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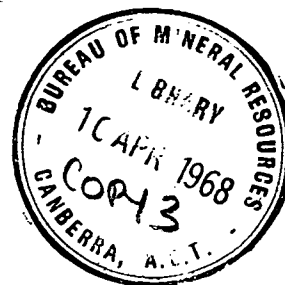
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DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

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REPORT ON PHOTO-INTERPRETATION OF THE LIMBUNYA
1:250,000 SCALE SHEET, NORTHERN TERRITORY.

by

C.E. Maffi

The information contained in this report has been obtained by the Department of National Development, as part of the policy of the Commonwealth Government, to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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SUMMARY

Scattered outcrops of Proterozoic rocks are widely distributed. They are unconformably overlain by the Antrim Plateau Volcanics, thick basalt flows considered of Middle Cambrian age. In the western part of the Sheet, the four formations of the Middle Cambrian Negri Group overlie the volcanics in apparently conformable succession. The Elder Sandstone believed to be of Devonian age, lies on the Negri Group. A thick mantle of laterite forms a wide north-east trending ^{band}/across the Sheet; soil and alluvium are scattered on the older formations.

Where beds are visible, the Proterozoic rocks are commonly sharply folded. The Antrim Plateau Volcanics are subhorizontal and little disturbed. The Negri Group and Elder Sandstone form a wide syncline complicated by faults and minor folds.

The main faults trend about north-west and north-east. Joints and lineaments show dominant trends to the north-north-west and north-north-east; they are particularly developed on Proterozoic and volcanic rocks.

INTRODUCTION

The purpose of this study is to prepare a photo geological map to assist in the planning and execution of future field work.

The photo-interpretation has been carried out on black and white contact prints from airphotos flown by the RAAF in 1948. The photo-coverage data are: runs direction east-west; focal length 152.2 mm; flight altitude 25,000'; nominal scale 1:50,000.

The stereo-models are commonly tilted; some runs are affected by large white stains which mask the details; generally the contrast is low.

A mirror stereoscope equipped with a 3 X magnification binocular has been used and dips and slopes have been estimated by the use of special floating marks.

Morphological units have been mapped, then correlated with stratigraphic units, on the basis of previous work (listed in the references) and of a two week field check in the area. More checking has been done on the Cambrian and younger formations than on the Proterozoic, because of the outcrop distribution and the difficulty of access. Field samples collected and their macroscopic descriptions are listed in the Appendix.

Overlays on every second photograph have been annotated, then modified where necessary after the field check. The annotations have been compiled on overlays of the photo-scale planimetric sheets prepared by National Mapping. The compilation has been photographically reduced to 1:250,000 scale, assembled and combined with the National Mapping 1:250,000 scale base map to produce a composite print.

The main homestead is Inverway, equipped with airstrip and petrol supply. Other homesteads are Limbunya, also with an airstrip, and Mistake Creek.

The road system is poorly developed. Some new roads (e.g. Wave Hill - Inverway) have been mapped on the photogeological sheet from Adastra air-photos flown in June, 1967. Some roads shown on the 1965 edition of the National Mapping planimetric sheet have been abandoned (e.g. the Limbunya - Mistake Creek and Limbunya - Inverway tracks).

Water may be obtained from holes along the main watercourses and from scattered windpumps.

PHYSIOGRAPHY

The central and western part of Limbunya belongs to the drainage system of the Ord River; its affluents Negri River and Stirling Creek are the main watercourses in this area. The lateritic high plateau separates them from the Victoria River system, which lies in the south-east corner of the sheet.

The drainage pattern is generally dendritic (Robert and Howe, 1958) or subdendritic on the Proterozoic and Cambrian outcrops; rectangular where controlled by fractures and joints; deranged on the laterite plateau. There are interesting examples of centripetal drainage along the flanks of the large syncline in the north-west corner of the sheet. Some sink holes and clay pans are visible in the north-east part of the sheet.

The areas of Proterozoic outcrops generally are flat or gently undulating, except where steeply dipping rocks crop out. The maximum relief is on the volcanics, where near-horizontal flows are separated by steep scarps. The altitude of the lateritic high plateau ranges from 980' in the north-east to 1540' ten miles north of Inverway. The highest elevation recorded on the I.C.A.O. 1:1,000,000 scale map, is 1570' at Mt. Napier, about 40 miles north-west of Inverway.

SUMMARY OF STRATIGRAPHY

<u>Photogeological character</u>	<u>Possible geological equivalent</u>				
Variable tone, treeless, flat lying	Qa	Alluvium, colluvium	QUATERNARY	CAINOZOIC	
Light grey toned, elevated position	Qt	Terrace deposits			
Very light toned, treeless, flat, characteristically variegated	Czb	Black residual soil and/or old alluvium			
Dark toned, mesa-form	Czl	Laterite, red soil			
Medium toned, smooth	Cz	Undifferentiated			
Medium toned, bedded	Db	Elder Sandstone	DEVONIAN	PALAEOZOIC	
Light toned, soft appearance	Gmp	Panton Formation	Negri Group MIDDLE		CAMBRIAN
Medium toned, bedded	Gml	Linnekar Limestone			
Light toned, soft appearance	Gmo	Nelson Shale			
Light toned, bedded	Gmy	Headleys Limestone			
Medium to dark toned, smooth surface, forming characteristic terraces, very jointed	Gla	Antrim Plateau Volcanics	LOWER		
Medium toned, flat lying	Buu			PROTEROZOIC	
Medium to dark toned, bedded	Bu ₃	Dolomite and inter-bedded siltstone			
Medium to dark toned, very jointed, elevated position	B ₈				
Medium to dark toned, jointed	B ₇	Bedded fine grained sandstone			
Medium to dark toned, scarp forming	B ₆	Dolomite and quartz sandstone			
Light toned, soft appearance	B ₅	Dolomitic siltstone			
Medium toned, bedded	B ₄	Silty sandstone			
Medium toned, jointed, separated by scarps	B _C	Massive microcrystalline quartz and quartz breccia			
	B _B	Thin-bedded dolomite			
	B _A				
Medium toned, low relief, generally very jointed	B	Undifferentiated			

STRATIGRAPHY

PROTEROZOIC

Rocks with medium grey tone, low relief, generally very jointed, lying under the Antrim Plateau Volcanics have been mapped as Undifferentiated Proterozoic (Table 1).

Three units have been differentiated in the central part of the sheet: B_A, B_B and B_C (from bottom to top). Their photogeological characters are very similar, but the presence of two lines of scarps has led to the separation. On the ground, south-west of Limbunya Station, unit B_B is thin-bedded dolomite and B_C is light brown chert and chert breccia. Because of lack of access it was not possible to check B_A.

In the north-east part of the sheet, as on the adjoining photogeological map of Wave Hill (Perry, 1966) the Proterozoic has been differentiated into the Units B₄, B₅, B₆ and B₇, plus an uppermost Unit B₈ outcropping only on Limbunya.

B₄ is a medium toned, hard, bedded rock. B₅ is light toned and soft. The remaining units are medium to dark toned, hard, very similar to each other but separated by scarps. No field check of this area has been possible; the geological equivalents in the legend have been obtained from Wave Hill Sheet.

Again by continuity with Wave Hill Sheet, a medium to dark toned, bedded unit is mapped as Bu₃ (dolomite and interbedded siltstone) and a medium toned, flat lying unit without visible beds is mapped as Buu.

PALAEOZOIC

Lower Cambrian

Unconformably lying on the Proterozoic rocks is a unit with the characteristic morphology of basalt. Several near-horizontal flows alternate in vertical succession and form terraces separated by scarps. Surfaces are medium to dark toned, smooth and commonly very jointed. This unit has been confidently assigned to the Antrim Plateau Volcanics, Gl.

A medium-toned, hard bed is mapped on top of G1a in the photo-scale compilation, south-east sheet, but has been deleted from the 1:250,000 scale map, because no lithological difference was found during the field check.

On the ground, vesicular basalt was found especially in the lower part and compact or agglomeratic basalt in the upper part of the outcrops. Among the fragments lying at the foot of the hills, generally fractured crystals of coloured quartz up to 1 inch across were found along Limbunya Station - Waterloo Station track.

Middle Cambrian

A succession of alternatively hard and soft beds rests apparently conformably on the Antrim Plateau Volcanics. It is a conformable sequence, ascribed to the Negri Group on the adjoining Dixon Range geological map (Dow and Gemuts, in press). Field sections have been checked along the Stirling Creek and the Inverway - Mistake Creek Station track. The Group is divided into four formations (from top to bottom):

Panton Formation
Linnekar Limestone
Nelson Shale
Headleys Limestone

The Headleys Limestone (Gmy), is a light toned, bedded unit characterized by well developed drainage. On the ground it is a thick bedded, two-toned limestone with lenses of yellow dolomite and chert, vesicular where eroded.

The Nelson Shale (Gmo) is described by previous workers in adjacent areas (Traves 1955, Dow and Gemuts in press.) as a succession of shale, limestone and mudstone; along the sections checked it is commonly concealed by soil and only the harder rock crops out.

The Linnekar Limestone (Gml) is a medium grey toned, well bedded unit. Quartz lenses are enclosed in the limestone.

The Panton Formation (Gmp) is very similar to the Nelson Shale both on airphotos and in the field.

Devonian

The Panton Formation is overlapped by a medium grey toned, bedded unit, concealed in places by thin soil; edges of beds appear through the mantle in a well defined trend. This unit is identified as Elder Sandstone (Db), described by Dow and Gemuts (in press) as brown, micaceous, cross-bedded, ripple-marked, ferruginous sandstone with interbeds of micaceous siltstone and shale. No field check has been possible.

CAINOZOIC

Undifferentiated Cainozoic (Cz) includes several patches of varying size with smooth appearance and low vegetation, generally clearly differentiated from the surrounding rocks. They are formed by old alluvium, sand and gravel.

Laterite (Czl) covers a wide band crossing the sheet in a north-easterly direction. It appears as a dark toned, high plateau covered by thick vegetation and in most places bordered by a steep scarp. Some isolated basalt hills are capped by laterite. The drainage is generally poorly developed and scattered.

The parent rocks appear to be the basalt and the Proterozoic.

On the ground, typical pisolitic laterite has been seen only along the lateral scarp or in creek banks; the plateau surface is generally covered by red soil.

Czb -- On the laterite plateau, very light, treeless areas are clearly differentiated. They form very flat, characteristically variegated surfaces, mapped as "Open Grass Plains" on the National Mapping planimetric sheet. On the ground they are layers of black soil, probably residual soil or old alluvium. The light photographic tone derives from the thick grass cover.

Quaternary - Alluvium is poorly developed along the main rivers and creeks. On Negri River and Stirling Creek banks, small fluvial terraces are found. Colluvium occurs in places along most slopes, but on account of its minor development and of the map scale, it has been either ignored or included in the Alluvium and in the Undifferentiated Cainozoic.

A SUPPOSED DYKE

A light toned, hard, rough, jointed and faulted bank of rock, bounded by near-vertical walls, crops out between the units G_{my} and G_{mo}, 6 miles west of Bigley Springs (Inverway - Mistake Creek track). It has been mapped as a supposed dyke but there was insufficient time for a field check.

STRUCTURE

Proterozoic rocks generally are folded and faulted. Minor structures involve the Undifferentiated Proterozoic in the central and south-west parts of the sheet. A large anticline is recognised within the units B_A, B_B, and B_C; the axis trends north-north-east; a fault parallel to the axis cuts the northern part of the structure. Narrow anticlines with axes trending north-north-west are found in the succession B₄ - B₈; they are continuous with the structures described on the Wave Hill sheet (Perry, 1966) and they are truncated on the east by a long fault trending north-north-west.

The Antrim Plateau Volcanics are subhorizontal and little disturbed by faults, but generally they are very jointed.

The Negri Group and the Elder Sandstone are folded in a large, syncline with gently dipping flanks, complicated in places by minor folds and faults. The axis trends north-west. South-westerly, the limb of the structure is cut by a vertical fault parallel to the axis; because the boundary between G_{la} and G_{my} on the south-west side of the fault ^{is} ~~has been~~ shifted horizontally about 16 miles relative to the position of the boundary on the north-east of the fault, a horizontal relative movement may have

occurred in addition to the vertical relative movement; however a moderate vertical movement could have been responsible, since the beds are very gently dipping and the rock thickness involved is small.

A remarkable tectonically disturbed zone trends west-north-west in the central part of the sheet. A possible extension is the east-west fault which separates B from Cla in the south-east quarter.

Joints and lineaments are well developed on the Proterozoic and volcanic rocks. Two dominant trends north-north-west and north-north-east, are recognizable. Fracture traces are particularly abundant on the Cla (central-northern part of the sheet and to the south of the Negri Group syncline); and on the unit Eb.

CONCLUSIONS

The factors of good exposure, and the close relationship between morphology and lithology, together with a brief field check, have allowed the Cambrian and younger rocks to be mapped in reasonable detail.

The main problem on the Limbunya sheet will be the stratigraphy of the Proterozoic and the correlations between isolated sequences.

Sections on the Proterozoic rocks may be measured in the central part of the sheet, where exposure is good but access is difficult. The Antrim Plateau Volcanics are generally well exposed. A section of the Negri Group and Elder Sandstone may be measured along the Mistake Creek - Inverway road.

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APPENDIX

LIST OF FIELD SAMPLES

Undifferentiated Proterozoic

- L 1 A - Fine grained, brown, labile, laminated sandstone.
 B - Fine grained, brown, labile to sub-labile sandstone.
- L 2 Fine grained, light grey quartzite.

B_B

- L 3 Very fine grained, light brown dolarenite with sub-parallel laminations.

Headleys Limestone

- L 4 A - Very fine to fine grained, light brown, vesicular calcarenite with scattered fine black grains.
 B - Very fine to fine grained, light brown calcarenite. Vertical micro-structures shown by differential solution.
 C - Fine grained, light brown calcarenite.
- L 5 A - Very fine grained, light brown, fairly vesicular calcarenite.
 B - Fine grained, light brown calcarenite with a few, scattered crystals of calcite.
- L 6 Fine grained, reddish brown, laminated calcarenite.
- L 7 A - Fine grained, light brown calcarenite with sub-parallel laminations.
 B - Coarse grained, white, crystalline calcarenite.

Nelson Shale

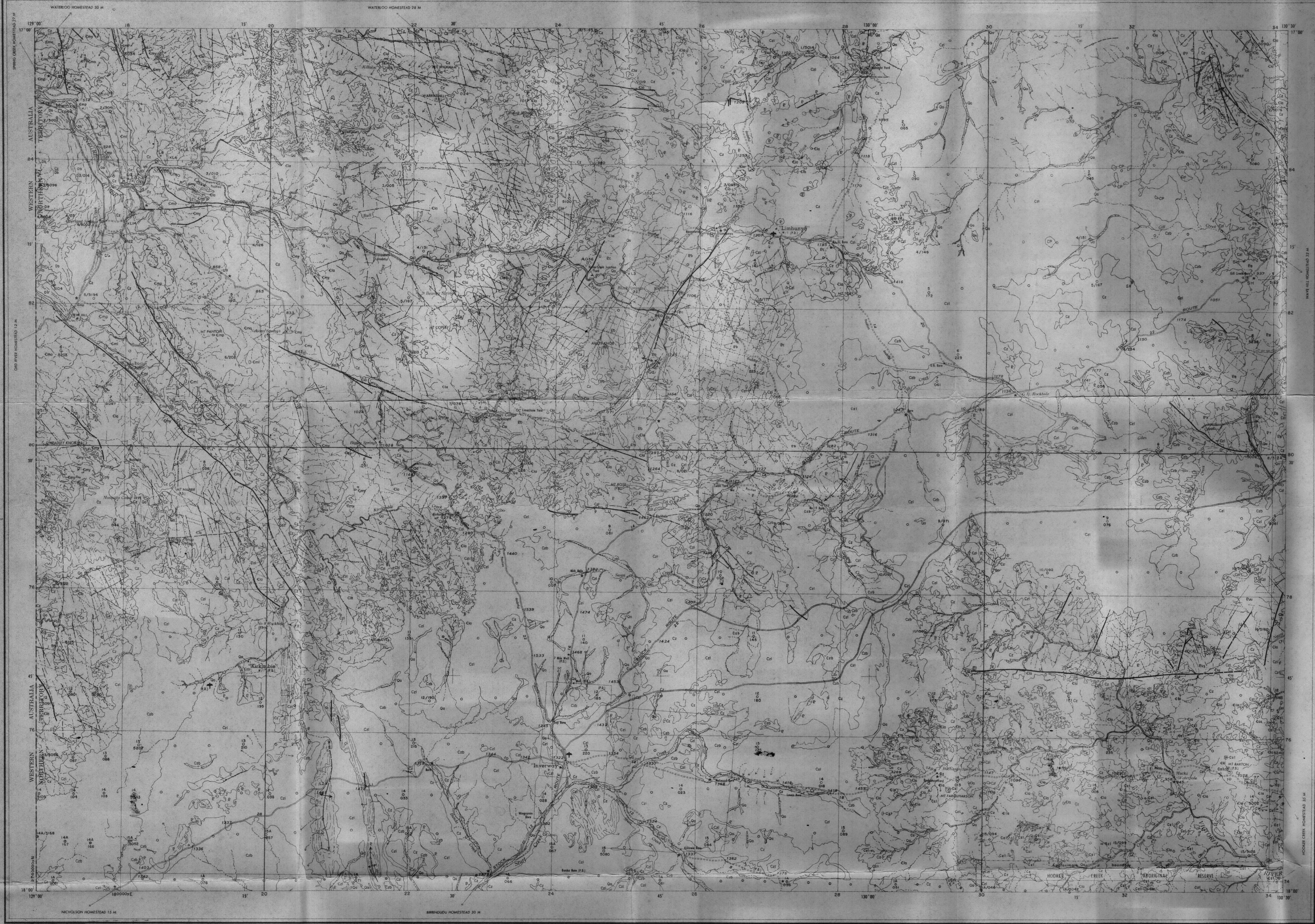
- L 8 Fine grained, light brown dolarenite with thin, sub-parallel beds of crystalline quartz.
- L 9 Fine grained, brown calcarenite with fine, scattered, transparent crystals.

Linnekar Limestone

- L 10 Very fine grained, light brown, laminated calcarenite; vesicles partly filled by fine, incoherent, fairly calcareous material.

Panton Formation

- L 11 Very fine, light brown, vesicular dolarenite with undulating laminations.
- L 12 Poorly sorted, light brown, fairly calcareous sandstone.
- L 13 Very fine grained, brown, vesicular dolarenite.
- L 14 Very fine grained, light brown, laminated, fairly vesicular dolarenite.



REFERENCE

Photogeological Character	Possible Geological Equivalent	
Variable tone, treeless, flat lying	Qa	Alluvium, colluvium
Light grey toned, elevated position	Q1	Terrace deposits
Very light toned, treeless, flat, characteristically variegated	Czb	Black residual soil and/or old alluvium
Dark toned, mesa-form	Cz1	Laterite, red soil
Medium toned, smooth	Cz	Undifferentiated
Medium toned, bedded	Db	Elder Sandstone
Light toned, soft appearance	Cmp	Panton Formation
Medium toned, bedded	Cml	Linnekar Formation
Light toned, soft appearance	Cmo	Nelson Shale
Light toned, bedded	Cmy	Headleys Limestone
Medium to dark toned, smooth surface, forming characteristic terraces, very jointed	C1c	Antrim Plateau Volcanics
Medium toned, flat lying	Euv	
Medium to dark toned, bedded	Eus	
Medium to dark toned, very jointed, elevated position	E8	
Medium to dark toned, jointed	E7	Bedded fine grained sandstone
Medium to dark toned, scarp forming	E6	Dolomite and interbedded siltstone
Light toned, soft appearance	E5	Dolomitic siltstone
Medium toned, bedded	E4	Silty sandstone
	E3	Massive microcrystalline quartz and quartz breccia
Medium toned, jointed, separated by scarps	E2	Thin bedded dolomite
	E1	
Medium toned, low relief, generally very jointed	E	Undifferentiated

- Lithological boundary

Probable lithological boundary, queried where inferred

Anticlinal axis

Synclinal axis

Fault, showing relative vertical movement

Probable fault, queried where inferred

Lineament

Edge of bed

Probable edge of bed

Edge of bed expressed as scarp

Estimated dips

Horizontal

Very low ($<5^{\circ}$)

Low ($3^{\circ}-10^{\circ}$)

Medium ($10^{\circ}-45^{\circ}$)

Steep ($>45^{\circ}$)

Vertical

Undetermined

Trend line

Joint pattern

Topographic scarp

General slope of surface

Dyke

Sink hole

Sample locality
- Principal road

Minor roads and tracks

Railway line

Telephone line

Fence

State boundary

Mine

Homestead

Yard

Windpump

Airport or Airfield, Landing ground

Bore

Tank

Well

Spring

Waterhole

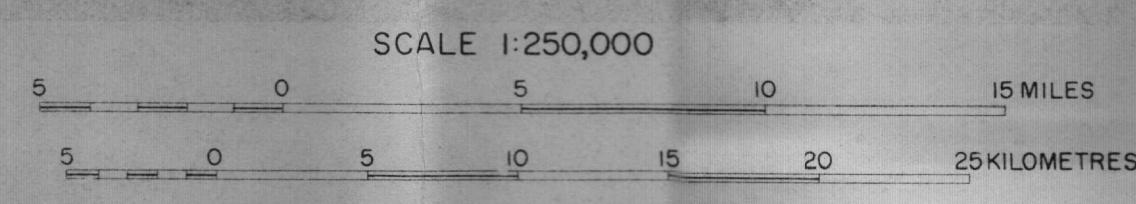
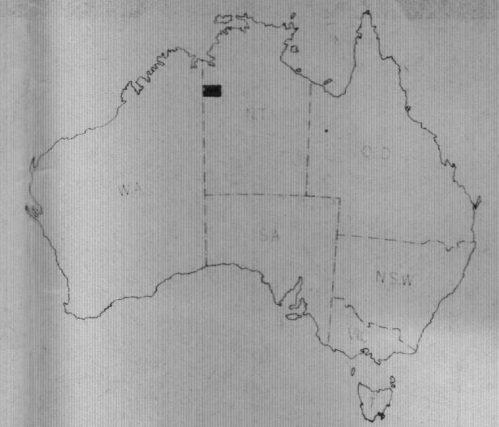
Dam

Clay pan

Photo-centre points

Photo-centre points-adjoint sheet

Compiled by the Bureau of Mineral Resources, Geology and Geophysics.
Detail adjusted to photoscale compilation prepared by the Division of National Mapping, Department of National Development.
Aerial photography by Royal Australian Air Force and Adastria Airways Pty Ltd, complete vertical coverage at 1:50,000 and 1:85,000 scale respectively.
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS

LISSADELL	WATERLOO	VICTORIA RIVER DOWNS
DIXON RANGE	LIMBUNYA	WAVE HILL
GORDON DOWNS	BIRRINDUDU	WINNECKE CREEK

Photo-interpretation by the Photogeological Group,
Bureau of Mineral Resources, Geology and Geophysics 1967
Interpreted by C. E. Moffit
Compiled by D. E. Brentnall and R. G. Winchester