DEPARTMENT OF
~~NATIONAL RESOURCES~~
NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1978/113

PROGRESS REPORT OF THE ALLIGATOR RIVER PARTY, 1973-6 FIELDWORK

by

R.S. Needham & P.G. Stuart-Smith

RECORD 1978/113

PROGRESS REPORT OF THE ALLIGATOR RIVER PARTY, 1973-6 FIELDWORK

by

R.S. Needham & P.G. Stuart-Smith

CONTENTS

PLATES

1. Arnhem Land Escarpment north of Deaf Adder Gorge.

2. East Alligator River gorge, looking northwest from the Beatrice Inlier.

3. Intraformational conglomerate forms a rubbly pavement in areas where no Nungbalgarri Volcanics were deposited. Jim Jim Sheet area, 18 km northeast of Jim Jim Falls.

4. Intraformational conglomerate in Kombolgie Formation lower sandstone unit, Howship Sheet area, 20 km northeast of Jabiru.

5. Slump folding in Kombolgie Formation upper sandstone unit. Gilruth Sheet area, 23 km southeast of Mount Gilruth.

6a & 6b Circular giant-scale load casts below Nungbalgarri Volcanic Member. Oenpelli Sheet area, 17 km southeast of Nabarlek. (a) 1: Nungbalgarri Volcanic Member. 2: Kombolgie Formation lower sandstone unit. 3: Fault. (b) Trees in depressions are up to 10 m high.

7. Rectilinear giant-scale load casts below Gilruth Volcanic Member. Howship Sheet area, 33 km south-southeast of Beatrice prospect. 1: Sandstone above volcanic member. 2: Volcanic member. 3: Sandstone below volcanic member. 4: Direction of orientation of load casts.

8a & 8b Nungbalgarri Volcanic Member. (a) Wooded slope between lower and upper sandstone units of the Kombolgie Formation. Howship Sheet area, 16 km south-southeast of Beatrice prospect. (b) Columnar jointing, Howship Sheet area, 25 km ESE of Beatrice prospect; largest hexagon is 50 cm across.

9. Dyke of porphyritic olivine basalt cuts the Nungbalgarri Volcanic Member, Howship Sheet area, 17 km southeast of Beatrice prospect.

10. Gilruth Volcanic Member forms rubbly, heavily vegetated steeper slope above a lateritised bench within Kombolgie Formation upper sandstone unit. Type locality, Howship Sheet area, 19 km ENE of Kub-o-wer Hill.

11. Large angular boulders of Lower Proterozoic quartzite in breccia-conglomerate of basal Kombolgie Formation, in re-exhumed valleys of the Mount Partridge Range. Jim Jim Sheet area.

12. Coarse subrounded pebble conglomerate overlies the breccia-conglomerate (Plate II) and grades sharply up into coarse quartz sandstone. Southern end of Mount Partridge Range, Jim Jim Sheet area.

13. The west end of a basement high of Oenpelli Dolerite forming an inlier within Kombolgie Formation sandstone. Howship Sheet area 13 km southwest of Beatrice prospect.

14. Mesas of Mesozoic lateritised claystone and sandstone overlying Nungbalgarri Volcanic Member (wooded) and lower sandstone unit of the Kombolgie Formation (middle distance). Howship Sheet area, 29 km east-southeast of Beatrice prospect.

15. Ridges of Kudjumarndi Quartzite dominate the topography of the Myra Falls Inlier. Looking northeast from the southwestern corner of the inlier.

16. Isoclinal folding in narrow quartzite bands within unit Blc_1b, 2.5 km northwest of Caramal track crossing over Tin Camp Creek.

17. Deeply sculptured black blocks of calcite-tremolite marble, (unit Blc_{1a}) form a discontinuously exposed bed in the northeast of the Myra Falls Inlier, 1.8 km southeast of Caramal Track crossing over Tin Camp Creek. Ridge of Kudjumarndi Quartzite in background.

18. Banded gneiss of unit Blc_1b, 1 km downstream from Caramal track crossing over Tin Camp Creek.

19. Feldspar quartz boudins with biotite chlorite selvages in banded gneiss of Blc_1b. Same locality as Plate 18.

20. Folded lit-par-lit gneiss of unit Blz_3, Nimbuwah Complex. 1 km north of Garrunghar prospect, Myra Falls Inlier.

21. Oenpelli Dolerite forms a prominent ridge along the northern margin of the Myra Falls Inlier.

22. Fault breccia containing large blocks of Kombolgie Formation sandstone forms spines along some ridges in the southern part of the Myra Falls Inlier.

23. Finely banded garnet hornblende biotite/quartz feldspar migmatite of unit Blz_2, central Caramal East Inlier.

24. Coarsely banded migmatite with hornblende-rich melanosome, unit Blz_2, western Caramal East Inlier.

25. Quartz-breccia zone in Tin Camp Granite, Caramal East Inlier, 6 km east of Myra Falls.

26. The lower sandstone unit of the Kombolgie Formation dips away from the edge of the Five Sisters Inlier at up to 20°.

27. Ground radiometric work in a trench at the Five Sisters uranium prospect.

28. Pink aplite intrudes Zamu Complex metadolerite adjacent to the margin of the Jim Jim Granite.

29. Exposure of horizontally jointed Jim Jim Granite suggesting proximity to roof of pluton. 22 km southwest of Five Sisters prospect.

30. Massive silicified dolomite, Masson Formation, 18 km northwest of Black Jungle Spring (Mundogie 1:100 000 Sheet area).

31. Pebble conglomerate and coarse-grained pebbly quartz sandstone, Mount Hooper Sandstone. (Field Island 1:100 000 Sheet area).

32. Chert pebble conglomerate, Mount Hooper Sandstone. The chert pebbles contain ghost carbonate rhombohedra, and are probably silicified dolomite derived from the underlying Cahill Formation. (Kapalga iron prospect, Kapalga 1:100 000 Sheet area).

33. Silicified dolomite breccia at base of Koolpin Formation 8 km northwest of Black Jungle Spring (Mundogie 1:100 000 Sheet area).

TABLES

FIGURES

MAP PLATES (scale of original compilation shown below; copies at reduced scale included in this report)

2C.	Oenpelli SW,	compilation	sheet	1:25 000	scale	(SE part)	
2D.	" "	"	"	"	"	(SW part)	
3A	Oenpelli SE	"	"	"	"	(NW part)	
3B.	" "	"	"	"	"	(NE part)	
3C.	" "	"	"	"	"	(SE part)	
3D.	" "	"	"	"	"	(SW part)	
4.	Goomadeer SW,	compilation	sheet	1:50 000	scale		
5.	" SE	"	"	"	"		
6.	Howship NW	"	"	"	"		
7.	" NE	"	""	"	"		
8.	" SE	"	"	"	"		
9.	" SW	"	"	"	"		
10.	Jim Jim NW	"	"	"	"		
11.	" " NE	"	"	"	"		
12.	Gilruth NW	"	"	"	"		
13.	" NE	"	"	"	"		
14.	Jim Jim SW	"	"	"	"		
15.	" " SE	"	"	"	"		
16.	Gilruth SW	"	"	"	"		
17.	" SE	"	"	"	"		
18.	Reference to Field Island and Kapalga Sheet areas						
19.	Field Island NW,	compilation	sheet	1:50 000	scale		
20.	" " NE	"	"	"	"		
21.	" " SW	"	"	"	"		
22.	" " SE	"	"	"	"		
23.	Kapalaga NW,	compilation	sheet	1:50 000	scale		
24.	" NE	"	"	"	"		
25.	" SW	"	"	"	"		
26.	" SE	"	"	"	"		

SUMMARY

This report is a progress account of BMR's semi-detailed mapping program that was begun in the Alligator Rivers region in 1971. The geology of areas studied by the Alligator Rivers Party in its 1973, 1975, and 1976 field seasons is described. The areas are: the Arnhem Land Plateau of Carpentarian strata, and inliers of Lower Proterozoic rocks on the Oenpelli, Howship, Gilruth, and Jim Jim 1:100 000 Sheets and part of the Goomadeer 1:100 000 Sheet (grouped here as the 'Eastern Block'); and the Field Island and Kapalga 1:100 000 Sheets (Lower Proterozoic bedrock), grouped as the 'Western Block'.

In the Eastern Block, the Arnhem Land Plateau consists of dissected Carpentarian Kombolgie Formation sandstone. The formation is up to 1150 m thick and contains two basalt-rhyodacite members, one up to 170 m thick and the other up to 5 m thick; the formation is mainly subhorizontal with an overall dip of about 2° to the southeast. Locally, dips steepen to 35° at the edge of the plateau. Inliers in the plateau contain Lower Proterozoic to Carpentarian rocks. Lower Proterozoic metasediments, and interbedded amphibolite, grade eastwards into migmatites of the Nimbuwah Complex. Carpentarian granites intrude the migmatites and the metasediments; they are characteristically extensively altered, are transected by quartz-breccia reefs, and are anomalously radioactive. Younger Carpentarian dolerite (Oenpelli Dolerite) intrudes the metasediments and migmatites as long arcuate bodies considered to be lopoliths. These bodies formed basement highs to Kombolgie Formation deposition, and have subsequently influenced scarp retreat patterns during erosion of the sandstone. Most of the smaller inliers contain only Oenpelli Dolerite. The best exposures of the metasediments are in the Myra Falls Inlier, where meta-arkose and quartzite at the base of the sequence are correlated with Mount Partridge Formation, and calc-silicate gneiss, psammitic gneiss, and carbonaceous schist with the Cahill Formation. Uranium prospects in the Eastern Block lie within these Cahill Formation equivalents or in migmatites probably developed from them.

The Western Block is dominated by long ridges of folded pebbly Lower Proterozoic sandstone and siltstone (Mount Hooper Sandstone) which outline a large southward-plunging syncline in the north, and a group of ridges, formed by more gently folded rocks, marking the arcuate limbs of

a northward-plunging syncline of Koolpin Formation. The southern ridges contain chert-banded hematitic siltstone, carbonaceous siltstone, and silicified dolomite. Drilling has established a stratigraphic sequence on the eastern limb, stratigraphically both above and below the relatively well exposed Mount Hooper Sandstone, but information in other areas blanketed by Cainozoic deposits is sketchy or non-existent. A sequence of schist, carbonate rocks, and minor arenite and carbonaceous schist below the Mount Hooper Sandstone is correlated with the lower member of the Cahill Formation, and shale, carbonaceous shale, and carbonate rocks overlying the sandstone are correlated with the Koolpin Formation. Scattered exposures mapped previously as Masson Formation in the southwest of the block are subdivided into Mount Hooper Sandstone, Koolpin Formation, Masson Formation, and Gerowie Tuff. Zamu Complex dolerite forms sills, folded with the Lower Proterozoic strata, mainly in the south of the area, and Fisher Creek Siltstone is postulated to occupy the centre of a syncline south of the Jim Jim Fault. Munmarlary Quartzite underlying Cahill Formation crops out over limited areas on the eastern edge of the block, and flanks Archaean granite of the Nanambu Complex exposed near the South Alligator River bridge. Mount Partridge Formation is exposed in the southeast of the block.

Minor U, Th, Sn, and Fe prospects are scattered through the areas mapped; U is associated with the Cahill, Koolpin, and Masson Formations; Th and Fe with the Mount Hooper Sandstone; and Sn with the Mount Partridge Formation.

The metamorphic grade of the Lower Proterozoic metasediments is amphibolite facies in the eastern block, but grades from amphibolite facies in the extreme east of the western block to very low-grade near Flying Fox Creek towards the centre of the Kapalga 1:100 000 Sheet area.

INTRODUCTION

From 1973 to 1975 a field party completed semi-detailed mapping of the Alligator Rivers uranium field. This Record is the last in a series of progress accounts of the party's findings (earlier work has been reported by Needham & Smart, 1972; and Needham & others, 1975a; 1975b). Field work by other parties in areas to the west is continuing, and will give complete 1:100 000-scale coverage of the Pine Creek Geosyncline. Reductions of compilation sheets (drawn originally at 1:25 000 or 1:50 000 scale) of the following 1:100 000 Sheet areas are included in this report: Oenpelli SW & SE Sheets; Howship (all sheets); Gilruth (all); Jim Jim (all); Goomadeer SW, SE: Field Island (all); Kapalga (all). Changes in stratigraphic nomenclature arising from the work in these areas are appended.

During 1973, traverses by Landrover, helicopter, and on foot were made from a base camp established on Tin Camp Creek 400 m downstream from the Caramal track crossing, permitting traverse work by vehicle over the Myra Falls Inlier, and helicopter traverses to the Goomadeer Sheet area and the northern half of the Howship Sheet area. Fly camps were then established for short periods at Koongarra and Munmarlary homestead, for helicopter work in the Gilruth and Jim Jim Sheet areas, the southern half of the Howship Sheet area, and in the Field Island and Kapalga Sheet areas. Further helicopter traverses were made over these areas during 1974 from a base at Cooinda Motel, and the southern half of the Kapalga Sheet area was covered by Landrover and helicopter traverses during 1975 from a base at Flying Fox Creek.

Field observations were plotted onto RC8 (1:16 000 scale) aerial photographs where available, or otherwise onto RC9 (1:83 000 scale) photographs. Detailed interpretation of these photographs was later transferred to overlays on 1:50 000 scale enlargements of RC9 photographs. Parts of the Oenpelli Sheet area were photointerpreted on 1:25 000 scale colour photographs which became available after the field work. All compilation was then drafted onto 1:50 000 scale corrected bases drawn from the R.A.S.C. topographic bases. A comprehensive selection of samples was thin-sectioned, and petrographic descriptions made mainly by Dr John Ferguson, and by Stuart-Smith.

LOCATION AND ACCESS

The location of the survey area is shown on Figure 1. The areas mapped comprise a Western Block (Kapalga and Field Island Sheet areas) 150 km east of Darwin, and an Eastern Block (Oenpelli, Goomadeer, Howship, Gilruth, and Jim Jim Sheet areas) 270 km east of Darwin. An index to the 1:50 000 scale and 1:25 000 scale Map Plates attached to this report is given in Figure 2.

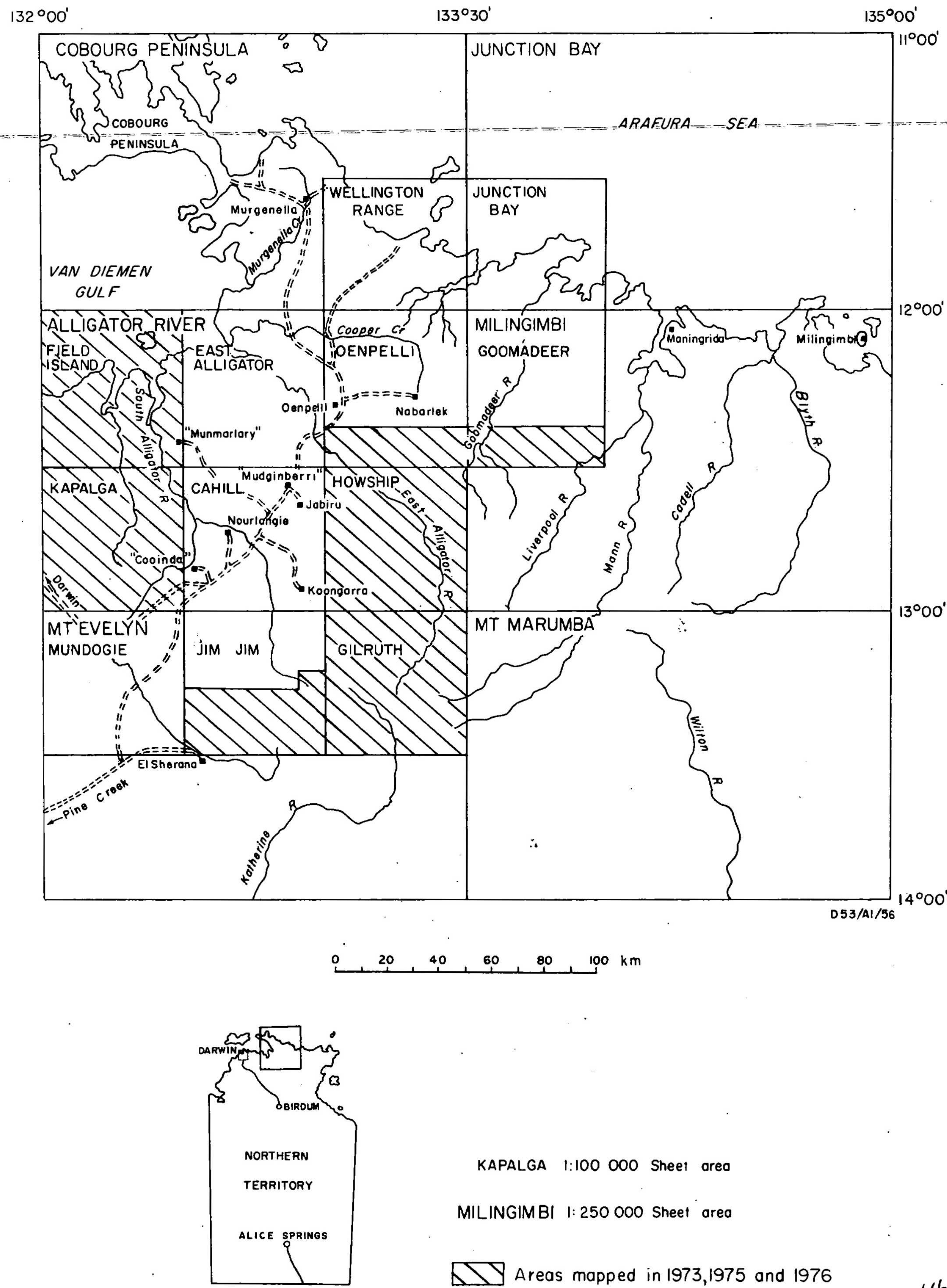
Access to the Eastern Block is limited, as the area constitutes the greater part of the Arnhem Land Plateau, a rugged, deeply dissected sandstone plateau. The only road access into the area mapped is by a track running south from Nabarlek camp into the Myra Falls Inlier, which provides adequate vehicular access in the inlier as far southeast as Caramal prospect and as far west as the East Alligator River. A helicopter was used for access to all other areas. The Eastern Block lies entirely within the Arnhem Land Aboriginal Reserve.

Access to the Western Block is by the new Arnhem Highway which crosses the central part of the Kapalga Sheet area. Access north of the highway is by exploration company tracks and an old track to the abandoned Kapalga homestead. A track to the Wildman River homestead provides access to the northeast of the Kapalga Sheet area from the Point Stuart road, 25 km west of the Sheet area. Generally access is poor, and a helicopter was used for mapping the Western Block. (Since the fieldwork was completed, roads graded for a CSIRO buffalo study have substantially opened up the Kapalga Sheet area north of the Arnhem Highway).

PREVIOUS INVESTIGATIONS

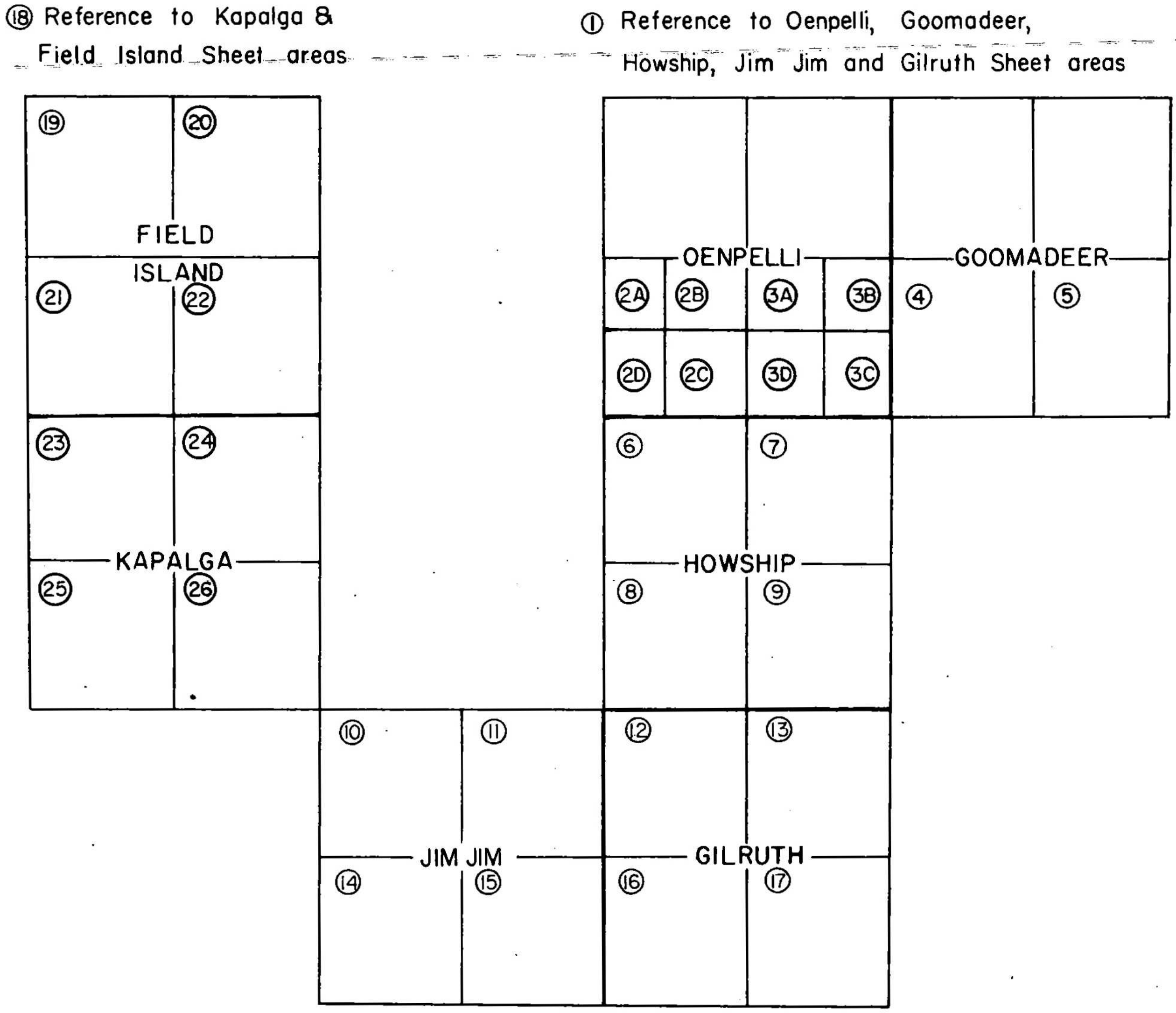
Investigations before the 1960s are listed by Walpole & others (1968) and Rix (1965). BMR field parties conducted reconnaissance mapping in the area between 1953 and 1957 (Alligator River 1:250 000 Sheet area: Dunn, 1962) and in 1962 (Milingimbi 1:250 000 Sheet area: Rix, 1964).

Since 1969, exploration companies have been active in the area, prospecting mainly for uranium. Reports of their activities are lodged with the Mines Branch, Darwin, NT.



.14

Figure 1 Locality map



D53/A1/57

Figure 2 Index to map plates
(in manilla folder attached to this Report)

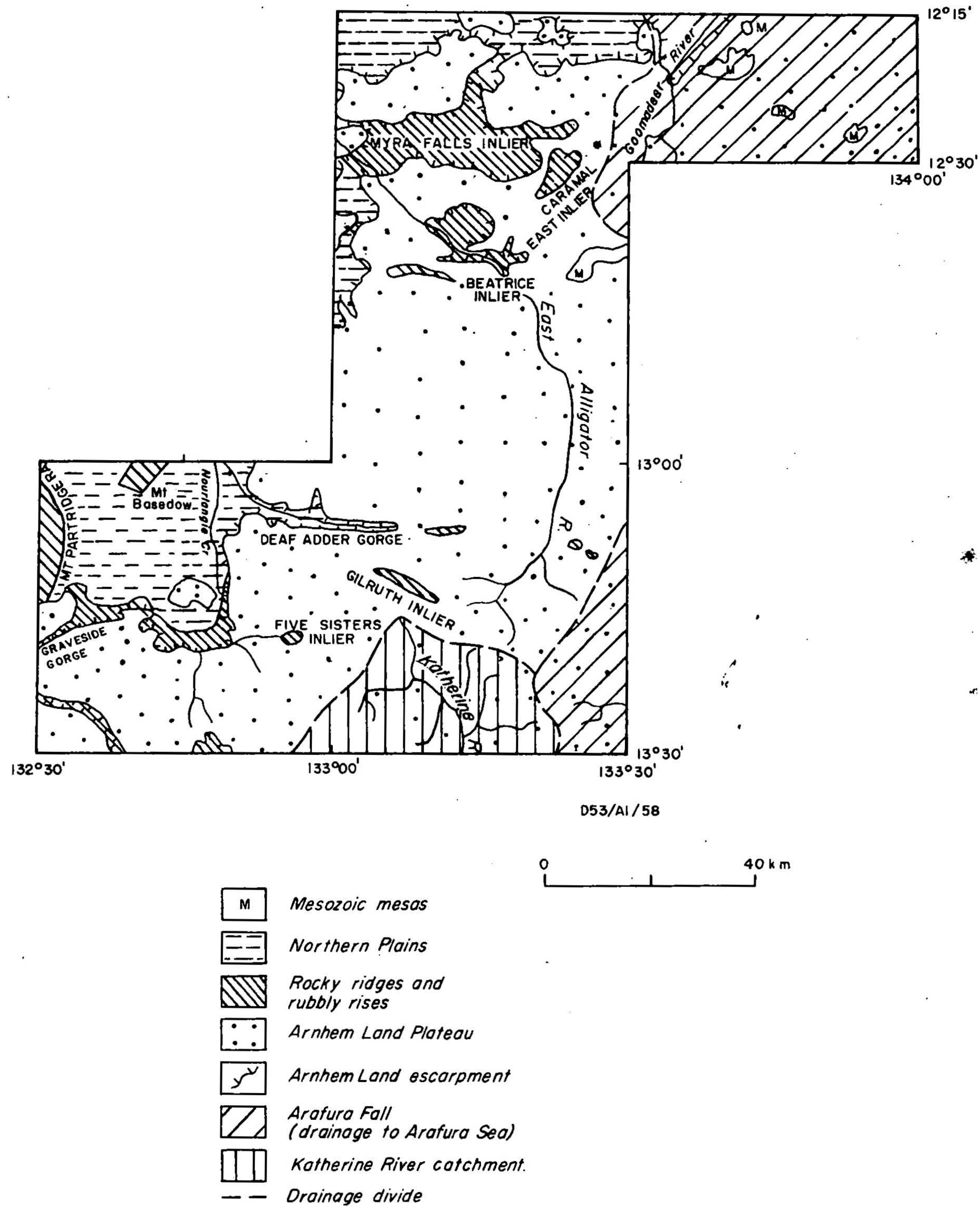


Figure 3 Physiographic sketch map, Howship, Gilruth and parts of Oenpelli, Goomadeer and Jim Jim Sheet areas (Eastern Block).

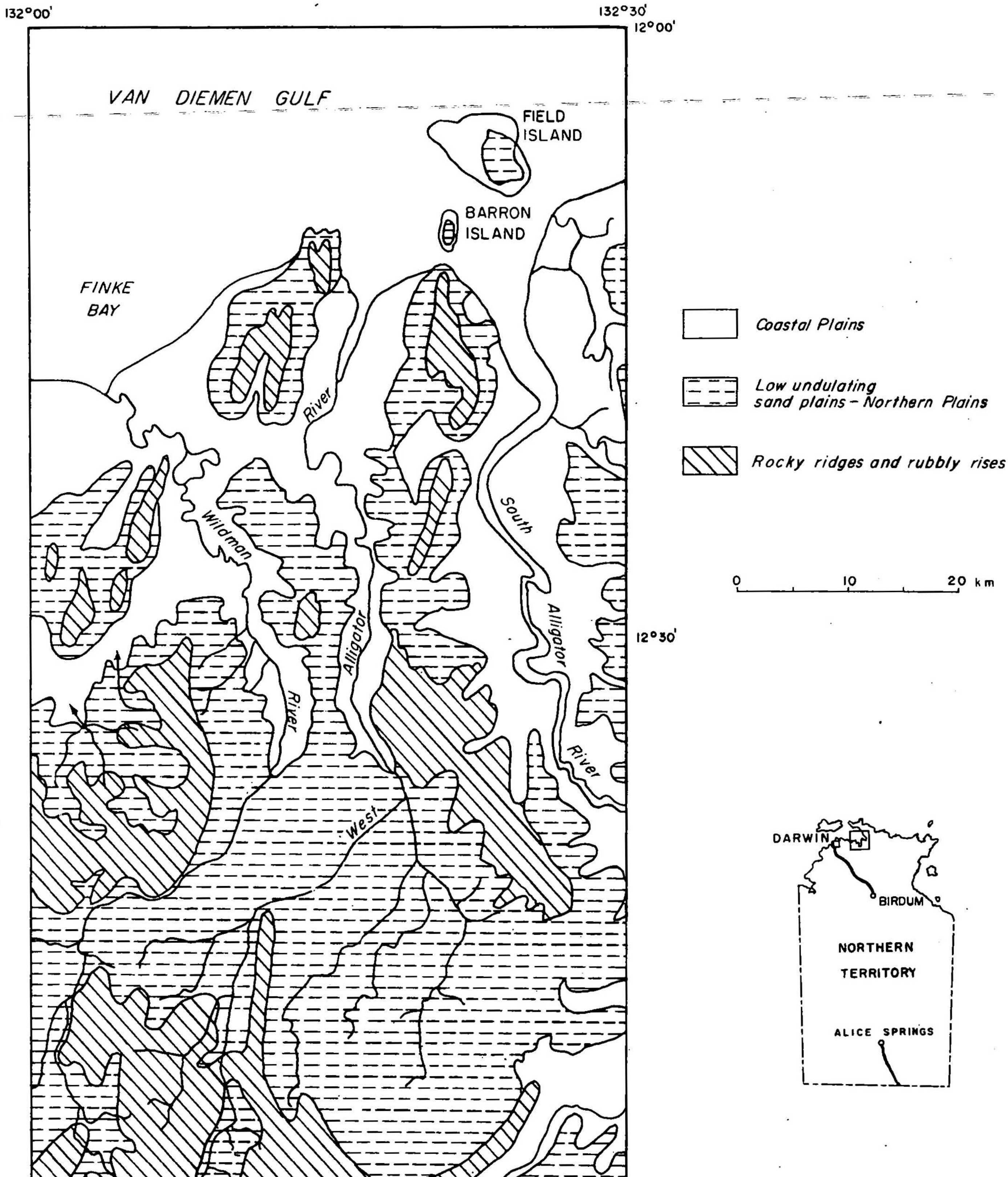


Figure 4 Physiographic sketch map, Field Island and Kapalga Sheet areas (Western Block)

D53/A1/59

This report is a progress account of BMR's semi-detailed mapping programme that was begun in the region in 1971. Previous work has been reported by Needham & Smart (1972), and Needham & others (1975a, 1975b) as a series of progress accounts.

PHYSIOGRAPHY

EASTERN BLOCK

A watershed (Fig. 3) trending approximately north along longitude 133°30' divides the mapped areas of the Eastern Block into the Arafura Fall, where drainage runs northeast into the Arafura Sea, and a westerly catchment served by the South and East Alligator Rivers, draining northwards into Van Diemen Gulf. The headwaters of the Katherine River form a third catchment in the extreme south of the area. Topographically the area comprises the low-lying Northern Plains, undulating sandy plains with typically little rock exposure, which lie north of Rocky ridges and rubbly rises adjacent to and as inliers within the Arnhem Land Plateau. The deeply dissected sandstone plateau is marked by a prominent escarpment along its western edge. The escarpment and gorges within the plateau form cliffs, in places up to 200 m high. The general elevation of the plateau is 300-400 m, with isolated peaks such as Mount Gilruth up to 558 m. Low mesas of Cretaceous sediments rise up to 30 m above the level of the plateau in the extreme northeast of the area, and are the remnants of a veneer of Cretaceous rocks that once covered much of the Arnhem Land Plateau.

WESTERN BLOCK

The Western Block (Fig. 4) is a low-lying area draining north into Van Diemen Gulf, comprising the catchment of the Wildman River and the northern parts of the Catchments of the West Alligator, and South Alligator Rivers. The Coastal Plains form a broad coastal strip about 10 km wide, and also follow the main channels of the rivers. They rise from sea level to about 10 m where they are succeeded by low undulating sandy plains of the Northern Plains, rising to 30 m. Forming north-trending 'spines' along the centres of the interfluves between the main rivers are Rocky ridges rubbly rises, which attain elevations of up to 100 m in places, such as Mount Hooper.

GEOLOGY

Units described in this report are summarised in Table 1, and generalised geology is shown in Figures 5 and 10.

EASTERN BLOCK

ARNHEM LAND PLATEAU

Kombolgie Formation

Carpentarian plateau sandstone and interbedded basic volcanics compose the Kombolgie Formation, which crops out as a deeply dissected and rugged but continuous plateau over the whole of the eastern block (Fig. 3, Plates 1 and 2). An escarpment, generally sheer along the western edge (Plate 1) but lower and less precipitous along the northern edge, marks the limits of the Arnhem Land Plateau. Within the plateau are inliers in which rocks underlying the Kombolgie Formation are well exposed. Inliers $<$ 2 km across and simply comprising basement highs of dolerite are described in this section, but the complex geology of the larger inliers is described separately. Isolated outcrops of tuff at the base of the Kombolgie Formation are correlated with the Edith River Volcanics of the South Alligator River valley area.

The Kombolgie Formation comprises lower and upper sandstone units (Ehk_1 and Ehk_2), separated by the Nungbalgarri Volcanic Member (Ehn). The upper sandstone unit contains a thin but extensive basaltic and tuffaceous unit which has not been previously identified. The proposed name for this unit is Gilruth Volcanic Member (Ehg); the definition appears below.

Lower and upper sandstone units (Ehk_1 and Ehk_2)

The petrology of these units is described by Needham & others (1975b) in an account of the geology of the Goomadeer Sheet area in the Oenpelli region. Petrographically the units show little variation throughout the whole of the Eastern Block. Estimated maximum thicknesses for these units are about 300 m (lower unit) and 650 m (upper unit). They thin gradually to the northeast. In the Gilruth Sheet area the Gilruth Volcanic Member lies about 300 m above the base of Ehk_2; this sandstone interval (i.e. Ehk_2 below the Gilruth Volcanic Member) thins to 40 m in the Goomadeer Sheet area (from measurements made at 133°11'E 13°8'S and 133°40'E 12°32'S, respectively).

TABLE 1. SUMMARY OF ROCK UNITS DESCRIBED IN THIS REPORT

UNIT	LITHOLOGY	MAX. THICKNESS (m)	AGE
KOMBOLGIE FORMATION	massive quartz sandstone; minor silt-stone and conglomerate, basalt-rhyodacite	1150	CARP.
EDITH RIVER VOLCANICS	rhyolite, dacite, tuff, ignimbrite, minor syenite, basalt, volcanic breccia; sand-stone and conglomerate lenses	100	"
OENPELLI DOLERITE	layered tholeiitic dolerite lopoliths, olivine dolerite, quartz dolerite; minor granophyric dolerite and granophyre		"
NIMBUWAH COMPLEX	granitoid migmatite, granite; gneiss, schist (migmatised L. Proterozoic sediments)		L. PROT.
ZAMU DOLERITE	differentiated tholeiitic sills and minor dykes		"
Bly	sedimentary breccia	unknown	"
FISHER CREEK SILTSTONE	siltstone, phyllite, feldspathic litharenite, chlorite-mica schist, quartz-mica schist	unknown	"
GEROWIE TUFF	cherty tuff, tuffaceous greywacke	750	"
KOOLPIN FORMATION	hematitic siltstone with chert lenses, bands and nodules, silicified dolomite, carbonaceous shale	5000	"
WILDMAN SILTSTONE	siltstone, red and white banded silt-stone, quartz sandstone, greywacke, phyllite	2000	"
MOUNT HOOPER SANDSTONE	quartz sandstone, quartzite, siltstone, phyllite, slate, conglomerate, feldspathic sandstone	5000	"

TABLE 1 (contd)

UNIT	LITHOLOGY	MAX. THICKNESS (m)	AGE
MASSON FORMATION	siltstone, carbonaceous siltstone, calcareous greywacke, quartz sandstone, dolomite, mudstone, quartz greywacke	unknown	"
CAHILL FORMATION	quartzite, quartzo-feldspathic schist, micaceous schist, minor carbonaceous schist, carbonate, and calc-silicate rock	2000	"
MOUNT PARTRIDGE FORMATION	arkose, siltstone, quartz sandstone, conglomerate, minor quartz greywacke	6000	"
KUDJUMARNDI QUARTZITE	orthoquartzite, micaceous quartzite, hornblende quartzite, micaceous feld-spathic quartz gneiss	150	"
MOUNT HOWSHIP GNEISS	massive quartzo-feldspathic gneiss	1000 +	"
MUNMARLARY QUARTZITE	muscovite quartzite, feldspathic quartzite	200	"
NANAMBU COMPLEX	leucocratic gneiss, biotite gneiss, granite, schist		ARCHAEAN-L. PROT.

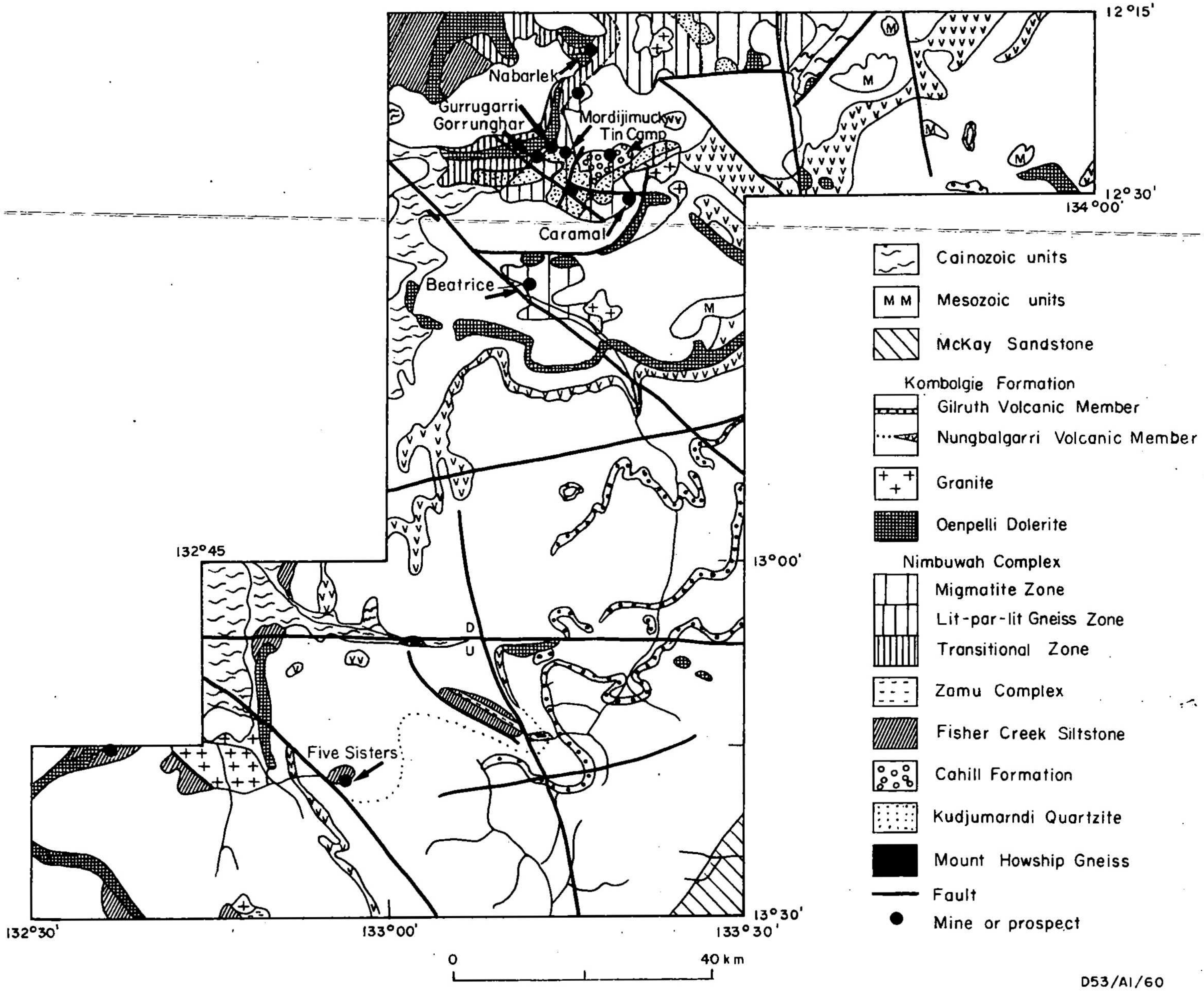


Figure 5 General geological sketch map, Eastern Block.

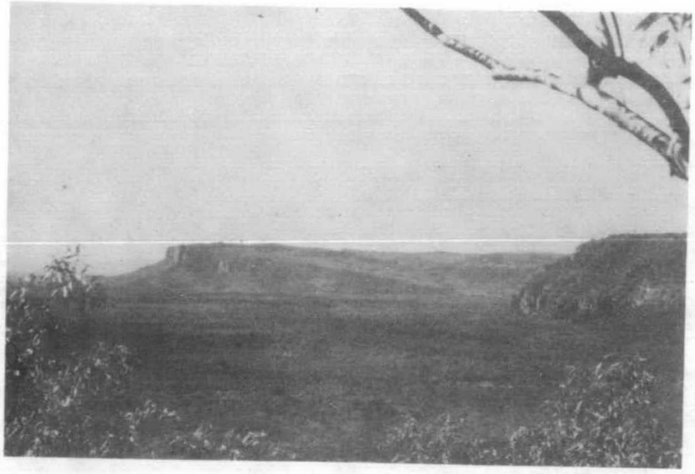


Plate 1: Arnhem Land Escarpment at the mouth of Deaf Adder Gorge(M/2240)

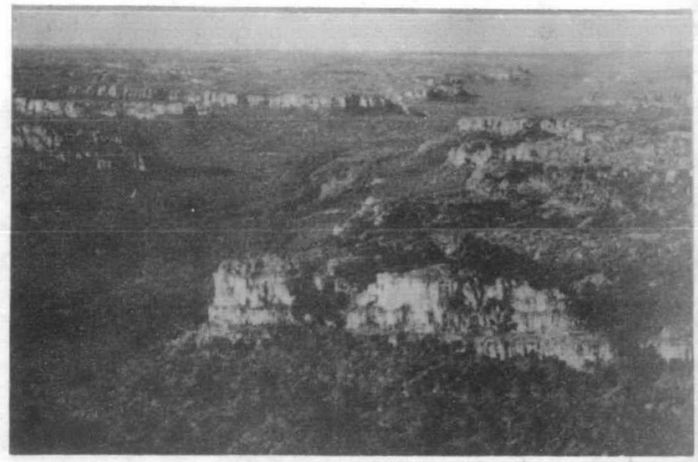


Plate 2: East Alligator River looking northwest from the Beatrice Inlier (m/2224)

Plate 3: Intraformational conglomerate forms a rubbly pavement in areas where no Nungbalgarri Volcanics were deposited. Jim Jim Sheet area, 18 km northeast of Jim Jim Falls. (m/2224)

Plate 4: Intraformation breccia in Kombolgie Formation lower sandstone unit, Howship Sheet area, 20 km northeast of Jabiru. (m/2224)

Plate 5: Slump folding in Kombolgie Formation upper sandstone unit. Gilruth Sheet area, 23 km southeast of Mount Gilruth. (GB/350).

Sedimentary structures not previously recorded in the sandstone units of the Kombolgie Formation are pictured in Plates 4-5. In addition, an upturned slab of sandstone 20 km northeast of Jabiru is covered with casts of tool markings, and possible feeding trails. These are the only structures found within the formation that could be indicative of biological processes. The rare occurrence of intraformational conglomerate and slump folding (Plates 4 and 5) indicates local instability before lithification. There is no obvious relationship between these features and the extensive fault and joint patterns characteristic of the sandstone units of the formation. Intraformational conglomerate (Bhk_{2b}) is exposed in an extensive pavement at 132°58' 13°13'S (Map Plate 11) and marks a break in sedimentation contemporaneous with extrusion of the Nungbalgarri Volcanic Member elsewhere (Plate 3); the volcanic member is absent between Deaf Adder Gorge and the Five Sisters Inlier, where there is a local unconformity between Bhk_1 and Bhk_2; this unconformable contact is best expressed north of the Gilruth Inlier (Map Plate 12).

An unusual and distinctive pattern of circular hollows, up to 250 m across, within the lower sandstone unit of the Kombolgie Formation, is exposed at many localities below the Nungbalgarri Volcanic Member in the Oenpelli, Howship, Gilruth, and Jim Jim Sheet areas (Fig. 6, Plate 6); each hollow is filled with volcanic rubble and laterite. In the rims of the hollows the sandstone is folded. The folds have irregular amplitudes, dips range up to 90°, and the traces of fold axes are commonly haphazardly refolded. There is no relationship between this erratic structure and larger-scale regional folding and faulting of the Kombolgie Formation sandstone. The folding is confined to the rims of the hollows; the structures are believed to be giant load casts formed by extrusion of basalt of the Nungbalgarri Volcanic Member onto water-saturated sandstone (Needham, 1978).

In the Howship Sheet area, and in other areas east and south of that described in this report (Fig. 6, Plate 7), the sandstone surface directly underlying the Gilruth Volcanic Member, within the upper sandstone unit, has a characteristic pattern of rectilinear depressions up to 50 m across and up to 1 km or more in length, that are thought to have a similar origin to the circular load casts (Needham, 1978). The depressions are filled with soil, sand, and laterite, and are separated by long narrow parallel anticlines aligned between the 045° and 060°. The pattern forms an extensive pavement in places which is up to 10 km wide in the southern half of the Howship Sheet area (Map Plates 8, 9). The extent of this pavement clearly illustrates the horizontal attitude of the Kombolgie Formation over most of the plateau away from the escarpment.

The sandstone beds immediately overlying the volcanic members are characteristically closely and deeply jointed; the Gilruth Volcanic Member is largely concealed by blocky sandstone scree from the overlying sandstone unit.

Nungbalgarri Volcanic Member (Bhn)

This member crops out continuously from the Goomadeer Sheet area (Map Plate 5), in the northeast of the plateau, as far south as Deaf Adder Gorge (Map Plates 12, 13). There the outcrop of the member is displaced 26 km laterally as a result of faulting (vertical displacement up to 150 m) and subsequent erosion. South of the gorge the member pinches out. Its stratigraphic position can be traced in places by unconformable relationships between the two adjacent sandstone units, and in other places by intraformational conglomerate (Bhk_2b). The member reappears about 10 km southwest of the Five Sisters Inlier (Map Plate 15), and continues south to Gimbat Creek (south of the area described in this report) where it is faulted off. The member is a probable correlative of the Birdie Creek Volcanic Member which occupies a similar stratigraphic position within the Kombolgie Formation even farther south, mostly in the Stow and Snowdrop 1:100 000 Sheet areas (Walpole, 1962; Walpole & others, 1968).

The Nungbalgarri Volcanic Member is composed predominantly of massive basalt which is thickest (170 m) in the northeastern part of the Howship Sheet area (Plate 8, Map Plate 7). The presence of more than one flow in places is suggested by intercalated sediments in parts of the Goomadeer Sheet area (Needham & others, 1975b). The best-exposed section, and also the thickest measured, is along a minor creek flowing north into a major tributary to the East Alligator River at 133°22'10"E 12°42'3"S (Locality NVM1, Map Plate 7). The section comprises a single flow of columnar-jointed dark grey-black massive basalt of which the top 60 m is vesicular and amygdaloidal (Plate 8b).

15

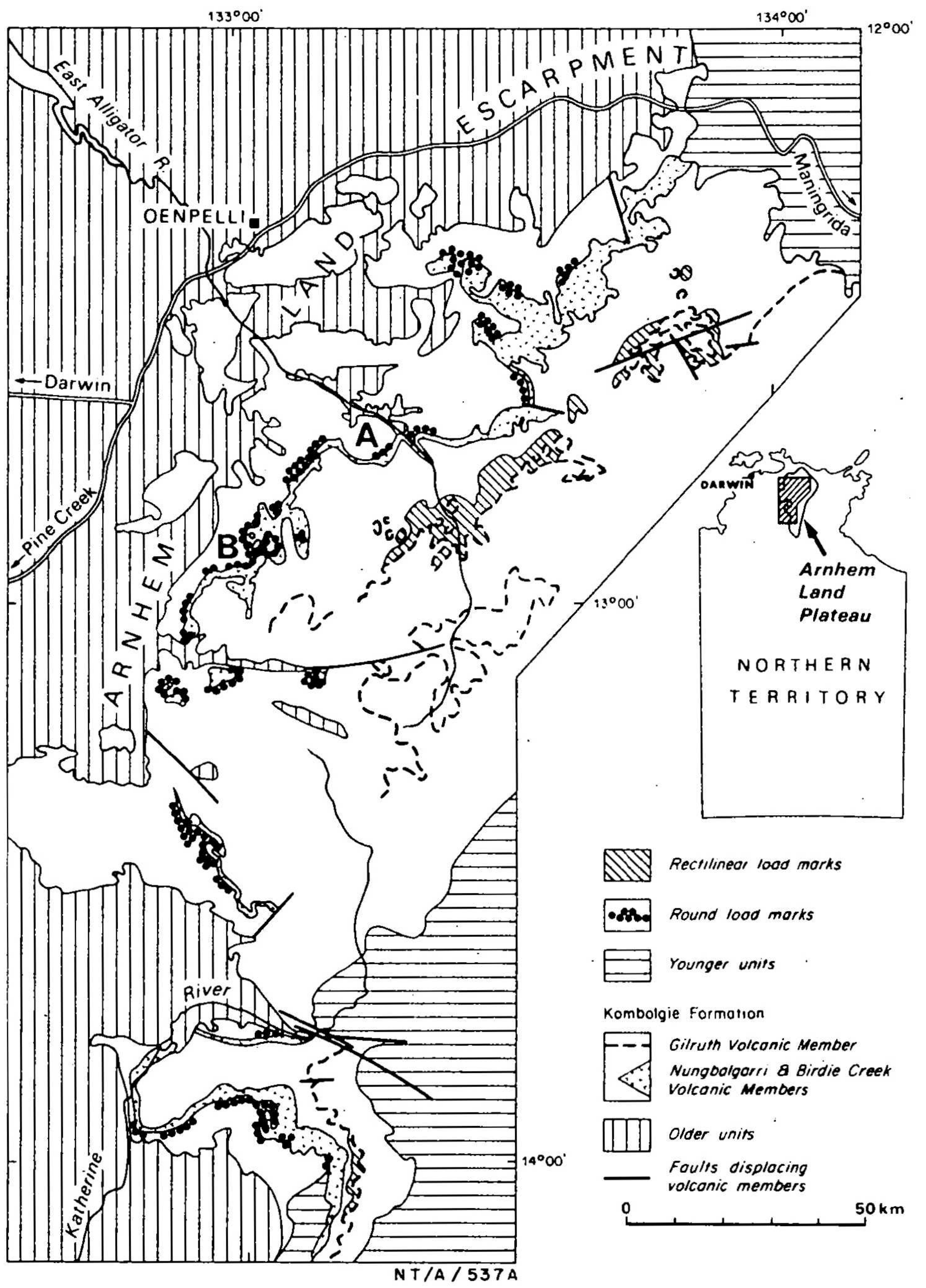
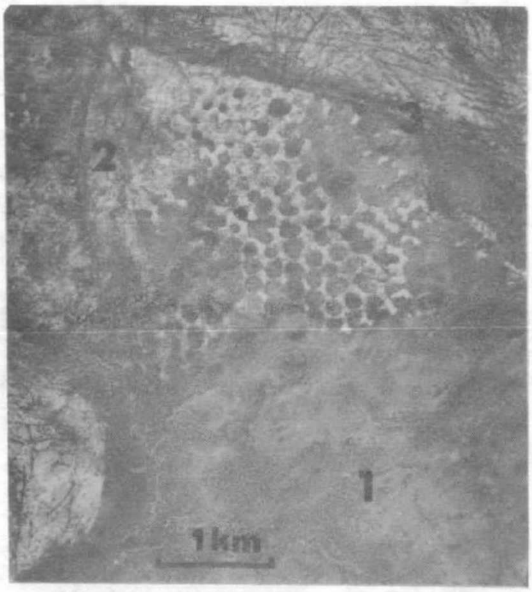
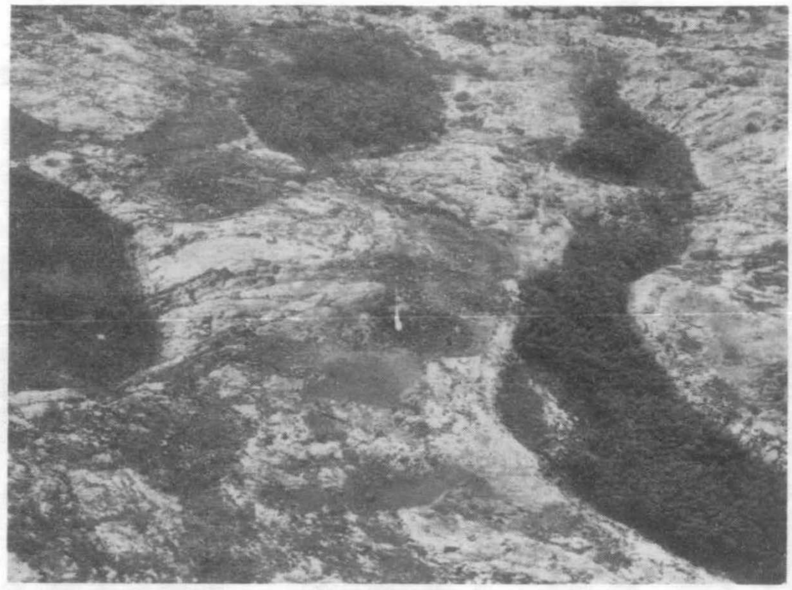


Figure 6 Distribution of giant load casts on the Arnhem Land Plateau



(a) GB/354



(b) GB/1421

Plate 6: Giant circular load casts below Nungbalgarri Volcanic Member. Oenpelli Sheet area, 17 km southeast of Nabarlek. (a) 1: Nungbalgarri Volcanic Member. 2: Kombolgie Formation lower sandstone unit. 3: Fault. (b) Trees in depressions are up to 10m high.

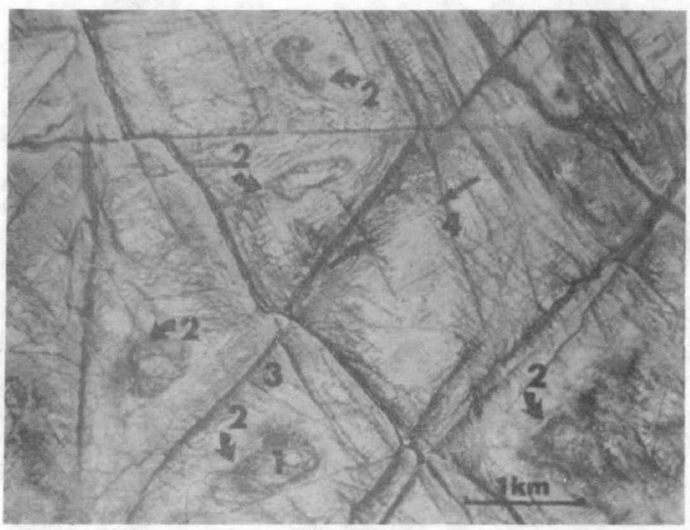
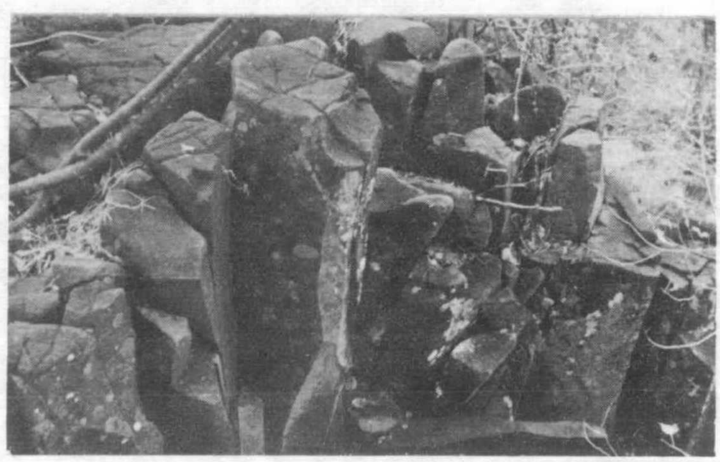


Plate 7. Parallel, rectilinear giant load casts below Gilruth Volcanic Member, Howship Sheet area, 33km SSE of Beatrice prospect 1: Sandstone above volcanic member 2: Volcanic member 3:' Sandstone below volcanic member 4: arrows indicate orientation of load casts. (m/2240)

(a) m/2225



(b) m/2224

Plate 8: Nungbalgarri Volcanic Member. (a) Wooded slope between lower and upper sandstone units of the Kombolgie Formation, Howship Sheet area, 16 km south-southeast of Beatrice prospect. (b) jointing, Howship Sheet area, 25 km ESE of Beatrice prospect; largest hexagon is 50 cm across.

The composition of the unit ranges from basalt through trachybasalt and dacite to rhyodacite. Cherty rhyolite and ignimbrite overlie the flows in places. Because of alteration and/or weathering some of the estimates of composition are approximate only, especially for the apparently more basic varieties. Estimates of composition are based on percentage of quartz, and, where possible, plagioclase extinction angles. No comprehensive suites of samples were collected through the unit, but the more basic samples are from the base and the more acidic ones from progressively higher up, where thin beds of rhyolite and ignimbrite generally rest on the scoriaceous surface of the flows. Columnar jointing, where apparent, is in the more basic types.

The phaneritic rocks generally consist of clearly to poorly interlocking laths of plagioclase, which are also interlocked with laths of alkali feldspar where present. Clinopyroxene is colourless and mostly interstitial, but in places, along with alkali feldspar, forms glomeroporphyritic aggregates up to 3 mm across. Quartz where present is interstitial, and scattered opaques, including magnetite, hematite, and pyrite, are commonly present. Chlorite, prehnite, sphene, epidote, carbonate, and quartz are common alteration products. In amygdaloidal varieties the amygdales consist of radially arranged feldspar, quartz, and calcite crystals up to several centimetres across; in many amygdales calcite is the dominant mineral, generally forming monomineralic cores.

Rhyolite and ignimbrite were recorded only from flow tops in the Goomadeer and Liverpool Sheet areas, where they form horizontal pink or reddish beds of cherty appearance less than 50 cm thick. The rhyolite contains euhedral grains of quartz about 2 mm across, in a fine quartz and feldspar matrix; feldspar is mostly altered to sericite. The ignimbrite contains fine shards intermixed with fine feldspar fragments, and there are minor rounded fragments of more basic material which contain interlocking plagioclase laths, about 0.5 mm long; the rock is sericitised, and green-brown zeolite is also a common alteration product.

Pillow structures are developed at the base of the volcanic member, at 133°16'40"E 12°44'45"S (locality NVM2 Map Plate 7), indicating that, at least in places extrusion was subaqueous. A vertical dyke of porphyritic olivine basalt about 25 cm wide cuts dacite of the unit at the same locality (Plate 9). Phenocrysts in the dyke are zoned plagioclase (labradorite) laths, anhedral olivine, and clinopyroxene. These minerals also form glomeroporphyritic aggregates in places. Some of the larger aggregates about 1 mm across appear to be fragments of dolerite, consisting of ophitic clinopyroxene and anhedral plagioclase. The groundmass consists of very fine-grained interlocking plagioclase laths, interstitial pale brown clinopyrxoene, and traces of granular olivine and opaques. The dyke has sharp chilled contacts with the adjacent dacite. Samples of basalt and dacite from the two localities described, and the dyke rock, were collected by R.W. Page, for Rb/Sr age determinations, but proved to be too altered.

The member thins north and south of localities NVM 1 and 2. It is about 60 m thick throughout the Goomadeer Sheet area, but locally thins against basement highs of dolerite where the underlying sandstone unit of the Kombolgie Formation (Bhk_1) is absent. The member thins markedly to less than 10 m in parts of the Howship SW Sheet area (Map Plate 8), and is absent between Deaf Adder Gorge and Five Sisters Inlier. The average thickness, where present in the Jim Jim and Gilruth Sheet areas, is 40-60 m.

An exposure of basalt in the extreme southeast of the Goomadeer Sheet area (Map Plate 5), mapped previously as undifferentiated dolerite by Rix (1965) represents the easternmost extent of the member known.

Basalt of the Nungbalgarri Volcanic Member is enriched in uranium and thorium (see detailed discussion under next heading).

Gilruth Volcanic Member (Bhg)

This is a new unit discovered during 1973 fieldwork; its definition, as approved by the Territories Committee on Stratigraphic Nomenclature, appears below:

Derivation of name: Mount Gilruth 133°04'30"E 13°02'45"S. Mount Evelyn 1:250 000 Sheet area.

Distribution: A meandering outcrop pattern with an outcrop width of generally 50 m extending from the headwaters of the Katherine River to the southern edge of the Goomadeer 1:100 000 Sheet area (Map Plates 16 and 5 in this report), and an overall northeast trend. About 5 km^2 exposure. Subsurface extent 5000 km^2.

Type locality: Small peak on Arnhem Land Plateau at 133°18'15"E 12°52'30"S (Map Plate 9), Alligator River Sheet area. Peak is medium to coarse quartz sandstone of the Kombolgie Formation with a prominent bench 10 m from top of peak developed at the base of the Gilruth Volcanic Member. Rubble on this bench contains weathered tuffaceous siltstone, rare amygdaloidal and vesicular purple (weathered) and black basalt, and banded quartz-jasper rock amongst laterite scree (Plate 10).

Lithology: Tuffaceous siltstone, banded quartz-jasper rock, amygdaloidal and vesicular basalt, commonly altered and haematitic, with amygdales of zeolite; groundmass is cryptocrystalline haematite and ilmenite with some corroded plagioclase laths; a remnant igneous texture is usually apparent. The unit is everywhere covered by large boulders of sandstone scree from overlying strata. Lithologies are apparent only as rubble amongst nodular laterite scree on a prominent bench commonly marking the base of the member.

Thickness: about 5 m

Relationships and boundary criteria: Interbedded in sandstone of the Carpentarian Kombolgie Formation, about 100 m above the Nungbalgarri Volcanic Member. Boundaries not yet found exposed. Base appears to be predominantly tuffaceous siltstone, underlain by sandy siltstone which is the topmost part of the underlying sandstone of the Kombolgie Formation.

Age and evidence: 1720-1200 m.y. (Page, Compston & Needham, 1979). Interbedded in Carpentarian Kombolgie Formation.

The discovery of the Gilruth Volcanic Member followed the realisation that a series of high U/Th ratio anomalies over the Arnhem Land Plateau recorded by a BMR airborne survey in 1972 (Horsfall & Wilkes, 1975) mostly coincided with one stratigraphic horizon within the Kombolgie Formation, and that the remainder were grouped in a stratigraphic interval roughly coincident with the base of the Nungbalgarri Volcanic Member. A joint ground inspection of these anomalies by a geophysicist and a geologist revealed that they were in each case within laterite developed down-slope from the volcanic members of the Kombolgie Formation (Needham & others, 1973). Subsequent analyses revealed $\angle$ 43 ppm uranium and 12 ppm thorium in laterite associated with the Gilruth Volcanic Member, and $\angle$ 19 ppm uranium and 19 ppm thorium for that associated with the Nungbalgarri Volcanic Member. Analyses of basalt from the Nungbalgarri Volcanic Member indicated a uranium content of $<$ 4 ppm uranium, and 12 ppm thorium. No fresh samples of the Gilruth Volcanic Member suitable for analysis were found, but in view of the higher uranium values for laterite associated with this member, and the higher U/Th ratio (about 4, as opposed to 1 for the laterites associated with the other volcanic member), the uranium content of the rocks of this member is most probably higher. The mean levels of uranium and thorium in basalts is 0.6 and 2.2 ppm, respectively (Taylor, 1964); the volcanic members of the Kombolgie Formation therefore contain at least about seven times the normal concentrations of these elements. Lateritisation has further concentrated these elements, with an obvious preference for uranium by a factor of about 4 (the U/Th ratio of basalt, 1:4, compares with 1:1 of laterite for the Nungbalgarri Volcanic Member).

The base of the Kombolgie Formation

The rocks of the Arnhem Land Plateau rest with marked regional unconformity on Archaean, Lower Proterozoic and early Carpentarian rocks of the Pine Creek Geosyncline. The pre-Katherine River Group erosion surface closely resembled the present morphology of the Northern Plains (Needham & Smart, 1972); the unconformity surface commonly has a local relief of up to 20 m. Isolated hills and ridges rise up to 250 m above the general level, and form basement highs against which the lower units of the Kombolgie Formation thin or pinch out. The Mount Partridge Range is a partly reexhumed basement high; the southern end of the range is covered by a thin ($<$ 10 m) section of the lower sandstone unit of the formation. Steep fossil valleys between the main ridges of the range are filled with massive breccia-conglomerate composed of angular boulders of Lower Proterozoic quartzite up to 1 m across (Plate 11). These breccia-conglomerate grade sharply into coarse conglomerates with rounded pebbles generally about 10 cm in diameter. They grade sharply in turn to coarse quartz sandstone which covers both the ridges and valleys of the Mount Partridge Range (Plate 12).

Lenses of tuffaceous sediments represent isolated pockets of valley-fill volcanic material underlying, apparently conformably, Kombolgie Formation sandstone mainly in the northwest part of the Howship Sheet area (Map Plate 6). They are finely laminated rocks with bands of well-rounded and sorted, to poorly sorted, rounded to highly angular quartz grains

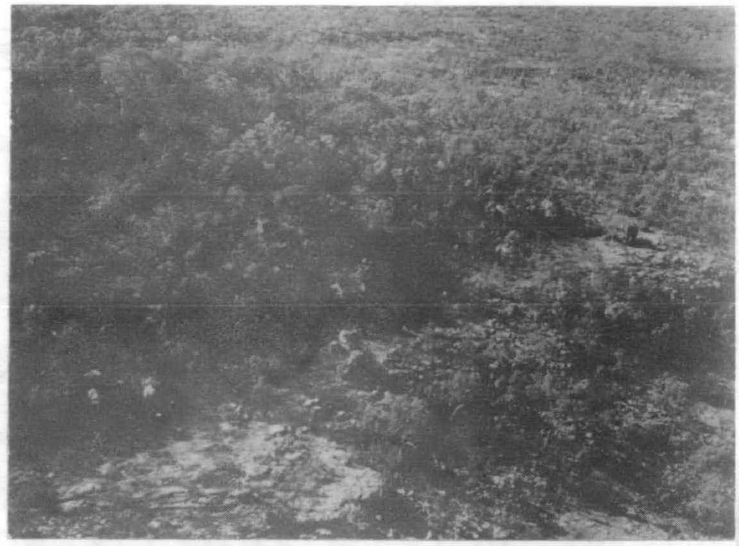


Plate 9: Dyke of porphyritic olivine basalt cuts the Nungbalgarri Volcanic Member, Howship Sheet area, 17 km southeast of Beatrice prospect. (m/2224)

Plate 10: Gilruth Volcanic Member forms a heavily vegetated steeper slope above a rubbly lateritised bench within Kombolgie Formation upper sandstone unit. Type locality Howship Sheet area, 19km ENE of Kub-o-wer Hill (m/2240)

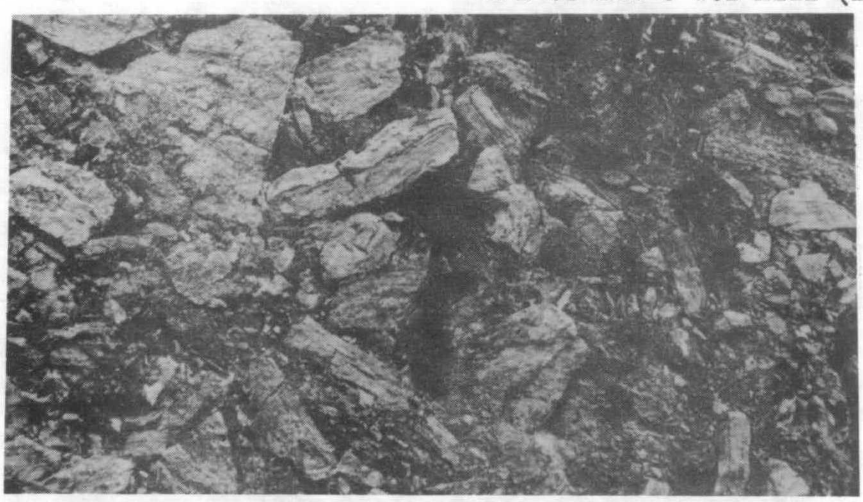
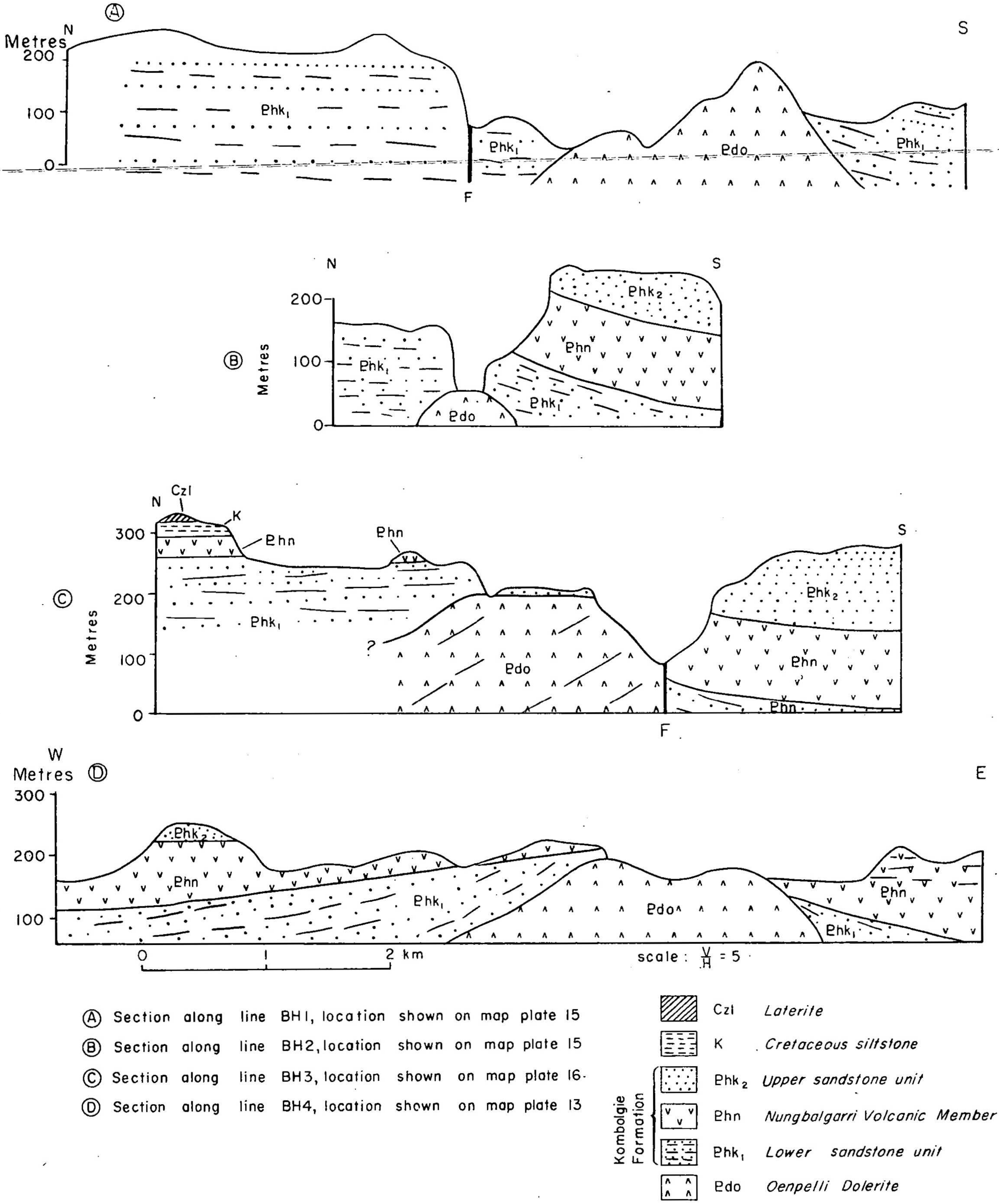


Plate 11: Large angular boulders of Lower Proterozoic quartzite in breccia-conglomerate of basal Kombolgie Formation, in re-exhumed valleys of the Mount Partiridge Formation, Jim Jim Sheet area. (m/2240)

Plate 12: Coarse subrounded pebble conglomerate overlies the breccia-conglomerate and grades sharply up into coarse quartz sandstone. Southern end of Mount Partridge Range, Jim Jim Sheet area. (m/2240).



D53/A1/61

Figure 7 Cross section through basement highs exposed within Arnhem Land Plateau broadly concordant but locally trangressing bedding as 'sandstone dykes'. The matrix of the quartz-rich bands and the fine laminae consists of minute splinters and angular grains of quartz set in clay. The stratigraphic position and volcanic affinity of these sediments suggest a correlation with the Edith River Volcanics; they appear to represent distal volcanic activity with addition of coarser water-borne clastics and hydraulic reworking, 120 km north of vent areas in the South Alligator Valley (Walpole & others, 1968).

Several inliers of dolerite have been found in the Arnhem Land Plateau; all of these were confused with the Nungbalgarri Volcanic Member by earlier workers owing to their almost identical photogeological expression in some areas in the plateau (Walpole & others, 1968; Dunn, 1962). Their distribution is shown on Figure 5. In each case the dolerite has been assigned to the Oenpelli Dolerite, described in detail by Stuart-Smith and Ferguson (1978). Usually only one or two of the phases of this unit are exposed in each of these isolated inliers, and this, together with the lack of igneous layering, generally precludes estimation of the attitude or form of the dolerite bodies. Neither the margins of, nor the country rock, to the dolerite of the inliers is exposed. The curvilinear nature of the larger inliers (Map Plates 6, 7) suggests that the dolerite forms the edge of basin-like structures or lopoliths as postulated by Needham & others (1974). The longest dolerite inlier is 15 km long and up to 1.5 km across, in the northwest of the Howship Sheet area (Plate 13).

Cross-sections through several of these small inliers appear on Figure 7, showing onlapping relationships of Kombolgie Formation units onto the basement highs.

Thickness of the Kombolgie Formation in the Arnhem Land Plateau

The maximum thickness of the formation north of the headwaters of the Katherine River is about 1050 m, including volcanic units; the formation thins generally northeast to about 650 m in the Goomadeer Sheet area.

South and west of the Katherine River headwaters the Kombolgie Formation sandstone units thicken considerably within a series of basins. Sandstone units comprise 1410 m of the total 1750 m section of the formation in the Edith River Basin (Rattigan & Clark, 1955); there is 1220 m of sandstone in a section of 1580 m measured in the Mount Callanan Basin by Walpole & others (1968).

The top of the Kombolgie Formation

The upper sandstone unit is conformably overlain by the McKay Sandstone in the extreme southeast part of the Gilruth Sheet area (Walpole, 1962; Roberts & Plumb, 1964). No ground observations of the McKay Sandstone within the Gilruth Sheet have been made either by earlier workers or in the current work. The sequence dips gently to the southeast at about 5°, and forms low rounded hills with a dark grey photo-tone. Two sandstone intervals, each less than 15 m thick, that have a similar air-photograph expression to the Kombolgie Formation (i.e., resistant, strongly jointed, white photo pattern) lie near the base of the sequence; they may indicate an interfingering of the uppermost part of the Kombolgie Formation with the McKay Sandstone.

Mesozoic and younger rocks of the Arnhem Land Plateau

Low mesas of white and purple claystone, and medium to coarse-grained friable sandstone up to 25 m thick, are sparsely distributed throughout the plateau (Plate 14). These rocks are probably equivalent to the Darwin Member of the Bathurst Island Formation (Lower Cretaceous), defined by Hughes & Senior (1973). They are rarely exposed; the only measured section, a landslip scar at the edge of a mesa 4 km south of the Goomadeer Sheet area, is shown in Figure 8. The Cretaceous section over the Arnhem Land Plateau is less than 25 m thick, and has an elevation of 340-400 m in the Gilruth and Howship Sheet areas, dropping to about 300 m in the Goomadeer Sheet area. The sequence is generally flat-lying.

The Cretaceous rocks are lateritised and covered by blocky pavements, generally about 1 m thick, of nodular and vermicular laterite. Laterite is also developed on detritus derived from the volcanic members of the Kombolgie Formation, and is in many places the source of radiometric anomalies (see earlier headings). Laterite is not found elsewhere on the Arnhem Land Plateau. The predominant monomineralic or near-monomineralic composition of the Carpentarian sandstone is unsuited to the development of laterite. Rare coatings of transported and recemented laterite have been found in places in the Myra Falls Inlier on displaced blocks of Kombolgie Formation sandstone.

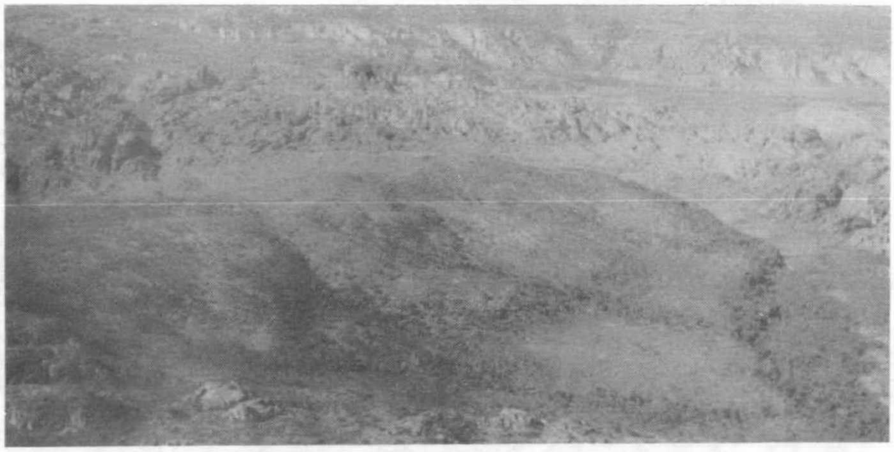


Plate 13: The west end of a basement high of Oenpelli Dolerite forming an inlier within Kombolgie Formation sandstone, Howship Sheet area, 13 km southwest of Beatrice prospect. (m/2240)

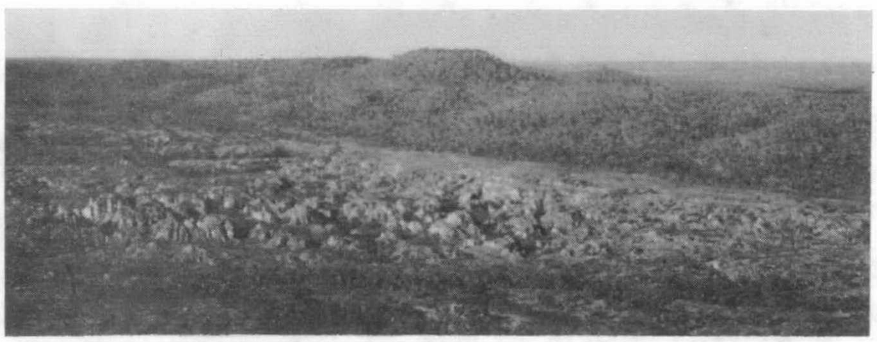


Plate 14: Mesa of Mesozoic lateritised claystone and sandstone overlying Nungbalgarri Volcanic Member (wooded) and lower sandstone unit of the Kombolgie Formation (middle distance), Howship Sheet area, 22 km east-southeast of Beatrice prospect. (GB/325).

Plate 15: Ridges of Kudjumarndi Quartzite dominate the topography of the Myra Falls Inlier. Looking northeast from the southwest corner of the inlier. (m/2240).

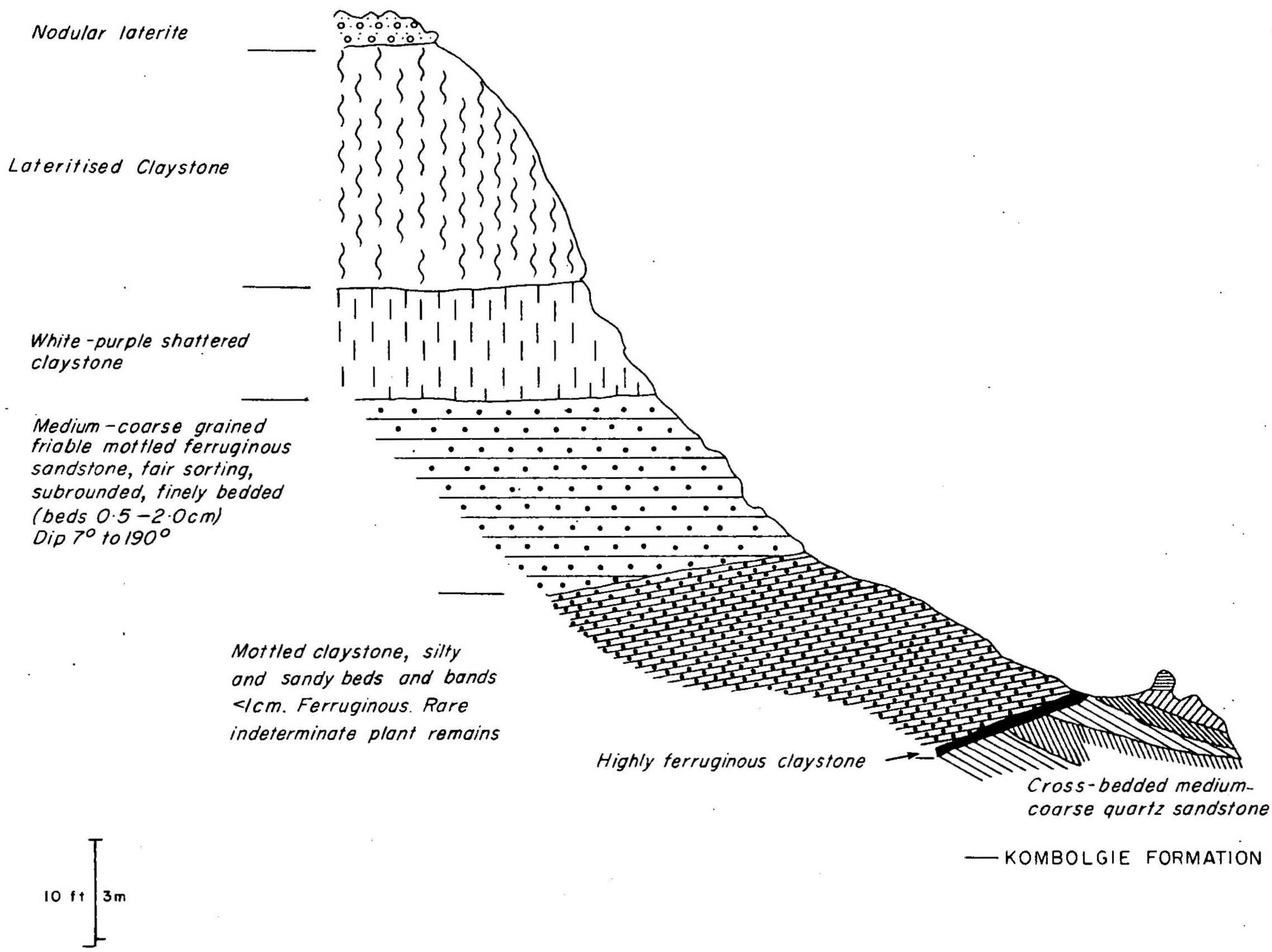


Figure 8 Measured section of Lower Cretaceous Darwin Member (?)
4km south of Goomadeer Sheet area. 12° 31'S 133° 48' 30"E

Tertiary to Recent colluvial and alluvial sand forms extensive thin sheets over some parts of the plateau, predominently in the northeast of the Howship Sheet area, in the southwest of the Howship Sheet area (the 'upper Magela basin'), and in the southern half of the Gilruth Sheet area where the sand cover masks the southward continuation of the Gilruth Volcanic Member. The sand was probably deposited following removal by erosion of Cretaceous strata. Meandering wide shallow valleys filled with sand and alluvium mark the course of ancient drainage systems which flowed to the southeast in the Liverpool Sheet area (not covered in this report - east of the Howship Sheet area). They are the vestiges of a consequent stream system most probably developed on Cretaceous strata. Since removal of these strata the drainage has assumed an angular pattern dictated by the major joint and fault directions within the Kombolgie Formation.

Structure

The rocks of the Arnhem Land Plateau have an overall gentle dip of less than 5^{o} to the southeast. Steeper dips occur locally as drape structures near basement highs or as folding associated with major faults. Basement highs of Oenpelli Dolerite form long arcuate ridges which most probably influenced deposition in early Kombolgie times. Major fault and joint directions are northwest, east, and northeast. The northwest set includes the major faults of the region; they are the Bulman Fault, the Jim Jim Fault, and the Devil Devil Fault. The east set is curvilinear, and faults curve to a northeasterly trend at their eastern ends. They are therefore possibly associated in some way with the northeast set which is best developed in a belt about 45 km wide which passes through the Gilruth Sheet area and the southeast part of the Howship Sheet area, and into the Liverpool and Goomadeer Sheet areas.

The northwest and east sets vertically displace the Kombolgie Formation, and can be traced as photolinear features through Lower Proterozoic strata in the lowlands. Fisher Creek Siltstone is thrown against Kombolgie Formation along the southwest margin of the Gilruth Inlier in the Gilruth Sheet area. The direction and position of the east set are commonly locally influenced by the arcuate trend of the Oenpelli Dolerite basement highs, e.g., the Deaf Adder Fault. The northeast set coincides with a series of linear magnetic features. Needham & others (1973) attributed them to magnetic material filling fractures within the

Kombolgie Formation - possibly near-vertical dolerite dykes, but no rock types other than sandstone are exposed within the fractures.

MYRA FALLS INLIER

This, the northernmost and largest of the inliers within the Arnhem Land Plateau, contains the greatest variety of rocks, and has the best exposures. The inlier is roughly rectangular, elongated east-west, and surrounded on most sides by Kombolgie Formation sandstone cliffs about 160 m high. The inlier is connected by corridors to the Nabarlek area, to the northern end of the Caramal Inlier, and to the coastal plains of the East Alligator River (Figs. 3 & 9). The first two corridors were developed by preferential erosion of the Kombolgie Formation along pre-Carpentarian basement highs of dolerite and quartzite, respectively, and those adjacent to the East Alligator River appear to have been formed by preferential erosion along faults.

The topography of the inlier grades from swampy flats in the west to steep ridges and moderately deeply dissected country in the east. Ridges and a large dome of quartzite dominate the landscape of the inlier. The inlier and adjacent corridors are drained by Tin Camp Creek and its tributaries which flow into the East Alligator River. The East Alligator River marks the western boundary of the inlier.

The rocks of the Myra Falls Inlier were described as Archaean mica schist, quartzite and 'amphibolite schist' by Walpole & others (1968), and Dunn (1962) recorded garnet in some of the schists, and also quartz sandstone and biotite granulite. None of these rock types was differentiated in the mapping, however.

Remapping has delineated a greater diversity of rocks than previously recognised. Most significantly, extensive areas of calc-silicate gneiss with minor marble and carbonaceous schist have been discovered, and these have been used to correlate the metamorphic rocks of the Myra Falls Inlier with rocks of similar grade and composition in the Lower Proterozoic Cahill Formation (Needham & Stuart-Smith, 1976). Isotopic dating of the rocks of the Myra Falls Inlier and of the nearby Nimbuwah Complex shows that they are Lower Proterozoic (Page, Compston & Needham, 1979). The rocks of the inlier

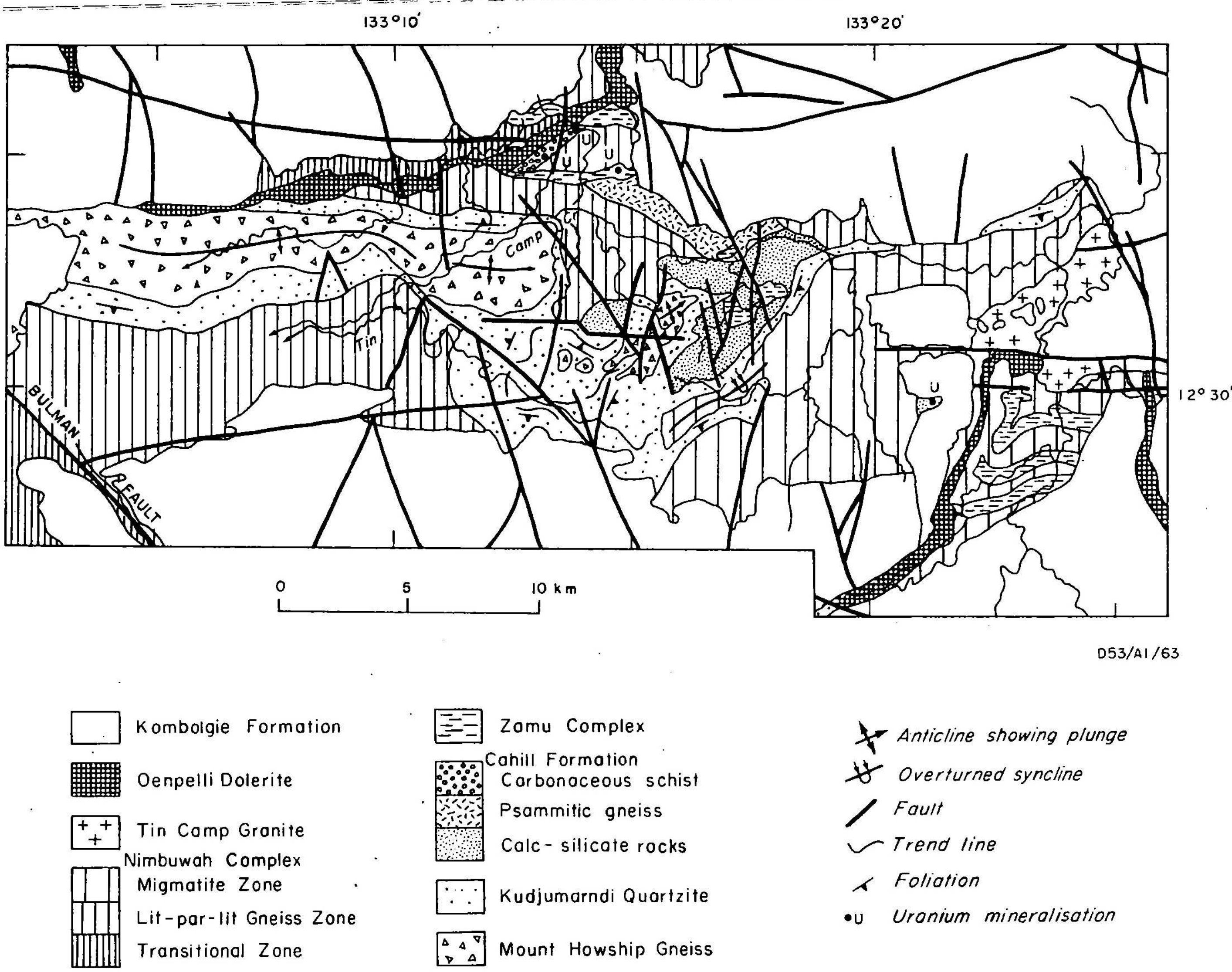


Figure 9 Generalised solid geology of the Myra Falls and Caramal East Inliers

grade easterly into partly differentiated 'lit-par-lit' schist and gneiss containing quartz and minor feldspar bands and boudins parallel to the foliation. Continuity with migmatite of the Nimbuwah Complex (Needham & others, 1975b) is lacking, but the inference is made that these rocks grade into the extensively differentiated gneiss and migmatite of the northern Oenpelli and Goomadeer Sheet areas. Consequently the rocks of the Myra Falls Inlier are better classed as the outer regions of the Nimbuwah Complex, similar to the schist and gneiss previously termed 'Myra Falls Metamorphics' northeast of Oenpelli Mission, and renamed Nimbuwah Complex by Needham & others (1975b). Where it has been possible to correlate exposures with Lower Proterozoic metasedimentary units to the west, the sedimentary nomenclature has been applied. The use of the term 'Myra Falls Metamorphics' should be discontinued.

The Myra Falls Inlier is covered by Map Plates 2c and d, 3c and d, 6 and 7. Generalised geology is shown in Figure 9. Lower Proterozoic stratigraphy is shown in Table 2. Amphibolite within the sequence is metamorphosed dolerite, and is correlated with similar predeformation metadolerite and amphibolite of the Zamu Complex in the Cahill Sheet area (Needham & Smart, 1972). Post-deformation Oenpelli Dolerite intrudes the metamorphic sequence as a large, shallowly northward-dipping dyke which forms a prominent ridge parallel to the northern side of the inlier, and also as rare steep narrow dykes less than a metre wide.

Most of the rocks of the Myra Falls Inlier are amphibolite-grade metasediments, which range from arenite to argillite in composition and texture to form the following metasedimentary continuum: arkose-quartzite-micaceous quartzite-feldspathic micaceous quartzite-schist. This continuum corresponds to an overall gradation in grainsize from coarse granular to medium-fine. Although described separately hereafter, the calc-silicate metasediments are part of this continuum, having been formed by the metamorphism of mainly calcareous quartz sandstone and sandy limestone. The arkose and quartzite contain muscovite, whereas the schist ranges from leucocratic to mesocratic, and contains mostly biotite. Foliation is generally parallel to bedding, and the medium to fine-grained rocks commonly cleave thinly along the more argillaceous layers. In the coarser rocks, fissility is poor to absent although a foliation is commonly represented by alignment of tabular to augen-shaped quartz aggregates and occasional mica-rich layers.

Meta-arkose (Blah) - 'Mount Howship Gneiss'

Granular quartzo-feldspathic rocks occupy the cores of domes and anticlines in the central part of the Myra Falls Inlier, and are generally massive or only faintly foliated. Quartz aggregates may be tabular or irregular in shape, and up to 3 cm across; their texture ranges from poorly polygonal to irregular. In these very coarse rocks muscovite commonly occurs as books 1-3 mm thick and 1-2 cm across wrapping around quartz, giving the rock a pegmatoid appearance. Quartz ranges from 30-75%. Microcline is commonly the dominant feldspar, although in some specimens plagioclase is equally abundant, and rarely, dominant. The rocks are slightly altered, and plagioclase is usually sericitised, whereas microcline is commonly not altered. Mica ranges up to 10% and is generally muscovite, but some specimens contain subordinate biotite. Apatite is a common accessory, and monazite is present in some specimens - both minerals occur as detrital subeuhedral to rounded grains.

The eastern part of the Myra Falls Inlier consists mainly of coarse, banded, quartzo-feldspathic gneiss similar to the arkosic gneiss of the central part of the inlier. Overall, the banded gneisses are slightly more mafic than the arkosic gneiss, as biotite predominates over muscovite. Hornblende is also present. Plagioclase is generally more abundant than microcline. Alteration is more intense here, virtually all the plagioclase being altered extensively to sericite and opaques. Biotite is commonly partly altered to chlorite. Banding is commonly present as biotite ($\pm$ hornblende) layers between quartz-feldspar layers. Muscovite occurs along the predominant biotite foliation, and also marks a weak secondary foliation about 40° to the biotite foliation. Euhedral muscovite books marking this secondary foliation truncate most other minerals and indicate a change in stress field after growth of the biotite. In places mineralogical banding is very clearly developed, especially where significant quantities of hornblende are present. This banding gives the rock the appearance of a migmatite, and is largely a result of crystallisation of hornblende into thicker layers or larger masses than those made up of the parent biotite.

Quartzite and quartz-rich gneiss (Blqk) - 'Kudjumarndi Quartzite'

Quartzite ridges dominate the topography of the Myra Falls Inlier, and mark the major structural elements of the area (Plate 15). The quartzite ranges from monomineralic through muscovitic and biotitic and hornblendic

TABLE 2

MYRA FALLS INLIER - LOWER PROTEROZOIC STRATIGRAPHY

MAP SYMBOL	LITHOLOGY	CORRELATION
Blz_{3-4}	gneiss, schist	
Blc_{1c}	carbonaceous schist	
Blc_{1b}	psammitic gneiss, banded and lit-par-lit gneiss	
Blc_{1a}	calc-silicate gneiss, garnet-hornblende muscovite-biotite gneiss, feldspar-quartz gneiss, amphibolite, marble, fine-medium muscovite-feldspar quartzite, schist	
Blq_k (Kudjumarndi Quartzite*)	coarse orthoquartzite, muscovite quartzite, minor gneissic biotite quartzite, banded mica-feldspar quartzitic gneiss, minor amphibolite; hornblende-muscovite quartzite (local development only)	
Blah (Mount Howship Gneiss*)	coarse muscovite-feldspar-quartz gneiss and muscovite-hornblende-biotite-feldspar-quartz gneiss	

* New name

types to micaceous and feldspathic gneissic varieties. The quartzite is differentiated solely on a quartz content of more than 75 percent from the arkose of Blah. This distinction is somewhat arbitrary, as petrographically the two units are gradational. The simple field technique used to map out the two units is topographic expression.

Foliation in the quartzite is parallel to strike of the ridges, and therefore the gross form of the quartzite layers, and is interpreted as bedding or foliation coincident with bedding. Rarely, cross-bedding is preserved, but is insufficiently well defined to indicate younging directions.

Muscovite is the commonest minor mineral, and in places composes up to 20 percent of the rock, but 5 percent is sufficient to impart a marked foliation. The muscovite is rarely altered, and generally forms large thin flakes dispersed through the rock. Sericite is present in many places, and may be interstitial to quartz, or may form pseudomorphs after plagioclase in which ghost twinning is occasionally evident. Fine masses or radiating aggregates of chlorite or clay are present in place of sericite in some specimens. Other subordinate minerals are amphibole, biotite, and rare garnet and orthoclase. The amphibole may be hornblende, or a pale green variety. Amphibole may be the sole subordinate mineral, but is more commonly present with muscovite or biotite. Biotite is not common, and is usually partly altered. Garnet accompanied biotite in some rocks, and forms poikiloblastic masses or grains 2-4 mm across.

Accessory minerals are monazite, sphene, apatite, and tourmaline, usually as rounded grains, although tourmaline may be prismatic and poikiloblastic with inclusions of quartz and sphene. Opaques are mostly irregular to rounded grains either scattered through the rock or clustered in clay-filled interstices. In haematite quartzite, the haematite forms long fine penetrative laths which mark the foliation of the rock. The penetrative and oriented haematite indicates that both phases in this rock have been recrystallised.

The quartzite textures range from massive and weakly foliated (less than 2 percent muscovite) to well foliated with medium to very coarse grain sizes. Bedding is preserved in some cases as bands of differing quartz grain sizes. Some discreet quartz grains are rounded, but polygonal textures are dominant, particularly in recrystallised aggregates.

Fresh plagioclase was seen only in a totally recrystallised biotite-plagioclase-quartz gneiss, where it occupies areas interstitial to quartz, and is patchily sericitised.

Calc-silicate gneiss and associated rocks (Blc_1a)

A distinctively patterned dendritic to irregular drainage system is associated with these rocks in the northeast of the inlier, west and southwest of Myra Falls. Numerous tightly sinuous finely dendritic creeks dissect the relatively soft strata into steep rounded hills. West of a tributary entering Tin Camp Creek 6 km west of Myra Falls, the topography over these rocks ages rapidly and gives way to low sand-covered rises within another 6 km. The rocks occupy an overturned syncline within Blqk quartzite, and are soft green massive fibrous actinolite gneiss; granular orange quartz-carbonate-actinolite gneiss; banded quartz ± plagioclase-actinolite-diopside gneiss, quartz-microcline-carbonate-actinolite gneiss, and plagioclase-quartz-actinolite-diopside ± garnet gneiss; and fibrous to coarsely crystalline white marble. These rock types represent metamorphism of calcareous feldspathic quartz sandstone, feldspathic quartz limestone, and limestone. They are coarsely interlayered with muscovite-feldspar-quartz schist ± garnet and amphibole, with quartz-feldspar pods elongated parallel to the main foliation, which represent interbeds of pelitic sandstone within the calcareous sediments.

The actinolite gneiss is almost monomineralic. The pale green to white actinolite is subhedral to anhedral, the prisms being less than 0.5 mm long, but occasionally poikiloblastic subhedra 3-4 mm long are present; the inclusions are smaller actinolite prisms and minor opaques. There are also bands where the actinolite is cryptocrystalline, and the variation in grainsize produces a marked layering. Plagioclase laths up to about 0.5 mm long are present in some layers. The actinolite gneiss is a metamorphosed impure dolomite.

The granular quartz-carbonate-actinolite gneiss is thinly layered; alternating bands are enriched in quartz, carbonate, microcline, or actinolite, and there are occasional lenses of medium to coarse quartz grains where most of the microcline is found. Actinolite is pale green to white, forming poikilitic prisms and small anhedra, and has clinozoisite with similar poikilitic habit in close association. Sphene, epidote, and opaques occur as accessories in the more mafic bands, and minor amounts of chlorite and sericite occur interstitially in the actinolite-rich bands. This rock is probably metamorphosed calcareous quartz sandstone.

The banded quartz-plagioclase-actinolite-diopside gneiss contains diopside anhedra about 2 mm across, and scattered poikiloblastic anhedra up to 10 mm long with quartz and subhedral actinolite inclusions. In quartz-rich layers other minerals are interstitial and fine-grained. Sphene is an accessory mineral in the banded gneiss, and sericite after plagioclase is common in interstitial areas. Plagioclase is more prominent in actinolite-rich areas where it forms fine-grained laths or rare poikilitic anhedra up to 2 mm across. Red garnet is present in some bands, which are about 10 mm wide. The garnet forms poikiloblastic anhedra up to 5 mm across, and contains inclusions of all the other minerals present in the banded gneiss.

In places, carbonate is a prominent constituent of the banded gneiss where quartz and K-feldspar are in higher than usual proportions. This quartz-K-feldspar-carbonate-actinolite gneiss is again typified by fine layers generally each enriched in one of the major minerals. The rock is fine and granular except for medium-grained quartz-rich lenses where the feldspar (tartan-twinned microcline) is concentrated. Clinozoisite preferentially accompanies actinolite, and both form prisms and small anhedra which may be poikiloblastic. The more mafic bands contain minor biotite and chlorite, and accessory sphene and opaques. Plagioclase and diopside are absent in this rock type.

Within the plagioclase-quartz-actinolite-diopside gneiss, diopside is the dominant mafic mineral, forming grains about 0.5 mm across and less common poikiloblastic anhedra up to 3 mm across. Pleochroic pale green actinolite is closely associated with diopside, and is similar in habit. Actinolite-rich layers generally contain fine laths and poikiloblastic anhedra (up to 2 mm across) of plagioclase. Granular fine quartz forms small irregular patches and lenses. Sericite patches after plagioclase contain rare flakes of coarser mica, and rare epidote replaces diopside.

The last of the calc-silicate rocks is a distinctive massive white fibrous marble composed entirely of calcite and tremolite. It forms bands about 1 m wide and crops out as a line of low blocks with black deeply sculptured surfaces (Plate 17). The calcite is polygonal, 0.5 - 1.0 mm across, with highly pleochroic colours along twin faces. The tremolite constitutes about 20 percent of the rock and occurs as grains scattered throughout the calcite, and as layers and pods up to 6 mm thick; euhedra up to 1 mm acorss and laths 5 mm long are scattered amongst the finer grains. The marble formed by metamorphism of clean quartzose dolomite.

Psammitic gneiss and lit-par-lit gneiss (Blc_1b)

These rock types crop out extensively in the northern half of the inlier, and are evident in many places along the track from Nabarlek to the Tin Camp Creek crossing. They display a range of textures from phyllitic (where very fine-grained mica lies along the bedding planes), to schistose or gneissic (where crystallisation of coarse mica flakes marks a pervasive foliation), to banded (alternating segregated concentrations of mafic and felsic minerals generally less than 1 cm wide, but with boudinaged quartz-rich bands up to 25 cm wide in places).

In the foothills of the escarpment north of the Tin Camp Creek crossing the gneiss commonly consists of medium-grained granular quartz-rich varieties, and where weathered is distinctly buff-coloured and sandy. Generally the gneiss is tightly folded, and in extreme cases the folding is ptygmatic. Narrow bands of quartzite within the gneiss clearly show isoclinal folds (Plate 16). Undulose foliation surfaces in segregation-banded gneiss are a result of deflection of folia around large quartz boudins (Plates 18 & 19).

Garnet grains up to 5 mm across are common in layers rich in mica. The gneiss ranges from mesocratic to leucocratic, reflecting either biotite or muscovite as the dominant mica. Quartz-rich gneiss is transitional mineralogically into the Blqk quartzite and quartz gneiss.

In this group the interlayered gneissic bands have distinctly different textures, as well as different mineralogy. Most commonly, 0.3 mm-wide layers consisting of a granular mosaic of anhedral quartz and minor

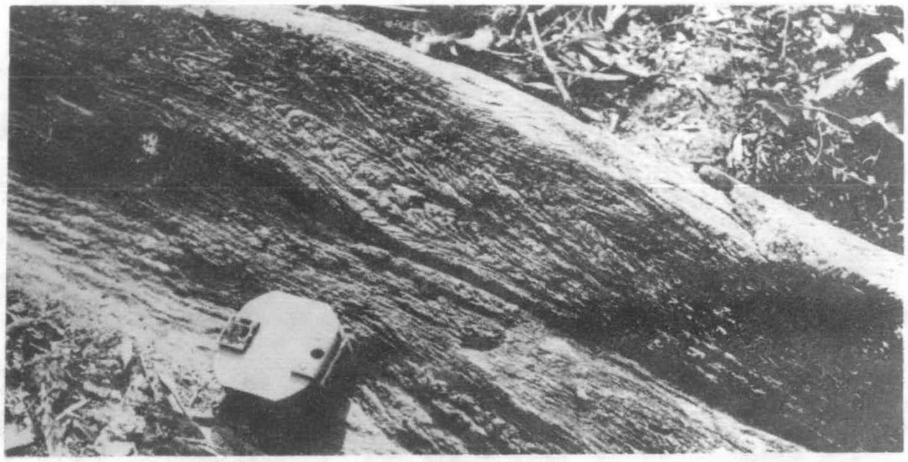


Plate 16: Isoclinal folding in narrow quartzite bands within unit Plc_1b, 2.5 km northwest of Caramal track crossing over Tin Camp Creek. (m/2224).

Plate 17: Deeply sculptured black blocks of calcite-tremolite marble form a discontinuously exposed bed in the northeast of the Myra Falls Inlier, 1.8km southeast of Caramal track crossing over Tin Camp Creek. Ridge of Kudjumarndi Quartzite in background (m/2224).

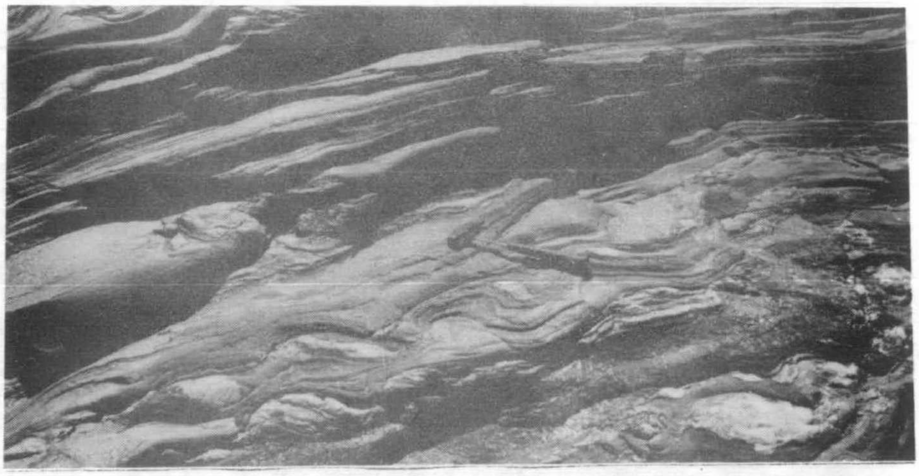


Plate18: Banded gneiss of unit Blc_1b, 1 km upstream from Caramal track crossing over Tin Camp Creek. (m/2224)

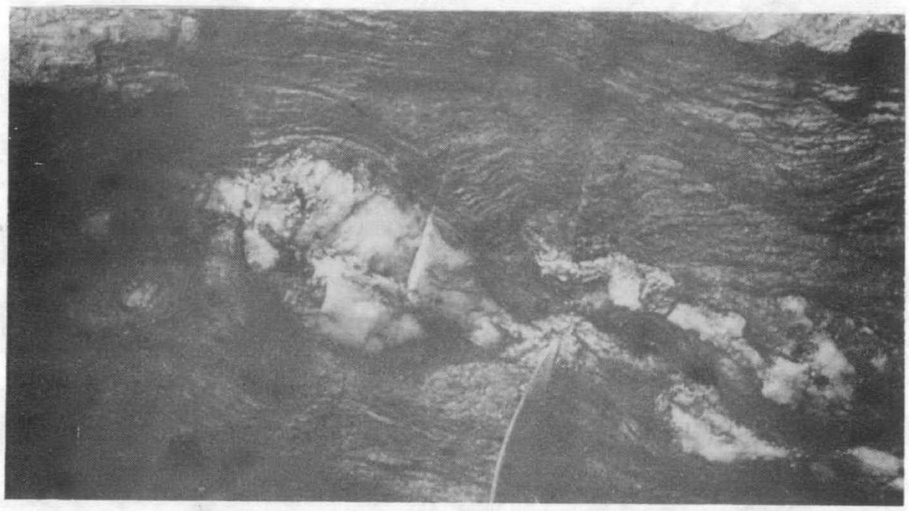


Plate 19: Feldspar-quartz boudin with chlorite biotite selvages in banded gneiss of Blc_1b. Same locality as Plate 18 (m/2225)

Plate 20: Folded lit-par-lit gneiss of unit Blz_3, Nimbuwah Complex. 1 km north of Garrunghar prospect, Myra Falls Inlier. (m/2225)

feldspar grains alternate with platy mica-rich layers less than 0.5 mm wide and the mica defines the strong foliation. In contrast, the foliation in adjacent coarser quartz-rich layers up to 1 cm wide and with minor mica, is defined by quartz grains about 2 mm long.

The quartz boudins and bands contain glassy quartz and up to 10 percent feldspar, books of muscovite up to 2 mm across, and aggregates of dark green to black chlorite which is either interstitial, or in rectangular or cube-like masses probably after feldspar.

The garnet is poikiloblastic, and is commonly accompanied by tourmaline. It averages 1 to 2 mm across, and contains inclusions of all the other minerals. Chlorite in places forms discontinuous mantles on garnet but more often forms fine-grained clusters of radiating flakes up to 2 mm across. The micas are commonly bent around garnet, although this is not everywhere so. Away from the quartz boudins mica is mostly fine-grained and bent. Muscovite forms rare cryptocrystalline patches, and biotite is commonly partly altered to chlorite. Zircon inclusions with associated metamict haloes are common in the biotite. Tourmaline forms subhedral to anhedral grains which are pleochroic (olive-green to pale green) and may be zoned with blue-green centres.

All quartz shows strain extinction. Feldspar is concentrated in the finer-grained layers as anhedral grains, generally smaller than 1 mm and with very fine inclusions. Plagioclase is commonly altered to sericite, but alteration of orthoclase is less common.

Accessory apatite occurs mostly as inclusions in biotite; minor opaques are sometimes present in biotite and chlorite.

Carbonaceous schist (Blc_1c)

These are similar to the finer-grained pelitic gneiss of Blc_1b, but in addition contain up to 5 per cent graphite. They crop out near the northern side of the inlier near Garrunghar prospect (Map Plate 6). The rocks typically have an open wavy foliation with alternating coarser quartz-rich and finer graphite-rich layers up to 5 mm wide. The quartz-rich bands may be composed of many fine irregular grains, or a single layer of quartz grains about 0.5 mm across. The finer-grained parts consist of a matrix of sericite, sericite-altered plagioclase, and minor quartz, with isolated flakes of muscovite and biotite, the latter mica being the more stumpy in habit. Graphite is concentrated at the edges of, or within, the fine-grained layers. The rock is cut by veinlets of quartz and sericite up to 2 mm wide, and quartz is everywhere strained throughout the rock.

Nimbuwah Complex gneiss, schist (Blz_3 and Blz_4)

Gneiss and schist which cannot be related to the metasedimentary stratigraphy outlined in Table 1 have been assigned to the Nimbuwah Complex. They are by and large identical to banded and lit-par-lit gneiss of Blc_1b, and are divided into varieties with incipient or patchy development of leucosome bands and lenses (Blz_4; (Transitional Zone' of the Nimbuwah Complex), and others with commonplace leucosome development (Blz_3; 'Lit-par-lit Gneiss Zone' of the Nimbuwah Complex, Plate 20). These units have been described by Needham & others (1975b). The boundary between them is somewhat difficult to define owing to its broad gradational nature, and where mapped must be regarded as roughly the mid-point of a 1-2 km or wider gradation from one unit to the other.

In the southeast corner of the Myra Falls Inlier between the Caramal Prospect and the easternmost ridge of Blqk quartzite is a large area of gneiss not easily related to other units in the inlier. The gneiss consists of muscovite, biotite, plagioclase, microcline, and accessory apatite and monazite; hornblende may or may not be present. Muscovite, where present with biotite, is undeformed and may cut across biotite-rich layers. The gneiss is generally a little more mafic than the meta-arkose of Blah, and has a wider textural diversity, ranging from finely banded and granular, to augen, to wavy mafic-leucocratic segregation banding of migmatitic character.

The closest rocks in appearance to this body of gneiss are the Blah meta-arkose, and the Tin Camp Creek Granite of the Caramal East Inlier (see next chapter). The texture and mineralogy of the gneiss suggests the rock is not a modified igneous rock. Therefore the gneiss is interpreted as a partly migmatised equivalent of Blah, and represents a gradation into the Migmatite Zone of the Nimbuwah Complex (Needham & others, 1975b). Accordingly, the calc-silicate gneiss of Blc_1a is interpreted as occupying the centre of an overturned syncline, and the easternmost limb of Blqk quartzite running through Myra Falls and into the northern end of the Caramal East Inlier, appears to be an overturned repetition of the Blqk quartzite in the centre of the Myra Falls Inlier (Map Plate 3d).

Zamu Complex (Bdi)

The metasediments are interlayred with broadly concordant bodies of amphibolite. The amphibolite is metamorphosed pre-deformation dolerite, and is therefore equated with the Zamu Complex metadolerite and amphibolite of the Cahill and Jim Jim Sheet areas (Needham & Smart, 1972; Needham & others, 1975; Ferguson & Needham, 1978). It is different from the para-amphibolite already described (Blc_1a), being dense, dark green to black, generally fissile, with elongate prisms of hornblende roughly aligned along the foliation, and which in places form flattened rosettes in the foliation plane. The hornblende prisms average 1 mm, but in places are up to 3 mm long, and compose about 60-70 percent of the rock. Twinning along 100 is common in hornblende, and pleochroic haloes suggest that minute high-relief inclusions at their centres are zircon or monazite.

The matrix consists mostly of quartz grains less than 0.3 mm across, and sericite after feldspar. Uncommon quartz-rich (up to 50 percent) layers up to 1 mm wide occur, with grains 0.5 - 1 mm across, and are probably the product of metamorphic differentiation. Rare garnet has hornblende prisms bent around it. Minor veins of clear amphibole less than 0.5 mm wide cut across the foliation at high angles. Carbonate, biotite, sphene, and possible zircon and opaques are accessory minerals.

Uncommon varieties of the amphibolite are those with leucocratic blebs 1 mm thick and 2-4 mm across, and flattened along the foliation, and those with alternating dark green and cream bands 1-8 mm wide, both in the Dead Dingo Creek area of Map Plate 3d.

The blebs consist of quartz, plagioclase, and possible orthoclase, containing minute hornblende prisms. The possible orthoclase has a micro-vermicular texture, and some of the blebs contain remnant garnet largely altered to sericite and biotite. Masses of sericite and biotite elsewhere in the blebs are therefore probably pseudomorphing garnet. Adjacent to the leucocratic blebs hornblende may be semi-poikiloblastic with inclusions of felsic minerals, but otherwise the melanocratic part of the rock is similar texturally to typical Zamu Complex amphibolite described above. Hornblende also contains inclusions of opaques, and biotite may be interwoven with the hornblende or lie along its margins, suggesting a reaction relationship. Euhedral apatite and haloed zircon in hornblende are accessory minerals.

The banded variety contains dark layers of hornblende, diopside, and felsic minerals, and light layers of diopside, felsic minerals, carbonate, and hornblende. The dark bands contain hornblende prisms up to 0.2 mm long aligned along the foliation. Diopside is minor, occurring as poikiloblastic grains up to 5 mm long with inclusions of felsic minerals and minor hornblende. The felsic minerals in the dark bands are quartz, sericite after plagioclase, and K-feldspar. In places the feldspar is relatively unaltered, and tartan-twinned microcline, and minor polysynthetically twinned plagioclase are evident. Rare biotite is associated with hornblende, which contains abundant minute haloed zircon grains. The lighter bands consist mainly of diopside grains, 1-2 mm across, oriented along the foliation and generally poikiloblastic. Felsic minerals - quartz, orthoclase, and plagioclase - are less than 0.3 mm across, and form the bulk of the matrix, but the feldspars are almost entirely altered to sericite; hornblende is minor, forming small prisms which penetrate the diopside, and carbonate anhedra are commonly marginal to the diopside. As in the typical Zamu Complex amphibolite described above, coarser quartz-rich layers are common. Sphene and opaques are common accessory minerals, and are more abundant in the diopside-rich layers.

The presence of garnet, or carbonate and diopside, in the spotted and banded rocks make their nature problematical. However, subsequent detailed chemical analysis has confirmed that they are orthoamphibolites (Ferguson & Needham, 1978).

Oenpelli Dolerite (Bdo)

A ridge running most of the length of the northern margin of the Myra Falls Inlier rises 100 m above the general ground level of the inlier, and consists of Oenpelli Dolerite (Plate 21). It is the southern rim of a basin-shaped intrusion, and dips 15°-25° north. It is continuous at depth with the dolerite dyke at Nabarlek, where the trend of the outcrop changes sharply across the long axis of the basin. The basin is ellipsoidal, and virtually circumscribes the Kombolgie Formation 'Oenpelli Massif' outlier.

Plate 21: Oenpelli Dolerite forms a prominent ridge along the northern margin of the Myra Falls Inlier. (m/2225)

Plate 22: Fault breccia containing large blocks of Kombolgie Formation sandstone forms spines along some ridges in the southern part of the Myra Falls Inlier. (m/2224)

The dolerite ridge appears to have controlled erosion of the Kombolgie Formation sandstone by initially providing planes of weakness along rock type interfaces and joints, and therefore focusing erosion of sandstone at the dolerite ridge. Once exhumed, the dolerite ridge protected the isolated sandstone block from further attack by encircling creek systems. The Oenpelli Dolerite of the Myra Falls Inlier is continuous with that of the 'Oenpelli region' described by Needham & pthers (1975b). The Oenpelli Dolerite throughout the Alligator Rivers Region is described in detail by Stuart-Smith & Ferguson (1978).

The dolerite dyke forming the ridge is about 200 m thick, and consists mostly of olivine dolerite which is porphyritic near the margins of the intrusion: minor quartz dolerite and gabbro are found near the centre. Quartzite xenoliths are common in places near the margins of the dolerite. Some quartz grains in the xenoliths retain their roundness; feldspar, prehnite, and amphibole as small prisms form small interstitial grains. The amphibole and prehnite are commonly concentrated at the margins of the xenoliths, and the amphibole may form radiating aggregates there. Rare ?cordierite with inclusions of quartz is present, and also minor calcite and accessory epidote.

The boundary where exposed, is sharp, and there is a chilled margin a few centimetres wide. Where the dolerite cuts quartzite in the western part of the inlier the contact is brecciated and chloritised over about 5 m. There is no apparent contact metamorphism of adjacent rocks.

The Oenpelli Dolerite also forms rare sub-vertical dykes less than 1 m wide. These are invariably porphyritic olivine dolerite, and have narrow chilled margins.

Kombolgie Formation (Bhk_1)

Large blocks of sandstone up to 15 m across are commonplace in areas of active erosion in the eastern part of the inlier up to 5 km away from the escarpment, and attest the current rapid rate of scarp retreat in the area. In the south of the inlier, fault breccia with angular fragments of sandstone up to 1 m across forms spines to some elongate ridges, and are the erosional remnants of fault zones which once cut both the Kombolgie Formation and the underlying rocks (Plate 22).

Structure

The major structural elements of the Myra Falls Inlier are shown in Figure 9. The metamorphic foliation mostly strikes easterly but trends north in a zone of relatively intense faulting at the eastern end of the inlier. Foliation is coincident with bedding in the limbs of the major folds of the Kudjumarndi Quartzite, but at fold closures bedding and foliation may intersect at high angles. The quartzite forms a large anticline 15 km long and 3 km wide in the west, and a prominent dome in the south; the anticline closes in the centre of the inlier, and this closure is repeated by faulting 5 km farther east. Calc-silicate gneiss occupies an overturned syncline between this second closure and a long sinuous limb of quartzite which trends northeast to Myra Falls and beyond. The occurrence of rocks similar to Blc_1 at the Caramal prospect suggests another anticlinal axis between Myra Falls and Caramal, but metamorphic differentiation in this area has apparently rendered the Kudjumarndi Quartzite unrecognizable, or alternatively the unit may have lensed out.

The Oenpelli Dolerite dips north at about 20° along the northern margin of the inlier and is broadly coincident with metamorphic foliation in that area.

Economic Geology

Caramal uranium prospect

This prospect was discovered by Queensland Mines Ltd by follow-up of an airborne radiometric survey, and was also indicated by later stream sediment geochemical surveys. It lies at the extreme eastern margin of the Myra Falls Inlier, and mineralisation continues under the Kombolgie Formation sandstone. Anomalous radioactivity was detected in schist under the sandstone beneath a small waterfall at the blind end of a short re-entrant into the escarpment where secondary minerals were exposed at the surface. Primary mineralisation has been intersected by diamond drilling in schist and carbonate overlying quartz-feldspar gneiss and dolerite. The deposit is open to the east, and few details of geology of mineralisation have been released. The best reported intersection is 12 m of 15.6 lb/ton U_3O_8 (Southern Miner, 4 October 1971). A hole drilled through the sandstone about 100 m east of the waterfall intersected mineralisation below about 160 m. The sandstone contains accessory apatite near the base of the sequence.

Other uranium prospects

Queensland Mines Ltd have discovered several uranium prospects in the Myra Falls Inlier. They are 'Gorrunghar', 16 km southwest of Nabarlek, 'Gurrugarri', about 15 km south-southwest of Nabarlek; 'Mordijimuck', about 11 km southwest of Nabarlek; an unnamed? prospect about 6.5 km south of Nabarlek, and another unnamed? prospect 24 km west-southwest of Nabarlek. As far as is known, work has shown that surface mineralisation does not continue at depth. Most of the prospects are in schist within a few tens or hundreds of metres from Oenpelli Dolerite or Zamu Complex amphibolite; this probably reflects the exploration philosophy of the company being pursued at the time of discovery. All the prospects are in rugged terrain except the one 6.5 km south of Nabarlek, which is in a black soil plain.

Tin Camp prospect

Small quantities of tin are worked from cassiterite-bearing placer deposits in Cainozoic sand about 2 km northwest of Myra Falls. The cassiterite is concentrated in small patches in creeks eroding the sand (Shields & Lau, 1972). Some of the creeks have eroded down to underlying metamorphic rocks, and Gray (1915) suggested that the cassiterite was derived from minor cassiterite-bearing quartz veins cutting the metamorphic rocks. He also noted minor apatite, beryl, and copper in the schist and gneiss of the area, but none of these minerals was noted in the current survey.

CARAMAL EAST INLIER

This is a triangular area about 20 km long, trending northeast, and widening at its northern end to about 6 km (Fig. 3). It is connected at its northern end to the northeastern corner of the Myra Falls Inlier, via a narrow pass 2 km east of Myra Falls which developed by preferential erosion of Kombolgie Formation sandstone above a prominent ridge of Blqk quartzite. The inlier is an undulating to rugged terrain drained by the headwaters of Tin Camp Creek, flowing northwards along a rectilinear course in the centre of the inlier, and surrounded by sandstone cliffs about 60-80 m high.

In spite of the proximity of the two inliers, the geology of the Caramal East Inlier is markedly different from that of the Myra Falls Inlier. A ridge of Blqk quartzite running east-northeast along the northern edge of the Caramal East Inlier is the only metasedimentary unit present. An altered granite body crops out in the northern section of the Inlier, and the remaining area consists of banded migmatite and amphibolite cut by Oenpelli Dolerite. The area derives its name from the Caramal uranium prospect 4 km west of the inlier.

The quartzite is identical to Blqk of the Myra Falls Inlier; the amphibolite is identical to the Zamu Complex amphibolite of the Myra Falls Inlier, except that no spotted varieties are evident.

Nimbuwah Complex migmatite (Blz_2)

Although categorised as rocks of the 'Migmatite Zone' of the Nimbuwah Complex as defined by Needham & others (1975b), these rocks differ from those migmatites in the Goomadeer and King River areas where the definition of Blz_2 was erected. The migmatite of the Caramal East Inlier and Beatrice Inlier (see later chapter) is more mafic, and is generally mesocratic (Plates 23 & 24). Bands are from 1 mm to 20 cm wide, colour ranges from leucocratic to melanocratic, and although banding is due mainly to differing mineral proportions, textural differences can also be responsible. Grainsize differences commonly reflect mineralogical differences, as the darker bands are invariably finer grained (about 0.6 mm). Other bands are granular and porphyroblastic. The porphyroblasts are usually orthoclase (up to 1.5 cm) or less commonly poikiloblastic garnet (up to 2 cm). Fresh feldspar is white, but plagioclase is commonly altered to pale green sericite. Biotite, hornblende, quartz, and, in places, garnet, form the matrix.

The minerals constituting these rocks are present in all the various layers - only the proportions differ. Plagioclase exceeds orthoclase, classifying these rocks as granodioritic or tonalitic. Orthoclase forms fine to coarse grains as well as porphyroblasts, and patches of microvermicular textures less than 1 mm across are common, especially along orthoclase-plagioclase boundaries. Stumpy plagioclase prisms average 3 mm long, are polysynthetically twinned, and are commonly altered to sericite along cleavage and fracture planes. Quartz-plagioclase boundaries are only rarely myrmekitic. The dominant mafic minerals are biotite and hornblende, which are clustered in areas interstitial to the felsic minerals along with minor clear clinopyroxene. These clusters mostly have very fine-grained cores (about 0.1 mm) up to 4 mm across of hornblende, quartz, and minor clear pyroxene and biotite, and very rare orthoclase. The same minerals may also

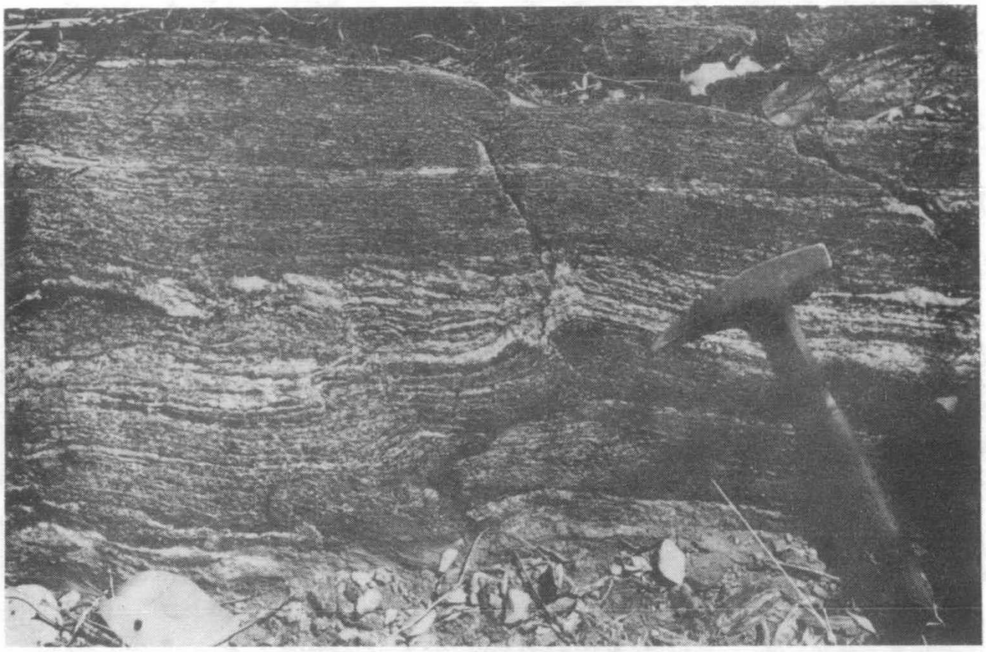


Plate 23: Finely banded garnet-hornblende-biotite-quartz-feldspar migmatite of unit Blz_2, central Caramal East Inlier. (M/2224)

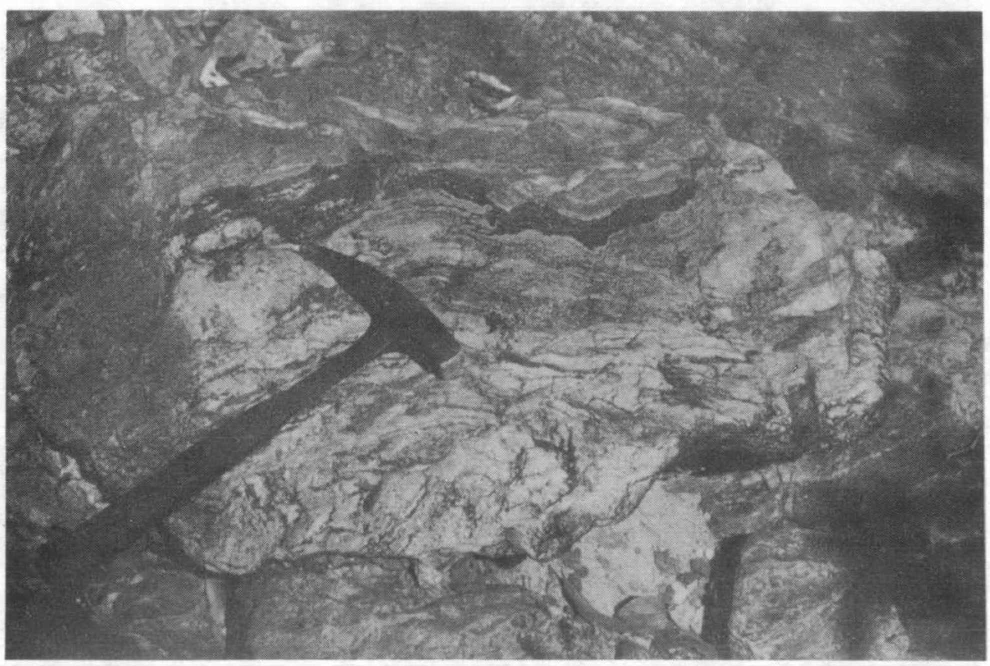


Plate 24: Coarsely banded migmatite with hornblende-rich melanosome, unit Blz_2, western Caramal East Inlier. (M/2225)

be present as inclusions in poikiloblastic hornblende. Apatite and zircon form inclusions in biotite and (less commonly) hornblende, which are both characteristically strongly poikiloblastic, and these two host minerals, along with epidote, display minor chlorite alteration. The clear pyroxene may also form separate anhedra, mostly reacting to hornblende. Quartz is strained, and commonly forms aggregates up to 1 cm across of 1-3 mm grain-size. Garnet is present in much of the migmatite as grains 2 mm across, or more commonly, poikiloblastic anhedra up to 2 cm across with inclusions of feldspar and quartz. Opaque accessory minerals are rare and sporodically distributed.

Some mylonite is present within the migmatite on the west side of the inlier; the mylonitic rocks are fine-grained and dark with augen generally about 1 mm, but up to 1 cm, across, mainly composed of one mineral (quartz or feldspar) or, less commonly, mineral aggregates, in a matrix of amphibole, chlorite, and minor carbonate.

The marked difference in composition between the migmatite of the Caramal East Inlier and Myra Falls Inlier suggests that the faulted western margin of the Caramal East Inlier may mark a zone of considerable displacement.

Oenpelli Dolerite (Bdo)

A dyke of Oenpelli Dolerite about 70 m thick parallels the western side of the inlier, and dips shallowly to the east (Map Plate 7). It then swings to the east at the northern end of the inlier, thins to 10-20 m, and strikes underneath the Kombolgie Formation. It consists of porphyritic and ophitic olivine dolerite, with granophyric dolerite in places near its centre. Hornfels aureoles are commonly developed in the adjacent gneiss and migmatite, and include cordierite hornfels and hornfelsed augen gneiss. The latter is retrogressed by hydrothermal alteration to quartz, clays, and hematite, whilst the former are pink-grey rocks with silver-grey porphyroblasts of cordierite up to 1 cm standing out as knobs on weathered surfaces. They are usually foliated, with pink masses and lenses of altered alkali feldspar interlayered with or including massive chlorite probably formed by alteration of muscovite. There is minor stained muscovite, and minor quartz, and the minerals between the porphyroblasts have a polygonal texture. The cordierite is generally almost entirely altered to pinite (fine clusters of radiating brownish green muscovite and chlorite).

A rock identified in the field as a hornfels, and directly overlying Oenpelli Dolerite in the extreme northwest corner of the inlier (Map Plate 3), contains dark patches of chloritoid or stilpnomelane? surrounded by rims of sericitised feldspar, and forming distinctive circular structures up to 5 mm across. In places the chloritoid or stilpnomelane? forms 'bow-ties' clustered in radiating aggregates. The matrix is fine quartz, sericite, and opaques. The rock is unusual in that its texture is reminiscent of an amygdaloidal volcanic rock, and, like a similarly-textured rock in the Beatrice Inlier, could be metamorphosed Edith River Volcanics.

A vertical dyke 1 m wide strikes north in the centre of the inlier, and lies about 200 m east of the main intrusive body (Map Plate 7). Although highly altered, its gross mineralogy appears similar to that of porphyritic olivine dolerite of the Oenpelli Dolerite, and the dyke is thus regarded as a stringer from the main body. Euhedral feldspar phenocrysts averaging 2-5 mm long are grouped in glomeroporphyritic aggregates up to 1 cm across, and are strongly altered to chlorite and opaques, or prehnite. The groundmass consists of very fine-grained altered plagioclase laths, sericite, and opaques. Pyrite is the dominent opaque, and forms mostly irregular grains about 0.1 mm across, and there is a trace of quartz.

Tin Camp Granite (Bgt)

This unit forms rubbly sparsely vegetated hilly terrain in the northern part of the inlier with plentiful boulder and pavement exposure of pale pink to cream altered granite traversed by mainly north-trending quartz-breccia zones (Plate 25; Map Plate 3). Euhedral plagioclase laths formed over 50 percent of the rock before alteration, mostly to sericite and suggest that trondhjemite is a more appropriate rock name, although no samples fresh enough to confirm this have been seen. Strongly altered brown masses of sericitic material replace the plagioclase, but display no relict twinning. Quartz makes up 40-45 percent of the rock; biotite is commonly green through alteration and contains opaque inclusions and zircon bordered by haloes. Quartz feldspar intergrowths with simultaneous extinction verify the igneous origin of these rocks. The contact of the granite is not exposed, but its relationships are inferred to be the same as those of the Nabarlek Granite 20 km to the north (Needham & others, 1975b). It is unconformably overlain by Carpentarian Kombolgie Formation sandstone. Quartz porphyry dykes intruding migmatite in the centre of the inlier are probably genetically related to the granite. The granite is radiometrically anomalous, averaging

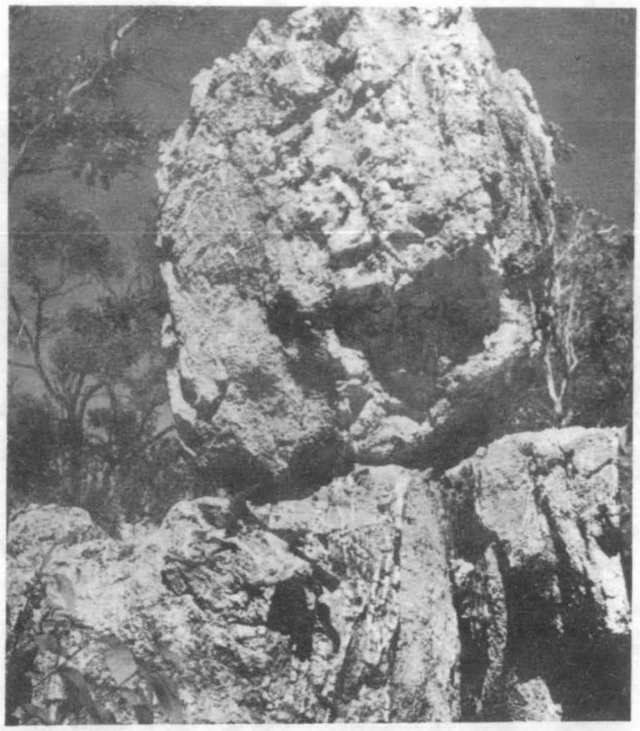


Plate 25: Quartz-breccia zone in Tin Camp Granite, Caramal East Inlier, 6km east of Myra Falls. (m/2224)

Plate 26: The lower sandstone unit of the Kombolgie Formation dips away from the edge of the Five Sisters Inlier at up to 20°. (m/2224)

Plate 27: Ground radiometric work in a trench at the Five Sisters uranium prospect. (m/2224)

60 ppm thorium and 11 ppm uranium (Wilkes, 1975).

BEATRICE INLIER

This is a triangular area bounded by faults along its north and southwest margins; its geology is similar to that of the Caramal East Inlier (Map Plates 6 & 7). Exposure is poor near the southwest margin in the valley of the East Alligator River, and in the eastern half of the inlier in flats along creeks draining into the same river. The terrain is more rugged in the northwest corner, where foothills of migmatite and gneiss rise up to a thin capping of Kombolgie Formation sandstone (Map Plate 6). The inlier is connected to the south along gorges marking the course of the East Alligator River and several unnamed tributaries to areas of gneiss and granite, which for the purposes of this report, are included as parts of the Beatrice Inlier. The area derives its name from the Beatrice uranium prospect, about 250 m from the East Alligator River in the west of the inlier.

Nimbuwah Complex (Blz_2, Blz_1)

Banded migmatite (Blz_2) of the Beatrice Inlier grades subtly from markedly foliated rocks in the north which may be granular or porphyroblastic, and which in places are strongly garnetiferous, to weakly foliated to massive unbanded coarse or porphyroblastic granitoid rocks (Blz_1), again garnet-rich in places, in the south. They are tonalitic in composition, and may be slightly higher-grade equivalents of the migmatite of the Caramal East Inlier. The only difference in composition noted between the migmatites of the two inliers is the presence of tartan-twinned stringlet microcline perthite in some specimens from the south of the Beatrice Inlier. Various migmatite interpenetration fabrics are developed, and indicate a higher degree of plastic flow in these rocks in contrast to the banded rocks of the Caramal East Inlier. Textures include raft, schlieren, agmatitic, stictolithic, and dictyonitic types (Mehner, 1968).

When seen in contact, the granitoid rocks truncate the migmatite; they are unbanded, only poorly foliated, coarser grained, and generally porphyroblastic. Pink perthitic feldspar phenocrysts are 2-3 cm long and 1-1.5 cm wide, and white to pale green plagioclase forms stumpy laths up to 5 mm long. Medium-grained quartz, hornblende, and biotite form the matrix. Alkali feldspar is mostly orthoclase and may be fine to coarsely granular, and in places forms porphyroblasts up to 1.5 cm across; they are partly mantled by thin (up to 1 mm wide) zones of very fine-grained material which have the same mineralogy as the medium-grained matrix, and which may represent 'ghosting' of the texture of the original rock. The feldspar phenocrysts themselves are fractured stringlet microcline perthite. Plagioclase is commonly altered to pale green sericite. Quartz is highly strained, and may form lensoid aggregates up to 1 cm long. The mafics are often poikiloblastic, containing quartz, hornblende, and minor clinopyroxene, biotite and orthoclase. Zircon and apatite are usually mingled within the mafics in 3-10 mm clusters. Sphene is concentrated marginally to hornblende, and commonly has inclusions of quartz, zircon and apatite also. Minor carbonate veins may intersect all other minerals.

Hills of granitoid migmatite west of the East Alligator River in the southwest of the inlier contain lensoid layers of banded amphibolite up to 10 m across. Essentially monomineralic bands of quartz and amphibole in a finer-grained matrix of alkali feldspar, some plagioclase, and amphibole and quartz suggest the banding resulted from metamorphic differentiation in what may originally have been a basic intrusive rock. Alternatively, the rock may be a migmatite melanosome although where seen elsewhere they are homogeneous, fine- to medium-grained, unbanded, dark rocks.

Tin Camp Granite (Bgt)

Granite similar to that in the north of the Caramal East Inlier crops out in a gorge about 16 km east-southeast of the Beatrice prospect. It is confined to the north side of the gorge, apparently being faulted against rocks of Nimbuwah Complex which crop out south of the creek in the floor of the gorge. This granite is also characterised by roughly north-trending quartz-breccia zones, and by pervasive alteration.

Two phases of the granite are known. A coarse-grained porphyritic variety has pale pink orthoclase string microperthite phenocrysts measuring up to 2 cm x 1 cm in a coarse groundmass of pale green sericitised zoned plagioclase, with alteration most prominent in the cores, and separate anhedral grains or aggregates of quartz. Feldspar comprises about 60 percent and quartz about 35 percent, of the rock. Interstitial biotite comprises less than 5 percent of the rock. Quartz grains show undulose extinction, range up to 2 mm across, and may occupy embayed areas in feldspar phenocrysts. Biotite is generally less than 1 mm long, and may be replaced by chlorite; both minerals semi-poikilitically enclose quartz, zircon, opaques, and fluorite and are embayed by feldspar.

The second phase is a fine, even-grained variety with alkali feldspar (orthoclase string microperthite) and plagioclase (zoned polysynthetically twinned) in equal amounts, as anhedral grains about 0.6 mm across, and which together make up about 65 percent of the rock. The cores of plagioclase grains again are commonly replaced by sericite. Anhedral quartz grains may be evenly distributed, or less commonly, may form clusters up to 2 mm across, and make up about 30 percent of the rock. Biotite is interstitial, and is extensively chloritised; less common is replacement by fluorite and yellow iron oxide. Fluorite also forms grains less than 1 mm across.

Oenpelli Dolerite (Bdo)

A 60 m-wide section including all the varieties of the unit is exposed in the north of the inlier as a dyke dipping about 15° south or southeast (see Stuart-Smith & Ferguson, 1978, for details). The contact with country rocks is sharp and altered granitoid rocks may extend up to 100 m from the dolerite. These altered country rocks appear more mafic than their unaltered equivalents, and were thought to be the product of iron and magnesium metasomatism by Smart & others (1976). However, closer examination has shown the rocks to be retrogressed; feldspar was altered to sericite and prehnite, and biotite or hornblende to very fine-grained dark green fibrous actinolite, which has imparted a pink or dark green colour to altered feldspar, and a dark green to brown colour to the biotite or hornblende, explaining the more mafic appearance. In the northwest part of the inlier, country rocks adjacent to the dolerite are usually coarse granitoid retrogressed rocks grading to unaltered granitoid over 100 m or so from the dolerite. In the northeast of the inlier, however, the contact zone is generally fine-grained and only a few tens of metres wide, even though the unaltered equivalents are the same as for the coarse retrogressed rocks. Once again, sericite alteration is dominent and the feldspar has been totally replaced. Quartz is generally the only other significant mineral, although hematite is present in places. One specimen from the extreme northeast corner of the inlier (Map Plate 16) contains pink spherules up to 3 mm across and small albite grains mantled by sericite masses, with minor admixed quartz. Areas between the spherules are mostly quartz, and in places cockscombs of brown-yellow mica define the shells of cavities filled by quartz. The spherules are reminiscent of an amygdaloidal texture, and the presence of fine angular albite grains suggests the rock could have been a rhyolite or similar volcanic rock. The cockscombs suggest that material between the spherules was leached and replaced by recrystallised quartz. The rock has thus been tentatively assigned to the Edith River Volcanics.

Beatrice Prospect

The prospect was discovered by follow-up of an airborne radiometric survey by Queensland Mines Ltd. Secondary uranium mineralisation was exposed by costeaning; it is associated with quartz veins with hematite-rich centres. The veins cut Nimbuwah Complex tonalitic granitoid migmatite. Oenpelli Dolerite crops out 1 km to the northwest, and dips under the prospect.

GILRUTH INLIER

This inlier forms an elongate northwest-trending depression 17 km long and 2.5 km wide in the Arnhem Land Plateau, centred 10 km south of Deaf Adder Gorge, in the northwest sector of the Gilruth Sheet area (Map Plate 12). The depression is an undulating wooded basin drained by the main tributary of Deaf Adder Creek. The tributary flows north through a narrow gorge for 8 km from the northwest end of the inlier before joining the west-flowing Deaf Adder Creek in the uppermost reaches of Deaf Adder Gorge.

The inlier is bounded by a cliff of Kombolgie Formation sandstone (Ehk_1). The northeast margin of the inlier is a curvilinear concave cliff face between 40 and 60 m high, and the southwest margin is a straight fault-controlled feature with associated quartz veining, brecciation, and drag folding of the Kombolgie Formation (dips to 50°), in places as high as 140 m.

The floor of the inlier is largely covered by Quaternary and Cainozoic sand and alluvium. Low sub-parallel rubbly rises and rocky ridges trend northeast along the floor of the inlier, and are more pronounced against the northeast cliff face. The rises and the flanks of the ridges are mostly composed of low, scattered exposures of phyllite and ferruginous metasiltstone with foliations dipping consistently northeast of between 60 and 90°. The ridge crests are formed by elongate exposures of dark grey to dark green slightly metamorphosed ophitic, porphyritic and granophyric dolerite forming sill-like bodies oriented parallel to the foliation of the enclosing pelitic rocks which are metamorphosed to massive green hornfels adjacent to the dolerite. Several prominent near-vertical narrow quartz-breccia ridges trending parallel to the pelitic rocks and the dolerites are exposed throughout the inlier. Many faults, generally weathered out to form deep narrow gorges in the sandstone surrounding the inlier, cut the pelitic rocks and dolerites, but displace them very little.

The pelitic rocks are believed to belong to the South Alligator Group; the apparent homogeneity of the rocks suggests that they are correlatives of the Fisher Creek Siltstone. The nearest verified exposures of Fisher Creek Siltstone are below the Kombolgie Formation at the mouth of Deaf Adder Gorge, 30 km to the northwest, and are similar lithologically and in metamorphic grade to the pelites in the Gilruth Inlier.

The dolerites are sill-like metamorphosed differentiated bodies texturally similar to the Oenpelli Dolerite. However, the fact that they are metamorphosed to about lower greenschist facies (the igneous texture of the rocks is partly obscured, but there are no apparent mineralogical changes) along with the enclosing pelites, and that they appear to have been intruded as sills, indicates that they belong to the Zamu Complex. The metamorphic grade of the Zamu Complex drops southwards from amphibolite facies in the Cahill Sheet area (Needham & Smart, 1972; Needham & others, 1975a) to unmetamorphosed differentiated dolerite in the Stow Sheet area (Bryan, 1962).

The Kombolgie Formation sandstone dips radially away from the inlier, at about 3 to 5°, and the dips become gradually steeper near the margins of the inlier. These dips are probably depositional, and suggest that the Lower Proterozoic rocks exposed within the inlier formed a basement ridge during early Carpentarian sedimentation.

Three low-order radiometric anomalies were detected by an airborne survey flown by Hunting Geology and Geophysics Ltd for Queensland Mines Ltd in 1970. The anomalies are essentially due to thorium, and were not followed up other than as part of a mapping programme of the inlier by the exploration company in 1971. Total-count values measured by hand-held scintillometer over the rocks of the inlier are 26-60 cps for the siltstone, 10 cps for the dolerite, and 25 cps for the quartz breccia reefs.

FIVE SISTERS INLIER

Pre-Carpentarian rocks are exposed in an oval-shaped area measuring about 4.5 by 3 km in the Arnhem Land Plateau 11 km east of Jim Jim Falls in the southeast sector of the Jim Jim Sheet area (Map Plate 15). The area is mostly on a level with the surrounding Kombolgie Formation sandstone; however, the sandstone in places forms low cliffs up to 10 m high rising above the older rocks. Much of the area is covered by Cainozoic quartz and laterite rubble and sand, and Recent alluvium is extensive along the course of Jim Jim Creek, which crosses the inlier. Exposures of the pre-Carpentarian rocks are limited to low strike ridges along the crests of low rubbly rises, mostly in the central east part of the inlier.

The pre-Carpentarian rocks are exposed as weathered ferruginous fissile shale and slate, phyllite, quartz-chlorite schist with augen-shaped knots, and fine-grained micaceous schistose sandstone. Fresh pale to medium-grey carbonaceous shale and slate are exposed in shallow costeans in the southeast corner of the inlier. The structure within these rocks is unclear owing to the scarcity of exposure. The foliation of the rocks exposed in the shallow costeans strikes northwest, and dips about vertically. Elsewhere the rocks along the crests of the rubbly rises strike predominantly 015° and 080°, but dips range widely. The only fault of significance is the southeast extension of the Jim Jim Fault, which transects the extreme western end of the inlier and probably has a relative displacement of less than 100 m.

The Kombolgie Formation dips radially away from the inlier (Plate 26). At the margin of the inlier dips of up to 20° have been measured although dips flatten rapidly to less than 5° within 200 m from the inlier. Basal beds are cross-bedded coarse to granule quartz sandstone with a clay matrix, containing quartz pebbles and cobbles, and less plentiful fragments of clayey quartz sandstone and phyllitic siltstone. The basal beds grade up into medium to coarse quartz sandstone with or without a clay matrix.

Five Sisters prospect

Two shallow trenches were dug by Pechiney (Australia) Ltd in a small area of moderately intense radioactivity in the southeast corner of the inlier. Count rate in the grey phyllite is 300 cps at the surface, and up to 450 cps in the trenches (Plate 27). Uranium content is about 40 ppm (Needham & others, 1973).

SOUTHERN PART OF JIM JIM SHEET AREA

Pre-Carpentarian units crop out in places in the extreme south of the Jim Jim Sheet area (Map Plates 14 and 15). Edith River Volcanics crop out at the foot of the Kombolgie Formation cliffs in the extreme southwest of the Sheet area; farther east Fisher Creek Siltstone, Oenpelli Dolerite, Edith River Volcanics, and Zamu Complex crop out within a long sinuous inlier formed by erosion along a basement ridge of Oenpelli Dolerite along the upper reaches of Koolpin Creek; farther east again Jim Jim Granite, Fisher Creek Siltstone, and Zamu Complex crop out between the headwaters of Jim Jim Creek and Fisher Creek, between numerous low mesas of Kombolgie Formation sandstone. There are very small exposures of Coirwong Greywacke and Koolpin Formation in the extreme southwest corner of the Jim Jim Sheet area. These formations will be described in subsequent progress reports describing areas to the west and south.

Edith River Volcanics (Bhe)

The Kombolgie Formation is underlain by an apparently conformable sequence of dark purple spotted agglomerate and tuff, purple to red-brown tuffaceous siltstone, welded tuff, and rhyolite. The agglomerate and tuff are rhyodacitic, and contain ellipsoidal fragments up to 1 cm long of fine-grained (about 1 mm across) plagioclase laths with interstitial quartz and muscovite, within a flow-banded very fine-grained matrix of hematite and other opaques, quartz, and feldspar. The tuff and tuffaceous siltstone are generally very finely laminated and colour-banded in red-brown shades. Graded bedding is common, with the beds ranging in thickness from 2 mm to 1 cm. The tuff and tuffaceous siltstone are very fragmentary, have granular textures, contain elongate splinters of quartz, and are usually strongly hematitised. The rhyolite is mostly porphyritic, with subhedral to euhedral quartz phenocrysts averaging 3 mm across and down to 1 mm across. The groundmass is allotriomorphic and contains fine granular alkali feldspar and quartz, and the feldspar also forms rims around the quartz phenocrysts. Clots of radiating muscovite and euhedral quartz in the groundmass are possibly vesicle fillings. There are scattered fine-grained opaques, and in places the rock is strongly hematitised. These rocks were included in the Pul Pul Rhyolite Member of the Edith River Volcanics by earlier workers (BMR undated); in places, the volcanic rocks are underlain by conglomeratic sandstone which was described as part of the Coronation Member of the Edith River Volcanics.

Fisher Creek Siltstone (Blf)

Siltstone unconformably underlies the Kombolgie Formation, but its contact with the Edith River Volcanics is not clearly evident. It is red hematitic siltstone grading to grey slate and phyllitic slate which is moderately to strongly cleaved and in places displays chevron to almost isoclinal folding. The cleavage or metamorphic foliation dips steeply to the northeast.

Zamu Complex (Bdi)

Dolerite of the Zamu Complex forms low rounded ridges away from the escarpment and higher basement ridges adjacent to the Kombolgie Formation, although these ridges are generally less prominent that those formed by the Oenpelli Dolerite. The Zamu Complex dolerite strikes northwesterly and forms almost, if not exactly, conformable intrusions within the Fisher Creek Siltstone, which is hornfelsed near the contact. Unlike the Zamu Complex dolerites farther north in the Jim Jim Creek area, these are unmetamorphosed, and are petrographically indistinguishable from similar rock types in the Oenpelli Dolerite (Ferguson & Needham, 1978).

The dominant phase is quartz dolerite. Plagioclase laths up to 2 mm long are mostly euhedral, and are commonly interlocked with interstitial anhedral quartz. Pyroxene is largely replaced by ophitic or prismatic greenish-brown amphibole up to 1 cm grain size, and pale green to colourless amphibole may be present as large euhedral to subhedral ragged prisms. The mesostasis contains anhedral to euhedral quartz, and alkali feldspar, which in places are graphically intergrown, and also minor amphibole and opaques. Sericite commonly replaces plagioclase, and quartz veining is common in places. Variations of this phase of the Zamu Complex include fine-grained, hematitised and chlorite-bearing types.

The other phase present is granophyre, which contains euhedral plagioclase laths and ragged prisms of greenish brown amphibole, both about 1 cm long. The mesostasis comprises about 50 per cent of the rock, and consists of graphic intergrowths of alkali feldspar and quartz, minor apatite and epidote and fine-grained fibrous green amphibole, and trace amounts of biotite. Opaques occur as skeletal grains following amphibole cleavage.

Jim Jim Granite (Bgj)

Both porphyritic and coarse-grained varieties are present. The porphyritic phase has anhedral quartz phenocrysts and orthoclase and microcline phenocrysts in a groundmass of anhedral quartz, alkali feldspar, plagioclase, and green-brown biotite. The feldspars show minor to moderate alteration to sericite. The coarse-grained phase contains polygonal alkali feldspar (possibly microcline), and orthoclase, anhedral quartz, biotite, and minor muscovite. Alteration is weak, and confined largely to sericitisation of alkali feldspar. Alteration in these granites is markedly weaker than in the Tin Camp Granite of the Caramal East and Beatrice Inliers, with which the Jim Jim Granite is probably genetically affiliated. Like the northern exposed part of the Jim Jim Granite, the southern part is significantly radioactive, ranging from 80 to more than 200 cps in places. Whereas the Tin Camp Granite is characterised by numerous north-trending quartz-breccia zones, they are seen only in places in the northern part of the Jim Jim Granite, and are absent in the southern part. Minor pink and cream fine-grained aplite dykes occur within the Jim Jim Granite and in places cut dolerite of the Zamu Complex (Plate 28). In places the granite has a slabby layered appearance which does not coincide with any mineralogical banding, and is therefore interpreted as jointing parallel to the roof of the pluton (Plate 29). Jointing in the southern part of the Jim Jim Granite is in many directions but predominantly along 095°, parallel to the major joint and fault directions in the overlying Kombolgie Formation sandstone in the southern part of the Jim Jim Sheet area.

Oenpelli Dolerite (Bdo)

The Oenpelli Dolerite forms basement ridges to the Kombolgie Formation which are never seen to be overlain by Edith River Volcanics, suggesting that the volcanics were valley-fill accumulations pinching out against the dolerite ridges. All the phases described by Stuart-Smith and

Ferguson (1978) are present, with coarse-grained to ophitic olivine dolerite being the dominant rock type. The outcrops in the southern part of the Jim Jim Sheet area appear to be connected at depth, and dip to the east forming the western limb of a large shallowly dipping basinal (lopolith-like) transgressive intrusion.

WESTERN BLOCK

Nanambu Complex (Ax)

The Nanambu Complex is not exposed in the Field Island or Kapalga 1:100 000 Sheet areas, but aeromagnetic patterns indicate that it probably extends beneath Cainozoic overburden between the Arnhem Highway and Munmarlary Homestead on the eastern side of the South Alligator River.

Where the complex crops out in the adjacent East Alligator and Cahill 1:100 000 Sheet areas,it consists of a group of igneous and metamorphic rock types distinguished from the surrounding metamorphic rocks by its predominant leucocratic character and its featureless magnetic response (Needham & others, 1974). A comprehensive description of the constituent rock types in these two Sheet areas is given by Needham & Smart (1972). Page & others (1979) postulated a broad three-fold division based on geochronological data obtained from these rock types:

1. Unmetamorphosed remnants of a crystalline Archaean core; mainly massive, undeformed gneiss, and granitoid rocks.

2. Metamorphosed and stressed, mostly strongly foliated, Archaean crystalline material and deformed gneisses which have had an 1800 m.y. age imprinted upon them.

3. Metamorphosed Lower Proterozoic rock types such as coarse leucogneiss, amphibolite, schist, and quartzite.

Foliated granite of the Nanambu Complex was intersected in a drillhole 500 m west of South Alligator River on the Arnhem Highway (Stuart-Smith, 1977). Similar granite crops out about 1500 m east of the drillhole in the Cahill 1:100 000 Sheet area, and was also intersected in drilling by the Department of Housing and Construction, Darwin, for bridge foundations over the South Alligator River. Rb-Sr isotopic results on the outcrop yielded a total-rock isochron age of 2520 ± 30 m.y. (Page, 1976).

73

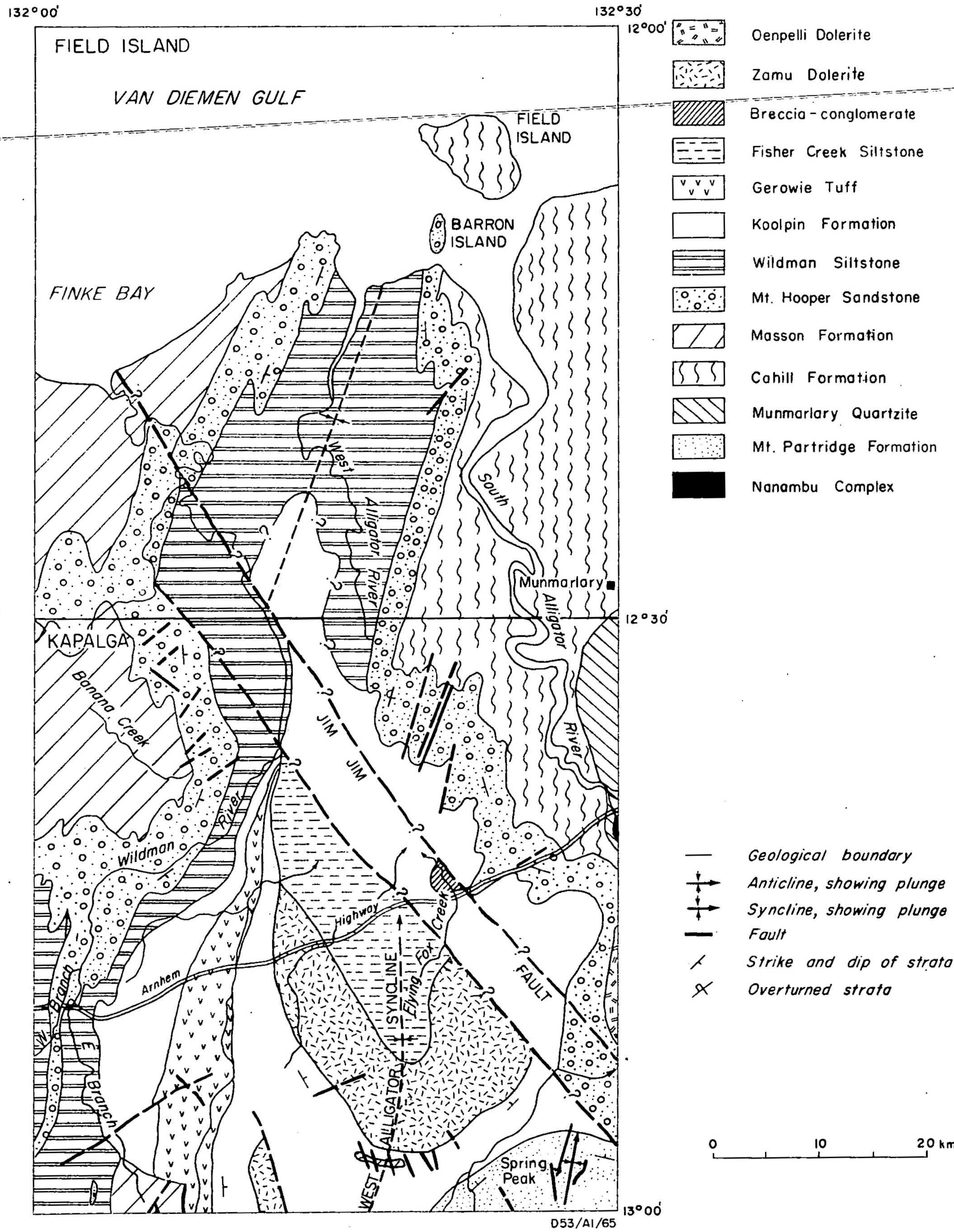


Fig 10 Generalised and interpretative geology of the Field Island and Kapalga 1:100 000 Sheet areas (Western Block).

The foliated granite consists of quartz, microcline, plagioclase, biotite, muscovite, and minor opaques. Microcline occurs as porphyroblasts up to 3 cm long, and also in the groundmass with granoblastic plagioclase, quartz, biotite, and muscovite. Commonly the feldspars are sericitised. A vertical foliation is defined by parallel alignment of the microcline porphyroblasts and micas in the groundmass.

Mount Partridge Formation (Blp_2, Blp_3, Blp_4)

The Mount Partridge Formation (Blp) is a thick sequence of psammitic and pelitic rocks which forms the nose of a broad north-plunging anticline in the extreme southeast of the Kapalga 1:100 000 Sheet area, near Spring Peak. The formation is best exposed farther south in the Mundogie and Jim Jim 1:100 000 Sheet areas, where it forms the Mount Partridge Range, and reaches a maximum thickness of 6000 m.

Needham & others (1975a) recognised four subunits.

(top) Blp_4 feldspathic sandstone, arkose, and quartzite

Blp_3 phyllite and minor feldspathic sandstone, quartzite, and schist

Blp_2 coarse conglomerate, feldspathic sandstone, arkose, and minor slate

Blp_1 siltstone, and minor arkose, slate, phyllite, sandstone, and greywacke.

Blp_1 (the lowermost subunit) is not present in the Kapalga and and Field Island 1:100 000 Sheet areas.

Blp_2 is a sequence of coarse conglomerate and feldspathic sandstone which forms Spring Peak and the western flank of the Mount Partridge Range. The conglomerate consists of large milky quartz pebbles and boulders in a clayey or medium-grained sandstone matrix.

Above Blp_2 is a sequence of phyllite and minor arkose and quartzite (Blp_3). In some places phyllite and schist are thought to result from dynamic metamorphism of siltstone in local shear zones.

The uppermost unit of the Mount Partridge Formation (Blp_4) is a sequence of fine to medium feldspathic sandstone, arkose, and quartzite. In places the feldspars are several centimetres long, suggesting rapid deposition and lack of sorting.

Munmarlary Quartzite (Blqm)

Quartzite in the Munmarlary area, described as part of the Nanambu Complex by Needham & Smart (1972), and mapped as 'Mount Basedow Gneiss' on the adjacent Cahill 1:100 000 Sheet area, is formally defined as the Munmarlary Quartzite in this Record, and is considered a correlative of the Mount Basedow Gneiss, Mount Howship Gneiss and Kudjumarndi Quartzite.

The Quartzite, chiefly micaceous or feldspathic, or both, crops out extensively around the western margin of the Nanambu Complex, and forms strike ridges or rubbly rounded hills. Drilling west of Munmarlary Homestead and along the Arnhem Highway (Stuart-Smith, 1977) shows that the Quartzite forms a 200 m-thick sequence overlain to the west by dolomite and mica schist of the Cahill Formation.

The unit contains the following types: quartzite consisting entirely of a granuloblastic quartz mosaic; sheared muscovite quartzite in which the mica flakes are strongly aligned; and feldspathic quartzite in which elongate blebs of feldspar (generally completely sericitised) are orientated parallel to shearing or bedding. Feldspar may constitute as much as 20% of the rock, and is normally interstitial between quartz grains, which are generally strained and fractured, and occur as elongate grains or lensoid lamellae, giving the rock a bedded appearance.

The Munmarlary Quartzite is the oldest Lower Proterozoic sedimentary unit in the area, and is interpreted as forming part of an old transgressive shoreline deposit on the western side of Archaean basement (Nanambu Complex).

Cahill Formation (Blc)

The Cahill Formation does not crop out in the area, but rock types typical of the lower member have been intersected in drillholes by BMR (Stuart-Smith, 1977), N.T. Water Resources Branch (Gildea, 1977) and Esso

Minerals Ltd, on the South Alligator River, and by Geopeko Ltd west of Munmarlary Homestead. Aeromagnetic patterns indicate that the formation is probably continuous under the South Alligator River floodplain from Cooinda (Cahill 1:100 000 Sheet area), where it is terminated by the Jim Jim Fault Zone, to Munmarlary Homestead and possibly to the coast near Field Island.

The drillholes intersected interbedded hematite-quartz-mica schist, carbonate-mica-quartz schist, dolomite, and minor arenite and carbonaceous chlorite schist. Most of the schist and arenite is isoclinally folded, and crenulated, and contains interstitial carbonate which is probably recrystallised cement. Dolomite forms bands 1 to 7 m thick in the schist; these are commonly massive and thinly bedded, and consists of granuloblastic dolomite, minor quartz, and traces of chlorite. Some dolomites near the surface are partly or largely silicified to a fine-grained mosaic of granuloblastic quartz.

The schist-dolomite seouence, about 2000 m thick, overlies the Munmarlary Quartzite, and is overlain to the west by the Mount Hooper Sandstone which is correlated with the upper member of the Cahill Formation.

Needham and Stuart-Smith (1976) postulated that the lower member of the Cahill Formation was deposited under shallow, near-shore shelf conditions with considerable admixed terrigenous material. Carbonaceous rocks were deposited in restricted reducing environments in depressions within the generally oxygenated carbonate/terrigenous sediment environment.

Masson Formation (Blm)

The Masson Formation as described by Walpole & others (1968) consists of a 3000 m thick sequence of quartz greywacke, siltstone, conglomerate, quartz sandstone, pyritic and carbonaceous siltstone, and dolomitic sediments. The formation was believed to be a transitional facies between the underlying Mount Partridge Formation and the overlying Golden Dyke Formation. Recent mapping in the Kapalga Sheet area (this report) and the adjoining Mundogie 1:100 000 Sheet area (Stuart-Smith & others, in prep) shows that large areas originally mapped as Masson Formation are Koolpin Formation, Mount Hooper Sandstone, Mundogie Sandstone, and Wildman Siltstone. The remaining Masson Formation consists of siltstone, carbonaceous siltstone, and minor calcareous greywacke, quartz sandstone and dolomite, and may possibly correlate with lower member of the Cahill Formation.

In the southeastern part of the Kapalga 1:100 000 Sheet area interbedded ferruginous siltstone, quartzite, and silicified dolomite crop out in strike ridges. The sequence is continuous with outcrops in the northern part of the Mundogie 1:100 000 Sheet area which comprise the uppermost section of the Masson Formation. The silicified dolomite is massive (Plate 30) and generally indistinguishable from dolomite of the Koolpin Formation except for the presence of interbedded quartzite. Contacts with the surrounding Mount Hooper Sandstone and the Koolpin Formation are not exposed, but are probably unconformable or faulted.

In the Banana Creek area deeply weathered mudstone, shale, siltstone, micaceous sandstone, and carbonaceous phyllite are exposed in creek beds or on the wash slopes adjacent to Cainozoic laterite plains. Carbonaceous dolomitic siltstone and calcilutite have been intersected by B.H.P. Ltd., drilling in the area. The sediments are similar to those in the upper part of the Masson Formation in the southeastern part of the area and are also overlain by the Mount Hooper Sandstone.

Mount Hooper Sandstone (Blh)

The Mount Hooper Sandstone crops out as strike ridges in a belt running from Kapalga Trig to the Van Diemen Gulf between the West and South Alligator Rivers, and on the western bank of the Wildman River. In between the ridges are rubbly rises or a thin veneer of Cainozoic laterite and sand.

The formation contains interbedded quartz sandstone, quartzite, siltstone, metasiltstone, phyllite, slate, and minor pebble conglomerate and feldspathic quartzite. The psammitic sediments form the predominant outcrop, but they probably constitute less than 50 percent of the formation. The sequence reaches a maximum thickness of about 5000 m on the western bank of the South Alligator River, and thins westwards to less than 2500 m near the Arnhem Highway crossing of the Wildman River.

Quartzite, feldspathic quartzite, and quartz sandstone are composed of pebbly medium- to coarse-grained, subangular to subrounded grains of quartz, and minor chert and kaolinised feldspar (Plate 31). The grains are tightly packed in a siliceous and ferruginous cement. Typically the rocks 78

Plate 28: Pink aplite intrudes Zamu Complex metadolerite adjacent to the margin of the Jim Jim Granite. 6 km east of Graveside Gorge(m/2240)

Plate 29: Exposure of horizintally jointed Jim Jim Granite suggesting proximity to roof of pluton. 22km southwest of Five Sisters prospect (m/2224)

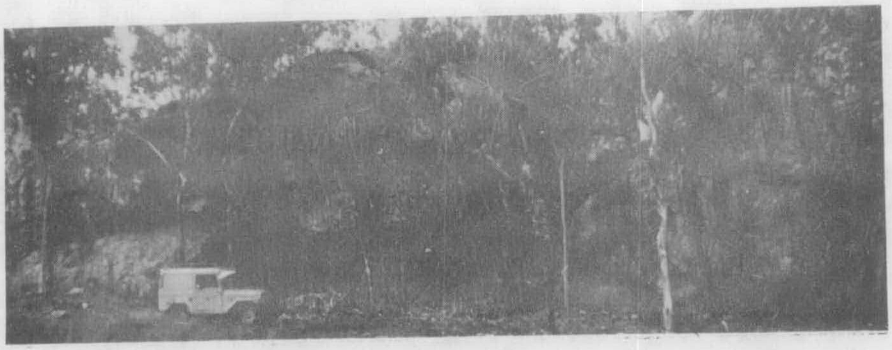


Plate 30: Massive silicified dolomite, Masson Formation, 18 km northwest of Black Jungle Spring (Mundogie 1:100 000 Sheet area) (m/2224)

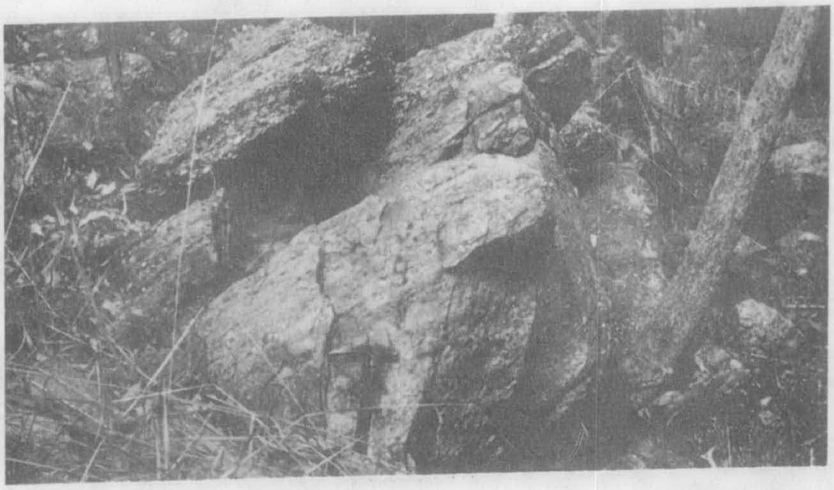


Plate 31: Pebble conglomerate and coarse-grained pebbly quartz sandstone, Mount Hooper Sandstone. (Field Island 1:100 000 sheet area) (m/2224)

Plate 32: Chert pebble conglomerate, Mount Hooper Sandstone. The chert pebbles contain ghost carbonate rhombohedra, and are probably silicified dolomite aerived from the underlying Cahill Formation (Kapalga iron prospect, Kapalga 1:100 000 sheet area)(m/2207).

Plate 33: Silicified dolomite breccia at base of Koolpin Formation, 8 km northwest of Black Jungle Spring (Mundogie 1:100 000 sheet area) (m/2224).

Plate 34: Hematitic siltstone with chert bands, lenses, and nodules, Koolpin Formation, southern part of Kapalga 1:100 000 Sheet area (m/2224).

in the siltstone. The nodules are flattened and commonly elongated by later structural deformation. The long axes of the nodules typically parallel fold axis orientations.

Massive and brecciated dolomite interbedded with hematitic, chert-banded siltstone crops out on the western limb of the West Alligator Syncline, and has been intersected in several drillholes throughout the area (Stuart-Smith, 1977; Gildea, 1977). The dolomite is silified at the surface to a chert or sugary quartzitic rock, and at depth is fine-grained granoblastic dolomite. No algal structures have been observed, but collenia-type algal structures occur farther south in the South Alligator Valley (Walpole & others, 1968). In the southwestern part of the area a prominent ridge of dolomite breccia (Plate 33) consisting of angular blocks of silicified dolomite in a sandy quartz matrix marks the base of the Koolpin Formation. Concentric silicification structures in the blocks are broken indicating that silicification occurred before formation of the breccia. Silicified dolomite of the Masson Formation crops out nearby, and was probably the source of the blocks.

Carbonaceous shale, shale, and phyllite do not crop out in the area, but have been intersected in several drillholes. They consist mainly of sericite and fine-grained muscovite with minor silty quartz grains and trace amounts of tourmaline and feldspar. Carbonaceous matter is commonly present as fine disseminated nongraphitic grains, and may constitute over 50 percent in carbonaceous shale. Graphite is present along some shear and foliated surfaces. The carbonaceous shales are commonly pyritic and contain quartz-carbonate lenses or bands.

Gerowie Tuff (Blva)

The Gerowie Tuff crops out as a low rubble-strewn rise and as a deeply weathered rock in a creek bed in the far southwest of the area. It occurs within the tightly folded basal section of the Koolpin Formation on the western limb of the West Alligator Syncline.

The Tuff is more extensive farther south in the Mundogie 1:100 000 Sheet area, and has been described in some detail by Crick & others (1978) as a sequence less than 750 m thick, and consisting of three types of tuff:

a fine-grained, thinly-bedded, blocky, black siliceous, chert-like variety commonly having a weathered white shell; a coarser-grained more feldspathic tuff which has a dull green-white spotted appearance; and a coarse-grained, greyish green, lithic tuff. All three types occur in the Kapalga 1:100 000 Sheet area.

Fisher Creek Siltstone (Elf)

Rock types typical of the Fisher Creek Siltstone do not crop out in the area, but have been intersected in several holes drilled by BMR (Stuart-Smith, 1977) and Pancontinental Mining Ltd (1976), which intersected a deeply weathered, shallowly dipping sequence of interbedded feldspathic litharenite, shale, silty shale, and siltstone beneath thick Cainozoic deposits in the central part of the Kapalga 1:100 000 Sheet area.

The feldspathic litharenite (nomenclature after Crook, 1960) is a fine to coarse, massive, pink to grey sandstone consisting of poorly sorted, subangular fragments of quartz, feldspar, metamorphic rock and shale clasts (up to 2 cm) in a matrix of finer-grained quartz and feldspar. The arenite is highly indurated, and apart from hair-like quartz veins and a weakly developed cleavage, shows little sign of metamorphic alteration or tectonic deformation. Most of the matrix feldspars (alkali feldspar, sodic plagioclase) and some of the larger grains are altered to fine-grained muscovite which forms an incipient foliation parallel to bedding. Minor amounts of fine-grained chlorite and granular epidote and clinozoisite are scattered through the matrix. Most of the feldspars and rock fragments are clearly of metamorphic origin: deformed twins, polygonal growths, irregular deformational lamellae, and idiomorphic textures in the rock and mineral fragments contrast with undeformed shale clasts. Fragments of mica schist, granophyre, and devitrified rhyolite have also been identified.

The litharenite contains interbeds up to 20 m thick of thinly laminated grey, brown and green, silty shale, and siltstone which in places contain rounded fine grains of quartz and minor feldspar in a matrix of sericite, chlorite, and fine-grained muscovite.

The distribution, attitude, and low degree of metamorphism of the sediments indicates that they unconformably overlie the Koolpin Formation in the central part of the West Alligator Syncline. The composition of the sediments and their relationship to the Koolpin Formation indicates they may be correlatives of the Fisher Creek Siltstone. Volcanic rock fragments have not previously been identified in the Fisher Creek Siltstone, but have been identified in the Burrell Creek Formation (Crick, 1978) which is considered a facies equivalent to the Fisher Creek Siltstone. The high proportion of feldspar and metamorphic rock fragments may reflect a nearby source for most of the sediments - possibly Archaean granite and metasediments of the Nanambu Complex. The source of the volcanic material is probably outside the present outcrop area of the Pine Creek Geosyncline, as the only known felsic volcanics in the Geosyncline are Carpentarian Edith River Volcanics which unconformably overlie the Fisher Creek Siltstone. A distal felsic volcanic source is also postulated for the Gerowie Tuff which is interbedded with the Koolpin Formation in the South Alligator Valley.

Breccia-conglomerate (Bly)

An isolated small hill of breccia-conglomerate, unique to the area, and composed of angular fragments of phyllite up to 10 cm across in a ferruginous coarse sandstone matrix, occurs 1 km north of the Arnhem Highway 2.5 km west of Flying Fox Creek. The outcrop forms an east-west crescent-shaped rubbly rise, and appears to dip steeply to the north. Although the breccia lies within the Jim Jim Fault Zone it does not appear to be a fault breccia, as it shows no sign of mylonitisation or slickensides, and the orientation of the outcrop does not relate to photo-lineament patterns or known faults. Its age is obscure; the similarity between the fragments and the phyllite intersected in BMR drill-holes Kapalga 3 and 4, about 4 km to the southeast, suggest that it is derived from reworking of Lower Proterozoic phyllite and sandstone, and hence is the youngest consolidated rock in the Kapalga Sheet area.

Zamu Complex (Bdi)

Basic igneous rocks of the Zamu Complex crop out in the southern part of the Kapalga 1:100 000 Sheet area; these rocks were named by Walpole & others (1968). The dolerite forms three major sills, up to 4 km thick and 30 km long, intruding the Koolpin Formation in the hinge area of the West Alligator Syncline. The intrusions form the northernmost extent of a belt of dolerite intrusions less than 12 km wide running parallel to the regional strike of the enclosing Koolpin Formation, Fisher Creek Siltstone, and Gerowie Tuff in the Mundogie 1:100 000 Sheet area. Two small outcrops of dolerite also occur in the Masson Formation near Banana Creek and in the Mount Hooper Sandstone near the Kapalga iron prospect.

Contacts of the dolerite are not exposed in the area, but farther to the south, in the Zamu Creek area, low-grade hornfels of Fisher Creek Siltstone forms elongate ridges parallel to the margin of the intrusion.

The basic igneous rocks have been described by Bryan (1962) as dolerite and minor felsic differentiates, and are attributed to one phase of tholeiitic magmatism. The conformity of the intrusions to the enclosing sediments and their low-grade alteration indicates that they were emplaced before the 1800 m.y. regional deformation and metamorphism.

Cainozoic

Cainozoic deposits form a veneer up to 120 m thick over most of the area. They have been divided into the following units: laterite, Late Tertiary sand, colluvial silt and sand, talus, and Quaternary continental and marine sediments.

Laterite (Czl)

Generally the profiles seen in the area are either detrital or are truncated remnants of the standard laterite profile described by Whitehouse (1940).

Of the laterite types described by Williams (1969) in the Adelaide River/Alligator River area, the following types have been recognized:

Detrital laterite is formed mainly from reworked material cemented by a ferruginous matrix. It generally forms blocks (up to 1 m) and pavements on low hills or breakaways over the Lower Proterozoic rocks.

Pisolitic laterite is the upper part of the standard laterite profile, and consists predominantly of cemented ovoid ironstone pisoliths, between 0.25 and 1 cm in diameter, which are commonly case-hardened or varnished. It occurs as blocks or pavements, mostly exposed in the stable regime at the margins of the depositional environment of the Estuarine Plans and Tidal Flats

86

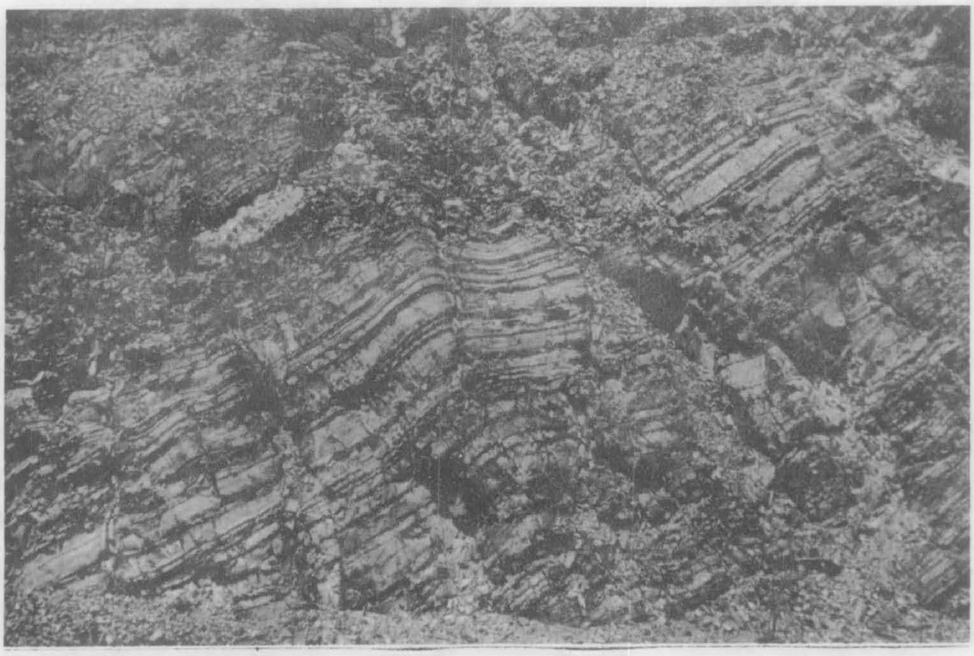


Plate 35: Laminated silty shale, Wildman Siltstone, Arnhem Highway road cutting between the Wildman River East and West Branches (m/2224)

Plate 36: Pisolitic laterite, Field Island (m/2224)

(Plate 36). Isolated detrital deposits of pisolitic laterite occur in places within depositional drainage systems. It can also be detrital.

Mottled-zone laterite is the middle part of the standard laterite profile, and consists of deeply weathered bedrock grading up into a ferruginous zone of generally pisolitic laterite, and down into a pallid zone. It commonly occurs in the bottom of amphitheatres at the head of creeks, and is typically surrounded by a breakaway of pisolitic or detrital laterite.

Concretionary laterite is pedogenetic in origin, and, unlike the varieties already described, is actively forming, rather than being in an erosional or stable environment. It is expressed as ferruginous mottling in poorly drained alluvial soils, or as ironstone nodules in situ in the soil profile.

Late Tertiary sand (Czs)

Coarse unconsolidated quartz sand forms the remnants of the Koolpinyah Surface (Hays, in Walpole & others, 1968) which covers much of the area; in places it is dissected. Where the sand has been almost completely removed, structures within the underlying weathered rocks are apparent on aerial photographs.

The Late Tertiary sand is probably a fan deposit (Story & others, 1969) derived from Mesozoic sand, silt, and claystone, Kombolgie Formation sandstone, and Lower Proterozoic rocks.

At the margins of the Estuarine Plains and the Tidal Flats, erosion and redeposition of Czs have produced a narrow but distinctive photogeological unit (Cza) which is characterised by a relatively steep slope of 5°; winnowing of the sand by erosion has resulted in the development of a sandy veneer on the slope. Because they are a direct product of erosion of unconsolidated sand, and not part of the open drainage system, the clay and silt deposits found in isolated 'swallow holes' developed on the Koolpinyah Surface are also included in the Cza unit; their formation has probably been continuous since the Early Tertiary.

Talus material and rubble (Czt)

Scree slopes and rubble plains are commonly developed adjacent to ridges of Koolpin Formation siltstone in the southern part of the area.

Quaternary continental deposits

Deposition in a continental environment during the Quaternary is represented by a variety of alluvial types.

Alluvial silt, sand, and clay (Qa) occur in the courses and flood plains of active rivers. Large bodies of unconsolidated quartz sand (Qs) within the channels of major creeks and rivers, and outwash deposits (Qs) over the adjacent flood plains, consist mostly of material derived from the Kombolgie Formation or Late Tertiary sand, and were mostly deposited during floods. The sediments of abandoned river courses (Qas) consist mostly of silt and mud. The oxbow lakes developed before the late Pleistocene to Recent emergence are shallow depressions in the surface of the flood plain, into which the present drainage system is incised. Silty levee deposits (Qal) are developed along the courses of some of the larger rivers. Black humic soil and clay (Qf) are commonly developed in poorly drained depressions within drainage systems.

Quaternary marine deposits

During the wet season (November to April) marine conditions strongly influence deposition in the major river courses for a considerable distance inland: brackish water extends 60 km inland in the South Alligator River.

Intertidal mangrove swamps (Qcm) extend along the coastline, and up to 15 km inland in the major river systems. Coastal alluvial deposits (Qca) are comparatively well drained silt and clay with sparse vegetation cover, such as sedge or samphire, and above the poorly drained black soil plains and mud pans (Qcp), which are also developed adjacent to, and within, estuarine channels. Salt pans are developed in areas bordered by Czs which are perenially waterlogged, and support paperbark and waterweed growth.

The coastal sand ridges (Qcr) are generally parallel to and within 2 km of the present coastline, or are adjacent and parallel to the edge of Czs. In the latter situation the strand lines developed at the beginning of coastal progradation during the Pleistocene (Christian & Stewart, 1953). The dunes are commonly composed of shelly sand, and support a woodland of non-eucalypts or semideciduous trees.

Metamorphism

West of the South Alligator River the Lower Proterozoic rocks show little alteration of their original sedimentary texture and mineralogy. Metamorphic changes appear to be only slaty cleavage development in pelitic rocks and minor crystallisation of sericite, epidote, chlorite and clinozoisite.

East of the South Alligator River the metamorphic grade is amphibolite facies. Drilling by BMR along the Arnhem Highway (Stuart-Smith, 1977) showed that the change in metamorphic grade across the South Alligator River floodplain is gradational over about 10 km. The change is indicated in pelitic rocks of the Koolpin and Cahill Formations by an increase eastwards in grainsize and in the proportion of muscovite to sericite, small xenoblastic porphyroblasts of dark yellow biotite (possible stilpnomelane) in phyllite from RDSH KA 6, the appearance of chlorite and biotite east of Kapalga Trig, and the presence of magnetite, garnet, and andalusite in mica schist intersected in RDSH KA 18.

The metamorphic grade changes along a north-south zone about 10 km wide running parallel to the South Alligator River and coinciding with a wide gravity lineament which can be traced into South Australia. This would suggest that the zone is a fundamental basement structure that may locally have influenced Lower Proterozoic sedimentation patterns.

Structure

The structure of the region is dominated by the West Alligator Syncline, a north-south elongate basin of Koolpin Formation and Fisher Creek Siltstone bordered by the prominent sandstone ridges of the Mount Hooper Sandstone in the north and the Mount Partridge Formation in the south. The syncline was probably an original sedimentary structure as indicated by sedimentary onlapping of the Koolpin Formation, accentuated by a major deformation probably coinciding with the 1800 m.y. metamorphic event. This deformation affected all the Lower Proterozoic sediments, and is characterised by tight to isoclinal folding about north-south axes as a result of east-west compression. Fold axes in the northern and eastern parts of the area plunge southwest, reflecting the original dip of the sediments away from the Archaean basement. Although a major unconformity separates the Koolpin Formation from underlying units, there appears to have been only gentle folding of the older units prior to deposition of the Koolpin Formation. Faults, minor associated drag folds, and joints developed during the major folding episode, and continued to be active until at least the Tertiary (Stuart-Smith, 1977).

The folding history is best observed in outcrops of the Mount Hooper Sandstone. The folds are typically rounded, tight to isoclinal, and composite, showing both concentric and similar behaviour, reflecting the differing competencies of sandstone and siltstone. Between the West and South Alligator Rivers the beds are locally overturned and dextrally sheared in an en echelon pattern along NNE axial-plane orientations. This was probably a result of interaction of the adjacent Nanambu Complex, which would have behaved essentially as a rigid body during deformation, and the beds which are orientated obliquely (i.e. NW) to the principal E-W stress.

The southern part of the West Alligator Syncline is marked by broad arcuate siltstone ridges of the Koolpin Formation. Towards the hinge area of the syncline and at the base of the Formation tight secondary folds have developed in the siltstone owing to the relatively plastic behaviour of the non-outcropping intervening shale units.

Small rounded to tight folds observed in siltstone of the Koolpin Formation appear to be drag folds associated with minor NW faulting (Fig. 11a).

Fault orientations show three distinct concentrations; 340°-350°, 50-60°, and 10°-20° (Fig. 11b) which correspond to three of the four major joint trends. Faults with 10-20° strike were most probably contemporaneous with the major period of folding, as they form in axial plane orientations, and are commonly strike-slip faults. Faulting in the other two orientations is post-folding and probably the result of deeper crustal movements which have affected the whole Geosyncline. Several of the north-west-trending faults transect the southern half of the Kapalga 1:100 000 Sheet area, and include the Jim Jim Fault, which displaces carbonaceous schist of the Koolpin Formation below the Cainozoic cover. Other parallel faults between

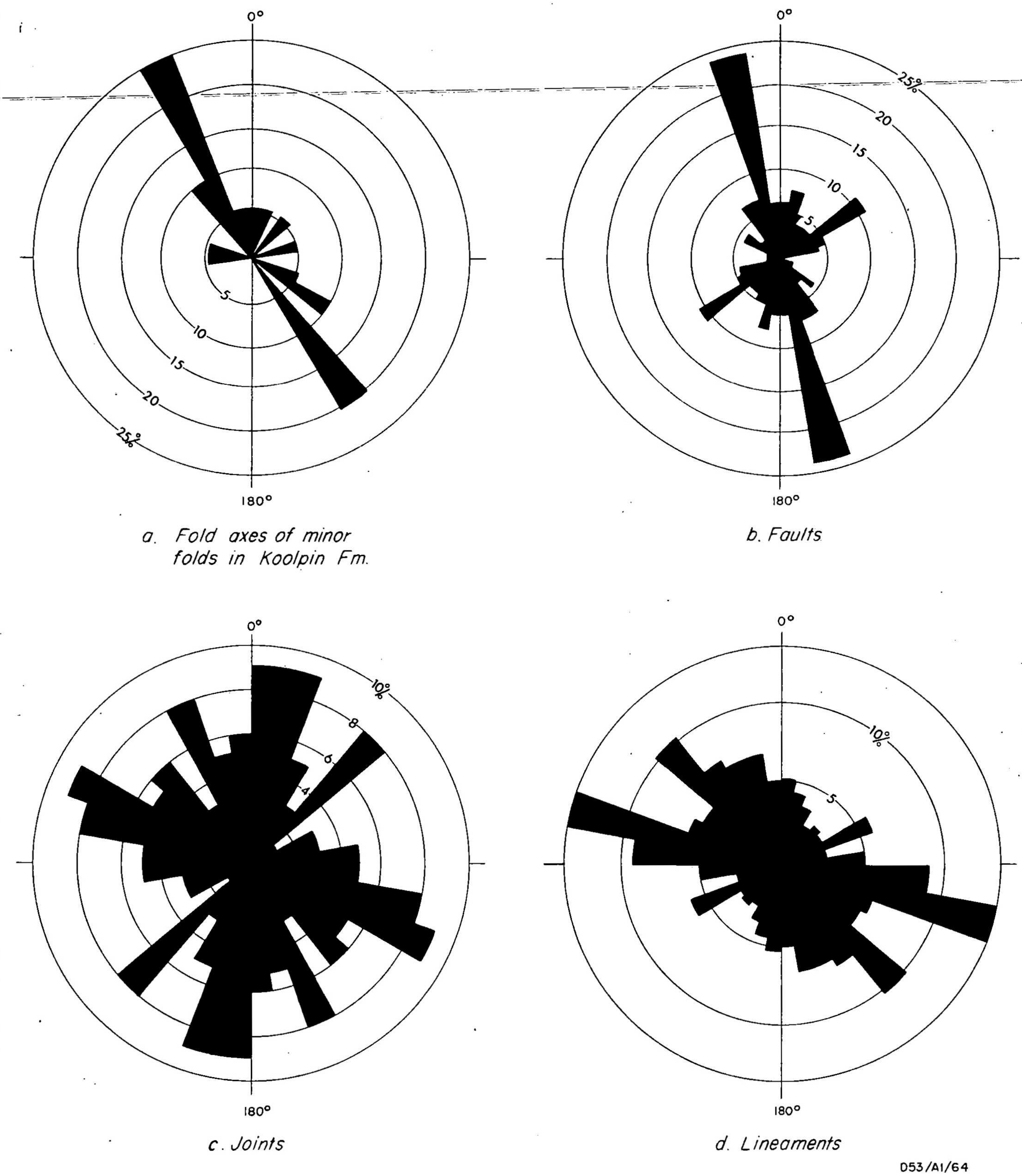


Fig 11 Azimuth distribution of structural features in the Western Block

the Wildman and West Alligator Rivers displace outcrops of the Koolpin Formation and the Zamu Complex. A major northeast-trending fault is interpreted as extending from Kapalga Trig, southwest through the Kapalga Sheet area, and linking up with the 'Grove Hill Crossflexure' of Walpole & others (1968, p. 152).

Joints in the Lower Proterozoic sediments and the Zamu Dolerite show a wide scatter (Fig. 11c) and four dominant orientations (280°-300°, 330°-340°, 0°-20° and 40° to 60°) which probably relate to both folding and faulting.

Lineaments are well developed throughout the area particularly in areas of little or no Cainozoic cover such as the Banana Creek area. Lineaments are concentrated in the NW field with 280° to 390° and 310° to 320° as dominant trends and a minor northeast trend (60-70°) (Fig. 11d). The trends parallel three major joint and two fault orientations. The 0-20° concentration noted in joints and faults is not particularly noticeable in the total lineament diagram but is a prominent orientation in the northern part of the area.

Economic Geology

Uranium

Airborne radiometric surveys since 1970 have located numerous uranium prospects in the area. The uranium anomalies are associated with sediments of the Cahill, Koolpin, and Masson Formations and thorium anomalies with sandstone and conglomerate of the Mount Hooper Sandstone. Work on the uranium prospects has included detailed follow-up ground geophysical and geological surveys and some auger and stratigraphic rotary drilling. The results of some of these surveys are to be found in open file reports held by the Northern Territory Mines Branch, Darwin.

No significant uranium mineralisation has been found, but the area remains prospective, particularly the Cahill and Koolpin Formations which are host to uranium mineralisation in the Alligator Rivers and South Alligator Uranium Fields, respectively. Similarly, the Masson Formation on the basis of its correlation with the lower member of the Cahill Formation is prospective for uranium.

Exploration in the area is hampered by extensive Cainozoic deposits, over 100 m thick in places, which cover much of the prospective formations.

Iron

A distinctive occurrence of ferruginous material in siltstone of the Mount Hooper Sandstone known as the Kapalga iron prospect has been recorded between the South Alligator and West Alligator Rivers about 20 km north of the Arnhem Highway (Dunn, 1957). An account of the occurrence is provided by Crohn in Walpole & others (1968) who described is as: '... a steeply dipping lens of ferruginous material ... estimated to have a maximum width of about 100 feet and a possible strike length of 5000 feet; two samples of the richest exposed material assayed 47.9 and 51.8 percent Fe_2O_3 and 7.3 and 22.6 percent TiO_2. The iron and titanium minerals are thought to be detrital in origin and to comprise hematite and ilmenite and/or rutile. The occurrence does not appear to be of economic importance as a source of iron ore, but the titanium content may warrant further investigation.'

Tin

Crohn in Walpole & others (1968) reported a number of small tin-bearing quartz reefs in sandstone of the Mount Partridge Formation about 3 km southeast of Spring Peak, and that: 'consteaning and diamond drilling of the prospect did not locate occurrences of economic importance.'

Water

Surface water as billabongs and waterholes in seasonal rivers and creeks, and in springs, provides the major source of fresh water in the area. Several bore holes are located in the Kapalga area which has been the subject of a recent groundwater source investigation for the Alligator Rivers regional township site by the Water Resources Branch of the Department of the Northern Territory (Gildea, 1977). The survey showed that carbonate rocks of the Koolpin and Cahill Formations provide high permeability aquifers of "good quality bi-carbonate rich water" with some saline intrusion close to the South Alligator River. The geological interpretation in the report is in error, however, and the recommended location given for the production bores is in Mount Hooper Sandstone, and not in massive carbonate rocks. The best supplies are probably in cavernous carbonate, indicated by the presence of sink holes, between the ridges of Mount Hooper Sandstone and the South Alligator River, in the Cahill Formation, away from areas of saline intrusion.

ACKNOWLEDGEMENTS

The significant contribution to fieldwork made by Phil Smart and Alan Watchman in 1973 is gratefully acknowledged. Many of the petrographic descriptions incorporated in this report were provided by Dr John Ferguson, and have greatly assisted in defining the geology of the Myra Falls, Caramal East, and Beatrice Inliers.

The cooperation afforded by Queensland Mines Ltd, Pechiney (Australia) Exploration Pty Ltd, Geopeko Ltd, Australian Anglo American Ltd, B.H.P. Exploration Pty Ltd, Esso Minerals Ltd, Pancontinental Mining Ltd., and Noranda (Australia) Ltd, during field operations in 1973, 1975, and 1976 is much appreciated.

REFERENCES

BMR undated - Geological map of the South Alligator River valley, scale 1:63 360, Bureau of Mineral Resources Australia.

BRYAN, R., 1962 - Lower Proterozoic basic intrusive rocks of the Katherine-Darwin area. Bureau of Mineral Resources Australia Record 1962/7 (unpubl.).

CHRISTIAN, C.S., & STEWART, G.A., 1953 - General report on survey of Katherine-Darwin region, 1946. Scientific and Industrial Research Organisation, Melbourne, Land Research Series 1.

CROOK, K.A.W., 1960 - Classification of arenites, American Journal of Science, 258, 419-428.

CRICK, I.H., 1978 - Geology of the Batchelor 1:100 000 Sheet area (5171), Northern Territory. Bureau of Mineral Resources, Australia, Record 1978/11 (unpubl.).

CRICK, I.H., STUART-SMITH, P.G., & NEEDHAM, R.S., 1978 - Stratigraphic significance of a discovery of Lower Proterozoic tuff in the Pine Creek Geosyncline. BMR Journal of Australian Geology and Geophysics, 3(2), 163-165.

DUNN, P.R., 1957 - Kapalga iron deposit. Bureau of Mineral Resources Australia, Technical file report.

DUNN, P.R., 1962 - Alligator River, N.T. - 1:250 000 Geological Series. Bureau of Mineral Resources, Australia, Explanatory Notes, SD/53-1.

FERGUSON, JOHN, & NEEDHAM, R.S., 1978 - The Zamu Dolerite - a Lower Proterozoic pre-orogenic continental tholeiitic suite from the Northern Territory, Australia, Journal of the Geological Society of Australia, 25(6), 309-322.

GILDEA, J.W.A., 1977 - Alligator Rivers regional township groundwater source investigation. Department of the Northern Territory, Water Resources Branch, Darwin, Report.

GRAY, G.J., 1915 - Reconnaissance of Arnhem Land. Bulletin of the Northern Territory of Australia, 14.

96

HORSFALL, K.R., & WILKES, P.G., 1975 - Aeromagnetic and radiometric survey of Cobourg Peninsula, Alligator River and Mount Evelyn (part) 1:250 000 Sheet areas, Northern Territory, 1971-2. Bureau of Mineral Resources, Australia, Record 1973/52 (unpubl.).

HUGHES, R.J., & SENIOR, B.R., 1973 - Progress report on the geology of the Bathurst Island, Melville Island, Cobourg Peninsula and Fog Bay 1:250 000 Sheet areas, Northern Territory. Bureau of Mineral Resources Australia, Record 1973/52 (unpubl.).

MEHNERT, K.R., 1968 - Migmatites and the origin of granitic rocks. Elsevier, Amsterdam

NEEDHAM, R.S., 1978 - Giant-scale hydroplastic deformation structures formed by the loading of basalt on to water-saturated sand, Middle Proterozoic, Northern Territory, Australia. Sedimentology, 25, 285-295.

NEEDHAM, R.S., in prep. - Pine Creek Geosyncline, in Hunter (ed.) Precambrian of the southern continents. Elsevier.

__________, SMART, P.G., & WATCHMAN, A.L., 1974 - A reinterpretation of the geology of the Alligator Rivers Uranium Field, N.T. Search, 5(8), 397-399.

__________________________________, 1975a - Progress report, Alligator River Party, N.T., 1972 (Jim Jim region). Bureau of Mineral Resources, Australia, Record 1975/31 (unpubl.).

__________________________________, 1975b - Progress report, Alligator River Party, N.T., 1972 (Oenpelli region). Bureau of Mineral Resources, Australia, Record 1975/39 (unpubl.).

__________, STUART-SMITH, P.G., 1976 - The Cahill Formation - host to uranium deposits in the Alligator Rivers Uranium Field, Australia. BMR Journal of Australian Geology and Geophysics, 1(4), 321-333.

__________, WILKES, P.G., SMART, P.G., & WATCHMAN, A.L., 1973 - Alligator Rivers region environmental fact-finding study - geological and geophysical reports. Bureau of Mineral Resources, Australia, Record 1973/208 (unpubl.)

PANCONTINENTAL MINING LTD, 1976 - Final report EL's 3, 4, 393, 394, and 395, Kapalga, Northern Territory. Northern Territory Department of Mines and Energy open file report CR77/50.

PAGE, R.W., 1976 - Geochronology of Archaean and Lower Proterozoic rocks in the Rum Jungle-Alligator River area, Northern Territory, Australia. 25th International Geological Congress Abstracts, Sydney V.I., p. 18.

PAGE, R.W., COMPSTON, W., & NEEDHAM, R.S., 1979 - Geochronology and evolution of the late Archaean basement and Proterozoic rocks of the Alligator Rivers Uranium Field, Northern Territory, Australia. International Uranium Symposium on the Pine Creek Geosyncline Sydney June 4-8 (Abstracts).

RATTIGAN, J.H., & CLARKE, A.B., 1955 - The geology of the Katherine-Mount Todd-Lewin Springs 1-mile Sheets, Northern Territory. Bureau of Mineral Resources, Australia, Record 1955/54 (unpubl.).

RIX, P., 1965 - Milingimbi, N.T., - 1:250 000 Geological Series. Bureau of Mineral Resources, Australia Explanatory Notes, SD/53-2.

ROBERTS, H.H., & PLUMB, K.A., 1965 - Mount Marumba, N.T. - 1:250 000 Series, Bureau of Mineral Resources, Australia, Explanatory Notes, SD/53-6.

SHIELDS, J.W., & LAU, G., 1972 - Geology and ground prospecting on Authority to Prospect 2384, Myra Falls area, near Oenpelli, N.T., 1971. Northern Territory Geological Survey Report 296.

SMART, P.G., WILKES, P.G., NEEDHAM, R.S., & WATCHMAN, A.L., 1976 - Geology and geophysics of the Alligator Rivers region in Economic Geology of Australia and Papua New Guinea-1. Metals. Australasian Institute of Mining and Metallurgy, Monograph 5 (ed. C.L. Knight).

STUART-SMITH, P.G., 1977 - Shallow stratigraphic drilling in the Kapalga 1:100 000 Sheet area, Alligator Rivers region N.T., 1974-6. Bureau of Mineral Resources, Australia, Record 1977/53 (unpubl.).

STUART-SMITH, P.G., & FERGUSON, J., 1978 - The Oenpelli Dolerite - A Precambrian continental tholeiitic suite from the Northern Territory. BMR Journal of Australian Geology and Geophysics, 3(2), 125-133.

STUART-SMITH, P.G., ROARTY, M.J., NEEDHAM, R.S., CRICK, I.H., in prep. - Geology of the Mundogie 1:100 000 Sheet area, N.T. Bureau of Mineral Resources, Australia, Record.

STORY, R., WILLIAMS, M.A.J., HOOPER, A.D.L., O'FERRALL, R.E., & McALPINE, J.R., 1969 - Lands of the Adelaide-Alligator area, Northern Territory. Commonwealth Scientific and Industrial Research Organisation, Land Research Series 25.

TAYLOR, S.R., 1964 - Abundance of chemical elements in the continental crust. Geochemica et Cosmochimica Acta, 28, 1280-1281.

WALPOLE, B.P., 1962 - Mount Evelyn, N.T. - 1:250 000 Geological Series. Bureau of Mineral Resources, Australia, Explanatory Notes, SD/53-5.

WALPOLE, B.P., CROHN, P.W., DUNN, P.R., & RANDAL, M.A., 1968 - Geology of the Katherine-Darwin region, Northern Territory. Bureau of Mineral Resources, Australia, Bulletin 82.

WHITEHOUSE, F.W., 1940 - The lateritic soils of Western Queensland. Papers of the Department of Geology, University of Queensland 2, 1

WILKES, P.G., 1975 - Results of radiometric surveys in the Alligator River and Cobourg Peninsula area of the Northern Territory. Proceedings of the Australasian Institute of Mining and Metallurgy, annual conference, Adelaide, 1975.

WILLIAMS, M.A.J., 1969 - Geology of the Adelaide-Alligator area in Lands of the Adelaide-Alligator area, Northern Territory. Commonwealth Scientific and Industrial Research Organisation, Land Research Series 25.

APPENDIX 1

CHANGES IN STRATIGRAPHIC NOMENCLATURE

Definitions of the following units have been published since preparation of earlier progress Records: Oenpelli Dolerite, Tin Camp Granite, Gilruth Volcanic Member. The definition of the Gilruth Volcanic Member appears in the 'Arnhem Land Plateau' section of this report, as it is confined to the area in question. The other units appear in several of the sections of this report, and their definitions are given below.

New names reserved and approved by the Stratigraphic Nomenclature Subcommittee of the Geological Society of Australia for certain units and defined herewith are: Mount Hooper Sandstone (for rocks previously mapped as Mount Partridge Formation in the Kapalga and Field Island Sheet areas); Munmarlary Quartzite (for rocks mapped previously as Mount Partridge Formation adjacent to and on the western side of the Nanambu Complex in the vicinity of Munmarlary Homestead in the Field Island and East Alligator Sheet areas); Wildman Siltstone (for siltstone in the Kapalga Sheet area mapped previously as Masson Formation); Mount Howship Gneiss (for leucocratic meta-arkose mapped previously as part of the undifferentiated Myra Falls Metamorphics); and the Kudjumarndi Quartzite (for quartzite mapped previously as part of the undifferentiated Myra Falls Metamorphics).

DEFINITIONS (approved by Stratigraphic Nomenclature Subcommittee, Territories Division, Geological Society of Australia).

Oenpelli Dolerite

Derivation of name: Oenpelli Mission, 133°04'E, 12°20'S, Alligator River 1:250 000 Sheet area.

Distribution: As arcuate ridges over 30,000 km^2 in the Alligator River, Mount Evelyn, Milingimbi and Cobourg Peninsula 1:250 000 Sheet areas between 132°30' and 134°00'E, and 11°45' and 13°30'S.

Type Locality: Graveside Gorge 132°34'E, 13°18'S. A ridge of differentiated dolerite 150 m high trending northeast along south side of gorge. Differentiates include porphyritic olivine dolerite, and ophitic gabbro with igneous lamination, and granophyric dolerite and syenite.

Lithology: An approximately symmetrically differentiated dolerite sill. Central part is igneously laminated ophitic dolerite commonly displaying locally ophitic gabbro, granophyric dolerite, granophyre, and syenite differentiates as large lens-shaped bodies. Central part grades upwards and downwards with decrease in groundmass grain size to porphyritic olivine dolerite containing phenocrysts of saussuritized pale green plagioclase $<$5 cm. A chilled margin is only rarely apparent at the outer margins of the porphyritic olivine dolerite phases. Gabbro pegmatite is rarely developed adjacent to the upper chilled margin.

Thickness: Range $<$ 250 m. Arcuate ridges probably are exposed rims of roughly ellipsoidal basins which may be part of a large undulating sheet of dolerite or mark individual lopoliths, the latter possibility being supported by a general thickening of the dolerite towards the centres of the basins. There are also occasional narrow (10 cm +) dykes of Oenpelli Dolerite (porphyritic olivine dolerite) with sharp margins.

Relationships: Intrudes Nanambu and Nimbuwah migmatite complexes. Intrudes all Lower Proterozoic sedimentary and metamorphic units. Forms basement highs to, and unconformably overlain by, Carpentarian Kombolgie Formation sandstone. Also intrudes Jim Jim Granite.

Boundary criteria: Generally sharp contacts with country rock, which is usually hornfelsed or extensively altered and retrogressed.

Age and evidence: 1720 m.y. total rock Rb-Sr isochron of 1718 $\pm$ 65 m.y. (Page, Compston, & Needham, 1979).

<u>Synonymy</u>: Walpole & others (1968) interpreted some exposures as either Zamu Complex or Nungbalgarri Volcanic Member - remainder of exposures were unnamed dolerite.

References: name first published: Needham & others, 1974.
name defined: Stuart-Smith & Ferguson, 1978; also Needham & others, 1975a, Needham & others, 1975b, Smart & others, 1976.

Tin Camp Granite

Derivation of name: Tin Camp Creek 133°10'E, 12°25'S, Alligator River 1:250 000 Sheet area.

Distribution: Two areas of outcrop each about 4 km^2 near of the headwaters of Tin Camp Creek. One area of exposure about 20 km^2 centred 15 km ESE of Beatrice prospect. Areas delineated on 1:250 000 special geological map 'Geology of the Alligator River region, Northern Territory'.

Type locality: Extensive pavement exposure on east bank of main southern tributary of Tin Camp Creek, in NE part of Caramal East Inlier, 5 km ENE of Caramal prospect, 133°24'E, 12°29'30"S. Altered massive medium-grained pink biotite granite cut by quartz breccia zones.

Lithology: Pink biotite granite, strongly altered in places to a quartz-clay rock with brown iron oxides. Transected by aplite dykes altered to quartz-sericite-clay rocks, and by approximately north-trending quartz breccias which often form ridges. Radioactive background is generally 10X that of Nimbuwah Complex.

Relationships and boundary criteria: Intrudes Nimbuwah Complex, unconformably overlain by Carpentarian Kombolgie Formation. Contact effects apparently masked by alteration effects. Petrographically similar to, and most probably genetically associated with, the Nabarlek Granite.

Age and evidence: About 1800 m.y. (Page, Compston, & Needham, 1979). Age to be viewed with caution owing to altered nature of material used.

References: First described but not named: Smart & others, 1976; Needham & others, 1973.
Named, not defined: Needham & Stuart-Smith, 1976.

Mount Hooper Sandstone

Derivation of name: Mount Hooper, 132°22'E, 12°18'S, Alligator River 1:250 000 Sheet area.

Distribution: Ridges and rubbly rises in a belt running from Kapalga Trig to the Van Diemen Gulf between the West and South Alligator Rivers and on the western bank of the Wildman River.

Type locality: A 3 km-long section along a well exposed 40 m-high ridge on which the Kapalga iron prospect is located (132°19'E, 12°32'S), and an adjacent breakaway slope beneath Cainozoic laterite running eastward from the ridge.

Lithology: Quartz sandstone, quartzite, siltstone (hematitic and ilmenitic in places) metasiltstone, phyllite, slate; minor pebble conglomerate forms beds up to 2 m thick, and consists mostly of well rounded chert pebbles thought to be silicified carbonate rock. Sedimentary structures including crossbedding and rarely ripple marks are well preserved.

Thickness: Variable from less than 2500 m to 5000 m.

Relationships and boundary criteria: Contacts not exposed. Appears to unconformably overlie the lower member of the Cahill Formation, and is transitionally overlain by the Wildman Siltstone. Also unconformably overlain by the Koolpin Formation. Probably correlates with the Mundogie Sandstone, Coirwong Greywacke, and the upper member of the Cahill Formation.

Age and evidence: Lower Proterozoic, as it forms part of the Lower Proterozoic metasedimentary sequence of the Pine Creek Geosyncline which overlies dated Archaean rocks (Page, Compston, & Needham, 1979), and underlies the Kombolgie Formation which locally is the lowermost unit in the McArthur Basin Carpentarian sequence.

Munmarlary Quartzite

Derivation of name: Munmarlary homestead, 132°30'E, 12°29'S, Alligator River 1:250 000 Sheet area.

Distribution: Scattered outcrop around the western margin of the Nanambu Complex on the eastern flank of the South Alligator River between Cooinda and 5 km north of Munmarlary homestead. Forms strike ridges or rubbly rounded hills.

Type locality: Scattered outcrop over an area about 14 km^2, 4 km southwest of Munmarlary homestead.

Lithology: Quartzite consisting entirely of a granuloblastic quartz mosaic, sheared muscovite quartzite, feldspathic quartzite. Feldspar may constitute as much as 20% of the rock, but is normally interstitial between quartz grains. Quartz grains are generally strained and fractured, and occur as elongate grains or lensoid lamellae which give the rock a bedded appearance.

Thickness: Not known, at least 200 m.

Relationships and boundary criteria: Contacts are not exposed. Appears to unconformably overlie the Nanambu Complex, and underlie the Cahill Formation. Correlates with the Mount Basedow Gneiss, Mount Howship Gneiss and Kudjumarndi Quartzite.

Age and evidence: Lower Proterozoic, as it forms part of the Lower Proterozoic metasedimentary sequence of the Pine Creek Geosyncline which overlies dated Archaean rocks (Page, Compston, & Needham, 1979) and underlies the Kombolgie Formation which is the lowermost unit in the McArthur Basin Carpentarian sequence. It is locally the lowermost Lower Proterozoic unit known.

Wildman Siltstone

Derivation of name: Wildman River, Alligator River 1:250 000 Sheet area.

Distribution: Exposed mainly as extensive rubble plains, low ridges, or in creek beds in the upper catchment area of the Wildman River.

Type locality: Road cutting on the Arnhem Highway between the Wildman River East and West Branches (132°01'E, 12°50'S).

Lithology: Red and white banded siltstone, ferruginous siltstone, minor quartz sandstone and phyllite. Rare graded beds of lithic feldspathic greywacke up to 30 cm thick occur within ferruginous siltstone.

Thickness: Unknown, at least 2000 m.

Relationships and boundary criteria: Overlain unconformably by the Koolpin Formation and conformably overlies, and is transitional with, the Mount Hooper Sandstone and the Mundogie Sandstone. The lower contact is gradational and defined by an increase in and the predominance of pelitic over psammitic units. The contact is well exposed 10.5 km south of Mundogie Hill.

Age and evidence: Lower Proterozoic, as it forms part of the Lower Proterozoic metasedimentary sequence of the Pine Creek Geosyncline which overlies dated Archaean rocks (Page, Compston, & Needham, 1979), and underlies the Kombolgie Formation which locally is the lowermost unit in the McArthur Basin Carpentarian sequence.

Kudjumarndi Quartzite

Derivation of name: Aboriginal site near Myra Falls, 133°20'E, 12°27'S (Christian, 1973).

Distribution: As ridges and small peaks throughout the Oenpelli 1:100 000 Sheet area, and in the extreme north of the Howship 1:100 000 Sheet area; concentrated in the Myra Falls Inlier.

Type locality: Partly dissected dome in the central southern part of the Myra Falls Inlier.

Lithology: Orthoquartzite ranging to muscovite or biotite or hornblende quartzite, to micaceous feldspathic quartz gneiss. Quartz more than 75 per cent. Massive and weakly foliated to well foliated varieties, medium to very coarse-grained. Bedding co-incident with foliation on limbs of folds. Rare cross-bedding preserved. The entire range of lithologies may be interbedded with beds a few centimetres to 5 m thick, although individual beds rarely exceed 2 m.

Thickness: Up to about 150 m.

Relationships and boundary criteria: Underlain apparently conformably by 'Mount Howship Gneiss' and overlain apparently conformably by metamorphic rocks thought to be equivalent to the Cahill Formation. The quartzite forms 'resisters' within the Transitional Zone and Lit-par-lit Gneiss Zone of the Nimbuwah Complex. By correlation with observed stratigraphy in the Cahill and Jim Jim Sheet areas, the upper contact of the quartzite may be an unconformable sedimentary contact which has been obscured by the later conformable metamorphic foliation.

Age and evidence: Lower Proterozoic, as it forms part of the Lower Proterozoic metasedimentary sequence of the Pine Creek Geosyncline which overlies dated Archaean rocks (Page, Compston, & Needham, 1979) and underlies the Kombolgie Formation which locally is the lowermost unit of the McArthur Basin Carpentarian sequence.

<u>Mount Howship Gneiss</u>

Derivation of name: Mount Howship, 133°08'E, 12°32'S, Alligator River 1:250 000 Sheet area.

Distribution: About 7 km^2 in the centre of the Myra Falls Inlier and about 40 km^2 at the eastern end of the Inlier. Forms topographically low inliers surrounded by ridges or cliffs of Kudjumarndi Quartzite.

Type locality: 133°15'30"E, 12°29'10"S. An area about 0.5 km^2 of rolling terrain with numerous low craggy ridges and pavements of gneissic meta-arkose, between a large hill of quartzite to the west, and a ridge of quartzite to the east.

Lithology: Granular quartzo-feldspathic gneiss, quartz 30-75 percent, mica (mostly muscovite) up to 10 percent, microcline the dominant feldspar with lesser plagioclase. Very coarse muscovitic varieties are pegmatoid in appearance; generally massive, foliated types less common.

Thickness: Not known. At least 1 km.

Relationships and boundary criteria: Lower contact not seen. Apparently conformably overlain by Kudjumarndi Quartzite.

Age and evidence: Lower Proterozoic, as it forms part of the Lower Proterozoic metasedimentary sequence of the Pine Creek Geosyncline which overlies dated Archaean rocks (Page, Compston, & Needham, 1979) and underlies the Kombolgie Formation which locally is the lowermost unit in the McArthur Basin Carpentarian sequence. It is locally the lowermost Lower Proterozoic unit known.

APPENDIX 2

List of abbreviations used on compilation sheets

Ad	andesite	flg	flaggy
Ae	agate	fol	foliated
ag	agmatitic	fri	friable
Agg	aggregate	Fs, fs	feldspar, feldspathic
altd	altered	g	grained
Am, am	amphibolite, amphibolitic	gar	garnetiferous
amyg	amygdaloidal	Gb	gabbro
ang	angular	Gns, gns	gneiss, gneissic
Ark, ark	arkose, arkosic	Gnt	garnet
Aug	augen	gyp	granophyric
Bd, Bds, bdd	bed, beds, bedded	Gr, gr	granite, granitic
BIF	banded iron formation	graph	graphitic
Biot, biot	biotite, biotitic	grnl	granular
Bld, Blds	boulder, boulders	Grtd	granitoid
Bnds, bndd	bands, banded	Gt, gt	graphite, graphitic
Brec, brecd	breccia, brecciated	Gwke	greywacke
brn	brown	gy	grey
Bs	basalt	Hbl	hornblende
$\bar{c}$	with	Hem, hem	hematite, hematitic
calclut	calcilutite	Hfls	hornfels
carb	carbonate	hom	homogeneous
cbns	carbonaceous	HQB	hematite quartz breccia
Cgl, cgl	conglomerate, conglomeratic	Ilm	ilmenite
Ch	chalcopyrote	incl	inclusions
Chl, chl	chlorite, chloritic	intbdd	interbedded
Cht, cht	chert, cherty	intfm	intraformational
Cl, cl	clay, clayey	intlyrd	interlayered
crend	crenulated	iso	isoclinally
csr	calc-silicate rock	jtd	jointed
di, dic	dictyonitic	ky	kyanite
Dl	dolerite	latd	lateritised
Do, do	dolomite, dolomitic	l-p-l	lit-par-lit
d/t	diatexite	lsm	leucosome
f	fine	lyrd	layered
Fe	iron	m	medium or meta-

fe, fed	ferruginous, ferruginised
fldd	folded
fldg	folding
Mi, mi	mica, micaceous
Mig, mig	migmatite, migmatitic
mnr	minor
Mt	magnetite, magnetitic
Musc, musc	muscovite, muscovitic
neb	nebulitic
Nod, nod	nodule, nodular
occ	occasional
opc	opthalmic
oph	ophitic
pbl, pbs	pebbly, pebbles
Peg, peg	pegmatite, pegmatitic
Phyl	phyllite
pk	pink
Po, po	porphyry, porphyritic
pob	porphyroblastic
ps	psammitic
purp	purple
py	pyritic
qb	quartz breccia
Qt, qtz	quartzite, quartzitic
qz, qzs	quartzitic, quartzose
recryst, rexst	recrystallised
recumb	recumbent
Rk	rock
Rub, rub	rubble, rubbly
Sch, sch	schist, schistose
Schl	schlieren
Sd, sd	sand, sandy
ser	sericitic
Sh	shale
shd	sheared
Si, si, sid	silica, siliceous, silicified
Sl	slate
Slt, slt	silt, silty
maf	mafic
mass	massive
Mdst	mudstone
Sy, sy	syenite, syenitic
Tf, tf	tuff, tuffaceous
tn	thin, thinly
trem	tremolitic
Trm	tremolite
U	uranium
unaltd	unaltered
v	very
vnd	veined
wh	white
wthrd	weathered
xbdd	cross-bedded

Sltst	siltstone
srtd	sorted
Sst	sandstone
stl	stictolithic
sto	stromatolitic
struct	structures

CAINOZOIC	QUATERNARY			Qca	Silt, mud; coastal alluvium
				Qcp	Clay, silt, mud: coastal mud pans
				Qa	Silt, sand, clay, locally consolidated grey sandy siltstone along some drainage courses; creek and river alluvium
				Qs	Unconsolidated sand: outwash and colluvial deposits
				Qas	Silt, clay abandoned channel deposits
				Qf	Black and brown humic soil and clay deposits
	TERTIARY TO QUATERNARY			Czt	Sandstone, quartzite and schist rubble, sand; talus scree
				Cza	Winnowed sand, clay: partially stripped Czs
				Czs	Unconsolidated sand: ferruginous clayey sand
				Czl	Nodular, concretionary, pisolitic and vermicular mottled laterites: in situ and reworked remnants of standard laterite profile
MESOZOIC	CRETACEOUS		Bathurst Island Formation, Marligur Member	Kla	Poorly sorted quartzose sandstone, siltstone and conglomerate; fossiliferous
				K	Sandstone, ferruginous sandstone, siltstone, basal conglomerate
PROTEROZOIC	CARPENTARIAN	Katherine River Group	Mc Kay Sandstone	Phm$_2$	Quartz sandstone, medium feldspathic sandstone, fine to medium ferruginous sandstone
				Phm$_1$	Ferruginous and feldspathic sandstone, greywacke, fine to medium siltstone
			Kombolgie Formation	Phk$_2$	Massive quartz sandstone, quartz greywacke, minor siltstone and pebble conglomerate; cross-bedded, ripple marked
			Gilruth Volcanic Member	Phg	Amygdaloidal basalt, tuff, tuffaceous siltstone, banded jasperite rubble
			Nungbalgarri Volcanic Mbr.	Phn	Basalt, amygdaloidal basalt, interbedded sandstone and tuffaceous siltstone
				Phk$_{2b}$	Conglomerate, reworked coarse quartz sandstone boulders and pebbles and siltstone shards in coarse ferruginous sandstone matrix, siltstone and tuffaceous siltstone
				Phk$_1$	Quartz sandstone, massive to flaggy, minor siltstone, tuffaceous siltstone, minor breccia conglomerate, hematitic and brown ferruginous sandstone, cross bedded, ripple marked. Conglomerate lenses
			Oenpelli Dolerite	Pdo	Porphyritic olivine dolerite, ophitic dolerite, granophyric dolerite and differentiates
			Edith River Volcanics	Phe	Spotted feldspar chloritoid hornfels
			Pul Pul Rhyolite Member	Phep	Agglomerate, green-pink rhyolite, ignimbrite
			Coronation Member	Phec	Sandstone, conglomerate
			Tin Camp Granite	Pgt	Sericitised biotite quartz plagioclase granite, cream to pink, anomalously radioactive, commonly with north-trending quartz-filled shears; anatectic granites
			Nabarlek Granite	Pgn	
			Jim Jim Granite	Pgj	
	LOWER PROTEROZOIC			Pl	Undivided Lower Proterozoic schist and gneiss
			Nimbuwah Complex	Plz	Undivided Nimbuwah Complex
				Plz$_1$	Diatexite: foliated to homogeneous granitoid migmatitic rocks, predominantly (hornblende) biotite granite, medium grained to porphyroblastic (Granitoid core)
				Plz$_2$	Metatexite: heterogeneous migmatite with various penetration fabrics, predominantly (hornblende) biotite gneiss and granitic rock, garnetiferous in places and augen gneiss (Migmatite Zone)
				Plz$_3$	Lit-par-lit gneiss, banded gneiss, garnet biotite schist, minor hornblende, amphibolite (Lit-par-lit Gneiss Zone)
				Plz$_4$	Muscovite biotite schist and banded gneiss, minor lit-par-lit gneiss, quartzite, amphibolite (Transitional Zone)
			Zamu Complex	Pdi	Fissile dark green to black hornblende orthoamphibolite in places containing leucocratic quartz feldspar blebs
		Finniss River Group	Fisher Creek Siltstone	Plf	Chlorite mica schist, quartz mica schist, minor garnet schist
		South Alligator Group	Koolpin Formation	Plk	Chert, banded carbonaceous siltstone and schist characteristically strongly hematite stained at surface, hematite schist
		Barramundie Group	Mundogie Sandstone	Plu	Feldspathic coarse sandstone and conglomerate, cross-bedded; siltstone
		Namoona Group	Cahill Formation	Plc	Undivided schist, gneiss and quartzite
				Plc$_2$	Feldspathic quartzite, feldspathic quartz schist, feldspathic schist, quartzite, garnet mica schist, mica-quartz schist and minor conglomerate, chloritized in places
				Plc$_1$	Feldspathic quartzite and hematitic quartz mica schist, commonly chloritized, pyritic carbonaceous schist, massive crystalline carbonate, chlorite-dolomite schist, calc-silicate gneiss; amphibole schist and amphibolite
				Plc$_{1c}$	Carbonacepus quartz schist, fine grained
				Plc$_{1b}$	Psammitic gneiss and lit-par-lit gneiss; garnet muscovite biotite quartz gneiss with feldspar quartz boudins
				Plc$_{1a}$	Green fibrous to orange granular calc-silicate gneiss, white calcite-tremolite marble
		Kakadu Group	Kudjumarndi Quartzite *	Plqk	Fine to coarse recrystallized orthoquartzite, minor feldspathic schist and gneiss and amphibolite rare cross-bedding
			Mount Howship Gneiss *	Plah	Coarse muscovite quartz feldspar gneiss, quartzite schist, minor biotite and hornblende
			Mount Basedow Gneiss *	Plab	Gneissic meta-arkose, quartzite, interbedded biotite gneiss and schist; transitional into Nanambu Complex Plxa
			Mount Partridge Formation	Plp	Undivided Mount Partridge Formation. Quartzite and siltstone
				Plp$_4$	Feldspathic sandstone, arkose, quartzite
				Plp$_3$	Phyllite, minor arkose, quartzite, minor schist
	ARCHAEAN-LOWER PROTEROZOIC			APlx	Granite, gneiss, schist, undivided Nanambu Complex
			Nanambu Complex	Plxp	Coarse pegmatoid leucogneiss and leucocratic muscovite gneiss, fine to coarse quartz, feldspar, biotite, and muscovite gneiss, garnetiferous in places, interbedded with muscovite biotite schist and biotite chlorite schist; minor augen gneiss and sheared quartzite; metamorphosed, and in places migmatised

c subscript 'c' denotes regolith developed over a unit i.e. there is little if any exposure
* Informal name

- Geological boundary
- Syncline showing plunge and dip of axial plane
- Anticline showing plunge
- Overturned antyiclne
- Fault
- Inclined fault
- Fault (D, U indicate relative movement down, up)
- Fault containing quartz breccia
- Fault zone

Where location of boundaries, folds and faults is approximate; line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

- Plunge of minor anticline
- Plunge of minor syncline
- Plunge of fold axis showing dip of axial plane
- Plunge of minor syncline, showing dip of axial plane
- Plunge of overturned minor fold axis with strike and dip of axial plane
- Plunge of drag fold
- Plunge added to trend line
- Plunge of fold axis
- Shear zone
- Strike and dip of axial plane of horizontal chevron folds
- Strike and dip of axial plane of horizontal folds
- Strike and dip of strata
- Strike and dip of strata dip not measured
- Horizontal strata
- Vertical strata
- Overturned strata
- Dip < 5°
- Dip < 15°
- Dip 15°-45°
- Dip > 45°
- Trend line
- Joint pattern
- Lineament

(Dip < 5° to Lineament: air photo interpretaion)

- Dip slope
- Dip slope, dip not measured
- Curving dip
- Prevailing dip of strongly deformed strata
- Prevailing dip of strongly deformed strata
- Generalised strike and dip of undulating strata
- Prevailing dip of strongly deformed strata, showing plunge of mineral elongation
- Strike and dip of joint
- Vertical joint
- Strike and dip of foliation
- Prevailing foliation
- Vertical foliation
- Horizontal foliation
- Strike and dip of cleavage
- Prevailing strike and dip of cleavage
- Vertical cleavage

- Horizontal strata with plunge of lineation (crenulation, mineral elongation)
- Strike and dip of strata with plunge of lineation (crenulation)
- Strike and dip of foliation with plunge of lineation (undifferentiated)
- Strike and dip of foliation " " " " (crenulation)
- Strike and dip of foliation " " " " (mineral elongation)
- Strike and dip of foliation " " " " (undifferentiated)
- Strike and dip of foliation with plunge of two lineations (crenulation)
- Strike and dip of foliation with horizontal lineation (crenulation)
- Strike and dip of strata with horizontal lineation (mineral elongation)
- Platy flow inclined
- Platy flow horizontal
- Direction of movement of sediment-bearing currents, x - cross stratification, r - ripple marks
- Direction of movement of sediment-bearing currents sense unknown
- Dyke or vein; q - quartz; a - aplite; p - porphyry d - dolerite
- Dyke or vein with dip
- Dyke with slickensided contacts
- Unworked major uranium deposit
- Prospect
- Alluvial workings
- Shaft
- Cu Copper
- Fe Iron
- Pb Lead
- Sn Tin
- U Uranium

- Waterhole on stream (WH)
- Waterfall on stream
- Rapids
- Spring
- Water gauging station (WG)
- Escarpment
- Vehicle track
- Landing ground
- Homestead, building (HS)
- Fence
- Boundary, Aboriginal Reserve

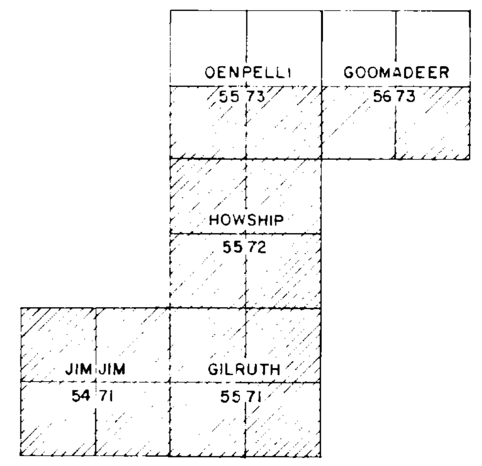
SCALE

0 2 4 6 8 10km

SCALE (OENPELLI ONLY)

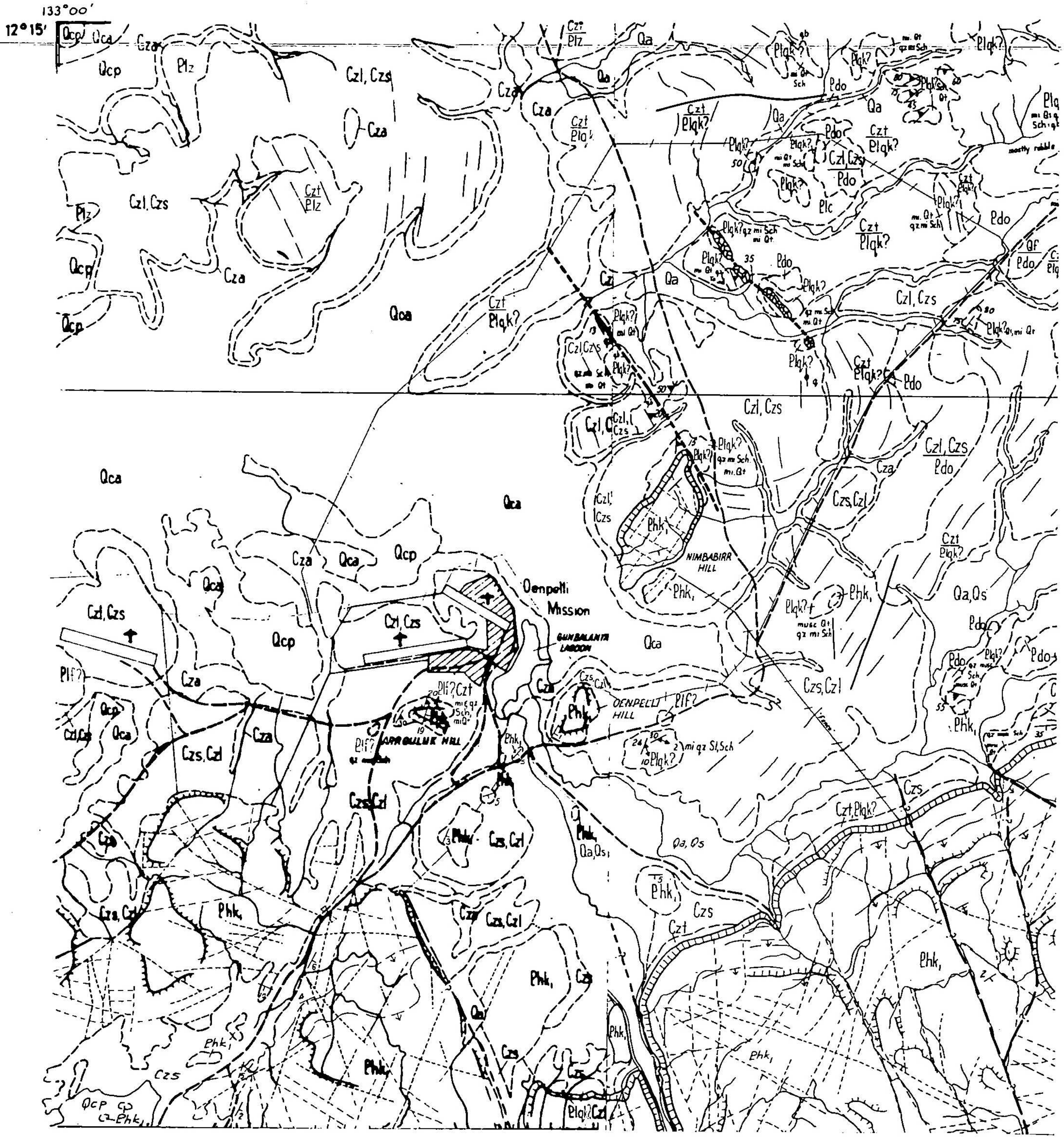
0 2 4 6 8 10km

1:100 000 SHEET AREAS



REFERENCE TO COMPILATION SHEETS OF THE OENPELLI, GOOMADEER, HOWSHIP, GILRUTH AND JIM JIM SHEET AREAS, NORTHERN TERRITORY

PLATE 2A



OENPELLI SW

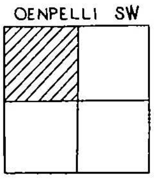
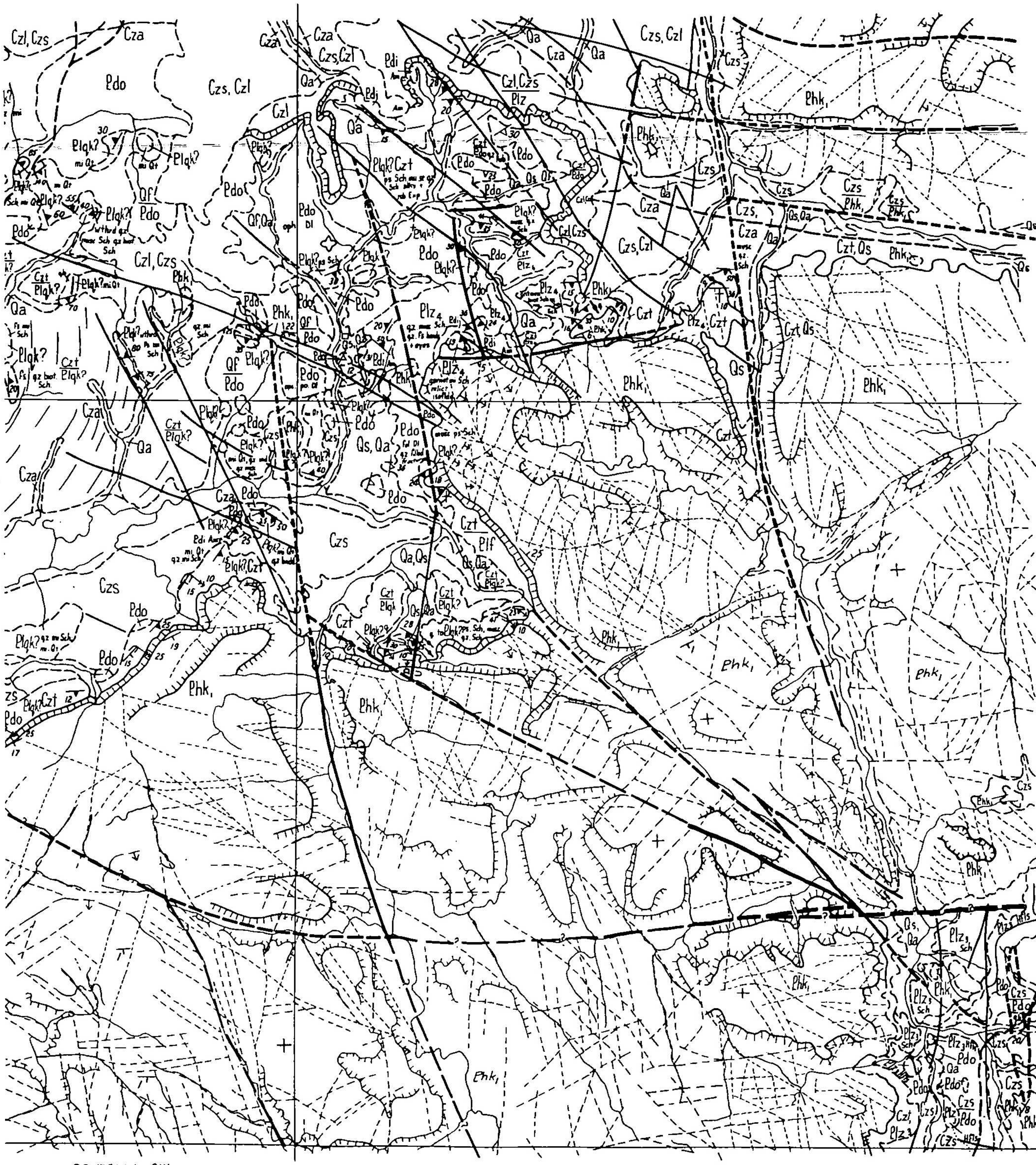
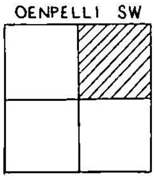
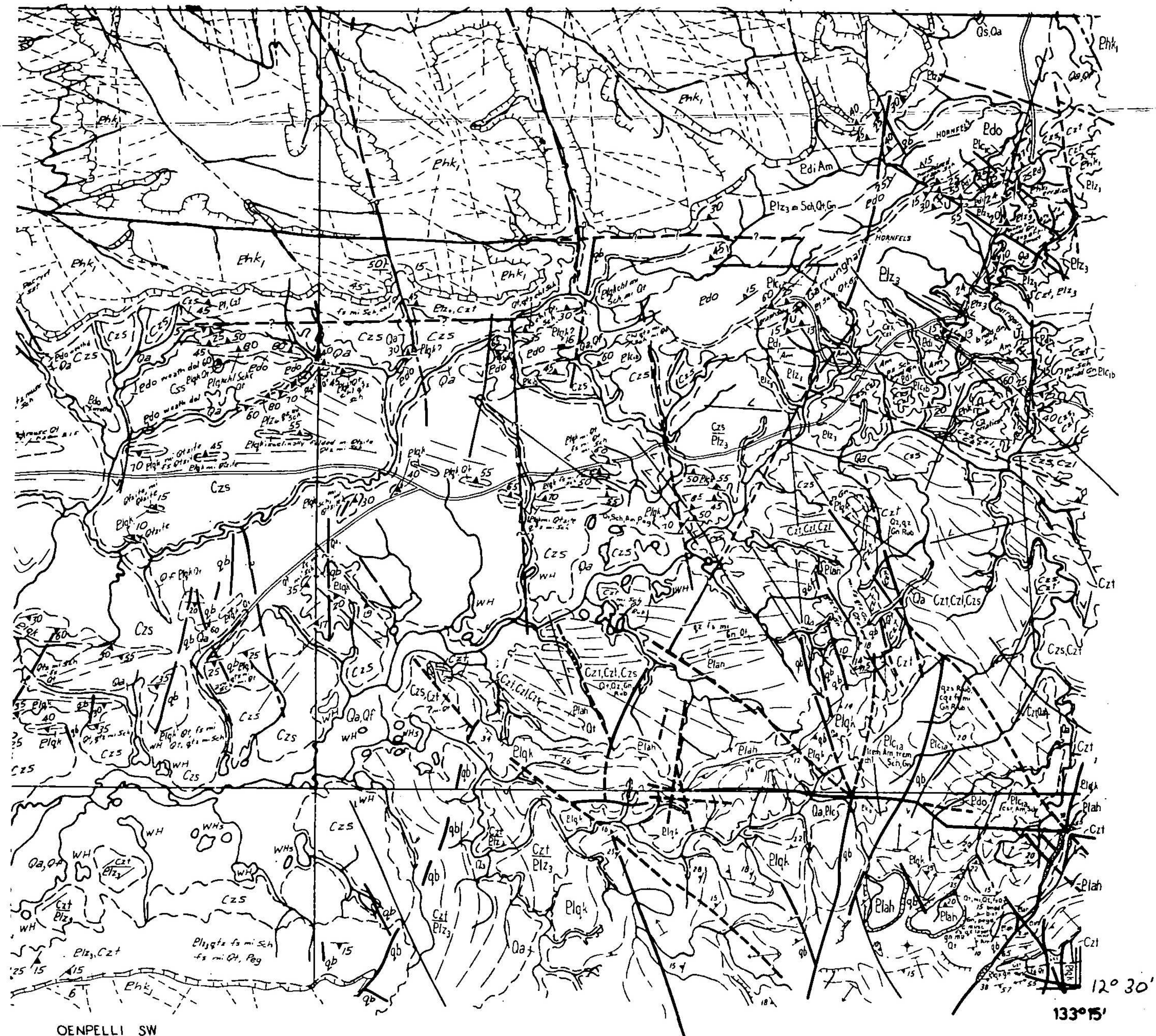


PLATE 2B

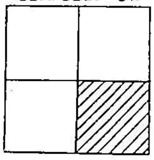


OENPELLI SW



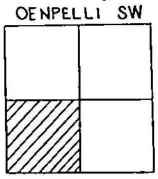


OENPELLI SW

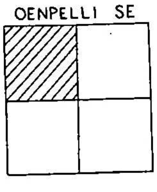



Qcp
Qca
Czs
Ꞓhk₁
Ꞓdo
Qa, Qf
Czt
Swamp
WH
Qs
BULMAN FAULT
12°30'
133°00''

OENPELLI SW

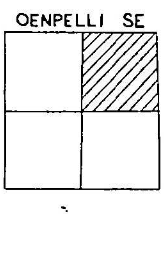


OENPELLI SE



Record 1978/113

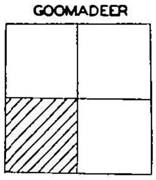

Czs
Cza
Qa
Phk,
Qf
Qs
Qs, Czs
Czs, Czl
Kla
Plz3
Plqk
Plzc
Czs
Pdo
Czt
Pgn
Czt, Plz
Qa, Qs
Qa, Czs
Qs, Qa
Czl
KJ
giant load moulds
Czl, Phn
Phn, Czl
Phk1, Phn, Czl
Czs, Czt
Phk1


OENPELLI SE

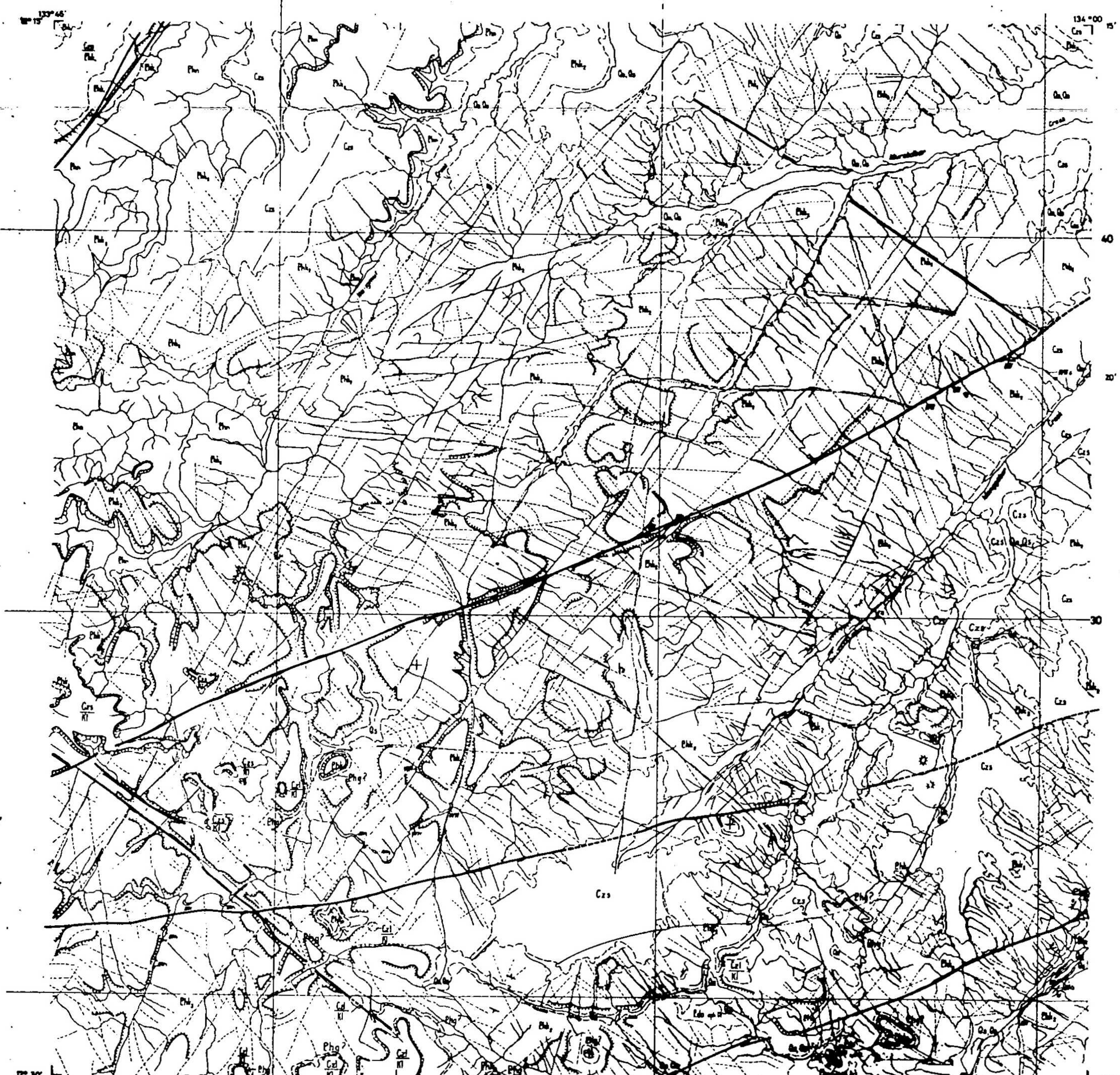

OENPELLI SE
12° 30'
133° 30
Czs, Czl, Ehn Rub
Czs, Czl, Ehn Rub


12°30'
133°15'
OENPELLI SE
SCARP
SCARP & GEOL BOUNDARY COINCIDENT

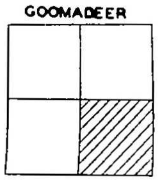
GOOMADEER



Geology : R.S. Needham
Compiled : P.H. Fuchs
20-5-78



GOOMADEER



Geology: R S Needham
Compiled

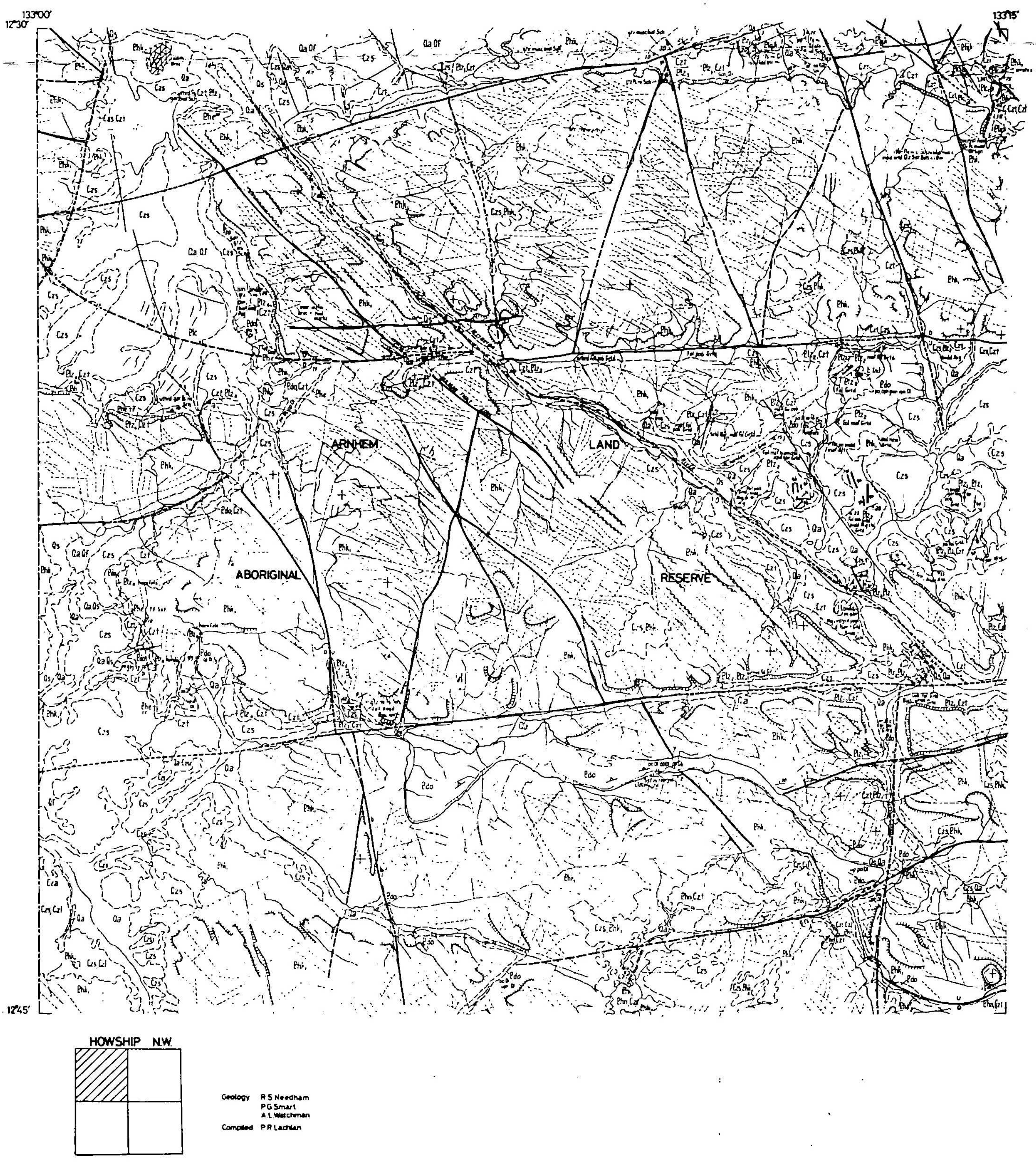
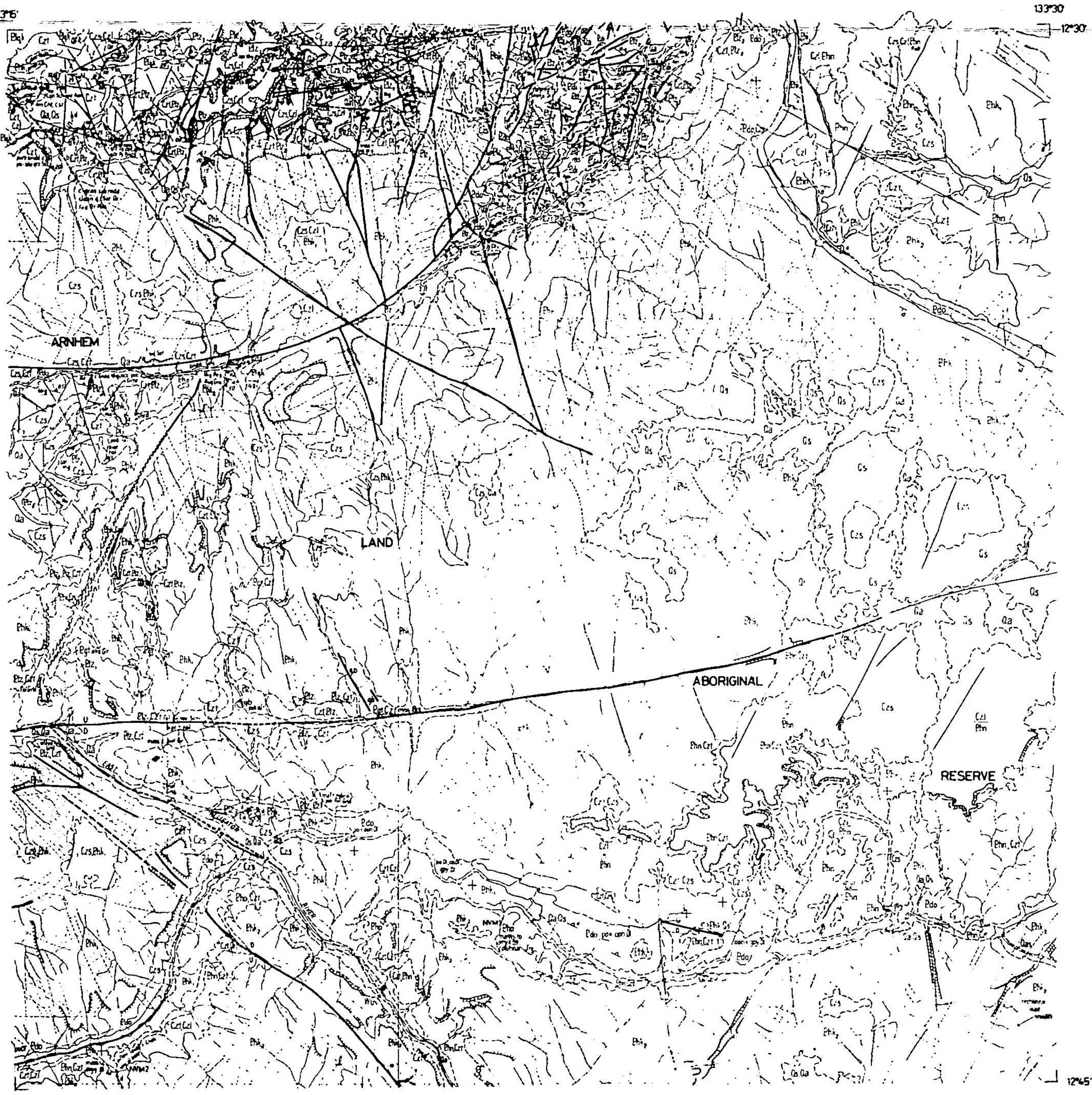
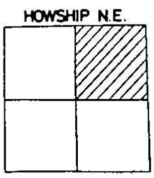
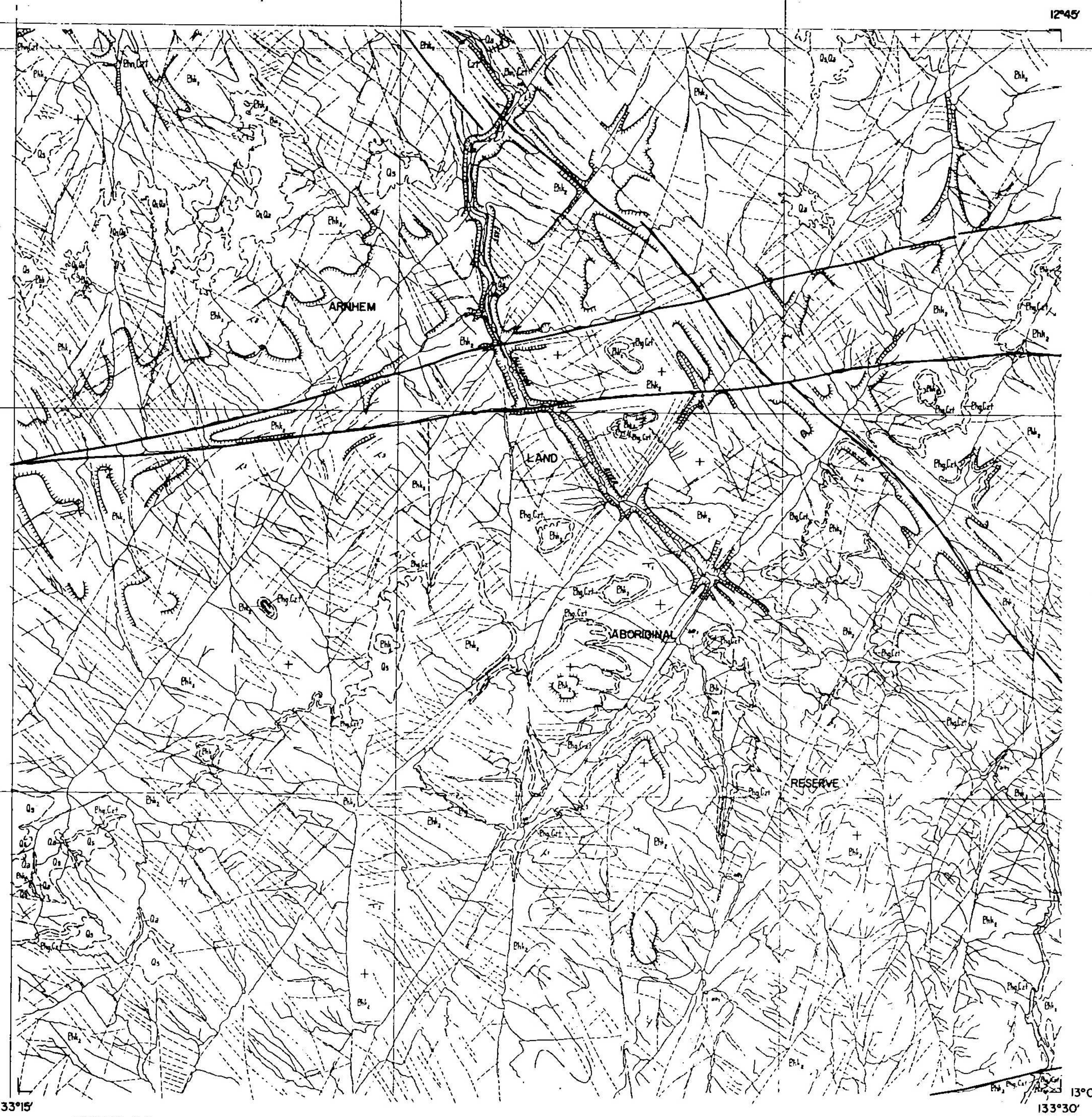

133°00'
12°30'
133°15'
12°45'
ARNHEM
LAND
ABORIGINAL
RESERVE
HOWSHIP N.W.
Geology R S Needham
P G Smart
A L Watchman
Compiled P R Lachlan

PLATE 7

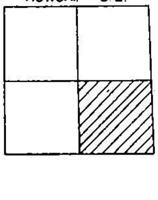




Geology A L Watchman
PG Smart
R S Needham
Compiled PR Lachlan

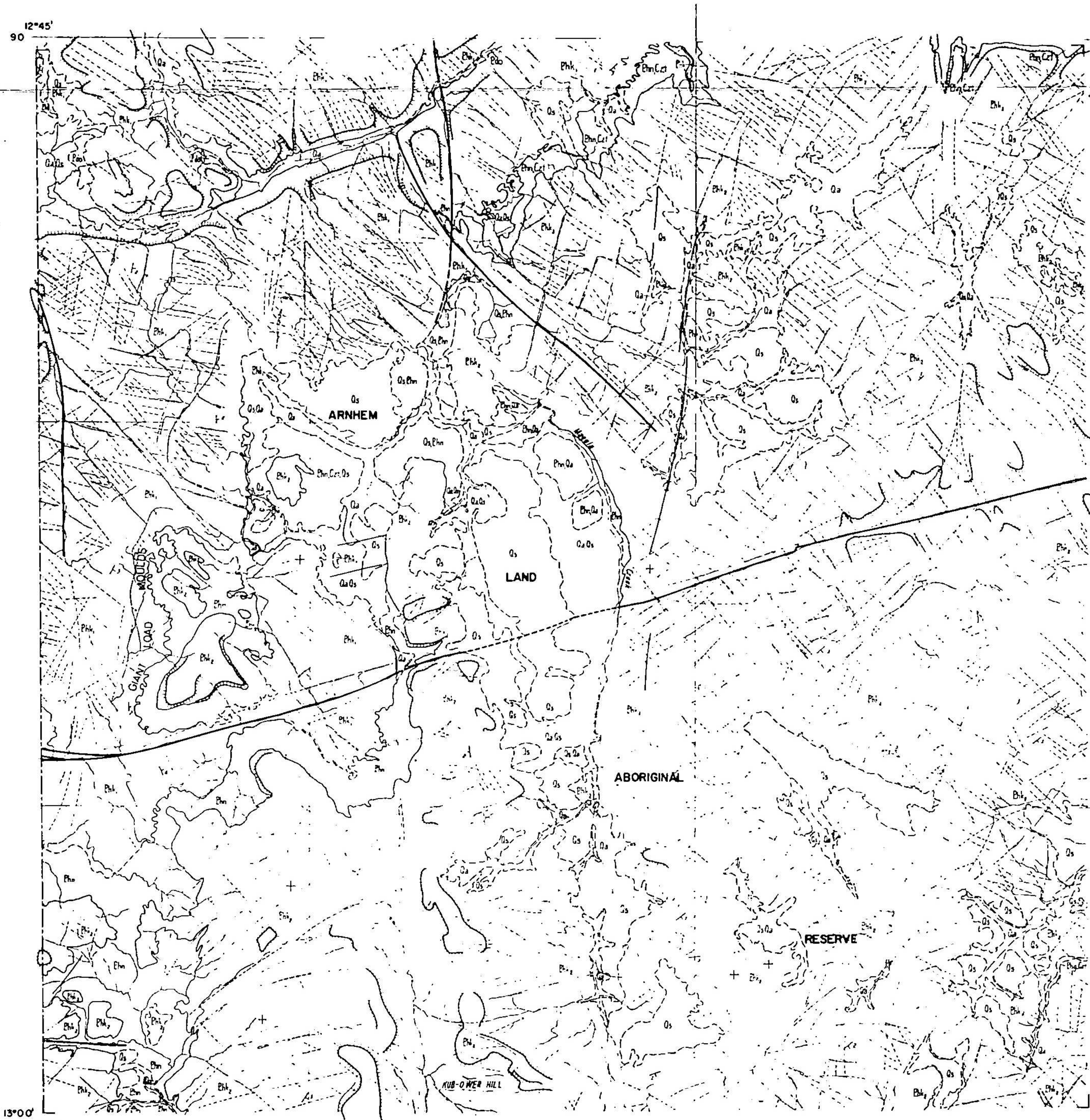


HOWSHIP S.E.

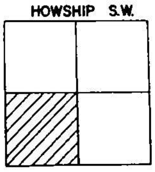


Geology R.S. NEEDHAM
Compiled P.R. LACHLAN

JULY 76

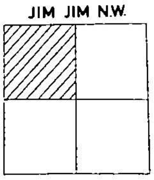


HOWSHIP S.W.



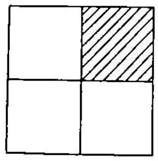
Geology: R.S. NEEDHAM
Compiled P.R. LACHLAN
JULY 76

JIM JIM N.W.

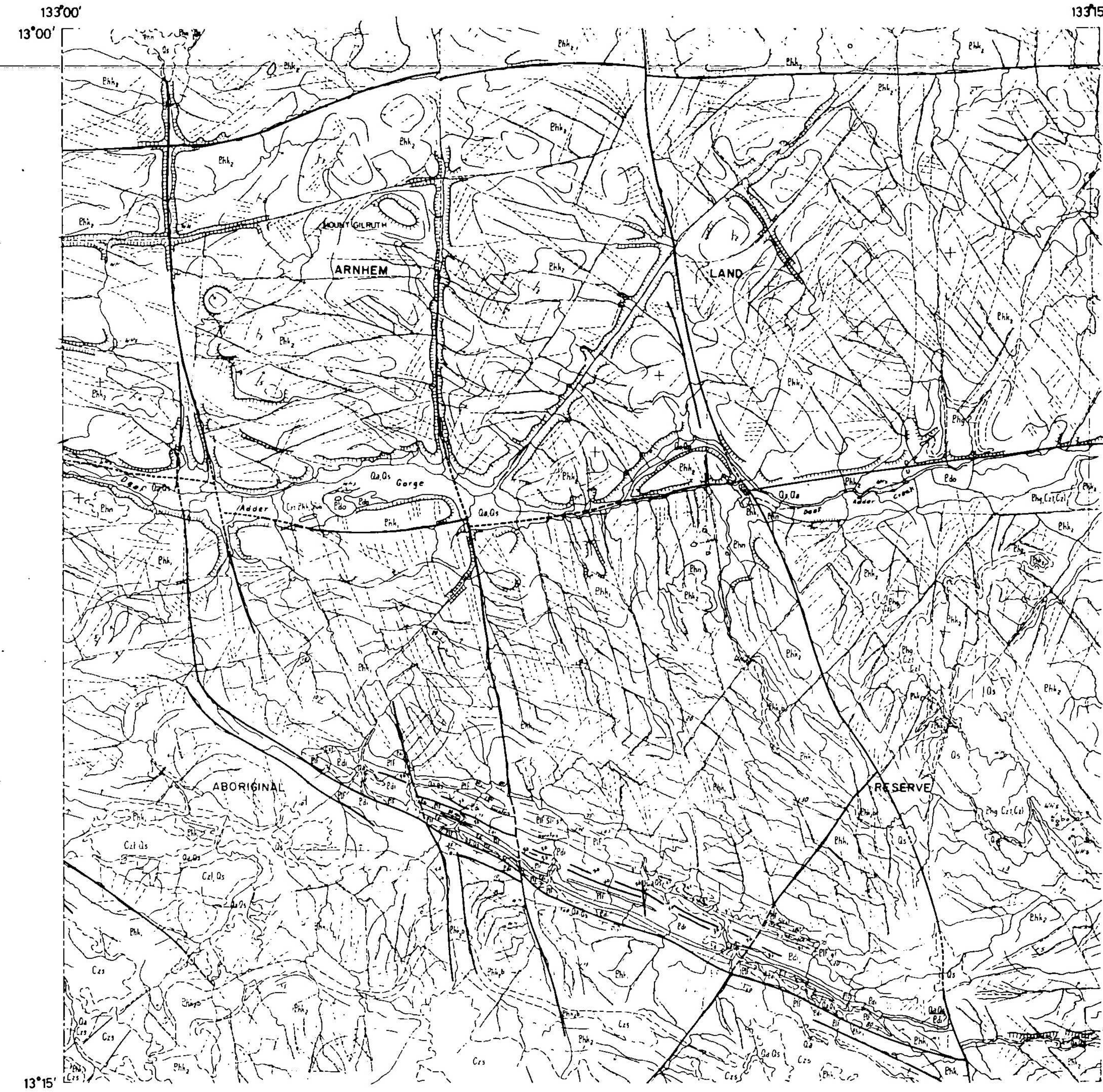


GEOLOGY: A.L.Watchman.
COMPILED: P.H.Fuchs.
July 1974
Nov 1977
Feb 1978

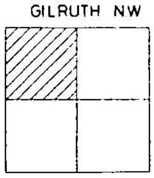
JIM JIM N.E.



GEOLOGY: P.G.Smart. R.S.Needham.
COMPILED: P.R.Lachlan. P.H.Fuchs.

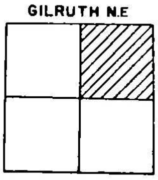


GILRUTH NW

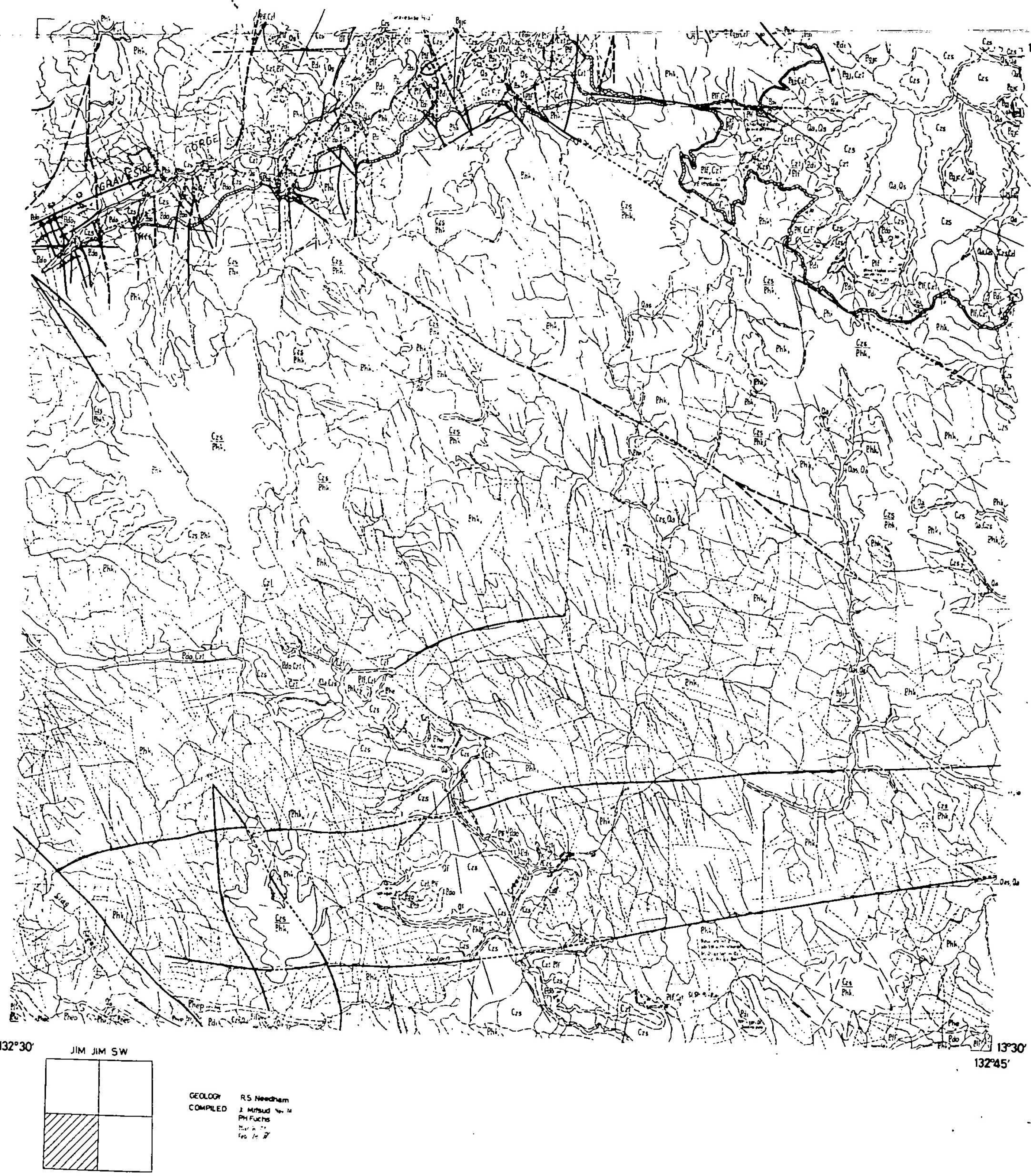


Geology: R.S. NEEDHAM
Compiled: P.R. LACHLAN
MARCH 76

GILRUTH N.E

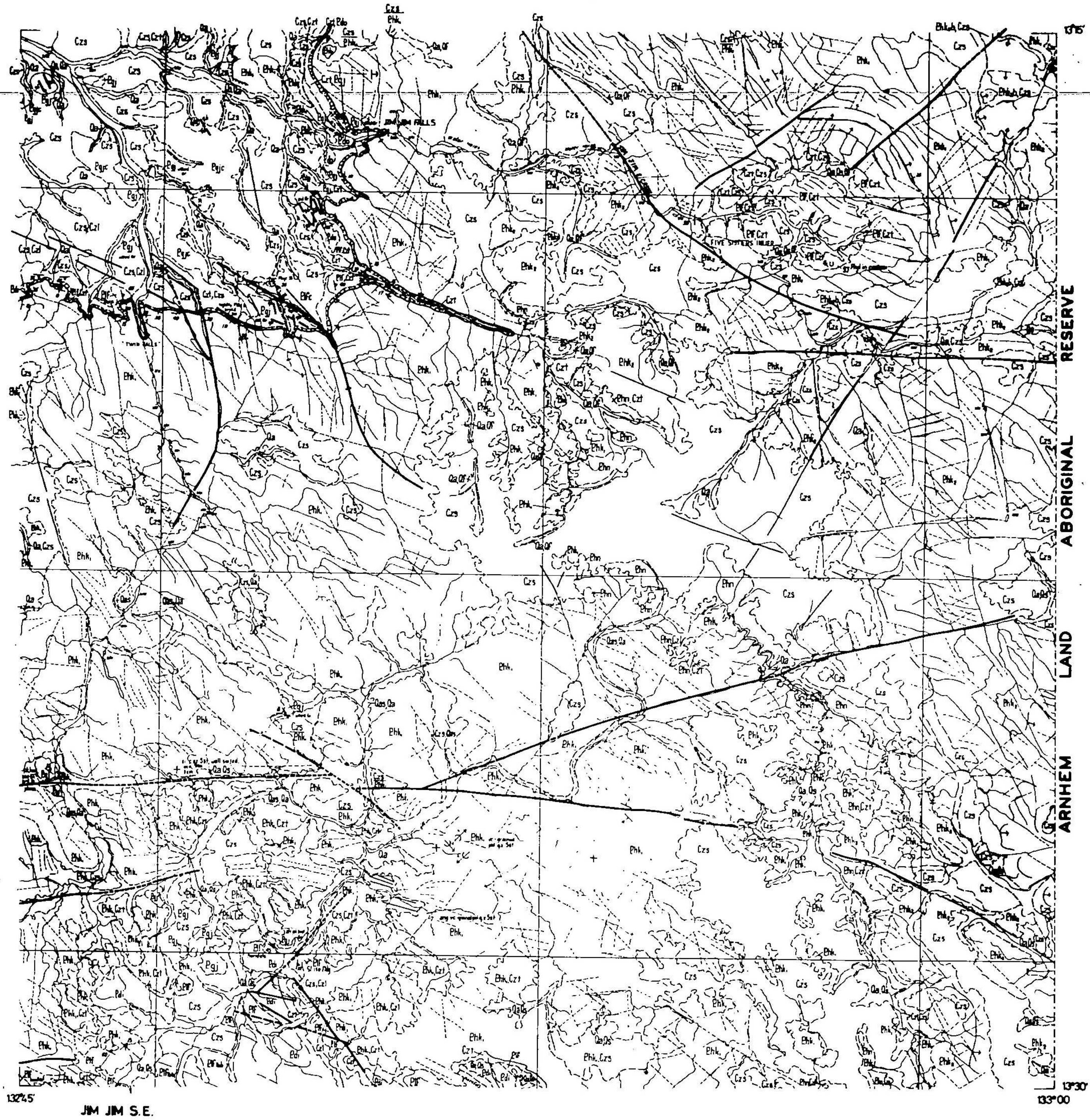


Geology: R.S. NEEDHAM
Compiled: P.R. LACHLAN
MARCH 78

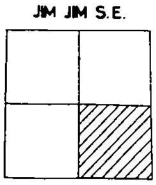


GEOLOGY R.S Needham

COMPILED J. Mifsud, PH Fuchs

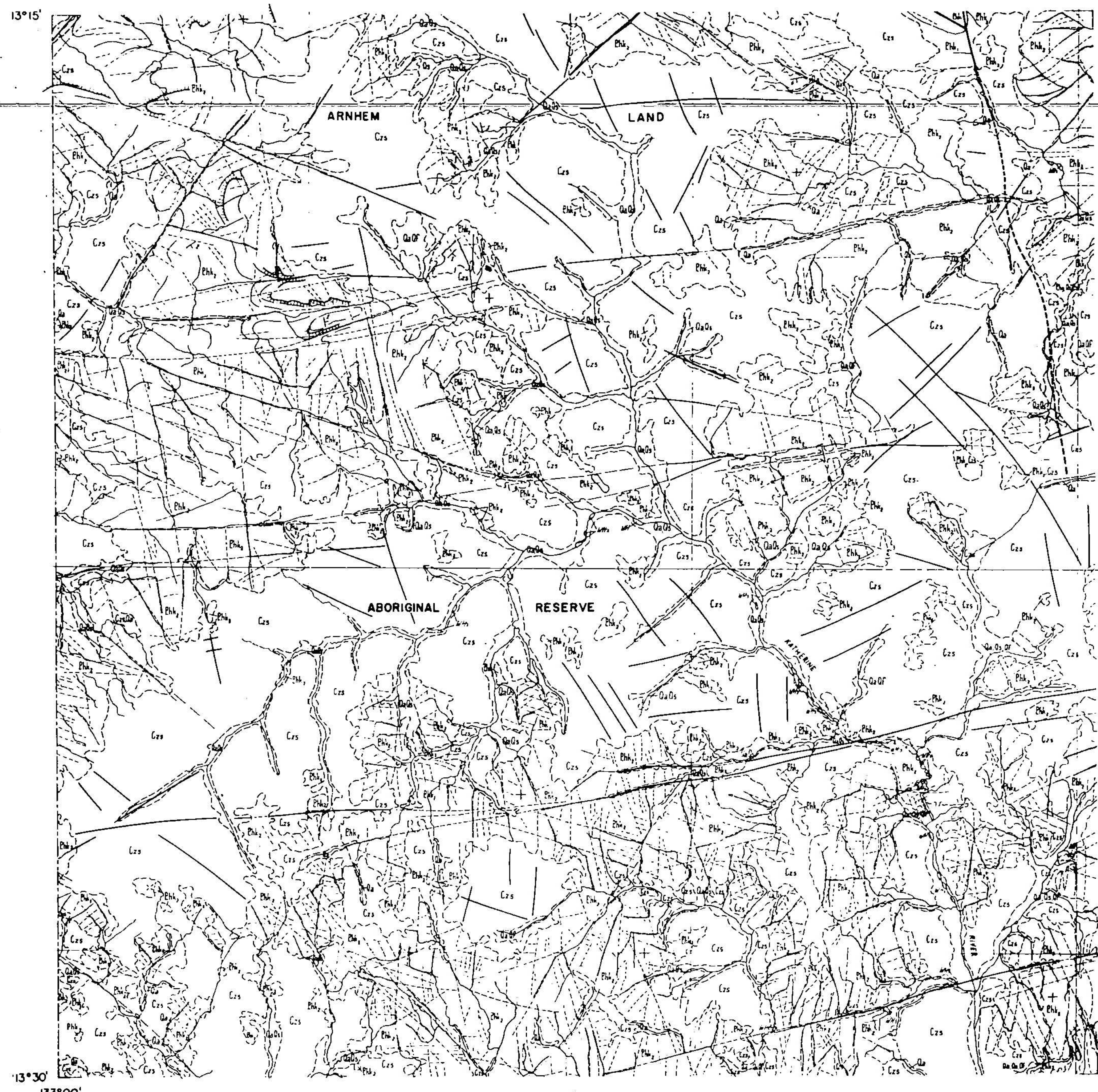


JIM JIM S.E.

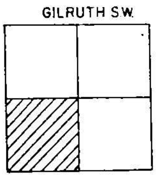


GEOLOGY: R.S. Needham
COMPILED: J. Mifsud. Nov 74
P.R. Lachlan

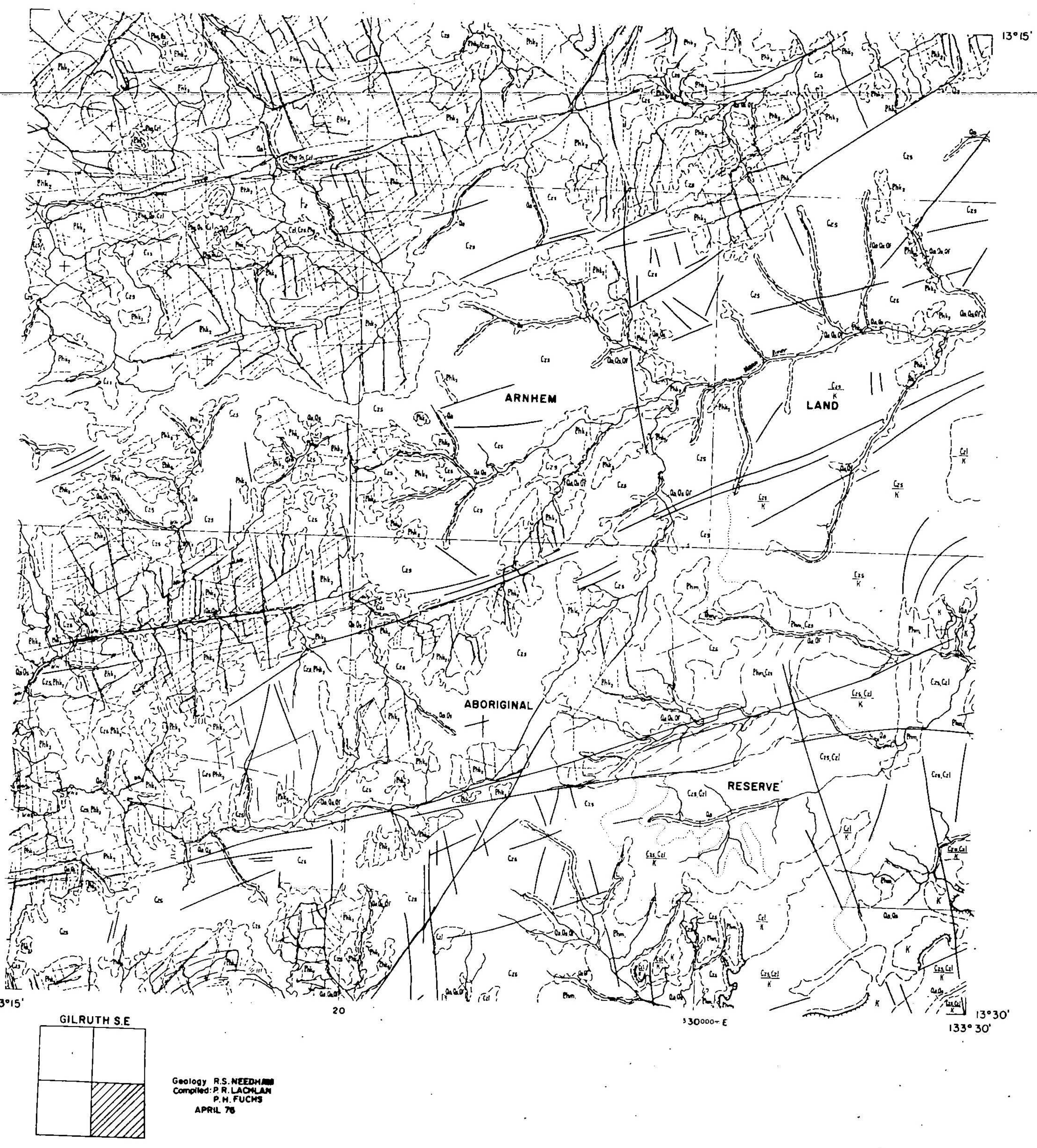
PLATE 16

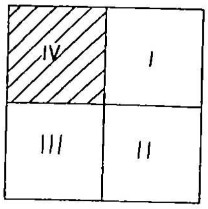


GILRUTH S.W.



Geology: R.S. NEEDHAM
Compiled: P.R. LACHLAN
APRIL 76

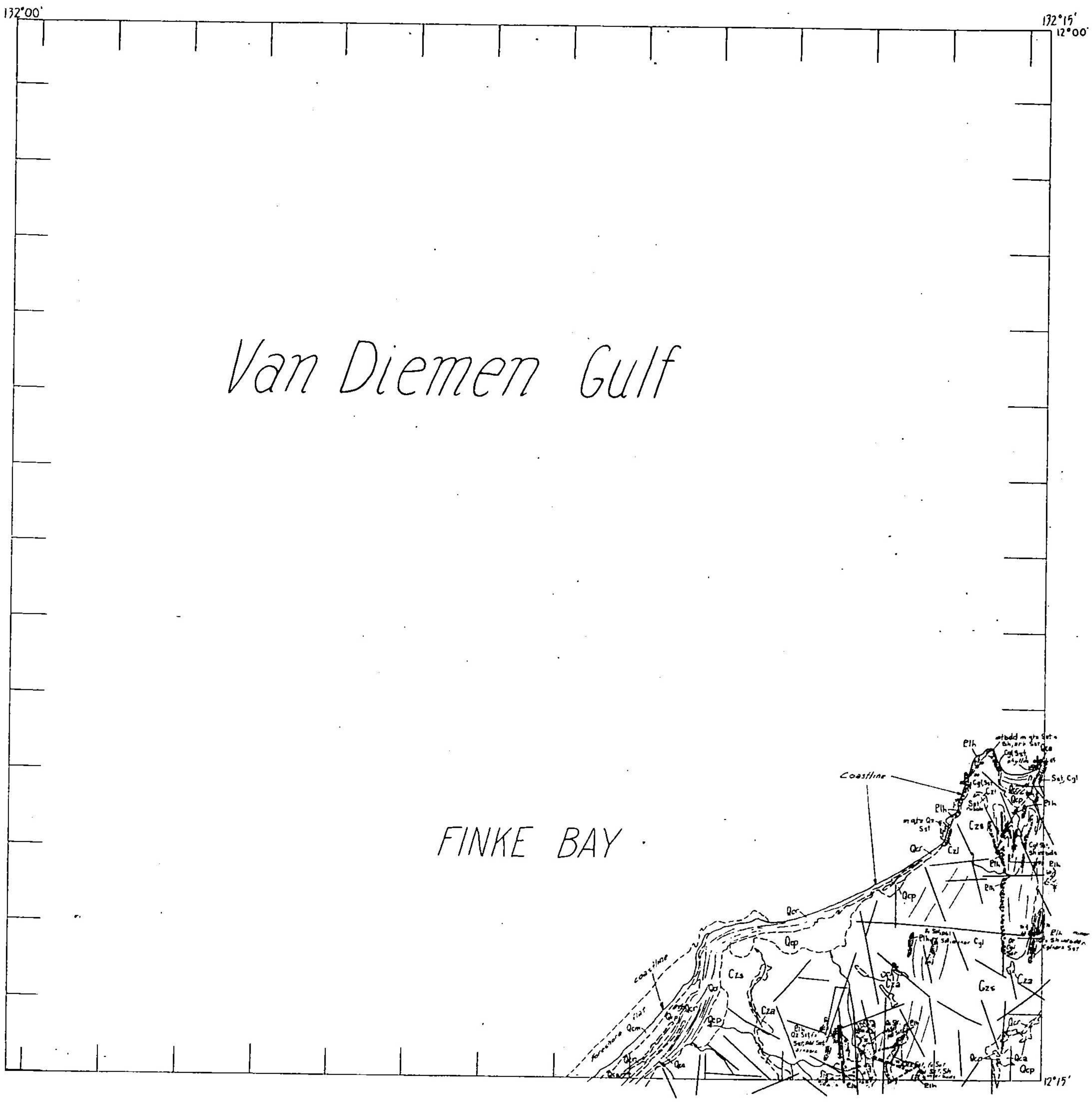

13°15'
ARNHEM
LAND
ABORIGINAL
RESERVE
133°15'
20
530000mE
13°30'
133°30'
GILRUTH S.E
Geology R.S. NEEDHAM
Compiled: P.R. LACHLAN
P.H. FUCHS
APRIL 76



FIELD ISLAND

Geology : A.L. Watchman
R.S. Needham
P.G. Smart 1973-4

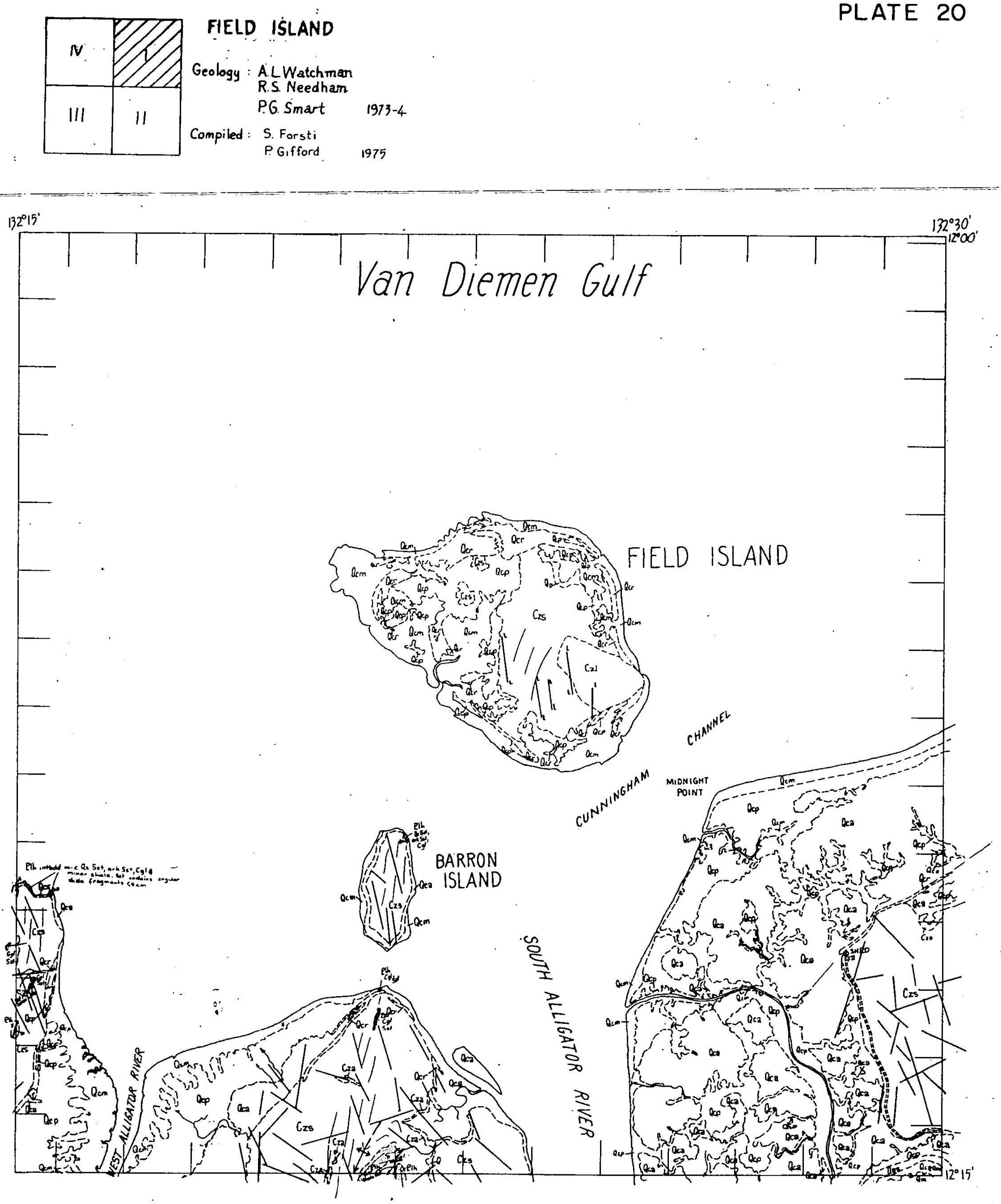
Compiled : S. Forsti
P. Gifford 1975

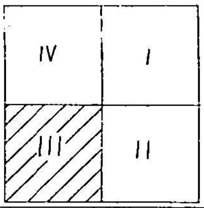


FIELD ISLAND

Geology : A.L. Watchman
R.S. Needham
P.G. Smart 1973-4

Compiled : S. Forsti
P. Gifford 1975

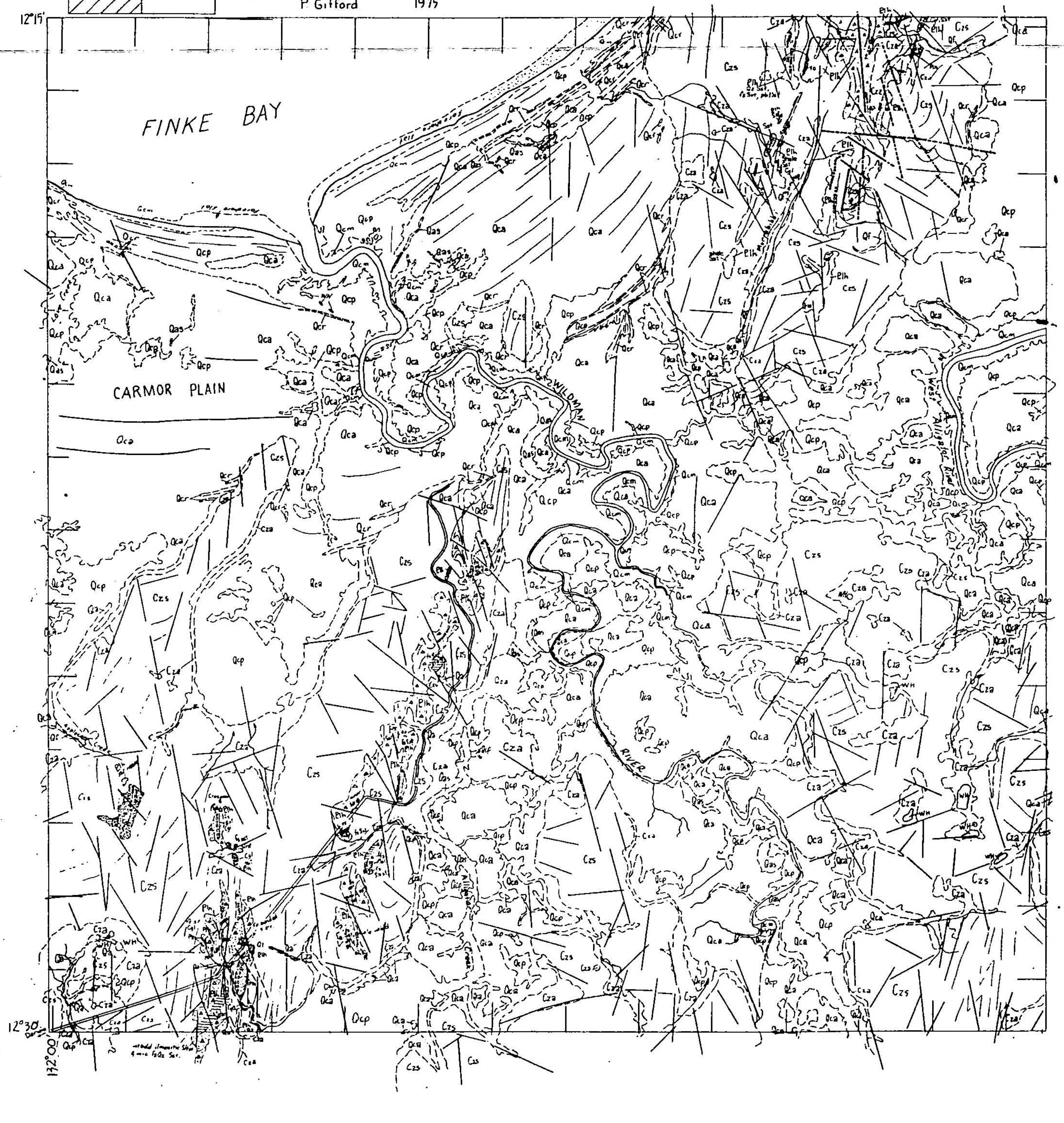


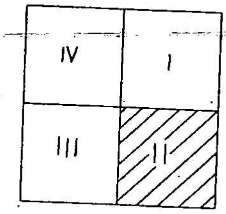


FIELD ISLAND

Geology : A.L. Watchman
R.S. Needham
P.G. Smart 1973-4

Compiled : S. Forsti
P. Gifford 1975

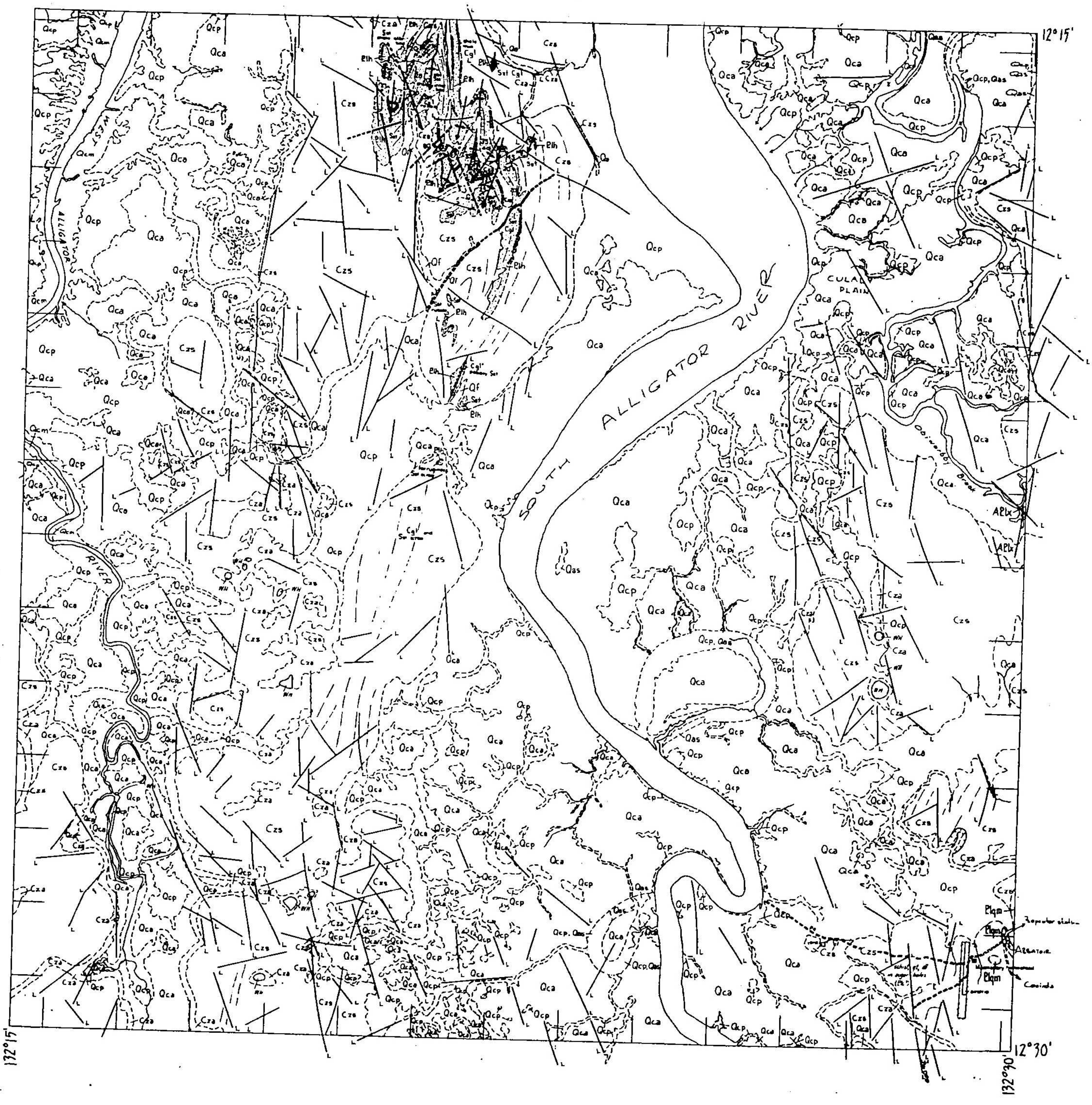


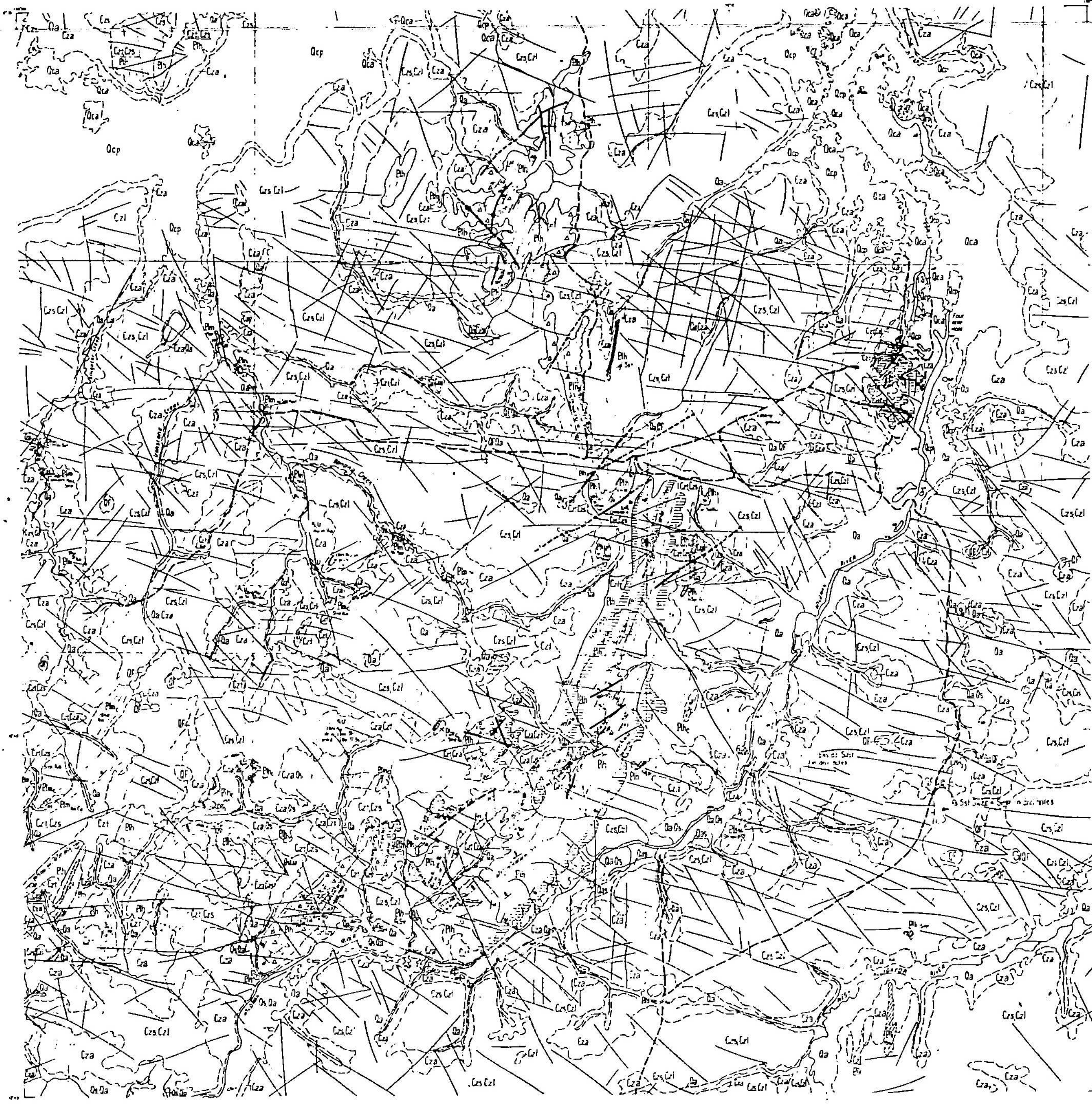


FIELD ISLAND

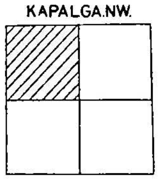
Geology : A.L. Watchman
R.S. Needham
P.G. Smart 1973-4

Compiled : S. Forsti
P Gifford 1975



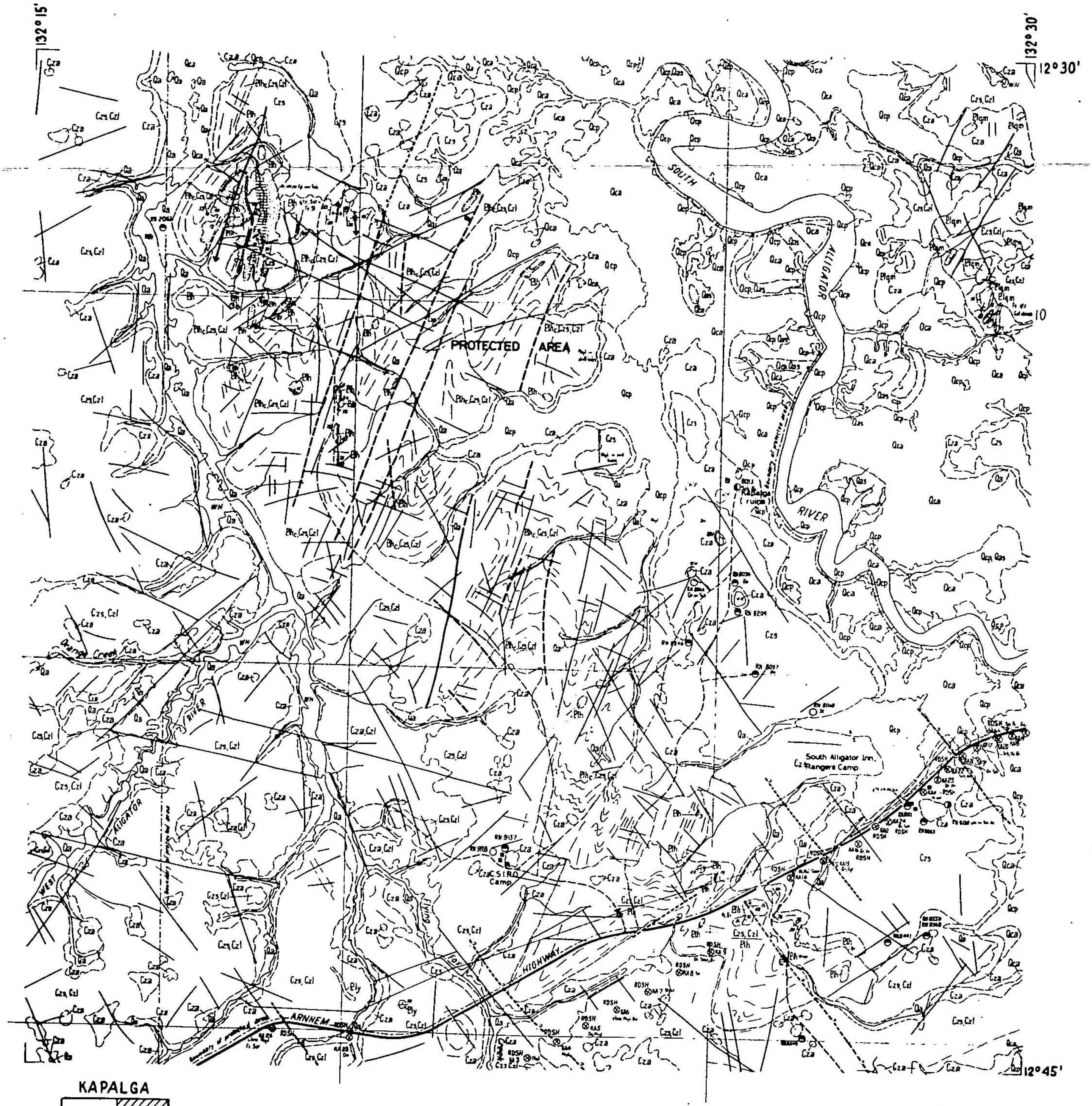


KAPALGA.NW.

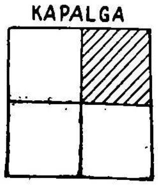


Geology: P.G.Stuart-Smith.
Compiled: P.R.Lachlan.
FEBRUARY 1977

137



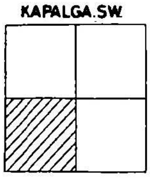
KAPALGA



5372

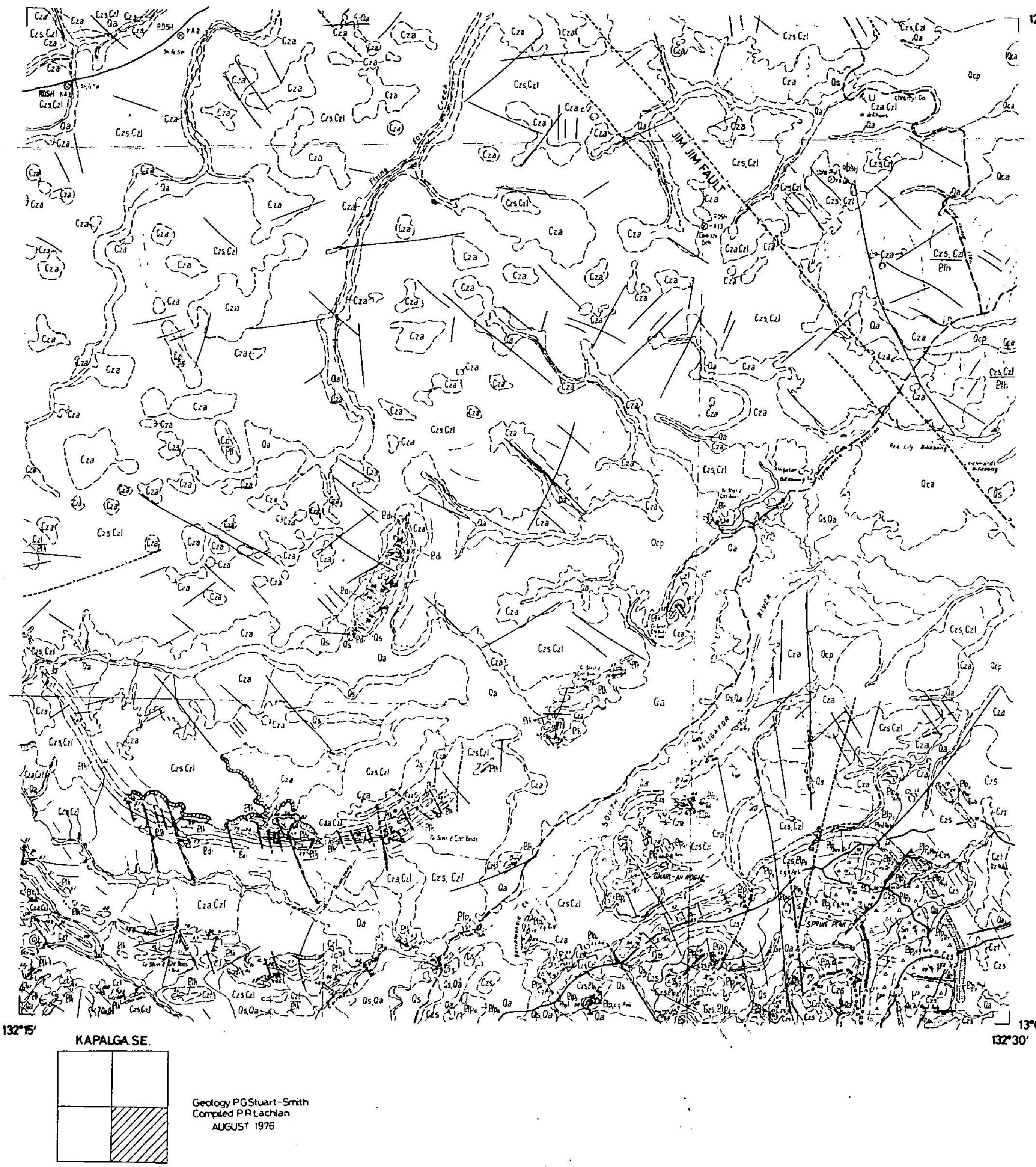
Compiled P.L. Blythe
P.R. Lachlan
1976-77

KAPALGA.SW



Geology: P.G. Stuart - Smith
Compiled: P.R. Lachlan
SEPTEMBER 1976

139


12°45'
13°00'
132°15'
132°30'
JIM JIM FAULT
SOUTH ALLIGATOR RIVER
KAPALGA SE.
Geology P.G.Stuart-Smith
Compiled P.R.Lachlan
AUGUST 1976