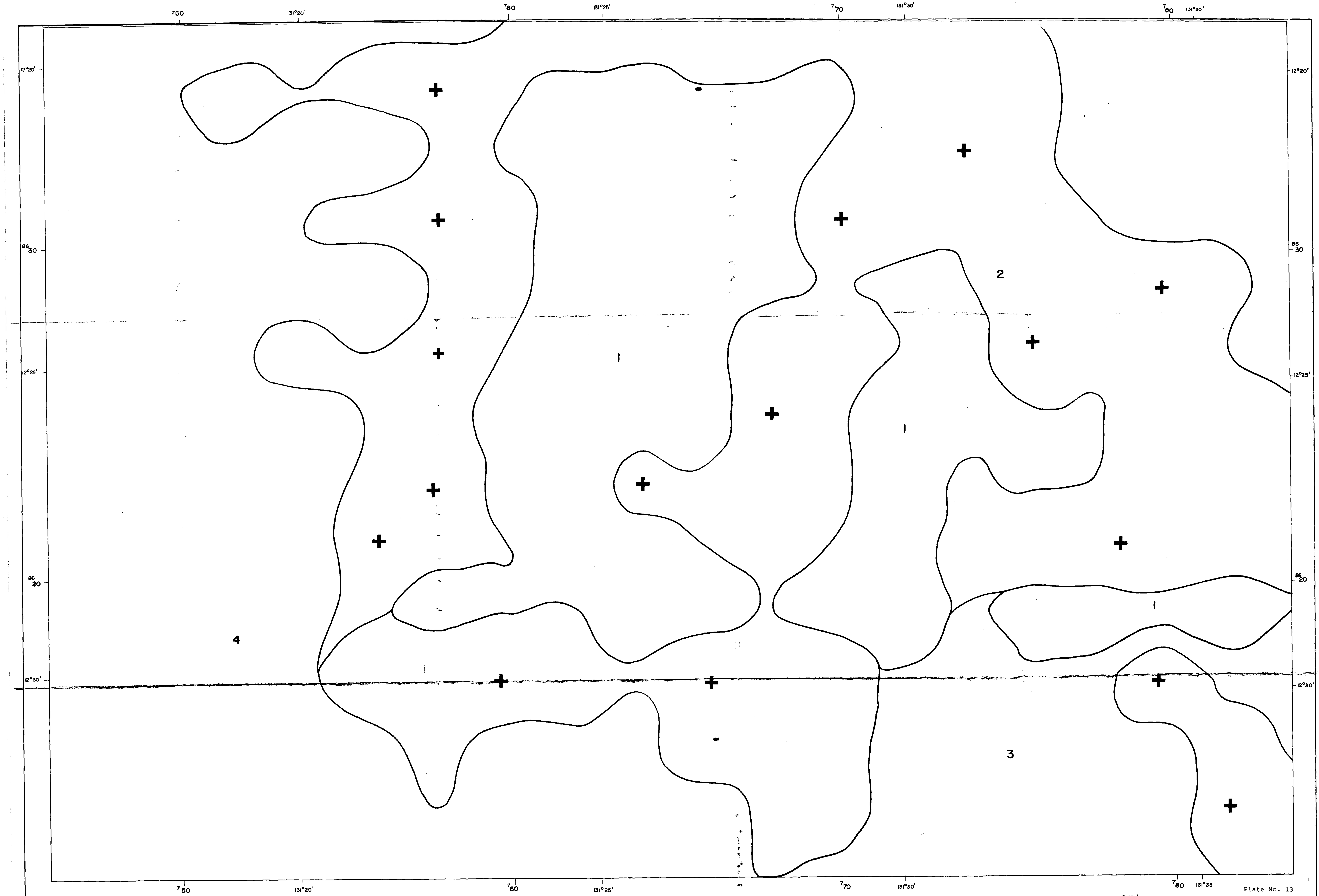


Plate No. 13

CR83/231A

✚ LOCAL GRAVITY HIGH

RESIDUAL GRAVITY DOMAINS

1 GRAVITY LOW 0 TO 2·7 Milligals

2 GRAVITY HIGH 0 TO 4·6 Milligals

3 GRAVITY LOW 0 TO 1·5 Milligals

4 GRAVITY LOW 0 TO −·5 Milligals

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

INTERPRETATION PLAN
RESIDUAL GRAVITY

CONTOUR PLAN

	DATE	BY	ADDNS	DATE	BY
COMPILED	OCT. '82	L.S.			
DRAWN	OCT. '82	R.G.H.			
SCALE	1: 50,000		DWG No	3·3178·1·0029	

APPENDIX 1

GROUND GEOPHYSICAL SURVEYS AT WOOLNER (EL 3478)
DURING 1982

BIBLIOGRAPHIC DATA

TITLE: Ground Geophysical Sruveys at Woolner (EL 3478) During 1982

AUTHOR: T. Von Strokirch

PAGES: 18

FIGURES: 1

APPENDICES: 1

PLATES: 34

KEYWORDS: Geophysics, GEM-8, Graphitic conductors, EM, Seismic, Gravity, Magnetics, Woolner.

SUMMARY

During the 1982 field season ground geophysical surveys were performed in the Woolner area (EL 3478) of the Northern Territory. EM, gravity, magnetic and seismic traverses were made to determine the relative effectivity of the above techniques in this type of terrain and to locate the edges of the granite domes where graphitic Lower Proterozoic sediments are expected.

The GEM-8 EM method proved capable of penetrating the conductive overburden and effectively located the Fish Creek Schists, a graphitic and pyritic unit on the western edge of the West Woolner Dome. Work elsewhere in the area located a small number of conductors which were also tested by ground magnetic surveys. Line B/C which lies between the two granite domes has relatively conductive zones near both granite edges. This line was tested with gravity and seismic techniques. The results warrant further testing by drilling on this line and as well as along other portions of the edges of the granites.

CONTENTS

INTRODUCTION

An orientation GEM-8 survey was conducted in August 1982. It was designed to pick the granite/sediment contacts at the edges of the granite domes using the GEM-8 electromagnetic system and thus to observe the effectivity of the technique in this environment. Following this survey a number of further traverses were planned to further outline the contact and any graphitic units that might be present. Gravity and seismic traverses were also completed along Line B/C in order to test these techniques as well and to gain a better understanding of the area. These surveys were also preceded by drilling along Line B/C on a number of EM and magnetic targets.

In November 1982, 13 lines were pegged across areas of interest and the EM program was completed along these lines. Ground Magnetics were begun but not all the lines were finished due to the beginning of the wet season.

PRIOR GEOPHYSICAL SURVEYS

In 1978-79 CRAE carried out a limited ground magnetic survey however, it was not until the ground was farmed out to a Geopeko-E.Z. joint venture that a basic program of geophysics was undertaken.

Airborne magnetics were flown over the area at a height of 120 metres with a flight line spacing of 300 metres. Regional gravity was completed at 2 kilometre centres with localised infilling to 1 kilometre. A further 150 kilometres of gravity profiling was completed along pegged lines at 100 metre spacing with lines 200 m apart. Ground magnetic surveys were completed over 300 kilometres of pegged grid with readings taken every 25 metres.

Sirotem was attempted across the Fish Creek Schists in the north of the E.L. however after two days the survey was terminated as the highly conductive surface materials tidal movement made it impossible to obtain a clear bedrock response. The E.M. work was not formally written up.

METHOD OF SURVEY

Topographic Survey Positioning the lines proved to be fairly difficult in some cases since the featureless nature of the mud flats made air photo location difficult. The regular summer inundation of the greater portion of the area also removed the majority of the pegs from the Geopeko gridding program. Line B was located using obvious road junctions, fence lines and Lake Finnis. It should be accurately positioned and tied into the Geopeko grid. Lines A and E were located by travelling across country using compass and topofil. No pegs or drill holes were found on these traverses even though considerable drilling was completed along them in prior surveys. The cross correlation of the boundaries located with the EM on these lines should be recognised as being approximate and the lines if necessary could be surveyed at a later date.

Electromagnetic Survey Horizontal, vertical and large loop configurations were used in the test to find which would be the most suitable for the area. Horizontal loop surveys were completed with the transmitter 200 m west of the receiver. Vertical loop surveys were used in two configurations with the transmitter at 200 m and 300 m away to the east from the receiver.

The later work entailed a further 13 lines (Table 1). As the lines were widely separated a baseline was not established. The lines were positioned individually from air photos with the northern or westernmost peg being the one located. From this peg the lines were extended using compass and topofil. Most lines were located on black soil plains where pegging was easy. Lines around the edge of the floodplain passed through thick scrub and required grading. Line 64.2 N is located over 2 km out from the edge of the floodplain and could not be accurately located on air photographs and may therefore contain some positioning error. It was located using compass and topofil from the western end of line 24.0 north.

Lines F, 73.5 E and 28.5 N lie on a section of floodplain (a lake in the wet season) which lies in the east of the area and has rather difficult access. Any follow up drilling would require construction of a bulldozed road around the south of Lake Finnis. The eastern lines between northings 24 and 31 run through open forests and light scrub growing on lateritic soil. Some laterite is visible on the edges of the floodplain. The remainder of the lines are on the black soil plains which have a high conductivity.

15.5 kilometres was tested with the GEM-8 initially and a further 19.1 kilometres of survey was completed in the follow up program.

The horizontal loop In Line method was chosen as the technique which would give rapid progress and reasonable penetration of the conductive material overlying the Proterozoic. A 200 metre receiver transmitter separation gives a reasonable penetration whilst allowing the frequencies up to frequency six (2642 Hz) to be received. A spacing of 100 metres between stations was used as it was felt that this should be sufficient to pick conductivity changes in the basement.

Gravity Survey

Detailed gravity readings at 50 metre spacing were undertaken along traverses B & C.

Seismic Survey

A trial seismic survey was undertaken along traverses B & C with geophone spacing 10 metres and with a spread of 110 metres. The offset shot distance was 3 to 120 metres.

Magnetic Survey

Ground magnetics was completed at 10 metre spacing on line B - C to give maximum accuracy when correlating with airborne work. On other lines a 25 metre spacing was used. The survey was not completed due to the onset of the wet season.

INSTRUMENTATION

GEM-8

The GEM-8 is an eight frequency ground electromagnetic system. The frequencies range from 41Hz to 5248 Hz which gives it a useful capability as an electromagnetic sounding tool.

It has three major physical components:

1. The vehicle based transmitter consisting of the transmitter console, generator, transformer and tuning box.

2. The transmitting loop which is attached to the transmitter console. It consists of a ten metre multicored cable.

3. The receiver which is distant from and not connected to the transmitter. An HP 41CV calculator is used to derive Tilt Angle and Ellipticity information during receiver operation.

Seismic

The 12 channel Oyo "McSeis 1500" system was used to record data both on paper trace and diskette. The energy source was a MkIII Betsy Gun MCM-3, 40 Hz. Marshphones were spaced at 10 m intervals. Shotpoints were at 20 m intervals resulting in a six fold C.D.P. shock.

Gravity

Lacoste and Romberg gravity meter (G-473) was read at 50 m intervals. The line was levelled with a GDD electronic level. The gravity values are tied to A.G.G. by a reading on the Woolner airstrip (A.G.G. station No. A2023). The levelling was not tied to A.H.D. due to distance from bench marks and an elevation of 5 m was assumed for the base level. Accuracy of the gravity meter is ±0.01 mgal and accuracy of the GDD is about ±0.1 m (i.e. ±0.03 mgal). This results in a relative error of ±0.04 mgal though the absolute error may be as high as ±4 mgal.

Magnetics

A geometrics Proton Precession magnetometer was used to take readings at 25 metre intervals except on Line B/C where readings were taken at 10 metre intervals.

REDUCTION OF GEOPHYSICAL DATA

Gravity

Bouguer anomalies were calculated using a density of 2.67 Tm^{-3}. A figure of 2.2 Tm^{-3} might be more realistic as the younger sediments covering the dolomite are of low density but since the area has a height range of only 3 - 5 metres, no relative error will result.

Magnetics

The raw data formed the main basis for interpretation. The Adept computer program which was used to process the airborne magnetic information was also used on line B/C.

E.M.

Tilt Angles and Ellipticities were calculated from the raw data and these were plotted as profiles and pseudosections. Conductivities were derived from the ellipticities and tilt angles in some cases and these were used to determine approximate depths of penetration.

Table 1.

GEM-8 Survey at Woolner in November 1982 at 100 metre spacings.

Line F	Runs 1.2 km North-East from FO	1.2km
Line 36	69.1E to 70.6E	1.6 km
Line 28.5N	74.7E to 75.2E	0.7 km
Line 73.5E	30.5N to 31.9N	1.5 km
Line 27.0N	64.6E to 67.4E	2.9 km
Line 26.0N	66.5E to 67.3E	1.9 km
Line 25.0N	66.3E to 67.2E	0.9 km
Line 24.0N	66.2E to 67.2E	1.1 km
Line 64.2E	23.0N to 24.1N	1.2 km
Line 31.0N	68.3E to 69.9N	0.8 km
Line 29.0N	66.4E to 68.4E	2.1 km
Line 26.0N	69.4E to 71.4E	2.1 km
Line 24.0N	69.3E to 70.3D	1.1 km
Line A		3.5 km
Line B/C	North of Lake	4.5 km
Line D	Along Road	5.0 km
Line E	Near Coast	2.5 km
		34.6 km total

RESULTS

Original Surveys.

Line A and Line E were placed across the Fish Creek Schists in which graphitic schist bands have been clearly located by drilling and ground magnetics. Horizontal loop surveys were performed on both lines, and vertical and large loop modes were also used on line A in an attempt to obtain finer resolution of the anomaly. The results are as follow:

Line A

3.5 kilometres of Line were traversed using the horizontal loop system. Low signal strength combined with a very high noise level to make it difficult to obtain stable repeatable readings, especially in the low and high frequencies. Short period and long period noise meant that a long time was required to obtain accurate readings at each station. These problems were assumed to be caused by near surface change inconductivity of the black soils in the area (encrusted salt could frequently be seen in the area as well as the occasional seaweed) and the tidal effects along Fish Creek itself. Two full days were taken to complete the original traverse, with only thirty-four stations being surveyed.

A conductive zone was found on the line but no pronounced narrow conductors were visible (Plate 1). From A16.5 to A0 the bedrock conductivity increases relative to the surface conductivity. This effect is most pronounced in the tilt angle data at frequency HIHZ. This indicates that the bedrock is at the limit of penetration of the system and that the conductive response is due to poor (disseminated) conductor.

The eastern boundary is evident at A16.5 coincident with the boundary as found by drilling. It is represented by a rise in conductivity over the schists from the granites to the east. Drill hole data located the western edge of the Fish Creek Schists at A11.5. It is expected that the crystalline dolomites would be more resistive than the graphitic and pyritic schists however this does not seem to be the case. A increase in conductivity is found in the west with the contact at approximately A12.0. The depth to the basement is estimate at 90 metres which is slightly in excess of the drill hole depth.

Vertical loop surveys were completed across the eastern contact to define more closely the boundary between the West Woolner Granite and the Fish Creek Schists (Plates 2,3). 200 metre and 300 metre spacings between receiver and transmitter were used. The noise problem was greatly reduced with this EM mode and both traverses (20 readings total) were completed in a morning. The coupling with these horizontal layers was too great and we did not get any definite bedrock response. The 200 metre spacing test was totally unresponsive, to bedrock and the 300 metre spacing data a small variation was measured at HIHZ. The tilt angle and ellipticity agree poorly indicating 3D effects however this is not the case with the Fish Creek Schists. It would appear that there is bedrock response allbeit poorly defined. The vertical loop method is unsuccessful on this line.

A large loop system (similar to TURAM) was tested to obtain deeper penetration (Plate 4). Noise effects were extreme and great difficulty was encountered in laying out the loop as the rough country making driving very slow and the featureless nature of the terrain making accurate sighting and positioning of the loop difficult. The transmitter loops were laid out as large rectangles 1.6 kilometre by 600 metres. It was only possible to get five readings on the line from each loop up to a maximum of seven hundred metres away. An increase in apparent conductivity was observed at the eastern end of the section of line tested in both cases. This would appear to be a parametric responce rather than any true bedrock response. The large loop system was not successful in penetrating the surface material.

Line E

This line was close to the coast and its entire length was covered with seaweed. A high near surface variable conductivity produced a high noise level however deep responses were detected on the tilt angle (Plate 5). The ellipticity profile showed little variation even at 41 HZ. The tilt angle showed two contacts at E19 and E7 as well as a slight positive anomaly at E18. Drill hole information shows these contacts to be at E19 and E7,the boundaries of the Fish Creek Schists. The small conductive response is presumed to be due to the dolerite found at the eastern contact. The zone to the west of E19 which is overlain by an increasing thickness of sediments is due either to porous Coomalie dolomite or to an older dolomitic rock on the edge of the Fish Creek Schists.

Line B and C

These two lines join with peg B30 being equivalent to CO so the two lines are plotted as one profit along a line meandering from the West Woolner Dome to the East Woolner Dome. The traverse along this line was fairly rapidly done using the horizontal loop (average 30 readings per day). The results are quite interesting (Plate 6). Drill hole information indicates a thickening of the overburden in the middle of the line. This is seen on the conductivity plot (Fig. 2) for frequency 41 HZ as a regional increase across the middle of the profile reflecting the increased amount of conductive overburden. Two zones of substantially higher conductivity are located on the EM profile between stations B2 and B4 in zone of conductive material which from drill hole information would appear to fall within the boundaries of the West Woolner Dome. Some pyrite was found in cross cutting veins in a nearby drill hole and it may be that this mineralisation is more extensive in this area than has been realized. The other possibility is that we have had rock movement in the area so that a portion of the granite has been faulted out of place and that the conductor is due to graphitic material faulted into the granite. The eastern conductive feature is more pronounced and the resistivity of the East Woolner Dome appears higher though this is partially due to decrease in the thickness of the cover. This conductor is interpreted to be due to graphitic material along the boundary with the granite.

Line D

This line is located southeast from the homestead water bore. It has no EM anomalies pronounced in its entire length so it is presumed to not have sufficient northern extent to reach the granite contact. As granite was encountered in the homestead bore the contact must be located to the south between there and the first reading which was taken two hundred metres away to be well clear of the buildings. No rise in conductivity was noted at the end point of the line so if any conductive unit exists at the granite boundary at this point it must be very narrow.

Line F

Conductive overburden is evident increasing in thickness to the south. At station F8 there is a high in the tilt angle response which is associated with an early turnover in the ellipticity. This could be indicative of a sedimentary channel in the Cretaceous sediments filled with more recent sediments and saline fluids.

Line 73.5E

The EM data approaches a three layer model when compared with the type curves although a four layer curve might be more representative. The upper layers are extremely conductive. There is a slight increase in conductivity at depth around 31.8E which indicates basement response with little variation, presumably a granite.

Line 26.0N (from 69.4E - 71.4E)

EM coupling is pronounced. The small changes in conductivity near the surface are due to variation in the thickness of the upper layer, namely the recent cover. The narrow conductor at 69.7E is also a shallow response. A feature at 71.0E is more persistent at depth and is interpreted to be related to bedrock, perhaps to sediments of Proterozoic age which are other than dolomite. The response is somewhat narrower than that on Line C which appears to be at an equivalent position in the sequence.

Line 26.0N (from 66.5E - 67.3E)

This data does not match our standard curves well. A stronger conductive layer is to be found at a depth of about 20 m. It wedges out to the west at 66.8E. The surface conductivity is particularly high at the edge of a flood plain.

Line 25.0N

Ground magnetics were completed on this line and showed up no anomalous features. The EM response indicates that the conductive overburden thickens sharply to the west of 66.8E.

Line 24.0N (from 69.3E to 70.3E)

At this line there is relatively shallow bedrock with conductive overburden generally less than 40 m in thickness. A narrow dyke with conductive features has been located 70.1E. The feature is strongly pronounced on both tilt angle and ellipticity. West of 70.0E the overburden thickens rapidly. A ground magnetics traverse indicates that the line can be divided into two zones east and west of 70.03. To the west the magnetic response is featureless. To the east it is sharply disturbed. This appears to be the contact between the dolomite in the west and laterite on top of granite or Proterozoic sediments in contact with a granite. In this area further ground magnetics would be useful to better define the extent of these two zones.

Line 24.0N (from 66.2E to 67.2E)

A ground magnetic traverse indicates a 500 gamma feature at 67.13E. This anomaly is interpreted as being caused by a dolerite dyke which dips steeply to the west. The magnetics is otherwise featureless indicating that the bedrock is covered by a thick layer of dolomite with a depth of at least 65 m. The EM also indicates that the thickness of overburden thickens to the west. A vertical feature occurs at 66.9E. It does not extend to depth and must be located in the Cretaceous sediments and not easily explained. A steeply dipping conductor is located at 66.6E.

Line 27.0N

The conductive overburden increase in thickness to the west from 66.6E. There is a west dipping dislocation in the overburden at 65.5E. A change in bedrock occurs at 66.87E with as contact dipping to the west at a small angle. The ground magnetics has no anomalies apart from small (10 - 15 gamma) highs which are at pegged stations and are probably due to readings being taken too close to the steel fence droppers which were used for gridding. A poor conductive response is present in frequency 41HZ at 64.9E. This is close to the granite contact as outlined by Peko. It is probably indicate a fault within the granite as the contact is at 66.9E.

Line 28.5N

This line is only 600 m long as difficulty was experienced in clearing the bush at either end of the line. A fault is located at 74.8E with a small change of conductivity across it. This could be the contact between two different types of granite. The overburden thickness is approximately 40 m. A ground magnetic profile over this line would indicate if we have a narrow dolerite present but the wet season set in before it was possible to survey this part of the area.

Line 29.0N

Magnetic contacts occur at 66.45E and 67.40E. Narrow dykes are indicated at 66.63E and 66.76E. The EM data indicates a basement contact dipping at a slight angle to the west from 66.8E. At approximately 20 m depth on the eastern portion of the line a highly conductive band shallows over possible granite.

Line 31.0N

Traverse is 800 m limited in length by thick bush. The surface material has a lower conductivity to that found on the flood plains. No conductive basement features are evident. A dyke is visible on the magnetic profit at 68.47E which is probably produced by a narrow dolerite dyke. A contact is located on the magnetic profile at 67.57. Proterozoic sediments occur on the west with dolomite occuring to the east.

Line 36.0N

No strong bedrock responses are evident though a change in frequency 41 HZ at 70.1E is probably caused by a contact between granite and sediments. At 70.2 to 70.3E a surface conductor indicates a possible sedimentary channel. A second channel not so pronounced could occur at 69.2E.

Line 64.2E

Very high conductivity in the surface layer is located on the line below the surface layer a layer of not quite so high conductivity but still high conductivity has been mapped. The magnetic along the line is quite featureless indicating dolomite bedrock. Noticeable variation produced by variation in thickness of the surface layer is shown by the tilt angle response.

Line B/C Seismic and Gravity

These surveys were conducted as a test for seismic and gravity survey methods in the highly weathered areas as well as to define more clearly the anomalous features detected with the EM along line B/C. Gravity readings at 50 m intervals defined the edges of a broad gravity high (1 mgal on amplitude) which lies between the two major granite domes. This represents a broad slab of flat lying Coomalie Dolomite which overlies granite and probable earlier Proterozoic sediments. Two types of granitic basement are evident on the gravity and also by initial perusal of the seismic data. One granite is a bouyant intrusive granite with low density of 2.61 gms/cc and the other is a somewhat denser granite gneiss of density 2.67 gms/cc. The Fish Creek Schists are widely distributed while the other metasediments occur only in a narrow band distinguished by slightly higher density and velocity and by lower magnetic response.

Except for the area around B9, the dolomite is up to 70 m thick therefore it is quite costly to drill, but this is required to ensure proper economic understanding of this area.

CONCLUSIONS AND RECOMMENDATIONS

The schists which have been proposed to exist below the Coomalie Dolomite between the two granite domes are an exploration target which it will be necessary to test by drilling Drill holes are recommended at Line 27N 65.7E to test rock type change in basement. Line 29N 66.85E to test basement conductor near granite contact. Line C 6E to test basement conductor. Bedrock should be encountered at 160m at the outside.

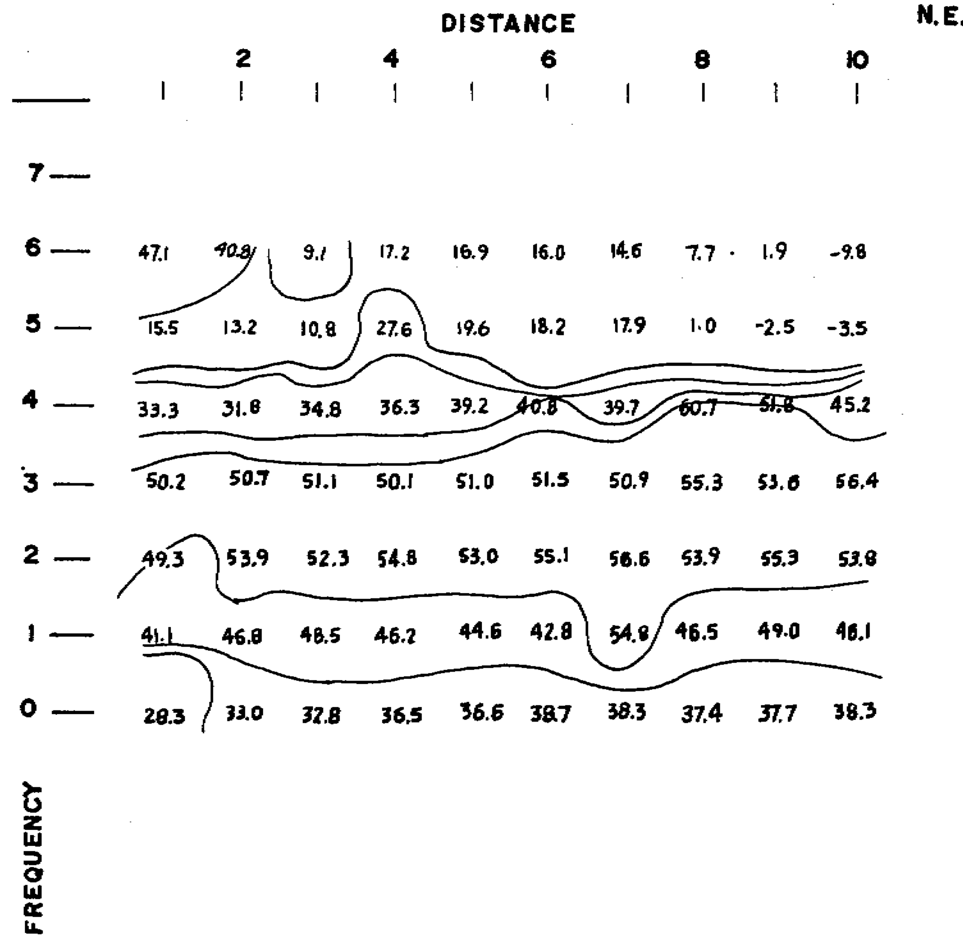
Elsewhere the edges of the granites are usually associated with some conductive response (except where the amount of cover is too great for the GEM-8 to penetrate). This indicates that the granite has upfaulted conductive Proterozoic metasediments, some of which possibly contain graphite from lower sections of the Fish Creek Schist. The sediments on the western end (adjacent to the eastern margin of the western dome) of the GEM-8 traverse in the embayment between the two domes are more conductive than those on the eastern end of the traverse (western margin of the eastern dome) Therefore the sediments on the western end of the traverse are more prospective for further study if drilling determines that there are promising graphitic schist horizons below the Coomalie Dolomite in the embayment between the two granites.

APPENDIX 1

Frequencies of GEM-8 channels.

Frequency 0	41 HZ
Frequency 1	82 HZ
Frequency 2	164 HZ
Frequency 3	328 HZ
Frequency 4	656 HZ
Frequency 5	1312 HZ
Frequency 6	2624 HZ
Frequency &	5248 HZ

LINE F (200 M SEPARATION)



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

6
|

TX IN SW

MOBIL ENERGY MINERALS AUSTRALIA

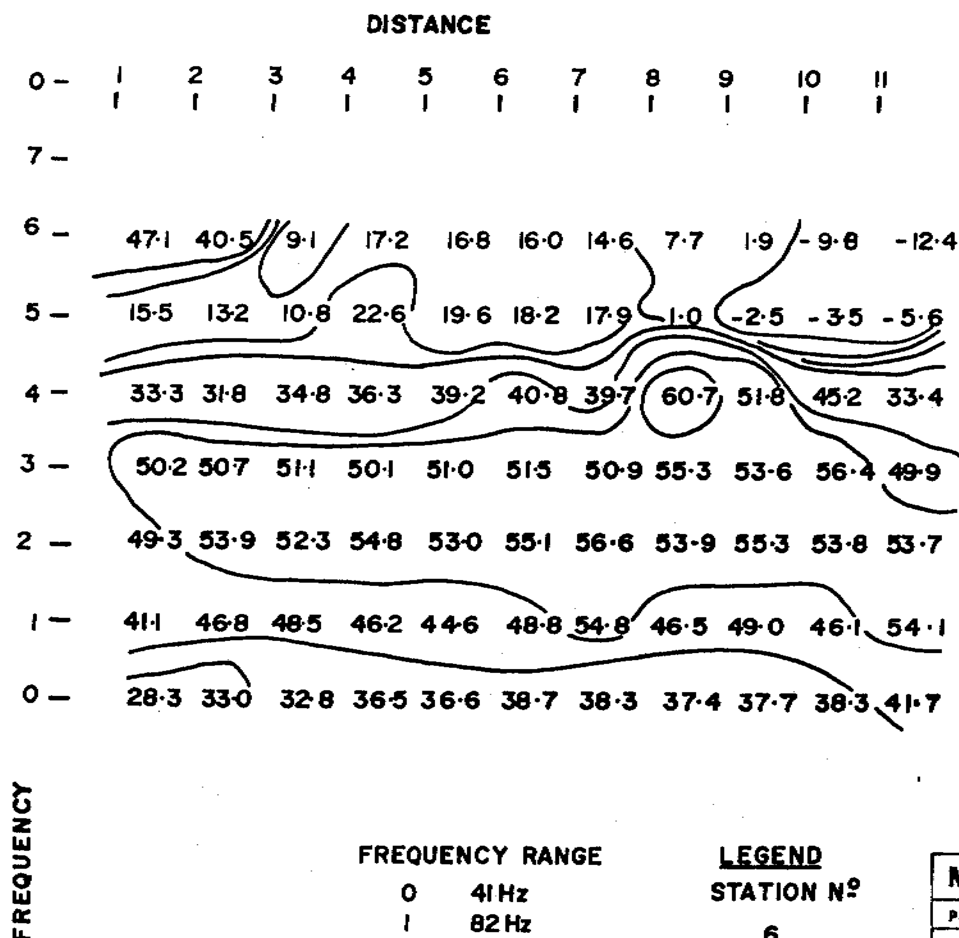
PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS
LINE F (200 M SEPARATION)

	DATE	BY	ADDNS	DATE	BY
COMPILED	Jan. 83	L.J.S.			
DRAWN	27·1·83	R.G.H.			
SCALE	1:10000		DWG No 3·3178·1·0091		

Plate No. 1

SW LINE F (200m SPACING) N E DIRECTION



FREQUENCY RANGE	
0	41 Hz
1	82 Hz
2	164 Hz
3	328 Hz
4	656 Hz
5	1312 Hz
6	2624 Hz

LEGEND

STATION Nº

6
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION

LINE F (200m SPACING)

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	2 FEB 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·098	

Plate No. 2

LINE E

DISTANCE

2 4 6 8 10 12 14 16 18 22 24 26

FREQUENCY																								
7																								
6	6.0	6.8	3.4	8.0	2.5	4.9	51.4	30.8	23.6	6.9	2.6	8.3	16.6	10.8	6.4	4.4	9.9	2.5	8.9	84.5	89.5	3.7	86.6	-1.4
5	7.5	7.3	6.4	8.6	5.1	6.2	71.0	9.7	8.7	14.2	8.2	6.9	10.7	6.0	5.7	10.4	84.0	1.7	88.0	-1.5	7.3	7.2	2.2	3.6
4	85.5	86.0	86.4	86.3	86.0	86.8	4.8	86.3	85.7	87.6	86.9	85.0	84.9	83.8	85.6	86.2	82.5	88.3	86.6	-3.3	85.6	84.0	84.3	84.3
3	84.5	85.8	86.4	84.8	84.7	85.3	83.1	84.0	83.9	82.9	85.2	84.5	84.7	82.7	85.1	83.8	85.1	88.9	85.4	85.9	86.1	88.8	-2.2	81.2
2	1.1	1.5	1.2	2.7	2.7	4.4	89.8	3.9	3.1	0.9	5.2	4.0	3.3	0.9	1.0	1.8	89.8	2.8	87.0	-3.7	82.7	82.6	80.3	81.3
1	75.7	76.9	78.8	74.8	74.9	75.2	7.3	70.6	65.2	69.3	71.1	71.9	69.5	67.7	70.0	69.8	65.7	69.1	61.3	64.9	65.0	59.1	56.8	58.5
0	55.9	57.6	58.7	55.5	57.0	54.3	51.4	51.0	50.0	50.6	51.5	51.0	51.1	50.4	50.4	49.9	49.3	51.0	43.9	46.6	45.1	42.4	41.0	40.0

FREQUENCY RANGE

0	41 Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

16

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION

LINE E

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	2 FEB. 83	R.G.H.			
SCALE	1:10000		DWG No 3-3178-1-097		

Plate No 3

LINE A (200 SPACING) Rx at 90°

FREQUENCY	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	APPARENT DEPTH
7	85.5	87.5	87.7	0.9	-1.5	81.6	-1.8	87.5	86.9	-1.6	12 metres
6	88.2	86.8	87.4	-1.9	-2.6	87.0	-3.3	86.5	85.7	-3.6	17
5	87.5	86.8	86.8	87.6	-3.4	86.7	86.4	85.7	85.2	-3.6	24
4	86.6	86.5	86.8	86.9	85.8	85.6	85.0	84.8	84.2	85.3	34
3	85.5	85.8	85.4	85.8	84.5	85.0	85.2	84.8	84.1	85.1	48
2	85.7	85.2	84.7	84.8	83.1	82.8	81.8	81.3	81.2	81.5	68
1	80.8	78.8	77.7	78.0	75.8	75.8	74.0	73.5	73.5	73.6	96
0	71.7	71.4	70.8	6.95	68.9	69.2	69.4	67.7	67.4	67.1	136

DISTANCE

FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
A16

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

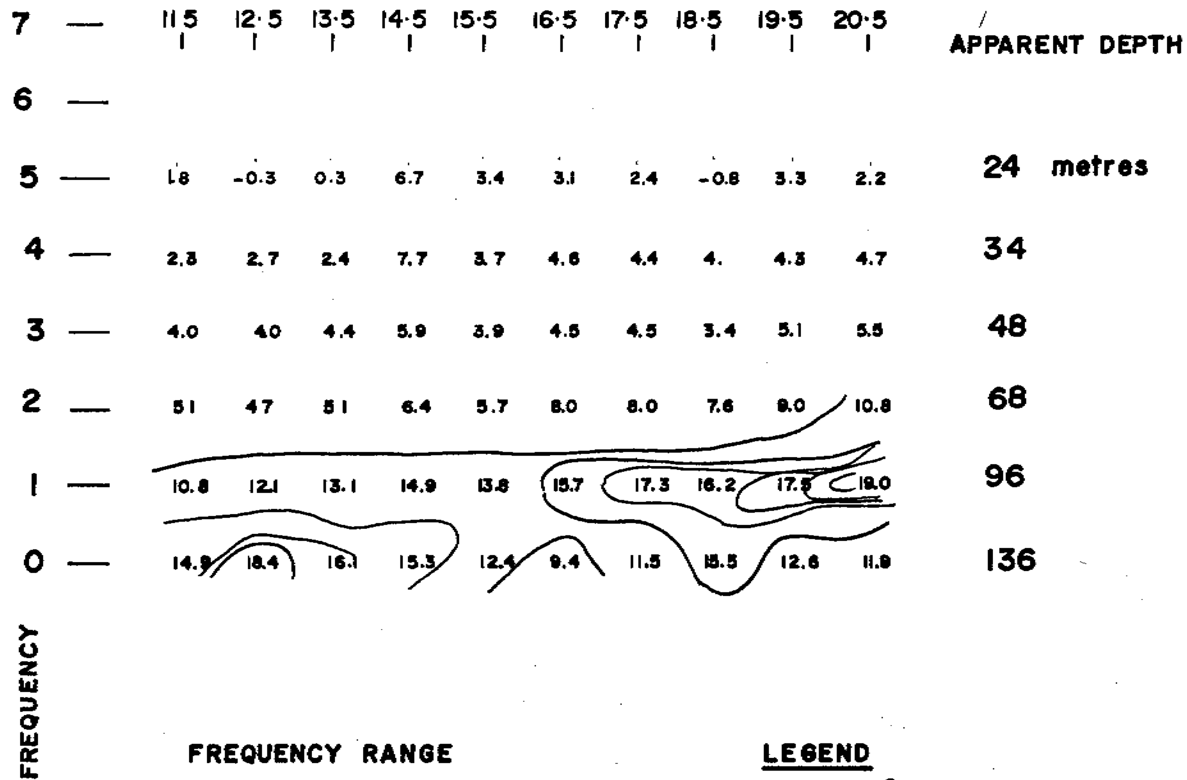
PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE A (200m SPACING)
Rx at 90° VERTICAL LOOP
IN LINE MODE

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	2 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0092	

Plate No. 4

LINE A VERTICAL LOOP (300m SPACING)



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

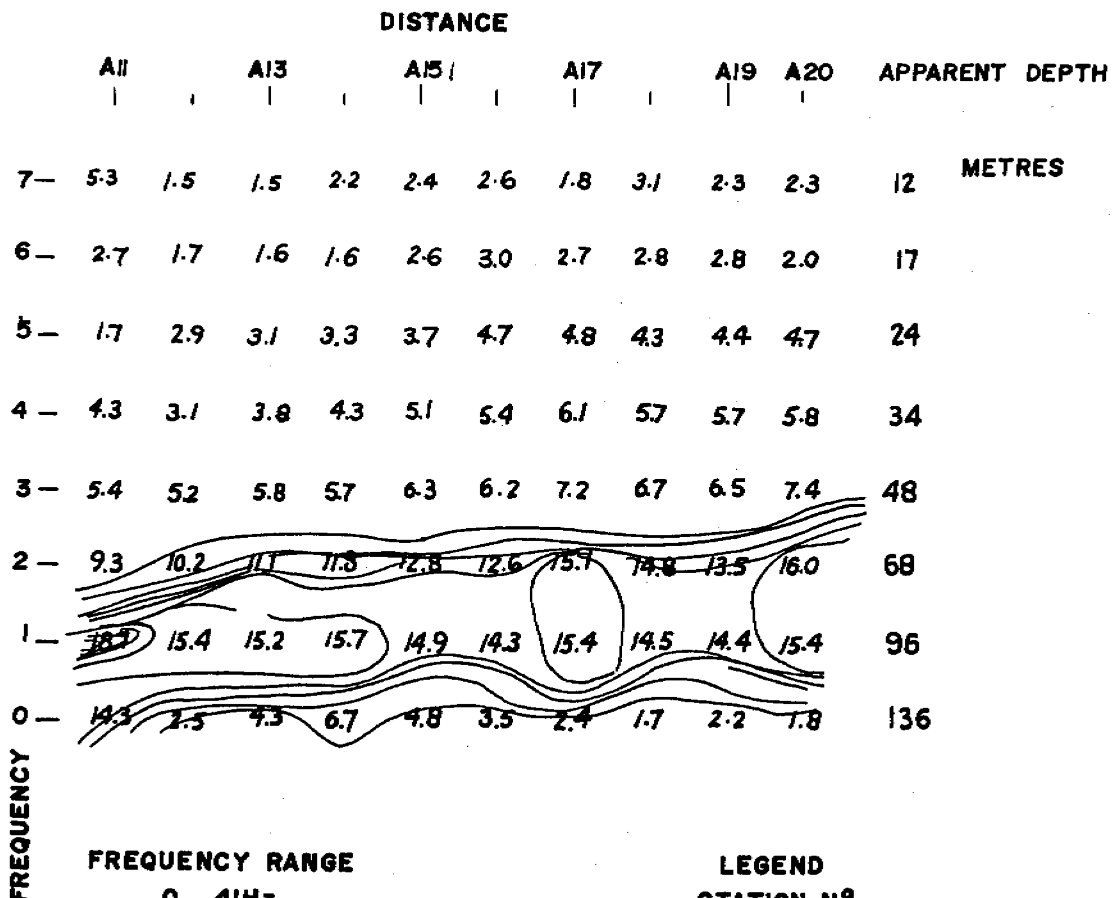
STATION Nº

TX IN WEST

MOBIL ENERGY MINERALS AUSTRALIA					
PROJECT	WOOLNER				
ELLIPTICITY PSEUDOSECTIONS LINE A VERTICAL LOOP (300 m SPACING) IN STRIKE MODE					
	DATE	BY		DATE	BY
COMPILED	JAN. 83	L.J.S.	ADDNS		
DRAWN	27 JAN. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0085	

Plate No. 5

LINE A VERTICAL LOOP (200M SPACING) RX AT 90°



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
A15
|

TX IN WEST

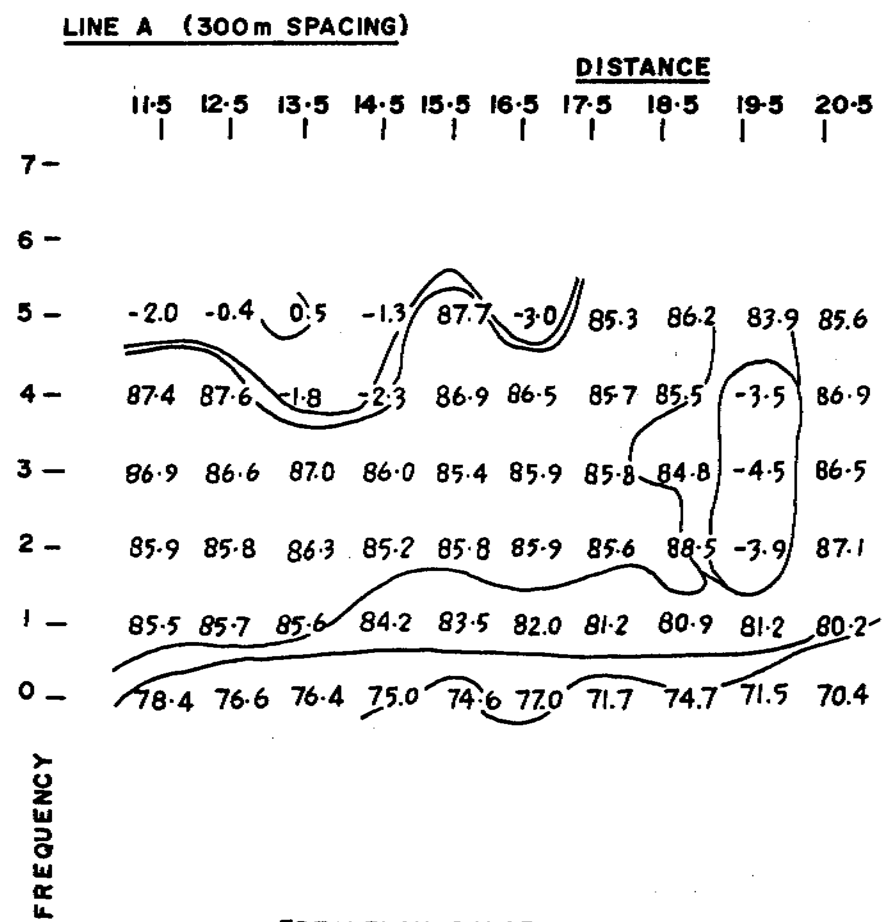
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDSECTIONS
LINE A
VERTICAL LOOP
IN LINE MODE

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	27 JAN. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0086	

Plate No. 6



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
16·5
|

Tx IN WEST

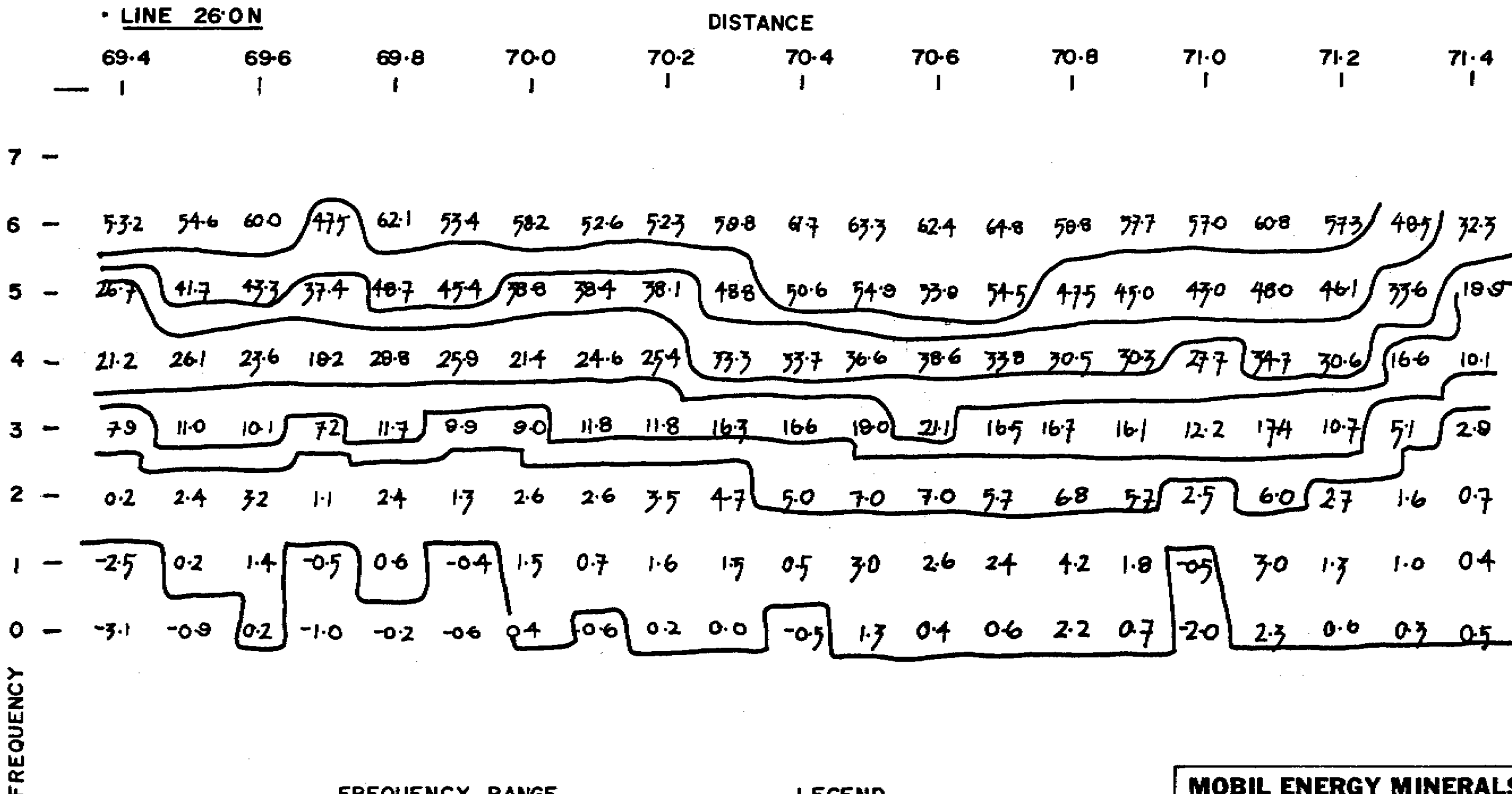
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE A (300 m SPACING)
VERTICAL LOOP
IN STRIKE MODE

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	2FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·1·093		

Plate No. 7



FREQUENCY RANGE

0	41 Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624 Hz

LEGEND
STATION Nº
70·2
|

Tx IN WEST

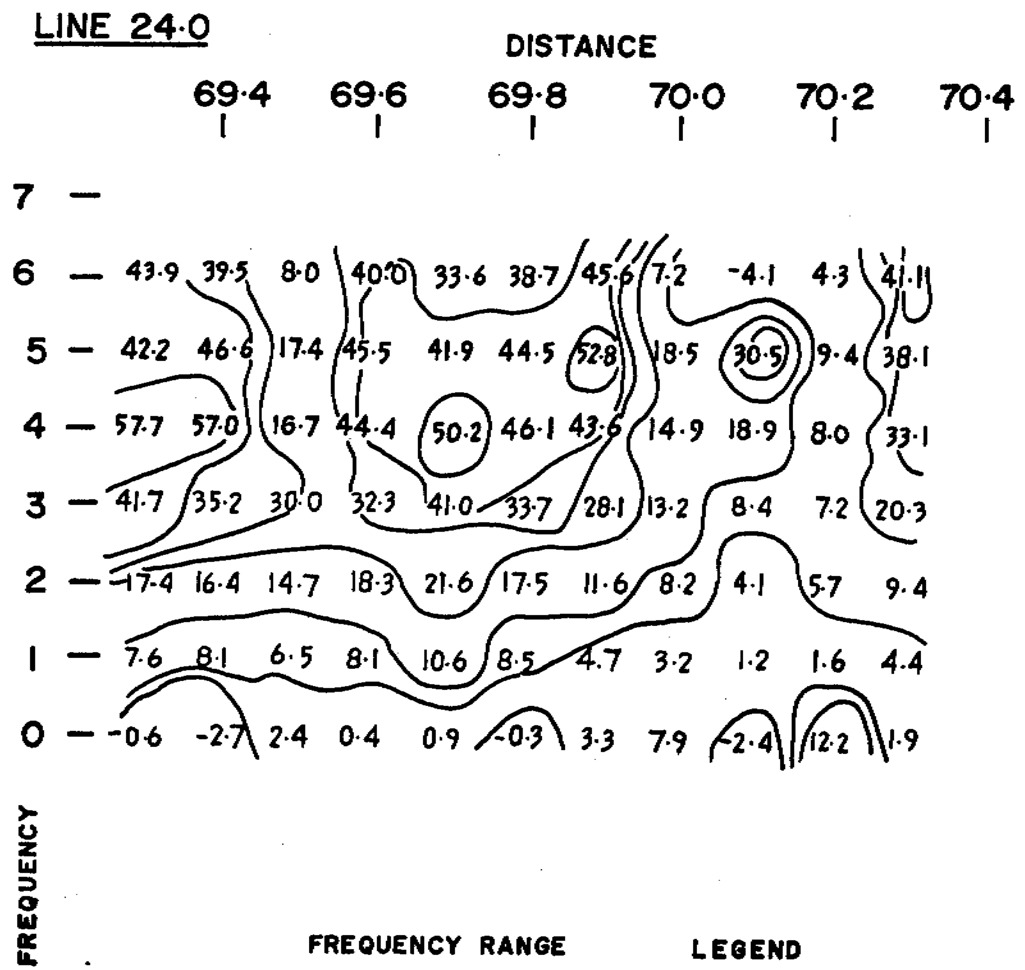
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICIY PSEUDOSECTION
LINE 26·0N

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	JAN. 83	H.S.			
SCALE	1:10,000		DWG No	3·3178·1·0077	

Plate No. 8



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

69·8

I

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

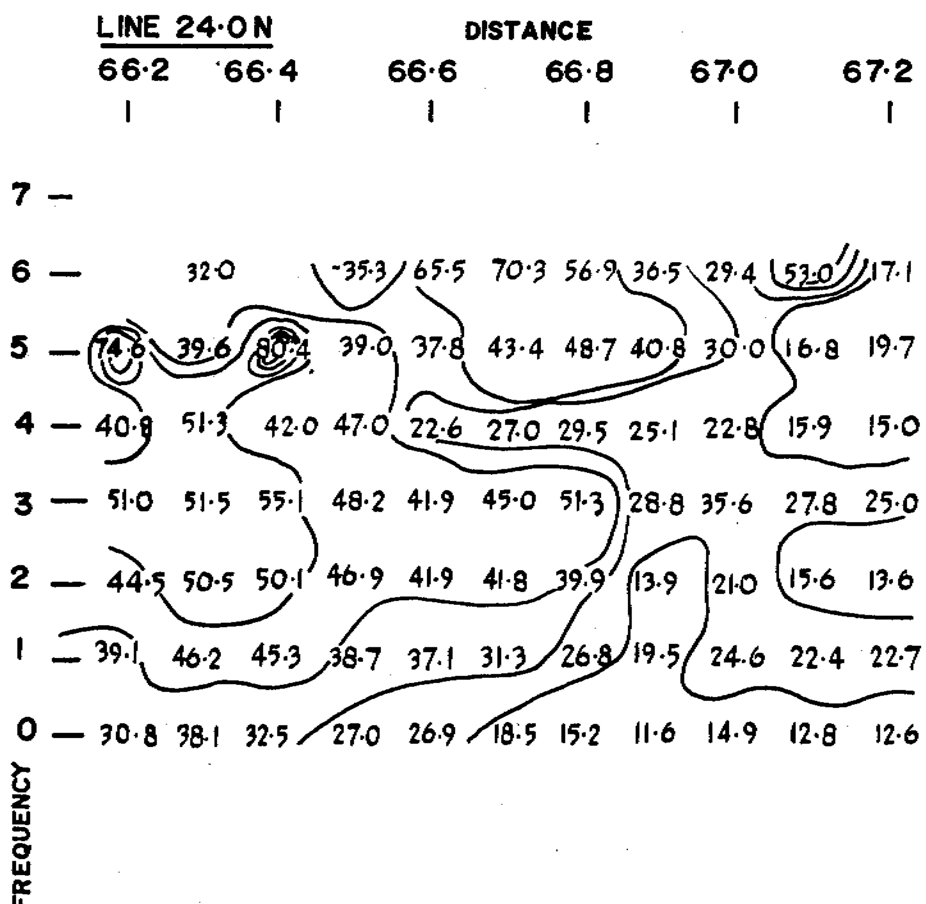
TILT ANGLE PSEUDOSECTION

LINE 24·0

EASTERN SECTION

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	7 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No. 3·3178·1·0099		

Plate No. 9



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
66·6
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

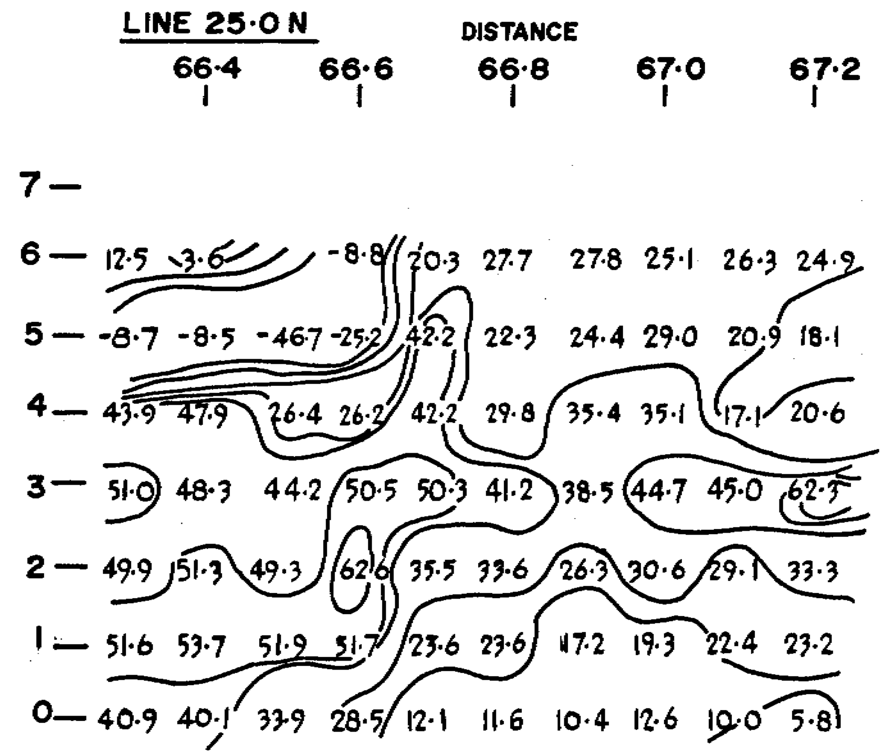
PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION

LINE 24·0 N
WESTERN SECTION

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L. J. S.			
DRAWN	7 FEB. 83	R. G. H.			
SCALE	1:10,000		DWG No	3·3178·1·0100	

Plate No. 10



FREQUENCY RANGE

0 41Hz
1 82Hz
2 164Hz
3 328Hz
4 656Hz
5 1312Hz
6 2624Hz

LEGEND

STATION Nº
66·8

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

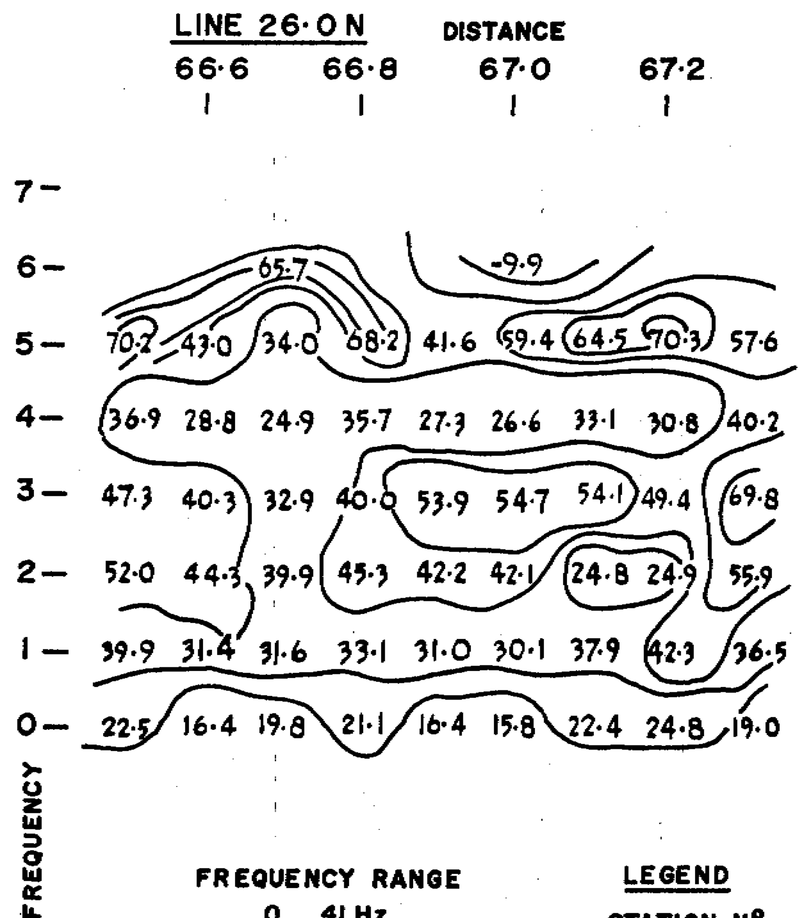
PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION

LINE 25·0N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	7 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·1·0101		

Plate No. 11



FREQUENCY RANGE

0	41 Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
67·0
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

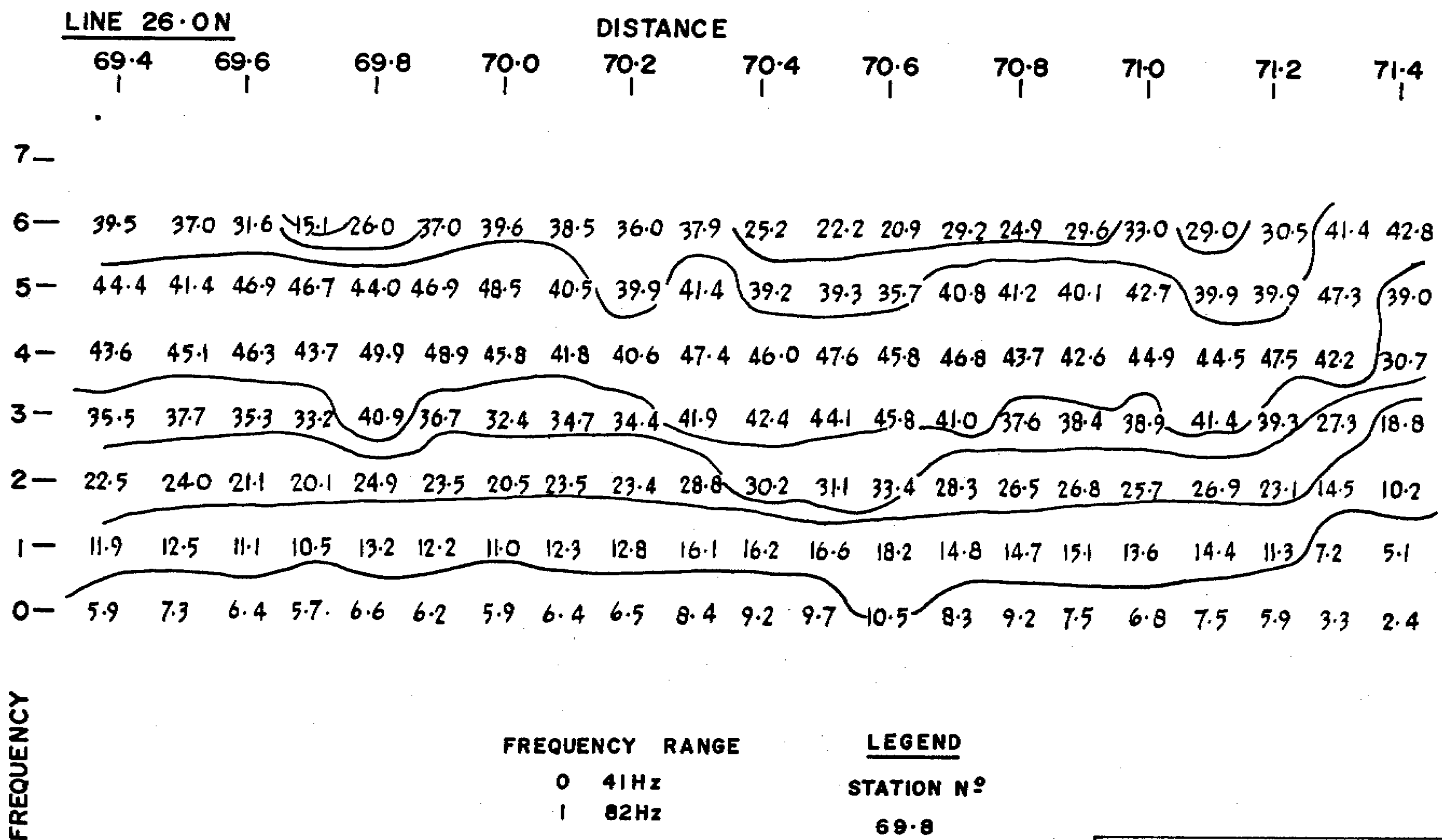
TILT ANGLE PSEUDOSECTION

LINE 26·0N

WESTERN SECTION

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	7 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·1·0102		

Plate No. 12



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
69·8
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

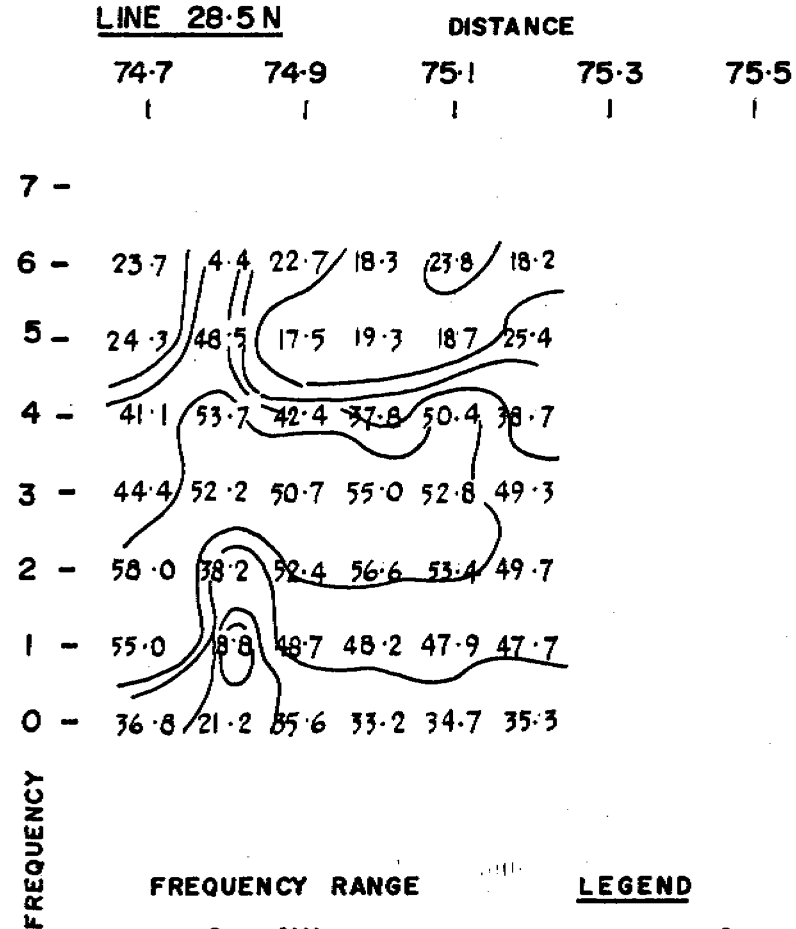
PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE 26·0N
EASTERN SECTION

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC.82	L.J.S.			
DRAWN	7FEB.83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·0103	

Plate No. 13

LINE 28·5N



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
75·1
|

Tx IN WEST

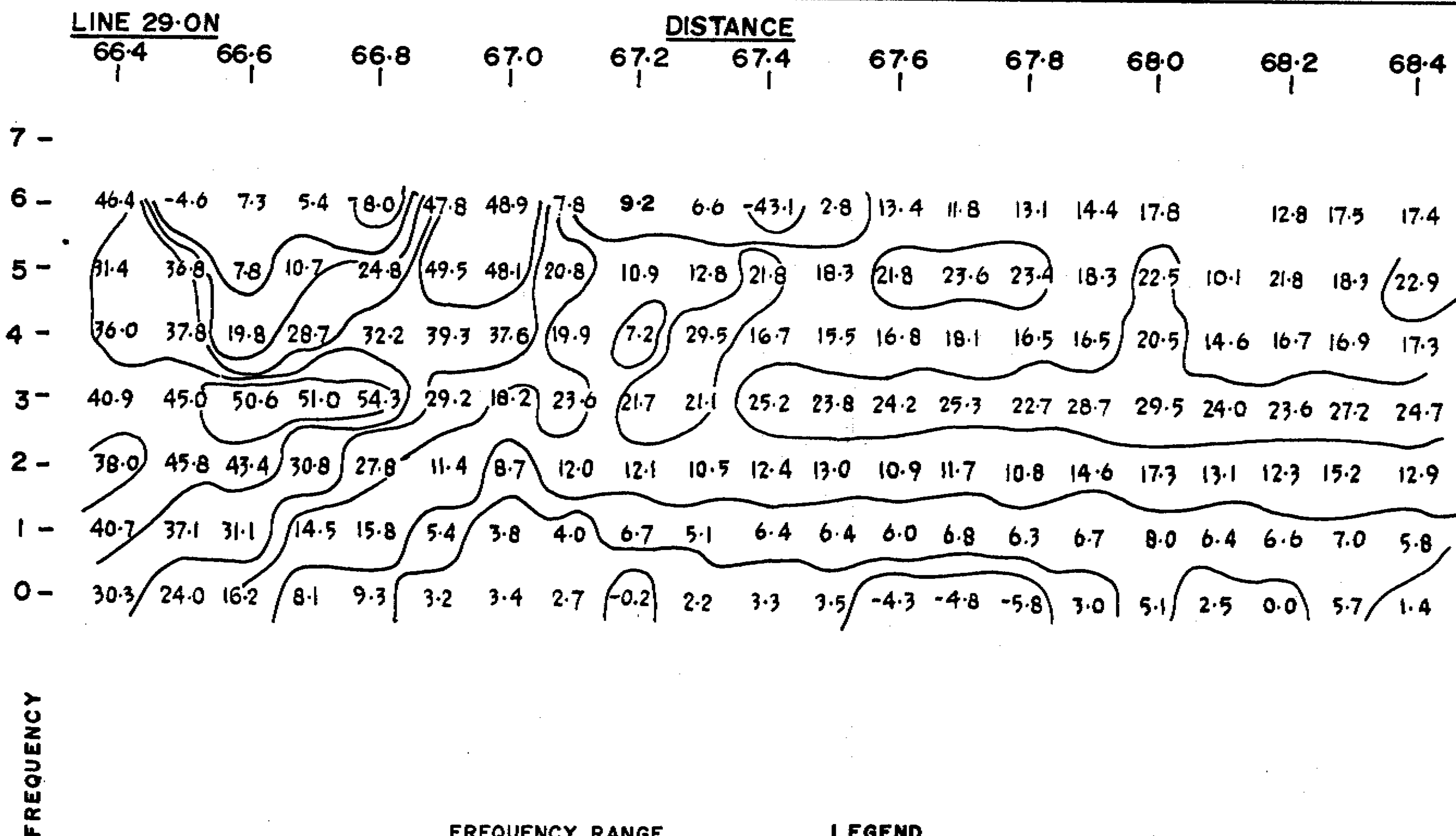
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE 28·5N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC.82	L.J.S.			
DRAWN	3 FEB.83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·1·0105		

Plate No. 14



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328 Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

66·8
|

Tx IN WEST

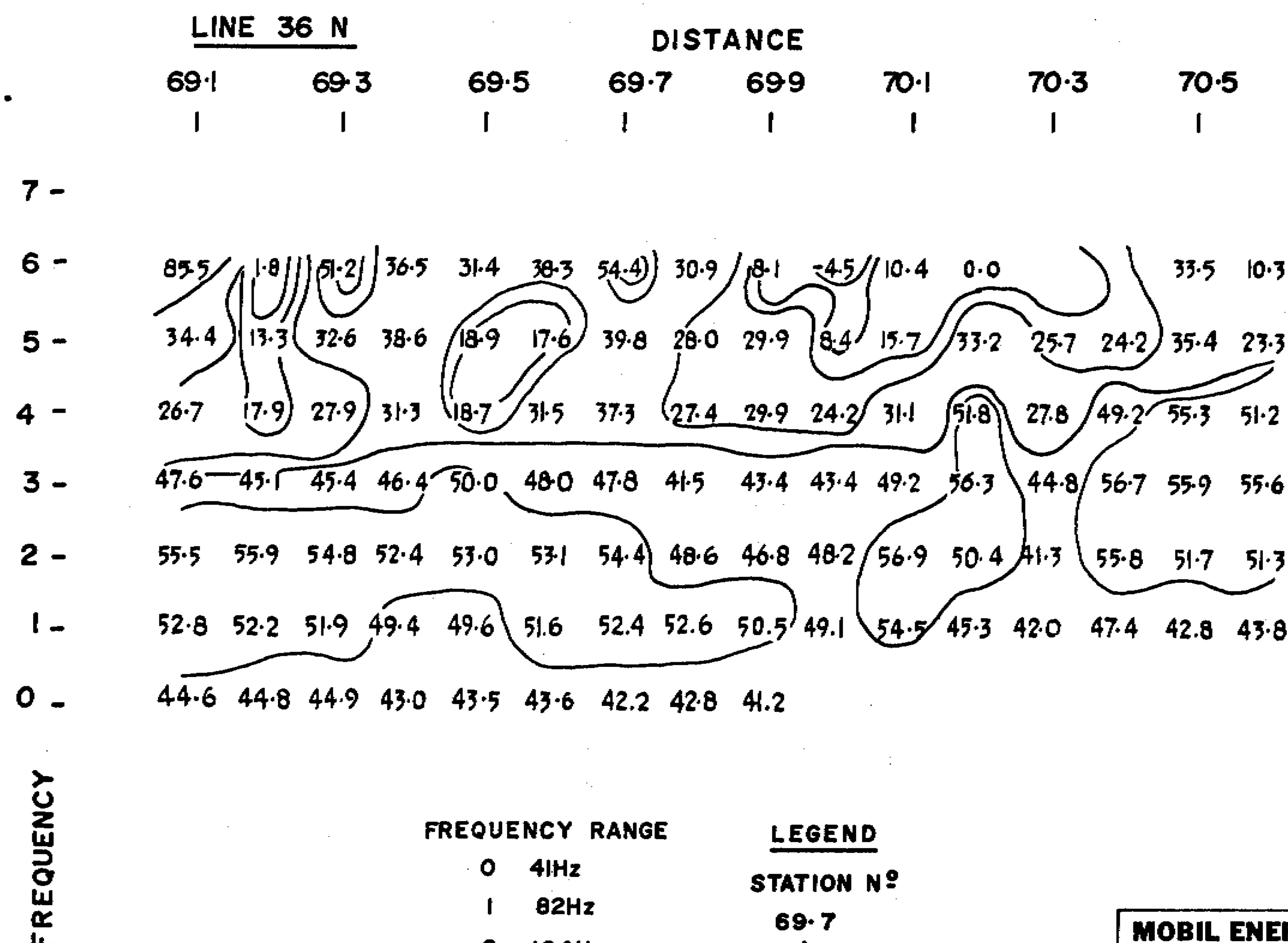
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE 29·0N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·0106		

Plate No. 15



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

69·7
|

Tx IN WEST

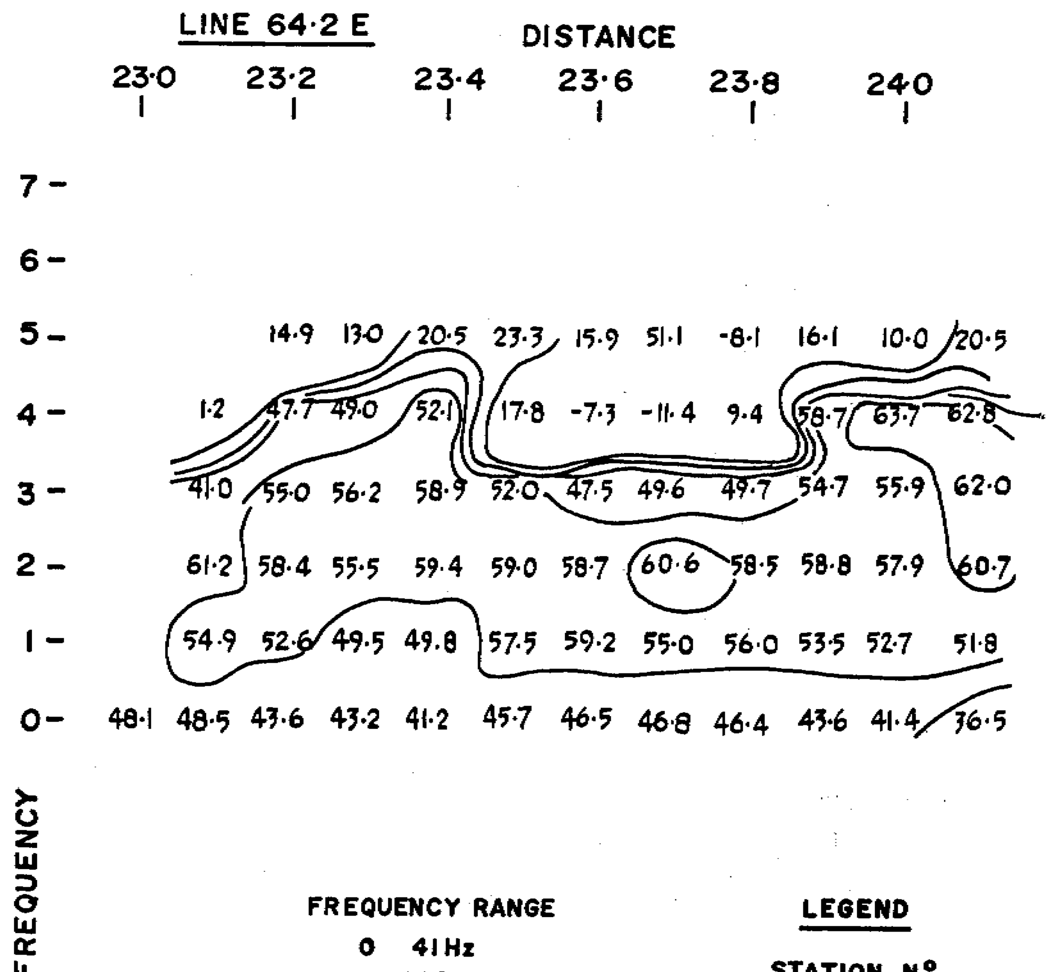
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE 36 N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0108	

Plate No. 16



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

23·4

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

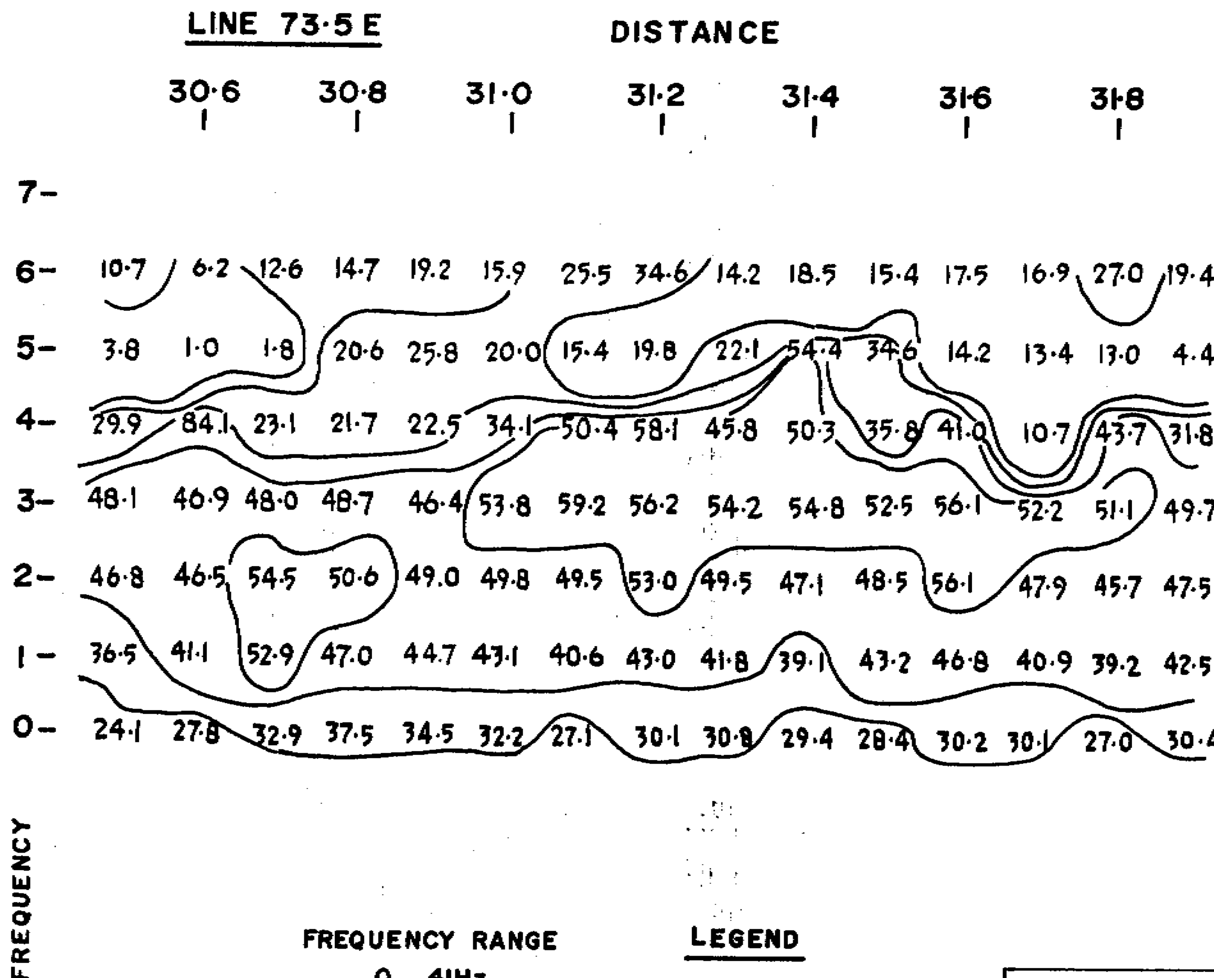
PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION

LINE 64·2 E

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0109	

Plate No. 17



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312 Hz
6	2624Hz

LEGEND

STATION Nº
31·2
I

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

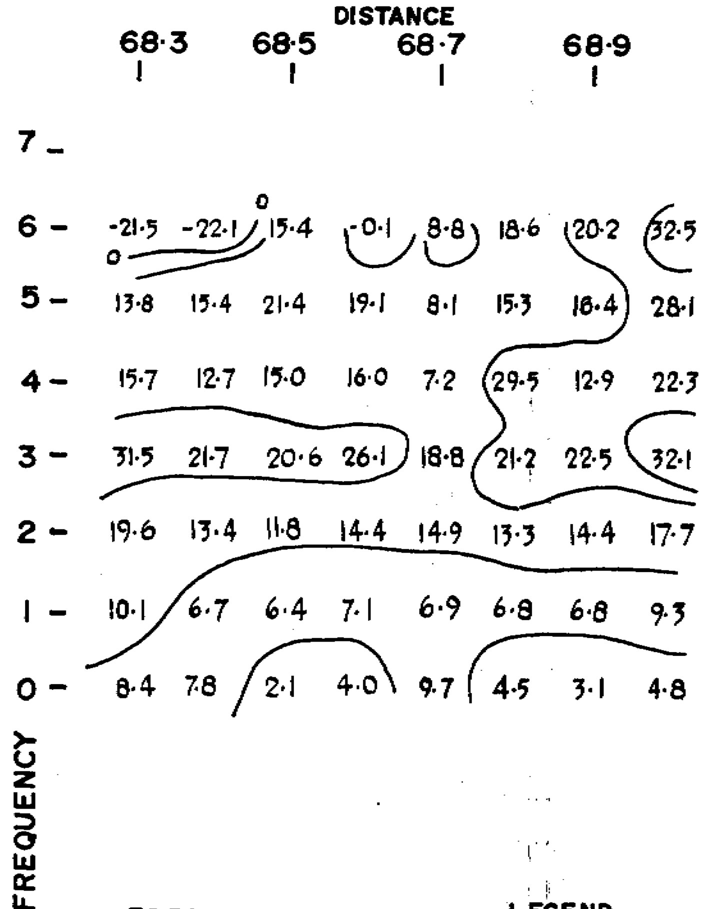
TILT ANGLE PSEUDOSECTION

LINE 73·5 E

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0110	

Plate No. 18

LINE 31·0 N



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312 Hz
6	2624Hz

LEGEND

STATION Nº
68·5
I

Tx IN WEST

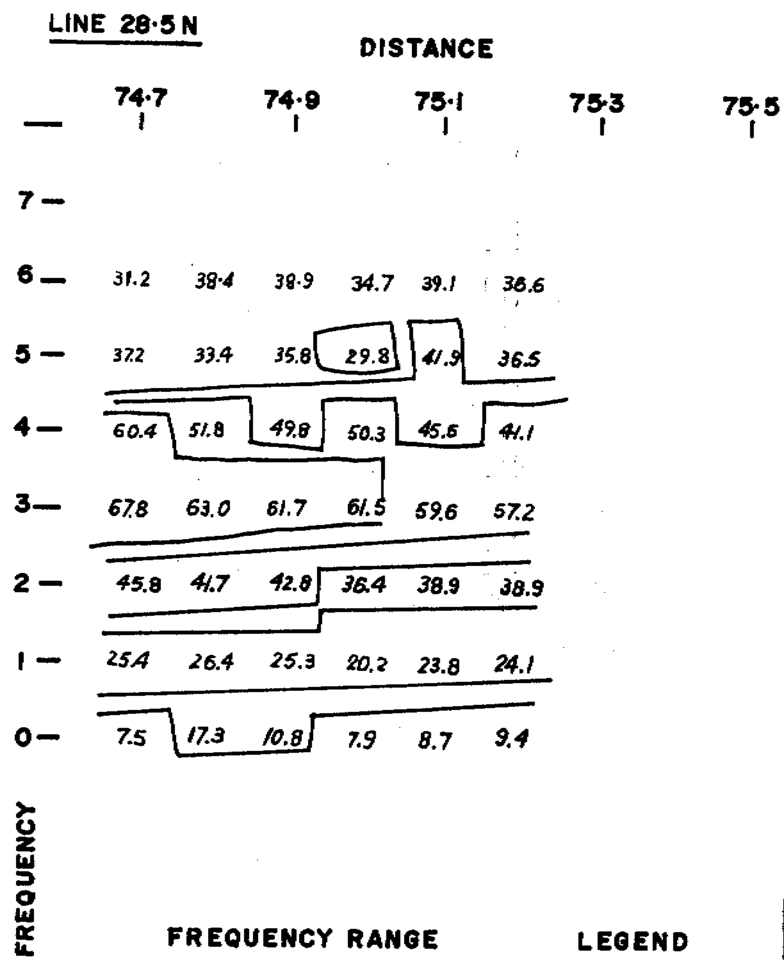
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE 31·0 N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC.82	L.J.S			
DRAWN	3 FEB 83	R.G.H.			
SCALE	1:10,000		DWG No 3·3178·1·0107		

Plate No. 19



FREQUENCY RANGE

0	41 Hz
1	82 Hz
2	164 Hz
3	328 Hz
4	656 Hz
5	1312 Hz
6	2624 Hz

LEGEND

STATION Nº
74·9
I

TX IN WEST

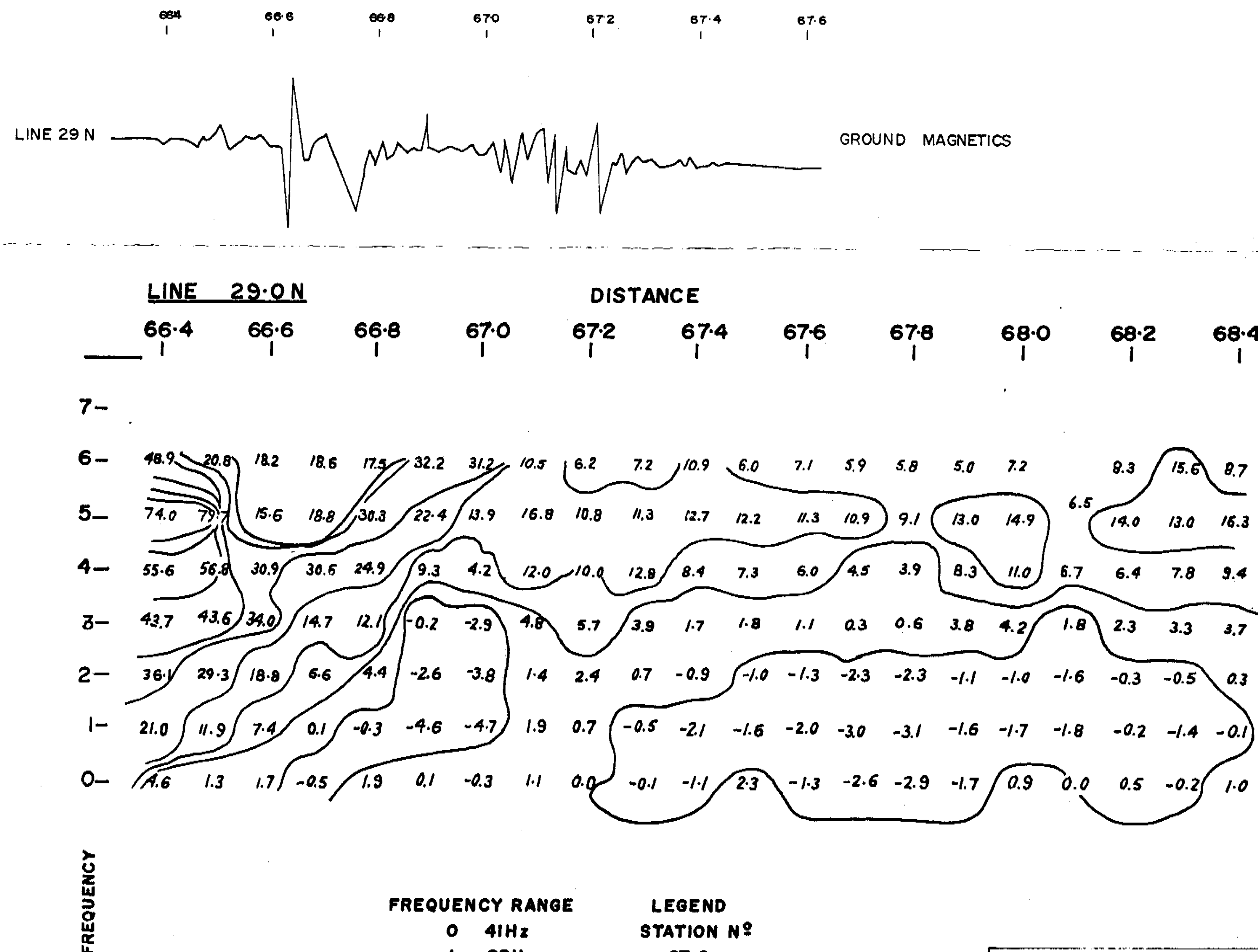
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS LINE 28·5N

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	27-1-83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0079	

Plate No 20



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
67·0
I

TX IN WEST

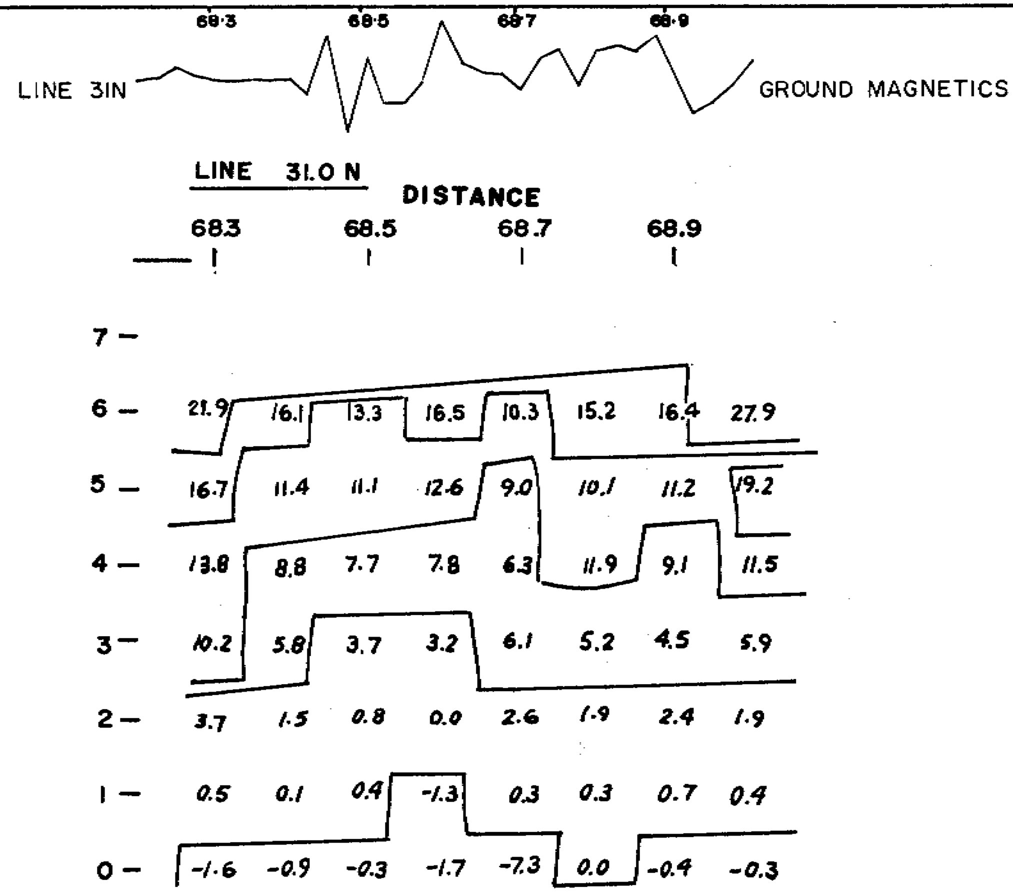
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS
LINE 29·0 N

	DATE	BY		DATE	BY
COMPILED	JAN. 83	L.J.S	ADDNS		
DRAWN	28-1-83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0080	

Plate No. 21



FREQUENCY

FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
68·5

TX IN WEST

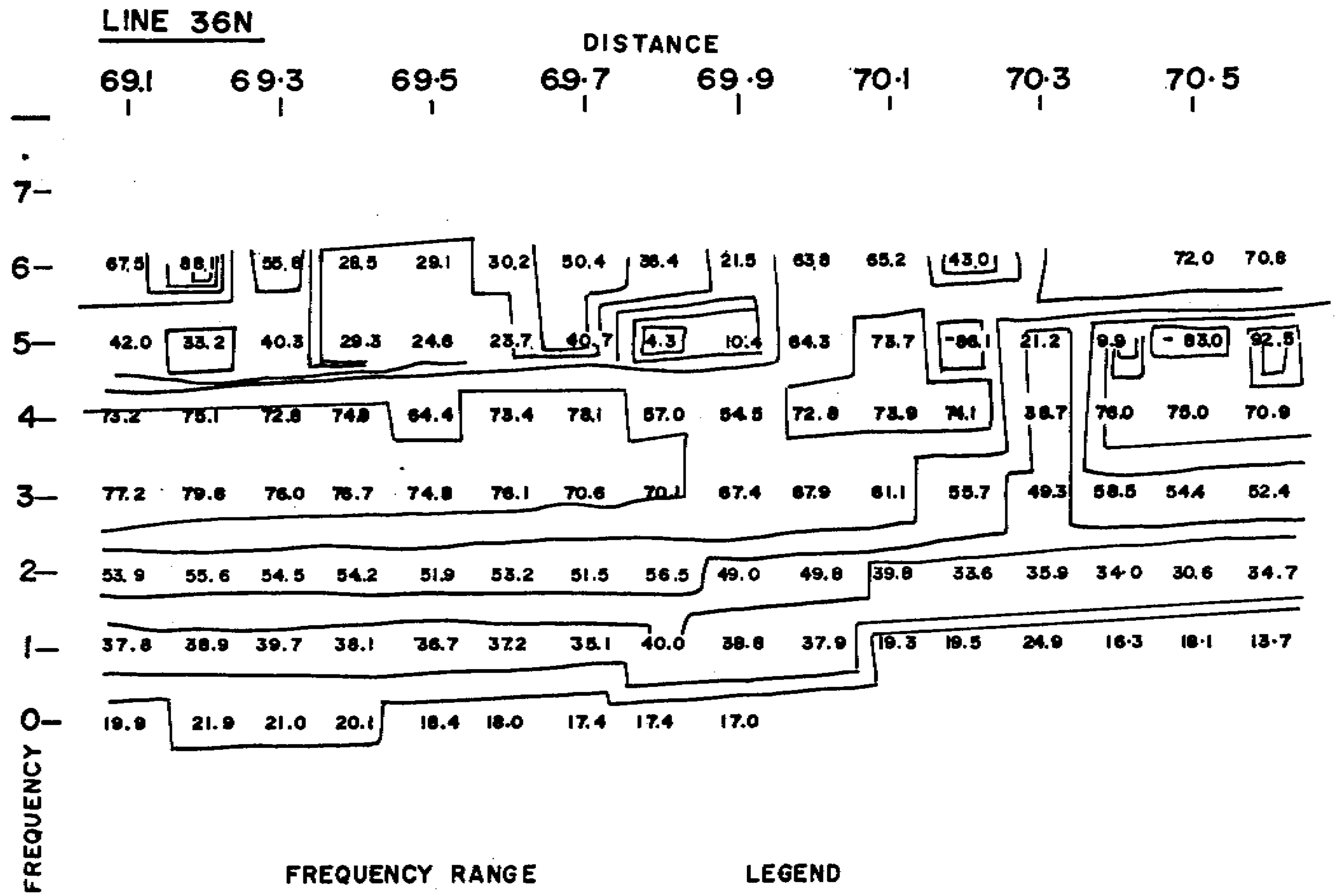
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS LINE 31.0 N

	DATE	BY		DATE	BY
COMPILED	JAN. 83	L.J.S.	ADDNS		
DRAWN	27·1·83	R.G.H.			
SCALE	1:10,000		DWG No.	3·3178·1·0081	

Plate No. 22



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
69·7

TX IN WEST

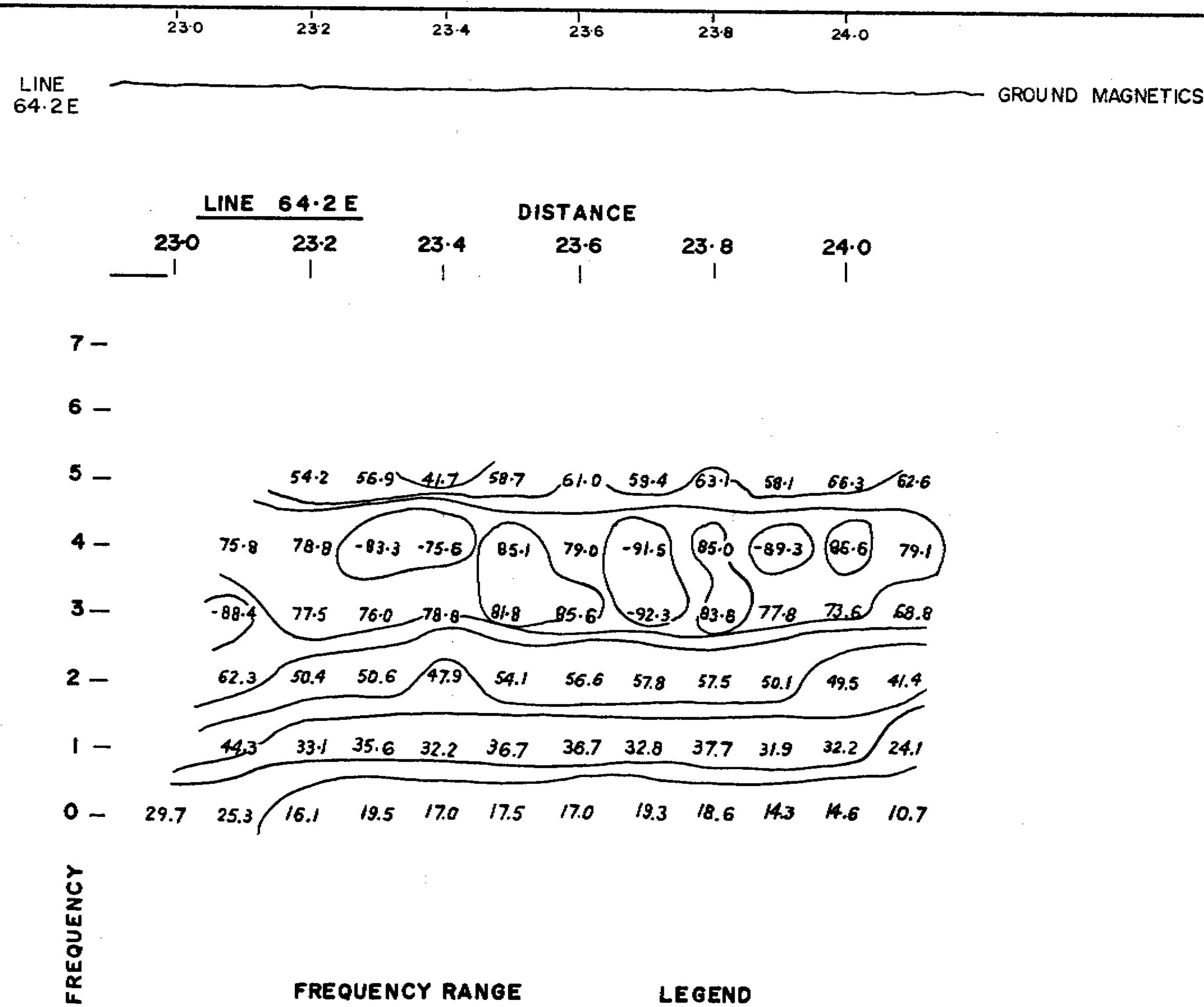
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTION
LINE 36N

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	27 JAN.83	R.G.H.			
SCALE	1: 10,000		DWG No	3·3178·1·0082	

Plate No. 23



FREQUENCY RANGE

0	41 Hz
1	82Hz
2	164 Hz
3	328Hz
4	656Hz
5	1312 Hz
6	2624Hz

LEGEND

STATION Nº

23·4

TX IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

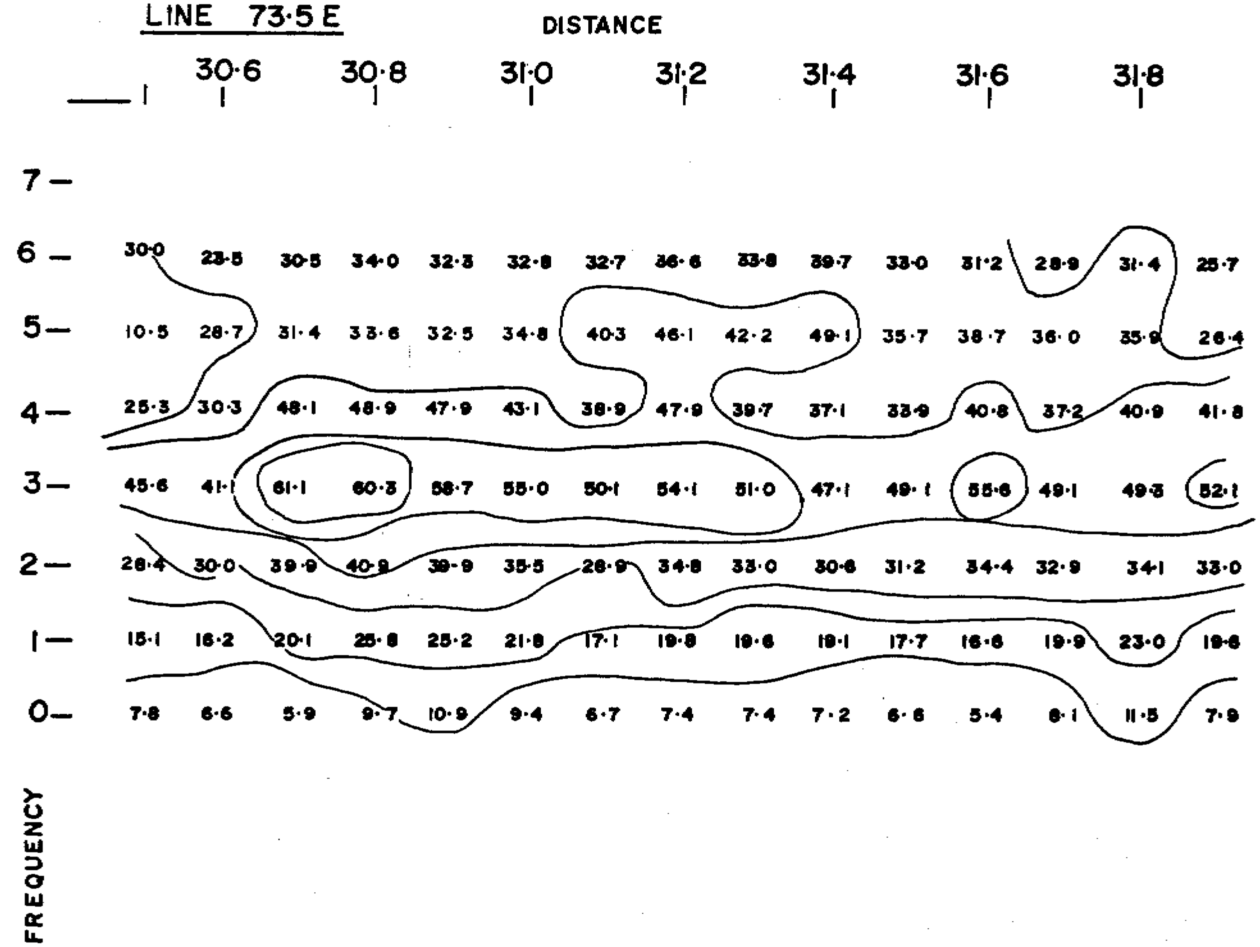
PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS
LINE 64·2 E

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	27-1-83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0083	

Plate No. 24

LINE 73·5 E



FREQUENCY RANGE

0 41Hz
1 82Hz
2 164Hz
3 328Hz
4 656Hz
5 1312Hz
6 2624Hz

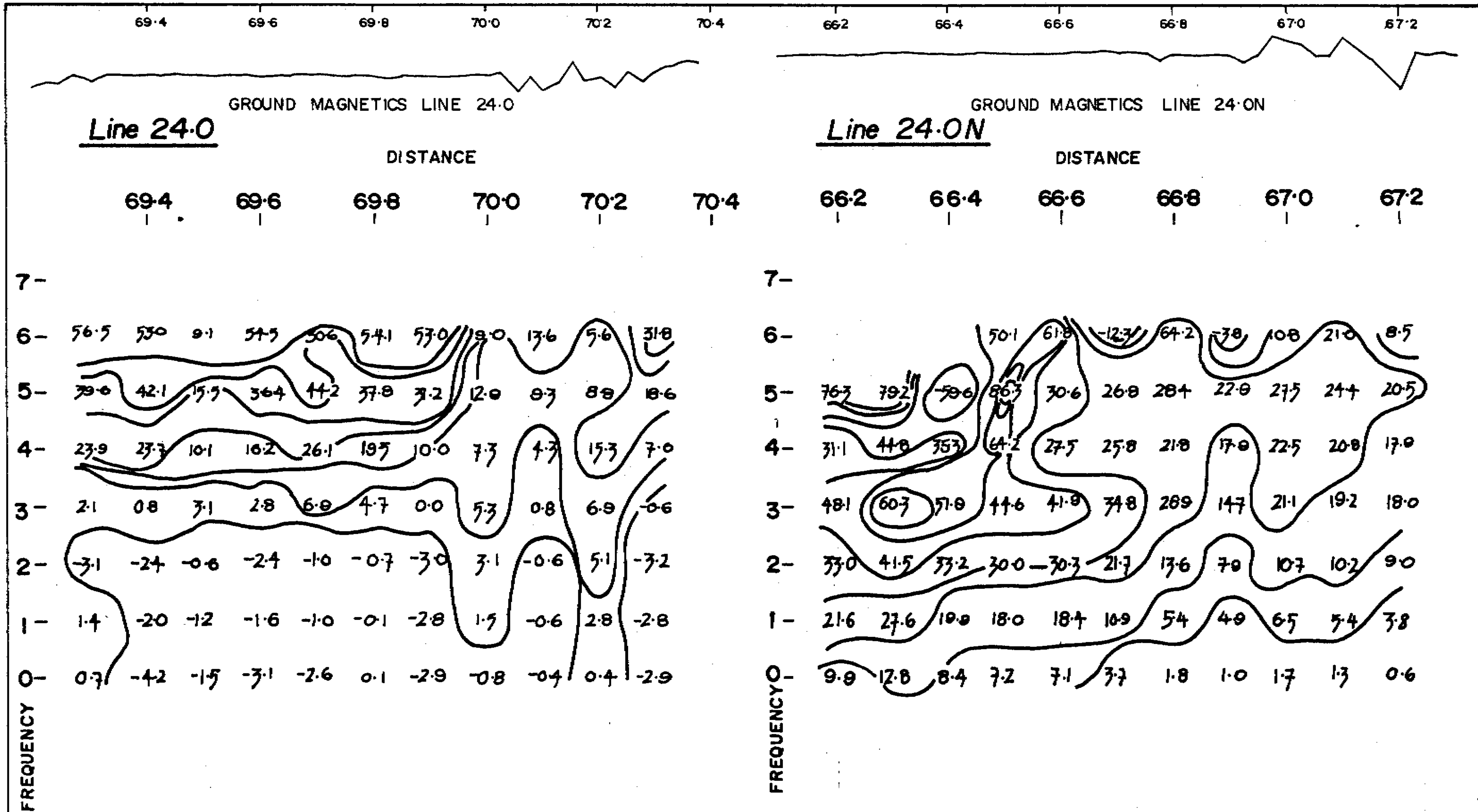
LEGEND

STATION Nº
31·0
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA					
PROJECT	WOOLNER				
ELLIPTICITY PSEUDOSECTIONS LINE 73·5 E					
	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	28 JAN 83	R.G.H.			
SCALE	1:10000		DWG No	3·3178·1·0084	

Plate No. 25



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND
STATION Nº
70·2

Tx IN WEST

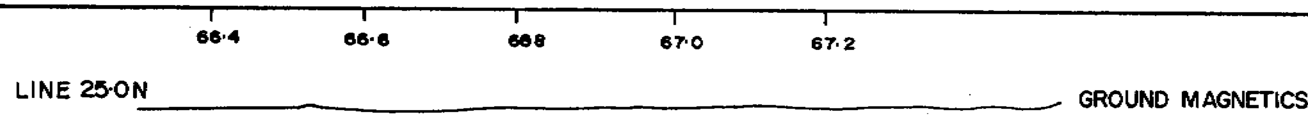
MOBIL ENERGY MINERALS AUSTRALIA

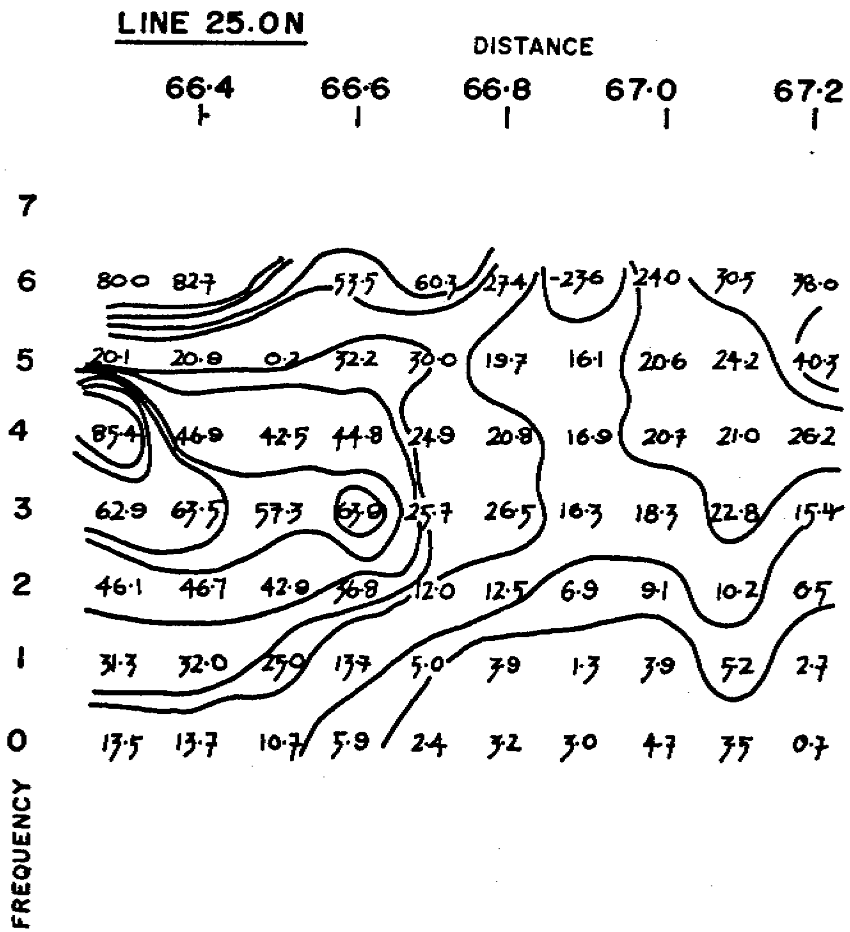
PROJECT WOOLNER

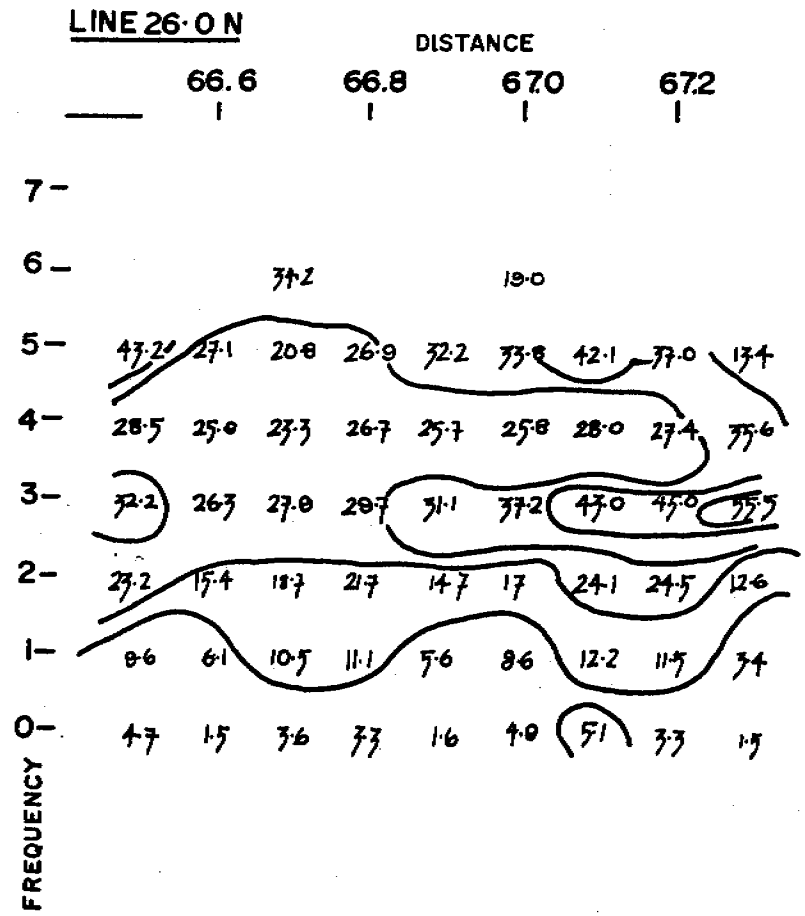
ELLIPTICITY PSEUDOSECTIONS
LINE 24·ON

	DATE	BY		DATE	BY
COMPILED	Dec 82	L S	ADDNS		
DRAWN	"	H S			
SCALE	1:10000		DWG No	3·3178·1·0075	

Plate No. 26







FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND
STATION Nº
66·8

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

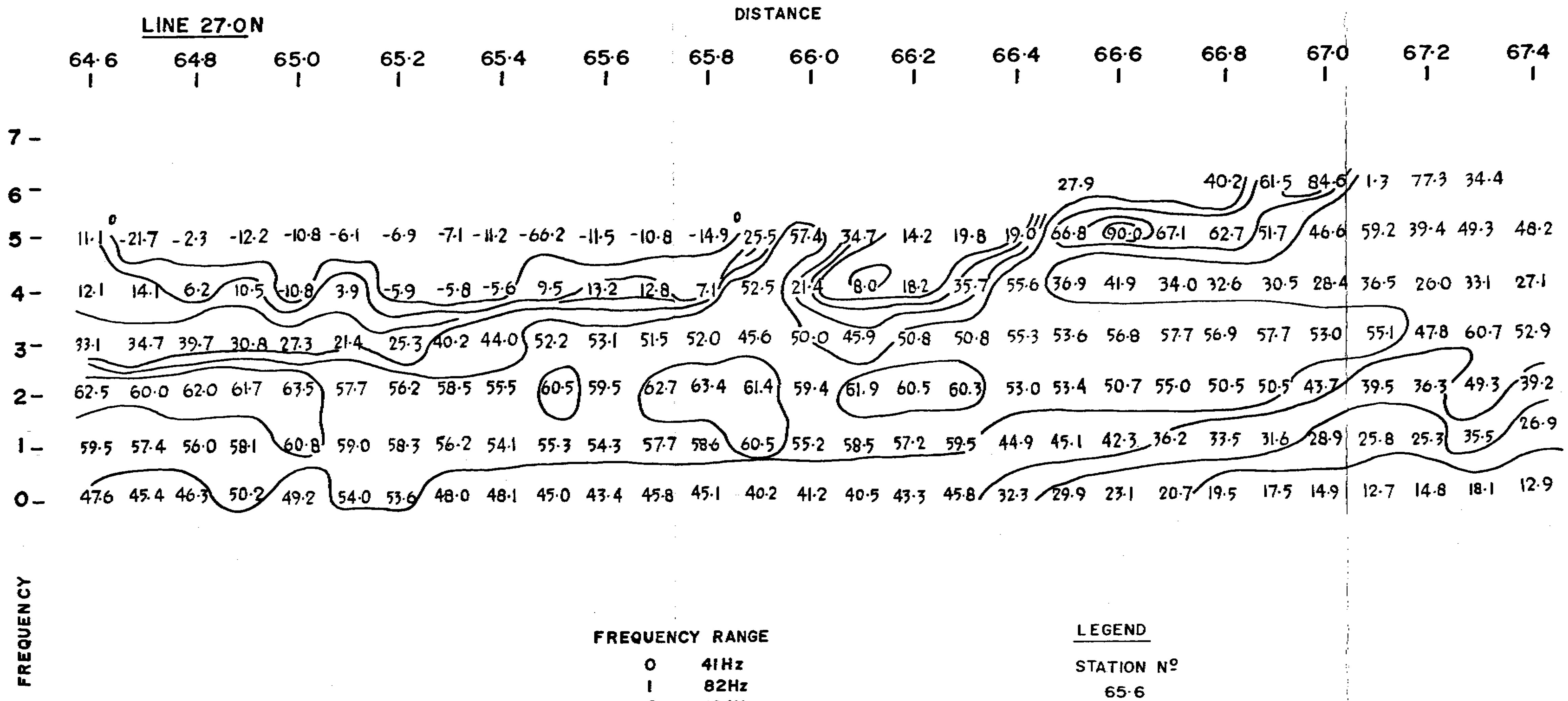
ELLIPTICITY PSEUDOSECTIONS

LINE 25·ON& LINE 26·ON

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	JAN. 83	H.S.			
SCALE	1:10 000		DWG No	3.3178.1.0076	

Plate No. 27

LINE 27·0N



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
65·6

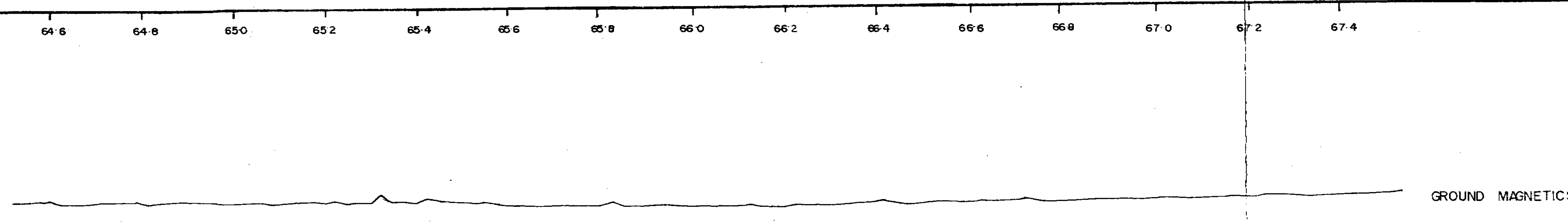
Tx IN WEST

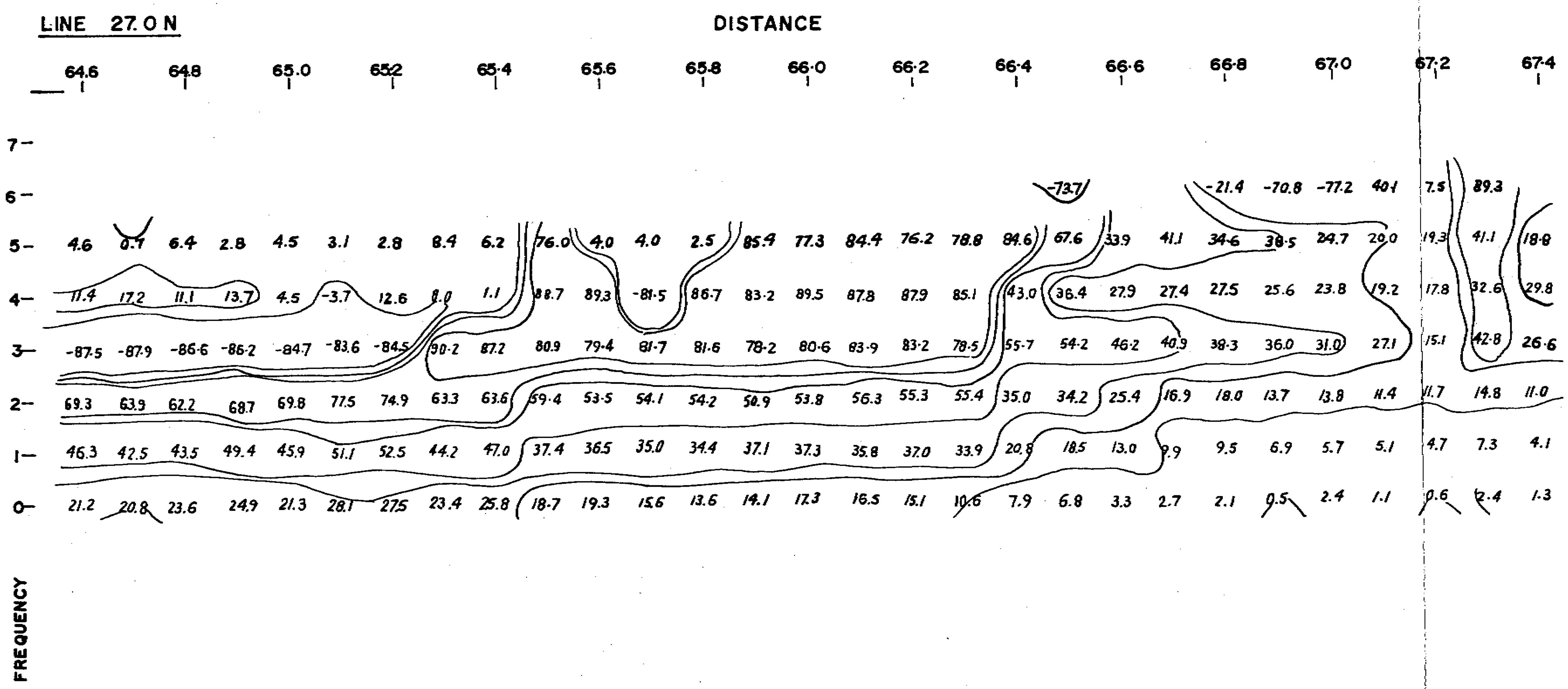
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION LINE 27·0N

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1 : 10,000		DWG No	3·3178·1·0104	





FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
65·4

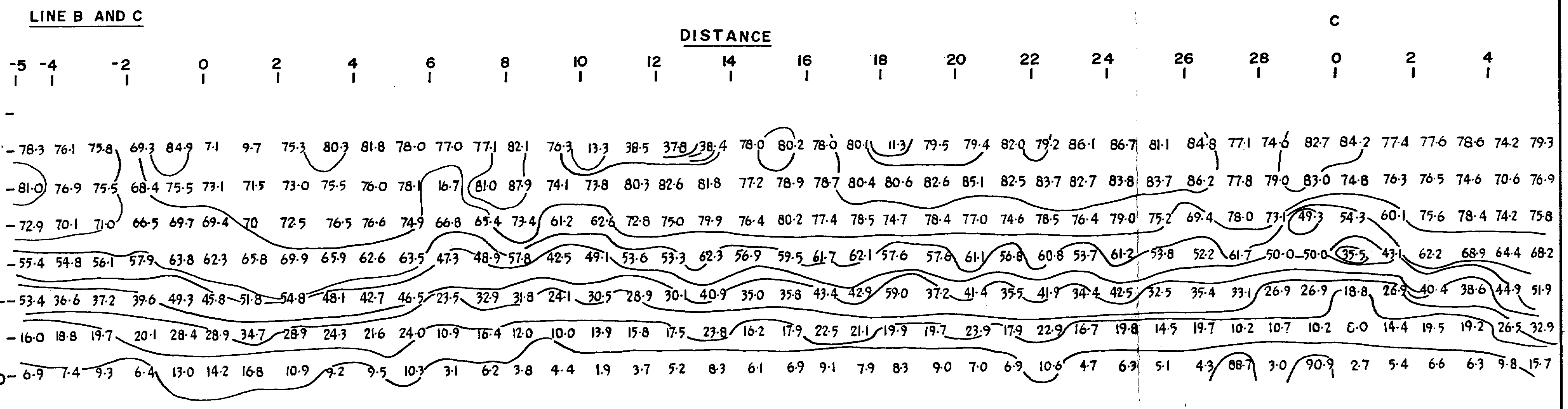
TX IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS
LINE 27.0N

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	27 JAN. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0078	



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION N<u>o</u>
16
I

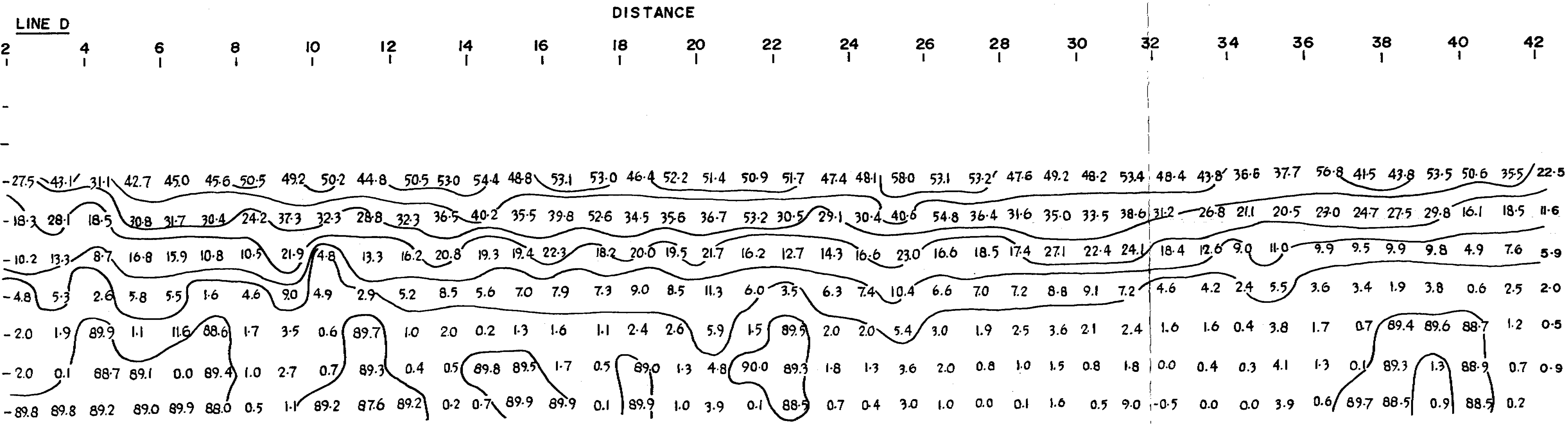
Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

TILT ANGLE PSEUDOSECTION
LINE B AND C

	DATE	BY	ADDNS	DATE	BY
COMPILED	DEC. 82	L.J.S.			
DRAWN	3 FEB. 83	R.G.H.			
SCALE	1:10,000		DWG No	3·3178·1·0095	



FREQUENCY

FREQUENCY RANGE

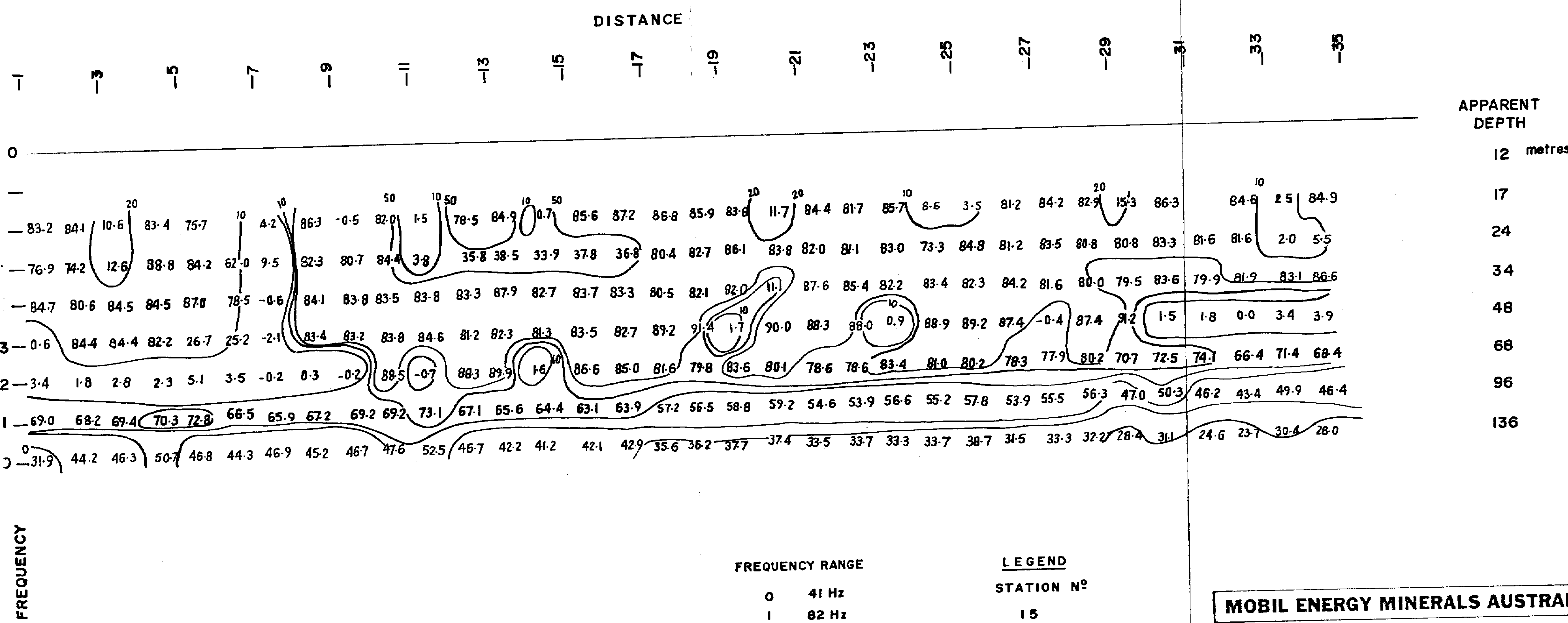
0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656 Hz
5	1312 Hz
6	2624Hz

LEGEND

STATION Nº
16
|

Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA					
PROJECT	WOOLNER				
TILT ANGLE PSEUDOSECTION					
LINE D					
	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	2FEB. 83	R.G.H.			
SCALE	1:10000		DWG No	3·3178·1·0096	



FREQUENCY RANGE

0	41 Hz
1	82 Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº

15

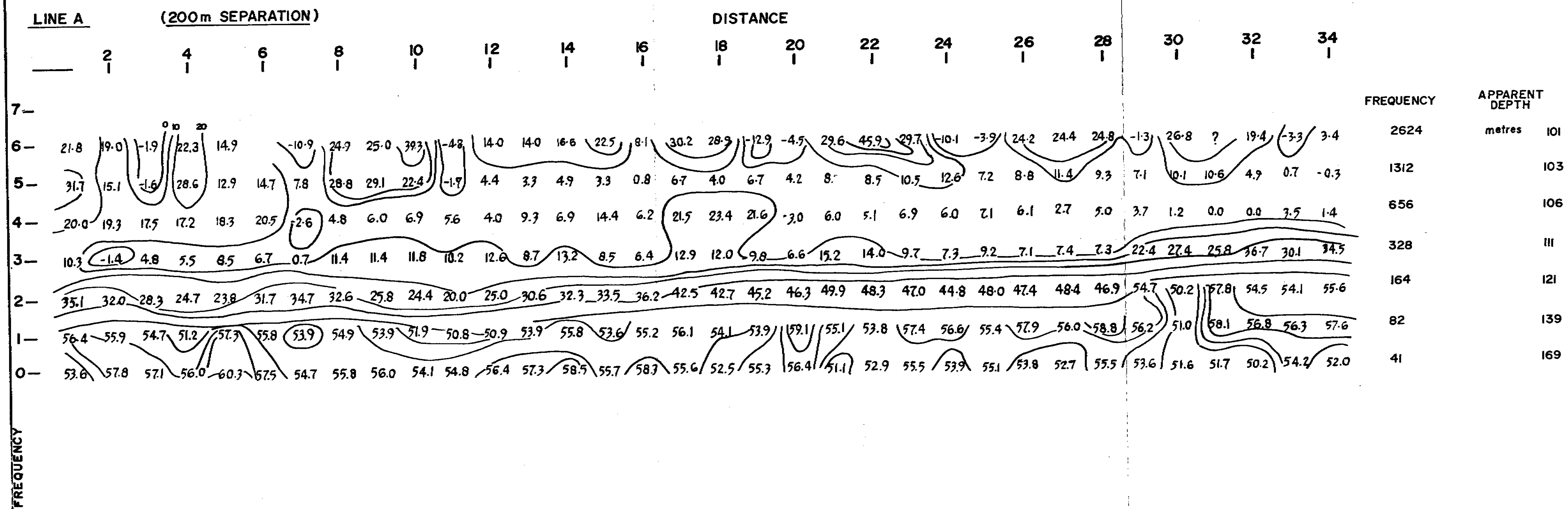
Tx IN WEST

MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

LINE A HORIZONTAL 200p
TILT ANGLE PSEUDOSECTION
IN LINE MODE
TRANSMITTER

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L.J.S.			
DRAWN	28 JAN.83	R.G.H.			
SCALE	1:10000		DWG No	3·3178·1·0094	



FREQUENCY RANGE

0	41Hz
1	82Hz
2	164Hz
3	328Hz
4	656Hz
5	1312Hz
6	2624Hz

LEGEND

STATION Nº
16

TX IN WEST

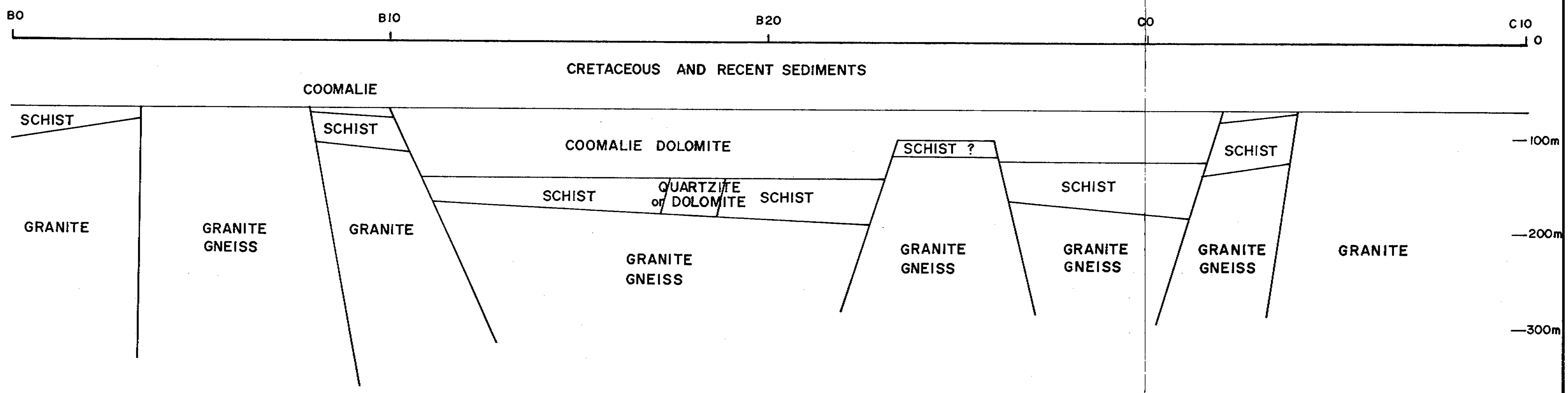
MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

ELLIPTICITY PSEUDOSECTIONS

LINE A (200m SEPARATION)
HORIZONTAL LOOP
IN LINE MODE

	DATE	BY	ADDNS	DATE	BY
COMPILED	JAN. 83	L. J. S.			
DRAWN	1 JAN. 83	R.G.H.			
SCALE	1:10000		DWG No	3·3178·1·0087	



MOBIL ENERGY MINERALS AUSTRALIA

PROJECT WOOLNER

LINE B/C
INTERPRETATIVE CROSS SECTION
FROM GEOPHYSICS

	DATE	BY	ADDNS	DATE	BY
COMPILED	Mar. '83	T.v S.			
DRAWN	Mar. '83	L.U.			
SCALE			DWG No	3·3178·1·0117	

APPENDIX 2

FINANCIAL STATEMENT

Mobil Energy Minerals Australia Inc.

(INCORPORATED IN DELAWARE, U.S.A.; LIMITED LIABILITY)
(REGISTERED AS A FOREIGN COMPANY IN THE STATE OF VICTORIA)

8th FLOOR, 31 QUEEN ST.,
MELBOURNE, VIC., 3000

POST OFFICE BOX 4507,
MELBOURNE, VIC., 3001.

TELEPHONE: 620 191
CABLE ADDRESS: "MOBILEMA"
TELEX: AA 37000

STATEMENT OF EXPENDITURE FOR PERIOD
JUNE 18, 1982 TO JUNE 17, 1983
EXPLORATION LICENCE 3478 - WOOLNER

Salaries and Wages (including on costs)	21,094
Professional Fees of Geologists and Consultants	27,430
Travel and Accommodation	6,180
Freight	2,176
Field Supplies	3,619
Communications	295
Equipment and Facilities	232
Hire of Field Equipment	15,503
Hire of Computer Equipment	1,953
Motor Vehicle Hire	742
Vehicle Operating Costs	2,627
Air Photographs	488
Airborne Surveys	1,875
Drilling Contractors	24,359
Laboratory Services	132
Contract Drafting Services	3,379
Other Contract Services	1,162
EDP Bureau Charges	9,284
Maintenance and Repairs	890
Power Generation	82
Motor Registration	297
Losses on Insurance	220
Miscellaneous Expenses	1,243
	125,262
Plus Head Office Overheads: 10%	12,526
	$ 137,788

J.H. Burnett
Acting Manager Accounting

BS

APPENDIX 3

AGE DETERMINATION REPORT

Ion microprobe U-Pb dating of zircons from granitoids recovered in core from drill holes P4/1D, P11/1, P12/11 and P14/1, Woolner, Northern Territory

Prepared for

Mobil Energy Minerals (Aust.)

23 June 1983

I.S. Williams and W. Compston
Research School of Earth Sciences
Australian National University.

Ion microprobe U-Pb dating of zircons from granitoids recovered in core from drill holes P4/1D, P11/1, P12/11 and P14/1, Woolner, Northern Territory.

I.S. Williams and W. Compston

Summary

This report documents ion microprobe U-Pb ages determined on zircons from four samples of granitoid recovered in drill core from Woolner, N.T. The isotopic analyses were made by the authors using the ion microprobe SHRIMP at the Research School of Earth Sciences, Australian National University, in co-operation with, and using heavy mineral concentrates prepared by, J. McAndrew (CSIRO, Sydney).

Two of the samples, P12/11 and P14/1, contained zircon with U-Pb compositions suitable for precise age measurements. These gave ages of 2660 ± 20 and 2690 ± 20 Ma, respectively. The compositions of the zircons from the other two samples were not suitable for measuring an age independently but were wholly consistent with these ages. As there is no evidence for a significant difference in age between the samples, the best estimate of the age of all is the mean of the above, 2675 ± 14 Ma.

Analytical instrumentation and methods

a) Principles of ion microprobe analysis.

An ion microprobe is a specialized mass spectrometer used for determining the isotopic composition of materials on a micron scale. The sample is prepared as for an electron probe, as a polished thin section or grain mount. In the ion microprobe, it is bombarded by a beam of high-energy primary ions (oxygen in the present case) focussed to a spot less than 30 μm in diameter, thereby producing secondary ions of the sample from that spot for isotopic analysis.

Until relatively recently, with the exception of pioneering work by Andersen and Hinthorne of Applied Research Laboratories, California, ion microprobes have been little used for geological studies. The reason is that geological samples are generally chemically complex, making it technically difficult to distinguish the ions to be analysed from interfering molecular ions of virtually the same mass. SHRIMP is one of very few intruments with sufficient mass-resolving power to make this distinction, and is presently the only instrument that can do so without a great reduction in ion beam intensity and therefore in analytical precision.

b) Zircon U-Pb dating using SHRIMP.

U-Pb dating of zircon populations by mass spectrometric isotope dilution is well established as one of the most reliable methods of determining the age of rocks that have had a complex geologic history. Zircon is very resistant physically and chemically and even granulite facies metamorphism or host rock partial melting rarely completely resets its U-Pb age. The zircons in a single rock, however, commonly are not all the same age and single crystals often show zoning representing different episodes of growth. Single crystals and zones can be dated individually by ion microprobe, giving both the rock's age and some of its metamorphic history. SHRIMP, developed and constructed at the Australian National University, is presently the only ion microprobe capable of rapid, precise zircon U-Pb dating.

To date zircon, it is necessary to measure both the isotopic composition of the Pb and the elemental ratio Pb/U. On SHRIMP, the ratio of the ion beams produced by the isotopes of Pb is within 0.2% of the ratio of those isotopes in the target zircon, so Pb isotopic composition can be determined directly. Such is not the case for the ratio of ion beams of different elements however, as different elements ionize with different efficiencies. It is necessary to correct the observed ratio $^{206}Pb^{+}/^{238}U^{+}$ to obtain the true ratio $^{206}Pb/^{238}U$ by relating the analyses of each unknown zircon to analyses of a standard zircon. By this method, Pb/U can be measured with a precision of better than 5%. Similar reference to a standard is used to determine U/Zr, for estimation of the U concentration, and Th/U.

The standard used for the present analyses was a piece of a Sri Lanka zircon, SLZ G3 Cp, in which the ratio $^{206}Pb/^{238}U$ has been determined accurately by isotope dilution as 0.0894. The ratio Pb/U in the Woolner zircons is referenced to this value.

Analyses of the Woolner zircons

The zircons from Woolner were analysed during one 15 hr working day. The data collected comprised analyses of the standard Sri Lanka zircon at the beginning and end of this period, and analyses of a total of fifteen spots on ten zircons from the four rock samples. The analyses are listed in Table 1 and plotted on a conventional Concordia diagram in Figure 1.

Because of time constraints, the analytical procedure was varied from that normally followed. Generally, we spend about 45 minutes in the U-Pb analysis of any one spot. Such an analysis consists of three determinations of all the isotopic ratios required, each determination being the mean of ten estimates of each ratio. This analysis in triplicate makes it possible to assess both the homogeneity of the spot and any systematic change in ion beam composition as the hole in the zircon is excavated. The five analyses in Table 1 which are normal triplicate determinations are the most accurate of the data listed. The remainder of the analyses were abbreviated to 15 or 30 minutes data collection, either because the composition of the particular spot was not suitable for age measurement or beacuse an extended analysis was not considered necessary.

The zircons from Woolner (Plate 1) are mostly fine-grained (prism diameters generally < 50 μm). The exception is sample P14/1, in which the zircons are euhedral crystals up to several hundred microns in length. In all samples, euhedral growth zoning is strongly developed, and cores (often unzoned) surrounded by thin zoned rims are common. Except for the large zircons in P14/1 it was not possible, with the 30 μm spot size of the ion microprobe, to analyse the zircon cores and rims separately. In the one case where separate analyses were made of a core and rim, P14/1 grain 12, no significant difference in age between the two was found.

The analyses listed in Table 1 are the means of from ten to thirty determinations of the isotopic ratios at any one spot. The concentrations of U and Th are calculated by reference to the standard zircon and assuming that the unknown zircons are stoichiometric $ZrSiO_4$. While the concentrations listed are approximate only, the ratios of Th/U are accurate to within 1%. The concentration data show the zircons to be generally richer in U than the average granitoid zircon (commonly ∿500 ppm U), especially so for samples P4/1D and P11/1.

The remaining parameters listed depend upon a correct estimation of the zircons' initial Pb contents and compositions. The zircons from P4/1D are unique in our experience with respect to initial Pb content, up to 74% of the ^{206}Pb in the zircon not being accountable for by radioactive decay of the grains' presently contained U. In normal zircons this value would usually be less than 0.1%. The initial Pb content of the zircons from P11/1 also is unusually high. The presence of large amounts of initial Pb makes estimation of the quantity and composition of the accumulated radiogenic Pb extremely difficult. *Therefore, these zircons cannot be used to make an independent estimate of the age of these two samples.*

The initial Pb contents of the zircons from samples P12/11 and P14/1 are considerably lower, though still above average. We believe that the high initial Pb contents of the zircons are an intrinsic feature and not surface contamination of the crystals during sample preparation. The reasons are, first, the common Pb content of the zircons, as indicated by the measured $^{204}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ratios, showed no tendency to diminish as each analysis proceeded, that is, as zircon below the polished surface was exposed by the ion sputtering. Secondly, repolishing and recoating of mount P4/1D at ANU made no obvious difference to the observed common Pb content. This can be seen from the analyses of two spots on zircon 15 of that mount, spot 1 being analysed before cleaning and having 9.6% initial ^{206}Pb, spot 2 being analysed after cleaning and having 14.6% initial ^{206}Pb.

An important additional feature of the initial Pb in the Woolner zircons that is rare in our experience is that the initial Pb, in all except sample P14/1, includes a significant radiogenic component. Evidence for this is the constant excess of ^{208}Pb in the zircons over that which can be accounted for by the decay of the Th presently observed, plus common ^{208}Pb. Either these zircons incorporated radiogenic initial Pb generated in a high Th/U source when they first crystallized, or they have taken in a mixture of radiogenic and common Pb at some later time.

We lack the necessary information to calculate the exact composition of the radiogenic initial Pb and therefore to determine its origin. To estimate the composition of the Pb present when the zircons first crystallized it would be necessary to determine the composition of the Pb in minerals with high Pb/U ratios that formed at that time, for example, sulphides or potassium feldspar. To estimate the possible composition of labile Pb that may have entered the zircons in the past, but significantly later than they first crystallized, it would be necessary to know more of the metamorphic history of the granitoids and to search for other minerals that may have incorporated the labile Pb at the same time. Possibilities would be epidote, micas, or secondary sulphides.

Even though we cannot determine the composition of the initial Pb uniquely, we can impose some limits on it. This can be done most readily in the case of sample P4/1D, which has the highest initial Pb content, although the composition range as determined applies only to that sample. Figure 2 shows the isotopic compositions of the Pb in the different P4/1D zircons as measured, plotted as $^{204}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$, both ratios which are very sensitive to initial Pb but independent of Th/U. The analyses form a nearly linear array with an extrapolated intersection on the $^{207}Pb/^{206}Pb$ axis of 0.185. The latter we infer to be the composition of the Pb produced *in situ* by U decay, which gives an apparent age of 2700 Ma. This is consistent with the ages measured on samples P12/11 and P14/1. The array does not extrapolate upwards to the composition of common Pb at 2700 Ma however, indicating that a third, radiogenic component is present. From the analysis of grain 6, we infer by extrapolation of line A that the $^{207}Pb/^{206}Pb$ value of the additional radiogenic component is at least as high as 0.31. This in itself places a limit on that component's origin: it must be older than 2200 Ma, even if it was separated from its parent U immediately that it formed. As it is more likely that the Pb evolved in contact with its parent U for a significant period of time before becoming incorporated in the zircon, a two-stage evolution concept is more realistic. The Pb composition does not define this evolution uniquely, but unless the $^{207}Pb/^{206}Pb$ of the radiogenic component exceeds 0.43, it does imply that the Pb was not incorporated in the zircon when it first crystallized. Assuming 0.31 and using a two-stage model, the age of the Pb depends upon the time it is assumed to have been separated from its parent U and *vice versa*. If the Pb evolution stopped yesterday, then it started 3500 Ma ago. If it started 2700 Ma ago, namely when the granitoids crystallized, then it stopped about 1800 Ma ago. Considering what is known of the history of the area, we consider the latter to be likely and have assumed such an evolution in calculating the P4/1D zircons' radiogenic Pb contents.

No matter what the initial Pb content or composition of the P4/1D zircons is, the isotopic analyses show that some of the zircons, 4 and 6 especially, are extremely deficient in the radiogenic Pb produced since crystallization. They contain only about 10% of the radiogenic Pb that their present U would have generated in 2700 Ma. Given general experience with zircon, we attribute this deficiency to a major loss of radiogenic Pb rather than a recent gain of U. The pattern of discordance in Figure 1 shows that this loss of Pb occurred comparatively recently.

The balance between the zircons' U and radiogenic Pb contents is well illustrated on the Concordia diagram, Figure 1. The graduated curve represents the present day Pb-U (daughter-parent) ratios of closed isotopic systems of different ages. It is general experience that zircon analyses may fall slightly below the curve, that is, they show a small radiogenic Pb deficiency, in which case the zircons' age is determined by extrapolating the line defined by the analyses (the discordance line) to the Concordia. The zircons from samples P12/11 and P14/1 have low initial Pb contents and plot close to the Concordia, giving relatively precise intersection ages of 2660 ± 20 (2σ) Ma and 2690 ± 20 Ma. The samples from P11/1 and most from P4/1D have high initial Pb contents and plot far below the Concordia, making the intersection age extremely uncertain. Data for these samples do, however, plot near to the extrapolation of the discordance line for the P12/11 and P14/1 zircons and we have no reason to suggest that they differ in age. This conclusion is strongly supported by P4/1D analysis 15-1, which plots close to the P12/11 and P14/1 data.

We conclude, therefore, that all the samples analysed are, within our uncertainties, the same age. Our best estimate of that age is

2675 ± 14 Ma. Three of the four sets of zircons contain radiogenic initial Pb, which is unusual in our experience. In some of the zircons, the initial Pb contents are extremely high. Evaluation of sample P4/1D shows that, in that sample, the initial Pb is older than 2200 Ma. It is likely that it was incorporated into the zircon at or after that time.

Table 1. Ion microprobe age determinations on zircons from the Woolner area (N.T.), submitted by Dr. J. McAndrew on behalf of Mobil Energy Minerals (Aust.).

Rock	Grain-spot	U ppm	Th ppm	Percent initial Pb	$^{206}Pb^*/^{238}U$	$^{207}Pb^*/^{235}U$	$^{207}Pb^*/^{206}Pb^*$	$^{207}Pb^*/^{206}Pb^*$ age(Ma)
70479b,	4 - 1§	311	135	8.9	0.271	6.67	0.1787	2640
P12/11	4 - 2§	348	242	0.6	0.499	12.62	0.1833	2680
	3 - 1§	578	245	1.9	0.527	13.25	0.1822	2670
	3 - 2§	475	354	3.4	0.473	11.69	0.1793	2650
70471,	4 - 1†	2749	570	71.9	0.0475	0.685	(0.105)	(1710)
P4/1D	6 - 1†	2412	319	73.9	0.0456	1.88	(0.299)	(3460)
	15 - 1§	392	275	9.6	0.432	11.38	0.1911	2750
	15 - 2†	1099	494	14.6	0.287	6.76	0.1711	2570
	16 - 1†	2776	1554	49.6	0.0793	2.64	(0.241)	(3130)
70478,	5 - 1†	1445	729	17.8	0.197	4.76	0.175	2610
P11/1	10 - 1¶	1544	1873	5.8	0.181	4.72	0.1891	2730
70492,	11 - 1¶	370	149	2.3	0.498	12.52	0.1822	2670
P14/1	11 - 2¶	311	122	0.5	0.465	11.68	0.1823	2670
	12 - 1¶ core	956	389	0.1	0.469	11.96	0.1848	2700
	12 - 2¶ rim	365	122	0.8	0.476	12.24	0.1867	2710

Decay constants: $\lambda^{235} = 0.98485 \times 10^{-9}\ yr^{-1}$, $\lambda^{238} = 0.155125 \times 10^{-9}\ yr^{-1}$

§ normal triplicate analysis

¶ duplicate analysis

† single analysis

* corrected for initial Pb

ANALYSTS: I.S. Williams,
W. Compston
Australian National University

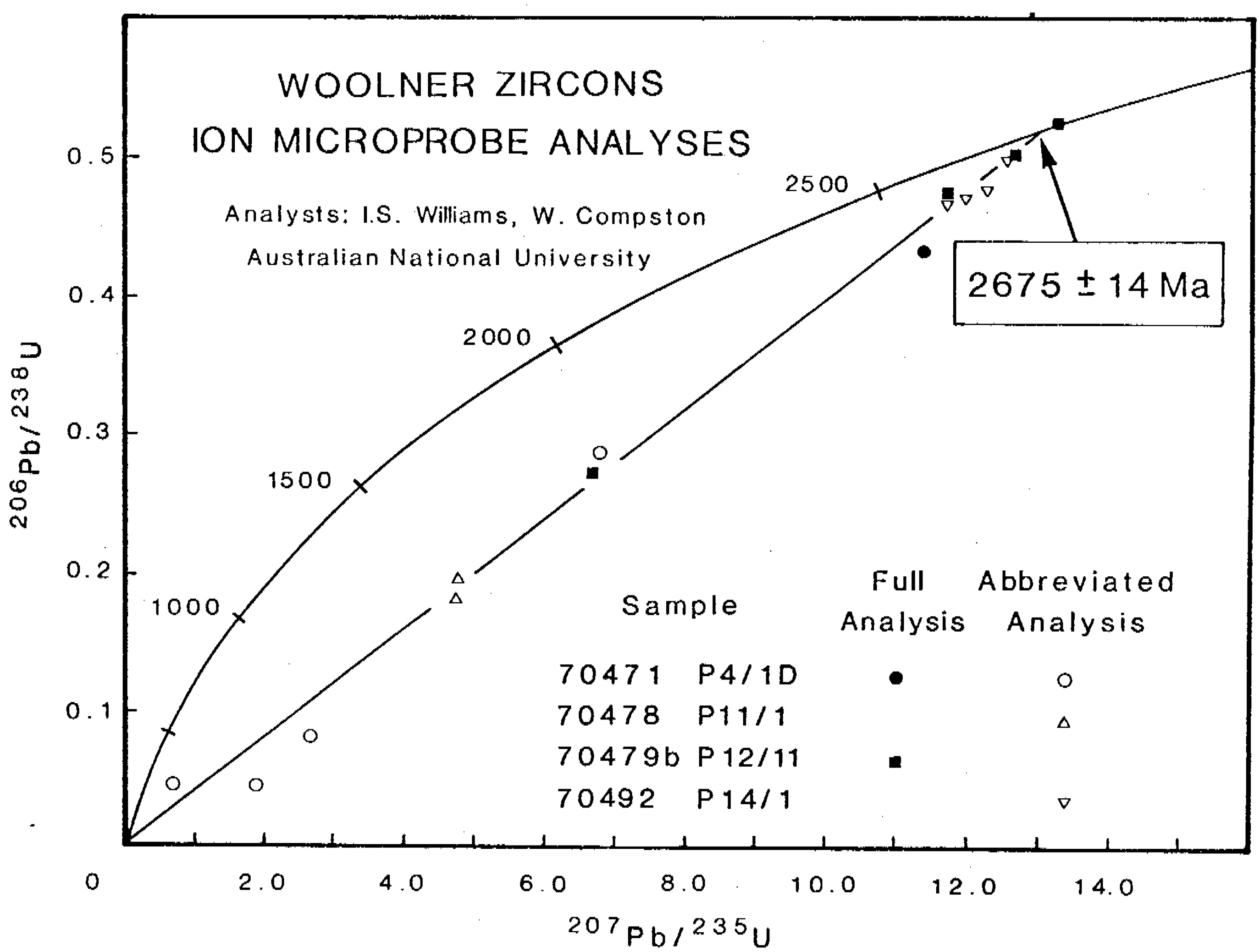


Figure 1.

Concordia diagram showing ion microprobe U-Pb analyses of zircons from granitoids intersected in four drill holes at Woolner, N.T. Only the zircons from holes P12/11 and P14/1 are suitable for precise age determinations. The mean age of these is 2675 ± 14 Ma.

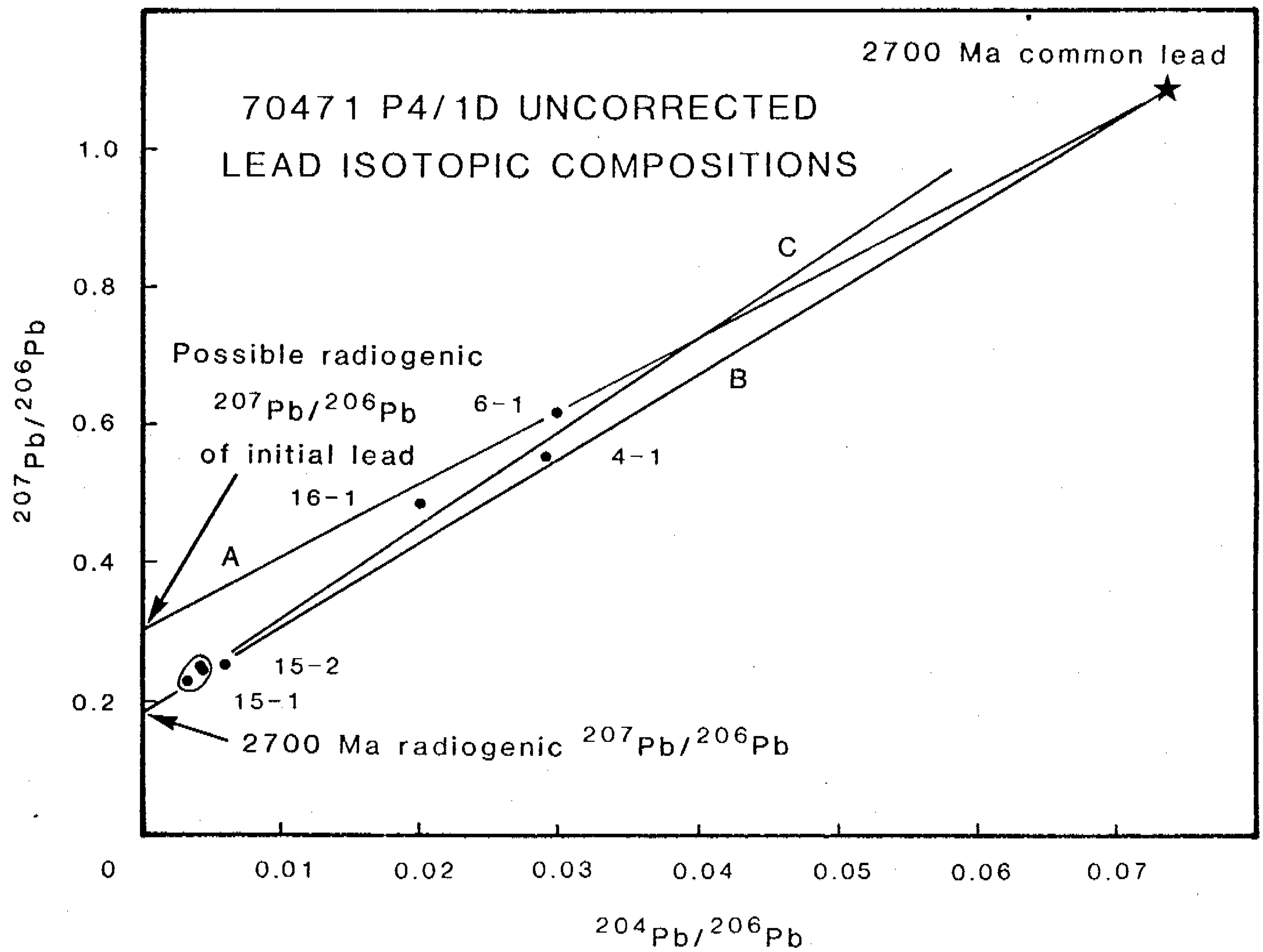
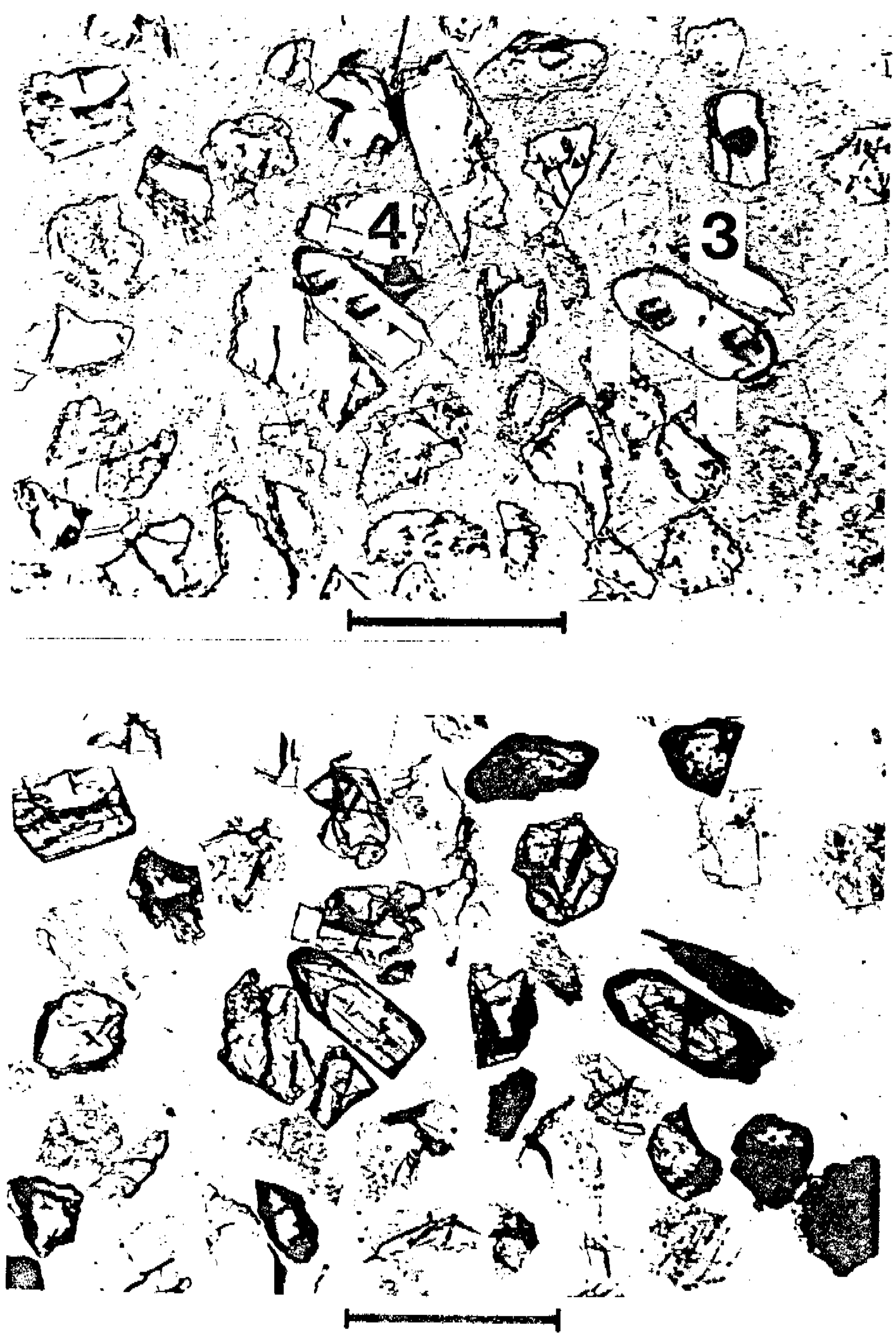


Figure 2.

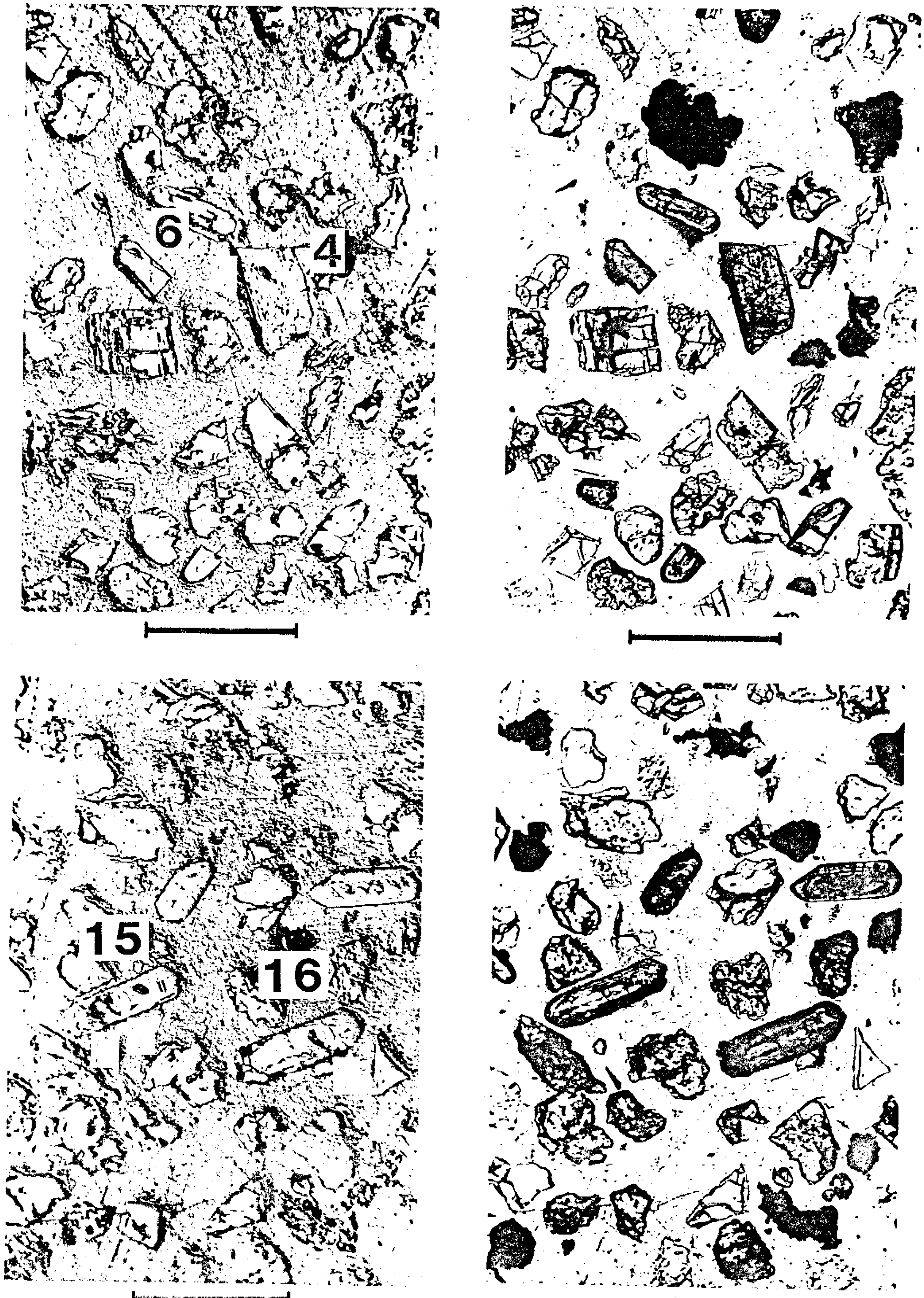
Pb compositions for zircons from sample 70471 (P4/1D). The mixing line defined by the analyses (C) deviates significantly from the mixing line between 2700 Ma common and radiogenic leads (B). The $^{207}Pb/^{206}Pb$ of the initial radiogenic Pb must be at least as high as indicated by the y-intercept of a line linking the composition of grain 6 and common Pb (A).

Plate 1. Photomicrographs of analysed grains. The photographs are in pairs; one transmitted light, one reflected light with Nomarski differential interference contrast. The numbers on the reflected light photographs identify the analysed grains (red) and spots (blue). Scale bars 200 μm.



70479b, P12/11

Plate 1 cont.



70471, P4/1D

Plate 1 cont.

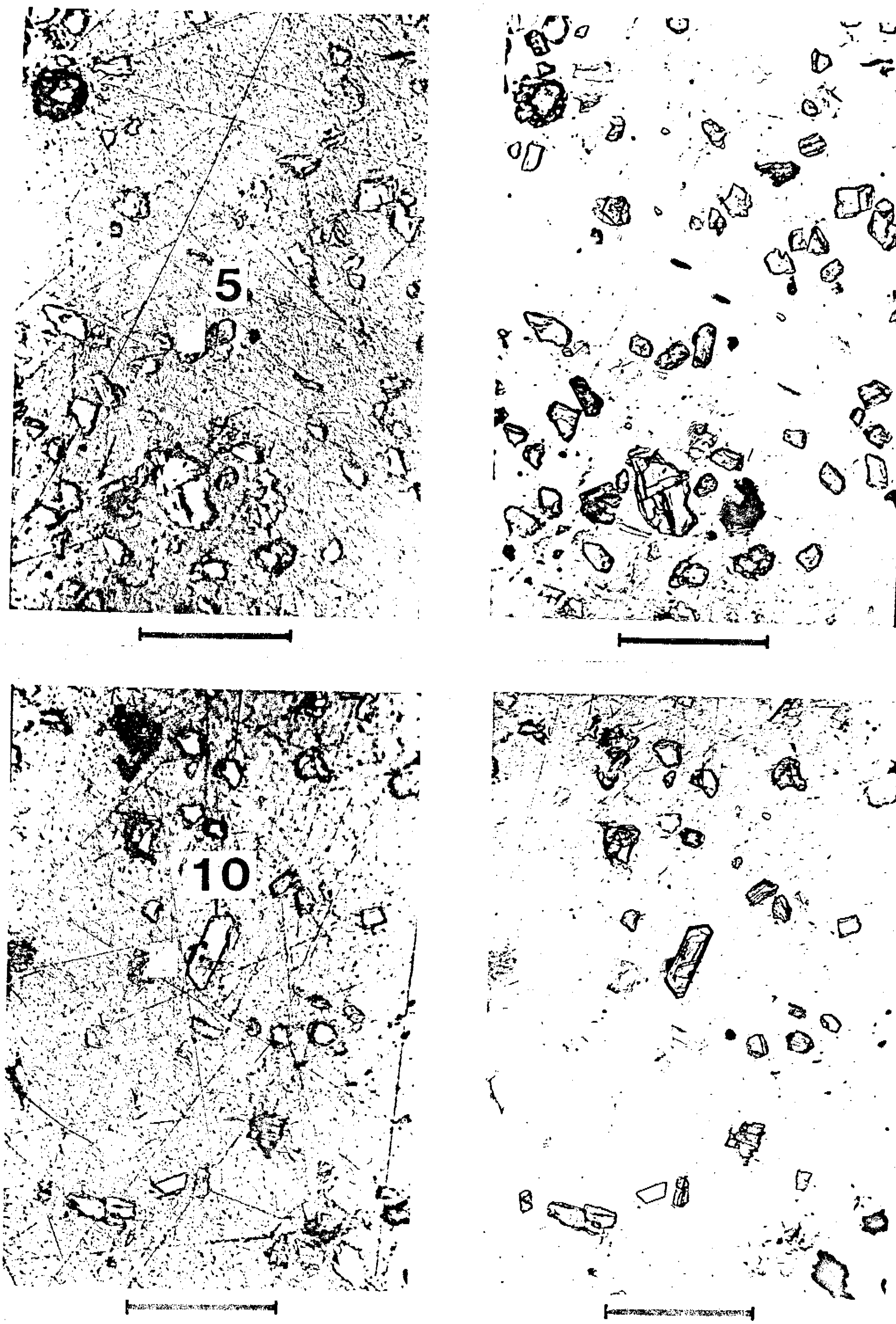
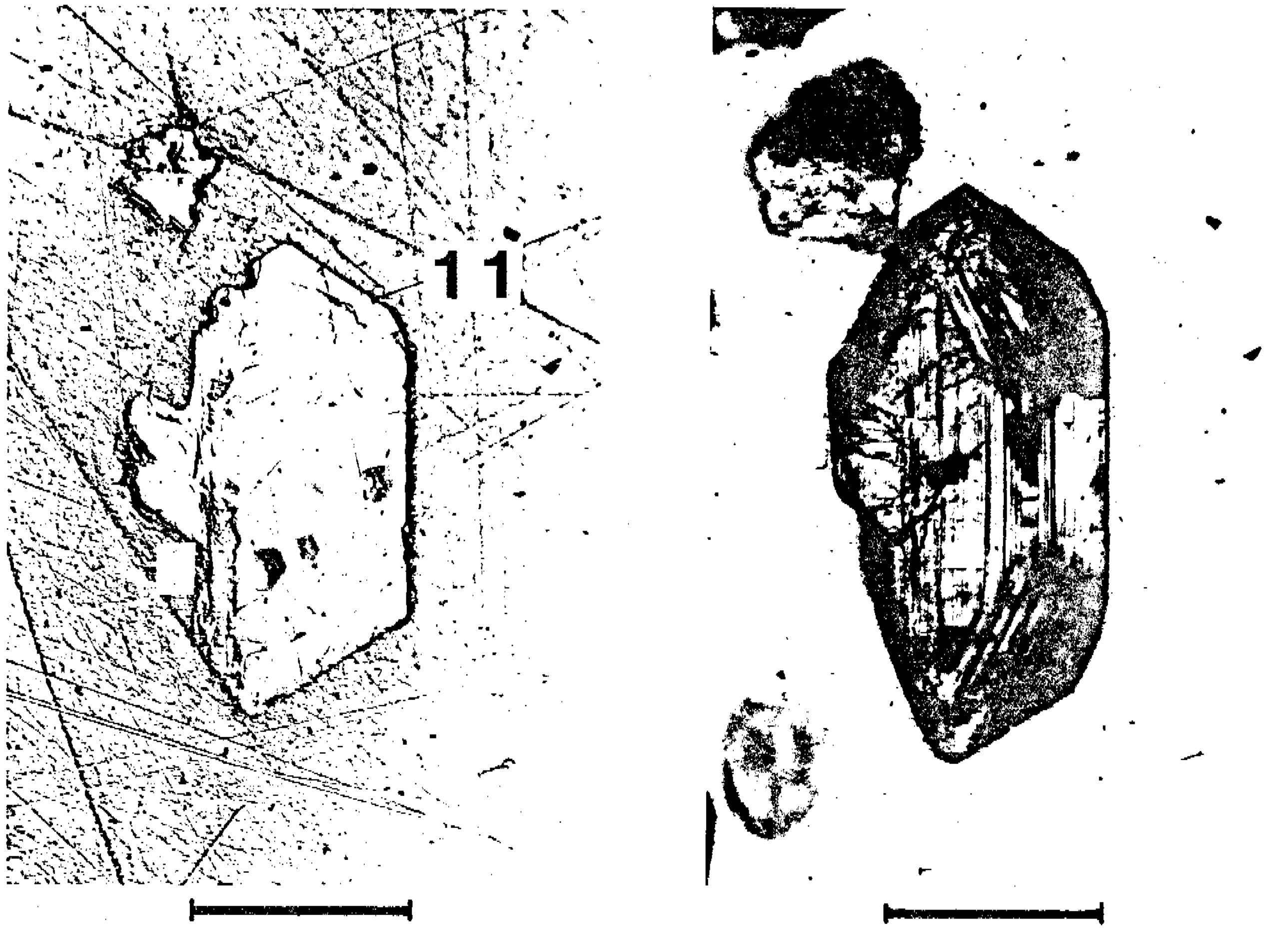
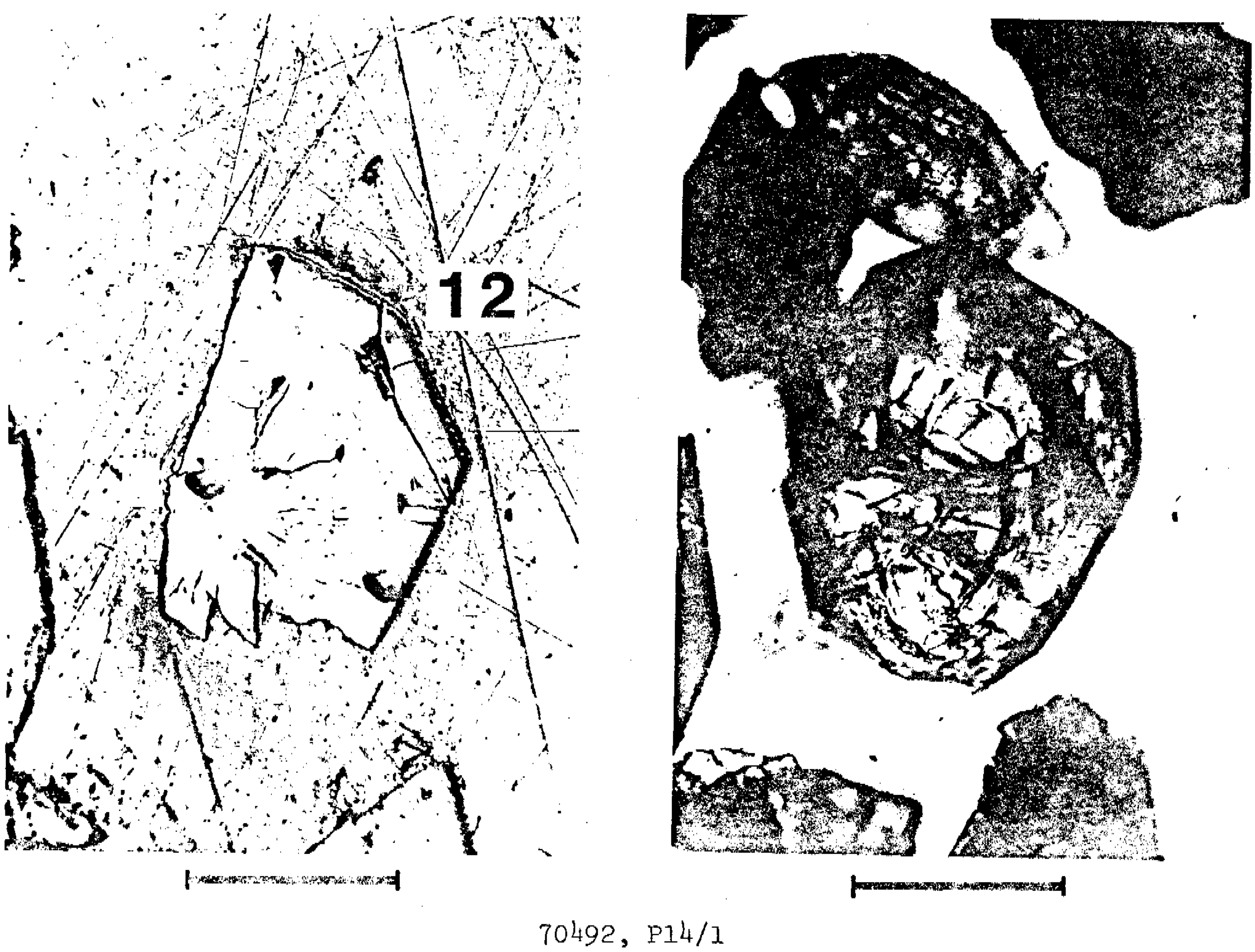


Plate 1 cont.





APPENDIX 4

DRILL LOGS

<u>DRILLING LOG</u>

<u>HOLE NUMBER WD1</u>

DRILL LOG FORM

TITLE NAME/NO.:

PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL: B19
AMG: 70.30E/33.68N
COLLAR R.L.:

HOLE No. WD1
BEARING Vertical
INCLINATION

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
1	BLADED BIT			Yellow brown med. grn. sand.		
2				Yellow sand with laterite pebbles		
3				Grey brown clayey sand - grey clay		
4	PRE-COLLAR 4"			Grey to black mud		
5				"		
6				"		
7				"		
8				"		
9				"		
10				"		
11				Cream white sandy clay		
12				"		
13				"		
14				" and thin interbedded pale grey		
15				" calcareous claystone		
16				" "		
17				" (washed sample gives only med. grained		
18				" rounded white quartz)		
19				"		
20				"		

DRILLING CO: Gaden
LOG BY: B.R.

RIG TYPE/MODEL: Warman 1000
CORE/HOLE SIZE & LENGTH: Pre-collar 0-62

DRILLER: G. Morris
CASING SIZE & LENGTH: core 62-82.2
PAGE 1 OF 5.

START: 11/11/82
WATER TABLE: 3m

FINISH: 13/11/82
VERTICAL SCALE:
HOLE T.D. 82.2m.

PURPOSE: Mag Anomaly
RESULT: Negative-dolomite, trace sulphides in thin sch. units

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral composite incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: .... CO-ORDINATES LOCAL B19 HOLE No. WD1

PROJECT NAME: WOOLNER AMG ..... BEARING .....

COLLAR R.L. ..... INCLINATION .....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graph Log
21				White clayey sands		
22				"		
23				"		
24				"		
25				"		
26				"		
27				"		
28				"		
29				"		
30				"		
31				"		
32				"		
33				"		
34				"		
35				"		
36				"		
37				"		
38				"		
39				"		
40				"		

DRILLING CO: .... LOG BY.........

RIG TYPE/MODEL: .... CORE/HOLE SIZE & LENGTH ....

DRILLER: .... CASING SIZE & LENGTH .... PAGE 2 OF 5

START: .... WATER TABLE ....

FINISH: .... VERTICAL SCALE .... HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compo[nents] incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciatio[n] (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....
PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL ....
AMG ....
COLLAR R.L. ....

HOLE No.: WD1
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
41				White clayey sands		
42				"		
43				"		
44				"		
45				"		
46				"		
47				Increasing clay content with depth.		
48				"		
49				"		
50				"		
51				"		
52				"		
53				"		
54				"		
55				"		
56				"		
57				"		
58				"		
59				"		
60				"		

RILLING CO: ....
G TYPE/MODEL: ....
DRILLER: ....
ART: ....
NISH: ....

CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....

LOG BY ....
PAGE 3. OF 5..
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compone incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....
PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL .... B19 ....
AMG ....
COLLAR R.L. ....

HOLE No.: WD1
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
61	END OF BLADE PRECOLLAR					
62				Weathered silicified dolomite-clay and qtz frags.		
63				Weathered and silicified cream dolomite- broken		
			0.90m	core - qtz fragments after silic. dolomite		
64.2				Minor kaolin and dolomite		
				Pale creamy yellow dolomite with interbedded talc		
				chlorite schist. Dolomite silicified in part,		
	NQ			generally along conformable regular shaped bands		
				2cm to 10cm wide (20% silicified). Stylolites.		
				Pale green finely foliated talc-chlorite schists		
				67.60 - 67.90m, 5° to core axis.		
69.30				Pale green carbonate-chlorite-talc schist,		
				foliated, gold sheen on foliation planes, finely		
			100%	disseminated sulphides along foliation and pale		
				pink hematitic alteration after 69.60.		
69.90						
				Grey white dirty dolomite with thin schist		
70.5				interbeds		
76.60						

DRILLING CO: ....
RIG TYPE/MODEL: ....
DRILLER: ....
START: ....
FINISH: ....

CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....

LOG BY ....
PAGE 4 OF 5.
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral components incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL ....
AMG ....
COLLAR R.L. ....

HOLE No.: WD1
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
76.6				Silicified dolomite - massive white qtz -		
78.9				fractured in part		
			100%	Pinkish dolomite - hematitic alteration along		
				fractures - 2cm green chlorite schist band		
				79.15m - partial silicification throughout		
82.2						
				END OF HOLE		
				Pvc tubing (32mm) inserted to bottom of hole.		
				Tubing not split.		

DRILLING CO: ....
LOG BY ....
R[illegible] TYPE/MODEL: ....
CORE/HOLE SIZE & LENGTH ....
DRILLER: ....
CASING SIZE & LENGTH ....
PAGE 5 OF 5
ST[illegible]RT: ....
WATER TABLE ....
F[illegible]ISH: ....
VERTICAL SCALE ....
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compone[nts] incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILLING LOG

HOLE NUMBER WD2

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL C4
AMG 71.60E/33.85N
COLLAR R.L. ....

HOLE No.: WD2
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
1				Black soil clays (edge of lake)		
2				Red-yellow-white mottled sands		
3				Grey clayey sand and laterite		
4				Grey to white sandy clay		C C C
5				"		C C
6				Yellow and white sandy clay - increasing		yc yc
7				clay content with depth		yc
↓						yc yc
22						yc yc
↓				Yellow clayey sand-coarse qtz grains-rounded-		yc
27				decreasing clay content with depth		yc
↓				Med. grn. rounded qtz grains in grey clay		
31				(lithified?) matrix.- hard drilling (kaolinite)		
↓				Pale yellow fine-med. grn sand.- minor clay		
41				throughout		
				White amorphous carbonate		
49						
				Carbonate plus minor pale green to grey sandy		
53				clay: increasing clay content to 53m		gc gc
						gc gc

DRILLING CO: Gaden
RIG TYPE/MODEL: Warman 1000
DRILLER: G. Morris
START: 13/11/82
FINISH: 15/11/82

CORE/HOLE SIZE & LENGTH Pre-collar 57m
CASING SIZE & LENGTH ...NQ Core 57-81.3m
WATER TABLE 4m
VERTICAL SCALE ....

LOG BY B.R.
PAGE 1 OF 2
HOLE T.D 81.3m

PURPOSE: EM Anomaly   RESULT: Dolomite - negative

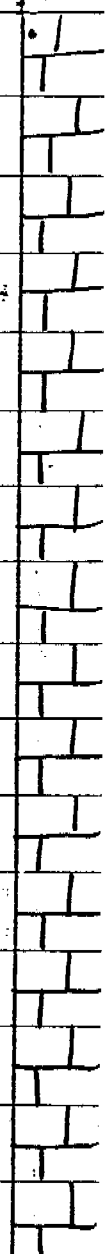
*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral component incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....
PROJECT NAME: ...WOOLNER......

CO-ORDINATES
LOCAL ....
AMG ....
COLLAR R.L. ....

HOLE No.: WD2
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
53						
54	PRECOLLAR ↑			Coarse angular qtz chips minor white clay -		
↓						
57				from silicified dolomite fragments		
	NQ ↓			Fine white qtz sand with fragments of weathered		
60.3	Core			silicified dolomite		
				Yellowish 'dirty' dolomite - finely laminated		
				in part, lamination 10° to axis, pale green		
				clay and fuchsite along fractures and lamellae		
69.5				- minor silicification		
				Brecciated dolomite - coarse breccia (fragments		
				up to 3cm) with hematitic alteration along		
				matrix lines. Green clay and fuchsite, also		
71				minor silicification		
				Creamy massive dolomite - fine lamination,		
				stylolites - cross cutting silicification		
81.3				around 71.3 and 79.3m		
BOH						
				9m of casing and shoe bit lost down hole		
				(48-57m)		
				Pvc tubing placed in hole		

DRILLING CO:........................
RIG TYPE/MODEL:........................
DRILLER:........................
START:........................
FINISH:........................

CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....

LOG BY B.R......
PAGE 2 OF 2
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compone. incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILLING LOG

HOLE NUMBER WD3

DRILL LOG FORM

TITLE NAME/NO.: ....
PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL C7
AMG 71.82E/33.72N
COLLAR R.L. ....

HOLE No.: WD3
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Gr. Log
1				Grey soil, in white and yellow sand		
↓				Mottled red-white-yellow clayey		
3				sand		
↓				White clayey sand - fn grn rounded qtz		
22						
23				Laterite material		
24 ↓				White and yellow clayey sand		
				Grey to white sandstone with hard grey		
				(kaolinite) matrix (hard drilling -		
34	PRE-COLLAR			small flaky chips)		
				White and pale yellow med to coarse grn qtz		
↓				sands - clay rich in part		
47						
↓				Pale green clay and coarse qtz sand		
				(rounded grains)		
52						
				Coarse qtz sand - angular chips (silicified		
↓				dolomite fragments)		
56						

DRILLING CO: Gaden
RIG TYPE/MODEL Warman 1000
DRILLER: G. Morris
START: 16/11/82
FINISH: 17/11/82

CORE/HOLE SIZE & LENGTH Pre-collar 0-56m
CASING SIZE & LENGTH NQ Core 56-75.3m
WATER TABLE 3m
VERTICAL SCALE ....

LOG BY. B.R.
PAGE 1 OF 2
HOLE T.D. 75.3m

PURPOSE: EM Anomaly
RESULT: Negative - dolomite

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compone incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....
CO-ORDINATES LOCAL: C7
AMG: ....
COLLAR R.L.: ....
HOLE No.: WD3
BEARING: ....
INCLINATION: ....
PROJECT NAME: WOOLNER

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
56				Dolomite - generally grey with yellow-orange		
				alteration in part (weathering)		
NQ CORE			100	%) Minor silicification. Lamination at low angle		
				to axis 10-30°		
				60.6-70m - pale grey green clay (weathered		
				schist)		
75.3						
EOH				Pvc inserted with bottom 1m split and wrapped		
				in alfoil.		

DRILLING CO: ....
RIG TYPE/MODEL: ....
DRILLER: ....
START: ....
FINISH: ....
CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....
LOG BY: ....
PAGE 2 OF 2
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral components incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILLING LOG

HOLE NUMBER WD4

DRILLING LOG

HOLE NUMBER WD5

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: WOOLNER

CO-ORDINATES LOCAL B10

AMG 69.45E/33.55N

COLLAR R.L. ....

HOLE No.: WD4

BEARING ....

INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graph. Log
1				Grey sand		
2				Yellow sand with minor gravel pebbles		
3				(dune deposit)		
4				Coarse laterite pebbles & grey-black clayey sand		
5				Grey sand, coarse laterite pebbles and shell		
6				fragments		
7				Grey sand and black vegetable material		
8						
9				Purple red sands, red clay, fine laterite pisolites		
10				"		
11				Laterite - laterite chips, small pisolites		
12				Laterite & mottled clays (mottled zone)		
13				White-yellow-orange mottled sandy clays (mottled		
↓				zone		
21				Silcrete zone - mottled lithified zone - of med		
				grn qtz grains in a mottled siliceous matrix		
				- iron rich in part, breccia fragments, chert		
				fragments, minor mottled clay		
30				Grey matrix- supported sandstone- med grn rounded		
				qtz grains in a grey hard (siliceous) clay (kaolin) matrix-(hard drilling)		

DRILLING CO: Gaden Drilling

LOG BY B.R.

RIG TYPE/MODEL: Warman 1000

CORE/HOLE SIZE & LENGTH NQ 83.2-102.4

DRILLER: G. Morris

CASING SIZE & LENGTH -0-83m - Precollar

PAGE 1 OF 3

START: 18/11/82

WATER TABLE 4m

FINISH: 22/11/82

VERTICAL SCALE ....

HOLE T.D. 102.4

PURPOSE: EM Anomaly

RESULT: Negative-dolomite

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compone incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciatior (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: WOOLNER

CO-ORDINATES
LOCAL: B10
AMG: ....
COLLAR R.L.: ....

HOLE No.: WD4
BEARING: ....
INCLINATION: ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graph. Log
31				Grey matrix supported sandstone		
↓						
42						
↓				Pale yellow and white sandy clay		
49 ↓				(white med to coarse sand and minor white		
52				(clay		
↓				White & yellow sandy clays, laterite pebbles		
58				(possible contamination)		
↓				Med. to coarse white sands & minor hard kaolin		
63				chips - (uncertain if kaolin or magnesite)		
↓				White sandy clay		
66						
				White to pale grey hard kaolin? (magnesite?) -		
70				amorphous, minor sand and clay		
				White sandstone - med grn with white kaolin		
				cement - granular texture - decreasing cement with		
82				depth		
	PRE-COLLAR			Sandstone & brown to black chert chips, silicified		
83.2				dolomite chips		

DRILLING CO: ....
RIG TYPE/MODEL: ....
DRILLER: ....
START: ....
FINISH: ....

CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....

LOG BY ....

HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral componen incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: ...WOOLNER.......

CO-ORDINATES
LOCAL ....B10..............................
AMG ....
COLLAR R.L. ....

HOLE No.: WD4.........
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graph. Log
83.2	1.2	0.4		Brown silicified dolomite - broken core and		
84.4				kaolin		
	3	0.25		Kaolinite & fragments of silicified dolomite		
87.4				showing lamination		
	3	0.3		Black grey and brown silicified dolomite		
90.4				fragments - distinctive carbonate texture		
				White and grey kaolinite - generally		
	3	2.5		massive - some minor brecciation		
93.4						
				White kaolinite, strongly brecciated with		
				sandy breccia matrix - 15cm of		
96.4				silicified dolomite		
	3	1.3		White kaolin and small silicified dolomite		
99.4				fragments mixed together		
		0.45		Kaolin and silic. dolomite fragments - large		
102.4				grey silicified dolomite fragments - scattered		
EOH						
				102m of Pvc tubing and with bottom m split		
				and wrapped in copper wire.		

DRILLING CO:........................ LOG BY..........

RIG TYPE/MODEL:........................ CORE/HOLE SIZE & LENGTH ....

DRILLER:........................ CASING SIZE & LENGTH .... PAGE 3 OF 3.

START:........................ WATER TABLE ....

FINISH:........................ VERTICAL SCALE .... HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral compon incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciatio (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILLING LOG

HOLE NUMBER WD5

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: .....WOOLNER.....

CO-ORDINATES
LOCAL ...B9
AMG ....69.35E/33.55N.......
COLLAR R.L.: ....

HOLE No.: WD5..........
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
1				Grey sandy soil		
3				Yellow sand with laterite pebbles		
4				Black mud with humic material		
6				Black sandy mud with abund. lat. pebbles & minor shells		
↓				red-orange-yellow white mottled sandy clays		
20						
↓				Pale grey sandstone - med grn qtz with grey clay		
30				(lithified) matrix		
				White sandy clay		
61						
↓				White clayey (kaolin) sand - coarse qtz grains,		
77				grain-supported sandstone with kaolin cement		
↓				coarse qtz sand - sub angular fragments		
82						
↓				Pale grey to white lithified kaolinite, minor		
93				coarse sand		
				Weathered granitic material - coarse angular		
↓				qtz and kaolin		
				118-first fragments weathered green schist- trace		
133						

DRILLING CO: Gaden
RIG TYPE/MODEL: Warman 1000
DRILLER: .....G. Morris.......
START: 22/11/82
FINISH: ...23/11/82

CORE/HOLE SIZE & LENGTH ....Pre-collar (5 1/8") 0-150m
CASING SIZE & LENGTH ..No core..........
WATER TABLE ......5m..........
VERTICAL SCALE ....

LOG BY: B.R.....
PAGE 1. OF 2.
HOLE T.D. 150m...

PURPOSE: Stratigraphy RESULT: Granite

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral component incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

DRILL LOG FORM

TITLE NAME/NO.: ....

PROJECT NAME: ......WOOLNER.....

CO-ORDINATES
LOCAL ....
AMG ....
COLLAR R.L. ....

HOLE No.: .WD5..........
BEARING ....
INCLINATION ....

DEPTH	Length Drilled	RECOVERY L/V	RECOVERY %	DESCRIPTION: See footnotes for information required.*	SAMPLE NUMBER & TYPE	Graphic Log
134						+
	Bladed ↑			Weathered granite - coarse qtz - pink feldspar		+ +
				trace mica and green schist - small granite		+ +
				fragments		
150						+ +
	EOH			Hole bottomed in weathered granite -		
				not suitable for coring.		
				Pvc tubing inserted to 150m with bottom 1m		
				split and entwined in copper wire.		

DRILLING CO: ....
RIG TYPE/MODEL: ....
DRILLER: ....
START: ....
FINISH: ....

CORE/HOLE SIZE & LENGTH ....
CASING SIZE & LENGTH ....
WATER TABLE ....
VERTICAL SCALE ....

LOG BY.B.R......
PAGE 2 OF 2...
HOLE T.D. ....

*DESCRIPTION: Colour & ROCK NAME: degree of weathering or alteration, proportion, grain size & roundness of mineral componer incl. matrix; bedding (quantitative, angle to LCA), schistosity (ditto), fractures/joints (ditto), brecciation (quantitative); ORE MINERALS (%, grain size & names); VISUAL ESTIMATE OF GRADE.

ORIENTATION

OTHER FEATURES

- 157·2 Airborne E-M survey line (INPUT SYSTEM) Fidecial number
- Airborne E-M survey anomaly
- Ground E-M (SIROTEN) survey line
- Ground E-M survey anomaly
- 27K (30) Drill hole location number and name Depth, metres
- Angle hole (60°)
- F Fault

GEOLOGY

- Cambrian sediments overlying graphitic quartz muscovite schists and metaquartzites.
- Hornfels–gneissic rocks.
- Granitoids, granodiorites / granites.
- Basic igneous rocks, dolerites / tremolites.
- Gneiss.
- Quartz, biotite, garnet schist.
- Graphite schists.
- Quartz muscovite schists (minor graphite).
- Graphitic quartz muscovite schist.

TOPOGRAPHY DATUM

SCALE 1:25,000

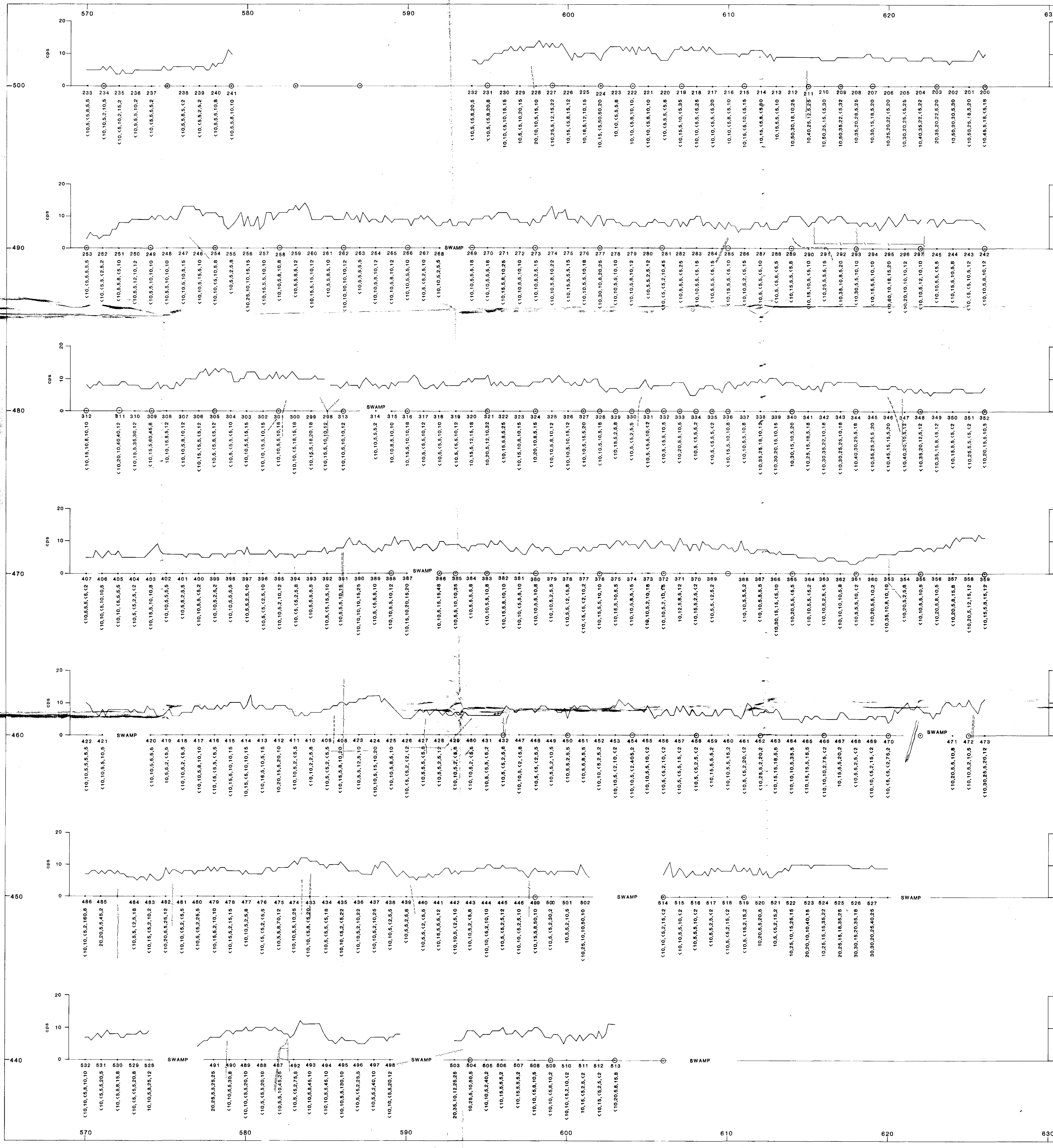
0 500 1000m 2 3 km

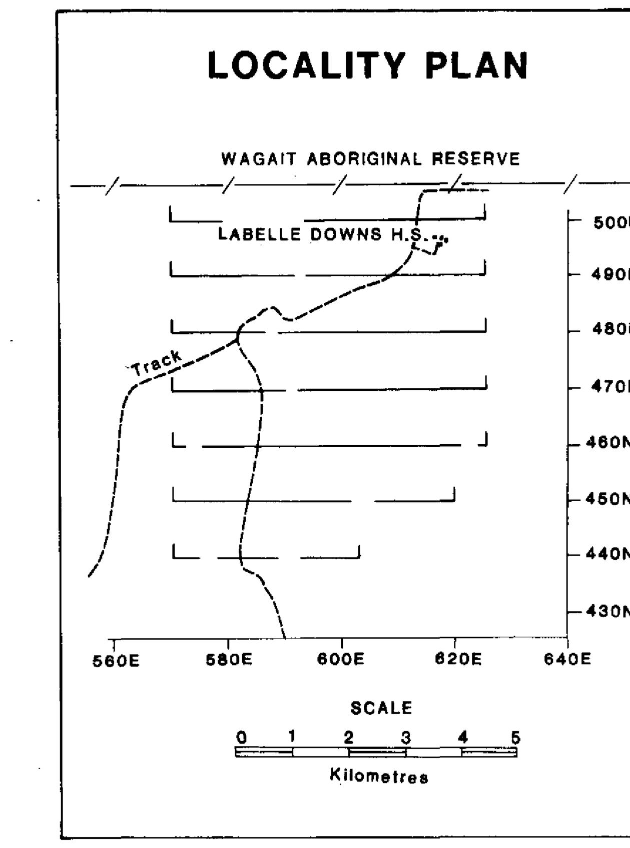
TITLE

URANGESELLSCHAFT AUSTRALIA PTY. LIMITED | PROJECT 821 | PLATE 3

WELLTREE E.L. 1731 NORTHERN TERRITORY PROJECT PROGRESS MAP

Date October 1979 | Prepared by: M Flook | Drawing Nº NS-222 | Project Nº 821-28





N

A.M.G.

LEGEND

Total count radioactivity counts per second

527 Soil sample number CSC 527

Soil Sample Analysis (p.p.m.) 25,40,25,20,30,30 — Cu, Pb, Zn, Co, Ni, Cr

Drillhole

Fence

Creek

Track

Surface radioactivity measured every 20 metres using an Exploranium Model GRS 101A Total Count Scintillometer

PLATE 4

A.O.G. MINERALS LIMITED

EL 1408 "ANSON BAY" Surface Exploration

COMPILED BY: G. Nicol | DATE: November 1980

DRAWN BY: R.Batten | REVISED:

SCALE 1:10,000

0 500 1000 Metres