

## **General Disclaimer**

### **One or more of the Following Statements may affect this Document**

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

78-101501  
CR-157244

THE USE OF LANDSAT IMAGERY IN RELATION TO AIR SURVEY IMAGERY  
FOR  
TERRAIN ANALYSIS IN NORTHWEST QUEENSLAND, AUSTRALIA

ERTS FOLLOW-ON PROGRAMME STUDY N° 2692B (29650)

"Made available under NASA sponsorship  
in the interest of early and wide dis-  
semination of Earth Resources Survey  
Program information and without liability  
for any use made thereof."

FINAL REPORT

by

MONICA M COLE

B.Sc., Ph.D(Lond.), F.I.M.M., F.R.G.S., F.G.S., F.R.Met.Soc.

and

E. STUART OWEN-JONES

B.Sc., Ph.D.(Wales), M.I.Inst.P.

Supported by the U.K. Department of Industry  
Monsanto House, 10-18 Victoria Street, London, SW1 ONQ

Volume III

(E78-10150) THE USE OF LANDSAT IMAGERY IN RELATION TO AIR SURVEY IMAGERY FOR TERRAIN ANALYSIS IN NORTHWEST QUEENSLAND, AUSTRALIA, VOLUME 3 Final Report (Department of Industry) 73 p HC A04/MF A01 N78-27480 Unclas CSCL 08B G3/43 00150

15 December 1977

"Made available under NASA sponsorship  
in the interest of early and wide dis-  
semination of Earth Resources Survey  
Program information and without liability  
for any use made thereof."

Original photography may be purchased from:  
EROS Data Center

Sioux Falls, SD 57198

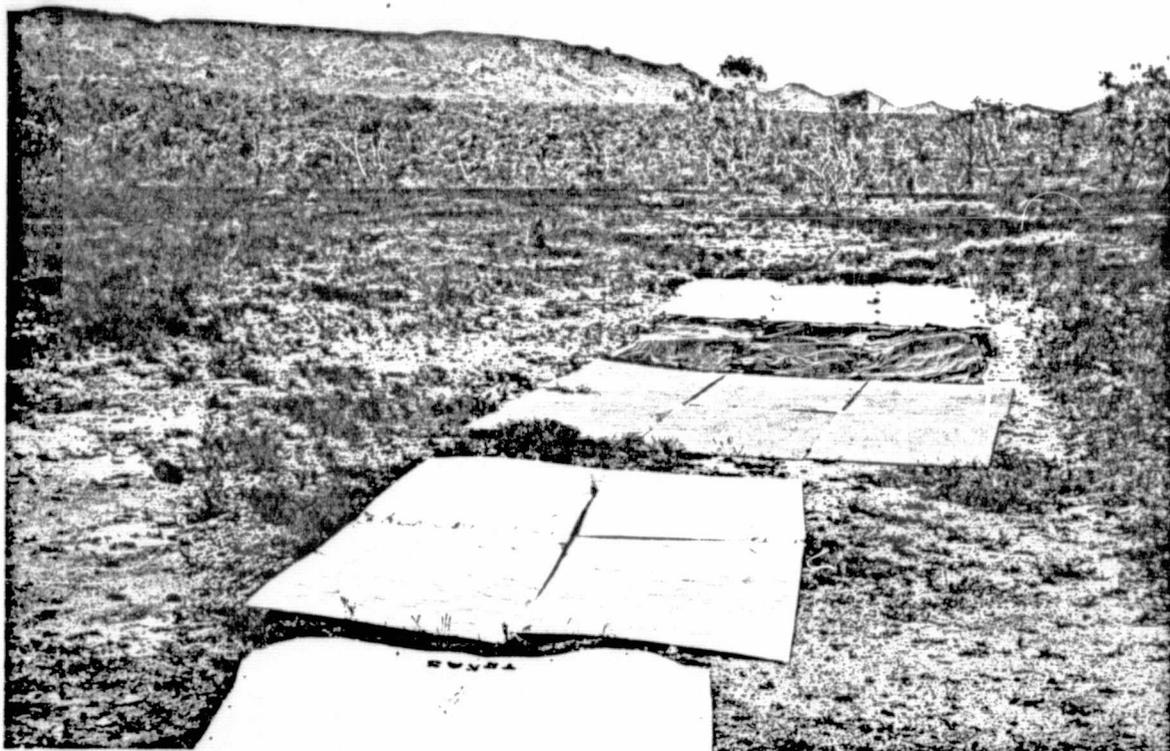


Plate 1 The Mary Kathleen - Cloncurry area. Removable marker boards which were placed under each flight line for the air survey carried out in April/May 1971.  
(Phot ref: MMC/A<sup>a</sup> 144/5 )

ORIGINAL PAGE IS  
OF POOR QUALITY

FOLIOOT-FRAME

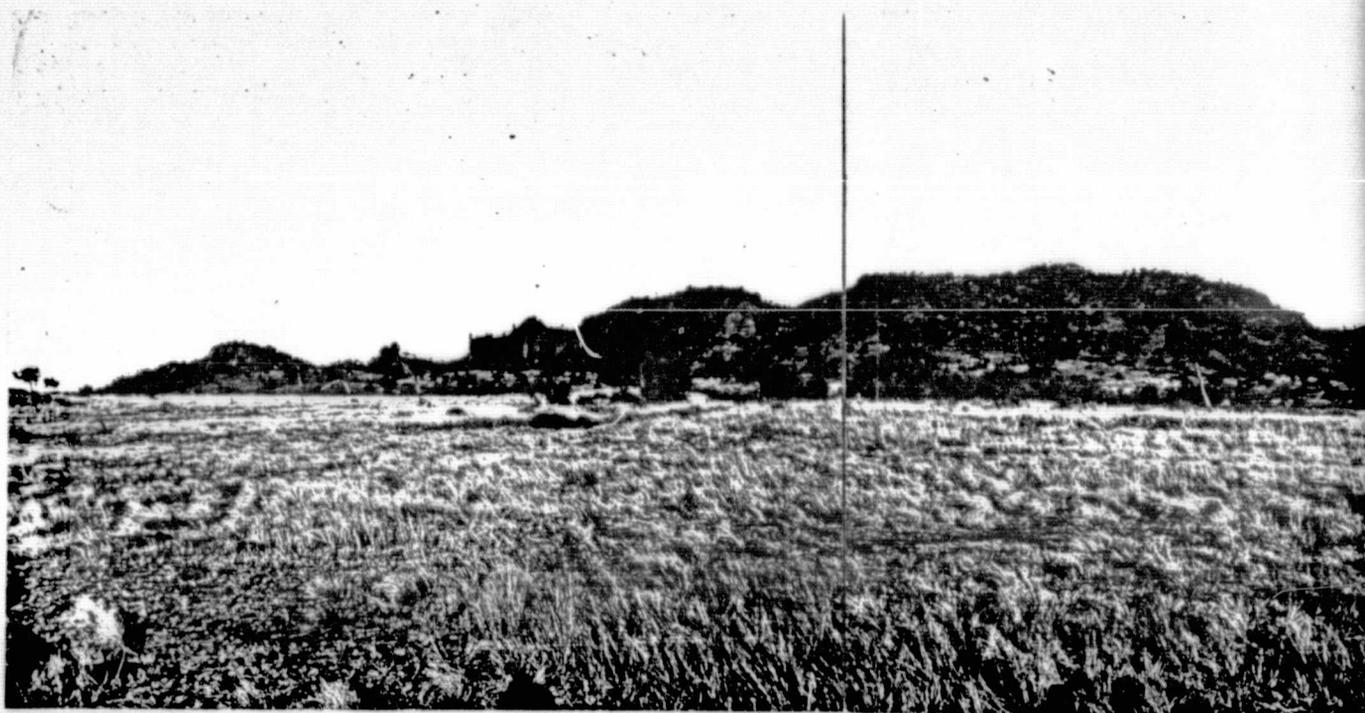
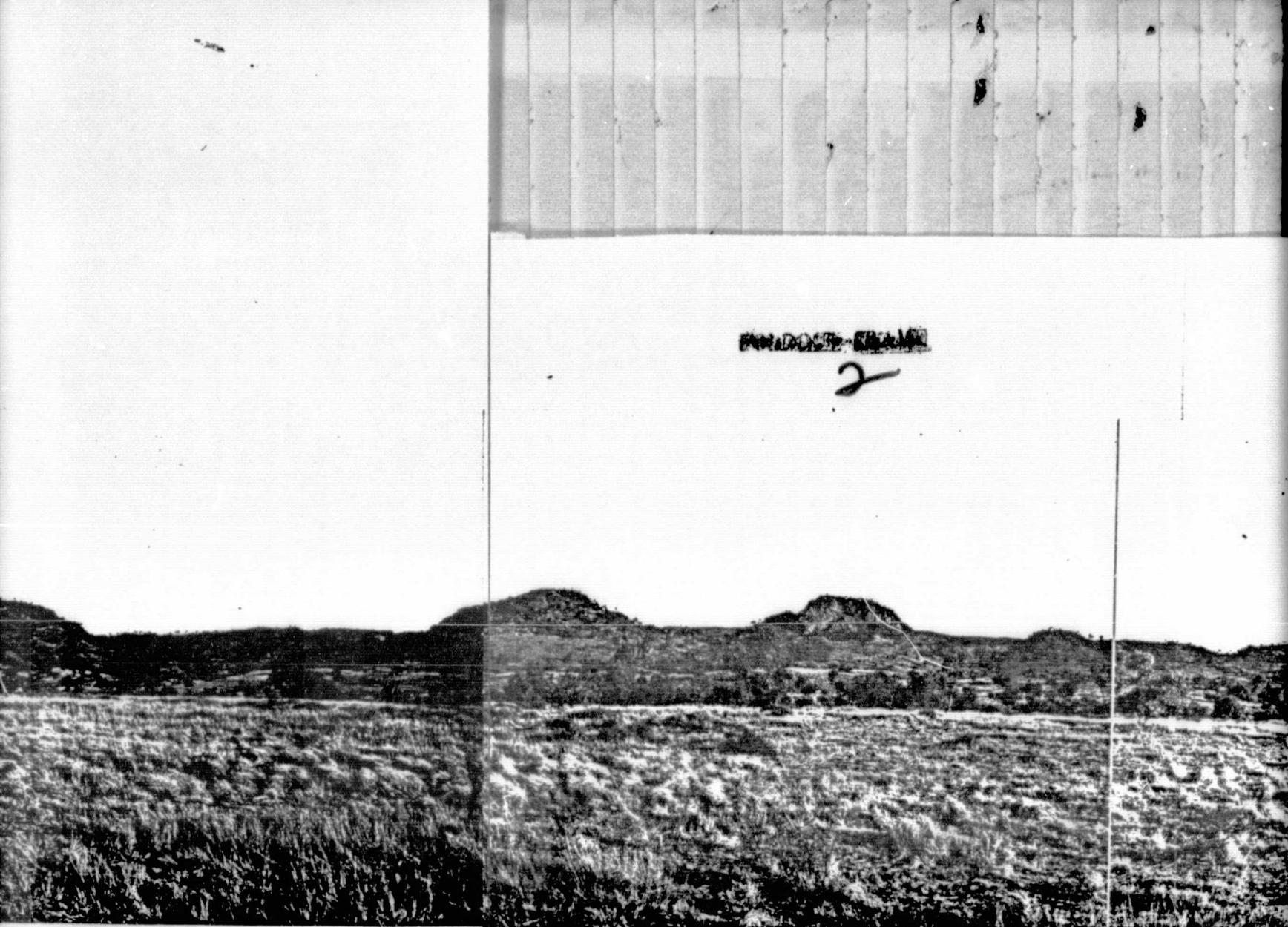


Plate 2 The Mary Kathleen - Duchess area. Panoramic view southwards across level terrain underlain by the Corella formation to hills formed of Mitakoodi quartzite and Overhang jasperlite. The flat-topped hills (right) represent Mesozoic residuals capped by laterite. The hills of Mitakoodi quartzite produce relatively light spectral signatures (3ade, 4aed, 4dea) on the colour composites generated from the December 1972 LANDSAT 2 imagery, whereas those capped by Overhang jasperlite have relatively dark spectral signatures (6eda, 6eab, 7eba).

(Photo ref: MMC/A<sup>a</sup> 181/1a-2a-3a-4a-5a September 1974)



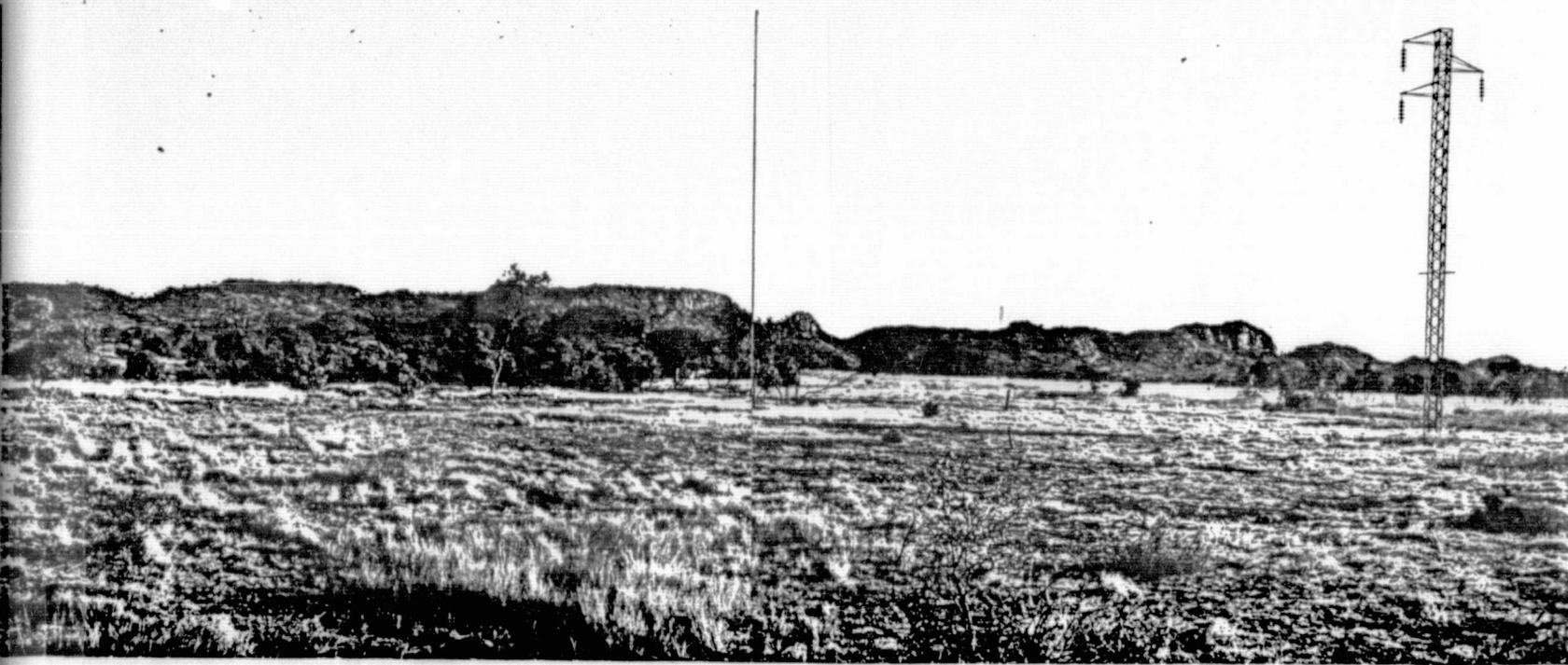
~~PHOTOGRAPH~~

2

ORIGINAL PAGE IS  
OF POOR QUALITY

WALDOGE - 11/1/51

3



148/6A-7, 7A-8, 8A-9

1



Plate 3

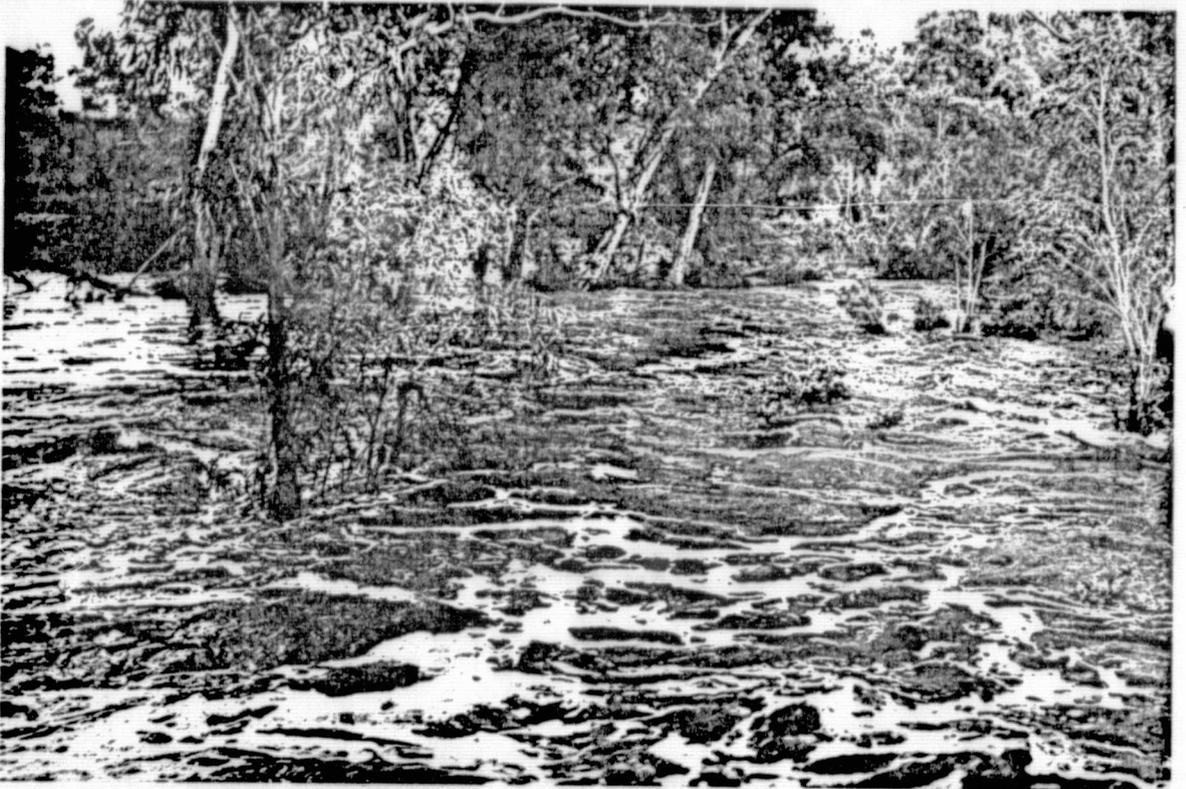
The Dugald River area. View over plain of dark brown to black cracking clay soils carrying a grassland in which the distributions of different communities produce lozenge shaped features, to residual hills of Mesozoic rocks capped by laterite in the background. The trees in the foreground are Acacia cambagei. The Mesozoic residuals produce dark dominantly blue spectral signatures on the colour composites of the LANDSAT imagery at all seasons. The grassland plains produce red signatures in March and light pink/yellow ones in July.

(Photo ref: MMC/A<sup>a</sup> 148/6A - 7, 7A - 8, 8A - 9 : July 1971)

WINDY-FLAME

2





ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 4 The Mary Kathleen - Cloncurry area. The Corella River in flood  
April 1971.  
(Photo ref: MMC/A<sup>a</sup> 142/15)

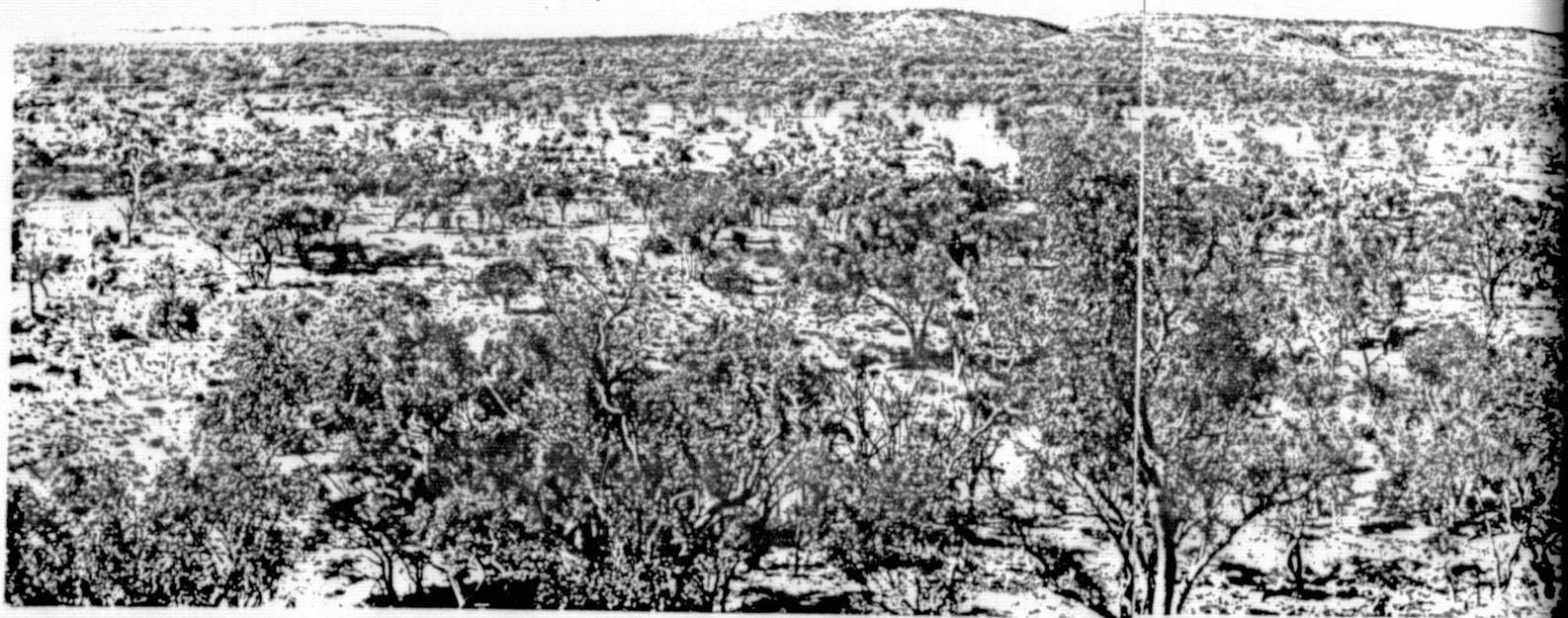
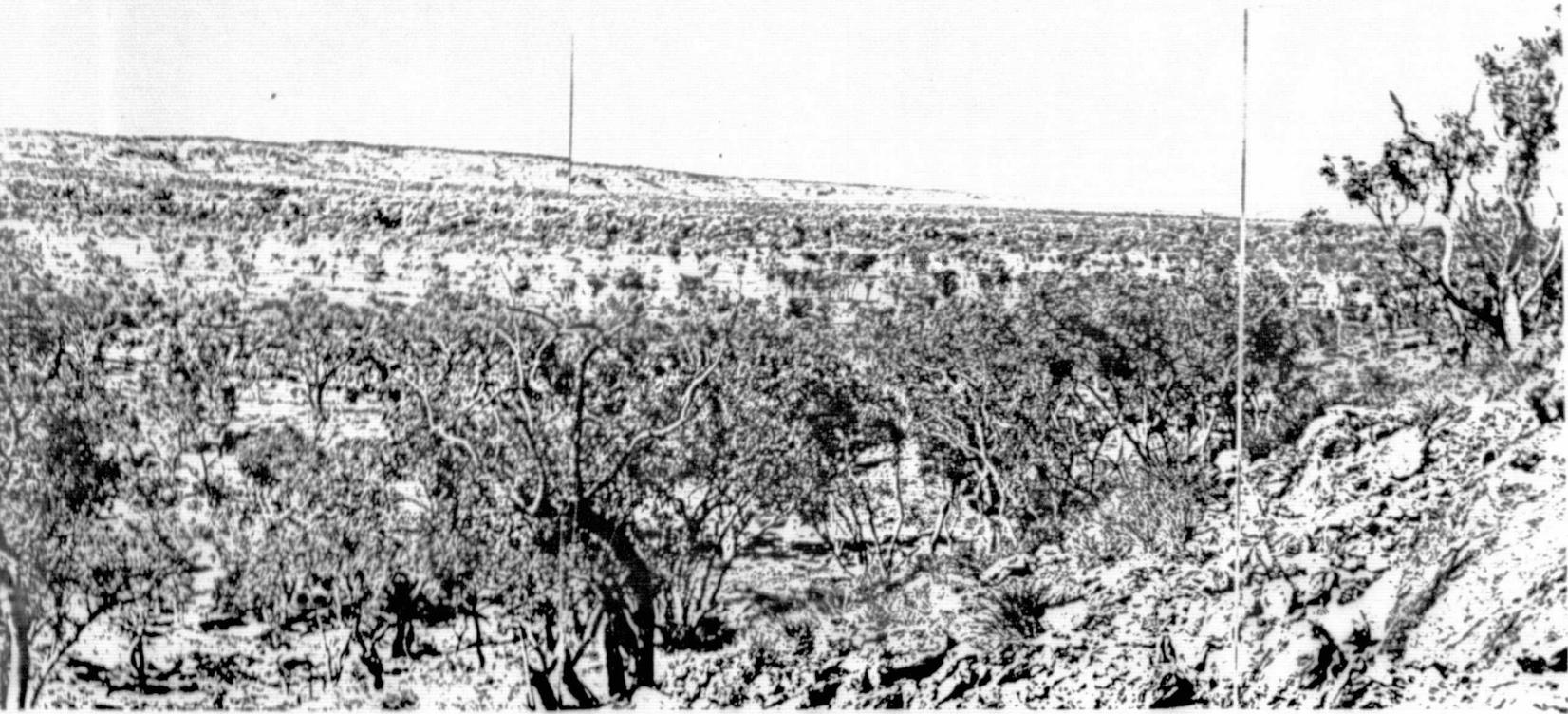


Plate 5 The Dugald River area. View southeastwards across areas of low tree and shrub savanna over calc-silicate rocks and grassland over alluvium to the Knapdale quartzite range from Mesozoic residual capped by laterite northwest of Cabbage Tree Creek. Photo ref: MMC/A<sup>a</sup> 143/12A-13, 13A-14, 14A-15, 15A-16 July 1971.

PHOTOGRAPH

2



ORIGINAL PAGE IS  
OF POOR QUALITY

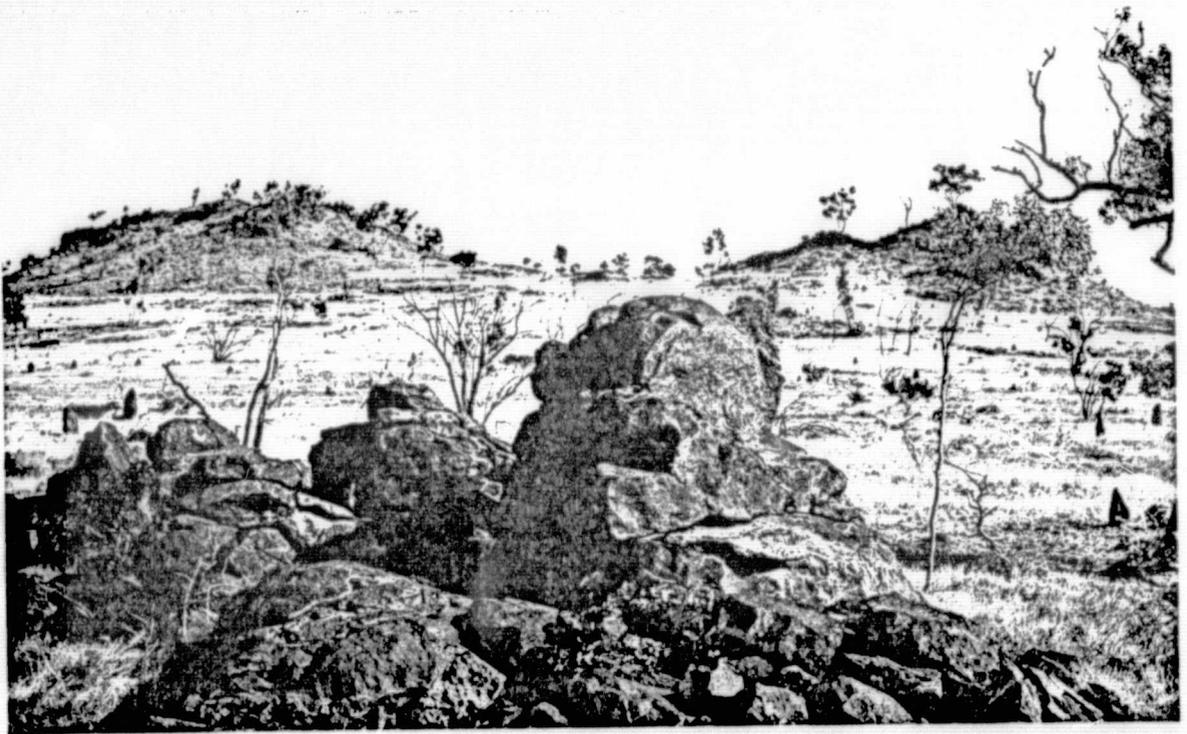


Plate 6

The Dugald River area. Bedrock coated with iron and manganese which gives rise to dark spectral signatures on the colour composite of the LANDSAT imagery. (Photo ref: MMC/Aa 155/10A August 1971).

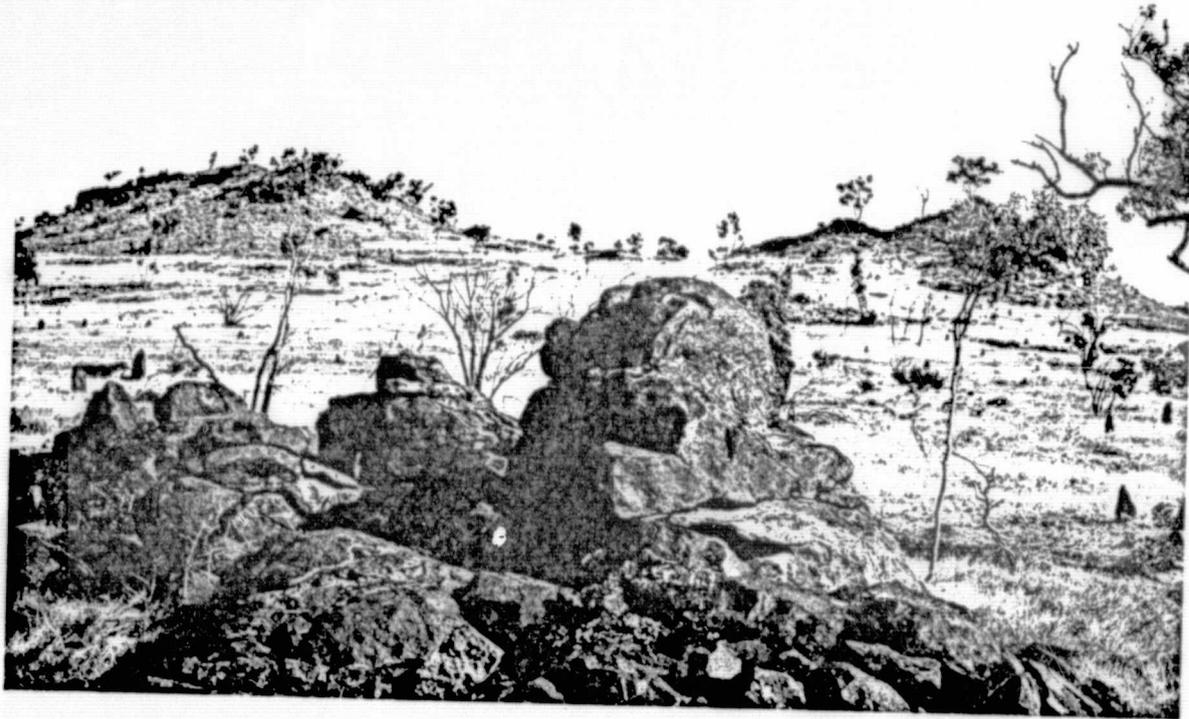


Plate 6 (A) The Dugald River - Naraku area. Tors and pediments developed over Naraku granite. In the foreground bedrock has a ferruginous coating. The areas underlain by the Naraku granite produce spectral signatures of medium tone and blue-green colour (5ed, 5de, 4eda, 5aed, 3dea) on the colour composites generated from the March 1975 LANDSAT 2 imagery.  
(Photo ref: MMC/A<sup>a</sup> 155/10a August 1971)

ORIGINAL PAGE IS  
OF POOR QUALITY

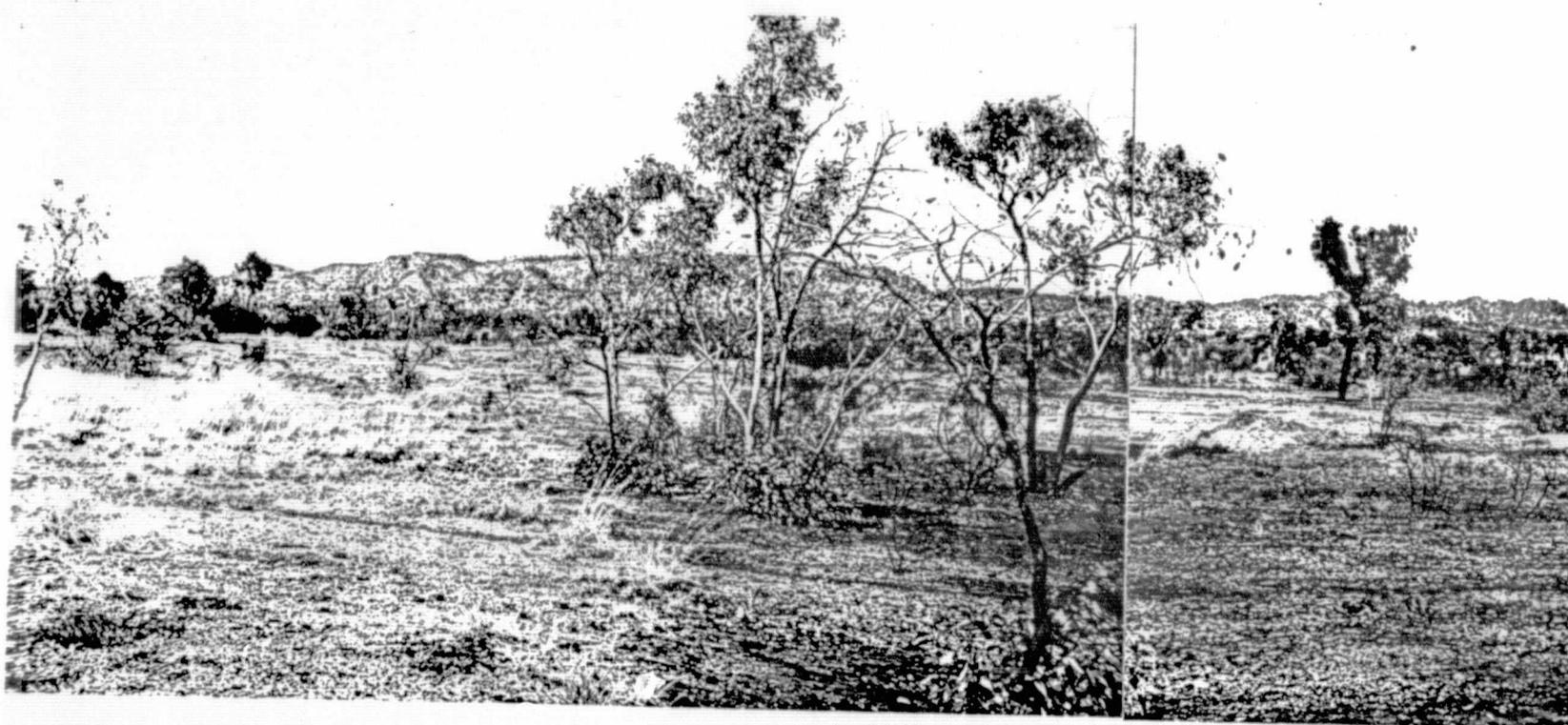


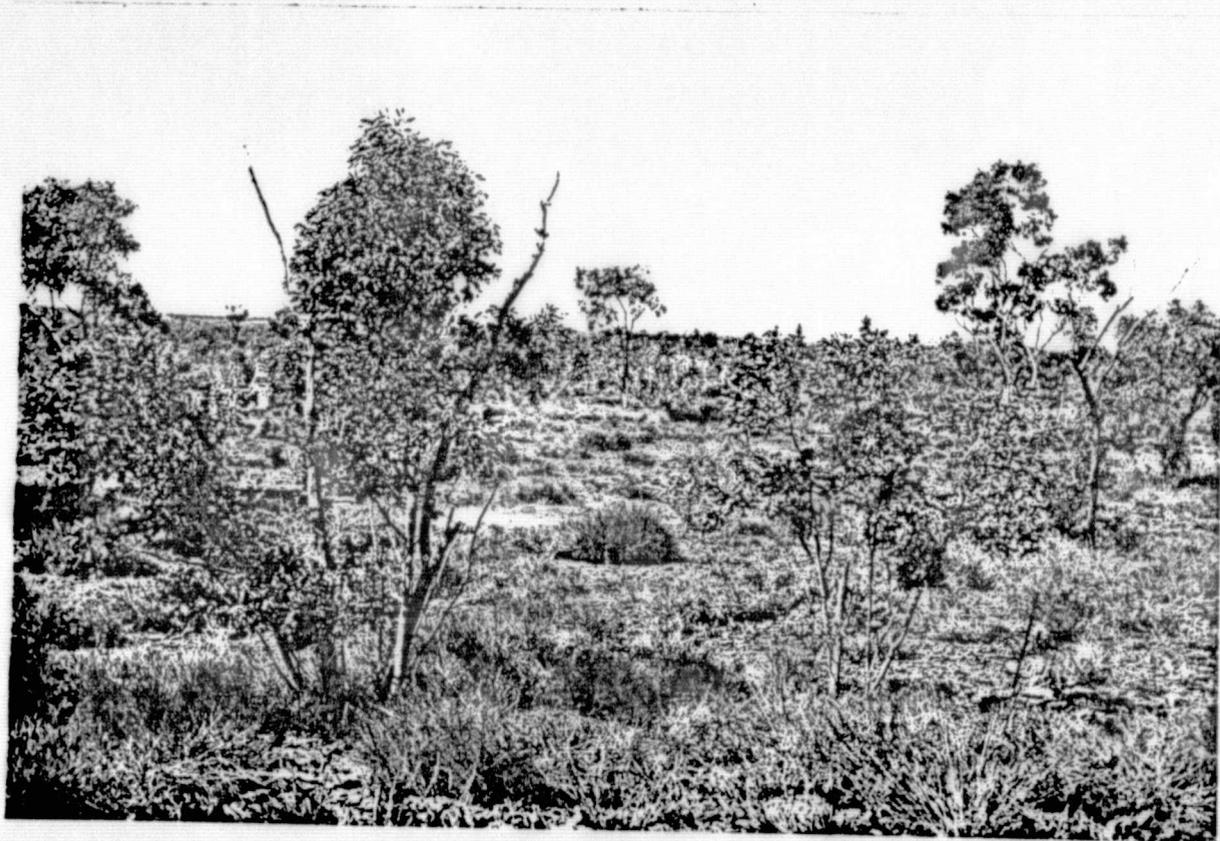
Plate 7 View southwards across area underlain by Leichardt Metamorphic rocks to hills of Corella rocks with the Mount Remarkable fault marking the line of contact. View taken southwest of Kajabbi.  
Photo ref: MMC/A<sup>a</sup> 191/16A-17, 17A-18, 18A-19 August 1975.

ORIGINAL PAGE IS  
OF POOR QUALITY

PHOTOGRAPH

2





ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 8 The Dugald River area. Low tree and shrub savanna dominated by Eucalyptus brevifolia trees west of the Dugald River lode. Photo ref: MMC/A<sup>a</sup> 149/18 July 1971.

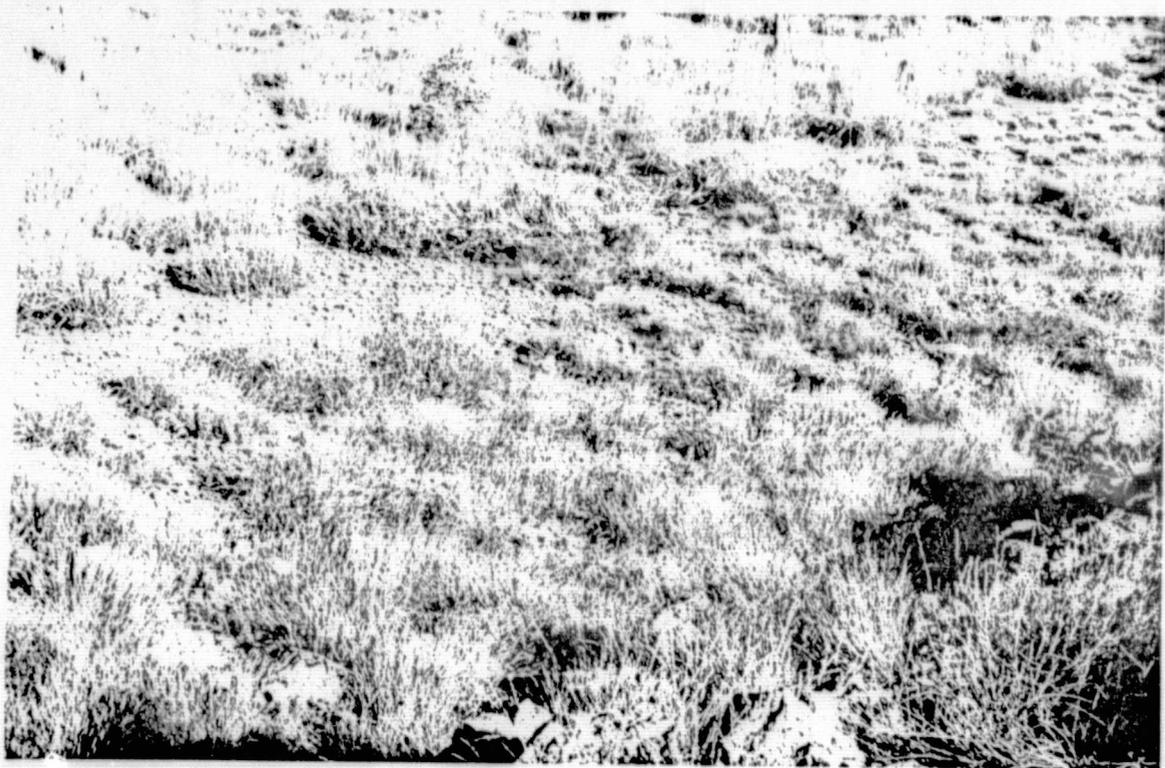


Plate 9      The Dugald River area. Triodia pungens grass.  
Photo ref: MMC/A<sup>a</sup>140/29A-30: April 1971.

ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 10 The Cloncurry Plains. Open grasslands dominated by Astrebla spp and Iseilima spp grasses.  
( Photo ref: MMC/Aa 178/ 19A-20 August 1974 )

ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 11

The Lady Annie area. Open low tree savanna of Eucalyptus brevifolia trees and Enneapogon polyphyllus and other annual grasses in the foreground; woodland of Acacia shirleyi in background. The former growing in residual soils over dolomites of the Paradise Creek formation produces spectral signatures of medium tone and dominantly red green colour (4 adce) on the March 1975 LANDSAT 2 imagery. The latter occupying ferruginous soils associated with laterite produces a spectral signature of dark tone and dominantly blue red colour (5 eap, 6 ed, 6 aed etc).  
(Photo ref: MMC/A<sup>a</sup> 142/9 : April 1971.)



Plate 12

The Cloncurry Plains. Grassland with stands of Acacia cambagei trees.

Photo ref: MMC/A<sup>a</sup> 178/23A-24 August 1974.

ORIGINAL PAGE IS  
OF POOR QUALITY

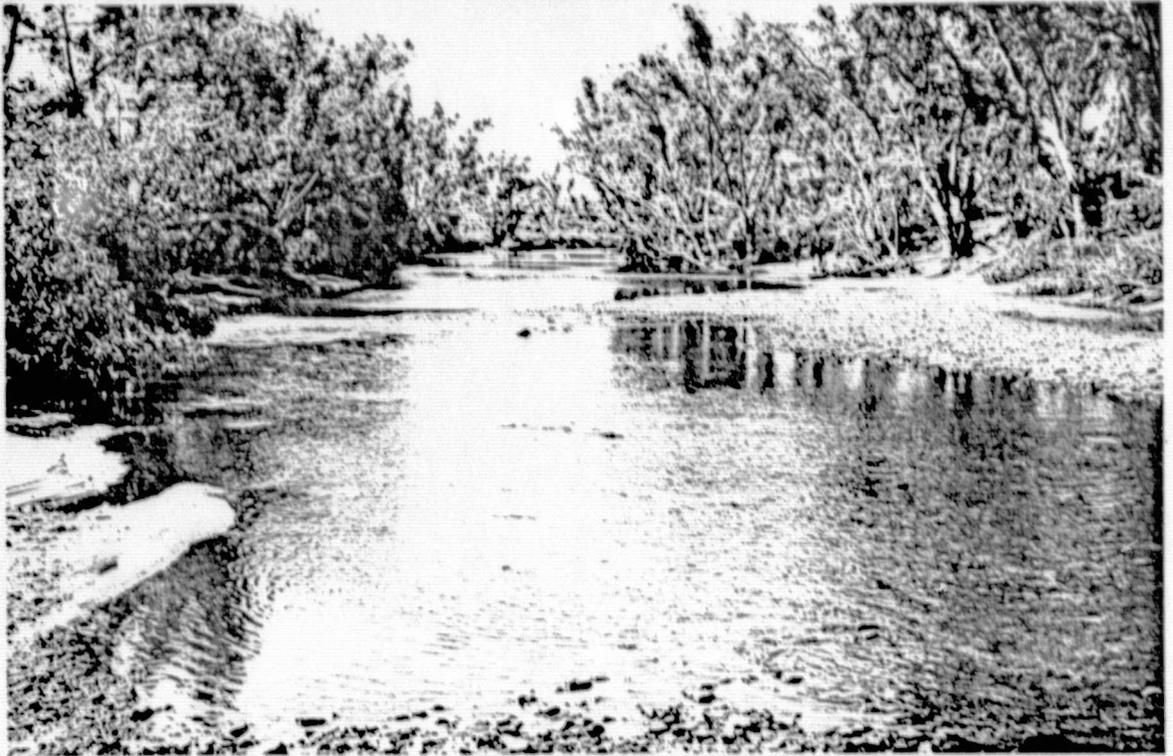
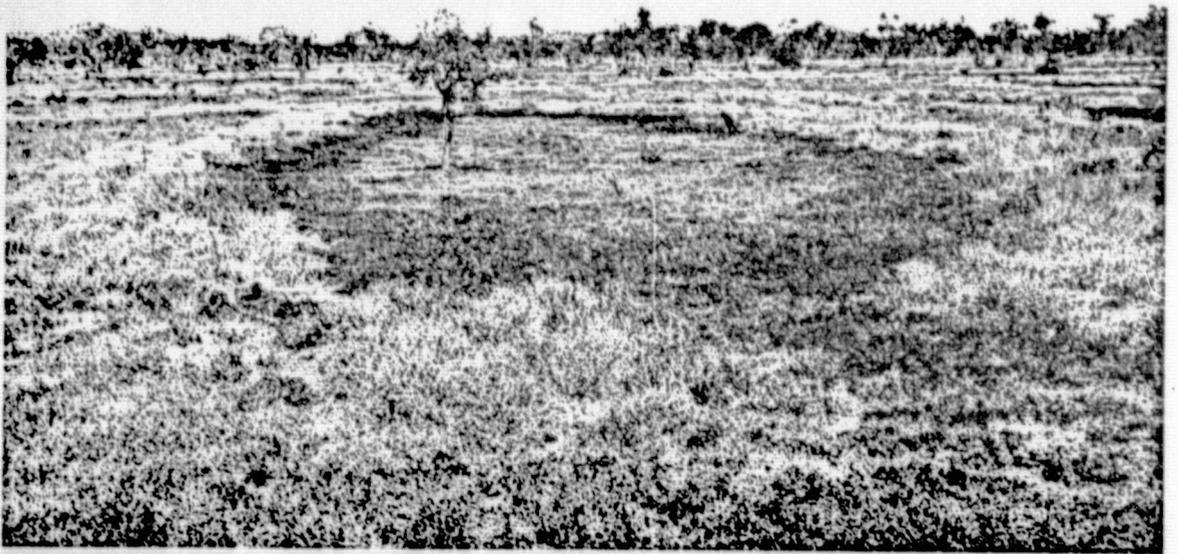


Plate 13

The Dugald River. Creek line vegetation of Tristania grandiflora, Eucalyptus camaldulensis, Bauhinia carronii etc. This vegetation produces red spectral signatures on the colour composites of the LANDSAT imagery at all seasons of the year. The river carries flood waters after rains but is dry for the greater part of the year. After the flood waters have passed a series of billabongs contain water for a short period.

(Photo ref: MMC/Aa 141/31 - 31A : April 1971)

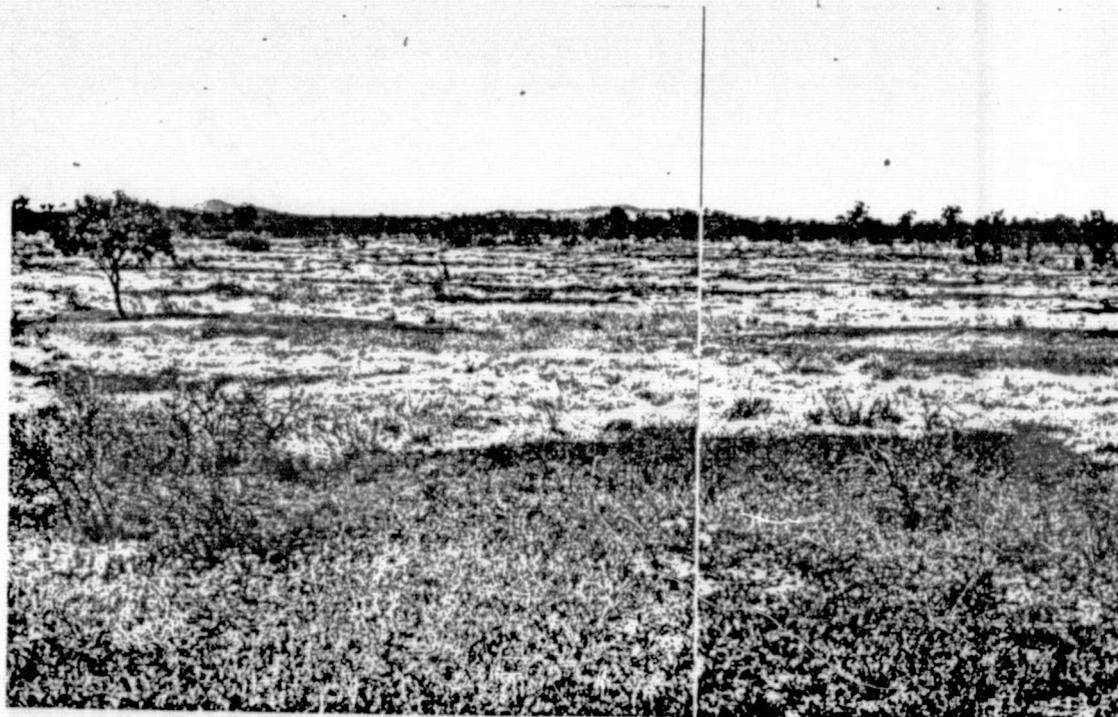


ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 14      The Dugald River area. The Little Eva Plains: distinctive grass communities whose distributions produce lozenge shaped features on the air photos.  
(Photo ref: MMC/A<sup>a</sup> 146/34A-35 July 1971).

~~CONFIDENTIAL~~

1



15 The Dugald River area. The Little Eva Plains; distinctive grass communities whose distribution produce the lozenge shaped features on the air photos.

(Photo ref: MMC/A<sup>a</sup> 148/23A - 24, 24A-25, 25A-26 )

PHOTOGRAPHY

2

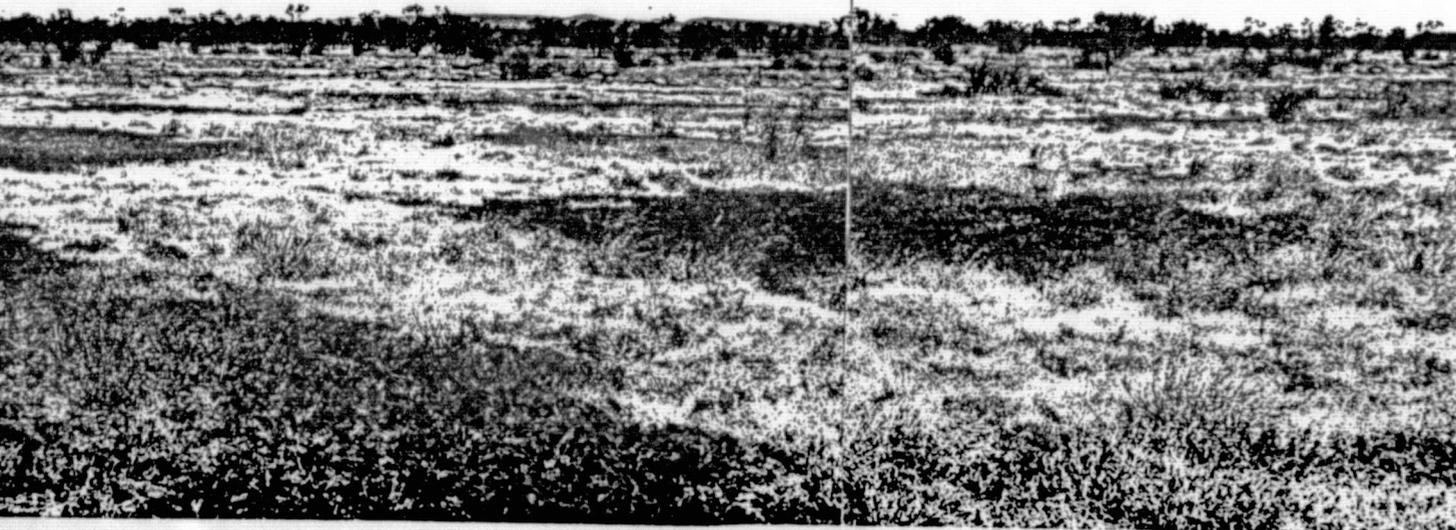




Plate 16

The Cloncurry area. View across level plains with savanna grassland occupying dark reddish-brown clay soils and displaying lozenge-shaped features produced by the concentric distributions of individual grass and herb communities, north of Marraba.

(Photo ref: MMC/A<sup>a</sup> 189/12a-13a-14a August 1975).

~~DOWNSTREAM~~  
2



ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 17 The Cloncurry Plains. Vegetation of Eucalyptus pruinosa and Triodia pungens over reddish brown sandy soil near Gipsy Plains Homestead. This vegetation gives a green blue spectral signature at all seasons on the LANDSAT I and LANDSAT II imagery.  
(Photo ref: MMC/A<sup>a</sup> 175/20A - 21: May 1974)

ORIGINAL PAGE IS  
OF POOR QUALITY

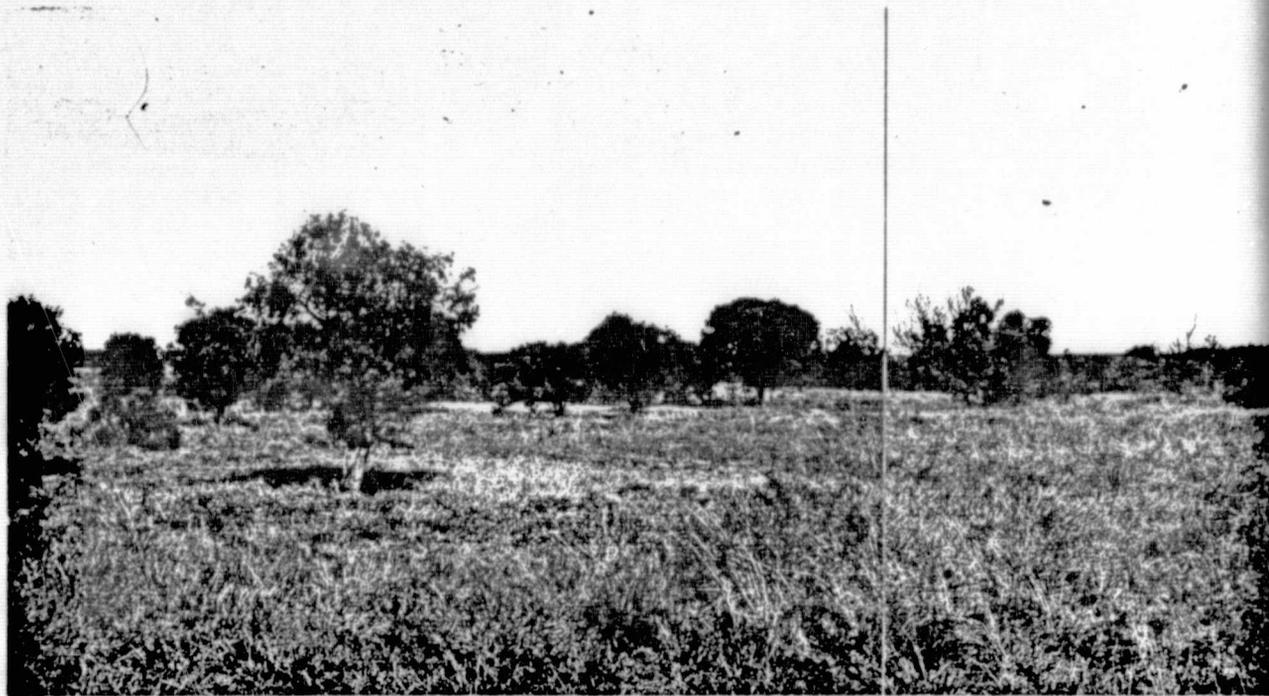
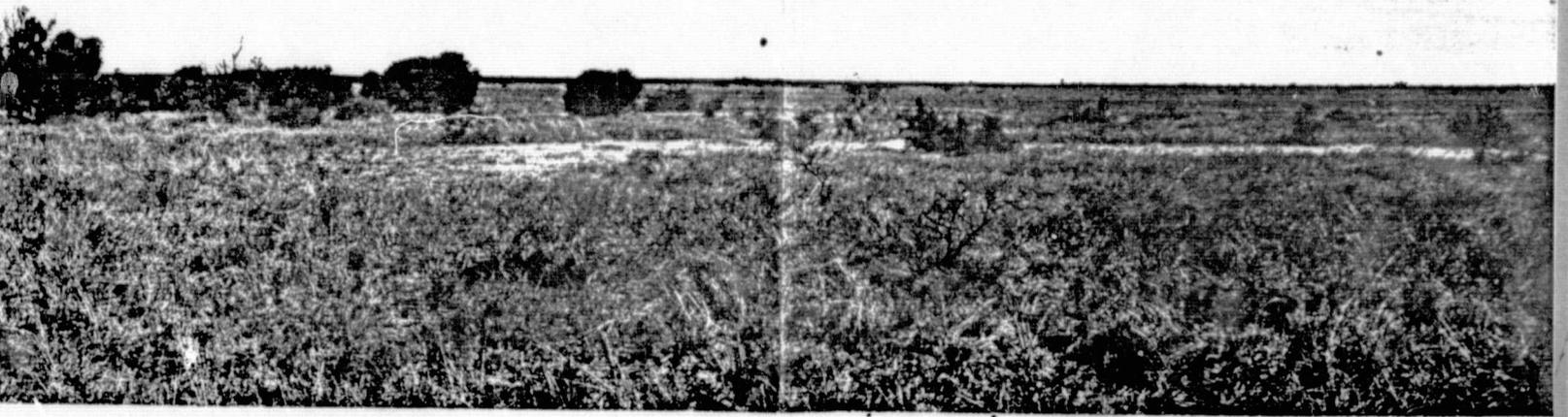


Plate 18.

The Cloncurry Plains. Stand of Acacia cambagei trees on the savanna grasslands dominated by Astrebla pectinata and Iseilima macrathera grasses. A lozenge shaped feature produced by concentric bands of different grass and herb species is apparent in the centre of the panorama. The grasslands produce bright red spectral signatures on the colour composite of the March LANDSAT 2 imagery. The stands of Acacia cambagei trees produce darker violet or blue red spectral signatures. (6 gea, 6 eda).  
(Photo ref: MMC/A<sup>a</sup> 175/21A - 22A - 23A May 1974)

~~ADOGS - PRAIRIE~~

2



ORIGINAL PAGE IS  
OF POOR QUALITY

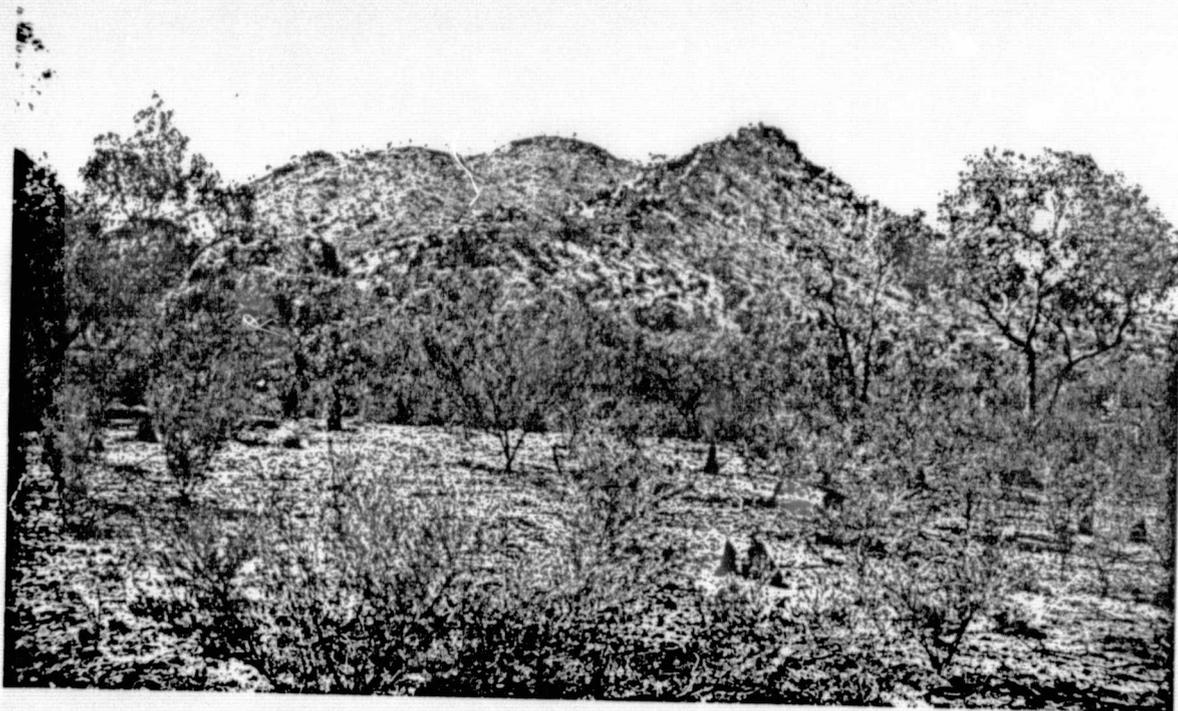


Plate 19

The Mary Kathleen area. View across level terrain underlain by the Wonga granite to hilly country built of the Argylla formation north-west of the Wonga Fault which marks the contact between the two formations. In the foreground low tree and shrub savanna of Eucalyptus brevifolia trees, Acacia chisholmii shrubs and Triodia pungens and annual grasses. (Photo ref: MMC/A<sup>2</sup> 195/27a-28 September 1975)

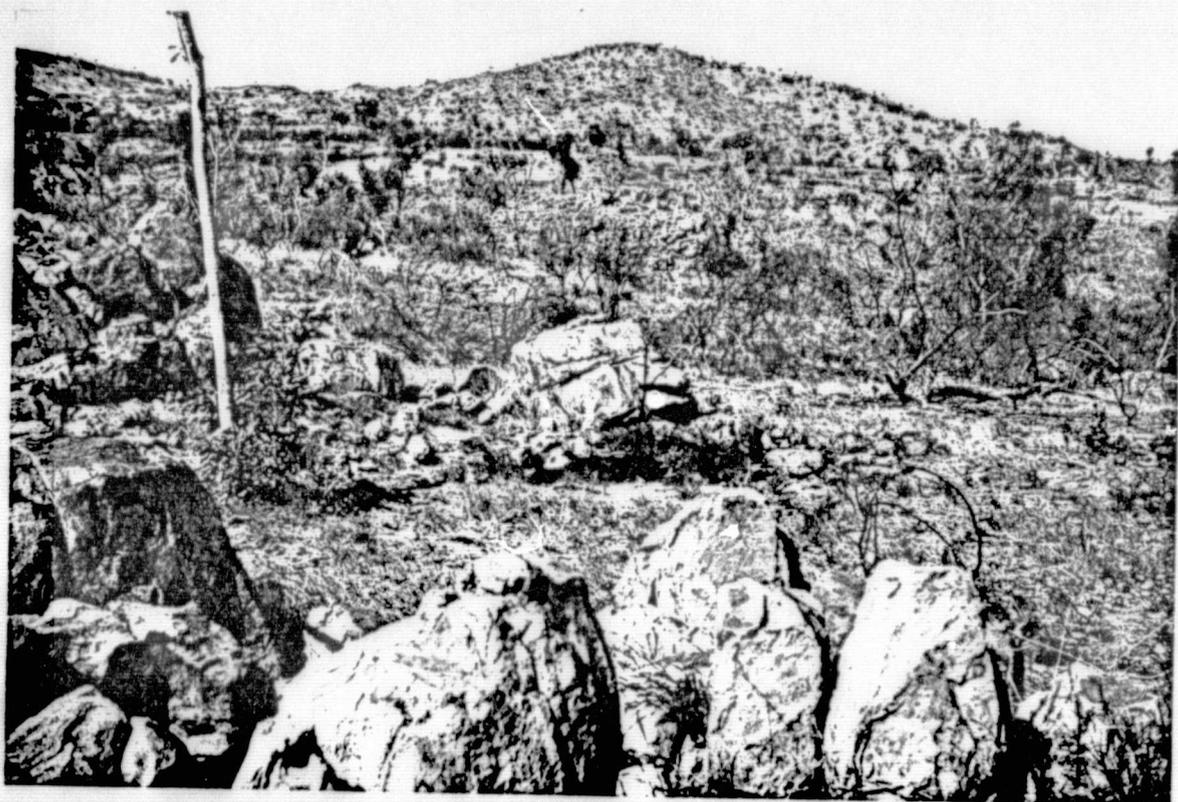


Plate 20 The Mary Kathleen area. View over relatively level terrain underlain by Leichardt Metamorphic rocks which outcrop in the foreground. This type of terrain produces light pink and blue spectral signatures (1he, 2h, 2hc etc.) on the colour composites generated from the March 1975 LANDSAT 2 imagery.  
(Photo ref: MMC/A<sup>a</sup> 196/8a September 1975)

ORIGINAL PAGE IS  
OF POOR QUALITY

201007-12412



Plate 21 The Mary Kathleen - Cloncurry area. Hill of Chumvale breccia with jasperlite fragments. In the foreground vegetation of Eucalyptus terminalis and Eucalyptus argillacea with Enneapogon polyphyllus and Chrysopogon fallax grasses. Around the base of the hill stands of Acacia cambagei trees. (Photo ref: MMC/A<sup>a</sup> 185/33a-34a-35a April 1975)

1

2

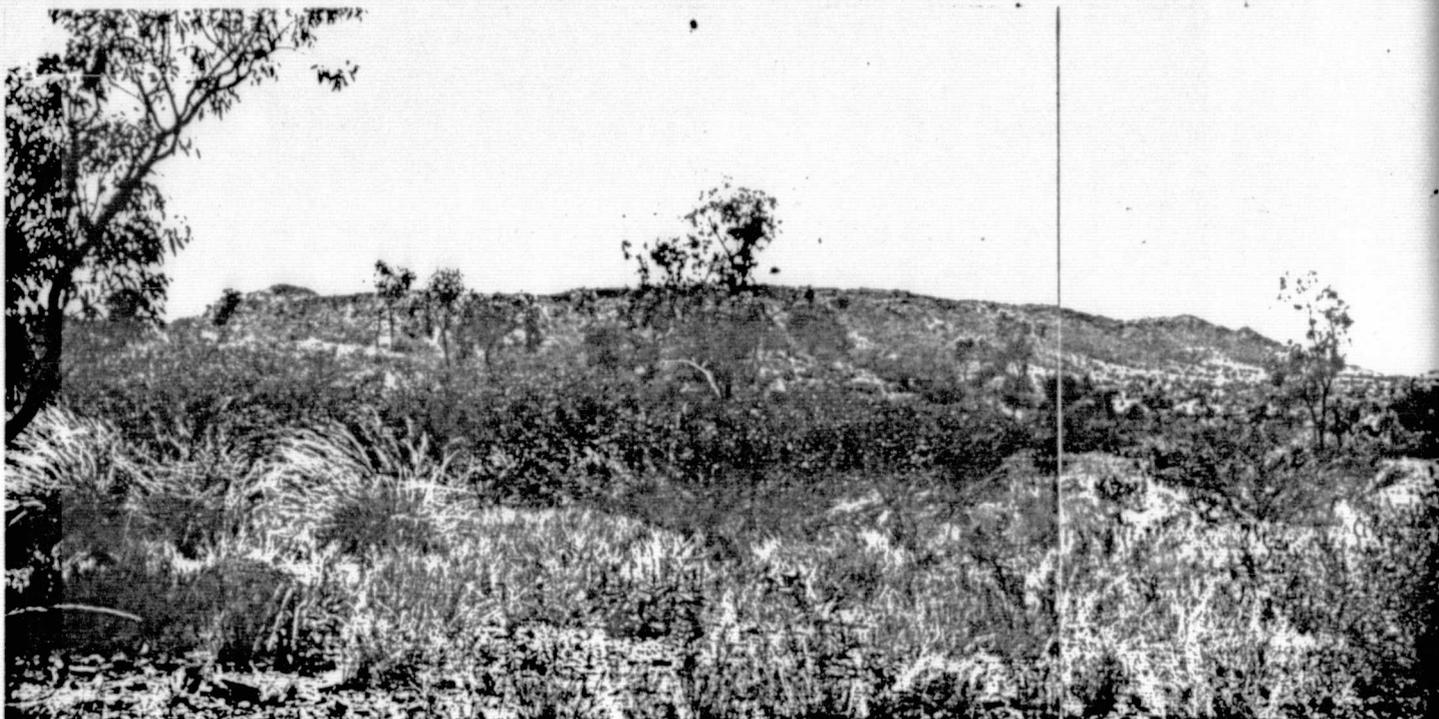




ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 21

The Mary Kathleen-Cloncurry area. Hills capped with Jaspilite southeast of Mary Kathleen. Vegetation in the foreground dominated by Enneapogon polyphyllus grass with scattered Eucalyptus brevifolia trees. (Photo ref: MMC/A<sup>a</sup> 175/33A May 1974).



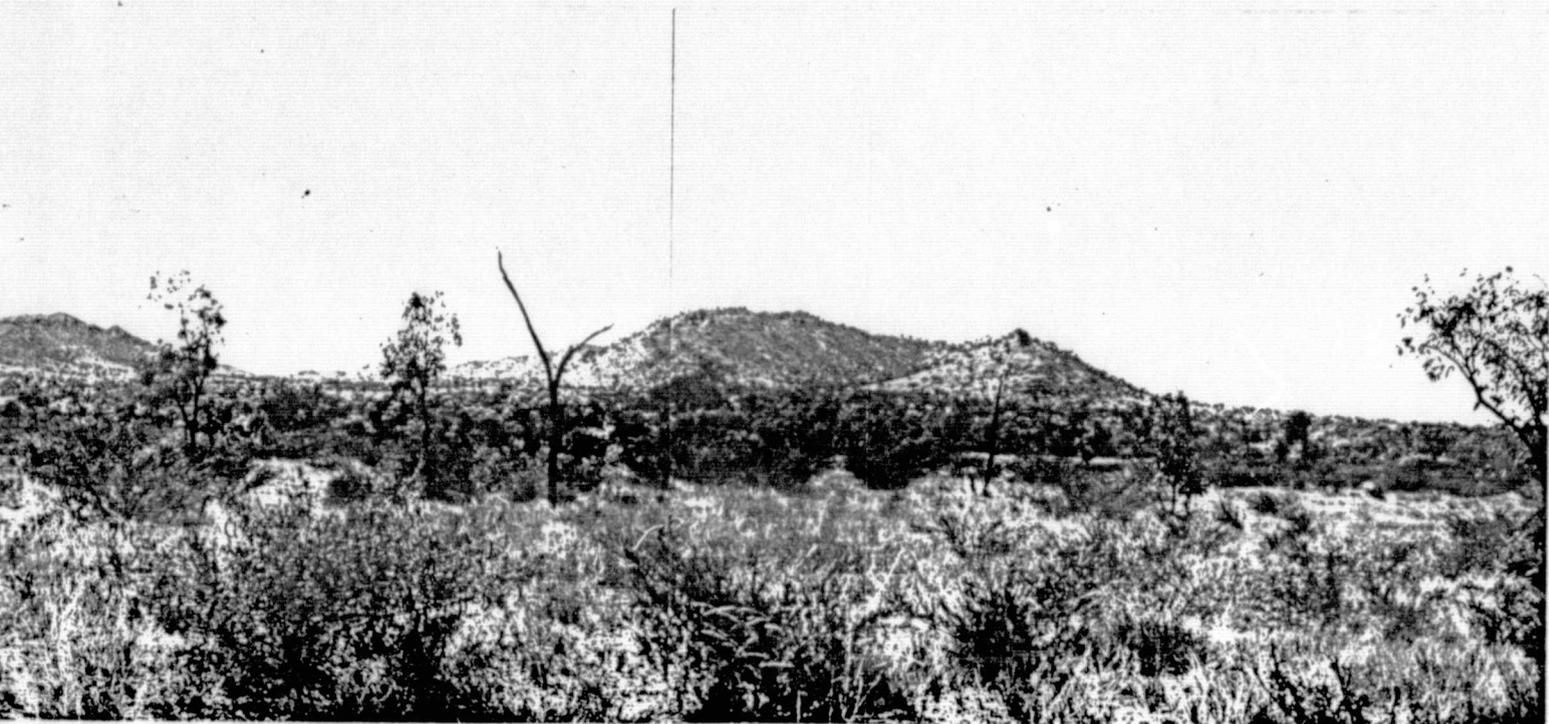
ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 22

The Mary Kathleen area. Hills of Mitakoodi quartzite disposed in the Wakeful syncline within the Mitakoodi anticlinorium. In the foreground low tree and shrub savanna of Eucalyptus brevifolia trees, Acacia chisholmii shrubs and Triodia pungens grass and associated annual grasses. The area of the Mitakoodi quartzite hills produces relatively light red green and yellow spectral signatures on the December 1972 imagery of LANDSAT 1.  
(Photo ref: MMC/A<sup>a</sup> 182/2A-3A-4A September 1974).

END OF PAGE

2



in  
he

e hills  
ares



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 23

The Mary Kathleen - Cloncurry area. View over a level terrain underlain by Marraba Volcanics carrying a grassland characterized by *Enneapogon polyphyllus* giving dominantly blue spectral signatures of medium tone on the LANDSAT 1 imagery for December 1972. In the background hills of Mitakoodi quartzite which produce relatively light red green and yellow spectral signatures.

(Photo Ref: MMC/A<sup>a</sup> 182/7A September 1974)



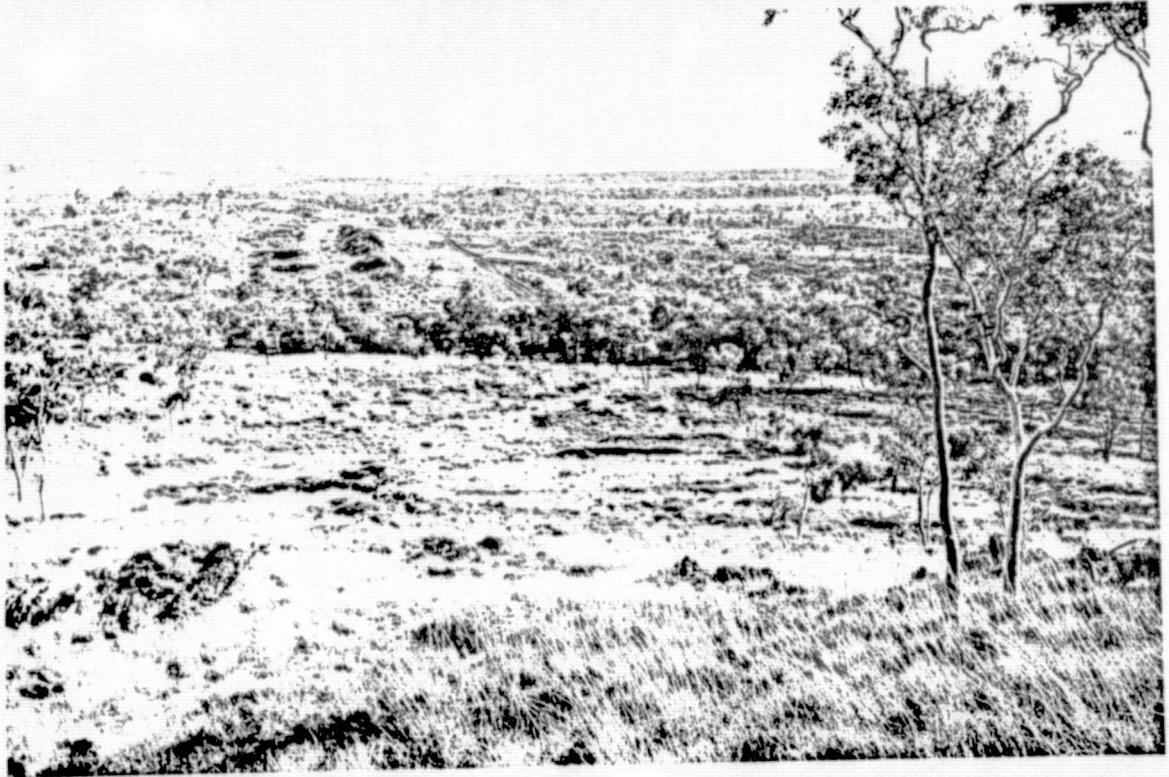
Plate 24 . The Dugald River area. View northwards over the anomalous plant community of Eriachne mucronata and Polycarpaea glabra over the Dugald River lead-zinc lode from north of Silvermine Creek.  
( Photo ref: MMC/Aa 174/ 31A-32 August 1974)

DO NOT FRAME

2



ous  
of



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 25 The Dugald River area. View northwards along the anomalous plant community of Eriachne mucronata and Polycarpaea glabra over the Dugald River lead-zinc lode. Background vegetation of Eucalyptus brevifolia and Eucalyptus argillacea trees and Triodia pungens grass to the east and west.  
(Photo ref: MMC/A<sup>a</sup> 140/28a-29 April 1971)

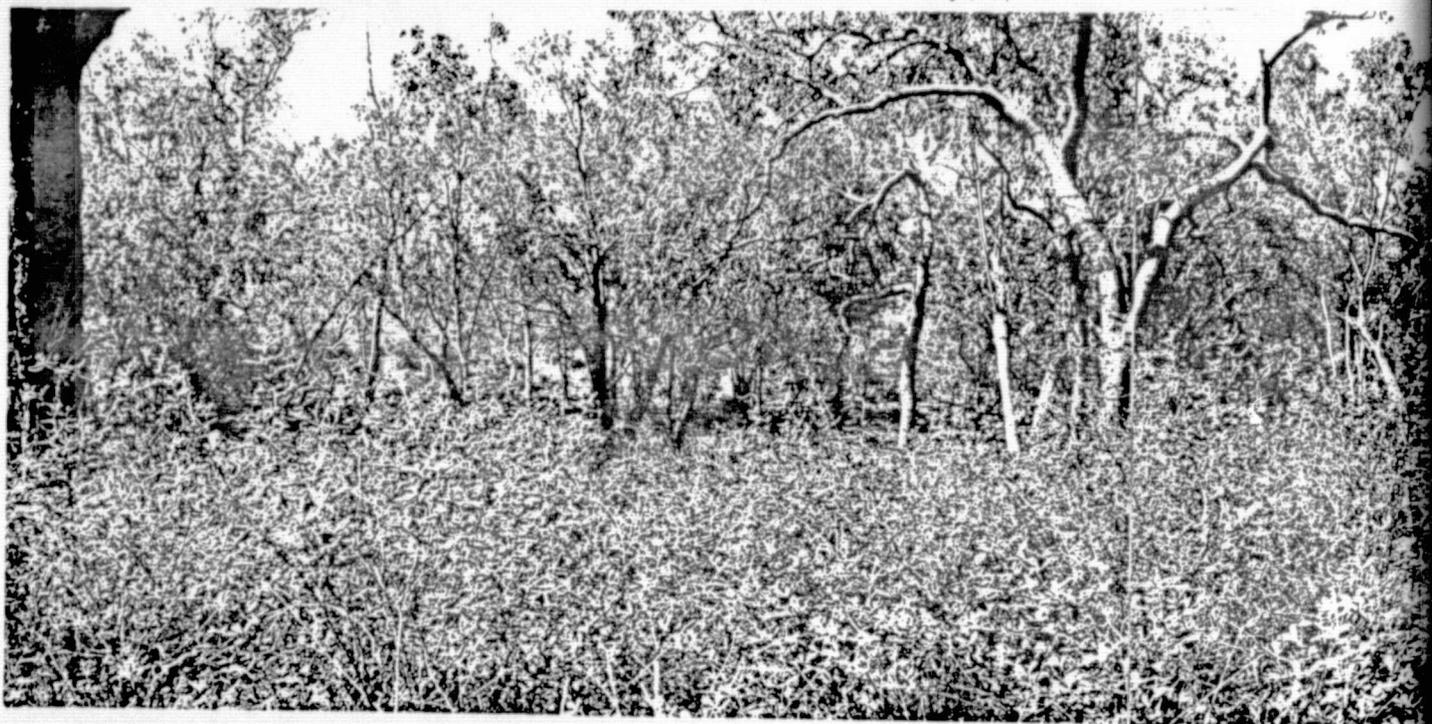


Plate 26 - The Dugald River area. Eucalyptus terminalis trees and Tephrosia sp.nov. shrubs on coarse alluvium following Silvermine Creek. The trees in the creek bed behind are Tristania grandiflora, Eucalyptus camaldulensis, Bauhinia carronii etc. The creek line vegetation produces a red signature on the LANDSAT 2 imagery for 2 March 1975 (ID2039-23555) and on the LANDSAT 2 imagery for 24 July 1975 (ID2183-23552). (Photo ref:MMC/A<sup>a</sup> 140/7A - 8, 8A-9).

~~FIELD NOTE~~

2



Tephrosia sp. nov.  
The trees in  
this  
vegetation  
March 1975  
1975



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 27

The Dugald River area. Anomalous plant community of Eriachne mucronata and Polycarpaea glabra growing over copper bearing calc-silicate rocks northeast of the Dugald River Lode.  
Photo ref: MMC/A<sup>a</sup> 147/11 July 1971



The Lady Annie area. View eastwards over lateritized beds of the Gunpowder Creek Formation carrying a woodland of Acacia shirleyi to the plateau of Myally Beds carrying a sparse vegetation of Eucalyptus brevifolia and Triodia pungens grass (on the horizon). The Gunpowder Creek beds produce very dark dominantly blue spectral signatures on the LANDSAT II imagery for March 1975. (ID2059-00012); the Myally Beds produce light green signatures on the same imagery. (Photo ref: MMC/A<sup>a</sup> 193/8,9, 10, August 1975).

~~XXXXXXXXXX~~ 1143

2



ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 29

The Lady Annie area. Vegetation of *Eucalyptus brevifolia* trees, and *Triodia pungens* and *Chrysopogon fallax* grasses over dolomite of the Paradise Creek formation. (Photo ref: MMC/Aa 194/26 August 1976)

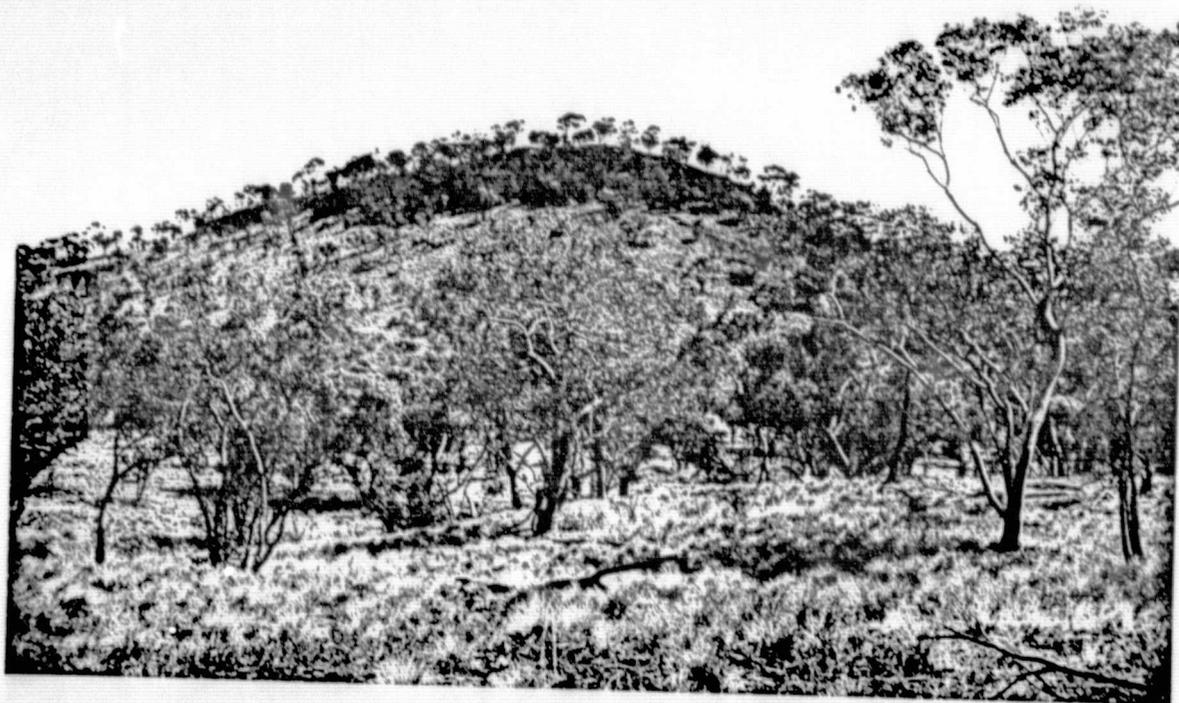
ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 30

The Lady Annie area. Open savanna woodland characterized by large Eucalyptus trees occupying covered ground east of the eastern plateaux block of Myally quartzite.

Photo ref: MMC/A<sup>a</sup> 192/35 August 1975.



ORIGINAL PAGE IS  
OF POOR QUALITY

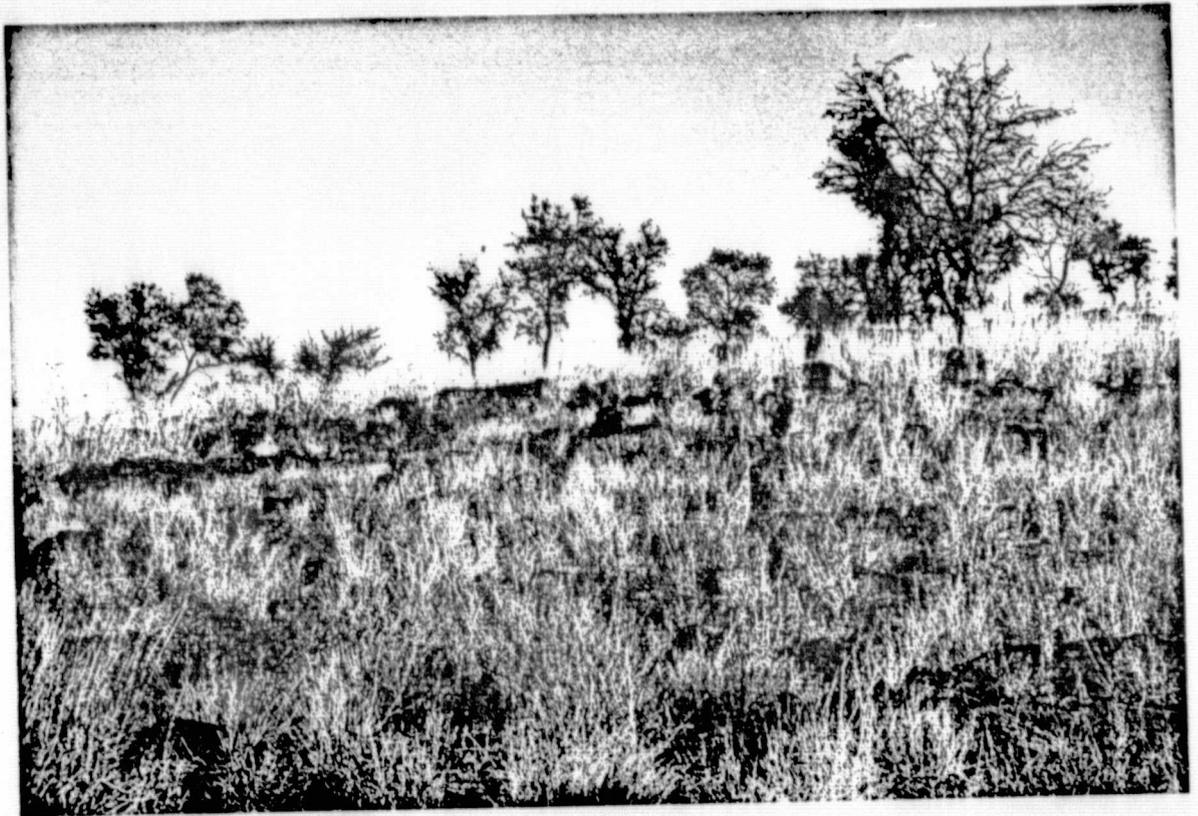
Plate 31

The Lady Annie area. Low tree and shrub savanna dominated by Eucalyptus brevifolia trees growing over covered ground underlain by rocks of the Paradise Creek formation north of the eastern plateaux block of Myally quartzite. In the background Mesozoic residual capped by laterite and carrying Acacia shirleyii.

Photo ref: MMC/A<sup>a</sup> 193/15A August 1975.



Plate 32    The Lady Annie area. Eriachne mucronata grass (in the foreground) replacing low tree and shrub savanna of Eucalyptus brevifolia trees and Heteropogon contorta grass in the background.  
(Photo ref: MMC/A<sup>a</sup> 194/36 August 1975)



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 33 The Lady Annie - Mount Gordon fault zone area. Vegetation of Bauhinia sp. and Terminalia sp. trees and Enneapogon brachystachys grass on the dolomitic limestones of the Paradise Creek formation west of Paradise Creek and the Mt Gordon fault zone. This area produces a medium tone red and green spectral signature on the colour composite of LANDSAT 2 imagery for 22 March 1975 (ID2059-00012)  
(Photo ref: MMC/A<sup>a</sup> 194/4-4A: August 1975).



Plate 34

The Lady Annie area. View towards low hill of Pilpah sandstone from the alluvial plain on Koolamarra Pastoral Station. Photo ref: MMC/A<sup>a</sup> 200/4A-5, 5A-6 August 1976.

44-2049-22A

2

8



LANDSAT FRAME



Plate 34(A)

The Lady Annie area. View across plains of dark brown to black clay soils carrying a grassland dominated by Astrebla pectinata and Chrysopogon fallax to the low hill of Pilpah sandstone on the horizon. The central part of the hill has a vegetation of Eucalyptus brevifolia trees and Triodia pungens grass which gives way to a belt of fairly closely spaced Eucalyptus pruinosa trees Acacia chisholmii shrubs and Chrysopogon fallax grass around the periphery. The hill feature produces a remarkably circular dark green spectral signature on the LANDSAT II imagery for 22 March 1975 (ID2059-00012). The surrounding plains have a red spectral signature. (photo ref: MMC/A<sup>a</sup> 200/4A - 5, 5A - 6: August 1976).

FRANK

2



ack  
ata  
n the

gives  
trees  
the  
ark green  
75  
signature.



Plate 35

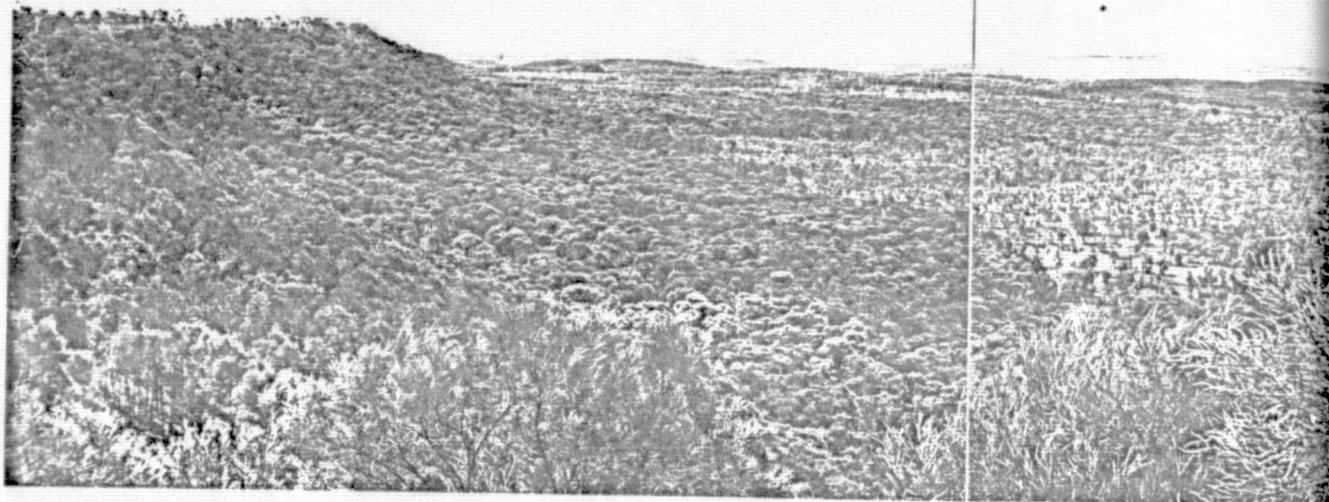
The Lady Annie area. Vegetation association dominated by Atalaya hemiglauca trees over the Beetle Creek formation comprising phosphatic siltstones and phoscorites.  
(Photo ref: MMC/A<sup>a</sup> 194/21 August 1975)



ORIGINAL PAGE IS  
OF POOR QUALITY

PUate 36      The Lady Annie area. Plant community dominated by  
Atalaya hemiglauca trees over the Beetle Creek formation.  
Photo ref: MMC/A<sup>a</sup> 142/6A-7 April 1971.

PROOF COPY



ORIGINAL PAGE IS  
OF POOR QUALITY

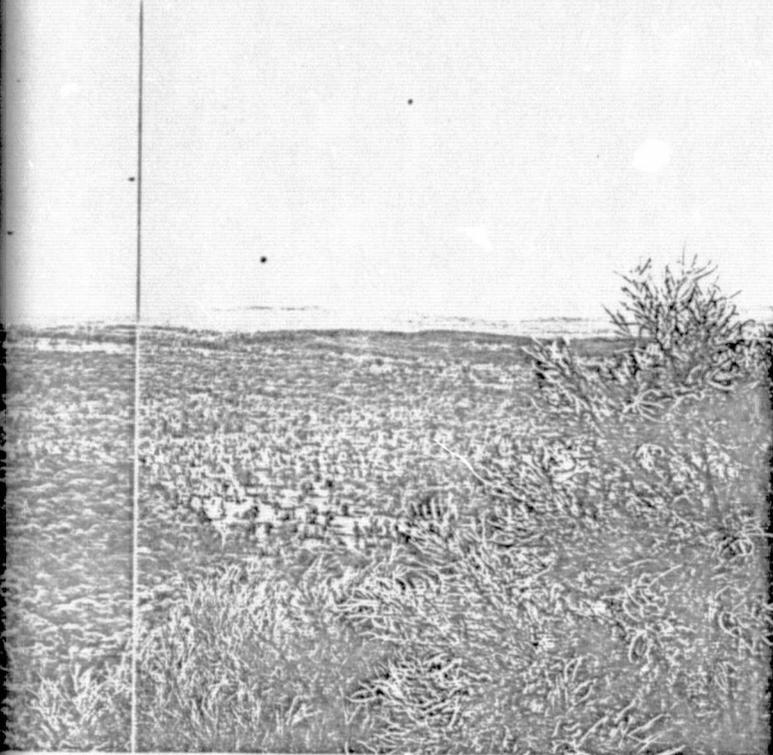
Plate 37

The Lady Annie-Lady Loretta area. View northwards with the ridge formed by the Paradise Creek beds of the Small Syncline on the left and the level terrain underlain by the Beetle Creek Formation on the right. The eastern slopes of the ridge are clothed with Acacia shirleyii woodland which produces dark spectral signatures on the LANDSAT imagery, whereas the level terrain has an open savanna woodland characterized by Eucalyptus trees.

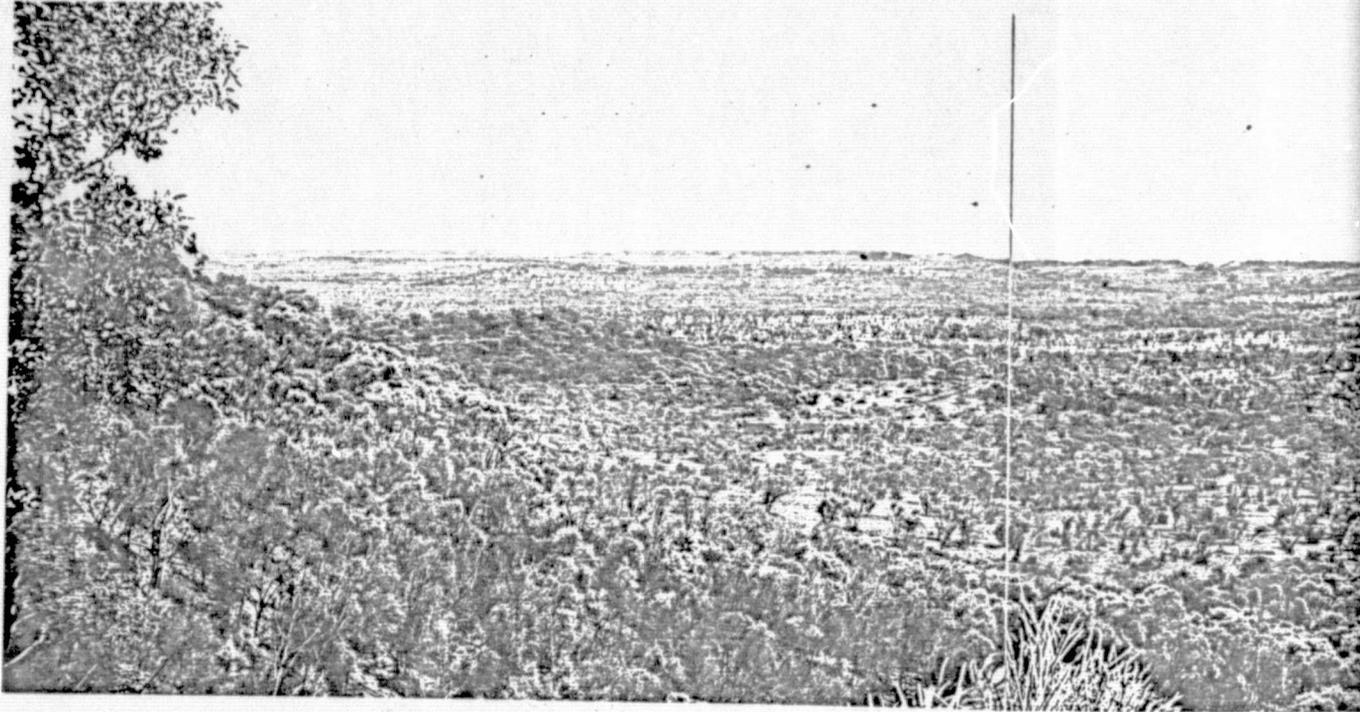
(Photo ref. MMC/Aa 192/8, 9: August 1975)

[REDACTED]

2



with the  
Syncline  
Little Creek  
age are  
dark  
the level  
Eucalyptus



ORIGINAL PAGE IS  
OF POOR QUALITY

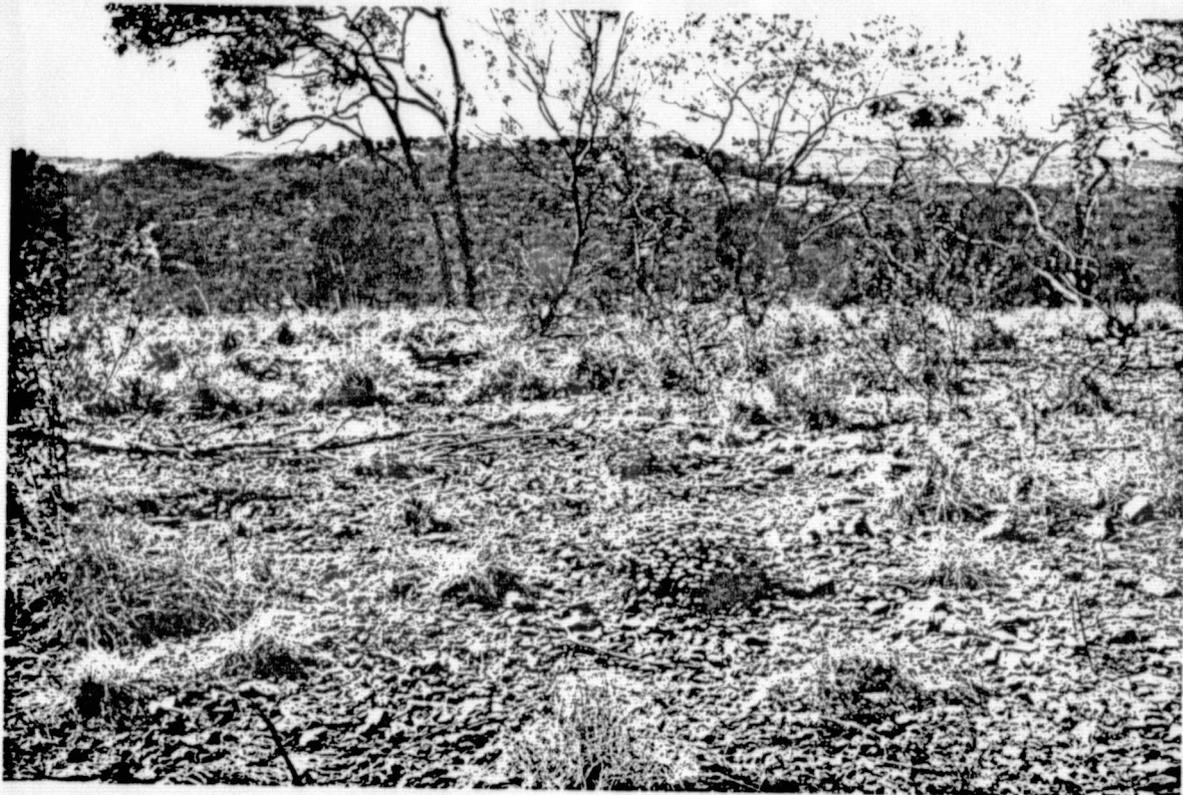
Plate 38 The Lady Annie - Lady Loretta area. View westwards from the Lady Loretta lead-zinc ore horizon in pyritic and carbonaceous shale of the Paradise Creek formation where it is disposed in the eastern limb of the Small Syncline and looking towards the western limb of this feature which is marked by Acacia shirleyi trees which have a dark tone on the photograph.  
(Photo ref: MMC/A<sup>a</sup> 192/18-19 August 1975)

~~XXXXXXXXXX~~

2



from  
d  
here  
line



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 39

The Lady Loretta area. Anomalous plant community of Polycarpaea glabra and Tephrosia sp. nov. over the pyritic and carbonaceous shale horizons containing the Lady Loretta lead-zinc deposit. This produces a dark blue green spectral signature on the colour composite of the LANDSAT 2 imagery for 22 March 1975 (ID 2059-00012)  
(Photo ref: MMC/A<sup>a</sup> 153/10: August 1971)



Plate 40 The Lady Loretta area. Sparse grass cover with scattered Tephrosia sp nov shrubs over the lead-zinc ore horizon contained in pyritic and carbonaceous shale host rock of the Paradise Creek formation. (Photo ref: MMC/A<sup>a</sup> 192/10 August 1975)



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 41

Lady Annie area. Woodlands of Acacia shirleyi with ground layer  
of Polycarpaea sp. (Photo ref: MMC/A<sup>a</sup> 151/29 August 1971)

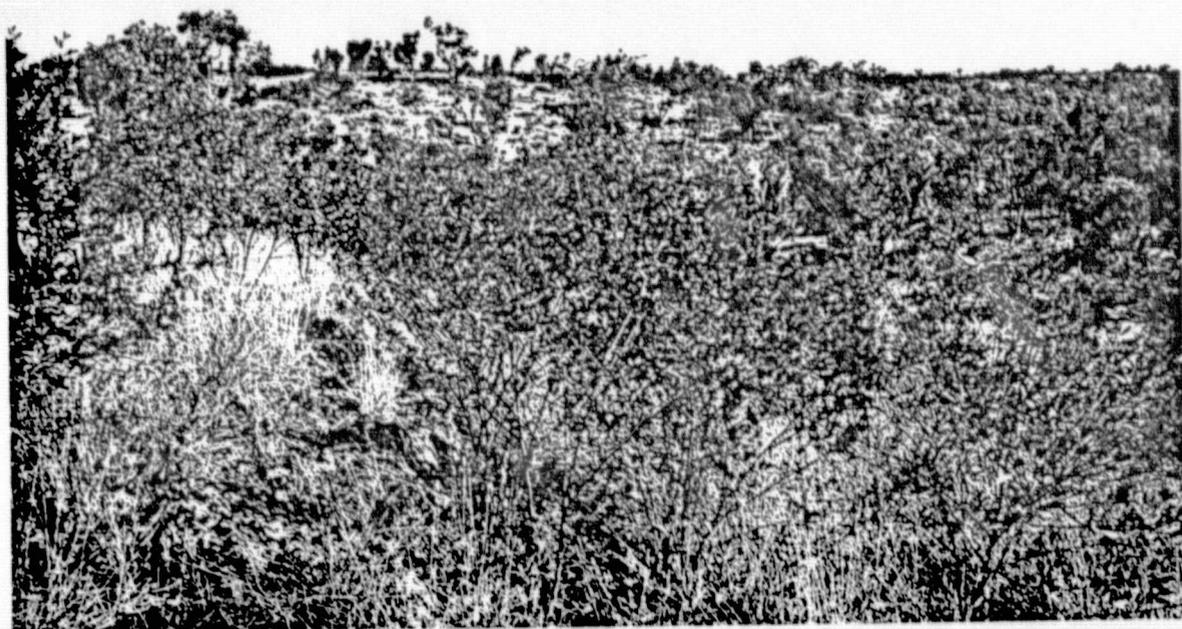


Plate 42 The Lady Annie - Lady Loretta area. Vegetation dominated by Tephrosia sp. nov. over laterite capped Paradise Creek bed south of Lady Loretta lead-zinc deposit. This area produces a dark blue green spectral signature on the colour composite of the LANDSAT II imagery for 22 March 1975 (ID2059-00012)  
(Photo ref: MMC/A<sup>a</sup> 151/3 August 1971).



Plate 43    The Lady Annie area. Algal dome of dolomite in the  
Paradise Creek formation.  
(Photo ref: MMC/A<sup>a</sup> 192/33 August 1975)

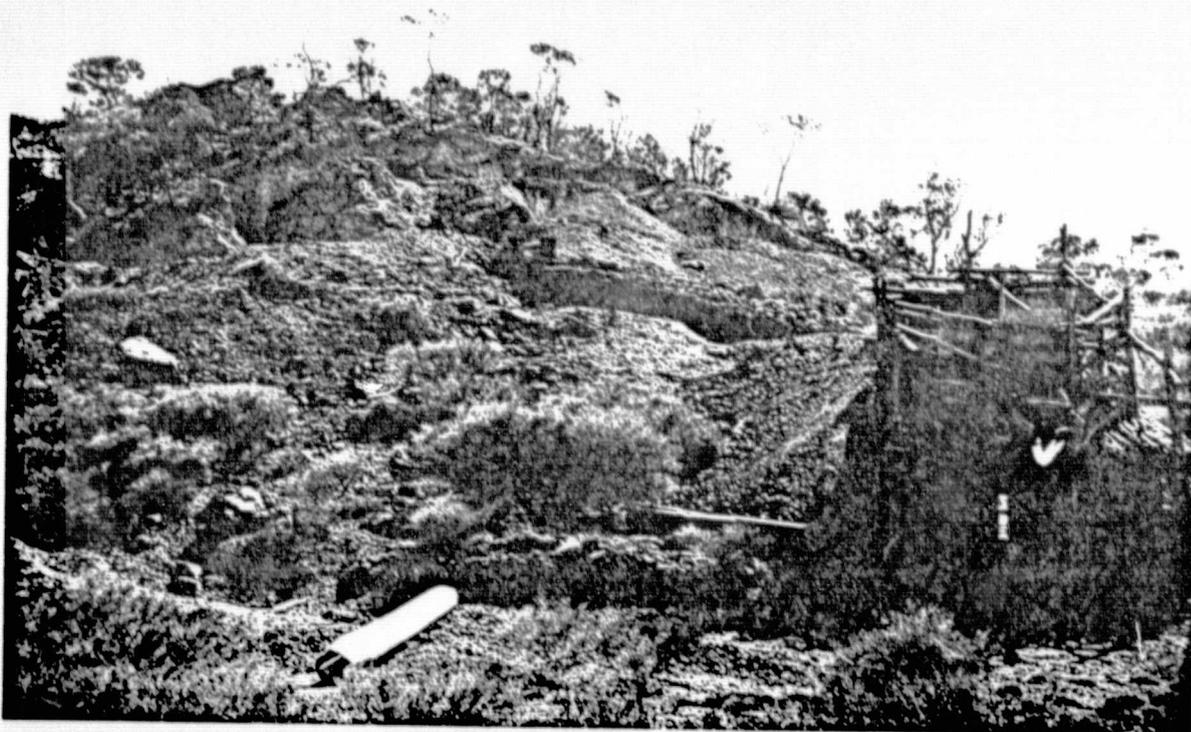
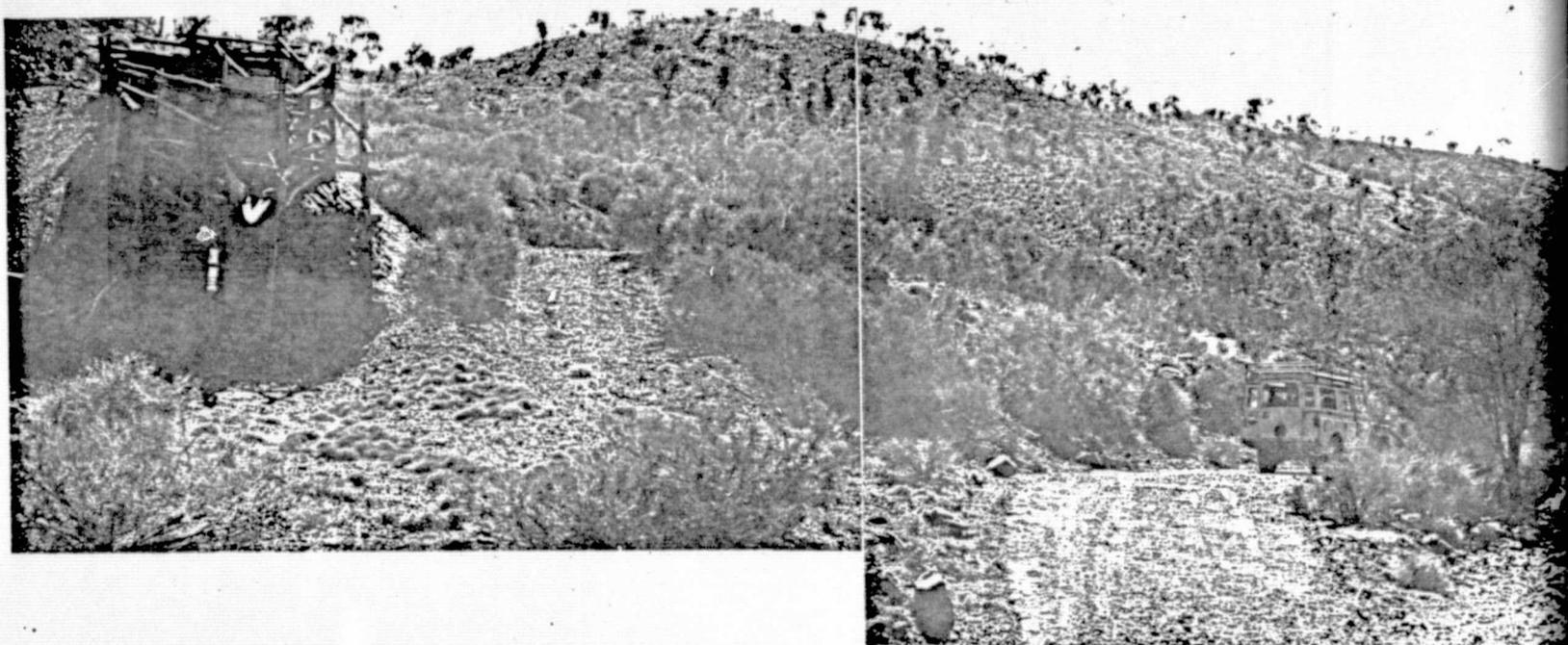


Plate 44 The Mount Kelly area. The old Mount Kelly copper mine at which ore deposits in the Paradise Creek formation were worked.

(Photo ref: MMC/A<sup>a</sup> 200/21 August 1976)

ORIGINAL PAGE IS  
OF POOR QUALITY



45 The Mount Kelly area. In the foreground the old Mount Kelly copper mine and terrain underlain by the Paradise Creek formation. In the background hills of Myally quartzite. On the right laterite residuals.  
(Photo ref: MMC/A<sup>a</sup> 200/22-23-24 August 1976)

[REDACTED]

2

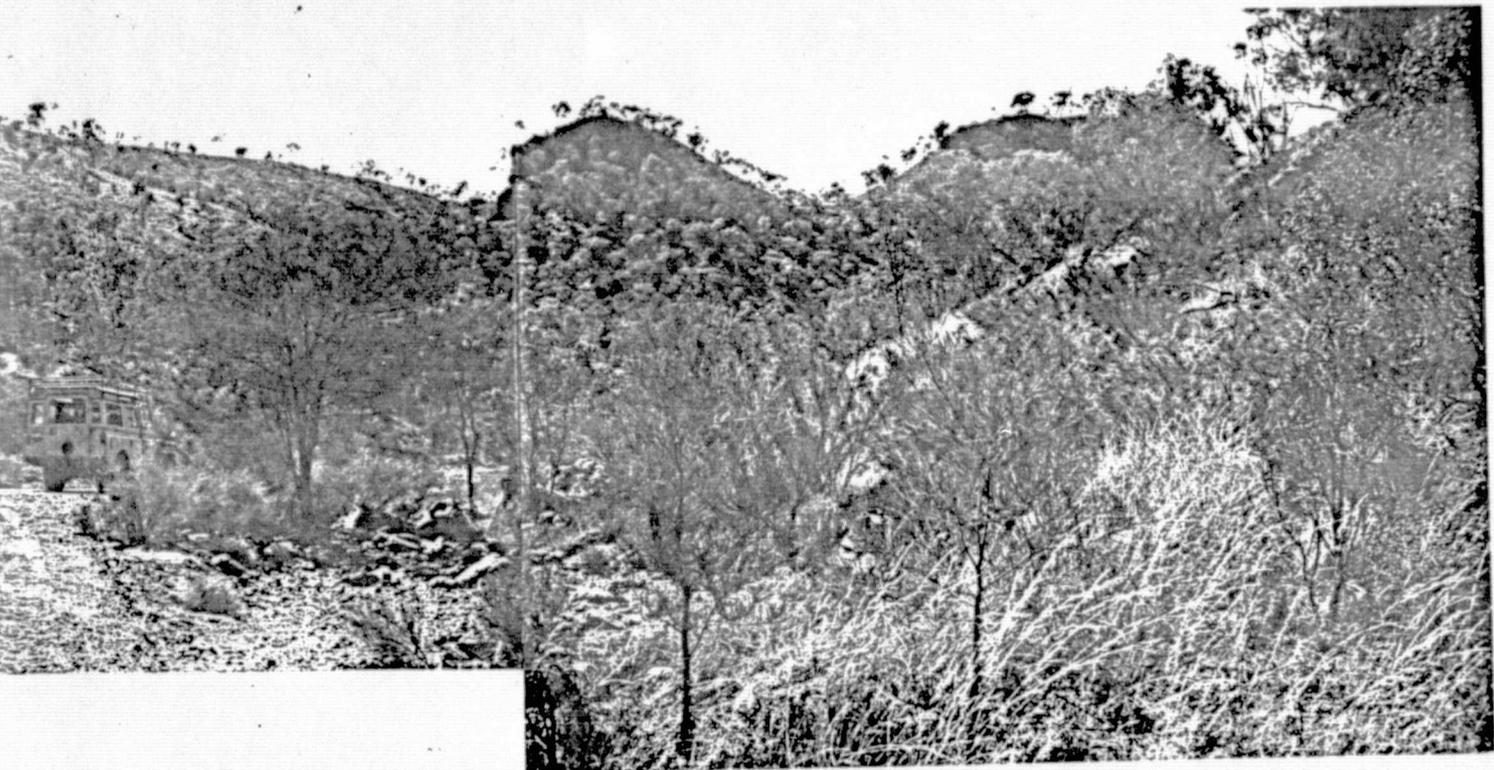




Plate 46

The Mount Kelly area. Anomalous plant community of Jacksonia ramosissima probably associated with copper mineralization in concealed bedrock north of Mount Kelly. In the background Acacia shirleyi woodland. (Photo ref: MMC/A<sup>a</sup> 204/5-6-7 September 1976)

~~SECRET~~

2



ORIGINAL PAGE IS  
OF POOR QUALITY



Plate 47 The Mount Kelly area. Anomalous plant community of Jacksonia ramosissima (centre foreground) occurring over concealed copper deposits in Paradise Creek and Gunpowder Creek formations. Background vegetation on the left of Eucalyptus brevifolia low tree and shrub savanna. On the right stands of Acacia shirleyii trees cover ironstone associated with the concealed mineralization.  
(Photo ref: MMC/A<sup>a</sup> 204/16 September 1976)



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 48      The Cloncurry Plains. Large Eucalyptus trees following the  
Williams River.  
Photo ref: MMC/A<sup>a</sup> 178/24A-25 August 1974.



ORIGINAL PAGE IS  
OF POOR QUALITY

Plate 49 The Urandangi area. Grasslands of Astrebla and Iseilima species over black soil plains near Urandangi.  
(Photo ref: MMC/A<sup>a</sup> 201/16a August. 1976)



Plate 50 The Mount Isa - Urandangi area. Parkland of Chrysopogon fallax grasses and Acacia georginae trees between Mount Isa and Urandangi.  
(Photo ref: MMC/A<sup>a</sup> 201/9 August 1976)

ORIGINAL PAGE IS  
OF POOR QUALITY