DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1978/71

GRAVITY SURVEY, ALLIGATOR RIVER 1:250 000
SHEET AREA, NORTHERN TERRITORY, 1972-73

by

E.B. Wronski

Note: The original Record contains overlays for plate# ____1____. If you wish to view the original, please contact the N.H. (Doc) Fisher Geoscience Library.

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GRAVITY SURVEY, ALLIGATOR RIVER 1:250 000 SHEET AREA, NORTHERN TERRITORY, 1972-73

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PLATES

SUMMARY

In 1972-73 BMR made a gravity survey in the Alligator River 1:250 000 Sheet area, Northern Territory, to assist in identifying rock types and locating geological boundaries in the area.

Gravity highs were observed over the Cahill Formation adjacent to the Nanambu Complex, and indicate that the gravity method might be useful in mapping this boundary. Other results indicate the presence of concealed granites and that the northeastern part of the Alligator River 1:250 000 Sheet area is underlain by extensive, dense material, possibly basic igneous rocks.

1. INTRODUCTION

The Bureau of Mineral Resources, Geology and Geophysics began detailed geological mapping in the Alligator Rivers area, Northern Territory, in 1971. Outcrop is sparse in most of the area and mapping of Lower Proterozoic rocks is difficult.

In September and October 1972 BMR made a gravity survey in the Alligator River 1:250 000 Sheet area to determine if the gravity method could assist in identifying rock types and locating geological boundaries. Three traverses with a station spacing of 0.5 km were located over areas where the geology was known reasonably well, and it was intended to extend the survey to areas of poor or no outcrop later if these results were satisfactory. The results indicated that positive gravity anomalies tend to occur over the Cahill Formation adjacent to the Nanambu Complex and suggested that concealed granites could be recognised by gravity lows. In September to November 1973 the survey was extended by traverses west and north of the 1972 traverses, with a station spacing of 1 km.

The traverses are shown on the transparent overlay to Plate 1: traverses 1, 2, and 3 were surveyed in 1972; traverse 4 and the extension of traverse 3 west of 132°30'E were surveyed in 1973. Traverses 1, 2, and 4 were positioned, pegged, and levelled by surveyors from the Department of Services and Property. Department of Works survey data were used for Traverse 3, along the Arnhem Highway. Level and gravity controls were obtained from the FQ series of third-order bench-marks and gravity stations of the 1967 helicopter reconnaissance gravity survey (Whitworth, 1970). The bench-mark levels are relative to AHD, and the gravity values to the BMR pendulum station in Darwin. The assumed density used in the reduction of results was 2.67 g/cm^3. The gravity survey was conducted by E.B. Wronski (Geophysicist) and N.A. Ashmore (Technical Assistant) using Worden gravity meter W260.

2. GEOPHYSICAL BACKGROUND

Previous BMR gravity work in the Alligator River 1:250 000 Sheet area consists of a northeast-trending traverse with a station spacing of about 3 km from near the South Alligator River at the southern edge of the sheet to Cannon Hill near the centre of the sheet (Stott & Langron, 1959), and the 1967 helicopter reconnaissance survey with a station density of about one station per 125 km^2. The results of the previous gravity surveys (Whitworth, 1970) show that the eastern part of the sheet is part of the Oenpelli Regional Gravity Complex which comprises Bouguer anomalies up to +50 mGal in amplitude and 30 km or more wide. These features extend along a 150 km band from the Katherine 1:250 000 Sheet area to the Cobourg Peninsula 1:250 000 Sheet area and are bounded in the west by a reduction in amplitude of the Bouguer anomalies. The western part of the Alligator River 1:250 000 Sheet area is part of the Mary Regional Gravity Shelf.

In 1971-72 BMR made an airborne magnetic and radiometric survey in the Alligator River, Cobourg Peninsula, and Mount Evelyn 1:250 000 Sheet areas. The results are described by Horsfall & Wilkes (1975) and proved useful in defining some geological boundaries and in mapping dolerite bodies.

3. GEOLOGY

The geology of the Alligator Rivers uranium field is described by Needham, Smart, & Watchman (1974) and Smart, Wilkes, Needham & Watchman (1975). Much of the area is covered by alluvium but an interpretation of the Proterozoic geology is presented in Plate 1, at 1:1 000 000 scale. The principal rocks in the area are Lower Proterozoic sediments, metamorphic complexes, and basic intrusives. Younger Proterozoic intrusives and sediments occur in the central and eastern parts of the area.

Lower Proterozoic sediments

Lower Proterozoic sedimentary rocks of the Pine Creek Geosyncline crop out in the southwest sector of the uranium field. The oldest strata are feldspathic sandstone, siltstone, greywacke, arkose, and conglomerate of the Masson Formation and the overlying Mount Partridge Formation. These are overlain, probably unconformably, by a series of sediments: chert and carbonate, and banded carbonaceous shale and siltstone. The sediments are typified by the Koolpin Formation, which is well exposed in the El Sherana district in the Mount Evelyn 1:250 000 Sheet area. Similar sediments - the Cahill Formation (Needham & Stuart-Smith, 1976) - form a continuous but heterogeneous belt of rocks in the metamorphic terrain of the Alligator Rivers uranium field and appear to have been deposited in the same sedimentary environment and at the same time as the Koolpin Formation. Both the Koolpin Formation and the Cahill Formation are overlain by Fisher Creek Siltstone. Generally, the metamorphic grade of the sedimentary units gradually increases to the northeast.

Metamorphic complexes

The Nimbuwah and Nanambu Complexes occupy the metamorphic centres of the uranium field, and consist of a large suite of migmatites. The bulk of the migmatite complexes was derived either from the immature sediments of the Mount Partridge and Masson Formations, or from Archaean basement. The Nimbuwah Complex comprises a 'Granitoid Core' of homogeneous granitoid migmatite, flanked by a belt of heterogeneous granitoid migmatites ('Migmatite Zone'). The Migmatite Zone grades outwards into banded, augen, and lit-par-lit gneiss and schist, which comprise the 'Lit-par-lit Gneiss Zone'. These rocks in turn grade through feldspathic and banded schists of the 'Transitional Zone' into schist and phyllite which have not undergone metamorphic differentiation and are recognisable equivalents of sedimentary units already described.

The Nanambu Complex is similar to the Nimbuwah Complex except that it is composed essentially of Lit-par-lit Gneiss Zone rocks with scattered Granitoid Core and Migmatite Zone rocks. A shear zone intersected by drilling at Ranger 1 probably represents a major zone of movement at the eastern margin of the Nanambu Complex.

Intrusive rocks

The Lower Proterozoic rocks are intruded by a variety of basic igneous rocks. Dolerites of the Zamu Complex intruded the sediments before regional metamorphism, and were folded with the sediments, and in places are incorporated in the migmatite complexes as amphibolite. Zamu Complex rocks are mostly restricted to the southwest of the area. The Oenpelli Dolerite was intruded after migmatisation as an extensive undulating sheet (or possibly as a series of lopoliths) up to 250 m thick composed of differentiated dolerite derived from an alkali basalt parent magma.

Several altered pink biotite granites intrude the migmatite complexes and the surrounding metamorphic and sedimentary rocks.

Other rocks

The subhorizontal sandstone, conglomerate, and interbedded basic volcanics of the Kombolgie Formation form a plateau (the Arnhem Land Plateau) which covers most of the central and eastern parts of the area. Inliers of older rocks, mostly Oenpelli Dolerite, are found throughout the plateau. The Kombolgie Formation is about 500 m thick and forms a sheer scarp up to 200 m high along its western margin.

Cainozoic sand, laterite, and alluvium cover all low-lying areas and restrict outcrop of the Lower Proterozoic units (which are mostly deeply weathered) to incised creeks and isolated hills.

4. RESULTS

The Bouguer anomaly profiles along the traverses are shown in Plate 2 at 1:250 000 horizontal scale. Plate 3 is a Bouguer anomaly contour map of the Alligator River Sheet area, also at 1:250 000. The contours have been plotted by a computer and the map includes data from the traverse of Stott & Langron (1959), the 1972-73 traverses, and the helicopter reconnaissance survey. The contour overlay for Plate 1 is a generalised version of Plate 3.

The geological sections shown with the gravity profiles in Plate 2 were obtained from large-scale compilation sheets and do not necessarily agree with the generalised geology shown in Plate 1.

Density determinations

Density determinations from drill core in the Alligator River 1:250 000 Sheet area have been made by Geopeko Limited and by L.A. Richardson and Associates Pty Ltd on behalf of Geopeko Limited; results have been kindly supplied to BMR and are summarised in the Appendix.

Estimates of the density of rock types in the Alligator River 1:250 000 Sheet area are:

Dolerite 3.0 g/cm^3

Amphibolite 3.0 g/cm^3

Dolomite 2.84 g/cm^3

Metamorphosed and migmatised sediments (mainly Cahill Formation) 2.76 g/cm^3.

Nanambu and Nimbuwah Complexes

Traverses 1, 3, and 4 crossed the Nanambu Complex, Traverse 2 the Nimbuwah Complex. In general the Bouguer anomaly profiles over the Complexes are smooth and exhibit no special features except for the steep gradients observed near station 504 on Traverse 3. The trough in the Bouguer anomaly profile centred on station 504 on Traverse 3 may indicate the presence of a concealed granite body.

Cahill Formation

The results show that gravity highs tend to occur over the Cahill Formation adjacent to the Nanambu Complex, for example on Traverse 1 (stations 36 to 43), Traverse 3 (stations 12 to 309), and Traverse 4 (stations 1 to 6). Dolomite commonly forms discontinuous lenses up to 250 m thick within the Koolpin Formation near its base (Stuart-Smith & Hone, 1975), and may be the source of these gravity highs.

Oenpelli Dolerite

The gravity highs which cover much of the northeastern part of the Alligator River 1:250 000 Sheet area coincide with an area of extensive outcrops of Oenpelli Dolerite. The greatest known thickness of the Oenpelli Dolerite is 250 m. If the density of the metamorphosed sediments is 2.76 g/cm^3 and the density of the Oenpelli Dolerite is 3.0 g/cm^3, an infinite, 250-m-thick slab of Oenpelli Dolerite would produce an anomaly of 2.5 mGal, which is much smaller than the gravity highs. The gravity data suggest, therefore, that the northeastern part of the Alligator River 1:250 000 Sheet area is underlain by extensive thick dense rocks, possibly basic igneous rocks.

Granites

Granite crops out around latitude 12°28'S, longitude 133°24'E, and around latitude 12°39'S longitude 133°19'E. The gravity contours show an extensive low enclosing the granite outcrops, indicating they may be part of one, mostly concealed, body. Granite also crops out around 12°17'S, 133°23'E, (about 7 km east of Nabarlek) and has been intersected by diamond drilling at Nabarlek at a depth of about 400 m. This granite is about 20 km northwest of the centre of the gravity low but is not enclosed by the low. The relationship between this granite and the granite outcrops to the south is not known.

The gravity low on the southern edge of the Alligator River 1:250 000 Sheet area at 13°00'S, 132°29'E is part of a gravity low centred at 13°04'S, 132°27'E, in the Mount Evelyn 1:250 000 Sheet area. This low may indicate the presence of a concealed granite.

The gravity lows in the southeastern part of the Alligator River 1:250 000 Sheet area at 12°51'S, 133°18'E and 12°57'S, 133°06'E, and near the centre of the Sheet area at 12°39'S, 132°32'E (traverse 3, station 504) may indicate the presence of other concealed granites.

5. CONCLUSIONS

The gravity highs observed over the Cahill Formation adjacent to the Nanambu Complex indicate that the gravity method might be useful in mapping this boundary.

The gravity data indicate the possible existence of concealed granite, and also indicate that the northeastern part of the Alligator River 1:250 000 Sheet area is underlain by extensive, thick, dense material, possibly basic igneous rocks.

6. REFERENCES

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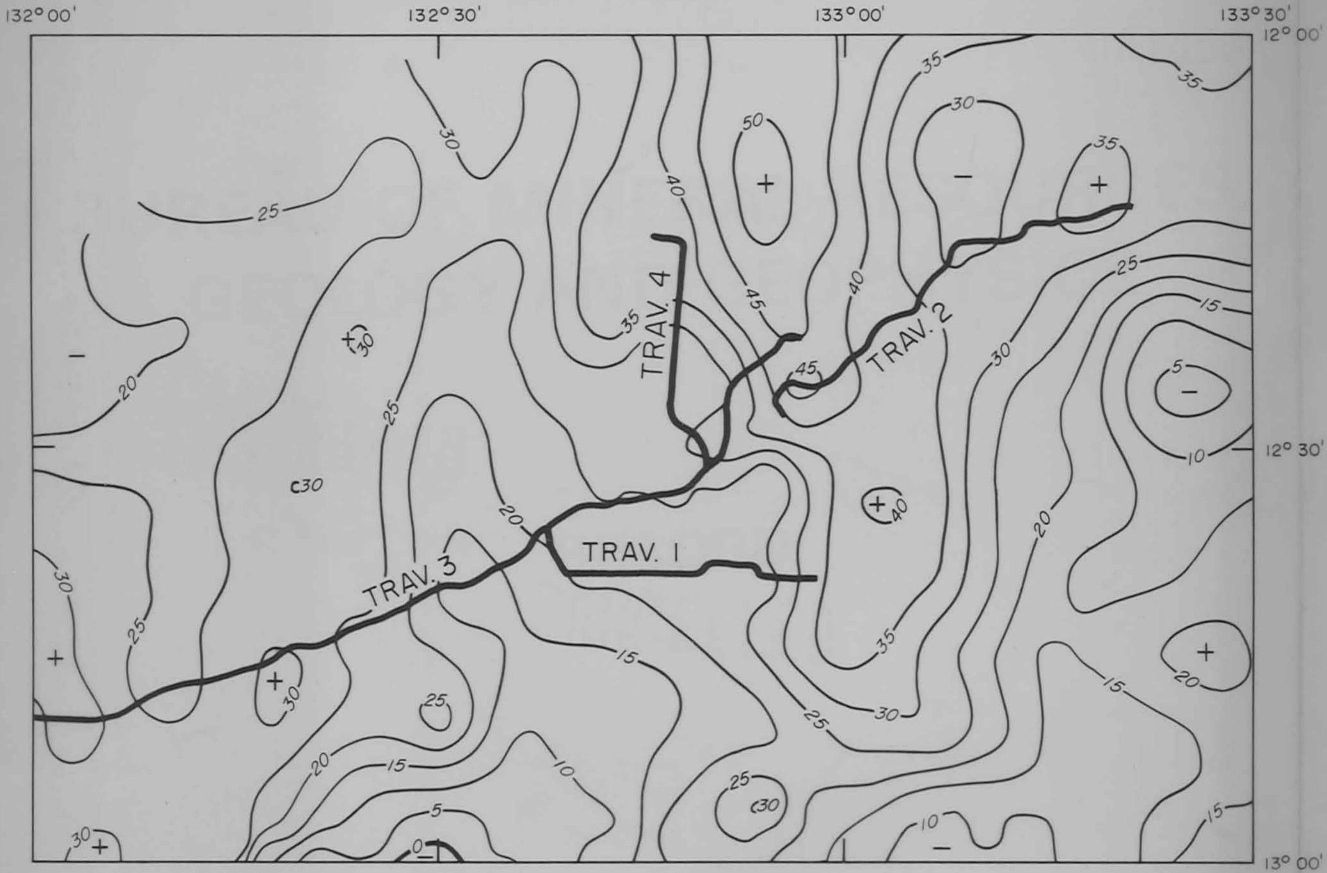
APPENDIX

SPECIFIC GRAVITY DETERMINATIONS ON DRILL CORE

Location	Rock Type	No. of samples	Specific gravity
Ranger 19	pegmatite	2	2.68
Ranger 19	pegmatoid	2	2.70
Ranger 11	gneiss	2	2.57
132°35½'E, 12°39'S	gneiss	2	2.76
Ranger 1	sandstone	7	2.63
Ranger 34	schist	12	2.90
Ranger 14	schist	3	2.45
Ranger 19	schist	16	2.77
R10 grid	schist	14	2.77
132°35½'E, 12°39'S	schist	1	2.71
132°42'E, 12°20½'S	schist	2	2.82
Ranger 1	chlorite schist	6	2.76
Ranger 19	chlorite schist	5	2.76
R10 grid	chlorite schist	15	2.76
Ranger 1	chlorite schist	7	2.58
Ranger 14	magnesite marble	6	2.94
Ranger 19	calcite marble	6	2.79
Ranger 19	dolomitic marble	11	2.83
R10 grid	carbonate	14	2.85
R10 grid	chloritic carbonate	9	2.77
Ranger 1	magnesite	2	2.83
Ranger 1	75% amphibolite	1	2.96
Ranger 1	amphibolite	1	3.08
Urralagoorwa	amphibolite	2	2.91
R10 grid	amphibolite	3	3.05
132°35½'E, 12°39'S	amphibolite	1	2.87
132°42'E, 12°20½'S	amphibolite	1	3.06
Ranger 19	chlorite-amphibole rock	1	3.10
Ranger 10	dolerite	1	3.02
Ranger 19	dolerite	6	2.98
132°35½'E, 12°39'S	dolerite	1	3.01

The determinations were supplied by Geopeko Limited and L.A. Richardson and Associates Pty Ltd.



Contour interval 5mGal
Rock density 2·67g/cm^3

BOUGUER ANOMALY CONTOURS
ALLIGATOR RIVER 1:250 000 SHEET

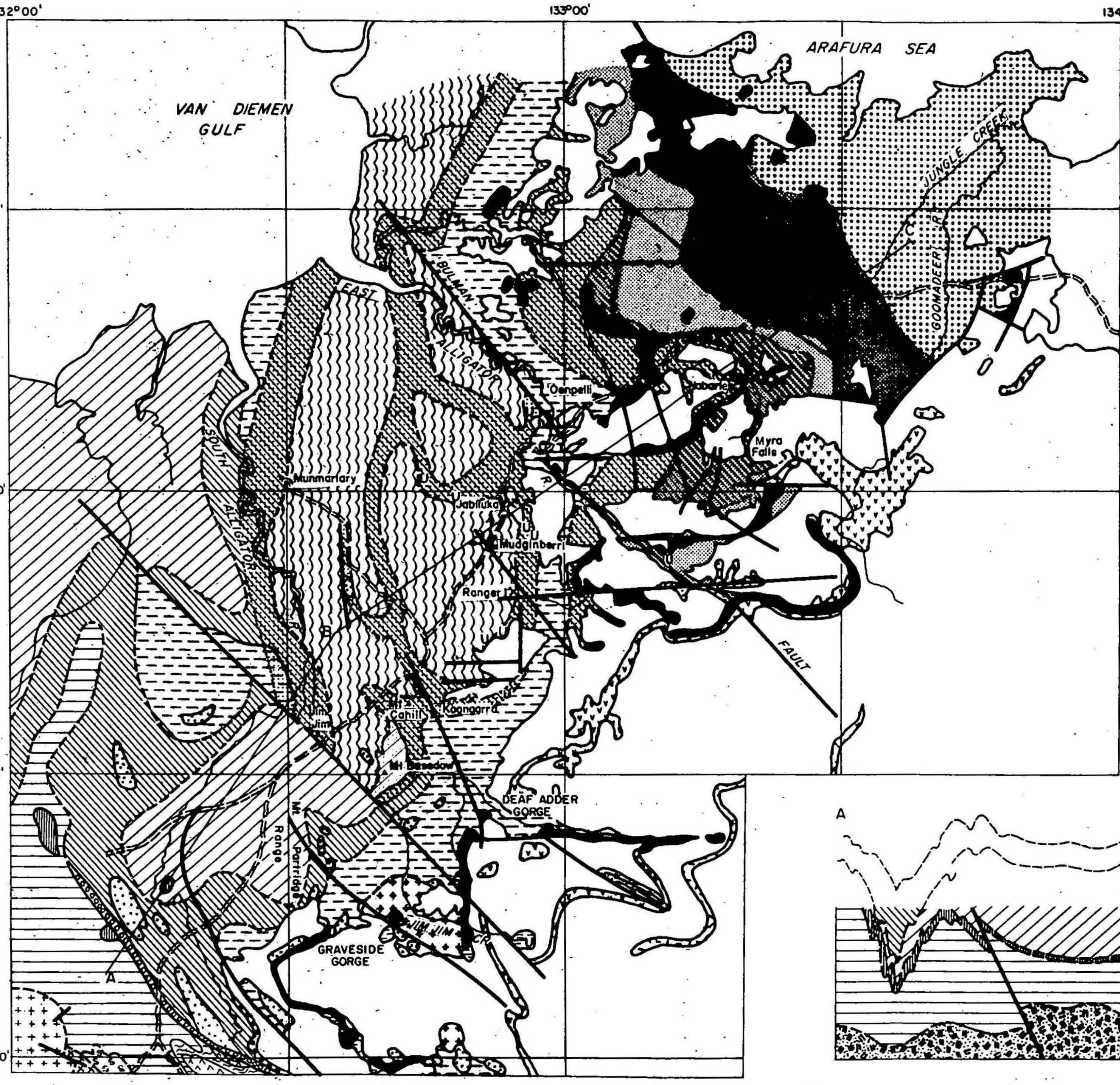
Record No. 1978/71

D53/B7-88A

Overlay to D53/BI-50

PLATE I

ALLIGATOR RIVERS AREA
INTERPRETATIVE PROTEROZOIC GEOLOGY



0 10 20 30 40 50 km

ADELAIDEAN		Phonolite dykes
LOWER PROTEROZOIC — CARPENTARIAN	Kombolgie Formation	
	Gilruth Volcanic Member	Amygdaloidal basalt and tuffaceous siltstone
		Sandstone, conglomerate
	Nungbalgarri Volcanic Member	Basalt
	Plum Tree Volcanic Member	Andesite, amygdaloidal volcanics
	Kurrundie Member	Greywacke, conglomerate
	Oenpelli Dolerite	Dolerite, gabbro, syenite
	Edith River Volcanics	Rhyolite, dacite, sedimentary lenses
		Biotite granite
LOWER PROTEROZOIC	Zamu Complex	Meta-dolerite, meta-gabbro, basic amphibolite
	Burrell Creek Formation	Greywacke, siltstone
	Fisher Creek Siltstone	Phyllite, schist, quartzite
	Golden Dyke Formation	Siltstone, carbonaceous siltstones chert, dolomite
	Koolpin Formation and Cahill Formation	Siltstone, chert dolomite quartzite and metamorphic equivalent
	Mt Partridge Formation	Meta-arkose, feldspathic
	Coirwong Greywacke	quartzite, meta-conglomerate
	Stag Creek Volcanics	Meta-basalt, agglomerate
	Masson Formation	Siltstone, greywacke, conglomerate
ARCHAEAN		Undivided basement (section only)

Formation boundaries

Zone boundaries (in migmatite complexes)

Fault

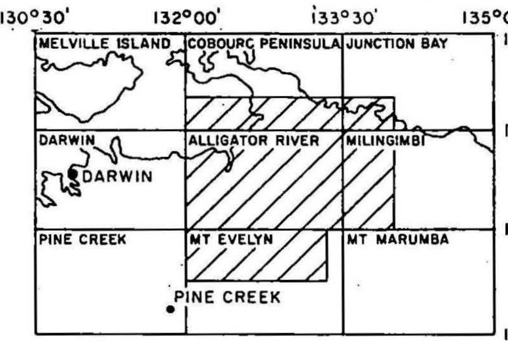
Uranium deposits

U Uranium prospects

Road

River

Homestead or Mission

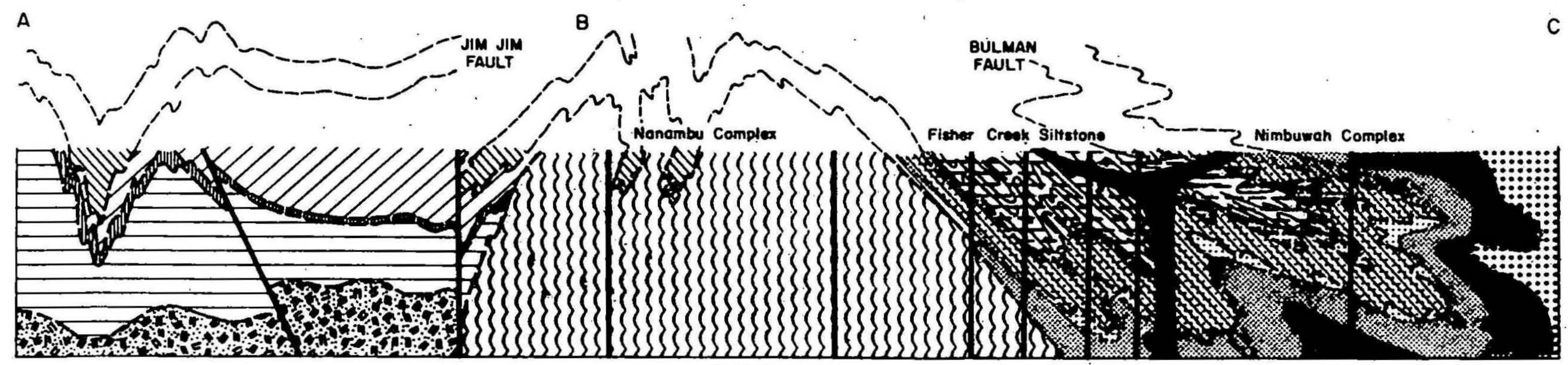


Reference to AUSTRALIAN MAP SERIES 1:250000

NORTHEAST OF JIM JIM CREEK

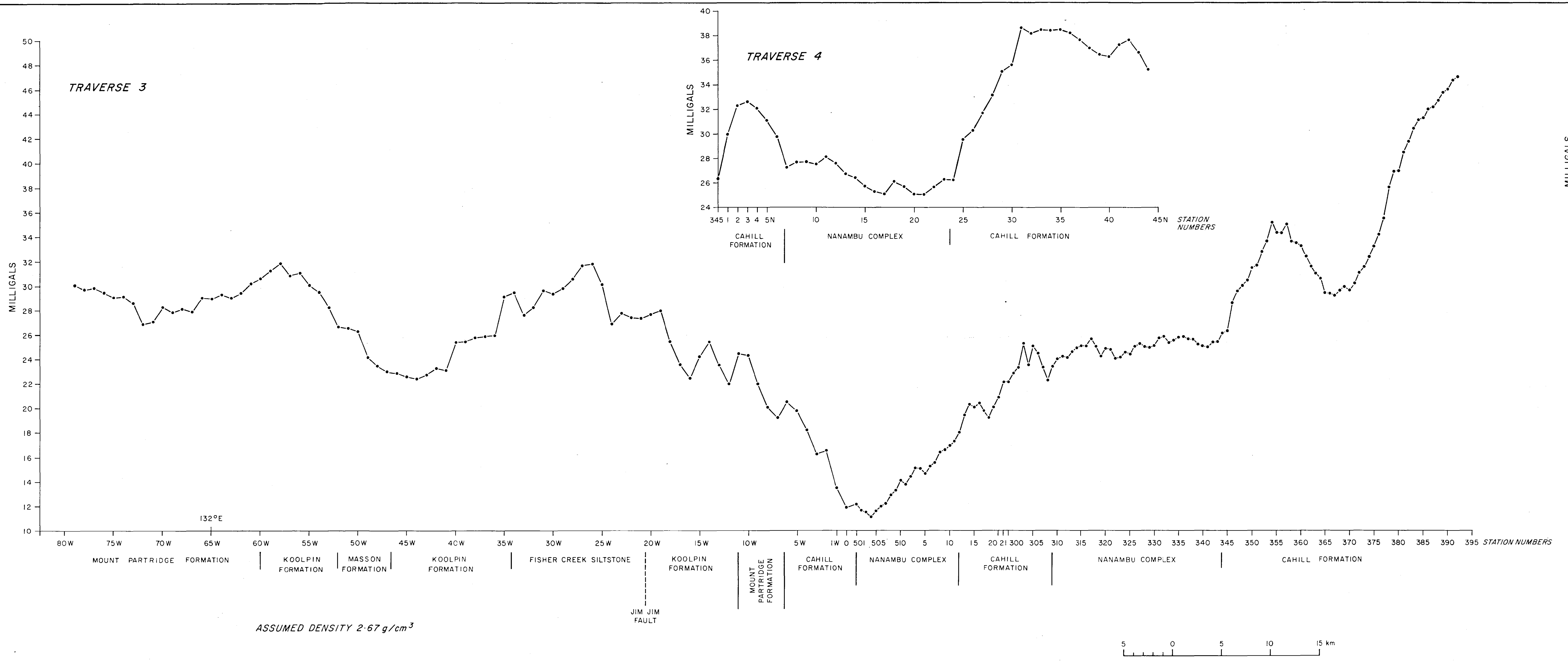
Nimbuwah Complex	Granitoid Core	Migmatised Lower Proterozoic sediments
	Migmatite Zone	
	Lit-par-lit Gneiss Zone	
	Transitional Zone	
Nanambu Complex	Transitional Zone	
	Migmatised Archaean basement core	

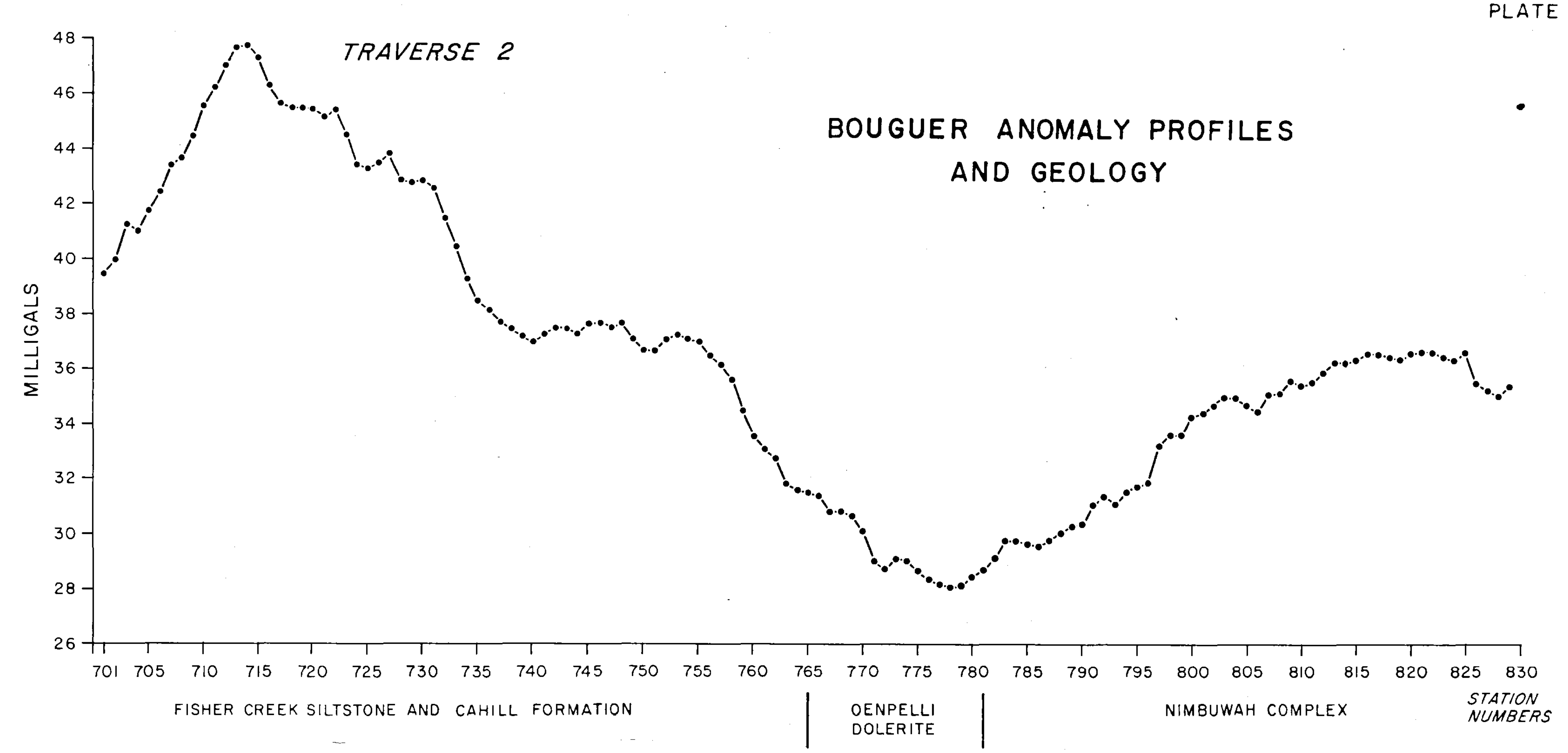
Geology after Smart and others (1975)

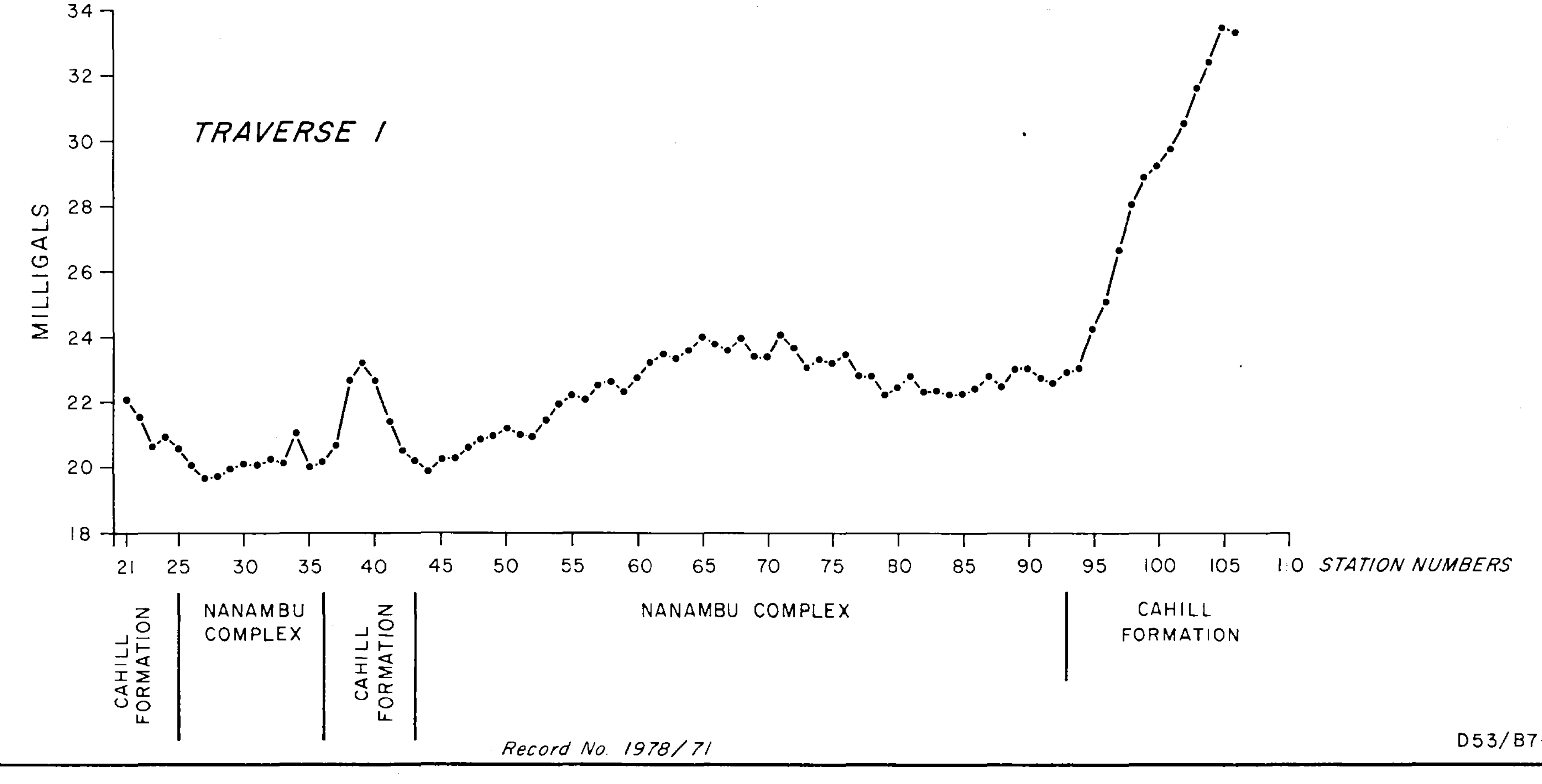


SECTION A – C

BOUGUER ANOMALY PROFILES AND GEOLOGY







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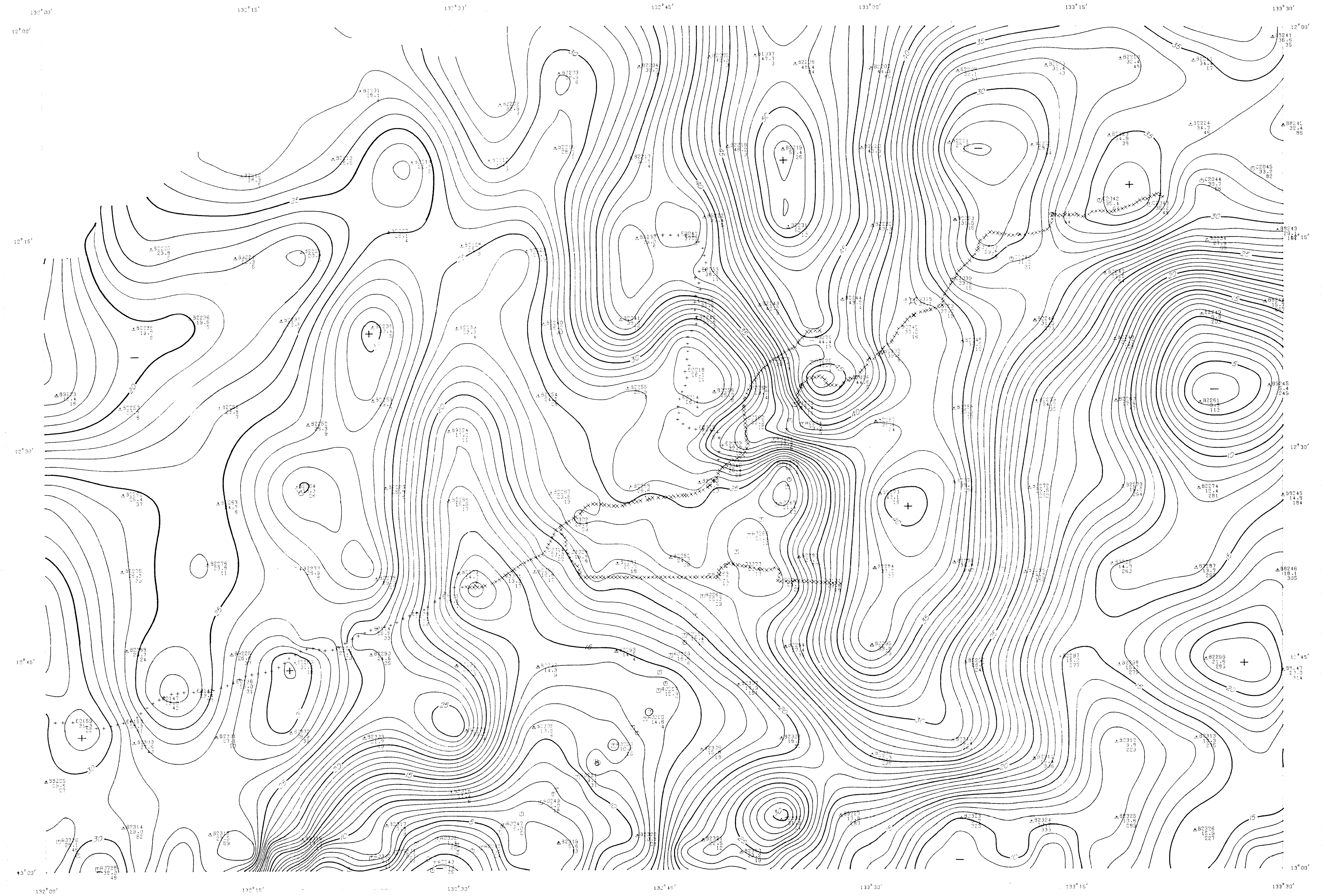
D53/B7-89

AUSTRALIA 1:250000 GRAVITY SERIES

ALLIGATOR RIVER

PLATE 3
D53-1



D53/B7-99

AUSTRALIAN NATIONAL SPHEROID
TRANSVERSE MERCATOR PROJECTION
ZONE 53 (AUSTRALIA SERIES)

BOUGUER ANOMALIES

0 5 10 15 20 km

SURVEY KEY

SYMBOL	LETTER	BMR NUMBER
⊡	A	5706
⌧	I	6491
△	B	6704
ⓘ	C	6708
×	D	7205
+	E	7316

DENSITY = 2.67 GMS/CC.

ALLIGATOR RIVER
NORTHERN TERRITORY

D53-1

CONTOUR LEVELS AT 1.00
5.00

LEGEND

A1234 : STATION NUMBER
56.7 : GRAVITY ANOMALY
456 : GROUND ELEVATION

LAT GRID = 1.25 MIN
LONG GRID = 1.25 MIN
ITERATIONS = 12/ 22
BORDER = 10.00 MIN

UNITS
HEIGHT : METRES
GRAVITY : MILLIGALS

Record No. 1978/71

PLOTTED 10/07/78
D53/B7-99