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EL 2707

LAKE FINNISS

ANNUAL REPORTS TO LICENCE EXPIRY FOR THE PERIOD 14/3/2000 TO 13/3/2005

Submitted by
Tuart Resources Ltd
2005

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Government of South Australia
Primary Industries and Resources SA

ANNUAL REPORT

ON EL 2707

STUART SHELF, SOUTH AUSTRALIA

BY

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CONTENTS

ABSTRACT

A review of the previous investigations carried out by Tuart has been undertaken. This is outlined in the Tuart Resources N.L. Prospectus of May 2000.

Recent investigations have been reviewed of exploratory data carried out by the Bureau of Geological Sciences.

The EM traverse conducted from Port Pirie to Tarcoola is reviewed and targets for exploration outlined.

1. Introduction

EL 2707 is located approximately 80 kilometres south of the township of Woomera. Access is via Oakden Hills track to Mahatewa. The area is located between Lake Finniss and Lake MacFarlane.

2. Regional Geological Setting and Exploration Philosophy

Geology of tenement EL 2707 is based upon the Tuart Resources Prospectus geological review.

Since its discovery in 1975, the Olympic Dam deposit has provided a geological model which is the focus of mineral exploration in South Australia and elsewhere. The exploration that led to the discovery of Olympic Dam targeted the general area on the basis of a geological model that proposed possible base metal mineralisation on the Proterozoic Stuart Shelf.

To this point this was a conventional exploration approach. However, the proposed target lithologies comprising the Stuart Shelf are concealed beneath up to 300 metres of Mesozoic sediments. The principal characteristic of the Olympic Dam discovery that set it apart from major discoveries elsewhere is that the deposit has absolutely no surface geological or geochemical expression. The drilling program that led to the initial discovery of mineralisation was based solely on targeting photo lineaments, aeromagnetic, and gravity anomalies. The size of Olympic Data deposit gave drilling of the deposit a high chance of success.

The realisation that exploration could be successfully carried out in areas of prospective Proterozoic terrain overlain by relatively thick cover of Mesozoic sediments has led to a fundamental reappraisal of the prospectivity of other Proterozoic cratonic regions of South

Australia by many companies. This has been the criterion for tenement selection adopted by Tuart Resources Limited in its applications for Exploration Licences in South Australia.

The Company's consultants have carried out detailed geological and geophysical investigations to identify major geological dislocation and structural lineaments in the various accessible parts of Proterozoic cratons that could act as loci for mineralizing events.

The Gawler Craton is interpreted as a fragment of an originally very large area of stable Archaen continental crust. Superimposed rocks of also ancient origin with measured ages in the range 1800 to 2400 Ma (million years ago) which have been subjected to multiple phases of folding and high grade metamorphism. The resulting gneissic terrain has been intruded at various times by granitic, mafic and ultramafic plutons accompanied by several episodes of mineralisation.

The principal mineral style of mineralisation discovered to date has been Olympic Dam style gold-uranium-base metal mineralisation. However, the similarity of this area with other areas of Archaean Shield suggests the Gawler Craton is prospective for copper-nickel mineralisation in ultramafic rocks, platinum-chromium in layered mafic-ultramafic complexes and copper-lead-zinc in acid volcanic sequences.

Much of the Gawler Craton is covered by a relatively thin veneer of Cainozoic detrital sediments. However, with the knowledge that significant deposits may be detected below this cover, this situation has changed dramatically with major programs being mounted across the whole of the Craton using state of the art geophysical surveys magnetic and gravity.

The Stuart Shelf and Spencer Shelf are a transitional zone between the eastern margin of the Gawler Craton and the Adelaide Geosyncline. These Shelf zones are characterized by rifting and down-faulting due to regional scale fracture systems that transect the Shelf area and are interpreted to penetrate the lithospheric plate. The fractures are potential sites for deep seated and repeated tectonic activity, which has provided conduits for mineralizing hydrothermal solutions and structural controls for emplacement.

The Gawler Project is located on the southern extension to the Stuart Shelf.

3. Previous Exploration

Although the Licence area has been held under part of various larger tenements in the past, there has been no systematic exploration on the ground within the current holding.

4. Recent Exploration

Tuart has previously conducted regional and local magnetic and gravity data interpretation on both ELs culminating in the application for the present Licence areas that were originally part of larger holdings. The results of this work are depicted in Figure 1 of this Report.

The regional geophysical data shows several features of significance:

- a circular magnetic high located to the west of EL 2707;
- NW trending magnetic dolerite dykes and geophysical contact zones extending through both of the Licence;
- A possible east-west dyke system hidden by the NW trending magnetic dolerite dykes.

5. Current Activities

5.1. Geology – EL 2707

Olympic Dam Style Gold/Base Metal Mineralisation

The location of the Licences on the northeastern margin of the Gawler Craton gives potential for this style of mineralisation beneath the Mesozoic cover. Major NNW-trending structures defined by gravity and magnetics passes through the Licences and provides specific targets for exploration. Major regional easterly trending magnetic-gravity lineaments are potential areas where there may be emplacement of the Hiltaba Suite Granites; the host for Olympic Dam style mineralisation.

The Olympic Dam deposit is situated within Middle Proterozoic rocks in the northeastern part of the Gawler Craton beneath un-deformed late Proterozoic and Cambrian platform sediments of the Stuart Shelf. A major north and northwesterly trending structural feature, the Torrens Hinge Zone, marks the eastern boundary of both the Gawler Craton and the Stuart Shelf. The deposit lies astride a major north-northwest trending photo lineament corridor at the intersection of a major north-northwest trending gravity lineament and lies on or near coincident magnetic and gravity highs.

Mineralisation occurs within an intrusive suite of granitic rocks; the Hiltaba Suite granites where the host granite is hydrothermally altered and brecciated to form a granite-hematite breccia complex surrounded by relatively unbrecciated granite.

The presence of a major north-northeast trending structure suggests potential for this style of mineralisation within Licence 2707. However, much of the prospective Proterozoic basement is inaccessible due to the thickness of Phanerozoic sediments overlying the basement. Structural highs in the basement, probably associated with block faulting within structural corridors offer the most plausible sites for exploration. The east-west dyke systems could also be a focus for base metal deposits as seen on Figure 1.

A review of drilling carried out to the north of the tenement in the Stuart Shelf has been undertaken by G. Bravo, Consultant Geologist, (Appendix 1). The recognition of a fracture zone containing hydrothermal fluids suggest that the presence of these fractures could be defined by ground water sampling from existing bore holes and hence provide targets for exploration.

5.2. **Geophysics**

(TEMPEST data - see Government of South Australia Mineral Resources Website) Fugaro (Appendix 2) on behalf of AGSO have conducted tempest surveys of Moorta and Tarcoola districts. The results of the traverse connecting the two areas have been compared to regional gravity and magnetic data. The results are presented on plates 2 to 5.

The results of the survey indicate that to the west of EL 2707 high conductivity is associated with the east-west dyke fracture system. Areas for further exploration by shallow drilling can be located where these fractures intersect NNW-NNE lineaments within the tenement.

6. **Conclusions and recommendations**

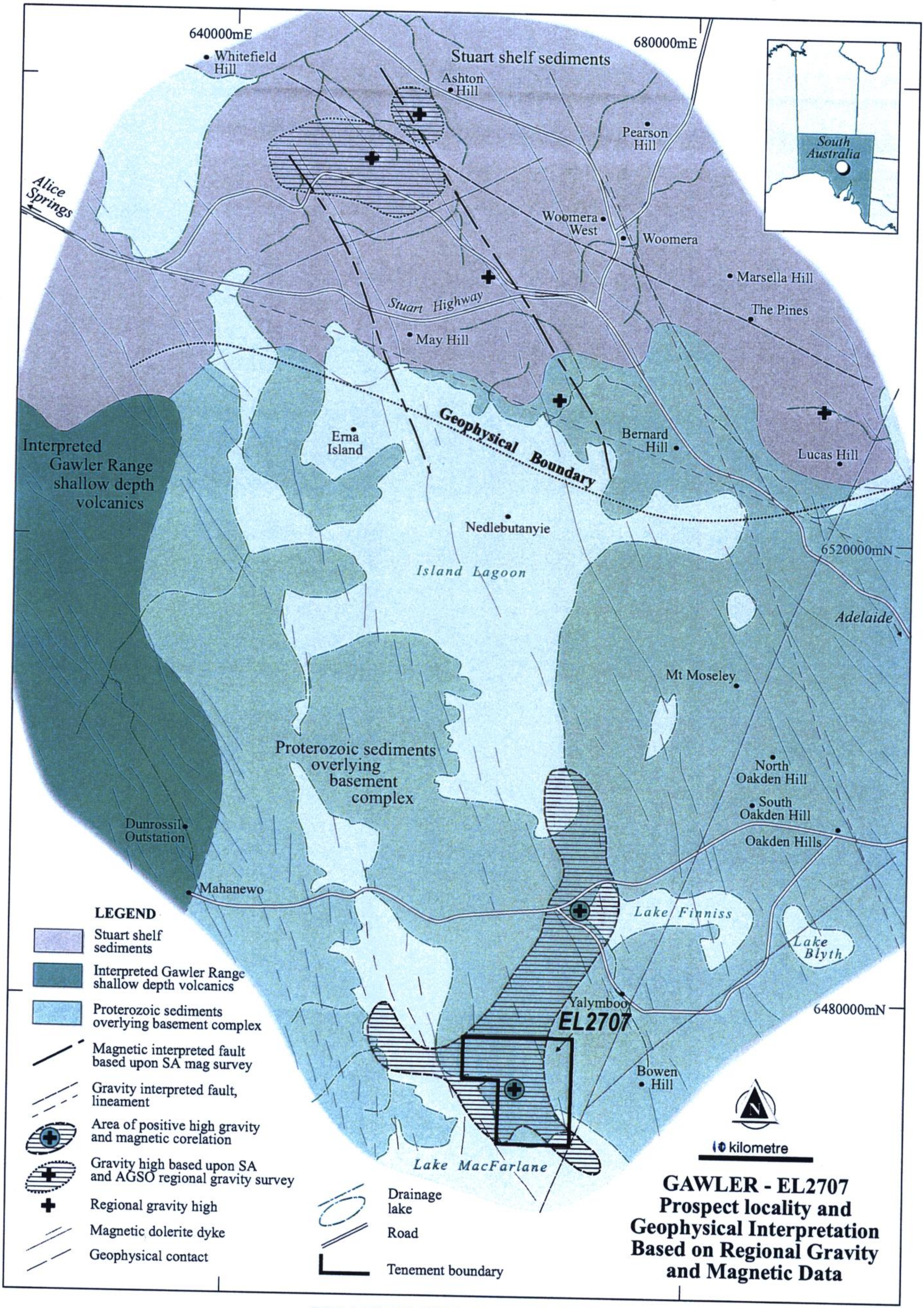
Targets for future exploration are located within EL 2707 as a result of the geological, geophysical data acquisition and interpretation conducted to date by Tuart.

A detailed sub-surface geochemical survey program is required to test the targets. This would initially initialise a RAB rig to enable sampling from depths of 25 to 50 metres to avoid comparatively recent surface overburden and may be required to probe to depths of 100 metres where necessary.

Remote sensing data acquisition and imagery interpretation from multi-spectral scanning methods is recommended as an adjunct to the planning of the geochemical sampling program and should be carried out prior to its instigation.

Where compilation of results from the first survey show anomalous zones then testing by RC drilling would comprise stage two.

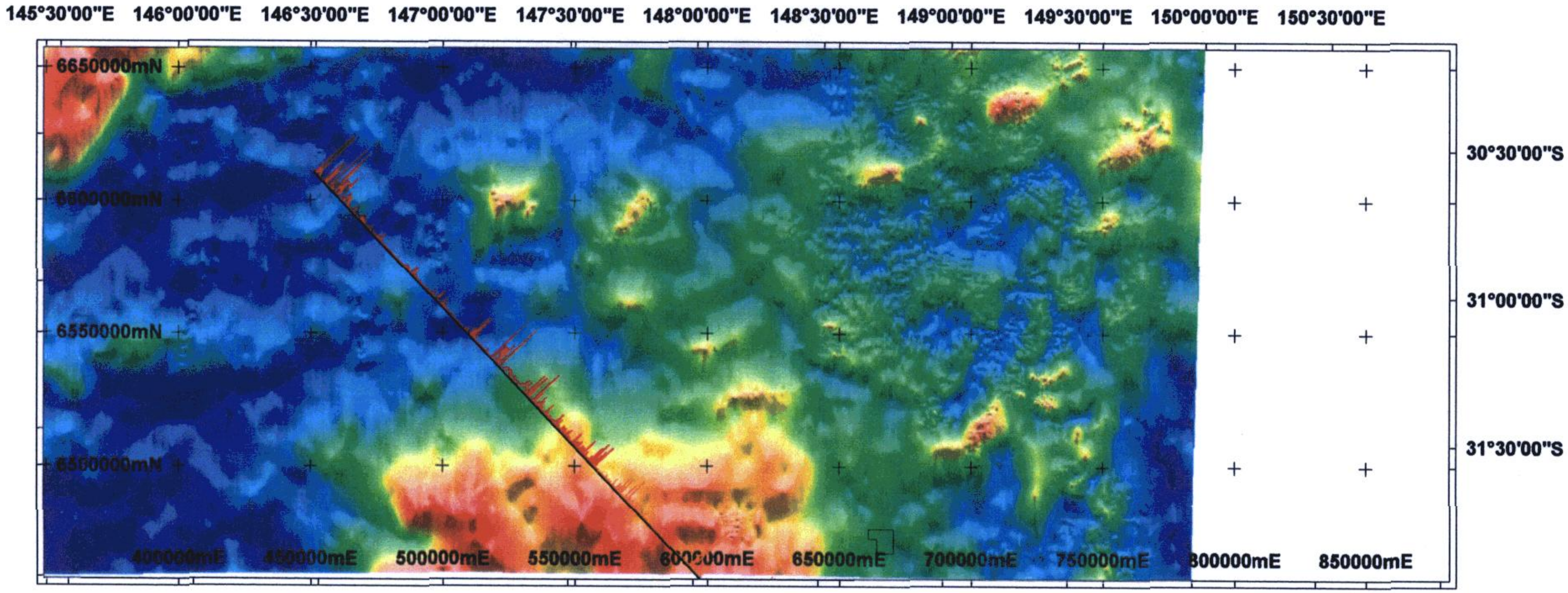
ILLUSTRATIONS



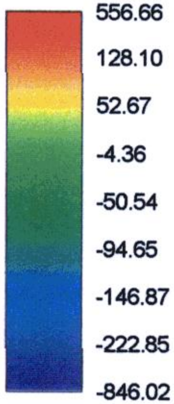
GAWLER - EL2707
Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

TUART RESOURCES LTD

Plate 1



TEMPEST PROFILE DEPTH 100M



Profile Specifications

Base Value	0
Vertical Scale	250 /cm

Scale 1:2,500,000

0.0 20.0 40.0 60.0 80.0100.0km

Projection: Transverse Mercator AMG Zone 55.

PLATE 2

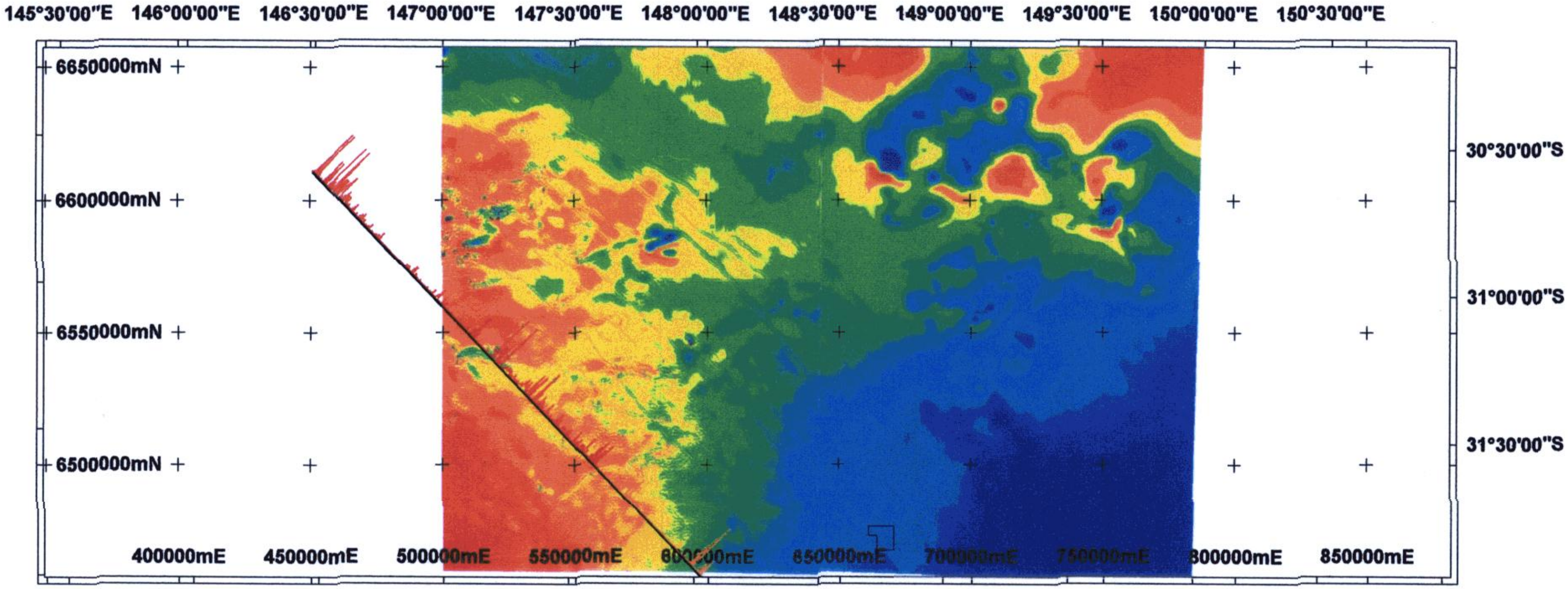
TUART RESOURCES LIMITED

GAWLER TENEMENT EL2707

REGIONAL GRAVITY IMAGE

AGSO REGIONAL TEMPEST PROFILE

Drawn By LS	16-02-2001



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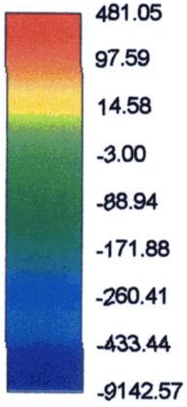


Profile Specifications

Base Value	0
Vertical Scale	250 /cm

Scale 1:2,500,000

0.0 20.0 40.0 60.0 80.0 100.0km

Projection: Transverse Mercator AMG Zone 55.

PLATE 3

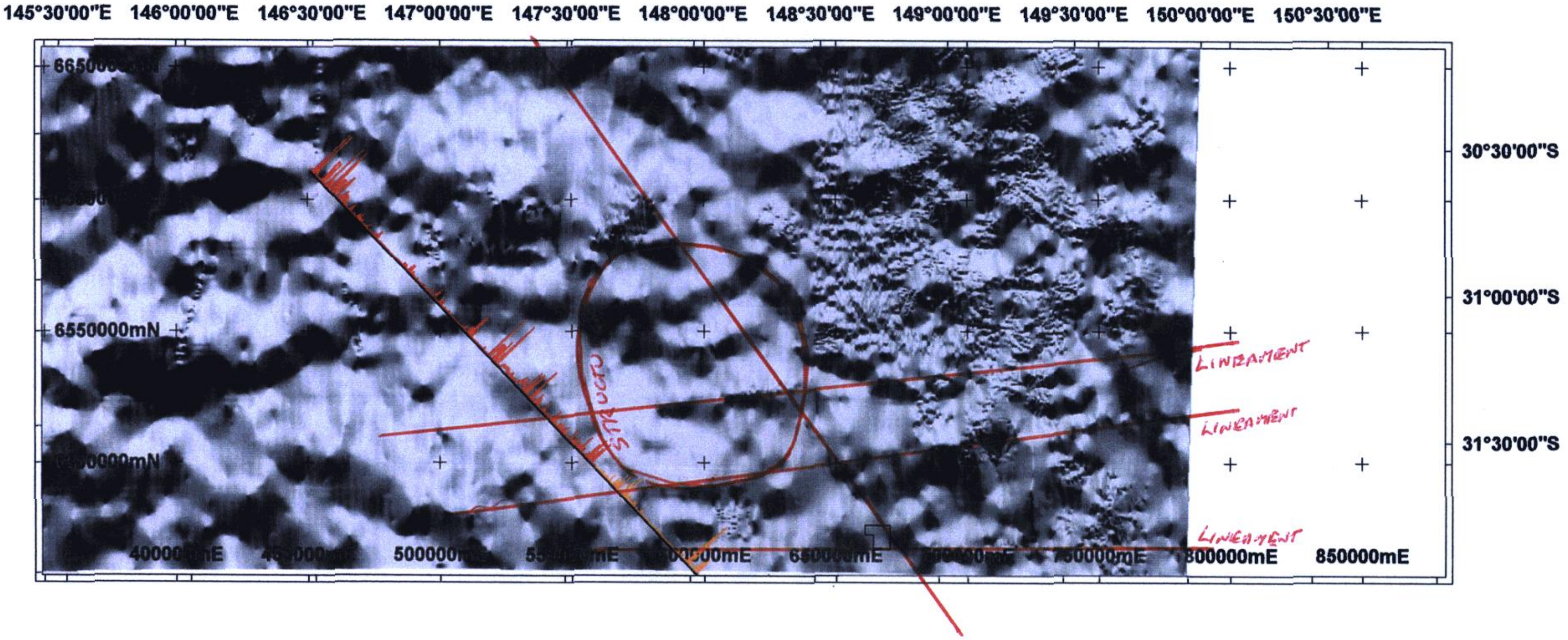
TUART RESOURCES LIMITED

GAWLER TENEMENT EL2707

REGIONALMAGNETIC IMAGE

AGSO REGIONAL TEMPEST PROFILE

Drawn By LS | **16-02-2001**



TEMPEST PROFILE DEPTH 100M

Profile Specifications

Base Value	0
Vertical Scale	250 /cm

Scale 1:2,500,000

0.0 20.0 40.0 60.0 80.0100.0km

Projection: Transverse Mercator AMG Zone 55.

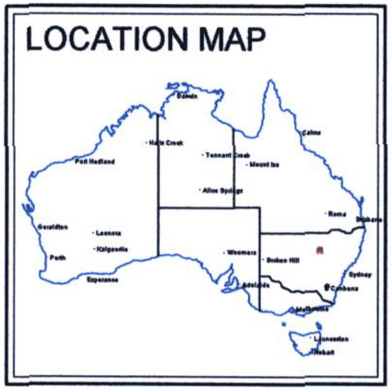


PLATE 4

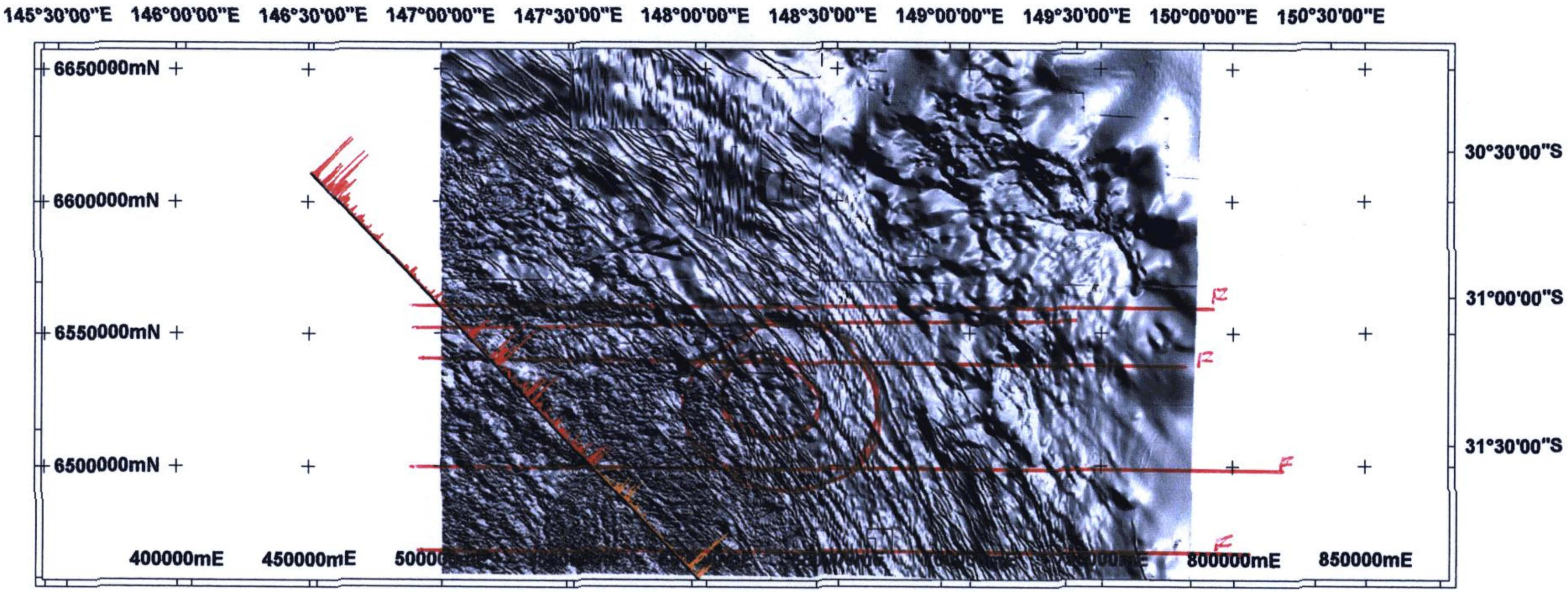
TUART RESOURCES LIMITED

GAWLER TENEMENT EL2707

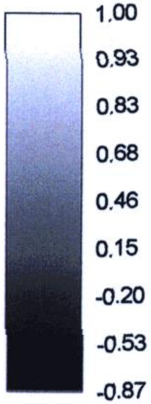
REGIONAL GRAVITY SHADOW IMAGE

AGSO REGIONAL TEMPEST PROFILE

Drawn By LS	16-02-2001



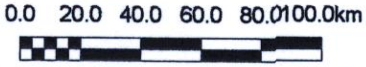
TEMPEST PROFILE DEPTH 100M



Profile Specifications

Base Value	0
Vertical Scale	250 /cm

Scale 1:2,500,000



Projection: Transverse Mercator AMG Zone 55.

LOCATION MAP

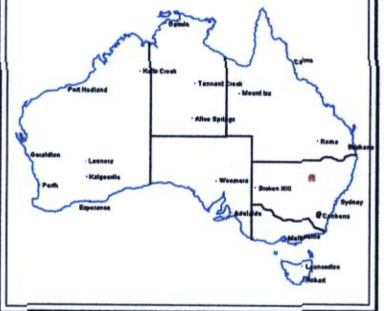


PLATE 5

TUART RESOURCES LIMITED

GAWLER TENEMENT EL2707

REGIONAL MAGNETIC SHADOW IMAGE

AGSO REGIONAL TEMPEST PROFILE

Drawn By LS	16-02-2001

APPENDIX

1. Review of BGS Drilling to the north of EL 2707.
2. Airborne EM traverse to the south of EL 2707 specifications.

Appendix 1

Visit to AGSO and Bureau of Resource Sciences for Tuart Resources NL

6 – 7 December 2000

CONTENTS

Gus Bravo
January 2001

1. INTRODUCTION

A visit to Canberra was arranged for 6 – 7 December 2000 to inspect core and rock chip material from a number of drillholes held by AGSO and relevant to the Stuart Shelf Cu-Au project of Tuart Resources NL. The holes were previously drilled in 14 locations in the vicinity of Woomera, South Australia as part of the Bureau of Resource Sciences Radwaste disposal investigation. Hole locations are shown on the attached plan included in the Appendix..

The visit provided an opportunity to meet with AGSO and BRS personnel and discuss their activities, in particular, work being conducted as part of their Gawler Craton Project.

Discussions were held with Ian Mc Naught (BRS), Lynton Jacques (AGSO) and Ollie Raymond (AGSO) regarding current AGSO activities including various projects under investigation in South Australia and on-line access to AGSO data and information. Unfortunately, Roger Skirrow (AGSO), Project Leader responsible for Gawler Mineral Promotion and Technical Advice was interstate. Contact details for these individuals are included in the Appendix.

2. GEOLOGICAL SETTING

The area of interest is located near Woomera, on the eastern margin of the Gawler Craton in the Stuart Shelf geological province. The ~1590 Ma Olympic Dam Cu-U-Au-Ag-REE deposit, which occurs approximately 100 km north of Woomera is described in Reynolds, 2000[1].

Basement metasedimentary rocks of the Early Proterozoic Hutchinson Group and deformed granitoids of the Lincoln Complex have been intruded by Middle Proterozoic Hiltaba Suite granitoids and correlates of the Gawler Range Volcanics. These rocks are in turn unconformably overlain by 300-500 metres of Late Proterozoic to Cambrian age sediments of the Wilpena Group across the northern part of the Stuart Shelf. The cover sequence consisting of flat-lying Arcoona Quartzite, Corraberra Sandstone and Tregolana Shale was deposited following Middle to Late Proterozoic erosion possibly during late Marinoan glaciation.

Regionally, the Olympic Dam deposit is distinguishable as a coincident magnetic-gravity anomaly considered to occur at the intersection of major NNW trending and WNW trending gravity lineaments. The deposit is hosted by the Olympic Dam Breccia Complex, a large body of hydrothermal breccias, within the Roxby Downs Granite an unaltered and undeformed syenogranite correlated with the Hiltaba Suite granitoids. The cone-shaped

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[1] Reynolds, L.J.2000 – Geology of the Olympic Dam Cu-U-Au-Ag-REE Deposit; in Porter,T.M. (Ed), Hydrothermal Iron Oxide Copper-Gold & Related Deposits: A Global Perspective, Australian Mineral Foundation Adelaide, pp 93-104.

Breccia Complex, which contains a complete gradation from granite breccia to haematite-rich breccia core is surrounded by a halo of weakly altered and brecciated granite extending up to 5 to 7 km from the core. Mineralisation is closely associated with the haematite-sericite alteration formed as a result of progressive hydrothermal brecciation of the granite. The initial hydrothermal activity is thought to have been localised by structures in a jog environment related to the gravity lineaments (Reynolds, 2000).

3. DISCUSSION – INSPECTION AND CORE LOGGING

Access was obtained to drillhole material from 14 sites investigated by the BRS in the area between Woomera and Roxby Downs.

The relatively shallow holes were drilled into the upper part of the Wilpena Group cover sequence to provide information on the geology, degree of weathering and hydrogeological profile of the upper part of the cover rocks. Holes varied in depth from 61 to 126 metres.

A total of 8 RC holes from 6 sites and 2 core holes from site 45a were inspected and logged. Detailed geological logs provided by the BRS are included in the Appendix.

Core Holes 45a NW and 45a SE from one of the more easterly sites 50 km NNE of Woomera were laid out for inspection. The 50m holes intersected a more silicious version of Corraberra Quartzite consisting mostly of alternating bands of shallow marine sandstone, transitional fine grained sandstone with mud pellets and chocolate brown shale. The flat-lying, well sorted sandstones contain finely laminated to cross-bedded horizons and thin minor clay bands.There is strong leaching in the top 20m then ferruginisation varies down the hole.

45a NW	0-1.25m	transported material and lateritic regolith on reddish brown silic sdst
	1.25-20.5m	alternating hard bands of med-cs, lam-cbded creamy white sdst, ferrug in places
	20.5-22.7m	transitional thin yellowish brown clay bands, clay pellets, ferrug in places
	22.7-23.8m	red ochrous sdst and choc brown claystone
	23.8-34.5m	becoming more silic with scattered clay pellets, occ clay bands, ferrug
	34.5-EOH	typical ferrug med-cs silic sdst, minor siltst-shale bands

45a SE	0-2.7m	transported material and lateritic regolith
	2.7-10.7m	leached creamy white med-cs silic sdst,
	10.7-12.0m	minor white clay bands
	12.0-21.0m	pale greenish grey sdst, occ clay band, becoming ferrug
	21.0-30.0m	strongly ferrug lam-cbded sdst, thin shale bands
	30.0-EOH	pinkish grey-purple silic sdst, minor silt-shale bands

RC Holes 7 SW, 10a N, 10a S, 12 SE, 13 SE, 33 S, 52a NW and 52a SE which are most proximal to the Tuart tenements and area of interest were inspected and logged from rock chips. Detailed geological logs completed by the BRS were available and copies have been included in the Appendix.

Logging indicated that the predominant lithology consisted of hard, fine-medium grained sandstone with lesser narrow bands of micaceous siltstone and horizons containing upto 20% claystone and laminated mudstone. Strong ferruginous staining was associated with intervals of maroon chocolate brown claystone. 7 SW which was the deepest hole drilled bottomed in purple and bluish grey slightly micaceous laminated mudstone from 112 – 126 metres(EOH). The mudstone was moist from groundwater seepage at this level.

A shallow regolith has developed across the area. It appears to be generally less than 2 metres thick and consists of transported material and gypsiferous clay or clays containing calcrete nodules often overlying thin bands of silcrete, ferricrete or hardened quartzite to 3 metres. Below this, a zone of leached to slightly ferruginous-stained weathered bedrock extends to depths of 20 – 30 metres. The rocks are kaolinised at this level and typical of the pallid zone developed in West Australian regolith profiles but have retained their structure and lithological features. In most holes, where the change to more ferruginous lower intervals occurs it has been logged by the BRS as a change in rock formation. The interval 20 –40 metres is often strongly ferruginous and coincident with the occurrence of maroon-brown claystone and shales although it could be considered part of the downward weathering cycle. Most holes were dry with some seepage coming in along claystone bands and below 100 metres.

All holes were devoid of any signs of quartz veining. Extensive ferruginous staining appears to be a feature of the area and has been modified by groundwater influences as discussed above.

A fracture zone containing hypersaline water occurs in the interval 100-102 metres in hole 12 SE. The BRS reported that the maroon silicified fine sandstone had traces of mica and sulphides on some fracture faces. Sulphides, consisting mostly of traces of pyrite were also logged in holes 10a N, 13 SE, 52a NW and 52a SE. Questionable azurite and malachite were noted in the interval 60-70 metres in 13 SE. The secondary copper minerals which occur in maroon and grey fine-medium sandstone appear to be related to water seepage associated with minor bands of micaceous siltstone occurring at this level.

APPENDIX

AGSO

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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Australian Geological Survey Organisation

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A Research Organisation of the Commonwealth
Department of Primary Industries and Energy

AGSO

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National Resource Information Centre

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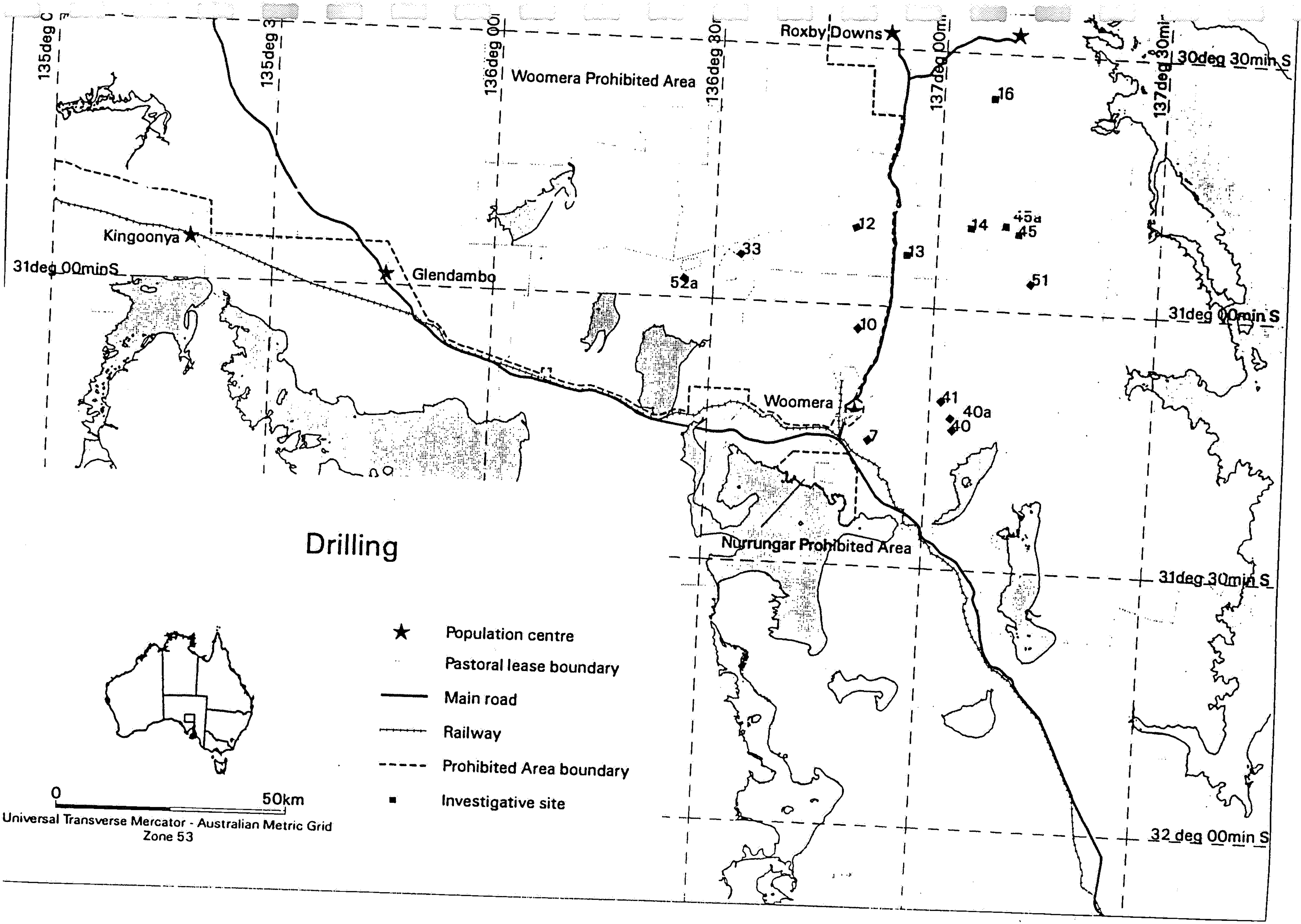
PO Box E11 Kingston ACT 2604 Australia


Drilling
135deg 00min
135deg 30min
136deg 00min
136deg 30min
137deg 00min
137deg 30min
30deg 30min S
31deg 00min S
31deg 30min S
32 deg 00min S
Woomera Prohibited Area
Roxby Downs
Kingoonya
Glendambo
Woomera
Nurrungar Prohibited Area
16
12
14
45a
45
13
33
52a
51
10
41
40a
40
7
Population centre
Pastoral lease boundary
Main road
Railway
Prohibited Area boundary
Investigative site
0
50km
Universal Transverse Mercator - Australian Metric Grid
Zone 53

ADWASTE DRILLING STAGE 1 Date: 21/5/99

OCALITY NAME: #7 SW LOGGED BY: J. Kellett

654066 N 676608 E 180 EST. RL.

WL: 61.8 11/6/99 YIELD: 0.5 L/sec SALINITY: 16,500 PPM Sheet 1 of 3

ELL STATUS: OBSERVATION. PIEZO DRILLING METHOD: RC HAMMER (AIR)

	Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
0–2			SOFT	Reddish brown plastic clay	Qc	
2–3			HBANDS	Purple ferruginised quartzite	2	weathering surface
3–6			VERY HARD	Pinkish-grey quartzite/silicified fine to medium sandstone	Pws	
6–8				Pale grey massive quartzite		
8–9				Pinkish grey quartzite		
9–16				Pale grey quartzite with minor white clay bands		
16–17			HBANDS	Abundant clay bands		
17–26			VERY HARD	Pale brownish grey quartzite with minor white clay bands		
26–27.5			HBANDS	Quartzite with clay bands	27.5	
27.5–33			HARD	Maroon fine to medium silicified sandstone; fissile. Minor siltstone bands, trace mica	Pwc	
33–34				Yellowish brown poorly sorted sandstone w/ mudstone bands		
34–39				Pale purple silicified medium sandstone; qtz poorly sorted, subround. Minor siltstone bands		
39–40				Pinkish grey — Fine to medium silicified quartzose sandstone. Qtz poorly sorted, subround. Minor siltstone interbeds. Trace mica; fissile		
40–42				Purple		
42–44				Pinkish grey		
44–47				Pale purple		
47–48				Strong purple		
48–50				Pinkish grey		

ADDITIONAL COMMENTS:

ADWASTE DRILLING STAGE 1 Date: 21/5/99

OCALITY NAME: #7SW LOGGED BY: J.Kellett

654066 N 676608 E 180 EST. RL.

WL: 61.8 11/6/99 YIELD: 0.5 L/sec SALINITY: 16,500 ppm Sheet 2 of 3

ELL STATUS: OBS PIEZO DRILLING METHOD: RC AIR HAMMER

Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
			Purple-maroon silicified fine to medium sandstone; poorly sorted, subrounded qtz grains. Minor siltstone bands, trace mica. Fissile	Pwc	
60			Pinkish grey		▽61.8 11/6
63			Maroon		▽64.0 21/5
65			Yellowish brown micaceous laminated siltstone + purple fine sandstone	65←	seepage 0.1 L/sec
66		HARD	Maroon-purple + brown Silicified fine to medium sandstone; qtz grains subrounded, poorly sorted. Minor micaceous siltstone interbeds.		
				72←	seep. 0.1 L/sec
73			Light brownish grey	75←	1 L/sec ~17,000 ppm
77			Purple-maroon		
81			Purple	Pwc 87←	0.2 L/sec
95			Light brownish grey silicified fine to medium sandstone	95←	0.2 L/sec
97			Pinkish grey to purple sil. fine to med sandstone w/- minor siltstone bands		

55 60 65 70 75 80 85 90 95 100

ADDITIONAL COMMENTS:

Open hole below 72m. Hole callapsed to 72.8m 22/5.

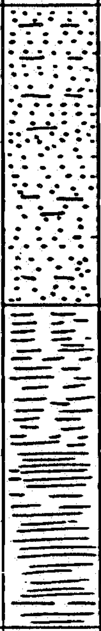
RADWASTE DRILLING STAGE 1 Date: 21/5/99

LOCALITY NAME: #7 SW LOGGED BY: J. Kellett

654066 N 676608 E 180 EST. RL:

SWL: 61.8 11/6/99 YIELD: 0.5 L/sec (airlift) SALINITY: 16,500 ppm Sheet 3 of 3

WELL STATUS: OBS. PIEZO. DRILLING METHOD: RC Air Hammer



	Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
	101		↑	Pinkish grey		
	103			Greyish brown		
105				Greyish brown — maroon Silicified fine-medium sandstone with minor Siltstone bands	Pwc	
110						
	112.5		HARD	112.5		
115				Purple and blueish grey mudstone; laminated, trace mica		
				118 ←		← seep
120					Pwm	
				122 ←		← seep
125			↓	No sample recovered 125.5 ←		← seep
				EOH 126 m Casing jammed 72 m, open hole below. Airlifted for 3 hours at 0.5 L/sec		

ADDITIONAL COMMENTS:

Full hydraulic connection may not be established.

0002

OCALITY NAME: #10a N

DATE: 6/6/00

6563976 N 0673778 E

LOGGED BY: J. Kellett

149 EST. RL.

WL: 32.0 (12/6/00) YIELD: 0.5 L/sec SALINITY: 18,000 ppm Sheet 1 of 2

LL STATUS: observation piezometer DRILLING METHOD: RC air hammer

Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeo
1		SOFT	Brown sandy clay with abundant small gibbers		
2.5			Reddish brown medium clay w/ minor small gibbers	Qc	
3		HARD	Yellowish grey silcrete		Ts
4.5		HB	Pinkish grey silicified medium sandstone (well sorted, rounded) & white quartzite bands; 30% white claybands		
		AHSB	Pale grey to white sil. fine sandstone (well sorted, rounded) with alt. quartzite bands. Trace white claybands 6-8m, 20% white cbs 8-9m		
9		SMHB			
10		AHSB	Pale grey clay w/ 30% pinkish grey qzite bands		
12			20% cbs		
13–16			2i^3% cbs		
17–19			trace cbs		
19–21			20% cbs		
21			trace cbs Pale grey to white silicified fine sandstone (well sorted, rounded - 'oolitic') with abundant quartzite bands. White to pale greenish grey claybands (proportions shown)	Pws	
25			Banded pale brownish grey and pale pinkish grey silicified fine sandstone (moderately well sorted, subrounded)/quartzite. Trace blueish grey softer fissile shale bands 28-29m.		
30		HB	Brown micaceous sil. fine sandstone with grey hard quartzite bands; trace softer choc brown mudstone bands; bronzed pyritic faces on bedding planes		
31		AHSB	Banded pinkish grey & pale grey quartzite/silicif. fine sandstone; fissile 33-35m.		▽ 32.0 12/6
35			Pale grey quartzite w/ minor blueish grey and greenish grey banding; minor softer brownish grey silicified fine sandstone bands		
40			Pale grey massive quartzite, trace shale bands 44-45.		← soak 42m
45		HB	Brown and maroon quartzite/sil. fine sandstone; minor maroon micaceous siltstone bands 46-47.		
47		AHSB	Pale greenish grey silicified fine to medium sandstone (well sorted, rounded - 'oolitic') with abundant quartzite bands; minor pinkish grey very hard qzite bands.		

ADDITIONAL COMMENTS:

SMHB = soft with minor hard bands (soft > hard)
HB = hard bands (soft ≃ hard)
AHSB = alternating hard & soft bands (hard > soft)

TOWNSITE DRILLING STAGE 2

Date: 18/6/00

OCALITY NAME: #10a S

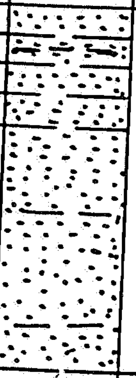
LOGGED BY: J. Kellett

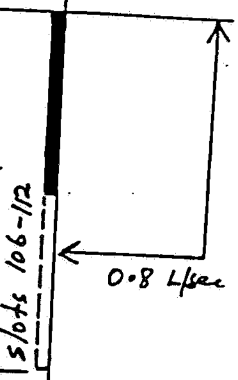
6561865 N 0673803 E 159 EST. RL.

WL: 39.7 (18/6/00) YIELD: 0·8 L/sec SALINITY: 16,000 ppm Sheet 3 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer

Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol
101			Maroon sil. fine sandstone; trace mica		
102			Interbedded maroon sil. fine sandstones and choc. brown siltstones; minor bands of brown sandstone		
103			Maroon and dark grey finely laminated sil. fine sandstone w/ ~20% pale brown softer sandstone bands.		
104		AHSB	Interbedded maroon & grey silicified fine sandstones and chocolate brown siltstones. Trace mica on bedding planes; minor pale brown softer sandstones.	Pwc	
			Banded maroon and grey slightly micaceous silicified fine sandstone (poorly sorted, subangular); some less silicified softer bands. Generally large tabular chips. Trace mudstone 106-108m, 110-111m.		
112			EOH 112m.		





ADDITIONAL COMMENTS:

AHSB = alternating hard & soft bands (hard > soft)

HDWASTE DRILLING STAGE 2

OCALITY NAME: # 10a S

Date: 16/6/00

6561865 N 067 3803 E

LOGGED BY: J. Kellett

159 EST. RL.

WL: 39.7 (18/6/00) YIELD: 0.8 L/sec SALINITY: 16,000 ppm Sheet 2 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air Hammer

Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeo
51			Pale greenish grey quartzite		
52.5		AHSB	Purple-brown silicified fine sandstone (poorly sorted, subangular) with harder grey quartzite bands; trace mica in sandstones, trace blueish grey claybands		
55			Pale grey quartzite with minor purple & brown bands of silicified fine sandstone		
58			Banded purple and brown silicified fine sandstone (poorly sorted, subang.); trace mica and thin siltstone bands; interbedded hard grey quartzite bands.		
		HARD	Banded grey and purple brown massive quartzite	Pws	
65			Pale grey quartzite		
66		AHSB	Banded pale grey, pale greenish grey and mauve silicified fine sandstone (moderately well sorted, subrounded, many fused quartz grains) and interbedded quartzite		
75		HARD	Pale greenish grey quartzite with interbedded silicified fine sandstone (poorly sorted, subrd.)		
77		AHSB	Banded pale greenish grey & purple quartzite with minor maroon siltstone bands; quartzite fractures into large tabular chips		
78.5					
80		HARD	Pale greenish grey quartzite w/ ~20% greenish grey siltstone bands; large tabular chips.		
			Pale greenish grey massive quartzite		
84		AHSB	Maroon with grey bands silicified fine quartzose sandstone (poorly sorted, subangular); minor mica in groundmass, mica conspicuous on bedding planes. Trace maroon and chocolate brown thin micaceous siltstone bands.	Pwc	
94			Maroon silicified fine sandstone (poorly sorted, subangular); trace mica on some bedding planes. Tabular chips. Minor soft bands of pale brown sandstone 96-97m.		soak 95m

ADDITIONAL COMMENTS:

AHSB = alternating bands of hard and soft rock (hard > soft)

DWASTE DRILLING STAGE 2

CALITY NAME: #10a S

Date: 12/16 / 6/6 / 00/00

6561865 N 0673803 E

LOGGED BY: J. Kellett

159 EST. RL.

VL: 39.7 (18/6/00) YIELD: 0.8 L/sec SALINITY: 16,000 ppm Sheet 1 of 3

ELL STATUS: Observation piezometer DRILLING METHOD: RC air hammer

	Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeo
–2.5			SOFT	Reddish brown medium clay, increasing plasticity with depth	Qc	
2.5–3.5			HARD	Yellowish brown silcrete/ferricrete	Ts	
3.5–10				Whiteish grey quartzite with bands of silicified fine quartzose sandstone (well sorted, rounded-subrounded – 'oolitic'); white clay films on some fracture faces	Pws	
10–12			AHSB	trace white cbs — Pale grey quartzite with claybands (proportions shown); minor interbedded silicified fine to medium sandstones (moderately well sorted, subrounded).		
12–14				20% white & pgg cbs		
14–17				trace white cbs		
17–18				20% white cbs		
18–30				trace white cbs		
30–35				trace pgg cbs — Pale greenish grey and pale grey quartzite with claybands (ppns shown)		
35–36				20% pgg cbs		
36–37				Banded purple & brown silicified fine sandstone (moderately well sorted, subrd.) w/- pale grey qtzite bands		
37–38				Pale grey & pale greenish grey quartzite		
38–				Purple-brown sil. fine sandstone w/- quartzite bands		
–42				Pale greenish grey silicified fine sandstone (poorly sorted, subang.-subrd.) with grey and purple-brown quartzite bands		▽ 39.7 (18/6)
42–44				Pale grey quartzite w/- minor pale yellowish grey sil. fine sandstone and siltstone bands		
44–46			HB	Pale greenish grey sil. fine sandstone (mod. well sorted, subrd); with thin lithic sandstone bands & trace bluish grey claybands		
46–47				Pale greenish grey quartzite; trace brown claybands		
47–			AHSB	Pale greenish grey quartzite with minor purple-brown sil. fine sandstone beds		

ADDITIONAL COMMENTS:

Abbreviations:

Pgg cbs = pale greenish grey claybands

HB = hard bands (hard ≃ soft)

AHSB = alternating hard & soft bands (hard > soft)

DATE: --/--/--

OCALITY NAME: #10aN

LOGGED BY: J. Kellett

6563976 N 0673778 E 149 EST. RL.

WL: 32.0 (12/6/00) YIELD: 0.5 L/sec SALINITY: 18,000 ppm Sheet 2 of 2

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer

Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydroge
52		AHSB	Banded grey and brown silicified fine to medium sandstone/quartzite (well sorted, rounded - 'oolitic'); trace brown claybands 50-51m	Pws	
56			Brown and grey sil. fine sandstone (poorly sorted, subang. - subrd.) with abundant quartzite bands; trace brown claybands 52-53m.		
57		HARD	Brown quartzite/sil. fine sandstone, trace pyrite		
62			Grey, with some brown banding, quartzite with bands of silicified fine to medium sandstone (moderately well sorted, subrounded); trace blueish grey shale 61-62m.		
			Banded pale blueish grey and greyish brown quartzite/silicified fine sandstone (poorly sorted, subangular - subrounded with trace mica). Large tabular chips.		
73			Purple-brown, with pale grey bands, quartzite/silicified fine sandstone (poorly sorted, subang.); trace mica and thin shale bands		
76			Pale grey massive quartzite		
78			Pale purple brown & steel grey quartzite, minor softer sandstone bands at top, increasing with depth		
80		AHSB (broken rock below 80m)	Maroon, with some grey bands, silicified fine sandstone (poorly sorted, subangular - subrounded); abundant mica on bedding planes & trace pyrite on bedding planes and fracture surfaces; minor maroon micaceous siltstone beds.	Pwc	slots 82-88 0.5 L/sec (86m)
88			EOH 88m		

ADDITIONAL COMMENTS:

AHSB = alternating hard & soft bands (hard > soft)

ADWASTE DRILLING STAGE 1

Date: 19/5/99

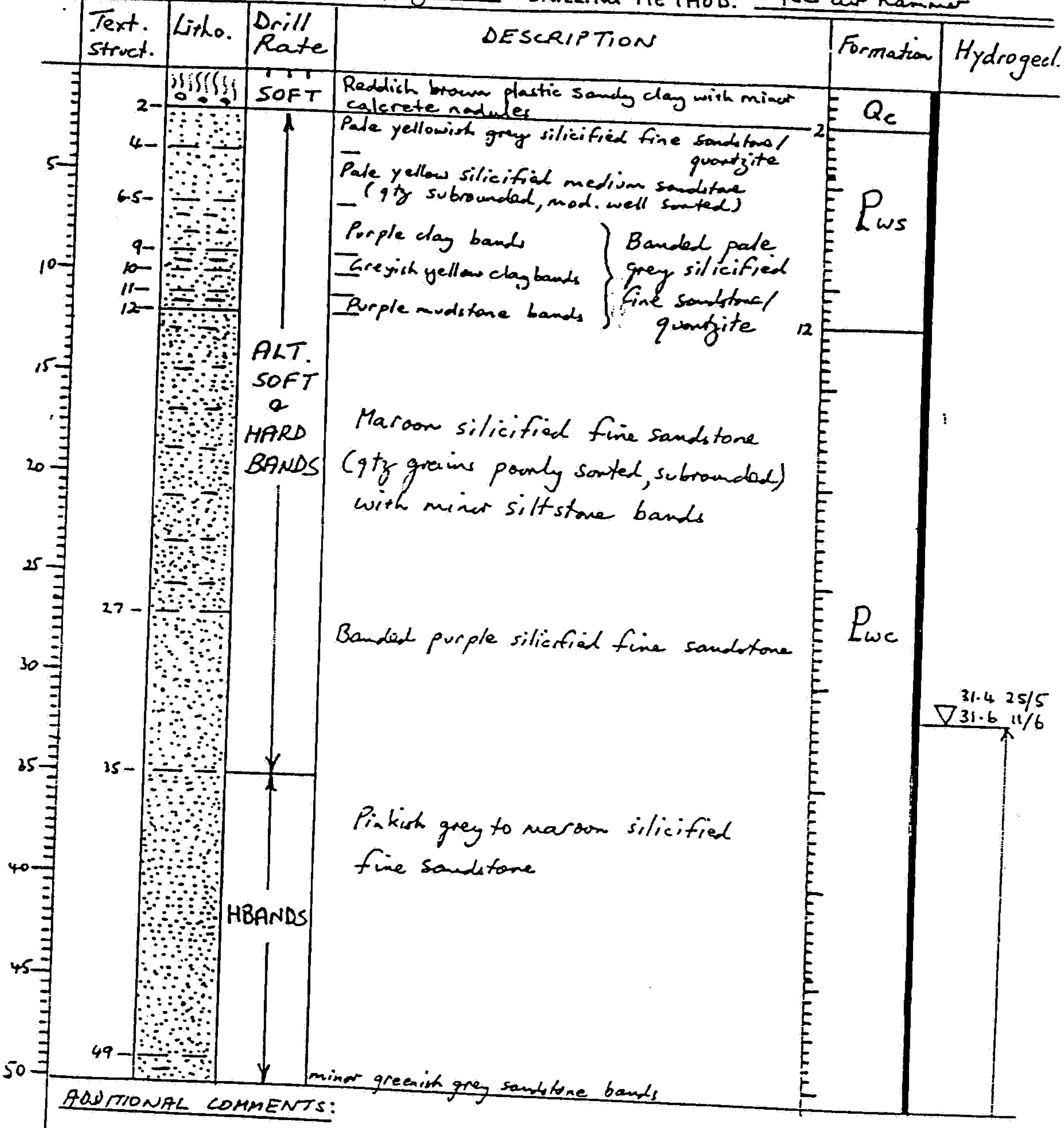
OCALITY NAME: #12SE

LOGGED BY: J.Kellett

6585641 N 674762 E 105 EST. RL.

WL: 31.6 11/6/99 YIELD: 3 L/sec SALINITY: 68,500 ppm Sheet 1 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer



Text. Struct.	Drill Rate	DESCRIPTION	Formation
	SOFT	Reddish brown plastic sandy clay with minor calcrete nodules	Qc
2		Pale yellowish grey silicified fine sandstone/quartzite	Pws
4		Pale yellow silicified medium sandstone (qtz subrounded, mod. well sorted)	
6.5		Purple clay bands } Banded pale grey silicified fine sandstone/quartzite	
9		Greyish yellow clay bands	
10			
11		Purple mudstone bands	
12	ALT. SOFT & HARD BANDS	Maroon silicified fine sandstone (qtz grains poorly sorted, subrounded) with minor siltstone bands	Pwc
27		Banded purple silicified fine sandstone	
35	HBANDS	Pinkish grey to maroon silicified fine sandstone	
49		minor greenish grey sandstone bands	

ADDITIONAL COMMENTS:

ADWASTE DRILLING STAGE 1

OCALITY NAME: # 12SE

Date: 27/5/99

LOGGED BY: J.Kellett

658564 N 674762 E 105 EST. RL.

WL: 31.6 11/6 YIELD: 3 L/sec SALINITY: 68,500 ppm Sheet 2 of 3

ELL STATUS: observation piezo. DRILLING METHOD: RC air hammer

	Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
			HBANDS	Maroon and grey silicified fine sandstone w/- minor med sandstone bands		
55	55–		HARD	Maroon silicified fine sandstone/quartzite		
	57– 58–			Choc brown & purple siltstone bands } "		
60	61–			Minor blueish grey fine sandstone bands }		
	63–			Banded grey & purple sil. fine sandstone		
65 70 75				Maroon silicified fine to medium sandstone (poorly sorted, subrounded); minor grey and maroon siltstone bands	Pwc	
	78–		VERY HARD	Steel grey silicified fine sandstone/quartzite. Dark grey staining on bedding planes.		76 ← seepage ~15,000 ppm
80	81–		HARD	Maroon and grey silicified fine sandstone; minor maroon siltstone bands.		
85	84– 85–		V.HARD	Pale grey quartzite		
			HARD	Banded maroon and grey silicified fine to medium sandstone		
90 95	89–			Maroon silicified fine sandstone; minor greenish grey fine-med sandstone bands. Some large angular drill chips		93– slots
100	99.5–	XXXXX		Fracture zone	Hole collapsed to 99 m	99– ← 3 L/sec 68,500 ppm

ADDITIONAL COMMENTS:

Hypersaline water in fracture zone

RADWASTE DRILLING STAGE 1 Date: 27/5/99

LOCALITY NAME: #12SE LOGGED BY: J.Kellett

6585641 N 674762 E 105 EST. RL.

SWL: 31.6 11/6 YIELD: 3 L/sec SALINITY: 68500 ppm Sheet 3 of 3

WELL STATUS: Obs. piezometer DRILLING METHOD: RC air hammer

	Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
	102	▨	HARD	Fracture zone; large angular chips; trace sulphides on fracture faces	Pwc	Hole collapsed to top of fract. zone
105	106	░		Brownish grey silicified fine sandstone/quartzite		
	107	░		Maroon & grey sil. fine sandstone; tr mica & sulphides		
				EOH 107m		

ADDITIONAL COMMENTS:

RADWASTE DRILLING STAGE 1

OCALITY NAME: #13 SE

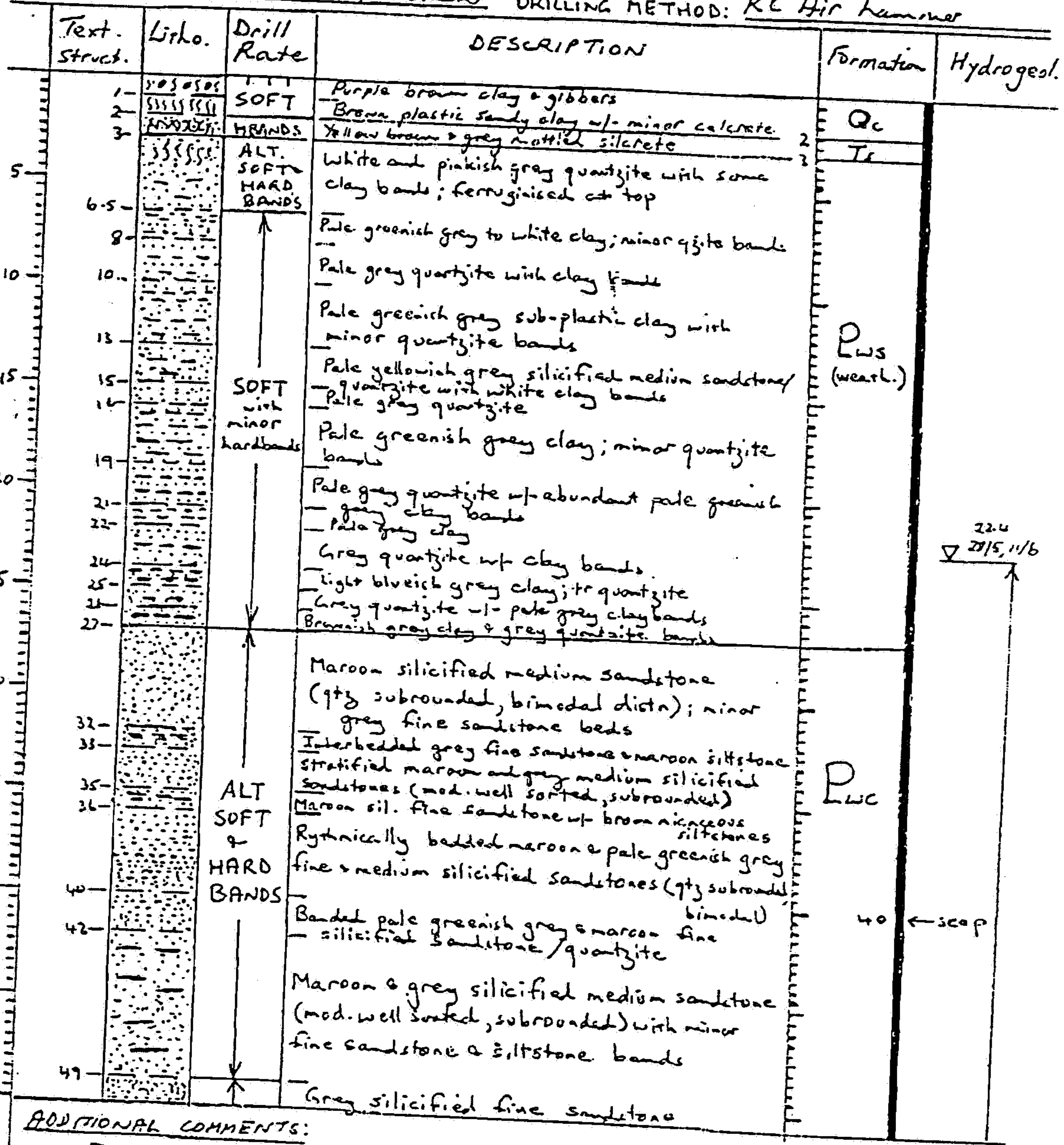
Date: 28/5/99

6579385 N 685448 E 105 EST. RL.

LOGGED BY: J.Kellett

SWL: 22.4 11/6/99 YIELD: 0·1 L/sec SALINITY: 23,000 ppm Sheet 1 of 2

ELL STATUS: Observation piezometer DRILLING METHOD: RC Air Hammer



Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
1		SOFT	Purple brown clay & gibbers	Qc	
2			Brown plastic sandy clay w/- minor calcrete.		
3		HBANDS	Yellow brown & grey mottled silcrete	Ts	
6.5		ALT. SOFT & HARD BANDS	White and pinkish grey quartzite with some clay bands; ferruginised at top	Pws (weath.)	
8		SOFT with minor hardbands	Pale greenish grey to white clay; minor qtzite bands		
10			Pale grey quartzite with clay bands		
13			Pale greenish grey sub-plastic clay with minor quartzite bands		
15			Pale yellowish grey silicified medium sandstone/quartzite with white clay bands		
16			Pale grey quartzite		
19			Pale greenish grey clay; minor quartzite bands		
21			Pale grey quartzite w/- abundant pale greenish grey clay bands		
22			Pale grey clay		
24			Grey quartzite w/- clay bands.		22.4 ∇ 28/5, 11/6
25			light blueish grey clay; tr quartzite		
26			Grey quartzite w/- pale grey clay bands		
27			Brownish grey clay & grey quartzite bands		
32		ALT SOFT & HARD BANDS	Maroon silicified medium sandstone (qtz subrounded, bimodal distn); minor grey fine sandstone beds	Pwc	
33			Interbedded grey fine sandstone & maroon siltstone		
35			stratified maroon and grey medium silicified sandstones (mod. well sorted, subrounded)		
36			Maroon sil. fine sandstone w/- brown micaceous siltstones		
40			Rythmically bedded maroon & pale greenish grey fine & medium silicified sandstones (qtz subrounded, bimodal)		
42			Banded pale greenish grey & maroon fine silicified sandstone/quartzite		40 ← seep
49			Maroon & grey silicified medium sandstone (mod. well sorted, subrounded) with minor fine sandstone & siltstone bands		
			Grey silicified fine sandstone		

ADDITIONAL COMMENTS:

Pws sequence deeply weathered.

RADWASTE DRILLING STAGE 1

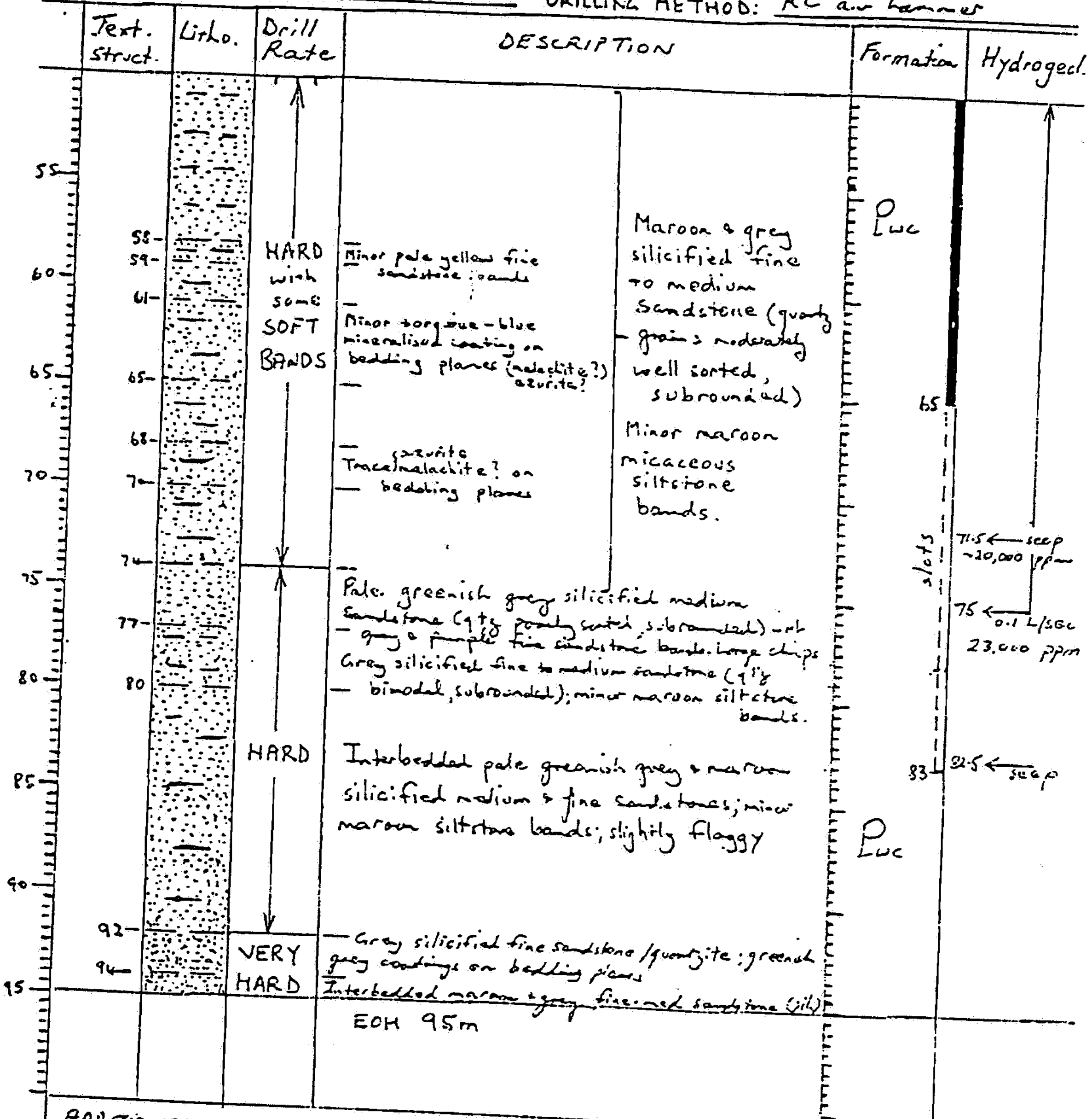
OCALITY NAME: F 13SE Date: 28/5/99

6579385 N 685448 E LOGGED BY: J.Kellett

105 EST. RL.

WL: 22.4 11/6 YIELD: 0.1 L/sec SALINITY: 23,000 ppm Sheet 2 of 2

ELL STATUS: Obs piezometer DRILLING METHOD: RC air hammer



Maroon & grey silicified fine to medium Sandstone (quartz grains moderately well sorted, subrounded)

Minor maroon micaceous siltstone bands.

Minor pale yellow fine sandstone bands

Minor turquoise-blue mineralised coating on bedding planes (malachite?) azurite?

Trace azurite / malachite? on bedding planes

Pale greenish grey silicified medium Sandstone (qtz poorly sorted, subrounded) with grey & purple fine sandstone bands. large chips

Grey silicified fine to medium sandstone (qtz bimodal, subrounded); minor maroon siltstone bands.

Interbedded pale greenish grey & maroon silicified medium & fine sandstones; minor maroon siltstone bands; slightly flaggy

Grey silicified fine sandstone / quartzite; greenish grey coatings on bedding planes

Interbedded maroon & grey fine-med sandstone (sil)

EOH 95m

ADDITIONAL COMMENTS:

ADWASTE DRILLING STAGE 1.

OCALITY NAME: #33S (Koolymilka)

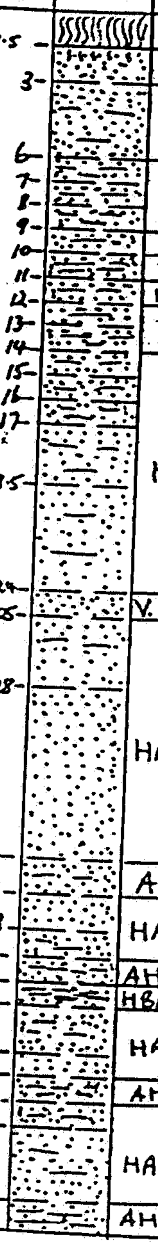
Date: 31/8/99 1/9/99

LOGGED BY: J. Kellett

6578 355 N 0 649244 E ________ EST. RL.

WL: 39.3 (1/9/99) YIELD: 0·5 L/sec SALINITY: 16,400 ppm Sheet 1 of 2

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer



Text. Struct.	Drill Rate	DESCRIPTION		Formation	Hydrogeol.
1.5	SOFT	Reddish brown plastic clay			
3	AHSB	Yellowish brown & grey quartzite w/- minor brown claybands. Purple Ironstone bands 1.5-2m		Qc weath. surface	
6	HARD	Pale grey & yellowish brown quartzite; trace yellowish brown claybands			
7	AHSB	~30% pink & grey cbs	Pale grey quartzite with variable clay bands		
8		~20% pale grey cbs			
9		~40% white cbs			
10	HARD	trace white cbs			
11	AHSB	~50% pale greenish grey claybands			
12	HARD	~20%			
13	AHSB	trace			
14		~30%			
15	HARD	~20%			
16		~20%			
17		~30%			
19.5		~20% pale greenish grey clay bands	Banded pale grey and pale greyish brown massive quartzite with minor clay bands in top half	Pws	
24		Trace pale greenish grey claybands			
25	V.HARD	clean quartzite			
28	HARD	Trace pale grey clay bands			
35		Clean massive quartzite			
36.5	AHSB	Pale greyish brown quartzite w/- ~20% pale greenish grey claybands			
38	HARD				
39		Banded grey & yellowish brown quartzite			
40	AHSB	Pale grey quartzite; trace claybands			39.3 1/9 ▽
41	HBANDS	~50% pale brownish grey claybands	Pale grey quartzite with claybands		
43	HARD	~70%			
44		~20%			
45	AHSB	trace			
46	HARD	~60%			
		~20%			
49		Trace grey claybands	Steel grey quartzite/silicified fine to med. sandstone with basal claybands		
50	AHSB	~60% grey claybands			

ADDITIONAL COMMENTS: No sample recovery 0-1m.

cbs = claybands

AHSB = alternating hard & soft bands (hard > soft)

ADWASTE DRILLING STAGE 1

OCALITY NAME: #33S (Koolymilka)

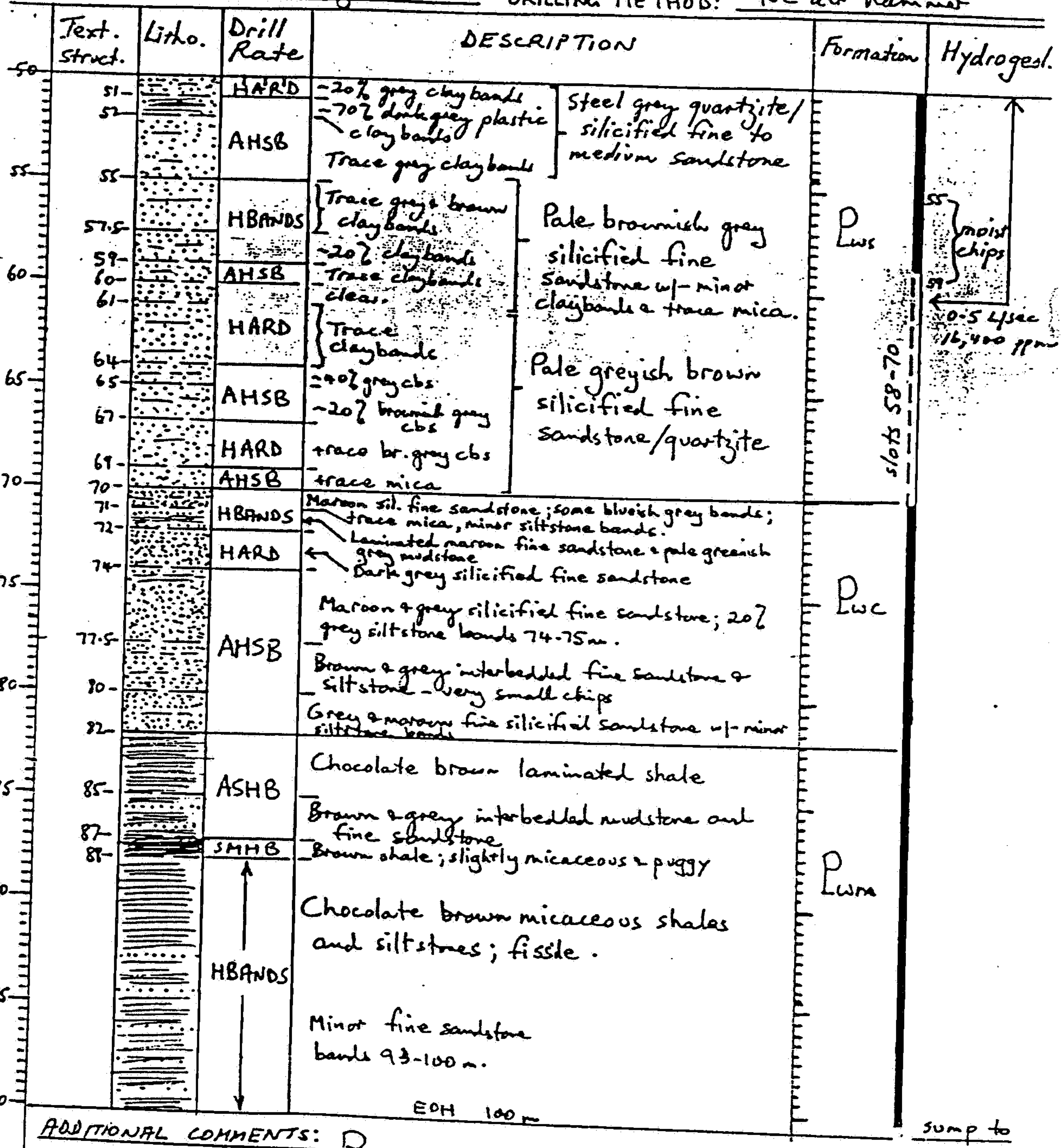
Date: 1/9/99

LOGGED BY: J. Kellett

6578355 N 0649244 E ______ EST. RL.

WL: 39.3 (1/9/99) YIELD: 0.5 L/sec SALINITY: 16,400 ppm Sheet 2 of 2

ELL STATUS: obs. piezometer DRILLING METHOD: RC air hammer



Text. Struct.	Litho.	Drill Rate	DESCRIPTION		Formation	Hydrogeol.
51		HARD	~20% grey claybands	Steel grey quartzite/ silicified fine to medium sandstone	Pws	
52		AHSB	~70% dark grey plastic claybands			
			Trace grey claybands			
55		HBANDS	Trace grey & brown claybands	Pale brownish grey silicified fine sandstone w/- minor claybands & trace mica.		55 – 59 moist chips
57.5			~20% claybands			
59		AHSB	Trace claybands			0.5 L/sec 16,400 ppm
60			clear.			slots 58-70
61		HARD	Trace claybands	Pale greyish brown silicified fine sandstone/quartzite		
64		AHSB	~40% grey cbs			
65			~20% brownish grey cbs			
67		HARD	trace br. grey cbs			
69		AHSB	trace mica			
70		HBANDS	Maroon sil. fine sandstone; some bluish grey bands; trace mica, minor siltstone bands.		Pwc	
71			Laminated maroon fine sandstone & pale greenish grey mudstone			
72		HARD	Dark grey silicified fine sandstone			
74		AHSB	Maroon & grey silicified fine sandstone; 20% grey siltstone bands 74-75m.			
77.5			Brown & grey interbedded fine sandstone & siltstone – very small chips			
80			Grey & maroon fine silicified sandstone w/- minor siltstone bands			
82		ASHB	Chocolate brown laminated shale		Pwm	
85			Brown & grey interbedded mudstone and fine sandstone			
87		SMHB	Brown shale; slightly micaceous & puggy			
88		HBANDS	Chocolate brown micaceous shales and siltstones; fissile.			
			Minor fine sandstone bands 93-100m.			
			EOH 100m			sump to 100m.

ADDITIONAL COMMENTS: Pwc unusually thin (12m)

ASHB = alternating soft & hard bands (soft > hard)

cbs = claybands

SMHB = soft with minor hard bands

WASTE DRILLING STAGE 2

ALITY NAME: #52a NW

Date: 8/6/00

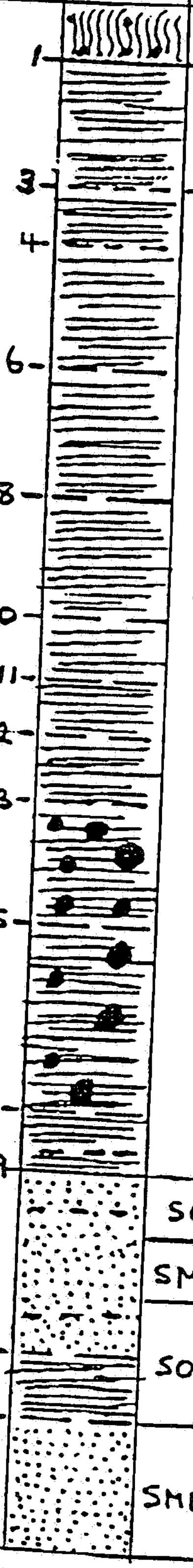
6574709 N 0636757 E

LOGGED BY: J. Kellett

158 EST. RL.

40.0 10/6/00 YIELD: 0.6 L/sec SALINITY: 12,000 ppm Sheet 1 of 3

STATUS: observation piezometer DRILLING METHOD: RC air hammer



Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeo
1		SOFT	Reddish brown plastic sandy clay with minor calcrete, gypsum & shale fragments	Qc	
3		SMHB	Reddish brown & yellowish brown laminated siltstone, abundant gypsum glaebules; some pale yellowish grey silt/shale bands.		
4		SOFT	Pale yellowish grey siltstone with minor claybands; puggy.	Kmb	
6			White laminated siltstone, trace reddish brown claybands 5-6m.		
8			Laminated greyish yellow & pale grey siltstone/mudstone; trace reddish grey silicified fine sandstone bands 6-7m.		
10			Whiteish grey and pale pinkish grey laminated siltstone; trace pale grey claybands 9-10m.		
11			Banded yellowish brown and pale grey siltstone/mudstone; puggy.		
12			Pale pinkish grey & pale grey siltstone, puggy; minor red staining on bedding planes.		
13			Pink & grey mudstone, balls up in hole.		
15			White siltstone with abundant well rounded quartzite & silicified sandstone broken fragments. Contains 50% pale yellowish grey claybands 14-15m.		
18			Pale yellowish grey mudstone with well rounded silicified fine sandstone fragments; puggy.		
19			Pale yellowish brown siltstone with trace dark brown & black micaceous fine sandstone bands		
22		SOFT SMHB SOFT	Pale brownish grey weakly indurated fine sandstone (poorly sorted, subangular-subrounded); highly porous with minor yellowish grey claybands; some harder thin silicified bands 20-21m	Kco	
23			Pale brownish grey siltstone, puggy.		
		SMHB	Pale brownish grey fine sandstone (poorly sorted, subang-subrounded); generally porosity decreasing with depth. Minor hard silicified bands.		

DITIONAL COMMENTS:

Kmb highly bleached to 10m depth, ferruginised in top 2m.

SMHB -

0272 4087 ARDC AUSTRALIA

007

WASTE DRILLING STAGE 2

ALITY NAME: #52a NW

Date: 8&10/6/00

6574709 N 0636757 E

LOGGED BY: J. Kellett

158 EST. RL.

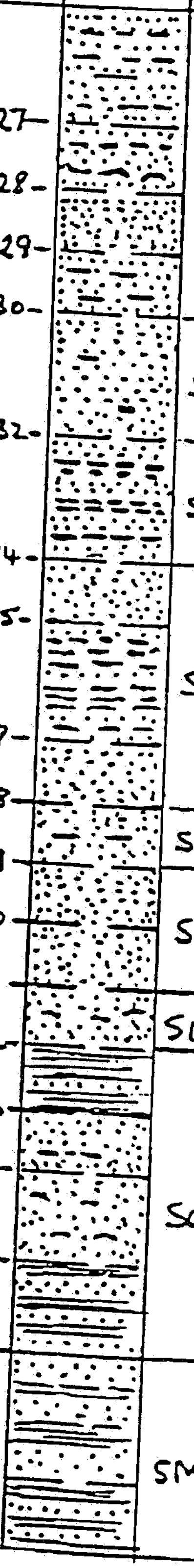
40.0 10/6/00 YIELD: 0.6 L/sec

SALINITY: 12,000 ppm

Sheet 2 of 3

STATUS: obs. piezometer

DRILLING METHOD: RC air hammer



Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeo
27 28 29 30		SMHB	Pale brownish grey fine sandstone; mostly weakly indurated with minor hard silicified bands; pale yellowish grey cbs 25-26 (30%) & 26-27 (10%) Brown fine sandstone with 40% cbs; trace pyritic & carbonaceous clayey sand Pale grey fine to med sandstone; porous in softer zones (mod well sorted, subrounded) Pale grey fine sandstone with 40% pale greenish grey cbs		
32		SOFT	Banded pale yellowish brown and pale grey weakly indurated fine sandstone (poorly sorted, subangular); trace cbs, tabular chips		
34		SMHB	Interbedded silicified fine sandstone and pale greenish grey clay (50:50)		
35 37 38		SOFT	Pale grey weakly indurated fine quartzose sandstone Pale greenish grey & pale yellowish grey silty clays (70%) with thin fine sandstone & siltstone bands Pale brownish grey fine sandstone; large tabular chips, weakly indurated.	Kco	
39		SMHB	as for 37-38, minor hard silicified bands, trace cbs		
40		SOFT	Brownish grey, weakly indurated fine sandstone Pale grey weakly indurated fine sandstone (poorly sorted, subrd).		▽ 40.0
41 42		SMHB	Brown fissile micaceous fine sandstone with minor pale grey silicified hardbands		
43 44 45.5 47		SOFT	Dark blueish grey silty clay, slightly carbonaceous, with 20% thin hard sil. sandstone bands; moist Brown to maroon micaceous fine sandstone, trace brown cbs Grey micaceous fine sandstone; mica coatings on bedding planes; med to large tabular chips Interbedded grey clays and fine sandstones/siltstones (50:50)		
49		SMHB	Stratified chocolate brown micaceous fine sandstone & siltstone; trace blueish grey siltstone bands Chocolate brown micaceous siltstone with thin hard pale blueish grey sil. fine sandstone bands; bronze pyrite faces on some bedding planes.	Pwc	

DITIONAL COMMENTS:

cbs = claybands

SMHB = soft with minor hardbands.

Note: D

ASTE DRILLING STAGE 2

LITY NAME: #52a NW

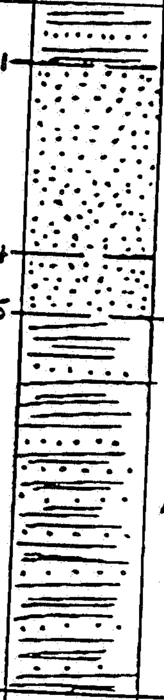
Date: 10/6/00

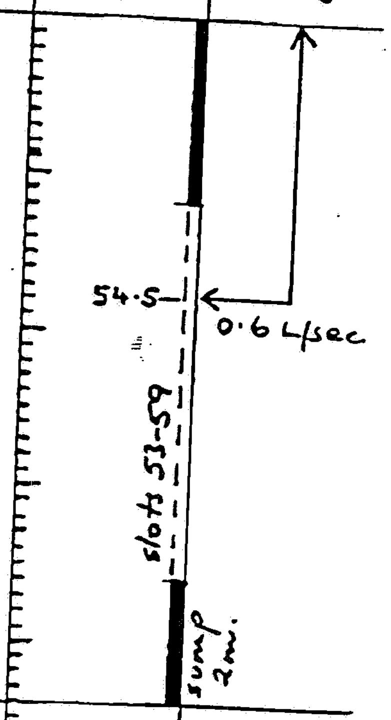
LOGGED BY: J. Kellett

574709 N 0636757 E 158 EST. RL.

40.0 (10/6/00) YIELD: 0.6 L/sec SALINITY: 12,000 ppm Sheet 3 of 3

STATUS: Obs. piezometer DRILLING METHOD: RC air hammer





Ext. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol
51			as for 49-50 (70% siltstone, 30% sandstone)		
		SMHB	Pale brownish grey fine sandstone (poorly sorted, subangular); minor thin grey silicified hardbands		
54			Pinkish grey fine sandstone with minor softer bluish grey bands	54.5	0.6 L/sec
55		ASHB	Chocolate brown slightly micaceous siltstone with hard fine sandstone bands; puggy 55-57 & 60-61		
			EOH 61m		

TIONAL COMMENTS:

MHB = soft with minor hardbands.

SHB = alternating soft & hard bands.

:ADWASTE DRILLING STAGE 2

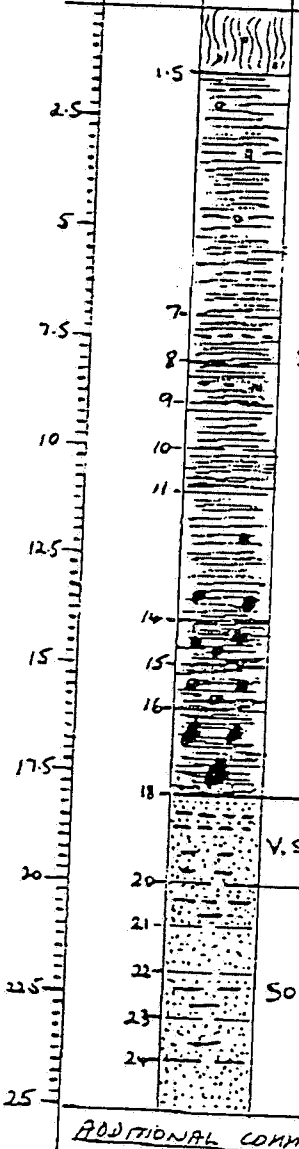
·OCALITY NAME: #52a SE Date: 13/6/00

6572610 N 0637153 E LOGGED BY: J Kellett

160 EST. RL.

·WL: 37·4 (13/6/00) YIELD: 0·6 L/sec SALINITY: 16,000 ppm Sheet 1 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer



Text. Struct.	Litho.	Drill Rate	DESCRIPTION	Formation	Hydrogeol.
		SOFT	Reddish brown plastic sandy clay; minor gypsum.	Qc	
1.5			Greyish white siltstone with trace white claybands; strongly ferruginised 1.5-2m, minor Fe staining 2-5m. Trace gypsum 1.5-5m.		ferr. surface
7			20% claybands } ″		
8			10-20% claybands } Pale yellowish brown siltstone/mudstone with pink-mauve claybands	Kmb	
9			trace claybands		
10			white and yellowish brown mudstone with 50% softer claybands		
11			Banded white and less common pale pinkish grey siltstone (60%) and pale coloured claybands (40%). Minor well rounded qzite fragments.		
14			Pale grey mudstone with minor reddish brown staining. 30% rounded quartzite fragments		
15			Pale yellowish brown siltstone/shale-silts - shale beds compl. weathered to clay. 30% qzite. fg.		
16			Whiteish grey siltstones & mudstones. Poggy. Large frosted, well rounded qzite frags; becoming sandier towards base.		
18		V. SOFT	Pale grey weakly indurated fine quartzose sandstone (mod. well sorted, subrounded) with interbedded drift sands. Claybands - 20% (18-19) trace (19-20m).		
20		SOFT	Pale grey fine sandstone with 30% white claybands + minor drift sand.	Kco	
21					
22			30% cbs } Pale grey fine quartzose sandstone (poorly sorted, subang - subr.) with some white claybands. Minor slightly harder weakly silicified bands; trace drift sands; becoming less porous with depth.		
23			trace - cbs		
24					

ADDITIONAL COMMENTS:

Kmb highly bleached to 8m.
Drift sands at top of Kco.

ADWASTE DRILLING STAGE 2

OCALITY NAME: #52aSC

Date: 13/6/00

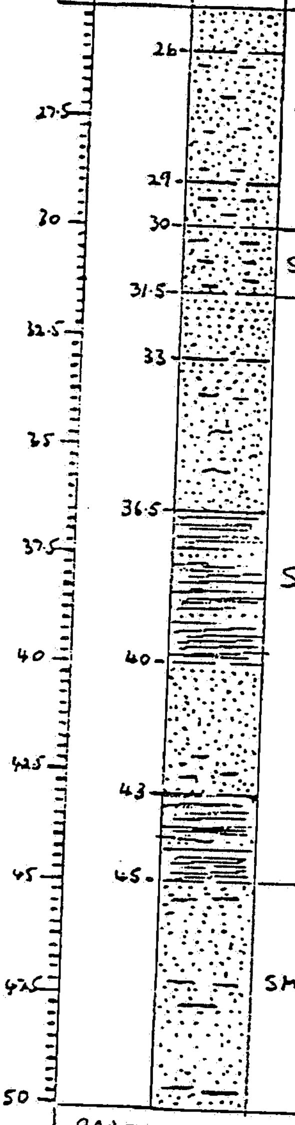
6572610 N 0637153 E

LOGGED BY: J. Kellett

160 EST. RL.

WL: 37.4 (13/6/00) YIELD: 0.6 L/sec SALINITY: 16 000 ppm Sheet 2 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer



Drill Rate		DESCRIPTION	Formation	Hydrogeol.
SOFT	trace claybands	Pale grey fine quartzose sandstone (poorly sorted, subangular–subrounded) with variable claybands; minor drift sands.	Kco	
SMHB	20% pale greenish grey claybands	minor harder thin silicified bands 30-31.5		
SOFT		Banded yellowish brown and pale grey weakly indurated fine sandstone. 20% yellow drift sand bands		
		Brown & yellowish brown laminated micaceous fine to medium sandstones; weakly indurated, (very poorly sorted, subangular); minor thin bronze shaley bands		
		Chocolate brown micaceous siltstones and mudstones with minor thin (hard) grey silicified sandstone bands; trace blueish grey claybands; puggy.	Pwc	▽ 37.4 13/6
		Yellowish brown to honey-coloured arkosic fine sandstone (poorly sorted, subangular) with minor silicified pale grey fine sandstone bands; trace mica on bedding planes & trace yellowish brown cbs 42-43.		
		Chocolate brown micaceous siltstones and mudstones, fissile, trace pyrite; minor thin blueish grey fine sandstone bands; very puggy.		
SMHB		Banded blueish grey and brown fine quartzose sandstone, alternating hard and soft bands (soft > hard) – poorly sorted, subangular with mica on bedding planes, blueish grey claybands – 20% (45-46, 47-48, 49-50); trace elsewhere		

ADDITIONAL COMMENTS: Pwc unusually clayey and soft, Kco unsaturated.

SMHB = soft with minor hard bands

ADWASTE DRILLING STAGE 2

OCALITY NAME: # 52a SE

Date: 13/6/00

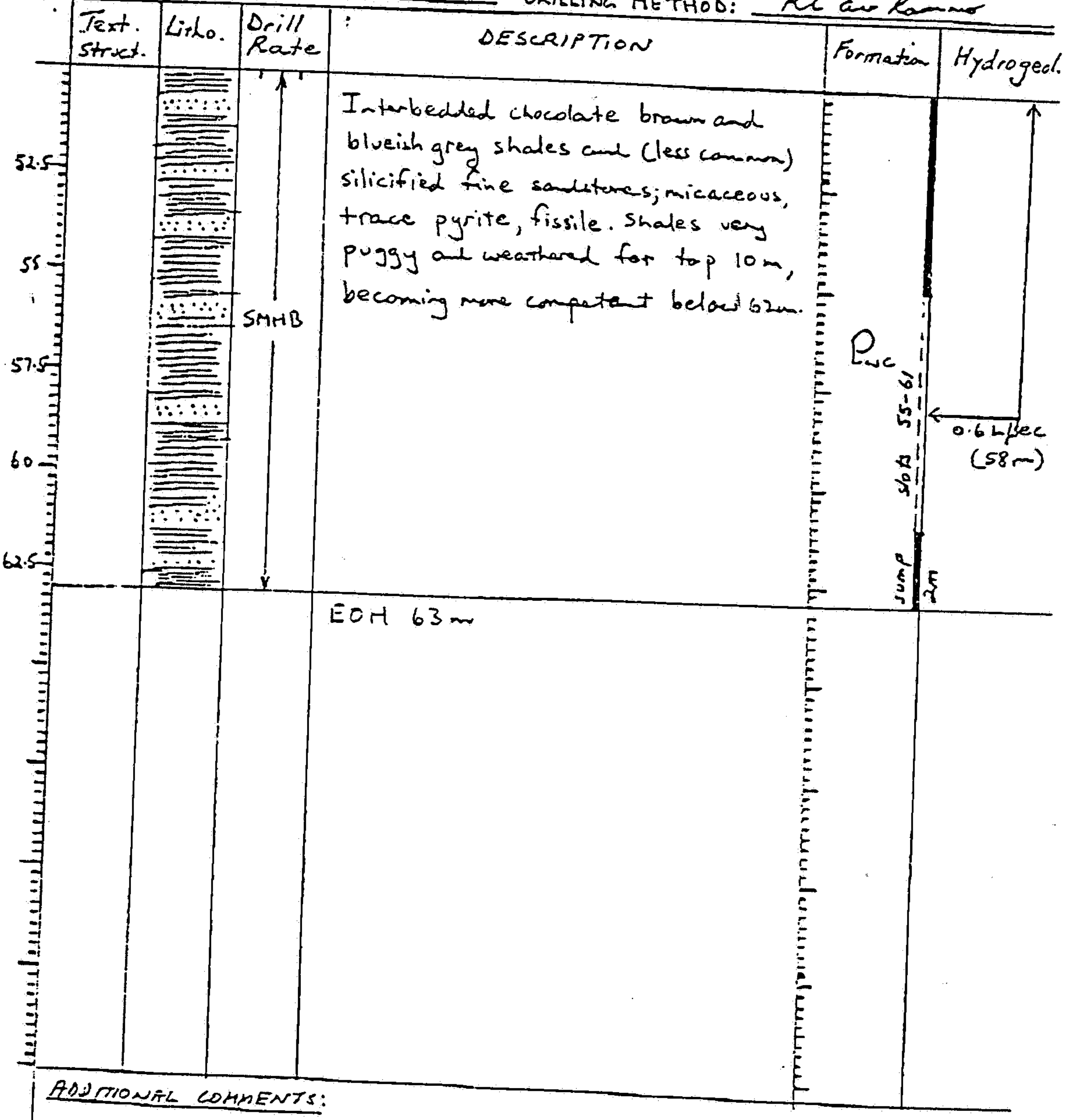
LOGGED BY: J. Kellett

6572610 N 0637153 E

160 EST. RL.

WL: 37.4 (19/6/00) YIELD: 0.6 L/sec SALINITY: 16,000 ppm Sheet 3 of 3

ELL STATUS: observation piezometer DRILLING METHOD: RC air hammer



Interbedded chocolate brown and blueish grey shales and (less common) silicified fine sandstones; micaceous, trace pyrite, fissile. Shales very puggy and weathered for top 10m, becoming more competent below 62m.

EOH 63m

ADDITIONAL COMMENTS:

Pwc unusually soft and shaley at this site.

SMHB = soft with minor hard bands.

Reynolds, L.J. 2000 - Geology of the Olympic Dam Cu-U-Au-Ag-REE Deposit; *in Porter, T.M. (Ed.), Hydrothermal Iron Oxide Copper-Gold & Related Deposits: A Global Perspective*, Australian Mineral Foundation, Adelaide, pp 93-104.

GEOLOGY OF THE OLYMPIC DAM Cu-U-Au-Ag-REE DEPOSIT

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Roxby Downs, SA, Australia, 5725

Abstract - The ~1590 Ma Olympic Dam Cu-U-Au-Ag-REE deposit is located in the Stuart Shelf geological province of South Australia, on the eastern margin of the Gawler Craton. The deposit is hosted by the Olympic Dam Breccia Complex, a large hydrothermal breccia system wholly contained within the Roxby Downs Granite, a Proterozoic age granitoid interpreted to be part of the Hiltaba Suite. Initial hydrothermal activity within the Olympic Dam Breccia Complex was probably localised by structures in a dextral fault jog environment. Subsequent development of the complex involved repetitive and overprinting physical, chemical and volcanic brecciation mechanisms, resulting in a highly variable array of irregularly shaped and distributed breccia zones with widely differing and gradational lithologies. A complex pattern of hydrothermal alteration dominated by hematite and sericite, with lesser chlorite, siderite and quartz is associated with the breccia zones. Mineralisation within the deposit is intimately associated with iron-oxide alteration of the granitoid, which dominantly occurs as hematite, with lesser magnetite at depth and on the periphery of the breccia complex. The principal copper minerals within the deposit show a broad lateral and vertical, hypogene zonation pattern grading from chalcopyrite on the margins to bornite, then chalcocite adjacent to a central barren core. Gold and silver are mainly associated with the copper sulfides, while uranium dominantly occurs in pitchblende disseminated throughout the hematitic breccia zones. Overall, mineralisation grade generally correlates with the degree of hematite alteration and is largely dependent on copper sulfide tenor. Minor brittle faulting post-dates breccia development and appears to have exploited existing anisotropies within the complex. Late-stage fault movements are associated with barite-fluorite vein arrays which overprint the orebody. The deposit formed in a high level volcanic environment, venting to the surface and possibly forming a composite phreatomagmatic eruption crater, which has subsequently been completely eroded. Mafic and felsic dykes intruded the breccia complex, locally producing diatreme structures. Tectonism, hydrothermal activity, dyke intrusion, brecciation, alteration and mineralisation within the system were broadly concurrent and interdependent. Hydrothermal fluids and metals have a dominantly magmatic source, probably associated with the Middle Proterozoic volcano-plutonic event correlated with the Gawler Range Volcanics and Hiltaba Suite intrusives.

ntroduction

e giant Olympic Dam iron oxide associated copper-anium-gold-silver-REE deposit is located in South ustralia, approximately 520 km NNW of Adelaide (Figure The discovery of the deposit in 1975 by Western Mining rporation (WMC) was the result of a multi-disciplinary ploration effort for sediment-hosted copper deposits egrating geology, geophysics and tectonic analysis. cussion of various aspects of the discovery are detailed Laylor (1984 & 1986), O'Driscoll (1985), Reeve 90a,b), Reeve *et al* (1990), and Rutter & Esdale (1985).

deposit contains ore reserves in excess of 600 Mt eraging 1.8% Cu, 0.5 kg/t U_3O_8, 0.5 g/t Au and 3.6 g/t (see Table 1). This is included within an enormous urce containing approximately 30 Mt of Cu, 930 Kt of O_8, 1,200 t of Au and 6,700 t of Ag. The deposit also tains approximately 10 Mt of rare earth elements ncipally La and Ce), however recovery of these metals is uneconomic with current technology. Average iron grade of the resource is approximately 26% Fe.

The orebody is exploited by a mechanised underground mining operation and on-site processing facilities comprising an autogenous mill, concentrator, hydrometallurgical plant, smelter, and refinery. Recent expansion of the mine and process plant has raised the annual production capacity of the operation to around 9 million tonnes of ore to recover approximately 200,000 t of refined copper, 4,300 t of U_3O_8, 80,000 oz Au and 800,000 oz Ag. Details of the development history of the deposit are documented by Roberts & Hudson (1983), Reeve (1990a,b) and Reeve *et al* (1990).

Regional Geological Setting

The Olympic Dam deposit is located on the eastern margin of the Gawler Craton, unconformably overlain by approximately 300 m of Late Proterozoic to Cambrian age,

	Tonnes (Mt)	Cu (%)	U_3O_8 (kg/t)	Au (g/t)	Ag (g/t)
Reserves					
Proved	121	2.4	0.6	0.6	4.2
Probable	485	1.6	0.5	0.5	3.4
Total	**605**	**1.8**	**0.5**	**0.5**	**3.6**
Resources					
Measured	500	1.8	0.5	0.5	3.6
Indicated	1,150	1.3	0.4	0.5	2.9
Inferred	670	1.1	0.4	0.4	2.4
Total	**2,320**	**1.3**	**0.4**	**0.5**	**2.9**

Table 1: Olympic Dam Resources and Reserves 1999 (from WMC Limited Annual Report, 1999). Note that Resources are shown inclusive of Reserves.

flat-lying sedimentary rocks of the Stuart Shelf geological province (Figure 1). The oldest basement rocks in the province are metasedimentary rocks and deformed granites correlated with the Early Proterozoic Hutchison Group and the Lincoln Complex granitoids, respectively (Parker, 1990). These rocks are intruded by Middle Proterozoic Hiltaba Suite granitoids and locally overlain by similar aged bimodal volcanic units correlated with the Gawler Range Volcanics (Flint, 1993). The edge of the craton, and the divide between the undeformed sediments on the Stuart Shelf and their thicker, deformed equivalents within the Adelaide Fold Belt, lies approximately 75 km east of the deposit, where it is defined by the NNW trending Torrens Hinge Zone.

The deposit is hosted within a large body of hydrothermal breccias, called the Olympic Dam Breccia Complex (ODBC) by Reeve *et al* (1990), which occur entirely within the Roxby Downs Granite. The Roxby Downs Granite is a pink to red coloured, undeformed, unmetamorphosed, coarse to medium grained, quartz-poor syenogranite with A-Type affinities (Creaser, 1989). Petrological and petrochemical characteristics of the granite detailed by Creaser (1989), indicate that the Roxby Downs Granite is similar to granitoids of the Hiltaba Suite, which are widespread in the Gawler Craton (Flint, 1993).

The ODBC and the surrounding areas of Roxby Downs Granite form a local basement high on a broader regional basement uplift. The basement unconformity has a gently undulating palaeotopographic relief of about 70 m (Reeve *et al*, 1990) and the overlying cover sequence has a minimum thickness of 260 m. The sedimentary rock units of the cover sequence are shown schematically on Figure 3 and are described by Roberts & Hudson (1983) and Preiss (1987).

The Olympic Dam deposit lies at the intersection of the major NNW trending G2 and WNW trending G9C gravity lineaments identified by O'Driscoll (1985). Regional geophysical data sets indicate that Olympic Dam is one of numerous coincident magnetic-gravity anomalies on the Stuart Shelf. Diamond drilling has revealed that many of these anomalies are caused by hydrothermal iron-oxide alteration in the basement, spatially associated with Hiltaba Suite granitoids (Gow *et al*, 1993).

Deposit Host Rocks

Olympic Dam Breccia Complex

Detailed descriptions of the Olympic Dam Breccia Complex (ODBC) have been documented by Oreskes & Einaudi (1990) and Reeve *et al* (1990). The ODBC primarily consists of a funnel-shaped, barren, hematite-quartz breccia "core" surrounded by an irregular array of variably mineralised and broadly zoned hematite-granite breccia bodies (Figures 2 & 3). These breccia bodies have a range of lithologies from granite-dominated on the periphery of the system, to intensely hematised equivalents within the complex which show textural evidence for polycyclic alteration and brecciation events. There is a complete gradation from granite breccias to hematite-rich breccias and the subdivisions of the rock types within the breccia complex are largely artificial (Reeve *et al*, 1990). Development of the ODBC can be considered as having formed by the progressive hydrothermal brecciation and iron metasomatism of the host granite (Oreskes & Einaudi, 1990).

In plan the ODBC is irregular in shape (Figure 2), with hematite-granite breccia bodies arranged around the central hematite-quartz breccia core, and a relatively long and narrow extension to the NW. An apparently less significant extension occurs in the SE of the deposit, and recently a new area of breccias has been identified in the SW of the deposit. A halo of weakly altered and brecciated granite extends out approximately 5 to 7 km from the core in all

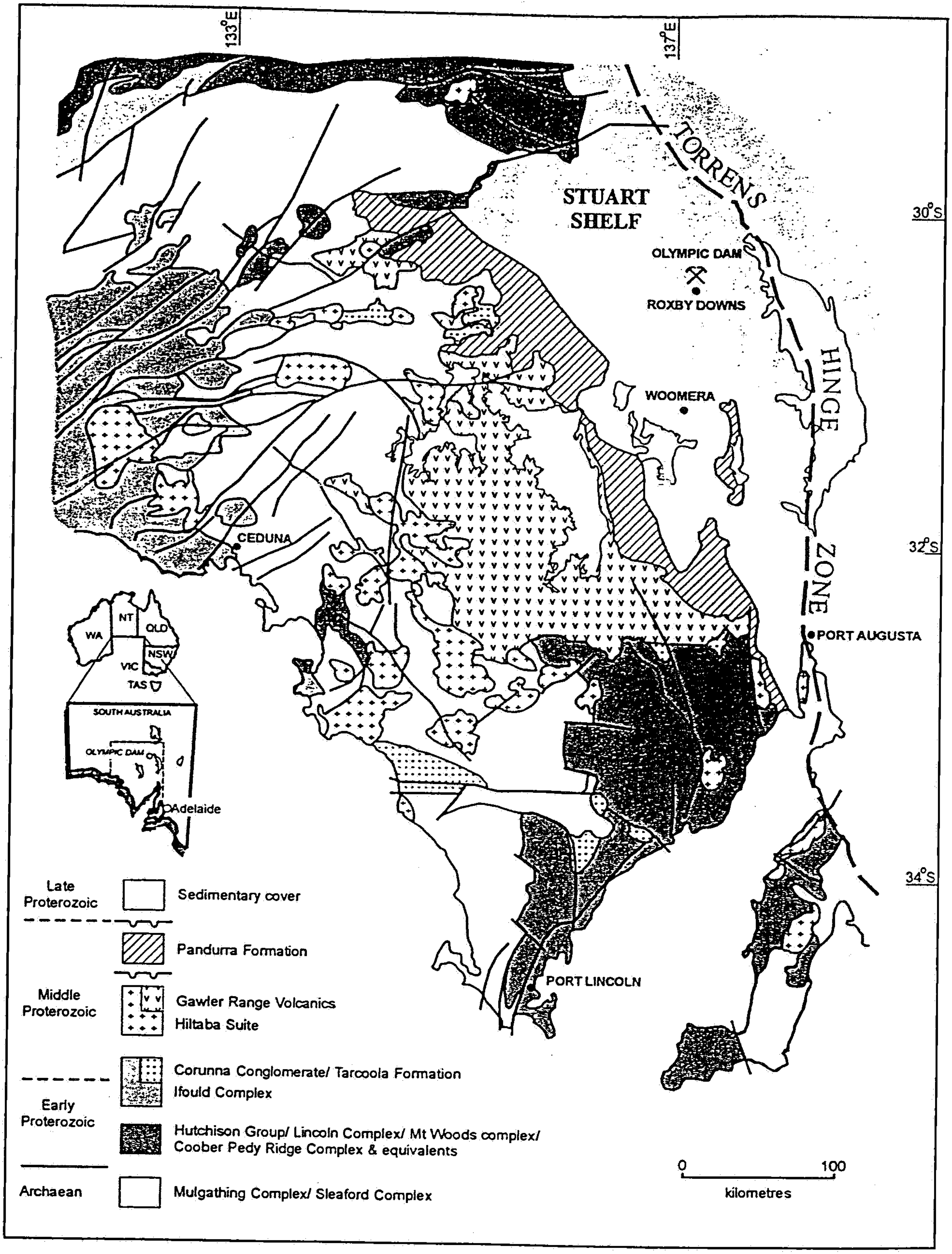

Figure 1. Interpreted subsurface geology at the Gawler Craton (modified from Daly et al, 1998).

directions, to an indistinct and gradational margin with the host granite. The strike length of more hematite altered breccias within the complex is greater than 5 km in a NW-SE direction, and it is up to 3 km across. The ODBC is generally poorly explored below 800 m depth but locally extends to depths of greater than 1.4 km. beyond the limits of current drilling.

Hematite-Granite Breccias

The hematitic breccia bodies within the ODBC are irregularly shaped and sized, though typically elongate and steeply dipping to sub-vertical. Breccia zones can taper or thicken with depth and may pinch and swell over short distances. The individual bodies are variably

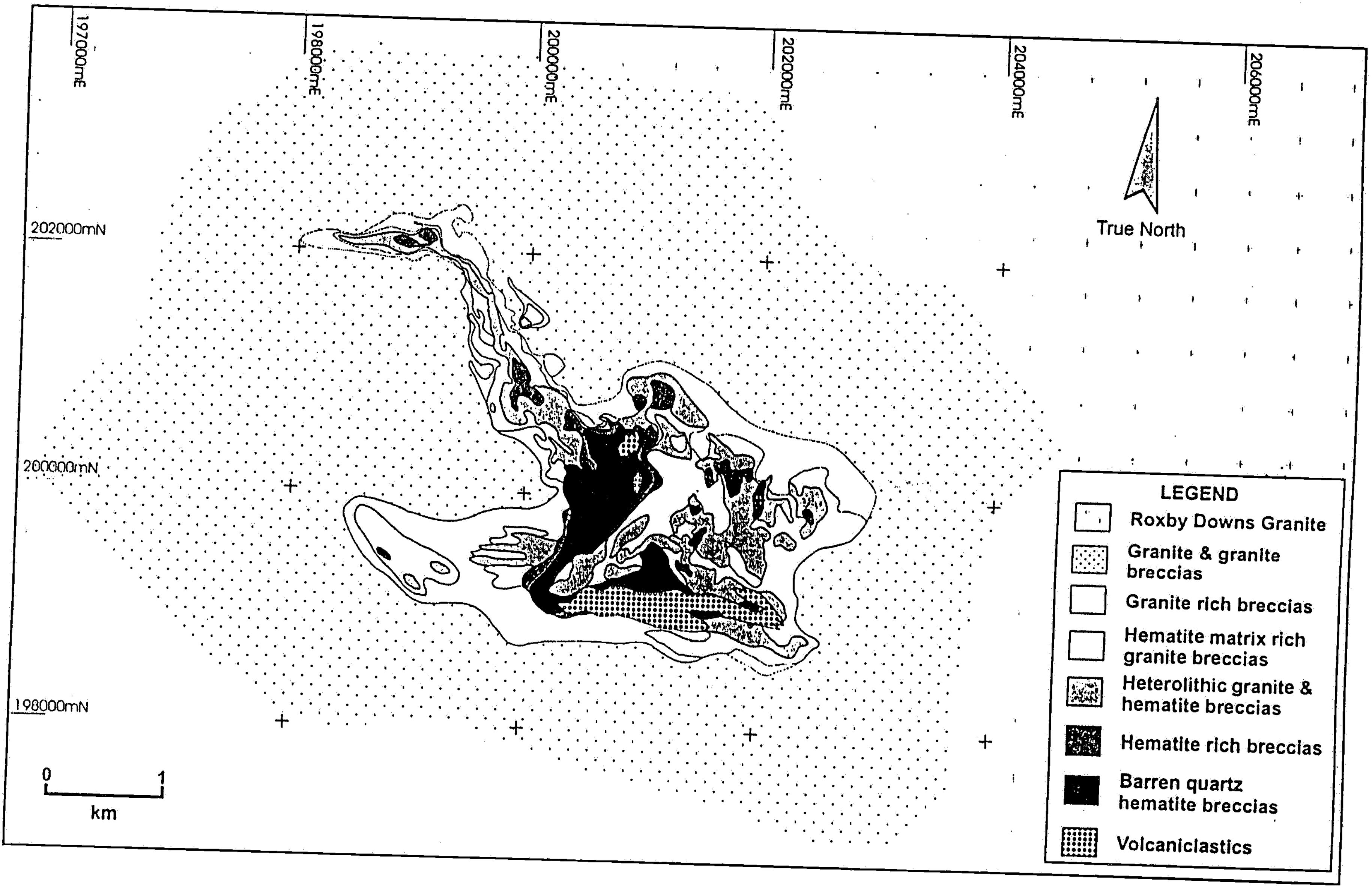

Figure 2. Simplified geological plan of the Olympic Dam Breccia Complex showing the general distribution of the major breccia types. Note the broad zonation from the host granite at the margins of the breccia complex to progressively more hematite rich lithologies in the centre.

mineralised, and while locally interconnected, they are highly variable in composition depending on the degree of brecciation and alteration they have undergone. Breccias are interpreted by Reeve *et al* (1990) to have formed through a combination of five main processes: hydraulic fracturing; tectonic faulting; chemical corrosion; phreatomagmatism; and, gravity collapse. The complex and repeated interplay of these processes contributes to the variable nature of the breccia compositions. Owing to the highly dynamic nature of breccia formation, correlation of the brecciation and alteration histories between different breccia zones is generally impossible.

In detail, breccia zones can mimic the general deposit trends, grading outward from hematite-rich breccias through "heterolithic" granite-hematite breccias, to granite breccias with hematite matrices, then to hematite altered granite or hematite veined granite, and finally into weakly sericitised and fractured granite. Gradational boundaries like these are observed on a scale of metres to tens or hundreds of metres. In contrast, breccia zone margins can also be abrupt, juxtaposing hematite-rich breccias with relatively weakly altered granite.

Textural variation of the breccias as a result of variable brecciation processes and intensity has been documented in detail by Reeve *et al* (1990). Granite-rich breccias are characterised by fracturing and veining and/or clast supported breccias, with crackle and jig-saw textures locally preserved. Hematite-rich breccias are more commonly matrix supported, poorly sorted and contain angular clasts generally <20 cm in size, although isolated clasts metres or tens of metres across are locally recognised. The breccia matrix is generally hematite with a component of fine-grained, intensely altered fragments derived from the granite host rock. Layering and discontinuous streaming textures are locally developed within the matrix.

Repetitive lithification and rebrecciation results in the mixing of granite clasts with clasts of hematite producing heterolithic breccias and, in more extreme examples, hematite breccias where both the clasts and matrix are dominated by hematite. Heterolithic breccias are the most common hematite-rich breccia type and can contain a wide variety and proportion of different hematite clasts and altered granite clasts (Reeve *et al*, 1990). Other lithologies occurring as minor clast types include porphyritic volcanics correlated with the Gawler Range Volcanics; highly altered ultramafic to felsic intrusives; vein fragments of copper sulfides, fluorite, barite or siderite; highly altered fragments of unknown primary lithology; and laminated fine-grained to arkosic sediments.

Hematite-quartz breccias occurring in the core of the deposit are considered an end-member product of repeated brecciation and hematite alteration of the host granite. These rocks typically only contain clasts of hematite and quartz within a matrix composed of hematite, barite and quartz grains (Reeve *et al*, 1990). They are differentiated from other completely hematised breccias within the ODBC by a distinct lack of sulfide mineralisation.

Incorporated Surficial Lithologies

Clasts of rock types interpreted to have formed in a near surface subaqueous or subaerial depositional environments (Reeve *et al*, 1990) are minor but widespread components of heterolithic breccias. Most abundant are clasts and blocks of fine-grained and finely laminated hematite-quartz±sericite siltstones and sandstones showing graded bedding and soft sediment deformation features, interpreted by Reeve *et al* (1990) to be fragments of epiclastic rocks derived from the major hydrothermal breccia types. Some may also represent exhalative sediments (Oreskes & Einaudi, 1990). A large, apparently down faulted block of these lithologies occurs in the southern part of the ODBC juxtaposed against hematite-quartz breccias and mineralised hematitic breccias (Figure 2).

Surficial volcaniclastic rocks such as lapilli tuffs and laminated ash-fall tuffs showing semi-pervasive or highly selective hematite replacement are preserved in the upper parts of phreatomagmatic diatreme structures in the central part of the ODBC (Reeve *et al*, 1990).

Some porphyritic felsic volcanic clasts within the ODBC may be derived from coherent extrusive lava flows correlated with the Gawler Range Volcanics. These rocks were either overlying the Roxby Downs Granite and subsequently incorporated into the breccia complex as the hydrothermal system developed, or alternately may have been epiclastic in origin (Reeve *et al*, 1990).

Veins

Narrow (generally <1cm thick) mono- or poly-mineralic veins, veinlets and vein fragments occur throughout the ODBC and in the surrounding granite. Vein assemblages typically consist of minerals which are also the dominant alteration and mineralisation phases within the breccia complex (Reeve *et al*, 1990) and consist of hematite, sericite, chlorite, siderite, barite, fluorite, quartz, sulfides or pitchblende in a variety of combinations. Rarer tourmaline and dolomitic veins also occur. Similar to the breccia zones which host the veining, the paragenesis of vein development is complex and multi-stage (Reeve *et al*, 1990), and impossible to correlate across the deposit.

A late-stage conjugate array of laminated barite-fluorite-siderite-sulfide veins up to several metres thick overprints the ODBC and locally extends into the sedimentary cover sequence. These veins are not considered to be associated with the development of the ODBC, despite the similarity of their vein mineral assemblages.

Dykes

The ODBC is intruded by a variety of ultramafic, mafic and felsic dykes and their intrusive pyroclastic equivalents. In the upper part of the ODBC, dykes typically occur as narrow (<1m), coherent bodies with irregular, tentacular or wispy morphologies (Reeve *et al*, 1990). Extensional drilling suggests that dykes are more abundant at depth within the deposit and are less disrupted by brecciation processes. However, the general distribution of dykes

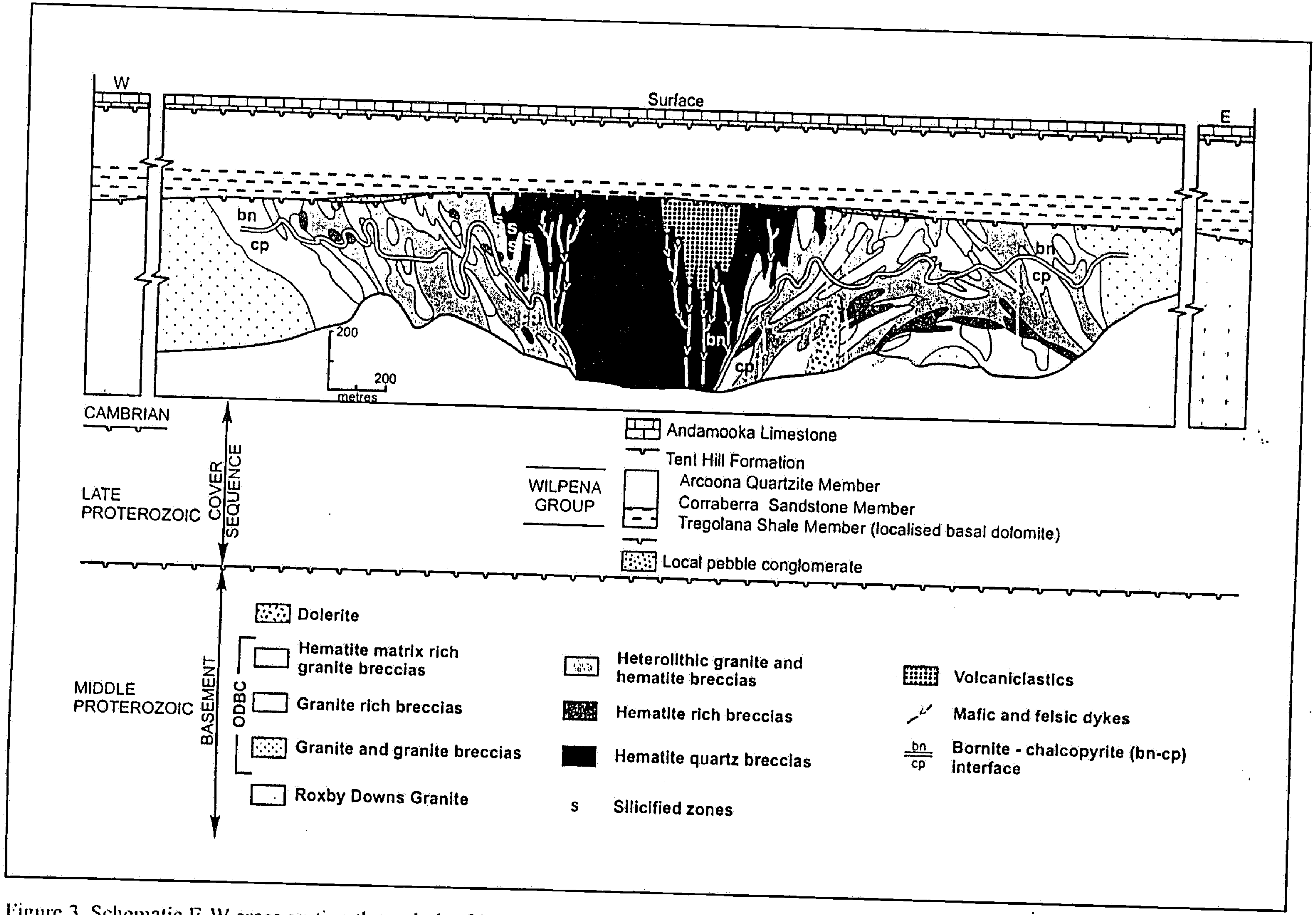

Figure 3. Schematic E-W cross section through the Olympic Dam Breccia Complex (modified from Reeve et al, 1990).

within the ODBC and their importance to brecciation and mineralisation is poorly understood.

The more mafic dykes have undergone intense texturally destructive sericite and hematite alteration and their intrusive origins are generally interpreted from morphology, geometry and lithogeochemistry. Felsic dykes commonly have preserved porphyritic textures and are petrologically similar to the Gawler Range Volcanics. Alteration and local mineralisation of dykes, quench fragmentation textures, reworked equivalents within breccia zones, juvenile fragments, and preservation of dykes within the root zones of diatreme structures indicate that intrusive activity was probably contemporaneous with hydrothermal activity.

A post-mineralisation, medium grained dolerite dyke, possibly associated with the regional Gairdner Dyke Swarm intrudes the breccia complex in the SE part of the deposit (Figure 3).

Alteration

The characteristic hydrothermal alteration mineralogy at Olympic Dam is sericite-hematite, with less abundant chlorite, silica, carbonate (siderite) and magnetite. The orebody is not associated with any sodic metasomatism (K. Ehrig, pers. comm.). In detail, alteration assemblages are highly variable and show complex mineral distribution patterns due to the polycyclic nature of the hydrothermal activity. Despite this, there are systematic patterns of alteration that are recognised across the overall deposit and at the scale of individual breccia zones (Figure 4).

In general, the degree of alteration intensity is directly associated with the amount of brecciation. The strongest alteration is therefore localised within, and on the margins of, the hematite-granite breccia bodies which host the ore deposit. The halo of weakly brecciated granite which surrounds the main breccia bodies is characterised by only weak and highly variable sericite-hematite-chlorite-carbonate alteration.

Iron Oxide Association

Magnetite cores within hematite grains suggest that the earliest phase of iron oxide alteration within the breccia complex was magnetite. Magnetite has subsequently been overprinted by widespread hematite alteration and is now only preserved at depth and within apparently less evolved breccia systems on peripheries of the ODBC. Magnetite contents in excess of 20% have been recorded within some strongly iron oxide altered breccia zones.

Hematite alteration is generally more abundant and intense towards the centre of the deposit, locally forming greater than 95% of the rock. Hematite mainly replaces pre-existing minerals, including primary granitic components, dykes and secondary hydrothermal or vein minerals (Reeve *et al*, 1990). Hematite has also precipitated from solution in veins and vugs. This variety of origins results in visually distinct hematite types defined by differences in crystallinity, grain size and colour.

Iron oxides, predominantly hematite, are intimately associated with copper mineralisation at all scales. A number of studies suggest that Cu, U and REE were introduced contemporaneously with Fe (Oreskes & Einaudi, 1990; Johnson, 1993; Johnson & McCulloch, 1995; Roberts & Hudson, 1983; and Reeve *et al*, 1990). Textural relations in mineralised breccias have been interpreted by Reeve *et al* (1990) to suggests that sulfides either post-date or are coeval with closely associated or intergrown hematite.

Silicate Alteration

Sericite is the dominant product of hydrothermal alteration of feldspars within the Roxby Downs Granite and is widespread within all breccias, except the hematite-quartz core. Locally very intense, texturally destructive sericitic alteration in particular results in zones or clasts of 'alteration lithologies' (Reeve *et al*, 1990).

Psuedomorphic chlorite alteration of feldspars within the Roxby Downs Granite is patchy but widespread within the breccia complex, and generally low to moderate intensity. Carbonate alteration is dominated by siderite and is generally weak within mineralised breccias. In the NE and SW parts of the ODBC, siderite veins, vein fragments and locally pervasive alteration are more abundant. Chlorite and siderite alteration is more abundant at depth and on the periphery of the breccia zones, and is commonly associated with more magnetite dominated alteration and chalcopyrite mineralisation.

Minor quartz alteration is present throughout the breccia complex. However, more intense silicification occurs in discrete, irregular zones, mainly around the margins of the central core of hematite-quartz breccias. These silicified zones are prospective for higher grade gold mineralisation.

Mineralisation

Ore Minerals

The principal copper-bearing minerals in the deposit are chalcopyrite, bornite, chalcocite (djurleite-digenite), which on the basis of Nd isotopic data, textural and geochemical features appear to have precipitated cogenetically (Johnson & McCulloch, 1995). A minor amount of native copper and other copper-bearing minerals are also locally observed. The main uranium mineral is uraninite (pitchblende), with lesser coffinite and brannerite. Minor gold and silver is intimately associated with the copper sulfides. The main REE-bearing mineral is bastnaesite (Oreskes & Einaudi, 1990).

Copper ore minerals occur as disseminated grains, veinlets and fragments within the breccia zones (Reeve *et al*, 1990). Massive ore is rare. Sulfides precipitated from the hydrothermal fluids, rather than replacing pre-existing mineral grains (K. Cross, pers. comm.), and consequently mineralisation primarily occurs within the matrix of the breccias, though repeated lithification and rebrecciation also results in mineralised clasts. Gold typically occurs as extremely fine particles within and associated with the copper sulfide grains. Silver largely occurs in solid solution

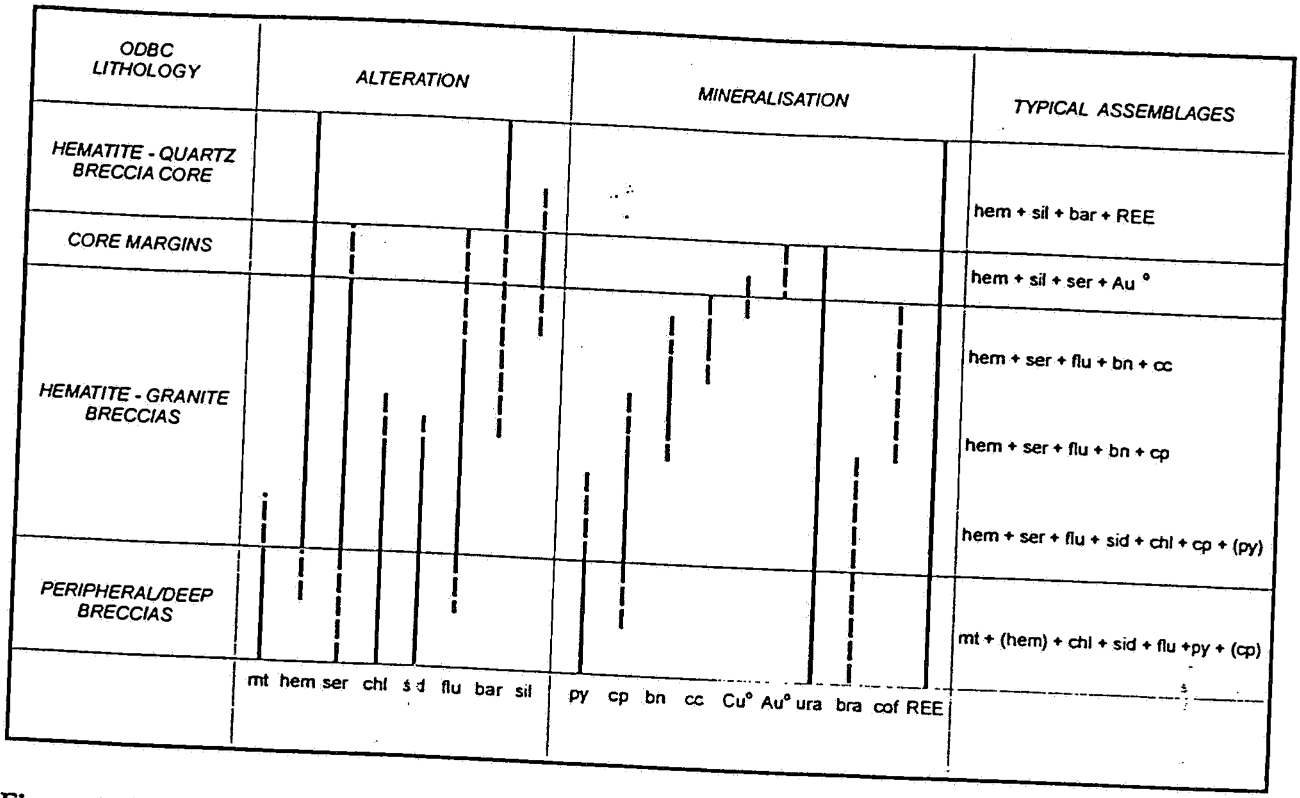

Figure 4: Generalised alteration and mineralisation patterns within the ODBC with some typical mineral assemblages. More common components of the ODBC shown in solid lines; neither absolute nor relative abundances are implied. mt=magnetite, hem=hematite, ser=sericite, chl=chlorite, sid=siderite, flu=fluorite, bar=barite, sil=silicification, py=pyrite, cp=chalcopyrite, bn=bornite, cc=chalcocite, Cu°=native copper, Au°=free gold, ura=uraninite, bra=brannerite, cof=coffinite, REE=lanthanum and cerium.

with the sulfide minerals. Pitchblende generally occurs as fine-grained disseminations within hematitic breccias, intergrown with sulfides and hematite (Oreskes & Einaudi, 1990).

Fluorite or barite mineralisation characteristically occurs together with sulfide mineralisation. Fluorite is locally abundant within mineralised breccias, occurring at levels of up to 1-2% as disseminations, clasts and veinlets (Reeve *et al*, 1990). Barite is present at low levels within most of the hematite-granite breccias, occurring as disseminations and crackle veins. Higher concentrations (typically 2-5% Ba) occur within the central hematite-quartz breccia core of the deposit.

Ore Zones

Ore zones within the ODBC account for only a small fraction of total volume of breccia but weak Cu, U, Au, Ag, and REE mineralisation is widespread within the ODBC at background levels of up to 0.5% Cu, 0.2 kg/t U_3O_8, 0.5 g/t Au and 1 g/t Ag (Reeve *et al*, 1990). There is a general correlation between higher grade copper-uranium mineralisation and more hematite altered rocks. However, the central hematite-quartz breccia zone is essentially barren of copper-uranium mineralisation.

Copper grade within the ore zones averages between 1% and 6%, and is generally higher within bornite-chalcocite ore due mainly to the increased copper tenor of the sulfides (Reeve *et al*, 1990). Bornite-chalcocite mineralisation comprises approximately 35% of the ore, while the remainder is dominated by chalcopyrite. Average gold grades of 0.6 g/t and uranium grades of 0.6 kg/t are similar throughout the ore zones, though higher grades show a weak correlation with bornite-chalcocite mineralisation, and both show local enrichment associated with favourable host lithologies. Silver grades average around 3 g/t but are also generally higher for bornite-chalcocite mineralisation. Variable REE mineralisation averaging 3000-5000 ppm combined La and Ce occurs throughout the breccia zones, including the central hematite-quartz core, where concentrations are generally higher.

The geometries of the ore zones are highly complex as a result of the sulfide zonation pattern (see below) and the distribution of more favourable hematite-rich lithologies within the breccia complex (Figure 5).

Mineralisation Zonation Patterns

Sulfide mineralisation within the deposit shows a broad, lateral and vertical zonation pattern (Reeve *et al*, 1990; Oreskes & Einaudi, 1990) from pyrite-chalcopyrite at depth and on the periphery of the deposit, grading into bornite, then chalcocite (Figure 4). Similar trends are observed at the scale of individual breccia zones (Oreskes & Einaudi, 1990). Higher-grade gold zones occur in narrow, complex zones within and around the silicified margins of the

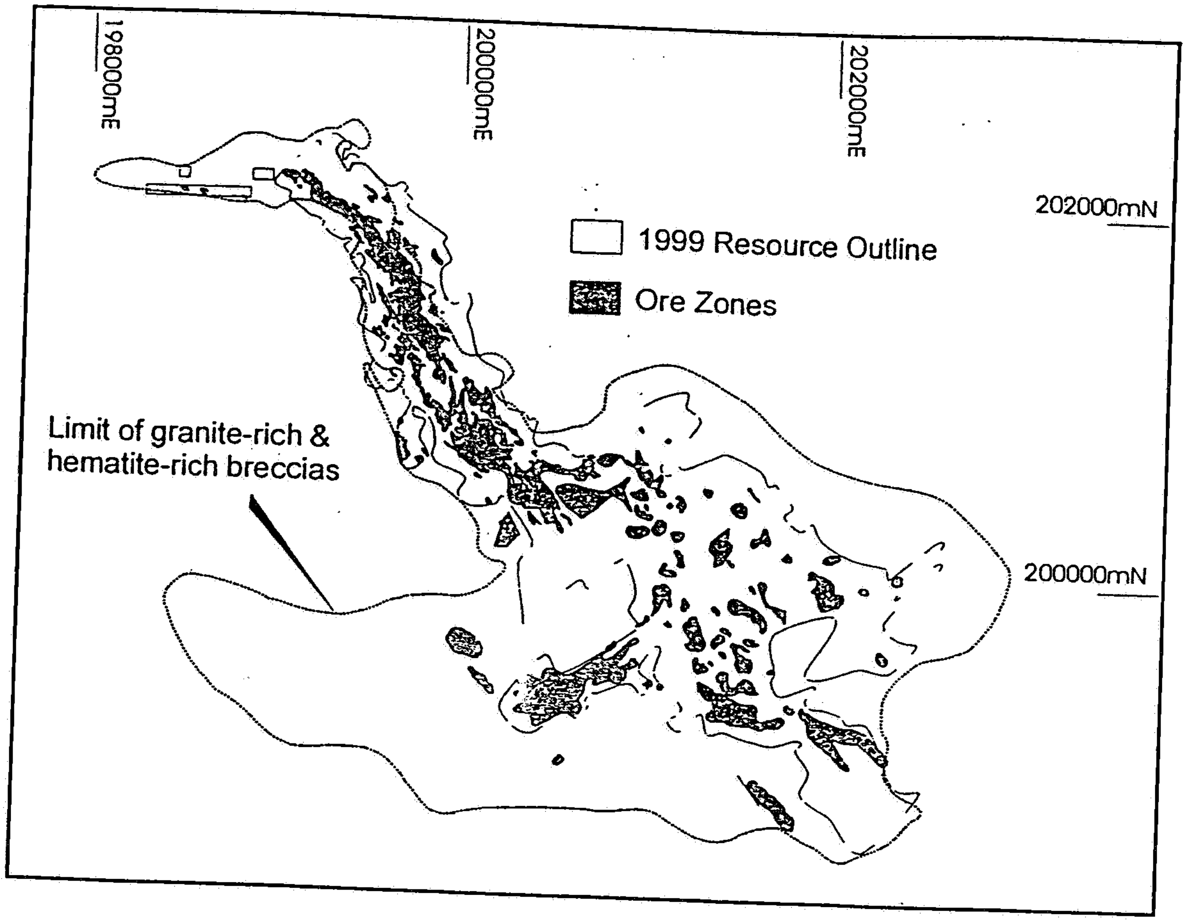

Figure 5: Olympic Dam resource outline at the 41 Level + 100m, showing distribution of ore zones

hematite-quartz core. Patchy but locally high-grade native copper and chalcocite mineralisation occurs in granite-rich breccia zones, both within and on the margins of the breccia complex (Reeve *et al*, 1990).

The interface between chalcopyrite and bornite, in particular, is generally sharp and readily mappable (Reeve *et al*, 1990). On a broad scale this boundary is flat-lying, becoming steeply dipping around the margins of the central hematite-quartz core. In detail, the bornite-chalcopyrite interface and other observed mineralogical boundaries are highly irregular and locally convoluted.

Reeve *et al* (1990) argue that the overall sulfide pattern is hypogene in origin, suggesting multi-stage introduction of hydrothermal fluids and a variety of ore precipitation mechanisms to explain the principal sulfide paragenetic series and complex relationships observed in mineralisation and alteration assemblages. The patterns can be considered to represent sulfide stability fields, primarily controlled by temperature, shifting Fe/Cu ratios, oxidation or depletion of reduced sulfur availability (Eldridge & Danti, 1994). These patterns probably evolved and changed over time with the development of the breccia zones.

There is apparently only minor local modification to the mineralisation pattern by supergene weathering processes (Reeve *et al*, 1990).

Structure

Structural studies of the Olympic Dam deposit are summarised by Sugden & Cross (1991). They observe that the individual breccia bodies within the ODBC generally have a NW to NNW trend, and are aligned along an overall WNW axis. Breccia zones also trend in E-W and NE-SW directions in particular parts of the complex. Early controls on the formation of the ODBC have probably been obliterated during the on-going processes of brecciation and alteration (Reeve *et al*, 1990; Sugden & Cross, 1991). However, the pattern of breccia bodies within the ODBC suggests an en-echelon fault network, possibly within a dextral dilational jog zone. The major bounding faults for such a jog have not been identified but it is possible that the photolineaments identified by O'Driscoll (1985) are the surficial expression of regional basement structures which have undergone minor post-Adelaidean reactivation.

At the mine scale, the ODBC is transected by an array of irregular and discontinuous brittle faults, with multiple and episodic movement histories. Most of these structures appear to post-date the major breccia formation events and many have exploited pre-existing anisotropies such as the lithological or intrusive contacts (Sugden & Cross, 1991). Individual faults are generally minor structures with small displacements (<10m) and short strike lengths which are only traceable in detailed mine development. A few structures are more prominent, with strike continuity of up to 2km, inferred displacements of around 100m and locally containing cataclastic zones up to 1m wide. Few structures are observed to offset the ODBC-Adelaidean unconformity surface.

Dominant structural trends documented by Sugden & Cross (1991) within the ODBC are subdivided into 1) syn-hydrothermal structures, 2) early strike-slip faults, 3) reverse faults and, 4) late stage vein arrays. Syn-hydrothermal structures inferred to have been active during the development of the ODBC are only preserved as isolated, discontinuous fragments. Early strike-slip faults which overprint the syn-hydrothermal structures are typically subvertical, discontinuous and occur throughout the mine as a conjugate set trending in WNW and NNW orientations. A prominent ENE trending structure in the SE part of the deposit is also correlated with this phase of faulting. Reverse faults which post-date the strike-slip faults are prominent in the NW of the deposit where they occur either as NW trending structures with a moderate (30°-50°) dip to the SW, or as steeply E dipping faults (60°-80°) with a N-S strike orientation. Late stage conjugate NW and E-W trending strike-slip fault zones are associated with barite-fluorite±carbonate vein arrays which transect the ODBC. Where observed, fracture trends in the cover sequence are similar to the late-stage vein arrays in the ODBC and these are interpreted by Sugden & Cross (1991) to have formed contemporaneously during the ca 500 Ma Delamarian Orogeny.

Geochronology

The age of the Roxby Downs Granite and maximum age of the brecciation and mineralisation at Olympic Dam is constrained by a U-Pb zircon date of 1588+4 Ma (Creaser, 1989, Creaser & Cooper, 1993). SHRIMP U-Pb zircon data collected from three felsic dykes within the Olympic Dam Breccia Complex by Johnson & Cross (1995) indicate an age of approximately 1590 Ma. On the basis of textural relationships between sulfides and Fe-rich breccias, and the cross-cutting relationship of the igneous units to the mineralised breccias, Johnson & Cross (1995) argue that brecciation, mineralisation and intrusive activity at Olympic Dam were contemporaneous at ~1590 Ma.

These data imply that brecciation at Olympic Dam must have closely followed emplacement and cooling of the Roxby Downs Granite (Johnson & Cross, 1995). The apparently short time lag between granite crystallisation and hydrothermal activity in a subvolcanic environment suggests that the granite was emplaced at a high level within the crust, an interpretation supported by field observations that some Hiltaba Suite granitoids intrude units of the Gawler Range Volcanics (Flint, 1993).

Deposit Model

Formation Environment And Geological Evolution

The Olympic Dam Breccia Complex predominantly formed in a high-level volcanic environment (Oreskes & Einaudi, 1990, 1992; Reeve et al 1990). Surficial lithologies within the breccia complex suggest that the hydrothermal system breached the palaeosurface and it has been proposed by Reeve et al (1990) that the deposit may have formed a phreatomagmatic volcanic edifice similar to a maar complex. It is unlikely that the ODBC was a significant eruptive centre of coherent lavas or ignimbrites associated with the Gawler Range Volcanics.

Hydrothermal brecciation initiated at structurally controlled sites within the Roxby Downs Granite evolved contemporaneously with alteration, veining, dyke intrusion, phreatomagmatic activity and mineralisation in a highly energetic, dynamic and complex system. Multiple, overprinting brecciation events and the incorporation of subvolcanic, volcaniclastic and epiclastic lithologies into the breccias contributed to the highly variable nature of the deposit host rocks. Brittle structures developed as the hydrothermal system waned and breccias became more lithified (Reeve et al, 1990).

The Roxby Downs Granite and an estimated 500 m of the upper parts of the ODBC (K. Cross, pers. comm.) were eroded during the Middle to Late Proterozoic, possibly during Marinoan glaciation (Reeve et al, 1990). The overlying sedimentary rock sequence was subsequently deposited. With the exception of large, late-stage barite-fluorite veins which overprint mineralisation and intrusion of mafic dykes possibly correlated with the Gairdner Dyke Swarm, there has otherwise been only minor geological modification of the deposit since burial and no significant sulfide recrystallisation (Reeve et al, 1990).

Genetic Models

During delineation drilling of the deposit, Roberts & Hudson (1983) described Olympic Dam as a stratabound sediment-hosted ore deposit, inferring that ore minerals were introduced by hydrothermal fluids associated with local volcanism. As underground development of the deposit advanced, it was recognised that mineralisation was contained within a granite-hosted breccia complex and a near surface hydrothermal origin was proposed to account for the observed geological features and mineralisation distribution (Oreskes & Einaudi, 1990, Reeve et al, 1990). However, the source or sources of the hydrothermal fluids and metals which formed the deposit remains a contentious issue.

Haynes et al (1995) proposed that metal deposition in the deposit was controlled by coupled redox reactions resulting from the mixing of an ascending, hot, reduced Fe-rich water, with cooler, oxidised and saline meteoric and/or lacustrine waters in the upper part of the breccia complex. Haynes et al (1995) argue on the basis of mineral composition, ore texture and thermodynamic modelling that the oxidised ground waters primarily contributed ore components to the system and invoke polycyclic mixing events to explain the observed mineralisation and alteration zonation patterns. On the basis of this work Barton & Johnson (1996) have included Olympic Dam in their evaporitic-source model for Fe-oxide-(REE-Cu-Au-U) mineralisation.

Oreskes & Einaudi (1992) proposed a two-stage genesis of the iron oxide assemblage at Olympic Dam, involving at least two, temporally distinct hydrothermal fluid types. In their model, magnetite formation is associated with an earlier high temperature fluid, possibly of magmatic origin. A significantly later, lower temperature fluid which destructively overprints the primary magnetite with hematite alteration and associated ore mineralisation possibly has some component of surficial origin. A similar model has been proposed for other iron oxide associated deposits on the Stuart Shelf such as Emmie Bluff (Gow *et al*, 1994).

A magmatic origin for mineralising fluids is also a possibility proposed by Johnson & McCulloch (1995) who analysed the Sm-Nd isotopic signature of the ore. Results indicate at least two mineralising fluid compositions, one in isotopic equilibrium with the Roxby Downs Granite and a magnetite alteration assemblage; the other strongly influenced by a mafic-ultramafic, mantle-derived magma associated with hematite alteration and ore mineralisation. Mafic and felsic dykes within the ODBC may indicate a direct magmatic association for these hydrothermal fluid sources (Johnson & McCulloch, 1995; Hitzman *et al*, 1992).

Current consensus among geologists at Olympic Dam is that the deposit is the product of an evolving hydrothermal system in which the hydrothermal fluids and associated metals were both primarily derived from a magmatic source. WMC sulfur isotope data (Eldridge & Danti, 1994) and unpublished fluid inclusion data support this interpretation (K. Ehrig, pers. comm.). Overall geological relationships within the ODBC indicate that hydrothermal activity, breccia formation and dykes were probably associated with high level, mafic-felsic Hiltaba Suite plutons and coeval Gawler Range Volcanics extrusive equivalents (Reeve *et al*, 1990; Johnson & Cross, 1995).

Acknowledgments

The current understanding of the Olympic Dam deposit is drawn from observations and research by numerous WMC geoscientists over the last 25 years; their contributions are acknowledged. The author particularly acknowledges the work of K.J. Ehrig, C.S. Eldridge and K.C. Cross, who have directed research and documentation of the deposit in recent years. Early versions of this manuscript were reviewed by the geological staff at Olympic Dam. Their assistance and constructive criticism is gratefully acknowledged. Diagrams were prepared by J. Myers in the Olympic Dam cartography office. This paper is published with the permission of WMC Resources Limited.

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TEMPEST data - see Government of South Australia Mineral Resources Website)

Appendix 2

Moonta/Challenger/Tunkillia Areas
and
Port Pirie to Tarcoola Traverse Line
TEMPEST
Geophysical Surveys

for

AGSO PIRSA CRC-LEME

Acquisition and Processing Report

Prepared by : M.Lawrence ....

R.Lane ....

M.Owers ....

Authorised for release by : ....

....

Survey flown: June 2000

by

FUGRO

Fugro Airborne Surveys
65 Brockway Road, Floreat. WA 6014, Australia
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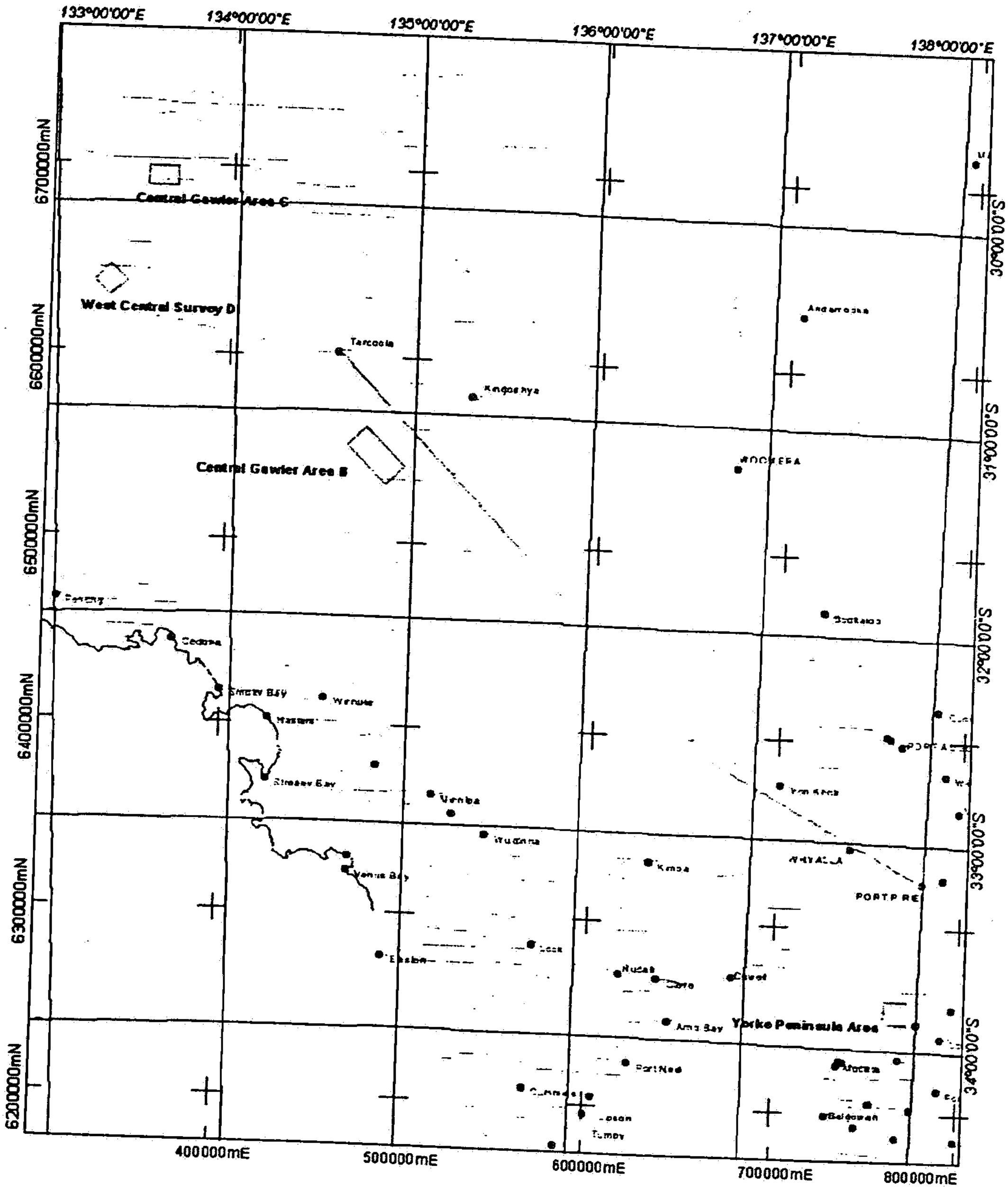
FAS JOB# 1440

1 Introduction

This report summarises the acquisition and processing of data from the TEMPEST survey flown by Fugro Airborne Surveys (FAS) for the joint AGSO/PIRSA/CRC-LEME project during June of 2000.

Electromagnetic and magnetic data were acquired over four areas shown below.



Location Plan for Job 1440 AGSO

Projection : Transverse Mercator
Spheroid : WGS 84
FalseEasting : 500000
FalseNorthing : 10000000
CentralMeridian : 135

1:3000000

0 30 60 90 120 Kilometers

2 Project Crew

The following personnel were employed for this project:

Field Operations

Processors	Matt Lawrence / Stephen Carter
Airborne Operator	Andrew Cole
Pilots	Jeff Ibbotson / Eivind Eikli

Base Operations

Project Manager	Ian Cook
Data Processing	Stephen Carter / Matt Owers / Matt Lawrence
Technical Supervisor	Richard Lane

3 Summary of Survey Parameters

3.1 Survey Area Parameters

Job Number	1440
Survey Company	Fugro Airborne Surveys
Date Flown	June 2000
Client	AGSO/PIRSA/CRC-LEME
Terrain Clearance	110 metres
EM System	25Hz TEMPEST
Total Line kilometres	5846 kilometres
Area 1 – Yorke Peninsula (Moonta)	
Line Kilometres	1054 km
Traverse Line Spacing	150 metres
Traverse Line Direction	110 – 290 degrees
Tie Line Direction	020 – 200 degrees
Area 2 – Central Gawler Area B (Tunkillia)	
Line Kilometres	3214 km
Traverse Line Spacing	150 metres
Tie Line Spacing	4500 metres
Traverse Line Direction	045 – 225 degrees
Tie Line Direction	135 – 315 degrees
Area 3 – Central Gawler Area C (Challenger)	
Line Kilometres	1130 km
Traverse Line Spacing	150 metres
Tie Line Spacing	14500 metres
Traverse Line Direction	110 – 290 degrees
Tie Line Direction	020 – 200 degrees
Area 5 – Pt Pirie – Tarcoola Traverse Line	
Line Kilometres	448 km
Traverse Line Direction	135 – 315 degrees

3.2 Flight Plans

The flight plans are given in Appendix I.

4 Data Acquisition equipment and Specifications

The airborne data acquisition system utilised on this project consists of the following sub-systems:

4.1 Survey Aircraft

A Shorts Skyvan SC7 Series 3, registration VH-WGT, was used for this survey.

4.2 TEMPEST System Specifications

Specifications of the TEMPEST Airborne EM System (Lane et al., 2000) are:

- Base frequency - 25Hz
- Transmitter area - 186m^2
- Transmitter turns - 1
- Waveform - Square
- Duty cycle - 50%
- Transmitter pulse width - 10 ms
- Transmitter off-time - 10 ms
- Peak current - 300 A
- Peak moment - 55,800 Am^2
- Average moment - 27,900 Am^2
- Sample rate - 75 kHz
- Sample interval - 13 microseconds
- Samples per half-cycle - 1500
- System bandwidth - 25 Hz to 37.5 kHz
- Flying height - 110m (subject to safety considerations)
- EM sensor - Towed bird with 3 component dB/dt coils
- Tx-Rx horizontal separation - 105m (nominal)
- Tx-Rx vertical separation - 45m (nominal)
- Stacked data output interval - 200 ms (~12 m)
- Number of output windows - 15
- Window centre times - 13 µs to 16.2 ms
- Magnetometer - Stinger-mounted cesium vapour
- Magnetometer compensation - Fully digital
- Magnetometer output interval - 200 ms (~12 m)
- Magnetometer resolution - 0.001nT
- Typical noise level - 0.2nT
- GPS cycle rate - 1 second

4.2.1 EM Receiver and Logging Computer

The EM receiver computer is a Picodas PDAS-1000 data acquisition system. The EM receiver computer executes a proprietary program for system control, timing, data acquisition and recording. Control, triggering and timing is provided to the TEMPEST transmitter and DSP signal processing boards by the timing card, which ensures that all waveform generation and sampling is accomplished with high accuracy. The timing card is synchronised to GPS through the use of the PPS output from the system GPS card. Synchronisation is also provided to the magnetometer processor card for the purpose of accurate magnetic sampling with respect to the EM transmitter waveform.

The EM receiver computer displays information on the main screen during system calibrations and survey line acquisition to enable the airborne operator to assess the data quality and performance of the system.

4.2.2 TEMPEST Transmitter

The transmitted waveform is a square wave of alternating polarity, which is triggered directly from the EM receiver computer. The nominal transmitter base frequency was 25 Hz with a pulse width of 10ms (50 % duty cycle). Loop current waveform monitoring is provided by a current transformer located directly in the loop current path to allow for full logging of the waveform shape and amplitude, which is sampled by the EM receiver.

4.2.3 TEMPEST 3-Axis Towed Bird Assembly

The TEMPEST 3-axis towed bird assembly provides accurate low noise sampling of the X (horizontal in line), Y (horizontal transverse) and Z (vertical) components of the electromagnetic field. The receiver coils measure the time rate of change of the magnetic field (dB/dt). Signals from each axis are transferred to the aircraft through a tow cable specifically designed for its electrical and mechanical properties.

4.3 PDAS 1000 Survey Computer

The SURVEY computer is a PICODAS PDAS 1000 data acquisition system. The SURVEY computer executes a proprietary program for acquisition and recording of location, magnetic and ancillary data. Data are presented both numerically and graphically in real time on the VGA LCD display, which provides an on-line display capability. The operator may alter the sensitivity of the displays on-line to assist in quality control. Selected EM data are transferred from the EM receiver computer to the SURVEY computer for QC display.

4.3.1 Cesium Vapour Magnetometer Sensor

A cesium vapour magnetometer sensor is utilised on the aircraft and consists of the sensor head and cable, and the sensor electronics. The sensor head is housed at the end of a composite material tail stinger.

4.3.2 Magnetometer Processor Board

A Picodas magnetometer processor board is used for de-coupling and processing the Larmor frequency output of the magnetometer sensor. The processor board interfaces with the PDAS 1000 survey computer, which initiates data sampling and transfer for precise sample intervals and also with the EM receiver computer to ensure that the magnetic samples remain synchronised with the EM system.

4.3.3 Fluxgate Magnetometer

A tail stinger mounted Bartington MAG-03MC three-axis fluxgate magnetometer is used to provide information on the attitude of the aircraft. This information is used for compensation of the measured magnetic total field.

4.3.4 GPS Receiver

A Novatel GPScard 951R is utilised for airborne positioning and navigation. Satellite range data are recorded for generating post processed differential solutions.

4.3.5 Differential GPS Demodulator

The Racal Surveys' LANDSTAR differential GPS service provides real time differential corrections.

4.4 Navigation System

A Picodas PNAV 2001 Navigation Computer is used for real-time navigation. The PNAV computer loads a pre-programmed flight plan from disk which contains boundary co-ordinates, line start and end co-ordinates, local co-ordinate system parameters, line spacing, and cross track definitions. The WGS-84 latitude and longitude positional data received from the Novatel GPScard contained in the SURVEY computer is transformed to the local co-ordinate system for calculation of the cross track and distance to go values. This information, along with ground heading and ground speed, is displayed to the pilot numerically and graphically on a two line LCD display, and on an analog HSI indicator. It is also presented on a LCD screen in conjunction with a pictorial representation of the survey area, survey lines, and ongoing flight path.

The PNAV is interlocked to the SURVEY computer for auto selection and verification of the line to be flown. The GPS information passed to the PNAV 2001 navigation computer is corrected using the received real time differential data, enabling the aircraft to fly as close to the intended track as possible.

4.5 Altimeter System

4.5.1 Radar Altimeter

A Collins ALT 50A radar altimeter is used for determining absolute altitude. The altimeter outputs a voltage proportional to height above terrain and has two scales for the indicated height: one scale covers altitudes up to 500ft (152m) while the second scale covers altitudes greater than 500ft. This signal is available to a dashboard analog indicator for the pilot, and to the PDAS 1000 computer for display and recording.

4.5.2 Barometric Altimeter

Output of a Digiquartz 215A-101pressure transducer is used for calculating the barometric altitude of the aircraft. The atmospheric pressure is taken from a gimbal-mounted probe projecting 0.5 metres from the wing tip of the aircraft and fed to the transducer mounted in the aircraft wingtip.

4.6 Video Tracking System

The video tape recorded by a PAL VHS colour video system is synchronised with the geophysical record by a digital fiducial display, which is recorded along with GPS latitude and longitude information and survey line number.

4.7 *Data Recorded by the Airborne Acquisition Equipment*

Raw EM data including fiducial, local time, X, Y, Z axis sensor response, current monitor and bird auxiliary sensor output are recorded on the EM receiver computer as "G" EM files.

The Survey computer records all other survey data including aeromagnetic and GPS data using as "S" Survey files, and "R" Rover files containing GPS raw range data for post processing.

5 Ground Data Acquisition Equipment

5.1 *GPS Base Station System*

The GPS base station consists of a Novatel GPS PC card mounted in a portable IBM computer. The computer is connected to a mains UPS backup, with a reserve capacity of approximately 100 minutes, to ensure continuous data logging in the event of mains power interruptions. For Area 1, the antenna for the GPS base station was located in Pt Pirie, and for Areas 2, 3 and 5 it was located at Tarcoola.

The GPS base station position was calibrated by logging data continuously at the base position over a period of at least 24 hours. These data were then statistically averaged to obtain the position of the base station.

The calculated GPS base position base was (in WGS 84):

Area 1	33° 11' 06.00" S,	138° 01' 27.92" E,	16.58 m.	(flights 1-8)
Area 3	30° 42' 30.84" S,	134° 34' 04.51" E,	127.39 m.	(flights 10-12)
Area 2	19° 38' 56.83" S,	134° 11' 08.11" E,	412.67 m.	(flight 19)
Area 2,3&5	30° 42' 30.70" S,	134° 34' 03.95" E,	130.61 m.	(flights 13-18, 20-27)

5.2 *Base Magnetometer System*

Two proton precession magnetometers were used as diurnal base stations. The units were located near the airport in an area where they were not affected by aircraft or motor vehicle movement.

The units were time checked prior to each survey flight commencement against the GPS receiver time in the aircraft, which is the time base for all acquired data.

6 EM and other Calibrations and Monitoring

At the beginning and end of each individual survey flight, the EM system is checked for background noise levels and performance. All of these checks are conducted at a nominal terrain clearance of 600 m (2000 ft) to eliminate ground response.

These checks include:-

6.1 *Pre-Flight Barometer Calibration: Line C1511*

A recording of the barometer output at a known elevation is carried out before take-off to assist with calibration and determination of drift during the flight. The barometer is used as a back-up to the GPS for aircraft altitude.

6.2 Pre-Flight Zero: Line C9001

This manoeuvre is performed once the aircraft is established en route to the survey area. Background EM levels are recorded and assessed by the airborne operator to determine if: -

a. the system noise level is acceptable,
b. the response had not varied significantly from previous flights, and
c. the sferic level is acceptable.

These data are recorded for approximately 90 seconds.

6.3 Pre-Flight Swoops: Line C9002

This manoeuvre is conducted immediately after the pre sortie zero. During this manoeuvre the relative position of the towed sensor is deliberately made to vary relative to the aircraft. The EM data are monitored by the airborne operator to confirm correct operation of the system during the manoeuvre.

6.4 Post-Flight Zero: Line C9003

This calibration is performed immediately following the completion of the survey sorties. Background EM levels are recorded to characterise any changes occurred in the system over the duration of the flight. These data are recorded for approximately 90 seconds.

6.5 Post-Flight Barometer Calibration: Line C1611

A recording of the barometer output is repeated following landing at the end of the flight to assist with calibration and determination of drift during the flight.

6.6 Additive EM Measurements: Lines C9004, C9005, and C9007

A recording of the background signal through the X, Y and Z receiver coil inputs is carried out before and/or after acquisition of data for survey lines on each flight. These measurements may be made with the transmitter on (C9004, C9005) or with the transmitter off (C9007). The signal from the receiver coils is removed from the signal pathway by disconnecting the power to the bird at the winch inside the aircraft.

6.7 Dynamic Magnetometer Compensation

To limit aircraft manoeuvre effects on the magnetic data that can be of the same spatial wavelength as the signals from geological sources, compensation calibration lines are flown in a low magnetic gradient area close to the survey. This involves flying a series of tests on the survey line heading and approximately 15 degrees either side to accommodate small heading variations whilst flying survey lines. The data for each heading consists of a series of aircraft manoeuvres, including pitches, rolls and yaws. This is done to artificially create the most extreme possible attitude the aircraft may encounter whilst on survey. Data from these lines are used to derive compensation coefficients for removing magnetic noise induced by the aircraft's attitude in the naturally occurring magnetic field.

Compensation data were acquired on the 6th June 2000.

6.8 *Parallax Checks*

Due to the relative positions of the EM towed bird and the magnetometer instruments on the aircraft and to processing / recording time lags, raw readings from each vary in position. To correct for this and to align selected anomaly features on lines flown in opposite directions, magnetics, EM data and the altimeters are 'parallaxed' with respect to the position information. System parallax is checked occasionally or following any major changes in the aircraft system which are likely to affect the parallax values.

6.9 *Radar Altimeter Calibration*

The radar altimeter is checked for accuracy and linearity every 12 months or when any change in a key system component requires this procedure to be carried out. This calibration allows the radar altimeter data to be compared and assessed with other height data (GPS and barometric) to confirm the accuracy of the radar altimeter over it's operating range.

Absolute radar and barometric altimeter calibration was carried out over water (off the coast of Perth on 2nd March 2000) and was successful in calibrating the radar altimeter to information provided by the GPS and barometer instrument. Calibration factors were as expected. The calibration procedure also provides parallax information required for positional correction of the radar and GPS altimeters.

6.10 *Heading Error Checks*

Historically, heading error checks have been part of the aeromagnetic data acquisition procedure but they are no longer used. Fugro Airborne Surveys now calculates these effects using the aircraft magnetic compensation system and specially developed software. The precision to which these effects are now calculated and corrected for is far in excess of the manual methods used in the past.

7 Data Processing

7.1 *Field Data Processing*

7.1.1 Quality Control Specifications

7.1.1.1 Navigation Tolerance

The re-flight specifications applied for the duration of the survey were:

Electronic Navigation - Absence of electronic navigation data (e.g. GPS base station fails).

Traverse Lines Separation - Actual flight line path deviates more than 30m off course for a distance of 1500m or more, or if a flight line intersects an adjacent flight line.

Altitude - Terrain clearance continuously exceeds the nominal terrain clearance by plus or minus 20m over a distance of 2km or more unless to do so would, in the sole opinion of the pilot, jeopardise the safety of the aircraft or the crew or the equipment or would be in contravention of the Civil Aviation Safety Authority regulation such as those pertaining to built up areas.

7.1.1.2 Magnetics Noise And Diurnal Tolerance

The re-flight specifications applied for the duration of the survey were:

Noise - Where the total RMS noise of the magnetometer exceeds 0.4nT for a cumulative total of 10% or more of any flight line or continuously over 2km or more.

Magnetic Diurnal- Where the magnetometer base station data exceeds a 5nT change in 5 minutes.

7.1.1.3 Electromagnetic Data

The quality control checks on the electromagnetic data were:

Noise - Where noise in the EM data exceeds 1fT or renders an important anomaly uninterpretable.

7.1.2 In-Field Data Processing

Following acquisition, multiple copies of the EM data are made onto Exabyte tapes. The EM, location, magnetic and ancillary data are then processed at the field base to the point that the quality of the data from each flight can be fully assessed. Copies of the raw and processed data are then transferred to Perth for final data processing. A more comprehensive statement of EM data processing is given in section 7.2.3.

7.2 *Final Data Processing*

7.2.1 Magnetics

Magnetic data are compensated for aircraft manoeuvre noise using coefficients derived from the appropriate compensation flight. The data are then corrected for diurnal variations. The IGRF reference field is removed, and first and second vertical derivatives calculated for quality checking purposes.

The total magnetic intensity (TMI) data were gridded to produce a hardcopy map. The magnetic data were reduced to the pole (RTP) with proprietary software and a map of the first vertical derivative (1VD) of the reduced to pole TMI was also produced.

The following table shows the magnetic declination and inclination angles used in the RTP calculations.

Table of magnetic declinations and inclinations as used in the RTP transformation

Area number	Magnetic declination (degrees)	Magnetic inclination (degrees)
1	7.6898	-66.2984
2	6.1342	-64.1318
3	5.5997	-62.8966

7.2.2 Derived Topography

Aircraft navigation whilst in survey mode is via real time differential GPS, obtained by combining broadcast differential corrections with on-board GPS measurements. Terrain clearance is measured with a radar altimeter.

The ground elevation, relative to the WGS84 spheroid used by GPS receiver units, is obtained by subtracting the terrain clearance from the aircraft altitude, noting the vertical separation between the

GPS antenna and the radar altimeter, and applying suitable parallax corrections between the two measurements.

Derived surface topography values with respect to mean sea level (referenced to the geoid) are obtained by correcting the spheroid values with geoid-spheroid separation values supplied by AUSLIG.

The digital terrain model (DTM) derived from this survey can be expected to have an absolute accuracy of +/- several metres in areas of low to moderate topographic relief. Sources of error include uncertainty in the location of the GPS base station, variations in the radar altimeter characteristics over ground of varying surface texture, and the finite footprint of the radar altimeter.

7.2.3 Electromagnetic Data Pre-processing

Details of the pre-processing applied to TEMPEST data can be found in Lane et al. (2000).

High altitude calibration data are used to characterise the system response in the absence of any ground response.

Routines to suppress sferic noise, powerline noise, VLF noise, coil motion noise and to stack the data are applied (termed "cleaning") to data from survey lines. Output from the stacking filter is drawn at 0.2 second intervals. The stacked data are saved to file as an internal data management practice.

The survey level stacked data are deconvolved using the high altitude reference waveform. The effect of currents in the transmitter loop and airframe ("primary") are then removed, leaving a "pure" ground response. The deconvolved ground response data are then transformed to B-field response for a perfect 100% duty cycle square wave. Finally, the evenly spaced samples are binned into a number of windows.

Table of TEMPEST window information for 25Hz base frequency

Window #	start sample	End sample	No of samples	start time (s)	End time (s)	centre time (s)	centre time (ms)
1	1	2	2	0.000007	0.000020	0.000013	0.013
2	3	4	2	0.000033	0.000047	0.000040	0.040
3	5	6	2	0.000060	0.000073	0.000067	0.067
4	7	10	4	0.000087	0.000127	0.000107	0.107
5	11	16	6	0.000140	0.000207	0.000173	0.173
6	17	26	10	0.000220	0.000340	0.000280	0.280
7	27	42	16	0.000353	0.000553	0.000453	0.453
8	43	66	24	0.000567	0.000873	0.000720	0.720
9	67	102	36	0.000887	0.001353	0.001120	1.120
10	103	158	56	0.001367	0.002100	0.001733	1.733
11	159	246	88	0.002113	0.003273	0.002693	2.693
12	247	384	138	0.003287	0.005113	0.004200	4.200
13	385	600	216	0.005127	0.007993	0.006560	6.560
14	601	930	330	0.008007	0.012393	0.010200	10.200
15	931	1500	570	0.012407	0.019993	0.016200	16.200

The data undergoes a review after windowing. Any decisions involving re-flights due to AEM factors are made at this point.

A number of "monitor" values are calculated during processing to assist with interpretation. They generally represent quantities that have been removed as far as is practical from the data, but may still be present in trace amounts. These are more significant for interpretation of discrete conductors than for general mapping applications.

The sferic monitor is the sum of the absolute differences brought about by the sferic filter operations, summed over 0.2 second intervals, normalised by the receiver effective area. It is given in units of uV/sq.m/0.2s. Many sferics have a characteristic form that is well illustrated by figure 2 in Garner and Thiel (2000). The high frequency, initial part of a sferic event can be detected and filtered more easily than the later, low frequency portion. The sferic monitor indicates where at least the high frequency portion of a sferic has been successfully removed, but it is quite possible that lower frequency elements of the sferic event may have eluded detection, passing through to the window amplitude data. Thus, discrete anomalies coincident with sferic activity as indicated by the sferic monitor should be down-weighted relative to features clear of any sign of sferic activity.

The Low Frequency Monitor (LFM) makes use of amplitudes at frequencies below the base frequency which are present in the streamed data to estimate the amplitude of coil motion (Earth magnetic field) noise at the base frequency in log10(pV/sqrt(Hz)/sq.m). The coil motion noise below the base frequency is rejected through the use of tapered stacking, but the coil motion noise at the base frequency itself is not easily removed. A sharp spike in the LFM can be an indicator of a coil motion event (eg the bird passing through extremely turbulent air). Note that the LFM will also respond to sferic events with an appreciable low frequency (sub-base frequency) component. This situation can be inferred when both the LFM and sferic monitors show a discrete kick.
The powerline monitor gives the amplitude of the received signal at the powerline frequency (50 or 60 Hz) in log10(pV/sqrt(Hz)/sq.m). Careful selection of the base frequency (such that the powerline frequency is an even harmonic of the base frequency) and tapered stacking combine to strongly attenuate powerline signals. When passing directly over a powerline, the rapid lateral variations in the strength and direction of the magnetic fields associated with the powerline can result in imperfect cancellation of the powerline response during stacking. Some powerline-related interference can manifest itself in a form that is similar to the response of a discrete conductor. The exact form of the monitor profile over a powerline depends on the line direction, powerline direction, powerline current, and receiver component, but the monitor will show a general increase in amplitude approaching the powerline.

Wide area VLF communication signals in the 15 to 25 kHz frequency band are monitored by the TEMPEST system. In the Australian region, signals at 18.2 kHz, 19.8 kHz, 21.4 kHz and 22.2 kHz are monitored as the amplitude of the received signal at these frequencies in log10(pV/sqrt(Hz)/sq.m). The strongest signal comes from North West Cape (19.8 kHz). The signal at 18.2 kHz is often observed to pulse in a regular sequence. These strong narrow band signals have some impact on the high frequency response of the system, but they are strongly attenuated by selection of the base frequency and tapered stacking. The VLF transmissions are strongest in amplitude in the horizontal direction at right angles to the direction to the VLF transmitter. This directional dependence enables the VLF monitors to be used to indicate the receiver coil attitude. Receiver coil pitch has a significant effect on early time Z component response and late time X component response (Green and Lin, 1996). Receiver coil roll impacts early time Z component response.

The geometric factor gives the ratio of the strength of the primary field coupling between the transmitter loop and the receiver coil at each observation relative to the coupling observed at high altitude during acquisition of reference waveform data. Variations in this factor indicate a change in the attitude and/or relative separation of the transmitter loop and the receiver coil.

Average transmitter to receiver geometry values for each flight are derived from the high altitude reference waveforms and knowledge of the system characteristics. The geometry values are given in the table below. These values (for each flight) should be used when modelling the "raw" data.

Table of average transmitter loop to receiver coil geometry values for each flight

Flight No	Horizontal separation (m)	Vertical separation (m)
2	110.1	42.8
3	109.8	43.1
4	109.8	42.8
5	109.7	42.8
6	109.7	43.0
7	110.2	41.9
8	110.2	41.9
10	108.6	46.8
11	110.2	41.5
12	110.0	42.6
14	109.9	42.8
15	109.6	43.8
16	110.1	42.3
17	109.8	42.7
18	109.8	42.9
19	109.9	43.0
20	110.3	41.4
21	110.5	41.6
22	110.0	42.1
23	109.4	44.0
24	110.0	42.4
25	110.1	42.0
26	108.5	46.0
27	110.5	41.1

The following corrections were added to the measured aircraft altitude to obtain transmitter loop altitude: transmitter loop to ground separation of +3.05 metres, and GPS antenna to ground separation of -3.3 metres.

Measured vertical gyro aircraft pitch and roll attitude measurements are converted to transmitter loop pitch and roll by adding +0.45 degrees for pitch and +0.6 degrees for roll. Nose up is positive for pitch, and left wing up is positive for roll.

The "raw" or "observed" located data is one of two principal data products of the TEMPEST system.

The "raw" EM amplitudes reflect not only the variations in ground conductivity but the variations in geometry of the various parts of the EM measurements (ie transmitter loop pitch, transmitter loop roll, transmitter loop terrain clearance, transmitter loop to receiver coil horizontal longitudinal separation, transmitter loop to receiver coil horizontal transverse separation, and transmitter loop to receiver coil vertical separation) during the survey. For example, the largest influence on the early time EM amplitude is the terrain clearance of the transmitter loop. The larger the terrain clearance, the smaller the amplitude. Later window times (larger window number) show diminished variations due to terrain clearance.

A second, "final" or "geometry-corrected", located data file is produced for optimum presentation of the EM amplitude data in image format (eg window amplitude images, principal component analysis images derived from the window amplitudes (Green,1998b). Between "raw" and "final" states, the ground response data undergoes an approximate correction to produce data from a nominated standard geometry. A dipole-image method (Green, 1998a) is used to adjust the data to the response that would be expected at a standard terrain clearance (110m), standard transmitter loop pitch and roll (zero degrees), and a standard transmitter loop to receiver coil geometry (the average values in the table of transmitter loop to receiver coil geometry values). These variables have been set to their respective standard values in the "final" located data (whereas the "raw" located data file contains the variable field data). Zero parallax is applied to transmitter loop pitch, roll, terrain clearance, X component EM and Z component EM data prior to geometry correction. Over extremely conductive ground (eg > 100 S conductance), the estimates for transmitter loop to receiver coil separation determined from the primary field coupling factors may be in error at the metre scale due to uncertainty in the estimation of the primary field. This will influence the accuracy of very early time window amplitude information in the "geometry-corrected" located data.

Limited range micro-levelling may be applied to the final window amplitudes for presentation purposes, principally for multi-flight surveys and when isolated re-flight lines are present.

Due to the asymmetry in the transmitter loop - receiver coil geometry with respect to flight direction, there is no single parallax value which will align the peak response for all conductivity distributions for lines flown in opposite directions. The choice of parallax value depends on the intended usage. A parallax value of 0.2 fiducials (1 fiducial = 1 second for this survey) was applied to the X component data, 1.4 fiducials to the Z component data, and 0.4 fiducials to the radar altimeter data, all with respect to the location information. These values produce optimum derived topography images (in the case of the radar altimeter parallax), and generally align peak responses over horizontal or broad conductors for the X and Z component window amplitudes at early to mid times. Relative to the above "horizontal" parallax values, the X component EM data should be parallaxed by 1.8 fiducials and the Z component data by -0.6 fiducials for optimum alignment of peak response from thin steeply dipping conductors.

7.2.4 Conductivity Depth Images (CDI)

The "final" data for each area were input to program EMFlow to calculate Conductivity Depth Images (CDI). EMFlow was developed within the CRC AMET through AMIRA research projects (Macnae et al, 1998, Macnae and Zonghou, 1998, Stolz and Macnae, 1998). The software has been commercialised by Encom Technology Pty Ltd. Examples of TEMPEST conductivity data can be seen in Lane et al. (2000), Lane et al. (1999), and Lane and Pracillio (2000).

Version 4.00 of the software was used.

Conductivity values were calculated to a depth of 250m below surface at each point, using a depth increment of 5m, for all areas except area 5 (Pt Pirie – Tarcoola traverse line) where conductivities were calculated down to 550m.

7.2.5 System Specifications for Modelling TEMPEST Data

Differences between the specifications for the acquisition system and those of the virtual system for which processed results are given must be kept in mind when forward modelling, transforming or inverting TEMPEST data.

Acquisition is carried out with a 50% duty cycle square transmitter current waveform and dB/dt sensors.

During processing, TEMPEST EM data are transformed to the response that would be obtained with a B-field sensor for a 100% duty cycle square waveform at the base frequency, involving a 1A change in current (from -0.5A to +0.5A to -0.5A) in a 1sq.m transmitter. Data are given in units of femtotesla (fT = 10^{-15} Tesla). It is this configuration, rather than the actual acquisition configuration, which must be specified when modelling TEMPEST data.

Window timing information is given above (see section 7.2.3).

7.2.5.1 Standard Height and Geometry

If using data from the "raw" located data files, the average relative position of the receiver coils from the transmitter loop for each flight can be obtained from the table given above (section 7.2.3). Transmitter loop pitch, transmitter loop roll and transmitter loop terrain clearance values for each observation can be obtained from the located data file.

The "final" EM data have been standardised through an approximate transformation to a standard transmitter loop terrain clearance, transmitter loop pitch and roll of zero degrees, and a transmitter loop to receiver coil geometry equal to the average values given above. Transmitter loop pitch, transmitter loop roll and transmitter loop terrain clearance values for each observation have been modified to reflect the standard values.

The following table summarises the values used to correct the height/pitch/roll/geometry to.

Table of values used to standardise transmitter loop height, pitch, roll and geometry

Variable	Standardised value
Transmitter loop pitch	0 degrees
Transmitter loop roll	0 degrees
Transmitter loop terrain clearance	110 metres
Transmitter loop – to – receiver coil geometry	110 metres behind and 43 metres below the aircraft

7.2.5.2 Parallax

The "raw" and "final" located data files utilise the following parallax values :-

- magnetics = 0.5 fiducials (2.5 observations from the zero parallax position),
- radar altimeter = 0.4 fiducials (2 observations from the zero parallax position),
- EM X-component = 0.2 fiducials (1 observation from the zero parallax position),
- EM Z-component = 1.4 fiducials (7 observations from the zero parallax position),

These EM parallax values are optimised for aligning the EM response amplitudes for *horizontal* or *broad steeply dipping conductors*, which account for the majority of responses in regolith-dominated terrains such as this.

For optimum gridded display of the response for *discrete vertical* or *narrow conductors*, the following EM parallax values are appropriate :-

- EM X-component = 2.0 fiducials (10 observations from the zero parallax position, or 9 observations from the "horizontal" parallax position),
- EM Z-component = 0.8 fiducials (4 observations from the zero parallax position, or -3 observations from the "horizontal" parallax position).

(NB Positive parallax values are defined in this case as shifting the indicated quantity back along line to smaller fiducial values. Location information remains in the zero parallax state.)

7.2.6 Delivered Products

Appendix V contains a complete list of data supplied digitally.

A number of hardcopy map products were produced. These are listed in the tables below.

Table of hardcopy map products (at 1:50,000 scale) produced for areas 1,2 and 3

Title	Units	Histogram Stretch
Flight path	-	-
Reduced to pole (RTP) TMI (with NE illumination)	nT	Equalised
1st vertical derivative of RTP TMI	nT/m	Normalised
Derived topography (with NE illumination)	m (AHD)	Linear
Principal components of X-component EM windows 1-15	-	equalised
Principal components of X-component EM windows 1-7	-	equalised
Principal components of X-component EM windows 6-15	-	equalised
Stacked CDI X-component conductivity sections	mS/m	Logarithmic

Table of hardcopy map products produced for areas 5 (Pt Pirie – Tarcoola traverse line)

Title	Units	Histogram Stretch
Flight path (at 1:1,000,000 scale)	-	-
Stacked CDI X-component sections (at 1:500,000 scale)	mS/m	Logarithmic

("Logarithmic" - mapping of logarithmic data intervals to each colour in the look-up table.)

Separate digital located data files were produced for the EM "raw" and "final" data sets for both the X- and Z-components. The header files for "raw" and "final" data are found in Appendix IV.

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APPENDIX I - Flight Plans

```
JOB_Number  1440.1
CLIENT      AGSO                                                                    *
AREA_NAME   Yorke Peninsula (Moonta)                                                *
PLANNED_BY  Matt Trevenen          02/06/2000                                       *
|                                                                                   *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                           *
DELTAXYZ    0        0          0          0.000 0.000 0.000 0.000                  *
HEMISPHERE  SOUTH                                                                   *
UTM_ORIGIN  53   135   135                                                          *
BOUNDARY    1   760000   6260000 -33.768225 +137.807406 -334605.6 +1374826.7 12     *
BOUNDARY    2   772000   6260000 -33.765211 +137.936833 -334554.8 +1375612.6 12     *
BOUNDARY    3   772000   6248000 -33.873298 +137.940533 -335223.9 +1375625.9 12     *
BOUNDARY    4   760000   6248000 -33.876324 +137.810944 -335234.8 +1374839.4 12     *
|                                                                                   *
NAVTYPE     NOVATEL                                                                 *
NAVMODE     U.T.M                                                                   *
PLAN_TYPE   Normal                                                                  *
LINE_TYPE   S.LINE     X.LINE    0         0                                        *
HEADING     110        020                                                          *
SPACING     150        11500     11500     11500                                    *
OVER_LINE   0          0                                                            *
OVERFLY     0          300                                                          *
MIN_LENGTH  5          5                                                            *
FIRST_LINE  10         10                                                           *
INCREMENT   10         10                                                           *
X_TRACK     50         100                                                          *
MASTER_PT   1   760250   6000000 -36.109812 +137.891208                             *
MASTER_NEW  1   766895   6253623 -33.823955 +137.883701                             *
KM_in_AREA  970        13                                                           *
KM+OVERFLY  1032       13                                                           *
                                                                                    *
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```
JOB_Number  1440.2
CLIENT      AGSO                                                                    *
AREA_NAME   Central Gawler Area B (Tunkillia)                                       *
PLANNED_BY  Ian Cook               19/05/2000                                       *
PLANNED_BY  Ian Cook               22/05/2000 Boundary                              *
|                                                                                   *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                           *
DELTAXYZ    0        0          0          0.000 0.000 0.000 0.000                  *
HEMISPHERE  SOUTH                                                                   *
UTM_ORIGIN  53   135   135                                                          *
BOUNDARY    1   463820   6552320 -31.162561 +134.620373 -310945.2 +1343713.3 12     *
BOUNDARY    2   473720   6562220 -31.073498 +134.724508 -310424.6 +1344328.2 12     *
BOUNDARY    3   494720   6541220 -31.263263 +134.944539 -311547.7 +1345640.3 12     *
BOUNDARY    4   484820   6531320 -31.352501 +134.840401 -312109.0 +1345025.4 12     *
SQUARE_KMS  415.800                                                                 *
|                                                                                   *
NAVTYPE     NOVATEL                                                                 *
NAVMODE     U.T.M                                                                   *
PLAN_TYPE   Normal                                                                  *
LINE_TYPE   S.LINE     X.LINE    0         0                                        *
HEADING     45         135                                                          *
SPACING     150        4500      4500      4500                                     *
OVER_LINE   0          0                                                            *
OVERFLY     0          300                                                          *
MIN_LENGTH  5          5                                                            *
FIRST_LINE  10         10                                                           *
INCREMENT   10         10                                                           *
X_TRACK     50         100                                                          *
MASTER_PT   1   501000   6000000 -36.144718 +135.011116                             *
MASTER_NEW  1   477772   6545073 -31.228296 +134.766601                             *
KM_in_AREA  2800       119                                                          *
KM+OVERFLY  2800       121                                                          *
                                                                                    *
```

```
JOB_Number  1440.3                                                                                        *
CLIENT      AGSO                                                                                          *
AREA_NAME   Central Gawler Area C (Challenger)                                                            *
PLANNED_BY  Matt Trevenen          02/06/2000                                                             *
|                                                                                                         *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                                                 *
DELTAXYZ    0          0          0          0.000 0.000 0.000 0.000                                      *
HEMISPHERE  SOUTH                                                                                         *
UTM_ORIGIN  53   135   135                                                                                *
BOUNDARY    1   355000  6689000 -29.921182 +133.497867 -295516.3 +1332952.3 12                            *
BOUNDARY    2   355000  6699000 -29.830965 +133.499218 -294951.5 +1332957.2 12                            *
BOUNDARY    3   370000  6699000 -29.832638 +133.654434 -294957.5 +1333916.0 12                            *
BOUNDARY    4   370000  6689000 -29.922860 +133.653222 -295522.3 +1333911.6 12                            *
|                                                                                                         *
NAVTYPE     NOVATEL                                                                                       *
NAVMODE     U.T.M                                                                                         *
PLAN_TYPE   Normal                                                                                        *
LINE_TYPE   S.LINE     X.LINE     0          0                                                            *
HEADING     110        020                                                                                *
SPACING     150        14500      14500      14500                                                        *
OVER_LINE   0          0                                                                                  *
OVERFLY     0          300                                                                                *
MIN_LENGTH  5          5                                                                                  *
FIRST_LINE  10         10                                                                                 *
INCREMENT   10         10                                                                                 *
X_TRACK     50         100                                                                                *
MASTER_PT   1   500250  6000000 -36.144718 +135.002779                                                    *
MASTER_NEW  1   366517  6692449 -29.891367 +133.617572                                                    *
KM_in_AREA  1015       11                                                                                 *
KM+OVERFLY  1079       11                                                                                 *
```

```
JOB_Number  1440.5                                                                                        *
CLIENT      AGSO                                                                                          *
AREA_NAME   Pt Pirie - Tarcoola Traverse                                                                  *
PLANNED_BY  Ian Cook                                                                                      *
|                                  18/05/2000 Initial Flight Plan                                         *
SPHEROID    22  W.G.S_1984 6378137.0 298.257223563 0.9996                                                 *
DELTAXYZ    0          0          0          0.000 0.000 0.000 0.000                                      *
HEMISPHERE  SOUTH                                                                                         *
UTM_ORIGIN  53   135   135                                                                                *
BOUNDARY    1   780598  6322503 -33.200000 +138.010000 -331200.0 +1380036.0 34                            *
BOUNDARY    2   780691  6322500 -33.200000 +138.011000 -331200.0 +1380039.6 34                            *
BOUNDARY    3   780659  6321391 -33.210000 +138.011000 -331236.0 +1380039.6 34                            *
BOUNDARY    4   780566  6321393 -33.210000 +138.010000 -331236.0 +1380036.0 34                            *
SQUARE_KMS  15.515                                                                                        *
|                                                                                                         *
LINE_BEG    1   780598  6322503 -33.200000 +138.010000 -331200.0 +1380036.0 34                            *
LINE_END    1   665554  6385959 -32.651600 +136.765200 -323905.8 +1364554.7 34                            *
LINE_BEG    2   665554  6385959 -32.651600 +136.765200 -323905.8 +1364554.7 34                            *
LINE_END    2   458826  6602458 -30.710000 +134.570000 -304236.0 +1343412.0 34                            *
|                                                                                                         *
NAVTYPE     NOVATEL                                                                                       *
NAVMODE     U.T.M                                                                                         *
PLAN_TYPE   Normal                                                                                        *
LINE_TYPE   S.LINE                                                                                        *
HEADING     0                                                                                             *
SPACING     20000                                                                                         *
OVER_LINE   1                                                                                             *
OVERFLY     500                                                                                           *
MIN_LENGTH  5                                                                                             *
FIRST_LINE  10                                                                                            *
INCREMENT   10                                                                                            *
X_TRACK     100                                                                                           *
MASTER_PT   1   500000  6000000 -36.144718 +135.000000                                                    *
MASTER_NEW  1   780000  6320000 -33.222697 +138.004368                                                    *
KM_in_AREA  152                                                                                           *
KM+OVERFLY  156                                                                                           *
```

1440.5 PORT PIRIE - TARCOOLA TRAVERSE LINE: FINAL LOCATED DATA

Survey Specifications:

Job Number	1440.5
Survey Company	FUGRO AIRBORNE SURVEYS
Date Flown/Compiled	June 2000
Client	AGSO/PIRSA/CRC-LEME
Area Name	Port Pirie - Tarcoola Traverse Line
Line kilometerage	448 kilometres
Traverse Line Direction	roughly 135 - 315 degrees
Terrain Clearance	110 metres
EM System	25Hz TEMPEST
Navigation	Real-time differential GPS
Datum	GDA94 (Zone 53)

Traverse Line Start/End Coordinates (in GDA94):

780598	665554	665554	458826
6322503	6385959	6385959	6602458

Located Data Format:

One file of combined line data for each component, written in the following ascii format :-

Variable	Units	Format	Undefined
Line	N/A	I5	
Flight number	N/A	I4	
Fiducial	N/A	F8.1	-99999
Easting (GDA94)	m	F9.1	-99999
Northing (GDA94)	m	F10.1	-99999
Longitude (WGS84)	m	F11.6	-99999
Latitude (WGS84)	m	F11.6	-99999
Easting (WGS84)	m	F9.1	-99999
Northing (WGS84)	m	F10.1	-99999
Tx loop altitude (AHD)	m	F7.1	-99999
Topography (AHD)	m	F7.1	-99999
Tx loop terrain clearance	m	F7.1	-99999
Tx loop pitch	deg	F7.2	-99999
Tx loop roll	deg	F7.2	-99999
15 EM windows	fT	F11.7	-99999
Magnetics	nT	F10.3	-99999
1st vertical derivative	nT/m	F9.4	-99999
Sferics	uV/sq.m/0.2s	F7.3	-99999
Low freq	log10(pV/root.Hz/sq.m)	F7.3	-99999
Powerline	log10(pV/root.Hz/sq.m)	F7.3	-99999
18.2kHz	log10(pV/root.Hz/sq.m)	F7.3	-99999
19.8kHz	log10(pV/root.Hz/sq.m)	F7.3	-99999
21.4kHz	log10(pV/root.Hz/sq.m)	F7.3	-99999
22.2kHz	log10(pV/root.Hz/sq.m)	F7.3	-99999
Geometric factor	N/A	F7.3	-99999

Each field separated by a blank
Each record terminated by <CR><NL>

NOTES

Geometry Corrections:

The EM data have been corrected for transmitter height/pitch/roll and transmitter-receiver geometry variations.

System Geometry:

The transmitter-receiver geometry has been corrected to be:

transmitter terrain clearance = 110 metres
distance behind the aircraft = 110 metres
distance below the aircraft = 43 metres

ANNUAL REPORT

FOR THE PERIOD 13th MARCH 2001 to 12th MARCH 2002

ON EL 2707, STUART SHELF, SOUTH AUSTRALIA

BY

TUART RESOURCES LIMITED

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WEST PERTH WA 6005

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WEST PERTH WA 6005

Telephone: 9481 6782

March 2002

CONTENTS

FIGURES

APPENDIX

ABSTRACT

A review of the previous investigations carried out by Tuart has been undertaken. This is outlined in the 2001 Annual Report for EL 2707.

Recent investigations included reviews of published geological and geophysical data generated from the recent surge of interest by exploration companies. Areas such as the nearby Minotaur Resources Ltd tenements provided some information on the depth of cover, structural trends and geophysical target characteristics. In the light of this information our own data was re-assessed and targets redefined. An exploratory drilling program has been planned to test the anomalous area.

1. Introduction

EL 2707 is located approximately 80 kilometres south of the township of Woomera. Access is via Oakden Hills track to Mahatewa. The area is located between Lake Finniss and Lake MacFarlane.

This is demonstrated on Figs.1 and 2.

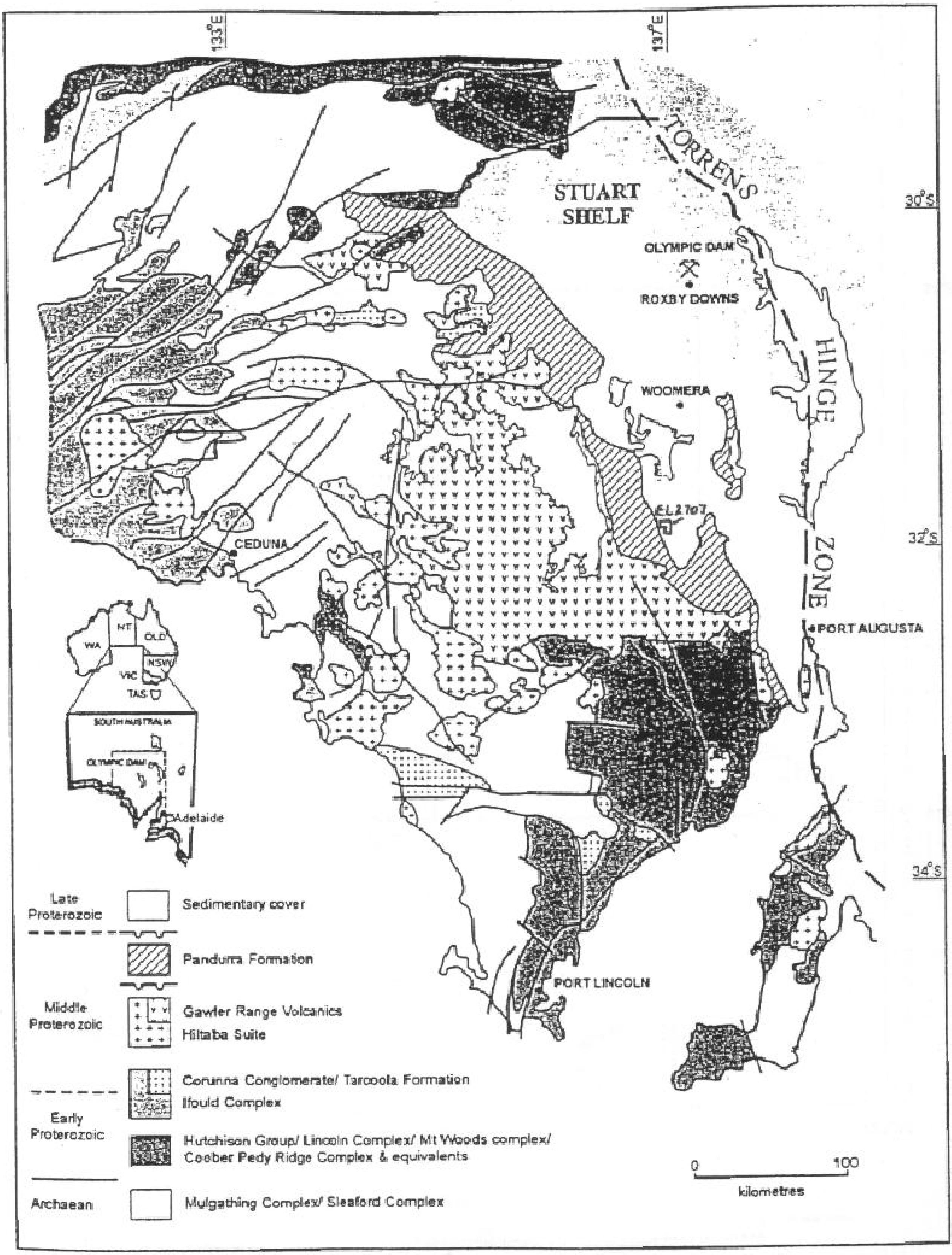


Figure 1. Interpreted subsurface geology at the Gawler Craton (modified from Daly et al, 1998).

TENEMENT LOCATION MAP

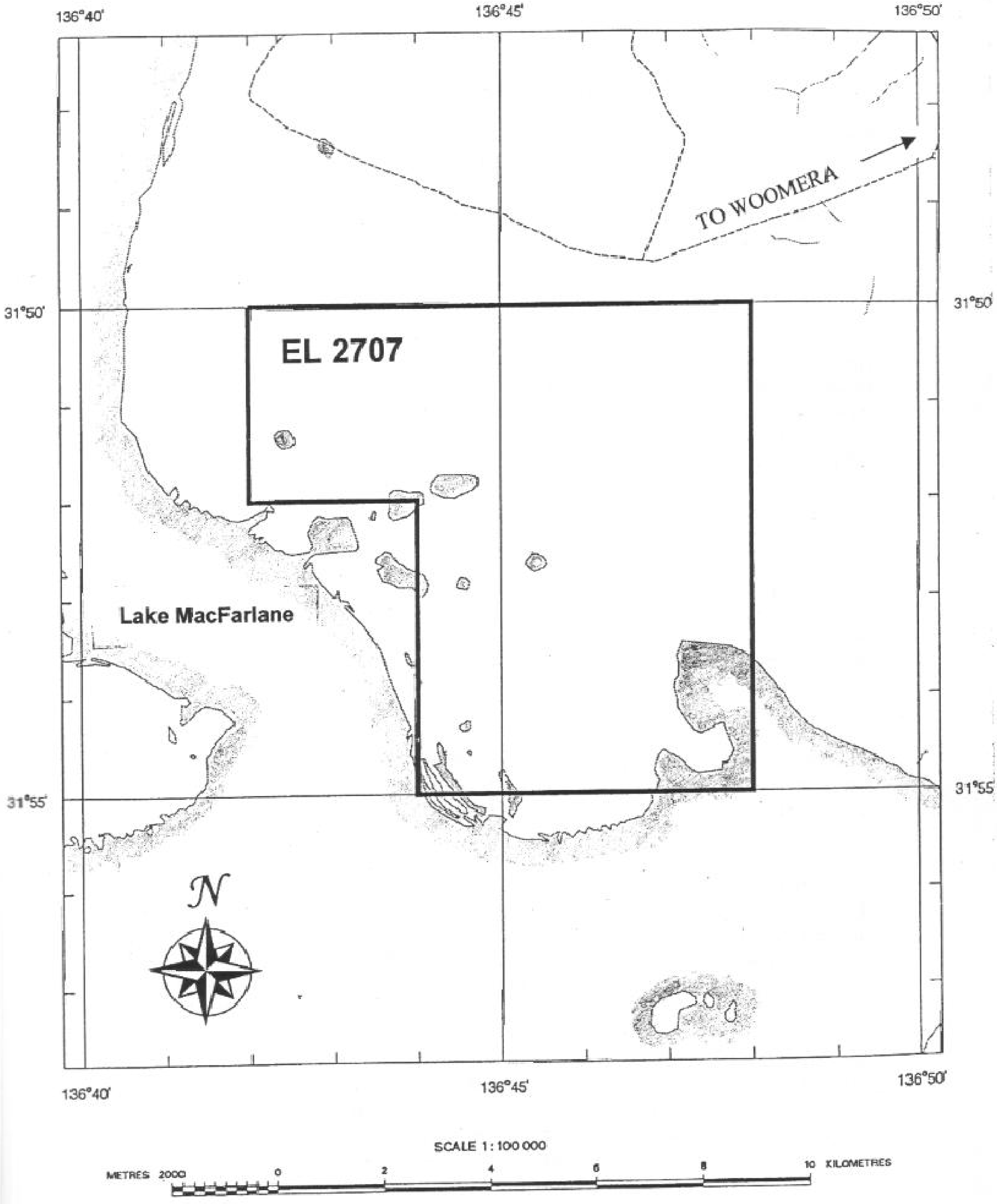


FIG. 2

2. Regional Geological Setting and Exploration Philosophy

Geology of tenement EL 2707 is based upon the Tuart Resources geological review and more recently published, publicly available information.

Since its discovery in 1975, the Olympic Dam deposit has provided a geological model that is the focus of mineral exploration in South Australia and elsewhere. The exploration that led to the discovery of Olympic Dam targeted the general area on the basis of a geological model that proposed possible base metal mineralisation on the Proterozoic Stuart Shelf.

To this point this was a conventional exploration approach. However, the proposed target lithologies comprising the Stuart Shelf are concealed beneath up to 300 metres of Mesozoic sediments. The principal characteristic of the Olympic Dam discovery that set it apart from major discoveries elsewhere is that the deposit has absolutely no surface geological or geochemical expression. The drilling program that led to the initial discovery of mineralisation was based solely on targeting photo lineaments, aeromagnetic, and gravity anomalies. The size of Olympic Data deposit gave drilling of the deposit a high chance of success.

The realisation that exploration could be successfully carried out in areas of prospective Proterozoic terrain overlain by relatively thick cover of Mesozoic sediments has led to a fundamental reappraisal of the prospectivity of other Proterozoic cratonic regions of South Australia by many companies. This has been the criterion for tenement selection adopted by Tuart Resources Limited in its applications for Exploration Licences in South Australia.The Company's consultants have carried out detailed geological and geophysical investigations to identify major geological dislocation and structural lineaments in the various accessible parts of Proterozoic cratons that could act as loci for mineralizing events.

The Gawler Craton is interpreted as a fragment of an originally very large area of stable Archaean continental crust. The basement complex is composed of ancient rocks with measured ages in the range 1800 to 2400 million years ago which have been subjected to multiple phases of folding and high grade metamorphism. The resulting gneissic terrain has been intruded at various times by granitic, mafic and ultramafic plutons accompanied by several episodes of mineralisation.

The principal style of mineralisation discovered to date has been Olympic Dam style gold-uranium-base metal mineralisation. However, the similarity of this area with other areas of Archaean Shield suggests the Gawler Craton is prospective for copper-nickel mineralisation in ultramafic rocks, platinum-chromium in layered mafic-ultramafic complexes and copper-lead-zinc in acid volcanic sequences.

Much of the Gawler Craton is covered by a relatively thin veneer of Cainozoic detrital sediments. However, with the knowledge that significant deposits may be detected below this cover, this situation has changed dramatically with major programs being mounted across the whole of the Craton using state of the art geophysical magnetic and gravity surveys.

The Stuart Shelf and Spencer Shelf are a transitional zone between the eastern margin of the Gawler Craton and the Adelaide Geosyncline. These Shelf zones are characterized by rifting and down-faulting due to regional scale fracture systems that transect the Shelf area and are interpreted to penetrate the lithospheric plate. The fractures are potential sites for deep seated and repeated tectonic activity, which has provided conduits for mineralizing hydrothermal solutions and structural controls for emplacement.

The Gawler Project tenement EL2707 is located on the southern extension of the Stuart Shelf.

3 Previous Exploration

Although the Licence area has been held under part of various larger tenements in the past, there has been no systematic exploration on the ground within the current holding.

3. Recent Exploration

Tuart conducted regional and local magnetic and gravity data interpretation and correlation factor analysis on EL2707. The results of this work are depicted in the Annual Report of March 13th 2000 to March 12th 2001.

The regional geophysical data shows several features of significance:

- A circular magnetic high located on the western part of EL 2707 (see Fig.3);
- A NE trending broad correlation zone between high gravity and magnetic anomalies;
- NW trending magnetic dolerite dykes (Gairdner Dyke Swarm?) and geophysical contact zones extending through the tenement;
- A possible east-west dyke system hidden by the NW trending magnetic dolerite dykes.
- A weakly developed, but significant N-S structural trend through the western side of the tenement (from Airborne Magnetics – East Gradient image). See Fig.4.
- A strongly developed N-S gravity low through the center of the tenement.
(See Fig.5.)

4.1 Geology – EL 2707

Olympic Dam Style Gold/Base Metal Mineralisation

The location of the tenement on the northeastern margin of the Gawler Craton gives potential for this style of mineralisation beneath the Mesozoic cover. Major NNW-trending structures defined by gravity and magnetics passes through the tenement and provides specific targets for exploration. Major regional easterly trending magnetic-gravity lineaments are potential areas where there may be emplacement of the Hiltaba Suite Granites; the host for Olympic Dam style mineralisation.

The Olympic Dam deposit is situated within Middle Proterozoic rocks in the northeastern part of the Gawler Craton beneath un-deformed late Proterozoic and Cambrian platform sediments of the Stuart Shelf. A major north and northwesterly trending structural feature, the Torrens Hinge Zone, marks the eastern boundary of both the Gawler Craton and the Stuart Shelf. The deposit lies astride a major north-northwest trending photo lineament corridor at the intersection of a major north-northwest trending gravity lineament and lies on or near coincident magnetic and gravity highs.

Mineralisation occurs within an intrusive suite of granitic rocks; the Hiltaba Suite granites where the host granite is hydrothermally altered and brecciated to form a granite-hematite breccia complex surrounded by relatively unbrecciated granite.

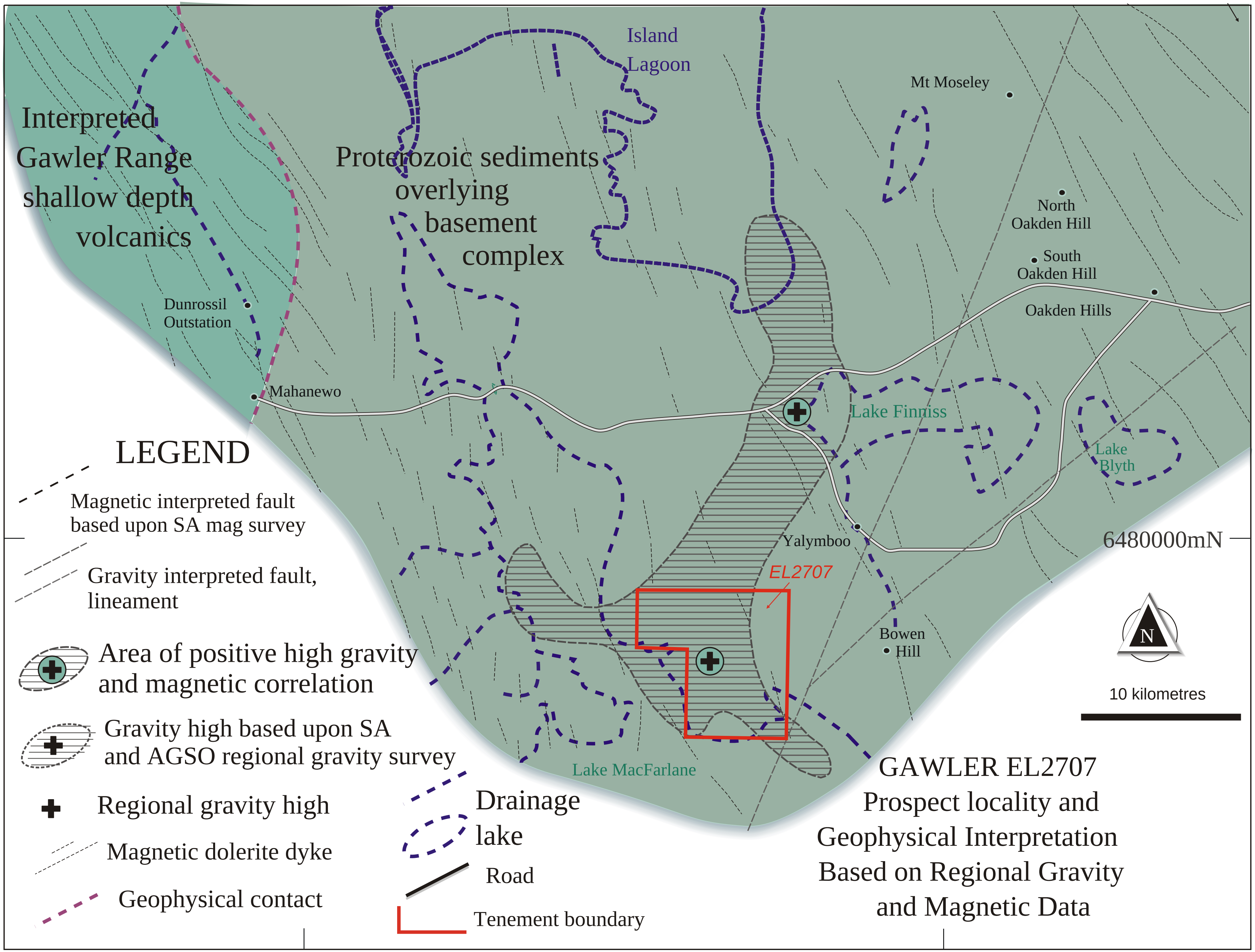
The presence of a major north-northeast trending structure suggests potential for this style of mineralisation within EL2707. However, much of the prospective Proterozoic basement is inaccessible due to the thickness of Phanerozoic sediments overlying the basement. Structural highs in the basement, probably associated with block faulting within structural corridors offer the most plausible sites for exploration. The east-west dyke systems could also be a focus for base metal deposits as seen on Figure 1.

A review of the regional AGSO Stuart Shelf drilling carried out to the north of the tenement was undertaken by G. Bravo, Consultant Geologist last year (Appendix 1 of 2001 Annual Report). This work highlighted the presence of a fracture zone containing hydrothermal alteration. These fractures could represent significant targets for exploration since they may well be the main conduits for hydrothermal fluid flow in the area.

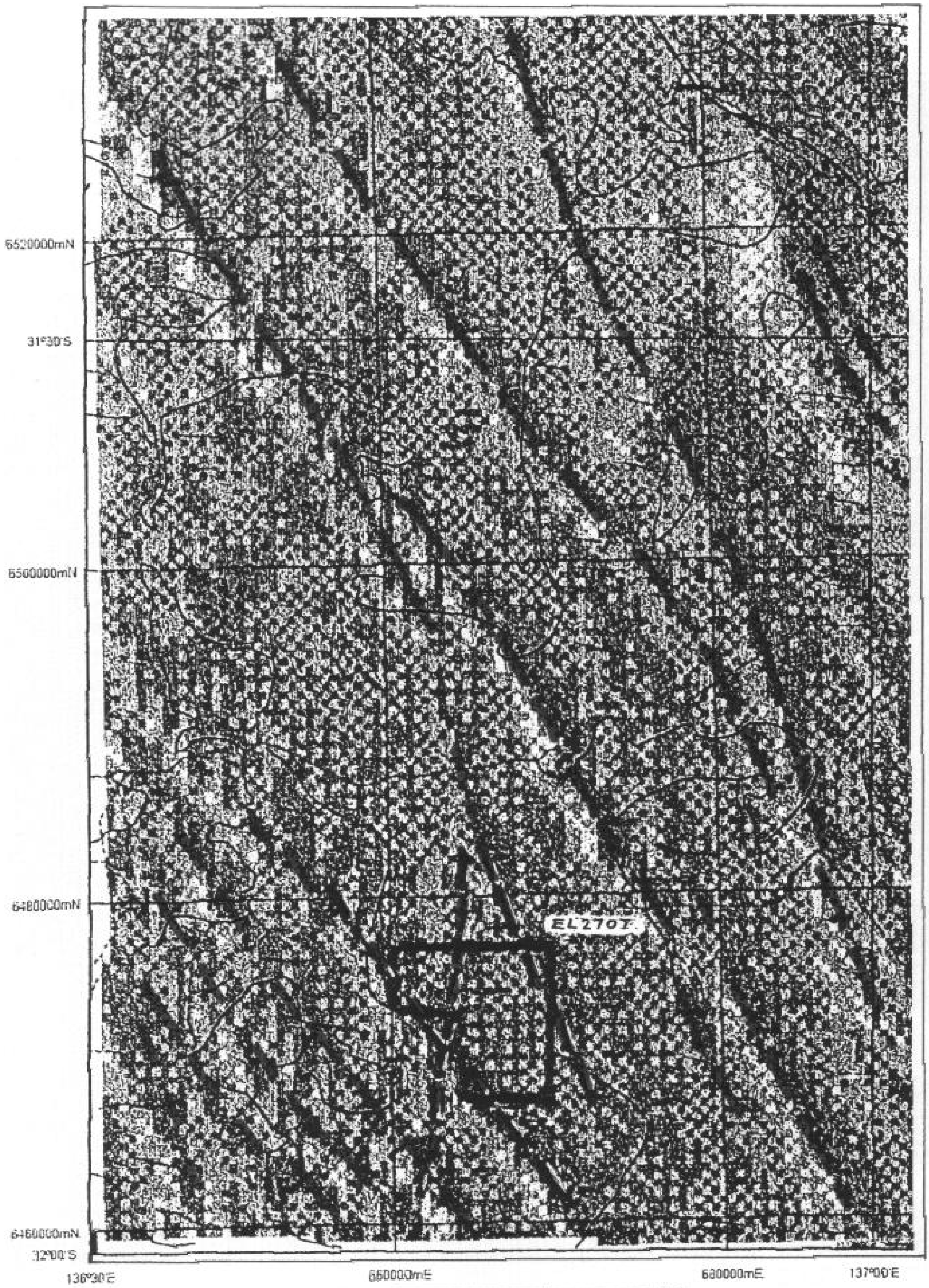
4.2 Geophysics

Fugaro on behalf of AGSO have conducted tempest surveys of Moorta and Tarcoola districts. Information from the traverse connecting the two areas has been compared to regional gravity and magnetic data. The results were presented in the March 2000 to March 2001 Annual Report.

The survey indicated that to the west of EL 2707 high conductivity is associated with the east-west dyke fracture system. Areas for further exploration by shallow drilling can be located where these fractures intersect NNW-NNE lineaments within the tenement.



GAWLER EL2707
Prospect locality and
Geophysical Interpretation
Based on Regional Gravity
and Magnetic Data



TUART RESOURCES

PROJECT GAWLER CRATON EXPLORATION AREA

PROSPECT STUART SHELF S.A.

MESA GIS & GEOPHYSICS

Airborne Magnetic Survey
EAST GRADIENT IMAGE
Grid Cell 500m

1 : 250,000

250,000 Ref ANDAMOOKA / TORRENS

100,000 Ref

ORIGINATOR L. Sterling

SCALE 1 : 250,000

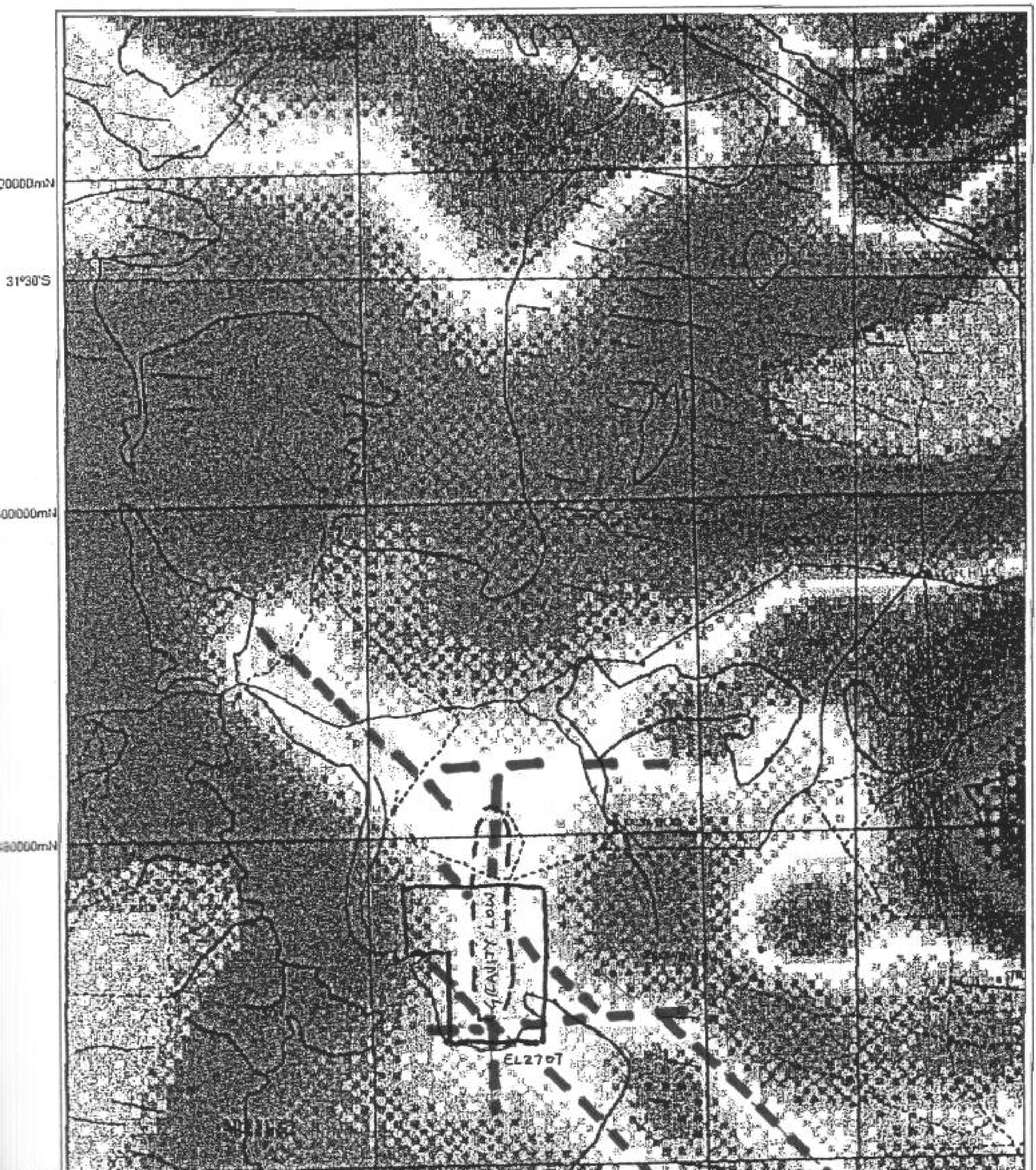
Revised Date

DRAWN M.R.B.

PLATE No

NOTE
NW linears
N-S weak
structural
trend

FIG. 4



PROJECT LOCATION

TUART RESOURCES

PROJECT. GAWLER CRATON EXPLORATION AREA
PROSPECT STUART SHELF S.A.

MESA GIS & GEOPHYSICS

AGSO Regional Gravity Survey
FIRST RESIDUAL IMAGE
Average Depth 1.9km

1 : 250,000

250,000 Ref ANDAMOOKA / TORRENS
100,000 Ref
SCALE 1:250,000
ORIGINATOR L. Stanley
Revision Date
Drawn M.H.B.
PLATE No.

NOTE N-S trending gravity low through centre of tenement and regional NW trending gravity features

FIG. 5.

5.0 Year 2002 Activities

The principal activities concerning the tenement consisted of

1 The development of a geological and geophysical model incorporating the results of expanded gravity data survey by AGSO and SAPIR.

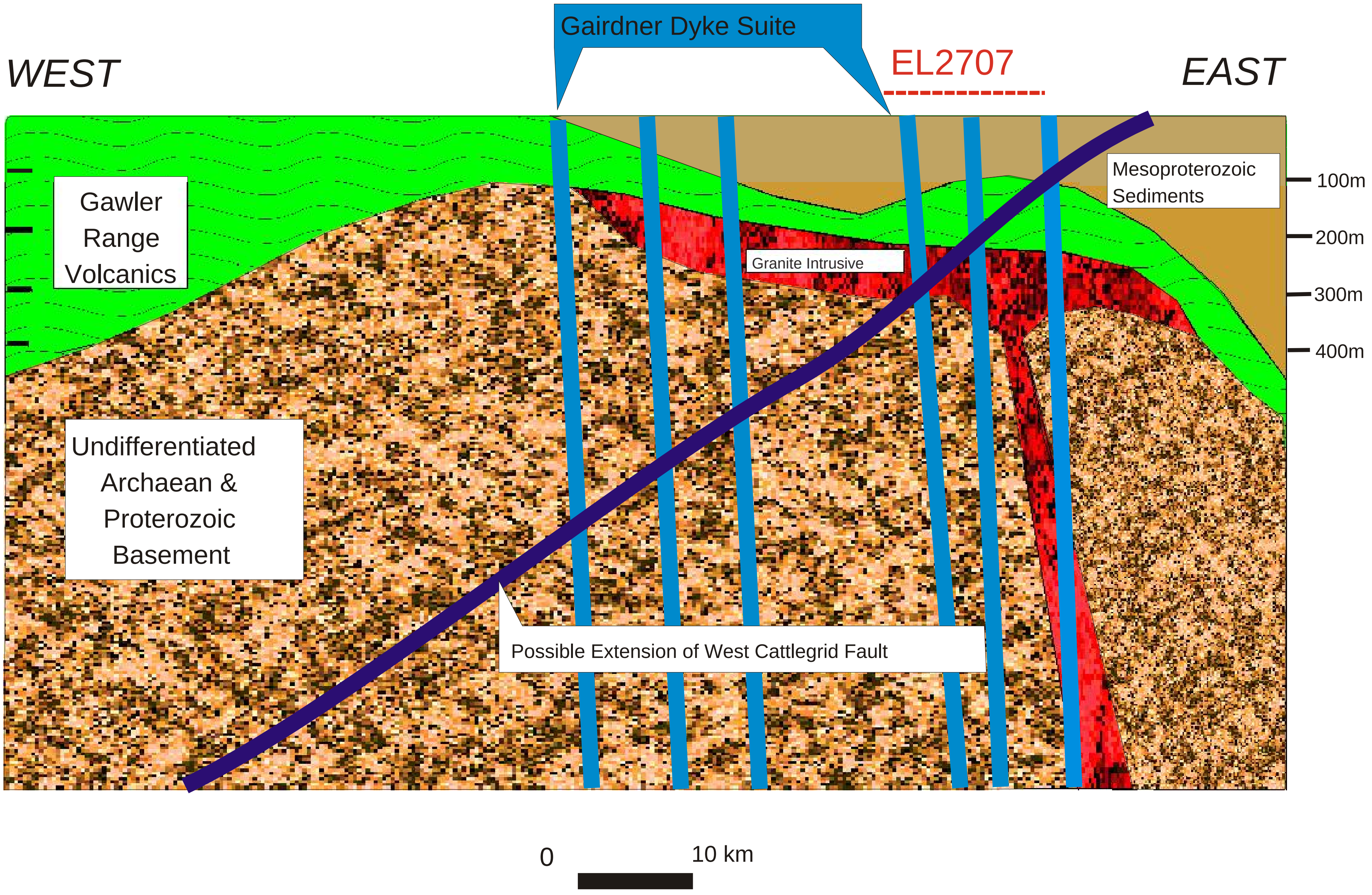
2 Defining more closely the target areas from the results of the borehole logging and assessment of the geophysical/geological model for the tenement area.

5.1 Geological Model and Section

The proposed geological model for tenement EL2707 is presented as Figure 3. The Gawler Range Volcanics form the basement to the Pandurra formation and the Stuart Shelf sequence of sediments. Combined magnetic and gravity lineaments intersect within EL2707 as displayed in the map on Figure 3.
The recent South Australian Gravity Survey data has been modeled to provide a detailed gravity interpreted section to define discrete drilling targets.
This cross-section, based on the known geophysical and geological information is shown on Fig. 6.

On the section there appears to be an upwelling of the basement, probably occupied by a granitoid intrusion. This feature is coincident with a Gairdner Dyke Swarm and is also traversed by a major structural discontinuity that is a possible extension to the West Cattlegrid Fault.

All of these features are potential carriers of hydrothermal fluids into the area.
It is proposed that if hydrothermal fluids are, or have been, associated with these structures they could have introduced base metals from the Archean basement beneath the Gawler Range volcanics. The reader could refer to the geological report written by G. Bravo (2001). The depth of Mesoproterozoic sediments at EL2707 is thought to be relatively shallow and estimated to be between 120 and 170 metres (see cross-section). Therefore the drilling program has been designed to test through this cover.

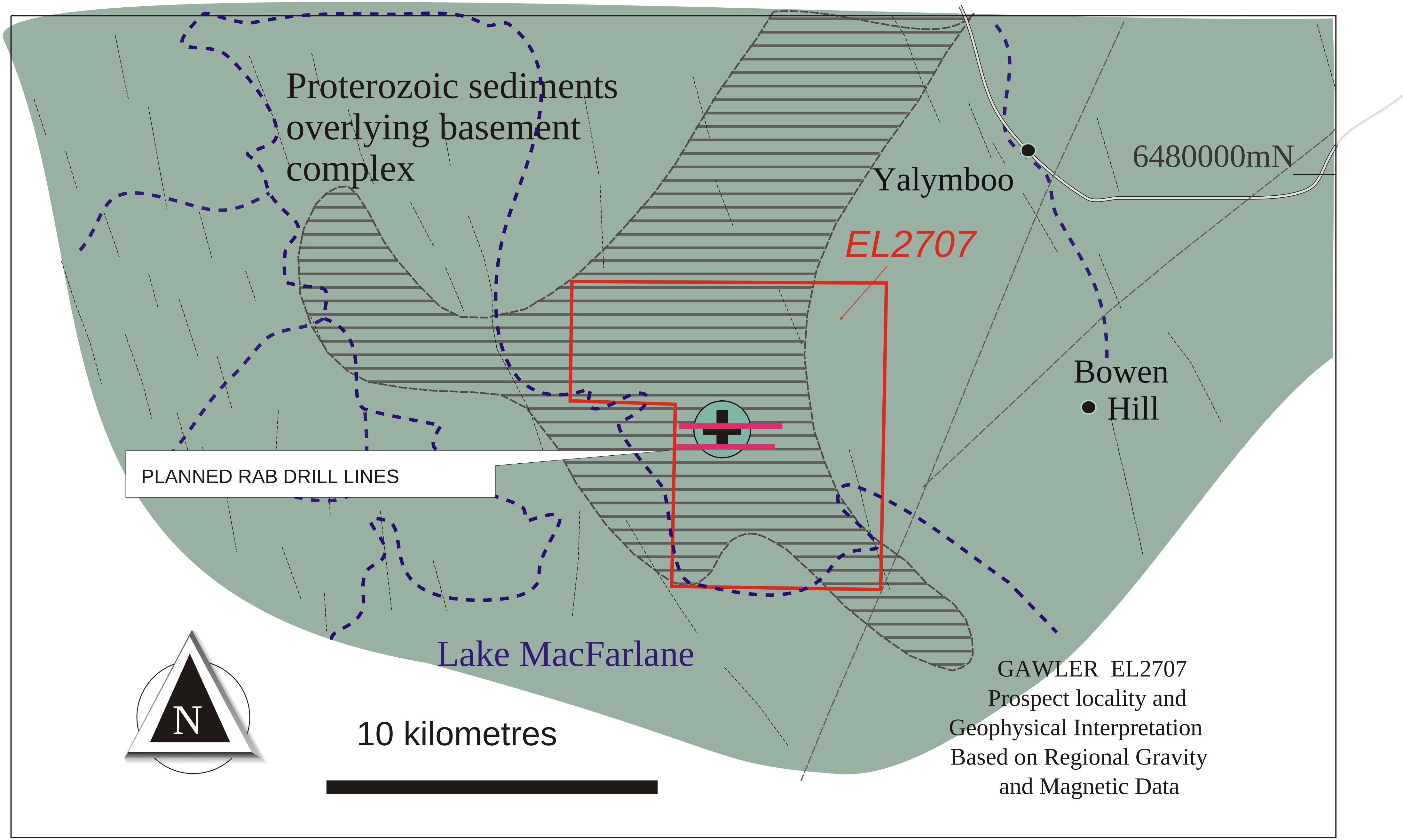


Schematic Cross Section of Geophysical Interpretation of EL2707

Interpretation by L.J.Starkey Drawn B.Davis. February 2002

6.0 Conclusions and Recommendations

- Recent geophysical modeling has indicated that beneath the cover rocks on E2707 there are significant magnetic and gravity anomalies present.
- Recent drilling results from exploration companies with nearby tenements provide good encouragement for the discovery of base metal sulphide deposits similar to those hosted by Hiltaba suite granite breccias of Olympic Dam.
- Detailed analysis of structural trends and their coincidence with geophysical anomalies has highlighted specific target areas on the tenement.
- The target areas form the basis of a drilling program that has been planned to penetrate the cover rocks into the Gawler Range Volcanics beneath.
- It is recommended that the drilling program be conducted in two stages. The first stage being approximately 4,000 metres of deep RAB drilling and the second being about 500 metres of RC drilling to follow up any significant results.
  (See approximate location of drill lines on Fig.7.



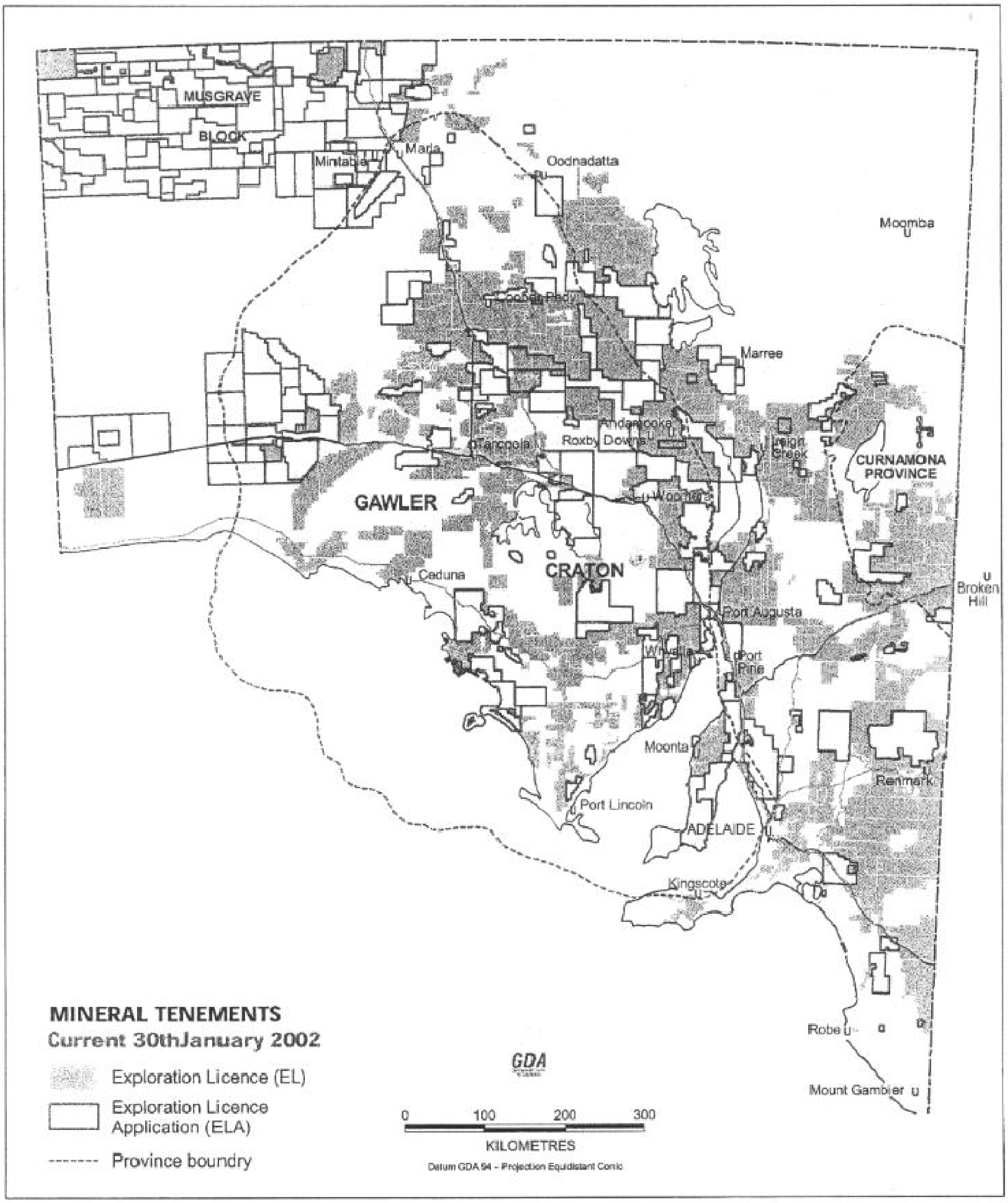
GAWLER EL2707
Prospect locality and
Geophysical Interpretation
Based on Regional Gravity
and Magnetic Data

APPENDIX

Tenement Maps

PRIMARY INDUSTRIES
AND RESOURCES SA

South Australia
MINERAL TENEMENTS



MINERAL TENEMENTS
Current 30thJanuary 2002

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Internet : www.minerals.pir.sa.gov.au

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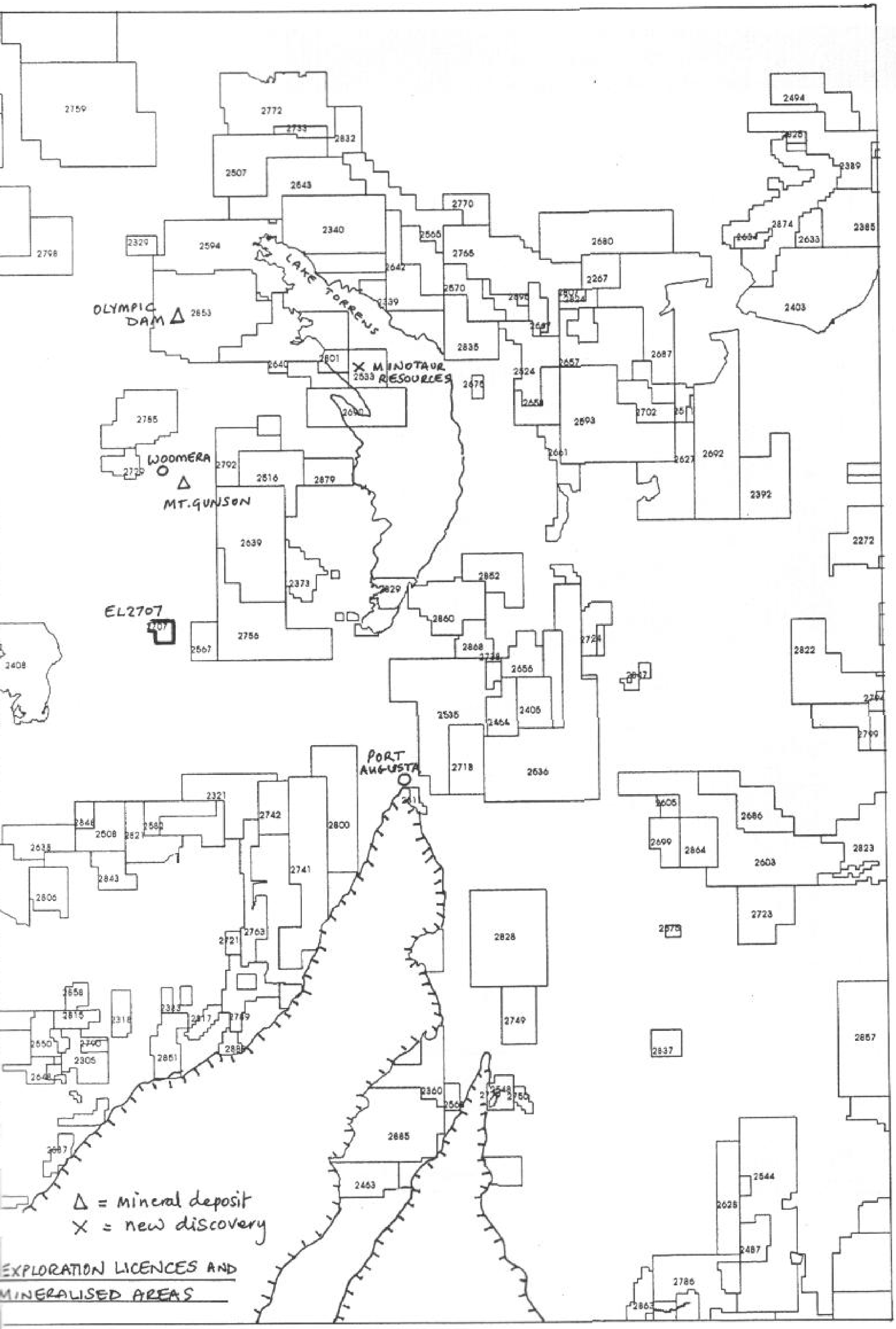

EXPLORATION LICENCES AND MINERALISED AREAS

ANNUAL REPORT
FOR THE PERIOD 13th MARCH 2002 to 12th MARCH 2003
ON EL 2707, STUART SHELF, SOUTH AUSTRALIA

BY

TUART RESOURCES LIMITED
LEVEL 1, 33 ORD ST
WEST PERTH WA 6005

J. Pratt, G. Steinepreis

Level 1, 33 Ord St
WEST PERTH WA 6005

Telephone: 9481 2407

March 2003

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FIGURES

APPENDIX

ABSTRACT

Tuart Resources Ltd was placed into administration on 13 January 2003 and as a consequence no work has been carried out over the last reporting period. However, the company is in the process of being restructured and expects to be released from administration following the completion of the deed of company arrangement on or around 16 July 2003 after which time exploration work will recommence on the licence.

A review of the previous investigations carried out by Tuart has been undertaken. Most of this work was outlined in the 2001 Annual Report for EL 2707.

Latest investigations included reviews of published geological and geophysical data. Areas such as the nearby Minotaur Resources Ltd tenements provided some information on the depth of cover, structural trends and geophysical target characteristics. In the light of this information Tuarts data has been re-assessed and targets redefined. An exploratory drilling program has been planned to test the anomalous area.

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The principal style of mineralisation discovered to date has been Olympic Dam style gold-uranium-base metal mineralisation. However, the similarity of this area with other areas of Archaean Shield suggests the Gawler Craton is prospective for copper-nickel mineralisation in ultramafic rocks, platinum-chromium in layered mafic-ultramafic complexes and copper-lead-zinc in acid volcanic sequences.

Much of the Gawler Craton is covered by a relatively thin veneer of Cainozoic detrital sediments. However, with the knowledge that significant deposits may be detected below this cover, this situation has changed dramatically with major programs being mounted across the whole of the Craton using state of the art geophysical magnetic and gravity surveys.

The Stuart Shelf and Spencer Shelf are a transitional zone between the eastern margin of the Gawler Craton and the Adelaide Geosyncline. These Shelf zones are characterized by rifting and down-faulting due to regional scale fracture systems that transect the Shelf area and are interpreted to penetrate the lithospheric plate. The fractures are potential sites for deep seated and repeated tectonic activity, which has provided conduits for mineralizing hydrothermal solutions and structural controls for emplacement.

The Gawler Project tenement EL2707 is located on the southern extension of the Stuart Shelf.

3. Previous Exploration

Although the Licence area has been held under part of various larger tenements in the past, there has been no systematic exploration on the ground within the current holding.

4. Recent Exploration

Tuart conducted regional and local magnetic and gravity data interpretation and correlation factor analysis on EL2707. The results of this work are depicted in the Annual Report of March 13 to March 12 2001.

The regional geophysical data shows several features of significance:

- A circular magnetic high located on the western part of EL 2707 (see Fig.3);
- A NE trending broad correlation zone between high gravity and magnetic anomalies;
- NW trending magnetic dolerite dykes (Gairdner Dyke Swarm?) and geophysical contact zones extending through the tenement;
- A possible east-west dyke system hidden by the NW trending magnetic dolerite dykes.
- A weakly developed, but significant N-S structural trend through the western side of the tenement (from Airborne Magnetics — East Gradient image). See Fig.4.
- A strongly developed N-S gravity low through the center of the tenement. (See Fig.5.)

4.1 Geology — EL 2707

Olympic Dam Style Gold/Base Metal Mineralisation

The location of the tenement on the northeastern margin of the Gawler Craton gives potential for this style of mineralisation beneath the Mesozoic cover. Major NNW trending structures defined by gravity and magnetics passes through the tenement and provides specific targets for exploration. Major regional easterly trending magnetic-gravity lineaments are potential areas where there may be emplacement of the Hiltaba Suite Granites; the host for Olympic Dam style mineralisation.

The Olympic Dam deposit is situated within Middle Proterozoic rocks in the northeastern part of the Gawler Craton beneath un-deformed late Proterozoic and Cambrian platform sediments of the Stuart Shelf. A major north and northwesterly trending structural feature, the Torrens Hinge Zone, marks the eastern boundary of both the Gawler Craton and the Stuart Shelf. The deposit lies astride a major north northwest trending photo lineament corridor at the intersection of a major north northwest trending gravity lineament and lies on or near coincident magnetic and gravity highs.

Mineralisation occurs within an intrusive suite of granitic rocks; the Hiltaba Suite granites where the host granite is hydrothermally altered and brecciated to form a granite-hematite breccia complex surrounded by relatively unbrecciated granite.

The presence of a major north-northeast trending structure suggests potential for this style of mineralisation within EL2707. However, much of the prospective Proterozoic basement is inaccessible due to the thickness of Phanerozoic sediments overlying the basement. Structural highs in the basement, probably associated with block faulting within structural corridors offer the most plausible sites for exploration. The east-west dyke systems could also be a focus for base metal deposits as seen on Figure 1.

A review of the regional AGSO Stuart Shelf drilling carried out to the north of the tenement was undertaken by G. Bravo, Consultant Geologist last year (Appendix 1 of 2001 Annual Report). This work highlighted the presence of a fracture zone containing hydrothermal alteration. These fractures could represent significant targets for exploration since they may well be the main conduits for hydrothermal fluid flow in the area.

4.2 Geophysics

Fugaro on behalf of AGSO have conducted tempest surveys of Moorta and Tarcoola districts. Information from the traverse connecting the two areas has been compared to regional gravity and magnetic data. The results were presented in the March 2000 to March 2001 Annual Report.

The survey indicated that to the west of EL 2707 high conductivity is associated with the east-west dyke fracture system. Areas for further exploration by shallow drilling can be located where these fractures intersect NNW-NNE lineaments within the tenement.

5.0 Year 2002 Activities

The principal activities concerning the tenement consisted of

1. The development of a geological and geophysical model incorporating the results of expanded gravity data survey by AGSO and SAPIR.
2. Defining more closely the target areas from the results of the borehole logging and assessment of the geophysical/geological model for the tenement area.

5.1 Geological Model and Section

The proposed geological model for tenement EL2707 is presented as Figure 3. The Gawler Range Volcanics form the basement to the Pandurra formation and the Stuart Shelf sequence of sediments. Combined magnetic and gravity lineaments intersect within EL2707 as displayed in the map on Figure 3.

The recent South Australian Gravity Survey data has been modeled to provide a detailed gravity interpreted section to define discrete drilling targets.

This cross-section, based on the known geophysical and geological information is shown on Fig. 6.

On the section there appears to be an upwelling of the basement, probably occupied by a granitoid intrusion. This feature is coincident with a Gairdner Dyke Swarm and is also traversed by a major structural discontinuity that is a possible extension to the West Cattlegrid Fault.

All of these features are potential carriers of hydrothermal fluids into the area.

It is proposed that if hydrothermal fluids are, or have been, associated with these structures they could have introduced base metals from the Archean basement beneath the Gawler Range volcanics. The reader could refer to the geological report written by G. Bravo (2001). The depth of Mesoproterozoic sediments at EL2707 is thought to be relatively shallow and estimated to be between 120 and 170 metres (see cross-section). Therefore the drilling pmgram has been designed to test through this cover.

6.0 Conclusions and Recommendations

- Recent geophysical modeling has indicated that beneath the cover rocks on E2707 there are significant magnetic and gravity anomalies present.
- Recent drilling results from exploration companies with nearby tenements provide good encouragement for the discovery of base metal sulphide deposits similar to those hosted by Hiltaba suite granite breccias of Olympic Dam.
- Detailed analysis of structural trends and their coincidence with geophysical anomalies has highlighted specific target areas on the tenement.
- The target areas form the basis of a drilling program that has been planned to penetrate the cover rocks into the Gawler Range Volcanics beneath.
- It is recommended that the drilling program be conducted in two stages. The first stage being approximately 4,000 metres of deep RAB drilling and the second being about 500 metres of RC drilling to follow up any significant results. (See approximate location of drill lines on Fig.7.)

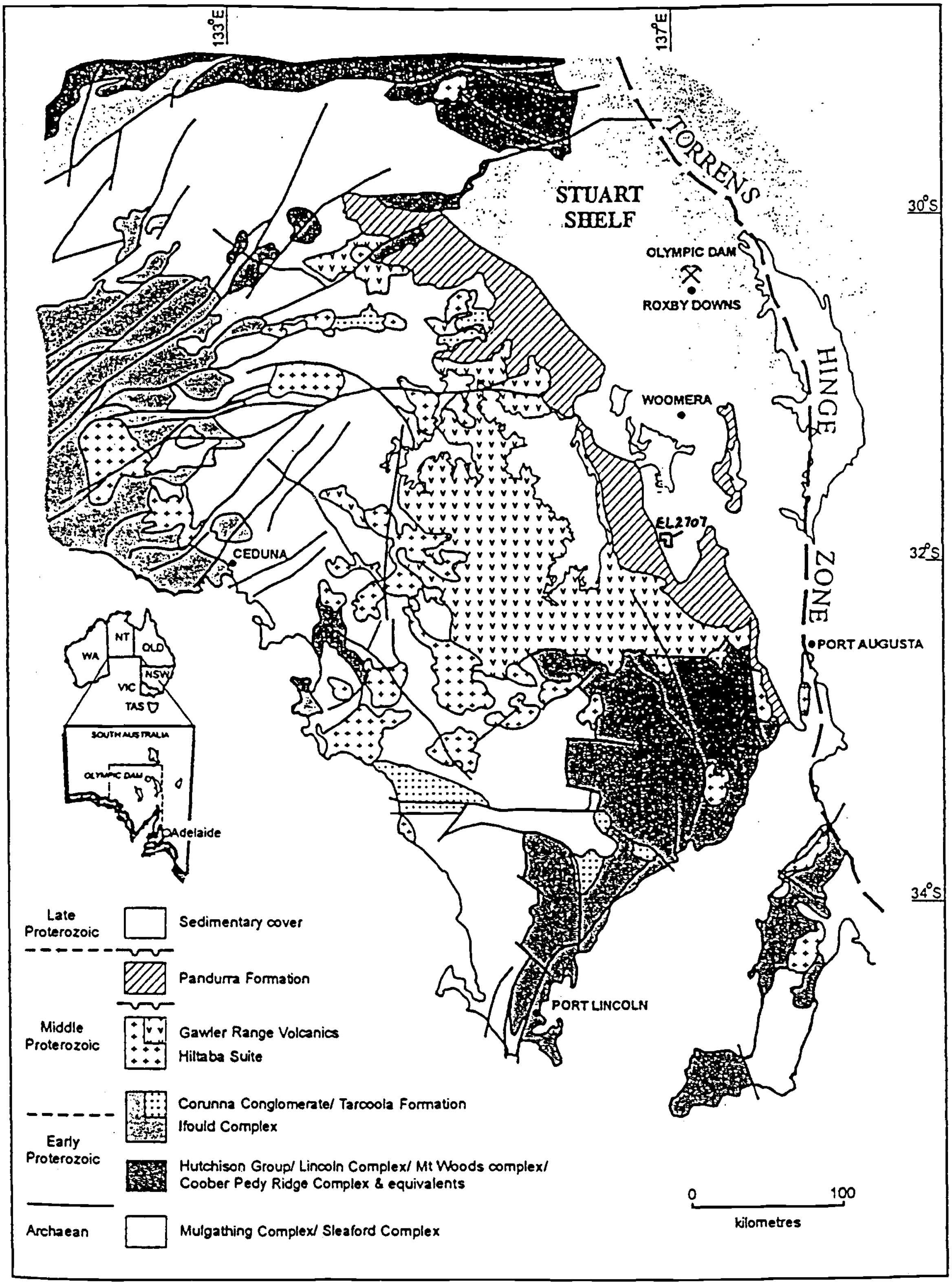


Figure 1. Interpreted subsurface geology at the Gawler Craton (modified from Daly et al, 1998).

TENEMENT LOCATION MAP

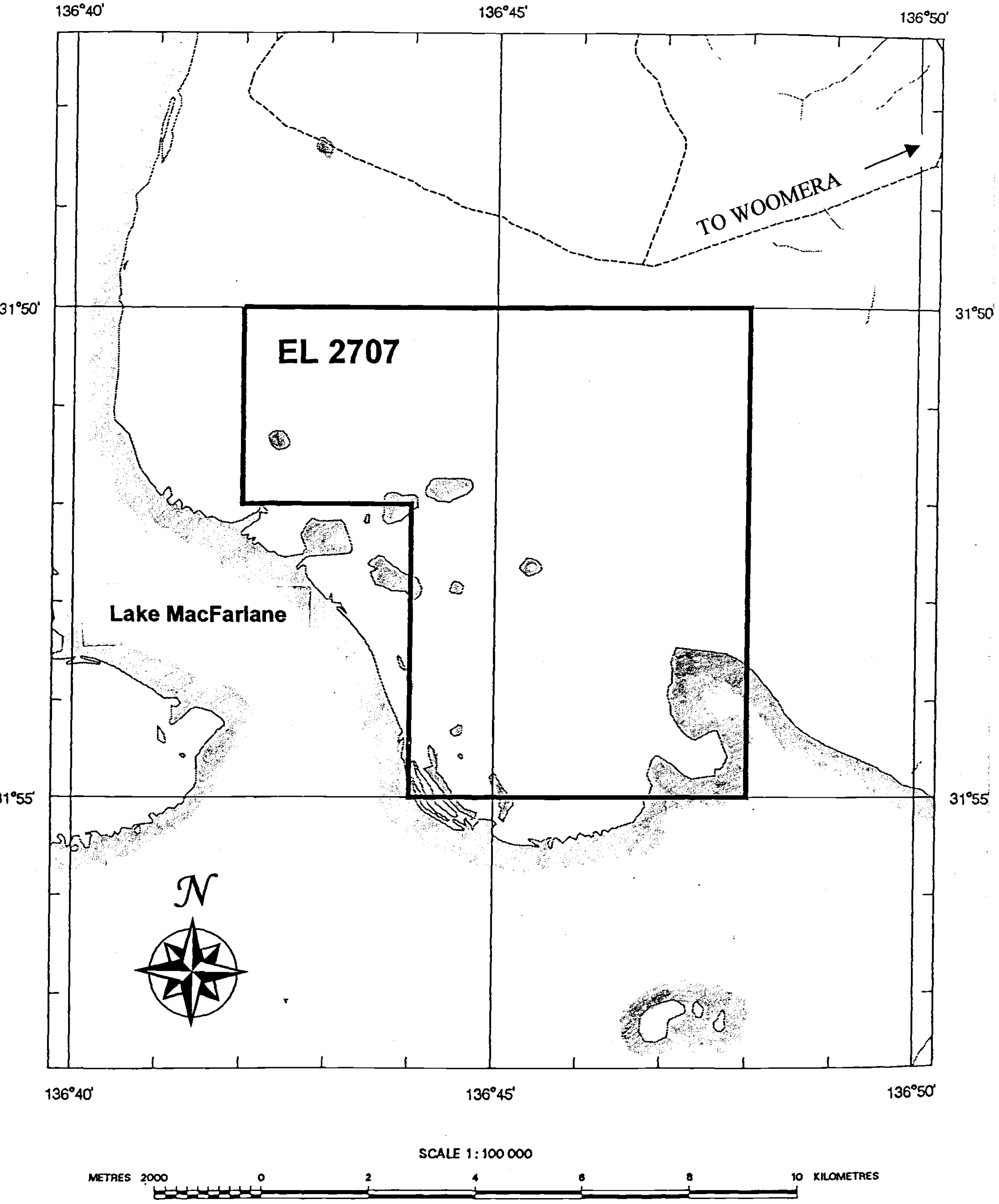
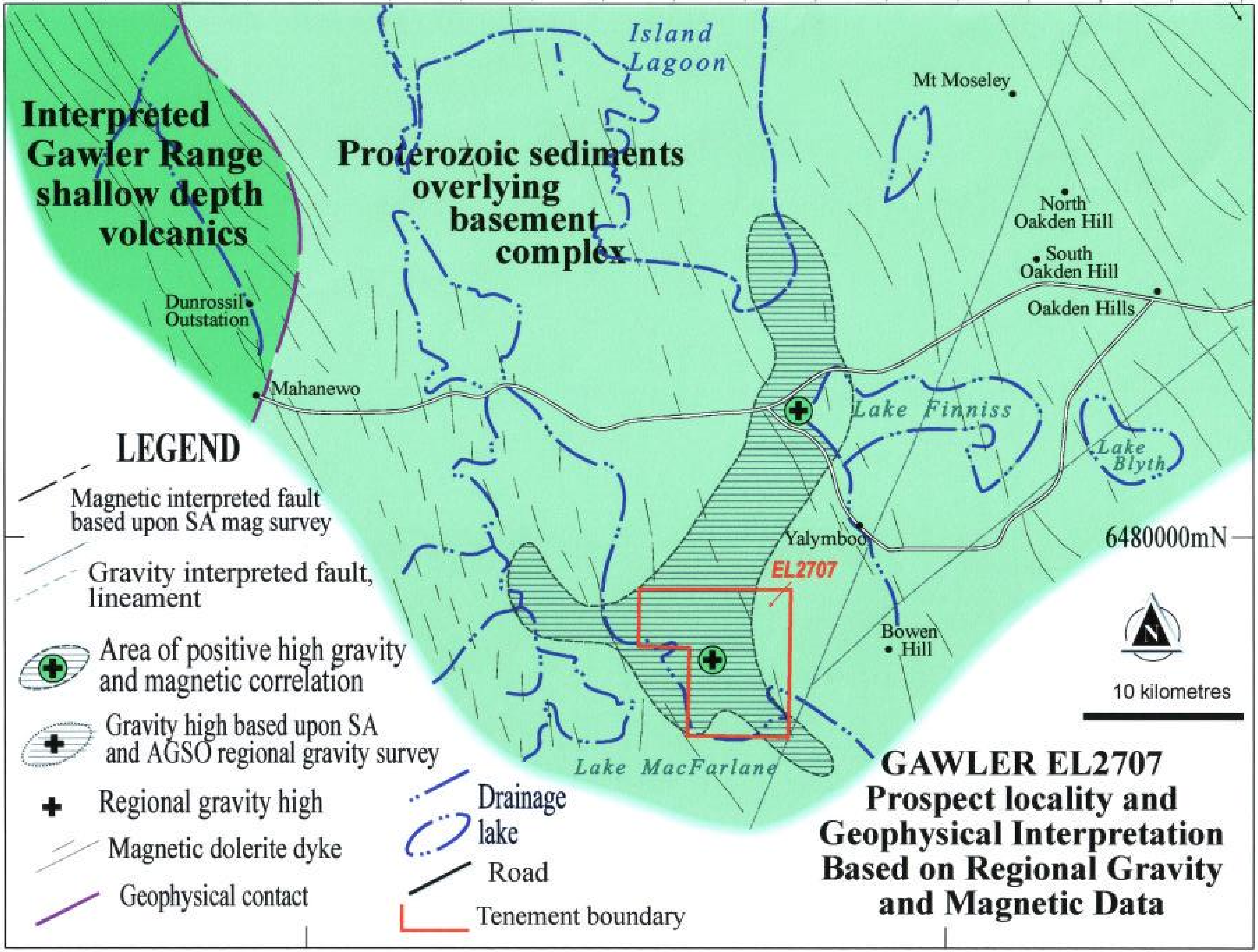
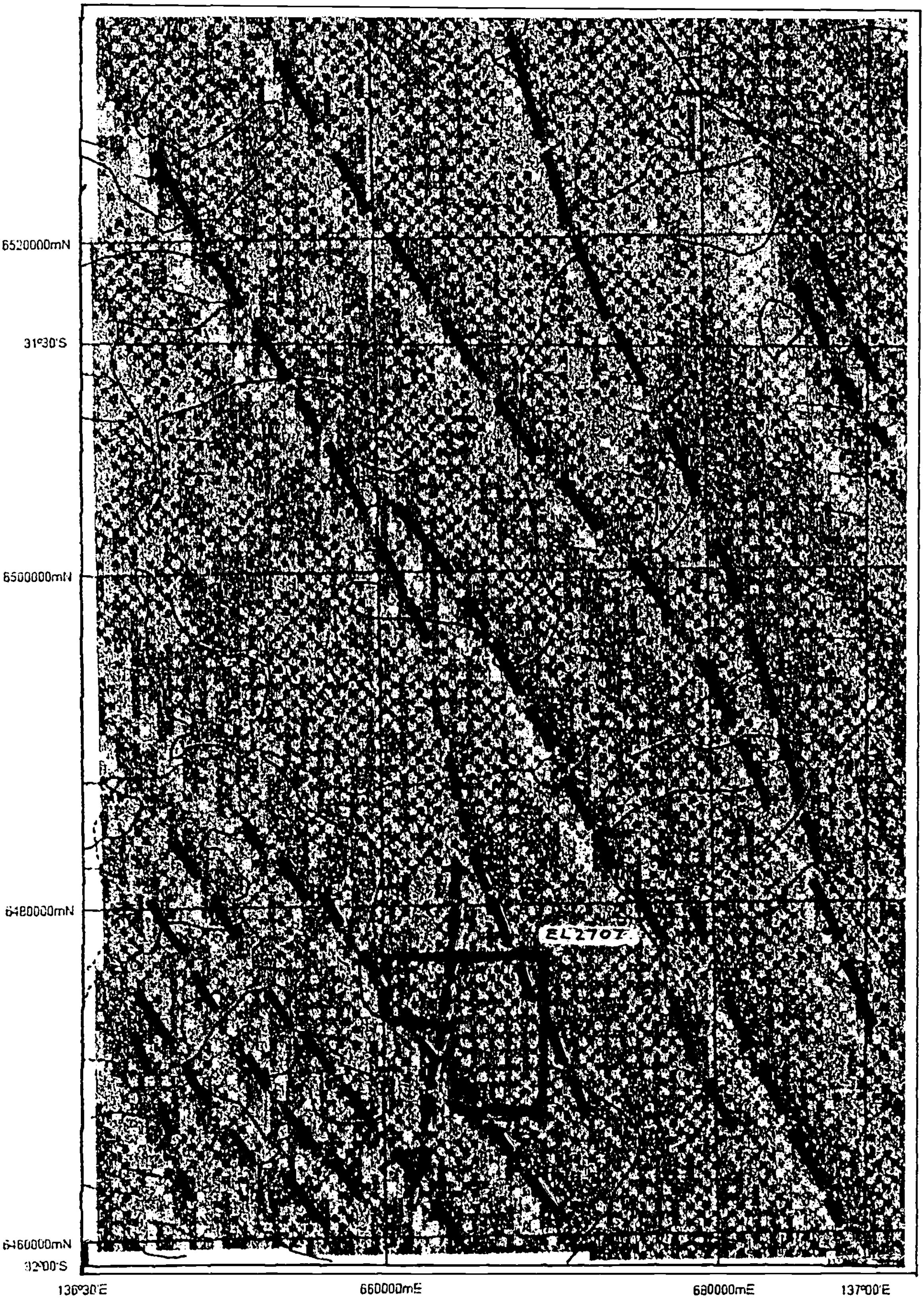


FIG. 2.



GAWLER EL2707
Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

FIG. 3.



PROJECT LOCATION

TUART RESOURCES

PROJECT: GAWLER CRATON EXPLORATION AREA
PROSPECT: STUART SHELF S.A.

MESA GIS & GEOPHYSICS

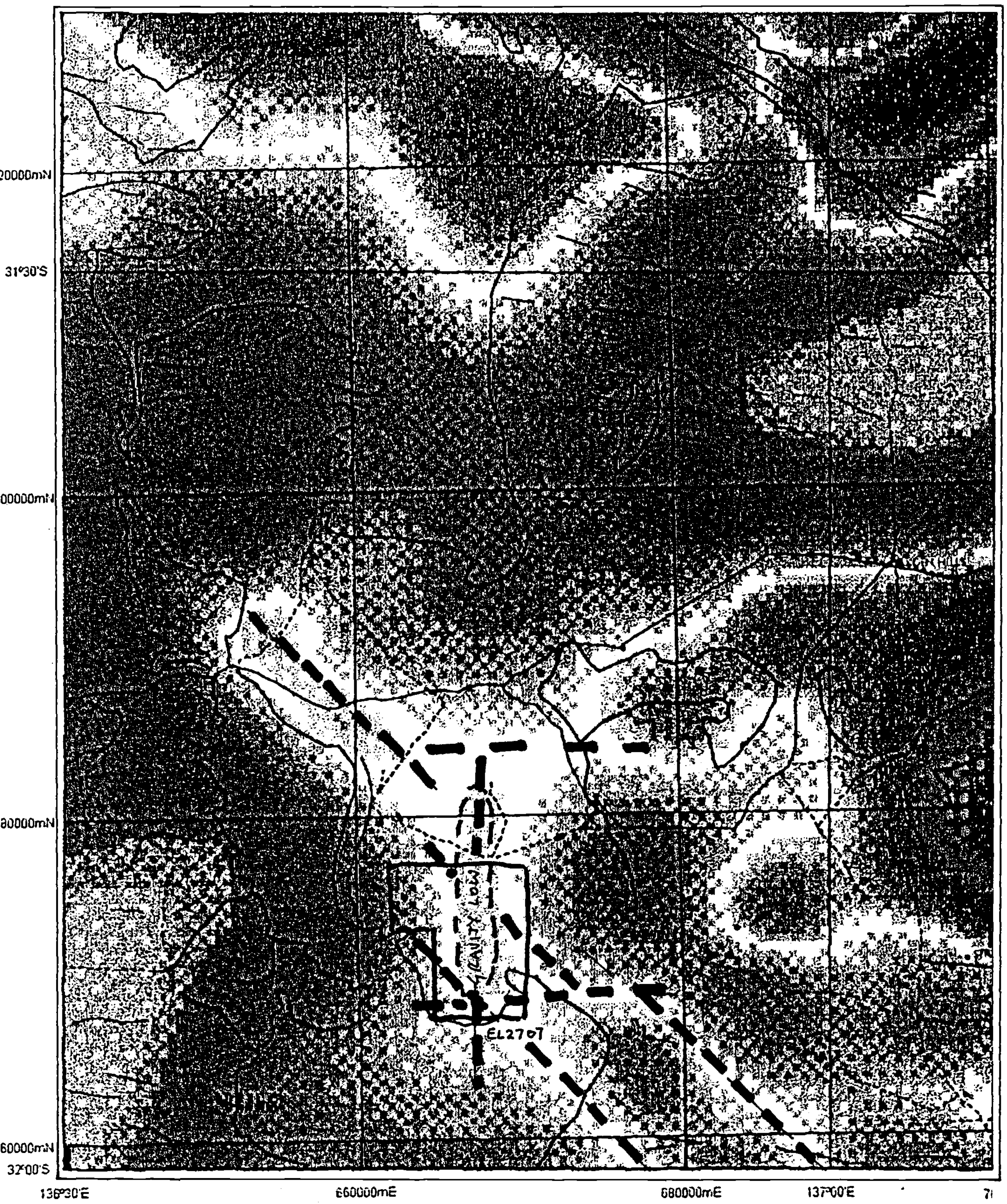
Airborne Magnetic Survey
EAST GRADIENT IMAGE
Grid Cell 500m

1 : 250,000
0 5 10 15 20 kilometres

250,000 Ref	ANDAMOOKA / TORRENS	100,000 Ref	
ORIGINATOR	L. Starkey	SCALE	1 : 250,000
Revision Date	DRAWN M.H.B.	PLATE No	
CAD INNOVATIONS			

NOTE
NW linears
N-S weak
structural
trend

FIG. 4



PROJECT LOCATION

TUART RESOURCES.

PROJECT. GAWLER CRATON EXPLORATION AREA

PROSPECT. STUART SHELF S.A.

MESA GIS & GEOPHYSICS

AGSO Regional Gravity Survey
FIRST RESIDUAL IMAGE
Average Depth 1.9km

1 : 250,000

0 5 10 15 20

250,000 Ref ANDAMOOKA / TORRENS

100,000 Ref

ORIGINATOR L. Starkey

SCALE 1 : 250,000

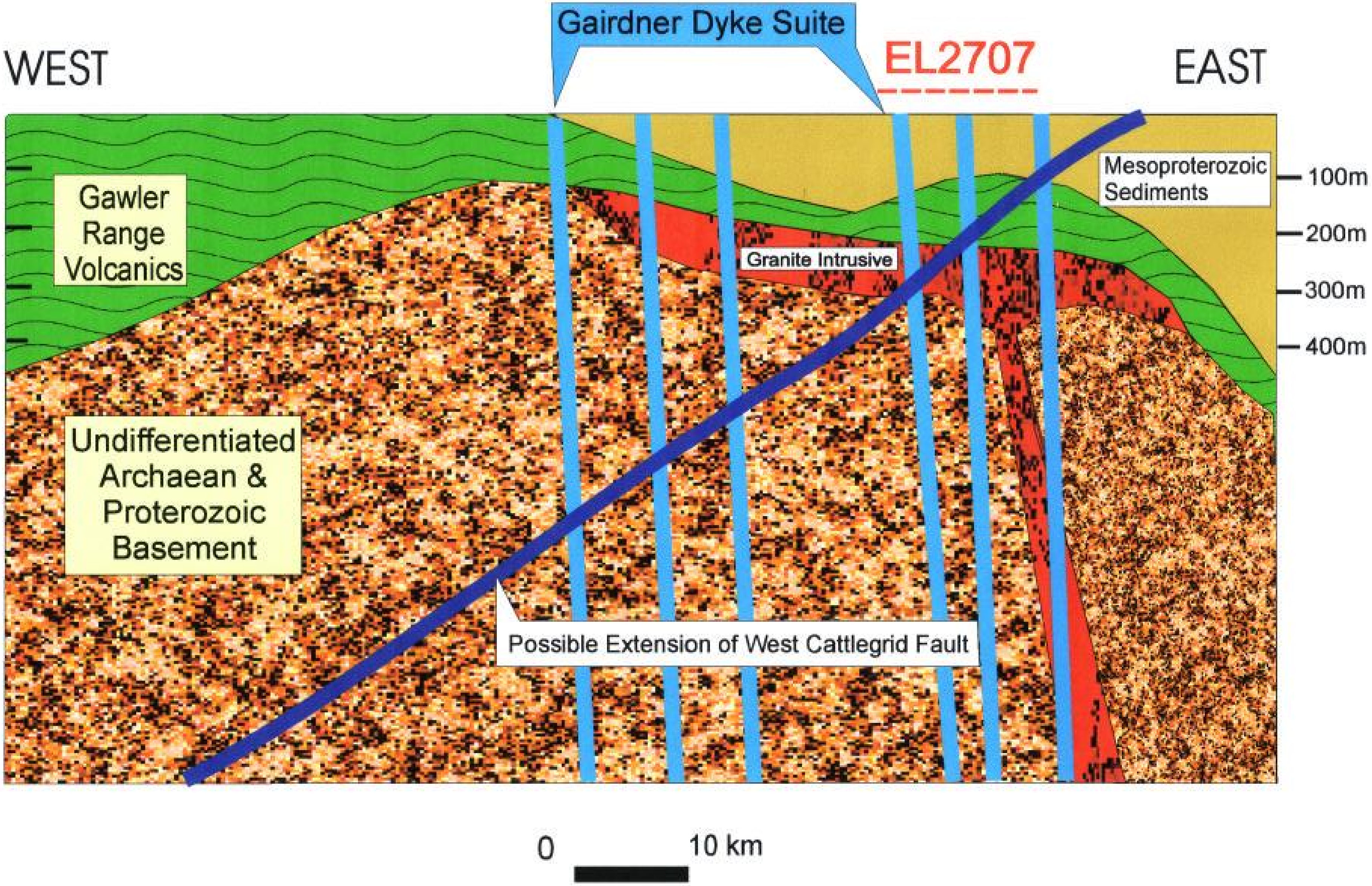
Revision Date

DRAWN M.H.B.

PLATE No

NOTE N-S trending gravity low through centre of tenement and regional NW trending gravity features

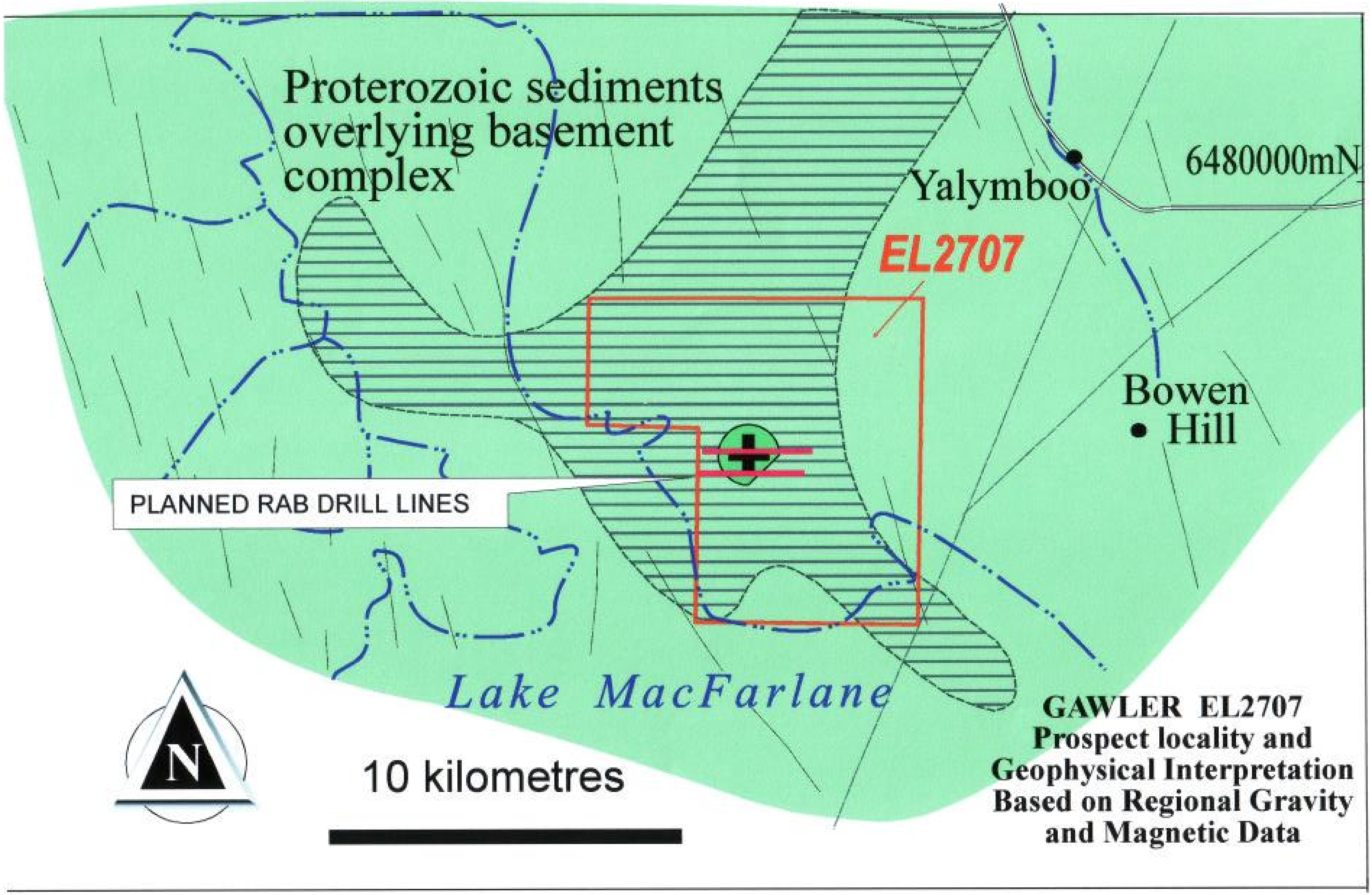
FIG. 5.



Schematic Cross Section of Geophysical Interpretation of EL2707

Interpretation by L.J.Starkey Drawn B.Davis. February 2002

FIG.6



GAWLER EL2707
Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

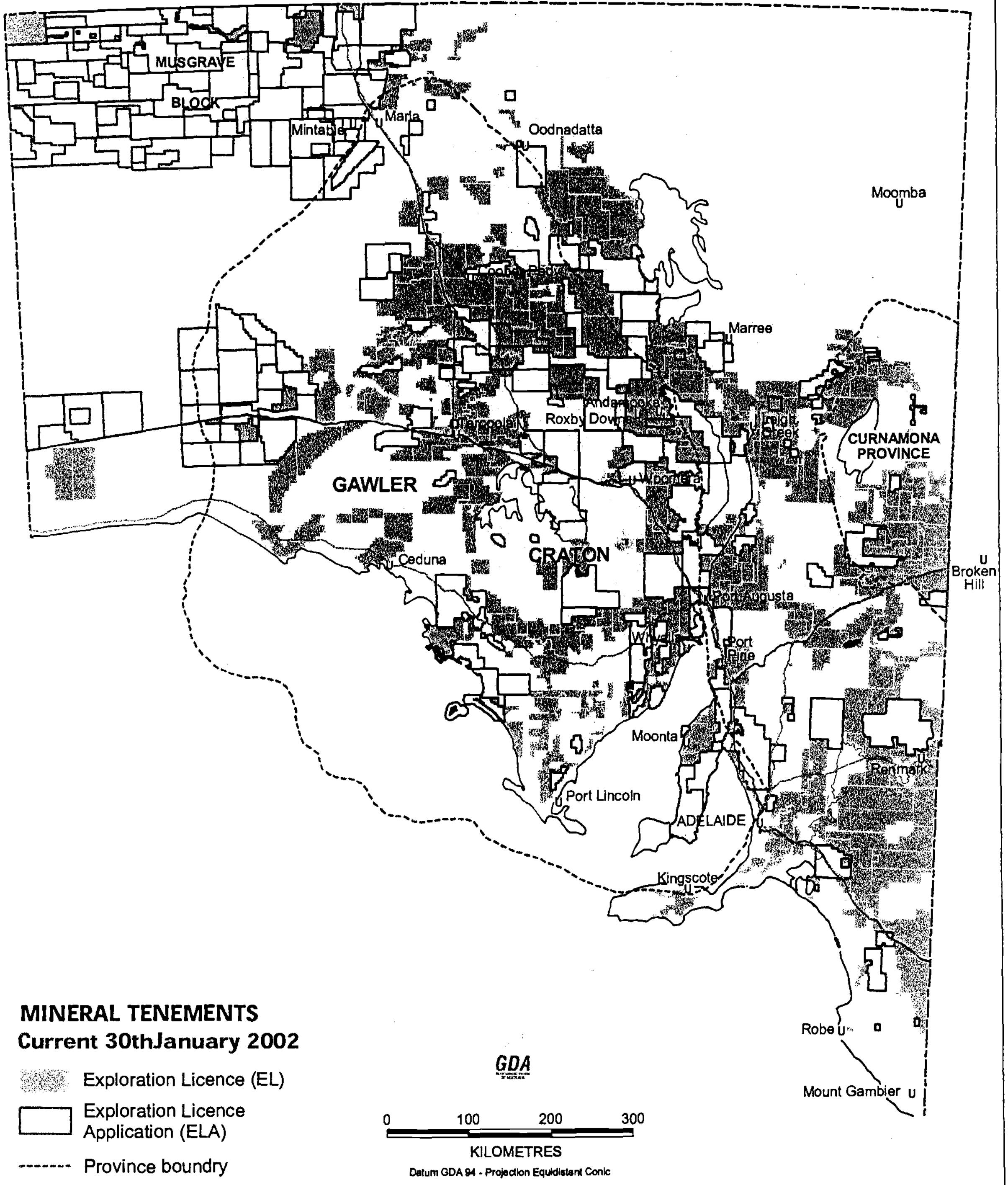
FIG. 7.

APPENDIX

Tenement maps

PRIMARY INDUSTRIES
AND RESOURCES SA

South Australia
MINERAL TENEMENTS



MINERAL TENEMENTS
Current 30thJanuary 2002

For information contact :

PIRSA - Minerals
101 Grenfell Street
Adelaide, South Australia 5000
GPO Box 1671
Adelaide SA 5001

Telephone : (08) 8463 3000
Facsimile : (08) 8463 3089
E-mail : pirsa.tenements@saugov.sa.gov.au
Internet : www.minerals.pir.sa.gov.au

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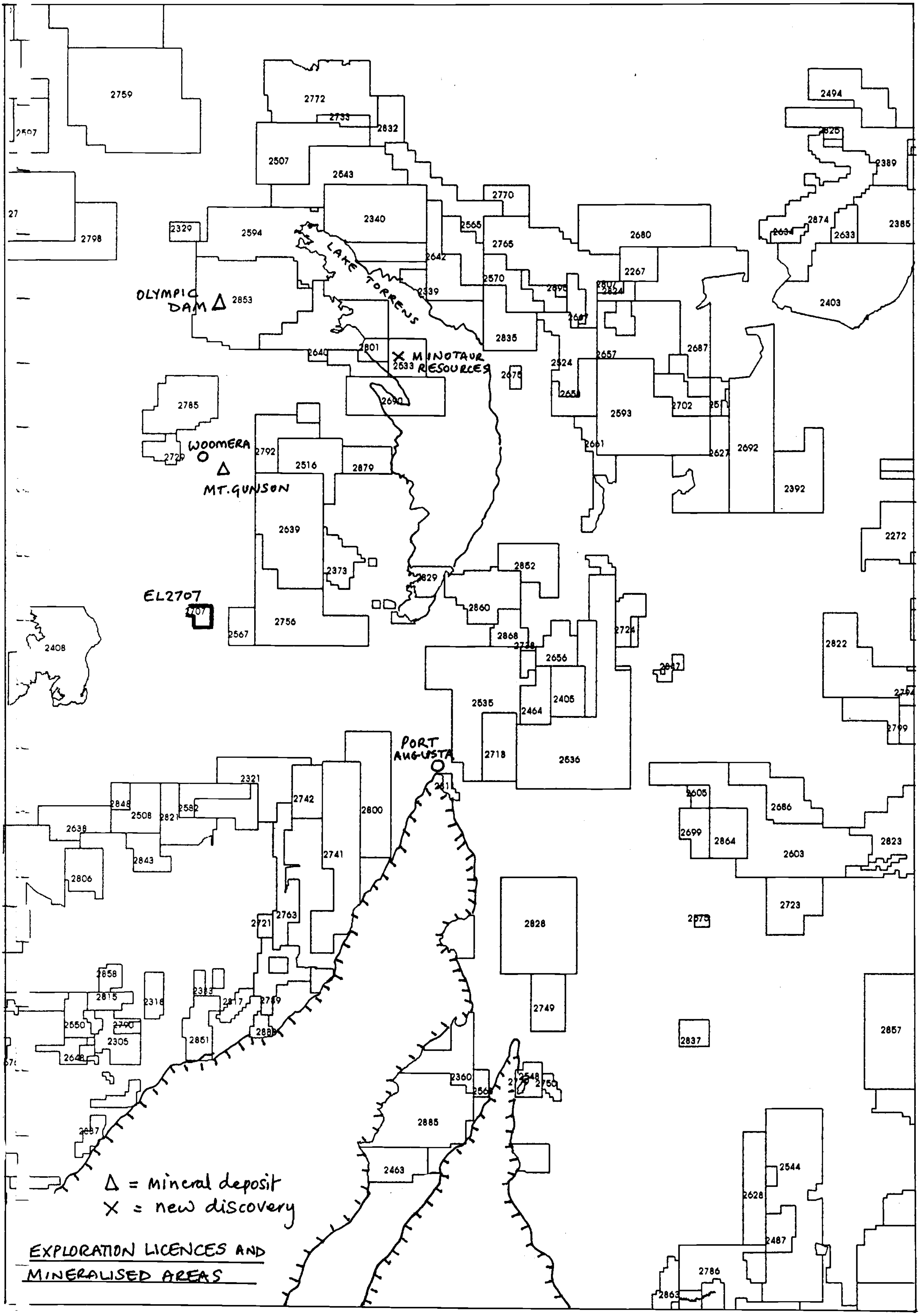


EXPLORATION LICENCES AND MINERALISED AREAS

Extract Resources Ltd
ABN 61 057 337 952

Ground Floor
47 Kishorn Road
Applecross, Western Australia, 6153
Australia

Telephone: + 61 8 9316 1214
Fax : + 61 8 9316 1274

29 April 2004

Mr George Kwitko
Primary Industries and Resources SA
GPO Box 1671
Adelaide SA 5001

RECEIVED
30 APR 2004

Dear George

Re: Annual Report for EL 2707

Please find enclosed a cd containing the Annual Report for Extract Resources Ltd on EL2707, Stuart Shelf, South Australia for the period ending 12 March 2004.

Also enclosed is one hard copy of the report.

If you have any questions, please do not hesitate to contact me on (08) 9420 9300.

Regards

pp Peter McIntyre

ANNUAL REPORT

FOR THE PERIOD
13th MARCH 2003 to 12th MARCH 2004

ON EL 2707, STUART SHELF, SOUTH AUSTRALIA

BY

EXTRACT RESOURCES LIMITED
LEVEL 1, 47 KISHORN RD
APPLECROSS WA 6153

ABSTRACT

Tuart Resources Ltd was placed into administration on 13 January. On 24 July 2003 the company completed a restructure and recapitalisation and was released from administration under the new name Extract Resources Limited (Extract). On 6th August 2003 Extract commenced trading on the ASX.

In August Extract entered into a joint venture agreement with MinRes Resources Inc by which MinRes can earn up to an 80% interest in the tenement through exploration expenditure.

A review of the previous investigations has been carried out. Previous investigations included reviews of published geological and geophysical data generated from the increased activity by exploration companies in this region in recent years. Areas such as the nearby Minotaur Resources Ltd tenements provided some information on the depth of cover, structural trends and geophysical target characteristics. In the light of this information our own data was re-assessed and targets redefined. Geochemical sampling, gravity surveys and exploratory drilling program have been planned to test the anomalous area.

1. Introduction

EL 2707 is located approximately 80 kilometres south of the township of Woomera. Access is via Oakden Hills track to Mahatewa. The area is located between Lake Finniss and Lake MacFarlane.

This is demonstrated on Figs.1 and 2.

2. Regional Geological Setting and Exploration Philosophy

The realisation that exploration could be successfully carried out in areas of prospective Proterozoic terrain overlain by relatively thick cover of Mesozoic sediments has led to a fundamental reappraisal of the prospectivity of other Proterozoic cratonic regions of South Australia by many companies. This was the criterion for tenement selection adopted by Tuart Resources Limited in its applications for Exploration Licences in South Australia.

The Company’s consultants have carried out detailed geological and geophysical investigations to identify major geological dislocation and structural lineaments in the various accessible parts of Proterozoic cratons that could act as loci for mineralizing events.

The principal style of mineralisation discovered to date has been Olympic Dam style gold-uranium-base metal mineralisation. However, the similarity of this area with other areas of Archaean Shield suggests the Gawler Craton is prospective for copper-nickel mineralisation in ultramafic rocks, platinum-chromium in layered mafic-ultramafic complexes and copper-lead-zinc in acid volcanic sequences.

Much of the Gawler Craton is covered by a relatively thin veneer of Cainozoic detrital sediments. However, with the knowledge that significant deposits may be detected below this cover, this situation has changed dramatically with major programs being mounted across the whole of the Craton using state of the art geophysical magnetic and gravity surveys.

The Gawler Project tenement EL2707 is located on the southern extension of the Stuart Shelf.

3. Previous Exploration

Although the Licence area has been held under part of various larger tenements in the past, there has been no systematic exploration on the ground within the current holding.

4. Recent Exploration

Tuart conducted regional and local magnetic and gravity data interpretation on EL2707. The results of this work are depicted in the Annual Report of March 13 to March 12 2001.

The regional geophysical data shows several features of significance:

- A circular magnetic high located on the western part of EL 2707 (see Fig.3);
- A NE trending broad correlation zone between high gravity and magnetic anomalies;
- A weakly developed, but significant N-S structural trend through the western side of the tenement (from Airborne Magnetics — East Gradient image). See Fig.4.
- A strongly developed N-S gravity low through the center of the tenement. (See Fig.5.)

4.1 Geology — EL 2707

Olympic Dam Style Iron-Oxide Copper-Gold Mineralisation

The location of the tenement on the northeastern margin of the Gawler Craton gives potential for this style of mineralisation beneath the Mesozoic cover. Major NNW trending structures defined by gravity and magnetics passes through the tenement and provides specific targets for exploration. Major regional easterly trending magnetic-gravity lineaments are potential areas where there may be emplacement of the Hiltaba Suite Granites; the host for Olympic Dam style mineralisation.

The presence of a major north-northeast trending structure suggests potential for this style of mineralisation within EL2707. However, much of the prospective Proterozoic basement is inaccessible due to the thickness of Phanerozoic sediments overlying the basement. Structural highs in the basement, probably associated with block faulting within structural corridors offer the most plausible sites for exploration.

A review of the regional AGSO Stuart Shelf drilling carried out to the north of the tenement was undertaken by G. Bravo, Consultant Geologist, in 2001 (Appendix 1 of 2001 Annual Report). This work highlighted the presence of a fracture zone containing hydrothermal alteration. These fractures could represent significant targets for exploration since they may well be the main conduits for hydrothermal fluid flow in the area.

4.2 Geophysics

Fugro, on behalf of AGSO, have conducted tempest surveys of Moorta and Tarcoola districts. Information from the traverse connecting the two areas has been compared to regional gravity and magnetic data. The results were presented in the March 2000 to March 2001 Annual Report.

The survey indicated that to the west of EL 2707 high conductivity is associated with the east-west dyke fracture system. Areas for further exploration by shallow drilling can be located where these fractures intersect NNW-NNE lineaments within the tenement.

5.0 Year 2003 Activities

The principal activities concerning the tenement consisted of

1. Review of existing geological and geophysical data
2. Defining more closely the target areas from the assessment of the geophysical/geological model for the tenement area.
3. Entering into a Farm-in Agreement with MinRes Resources Inc.
4. Planning of exploration activities expected to commence in April.

5.1 Geological Model and Section

The proposed geological model for tenement EL2707 is presented as Figure 3. The Gawler Range Volcanics form the basement to the Pandurra formation and the Stuart Shelf sequence of sediments. Combined magnetic and gravity lineaments intersect within EL2707 as displayed in the map on Figure 3.

South Australian Gravity Survey data has been modeled to provide a detailed gravity interpreted section to assist in targeting.

This cross-section, based on the known geophysical and geological information is shown on Fig. 6.

On the section there appears to be an upwelling of the basement, probably occupied by a granitoid intrusion. This feature is coincident with a Gairdner Dyke Swarm and is also traversed by a major structural discontinuity that is a possible extension to the West Cattlegrid Fault.

All of these features are potential carriers of hydrothermal fluids into the area.

6.0 Conclusions and Recommendations

- Recent geophysical modeling has indicated that beneath the cover rocks on EL2707 there are significant magnetic and gravity anomalies present.
- Recent drilling results from exploration companies with nearby tenements provide good encouragement for the discovery of IOCG deposits similar to those hosted by Hiltaba suite granite breccias of Olympic Dam.
- Detailed gravity survey over entire tenement at 500m x 500m centres with infill over anomalies generated at 100m x 100m centres.
- Reconnaissance calcrete geochemical sampling at 800m x 400m spacing to be analysed for gold and a suite of base metals.

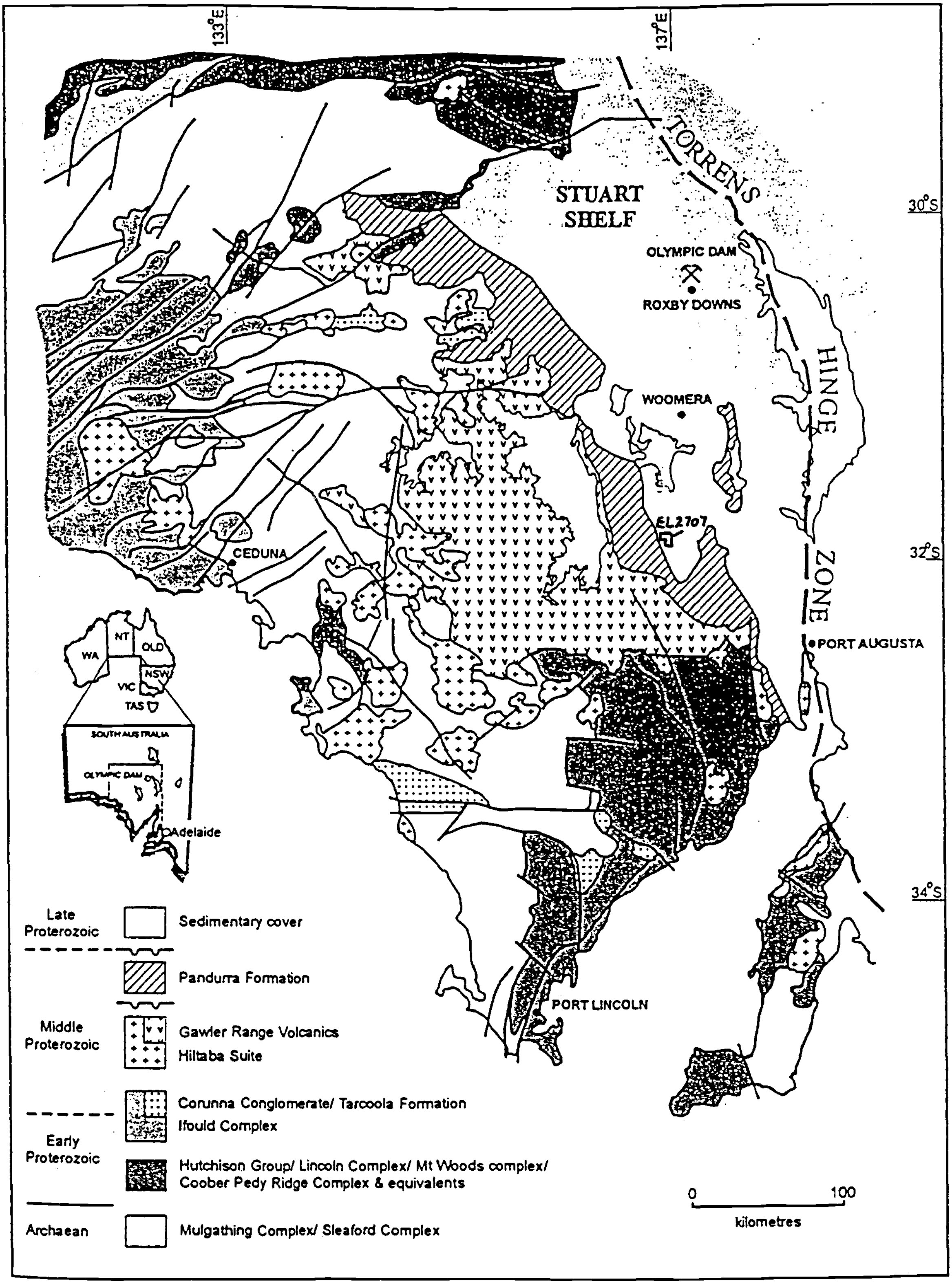


Figure 1. Interpreted subsurface geology at the Gawler Craton (modified from Daly et al, 1998).

TENEMENT LOCATION MAP

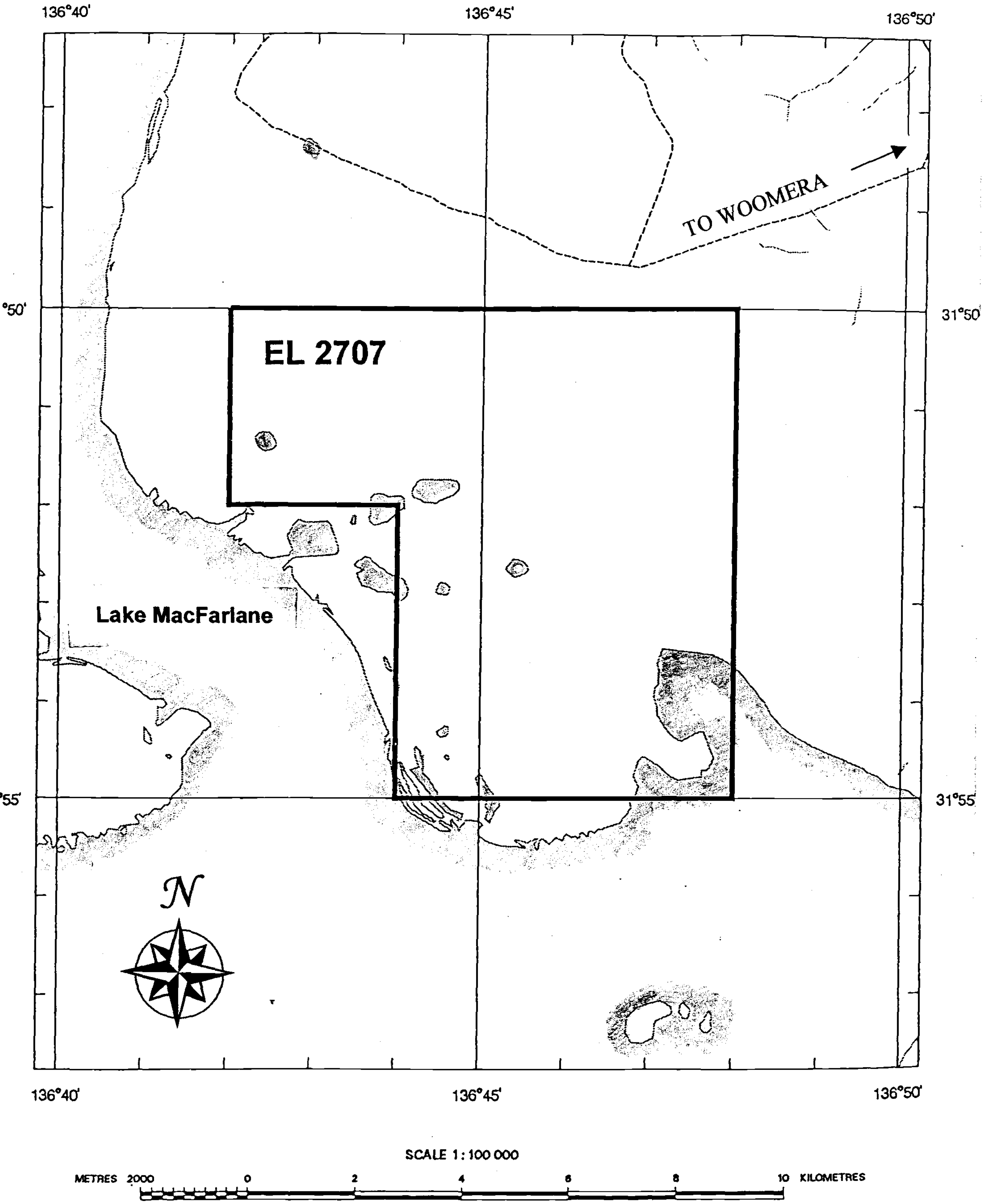
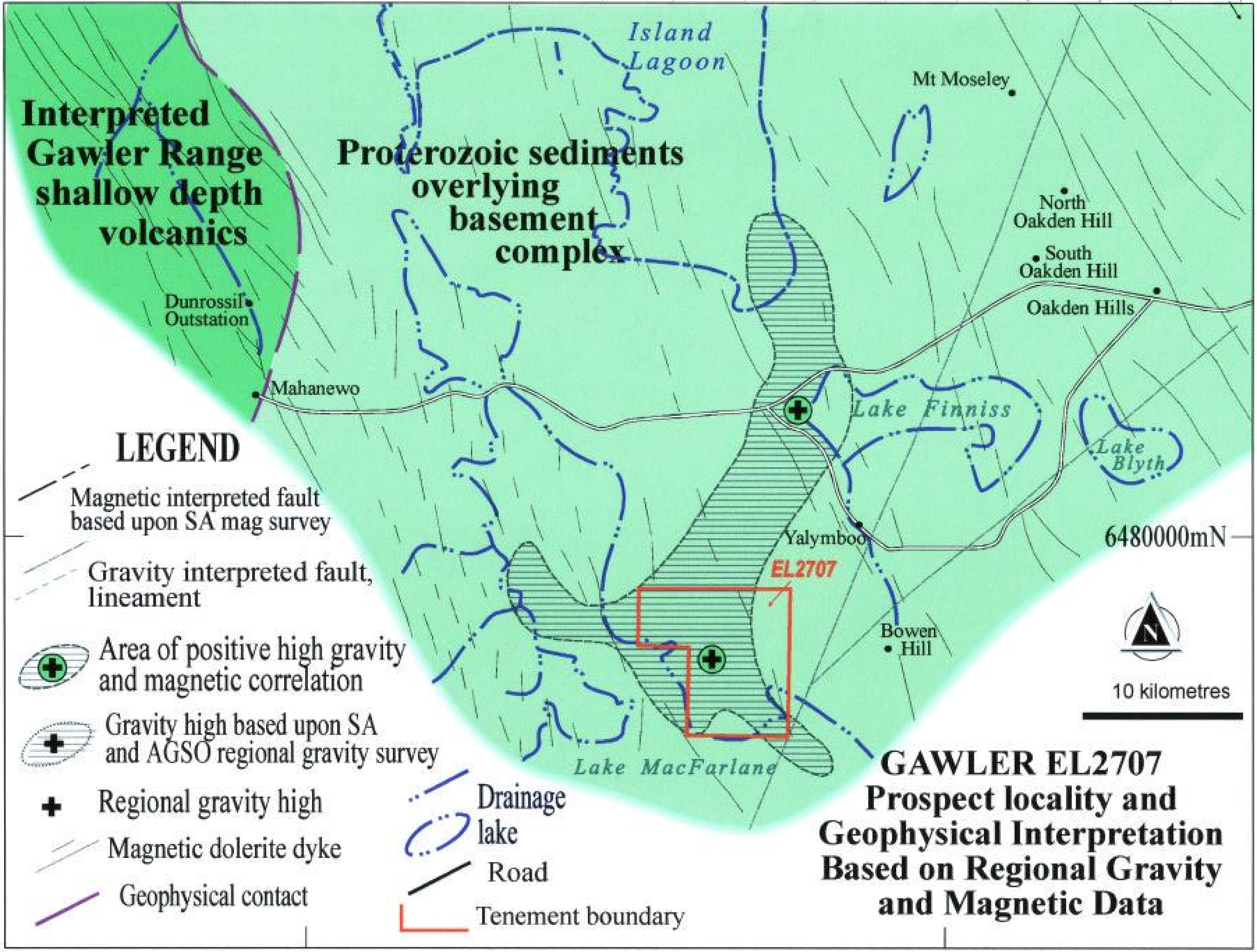
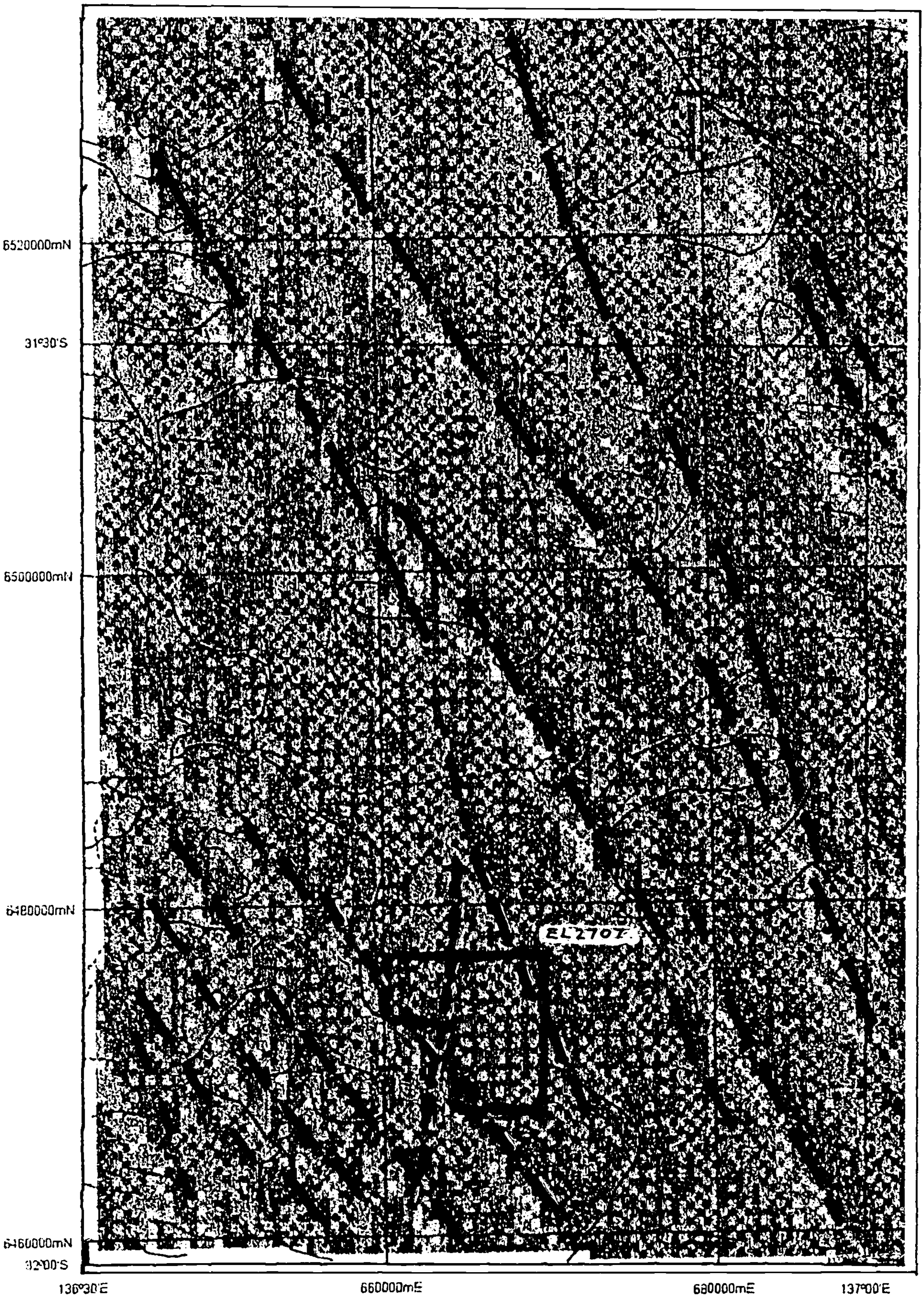


FIG. 2.



GAWLER EL2707 Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

FIG.3.



PROJECT LOCATION

TUART RESOURCES

PROJECT. **GAWLER CRATON EXPLORATION AREA**
PROSPECT: **STUART SHELF** S.A.

MESA GIS & GEOPHYSICS

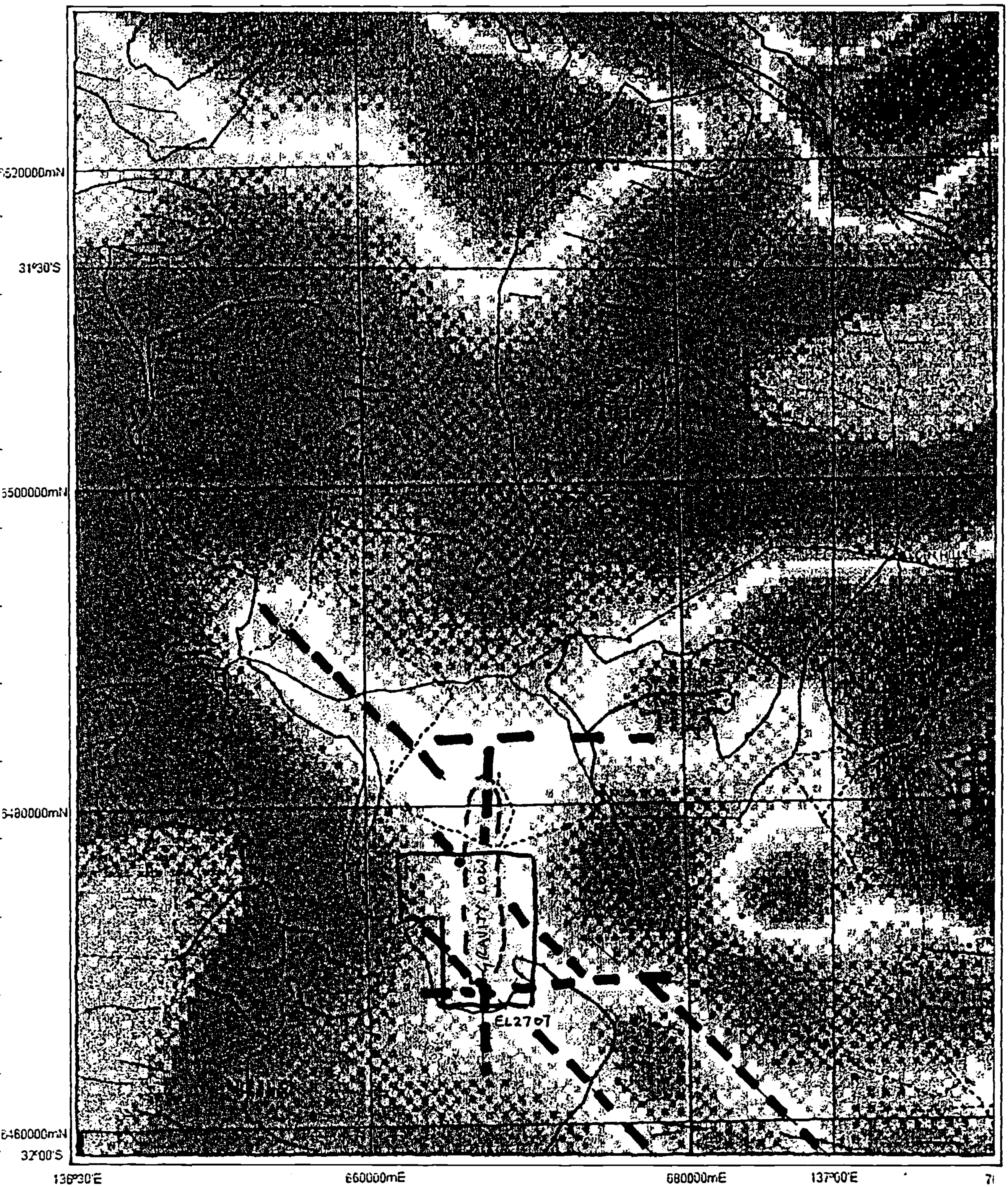
Airborne Magnetic Survey
EAST GRADIENT IMAGE
Grid Cell 500m

1 : 250,000
0 5 10 15 20 kilometres

250,000 Ref ANDAMOOKA / TORRENS
100,000 Ref
ORIGINATOR L. Starkey
SCALE 1 : 250,000
Revision Date
DRAWN M.H.B.
PLATE No
CAD INNOVATIONS

NOTE
NW linears
N-S weak
structural
trend

FIG. 4



PROJECT LOCATION

TUART RESOURCES.

PROJECT. GAWLER CRATON EXPLORATION AREA
PROSPECT. STUART SHELF S.A.

MESA GIS & GEOPHYSICS

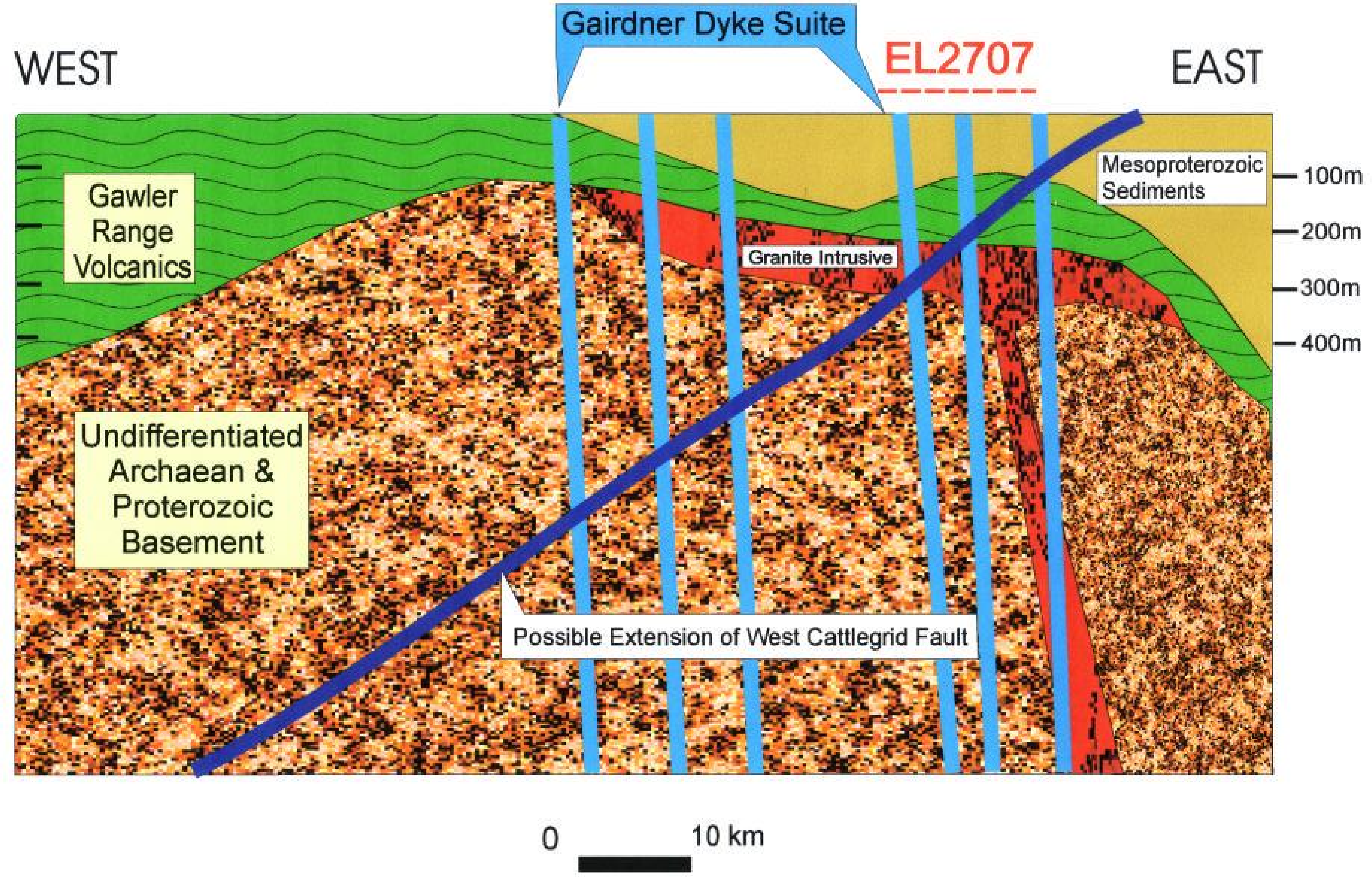
AGSO Regional Gravity Survey
FIRST RESIDUAL IMAGE
Average Depth 1.9km

1 250,000
0 5 10 15 20 kilometres

250,000 Ref ANDAMOOKA / TORRENS
100,000 Ref
ORIGINATOR L. Starkey
SCALE 1 : 250,00
Revision Date DRAWN M.H.B.
PLATE No

NOTE N-S trending gravity low through centre of tenement and regional NW trending gravity features

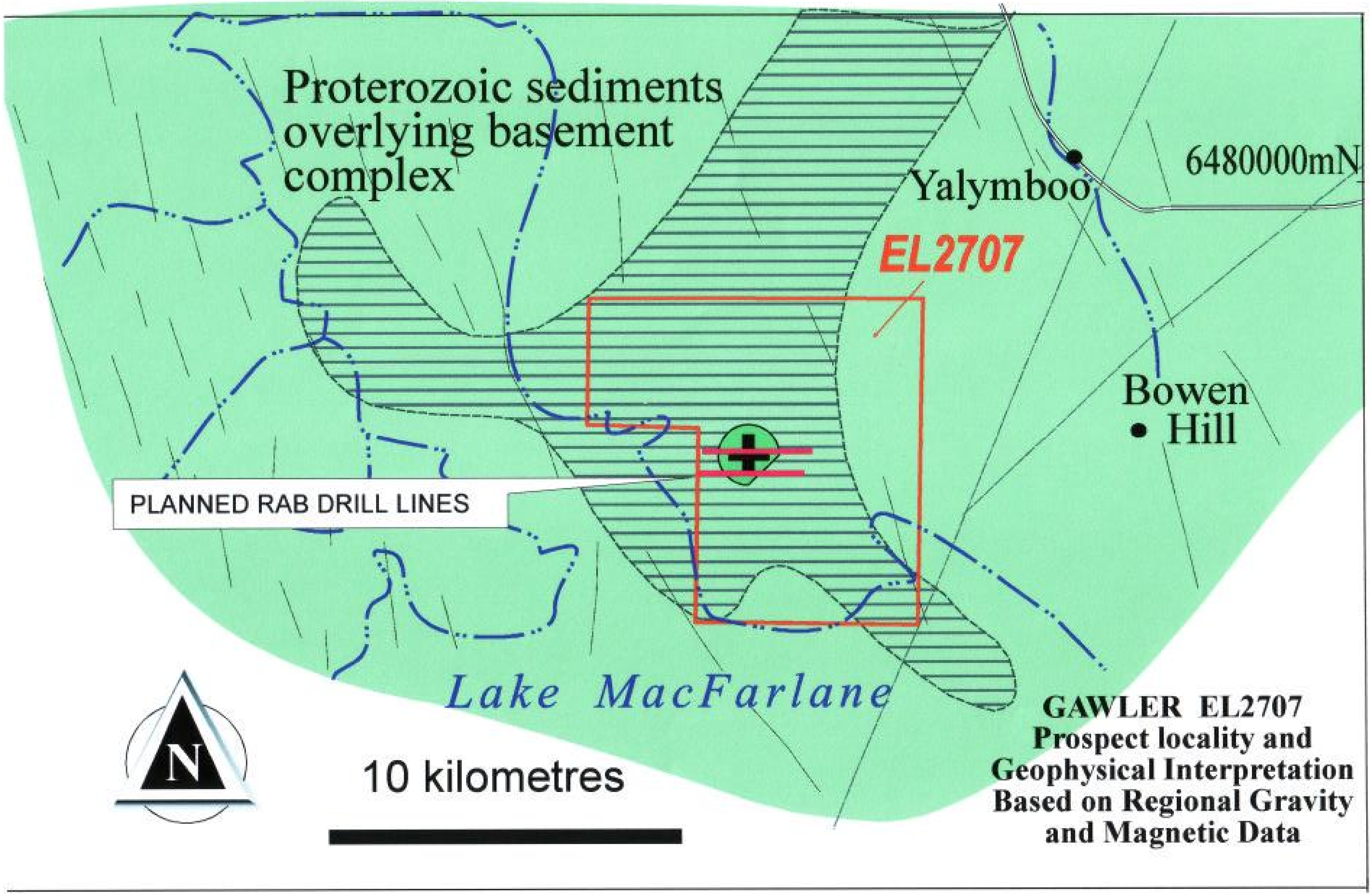
FIG. 5.



Schematic Cross Section of Geophysical Interpretation of EL2707

Interpretation by L.J.Starkey Drawn B.Davis. February 2002

FIG.6



GAWLER EL2707
Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

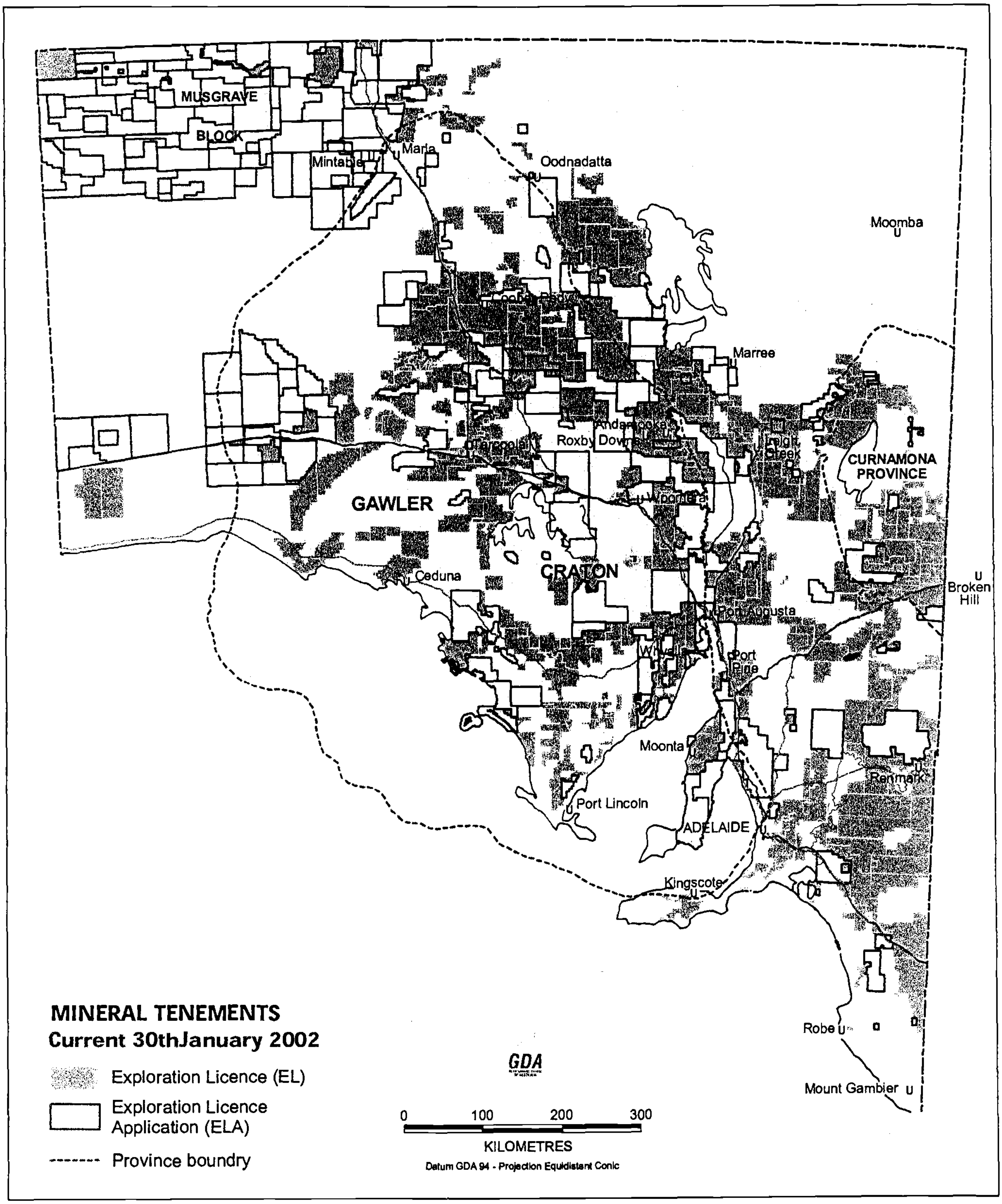
FIG.7.

APPENDIX

Tenement maps

PRIMARY INDUSTRIES
AND RESOURCES SA

South Australia
MINERAL TENEMENTS



MINERAL TENEMENTS
Current 30thJanuary 2002

For information contact :

PIRSA - Minerals
101 Grenfell Street
Adelaide, South Australia 5000
GPO Box 1671
Adelaide SA 5001

Telephone : (08) 8463 3000
Facsimile : (08) 8463 3089
E-mail : pirsa.tenements@saugov.sa.gov.au
Internet : www.minerals.pir.sa.gov.au

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of South Australia

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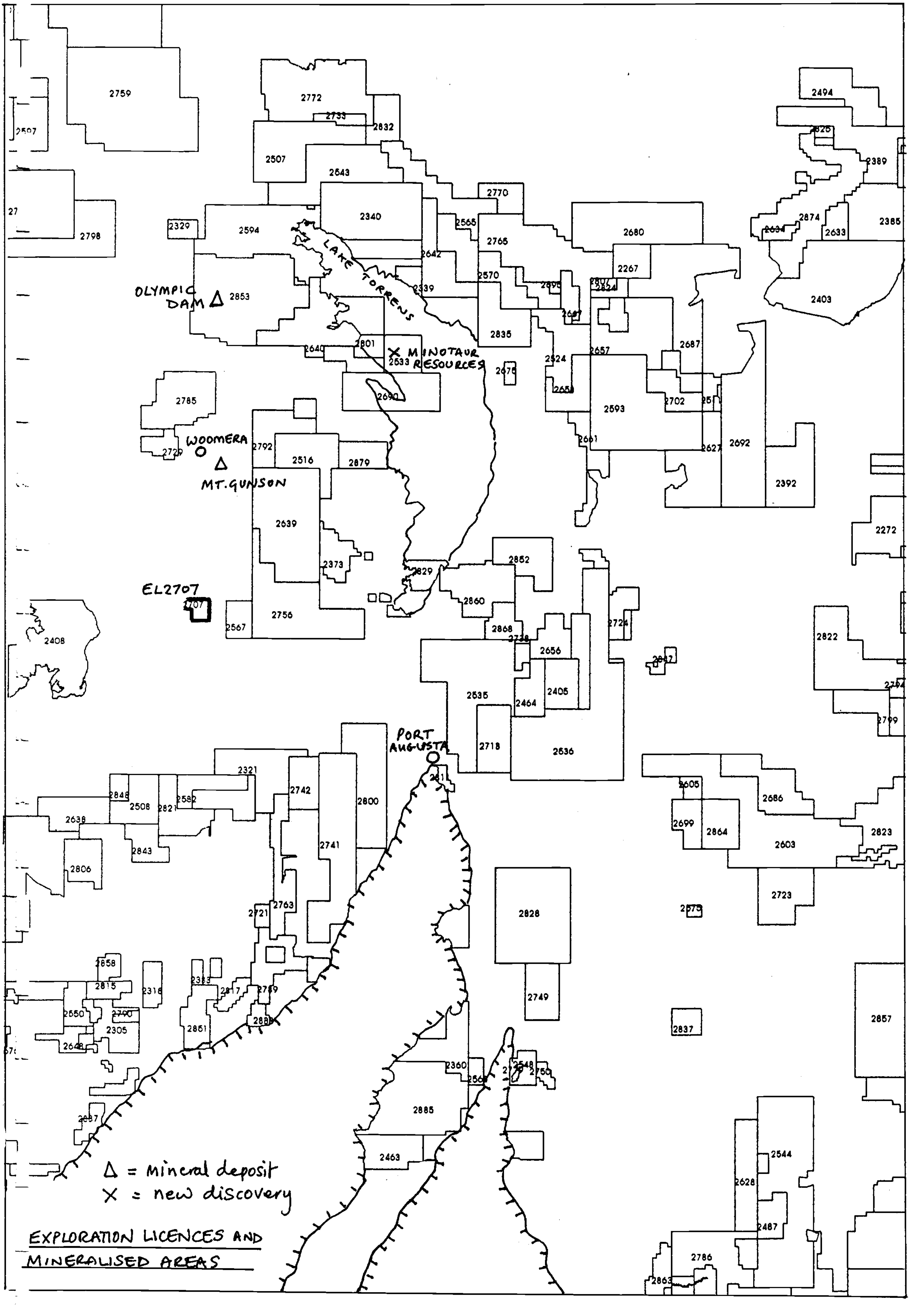


EXPLORATION LICENCES AND MINERALISED AREAS

James Pratt
c/- Extract Resources Limited
PO Box 1246
CANNING BRIDGE WA
6153

6 April 2005

Sue Watson
Deputy Mining Registrar
PIRSA
Gpo Box 1671
Adelaide SA 5001

Dear Sue,

On behalf of Extract Resources Limited please find enclosed a CD containing the final Annual Technical Report and final 6 monthly Summary Report for EL 2707.

Kind Regards
James Pratt

OFFICE OF MINERALS & ENERGY
RESOURCES [illegible]
TENEMENTS
RECEIVED
- 8 APR 2005

ANNUAL REPORT

FOR THE PERIOD
13th MARCH 2004 to 12th MARCH 2005

ON EL 2707, STUART SHELF, SOUTH AUSTRALIA

BY

EXTRACT RESOURCES LIMITED
LEVEL 1, 47 KISHORN RD
APPLECROSS WA 6153

ABSTRACT

During April 2004 MinRes Resources Inc (MinRes), under the terms of a farm-in agreement with Extract Resources Limited (Extract), the holder of the tenement, undertook exploration activities at the Lake Finniss Project consisting of a gravity survey to cover the entire property on 500m x 500m centres. The results of the survey revealed a 0.8mgal gravity anomaly in the northeast corner of the tenement.

Subsequent to this work MinRes entered into a transaction with Geoinformatics Explorations Limited (Geoinformatics) under which the management of Geoinformatics took over management of MinRes. The new management have reviewed the work done to date on EL2707 and elected to withdraw from the farm-in agreement.

1. Introduction

EL 2707 is located approximately 80 kilometres south of the township of Woomera. Access is via Oakden Hills track to Mahatewa. The area is located between Lake Finniss and Lake MacFarlane.

This is demonstrated on Figs.1 and 2.

2. Regional Geological Setting and Exploration Philosophy

The realisation that exploration could be successfully carried out in areas of prospective Proterozoic terrain overlain by relatively thick cover of Mesozoic sediments has led to a fundamental reappraisal of the prospectivity of other Proterozoic cratonic regions of South Australia by many companies. This was the criterion for tenement selection adopted by Tuart Resources Limited in its applications for Exploration Licences in South Australia.

The Company’s consultants have carried out detailed geological and geophysical investigations to identify major geological dislocation and structural lineaments in the various accessible parts of Proterozoic cratons that could act as loci for mineralizing events.

The principal style of mineralisation discovered to date has been Olympic Dam style gold-uranium-base metal mineralisation. However, the similarity of this area with other areas of Archaean Shield suggests the Gawler Craton is prospective for copper-nickel mineralisation in ultramafic rocks, platinum-chromium in layered mafic-ultramafic complexes and copper-lead-zinc in acid volcanic sequences.

The Gawler Project tenement EL2707 is located on the southern extension of the Stuart Shelf.

3. Previous Exploration

Although the Licence area has been held under part of various larger tenements in the past, there has been no systematic exploration on the ground within the current holding.

4. Recent Exploration

Tuart conducted regional and local magnetic and gravity data interpretation on EL2707. The results of this work are depicted in the Annual Report of March 13 to March 12 2001.

The regional geophysical data shows several features of significance:

- A circular magnetic high located on the western part of EL 2707 (see Fig.3);
- A NE trending broad correlation zone between high gravity and magnetic anomalies;
- A weakly developed, but significant N-S structural trend through the western side of the tenement (from Airborne Magnetics — East Gradient image). See Fig.4.
- A strongly developed N-S gravity low through the center of the tenement. (See Fig.5.)

During April 2004 MinRes Resources Inc (MinRes), under the terms of a farm-in agreement with Extract Resources Limited (Extract), the holder of the tenement, undertook exploration activities consisting of a gravity survey to cover the entire property on 500m x 500m centres. The results of the survey revealed a 0.8mgal gravity anomaly in the northeast corner of the tenement.

A report on the results of the survey are attached as Appendix 2.

4.1 Geology — EL 2707

Olympic Dam Style Iron-Oxide Copper-Gold Mineralisation

The location of the tenement on the northeastern margin of the Gawler Craton gives potential for this style of mineralisation beneath the Mesozoic cover. Major NNW trending structures defined by gravity and magnetics passes through the tenement and provides specific targets for exploration. Major regional easterly trending magnetic-gravity lineaments are potential areas where there may be emplacement of the Hiltaba Suite Granites; the host for Olympic Dam style mineralisation.

The presence of a major north-northeast trending structure suggests potential for this style of mineralisation within EL2707. However, much of the prospective Proterozoic basement is inaccessible due to the thickness of Phanerozoic sediments overlying the basement. Structural highs in the basement, probably associated with block faulting within structural corridors offer the most plausible sites for exploration.

A review of the regional AGSO Stuart Shelf drilling carried out to the north of the tenement was undertaken by G. Bravo, Consultant Geologist, in 2001 (Appendix 2 of

2001 Annual Report). This work highlighted the presence of a fracture zone containing hydrothermal alteration. These fractures could represent significant targets for exploration since they may well be the main conduits for hydrothermal fluid flow in the area.

4.2 Geophysics

Fugro, on behalf of AGSO, have conducted tempest surveys of Moorta and Tarcoola districts. Information from the traverse connecting the two areas has been compared to regional gravity and magnetic data. The results were presented in the March 2000 to March 2001 Annual Report.

The survey indicated that to the west of EL 2707 high conductivity is associated with the east-west dyke fracture system. Areas for further exploration by shallow drilling can be located where these fractures intersect NNW-NNE lineaments within the tenement.

5.0 Year 2004 Activities

During April 2004 MinRes Resources Inc (MinRes), under the terms of a farm-in agreement with Extract Resources Limited (Extract), the holder of the tenement, undertook exploration activities consisting of a gravity survey to cover the entire property on 500m x 500m centres. The results of the survey revealed a 0.8mgal gravity anomaly in the northeast corner of the tenement. The results of the survey are provided in a report attached as Appendix 2.

Subsequent to this work MinRes, the manager of the project, entered into a transaction with Geoinformatics Explorations Limited (Geoinformatics) under which the management of Geoinformatics took over the management of MinRes. The new management have reviewed the work done to date on EL2707 and elected to withdraw from the farm-in agreement.

5.1 Geological Model and Section

The proposed geological model for tenement EL2707 is presented as Figure 3. The Gawler Range Volcanics form the basement to the Pandurra formation and the Stuart Shelf sequence of sediments. Combined magnetic and gravity lineaments intersect within EL2707 as displayed in the map on Figure 3.

South Australian Gravity Survey data has been modeled to provide a detailed gravity interpreted section to assist in targeting.

This cross-section, based on the known geophysical and geological information is shown on Fig. 6.

On the section there appears to be an upwelling of the basement, probably occupied by a granitoid intrusion. This feature is coincident with a Gairdner Dyke Swarm and is also traversed by a major structural discontinuity that is a possible extension to the West Cattlegrid Fault.

All of these features are potential carriers of hydrothermal fluids into the area.

6.0 Conclusions and Recommendations

- Geophysical modeling has indicated that beneath the cover rocks on EL2707 there are significant magnetic and gravity anomalies present.
- Recent drilling results from exploration companies with nearby tenements provide good encouragement for the discovery of IOCG deposits similar to those hosted by Hiltaba suite granite breccias of Olympic Dam.
- Detailed gravity survey over entire tenement at 500m x 500m centres highlighted a 0.8mgal gravity anomaly in the northeast corner of the tenement.

The results of the exploration undertaken did not provide sufficient encouragement for the new management of MinRes to continue with the farm-in agreement. As the project is no longer core to Extract’s business the company has elected to allow the tenements to expire.

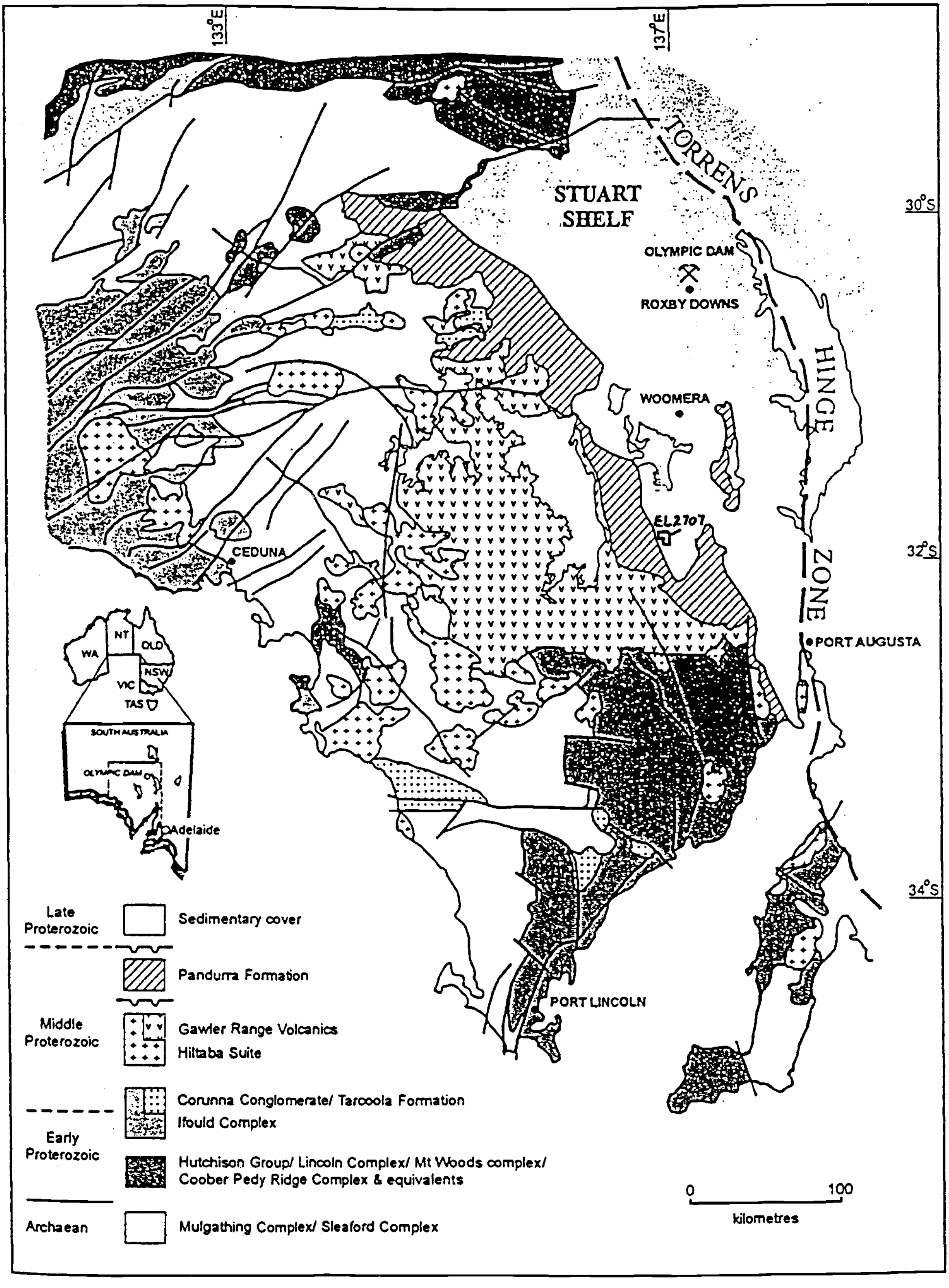


Figure 1. Interpreted subsurface geology at the Gawler Craton (modified from Daly et al, 1998).

TENEMENT LOCATION MAP

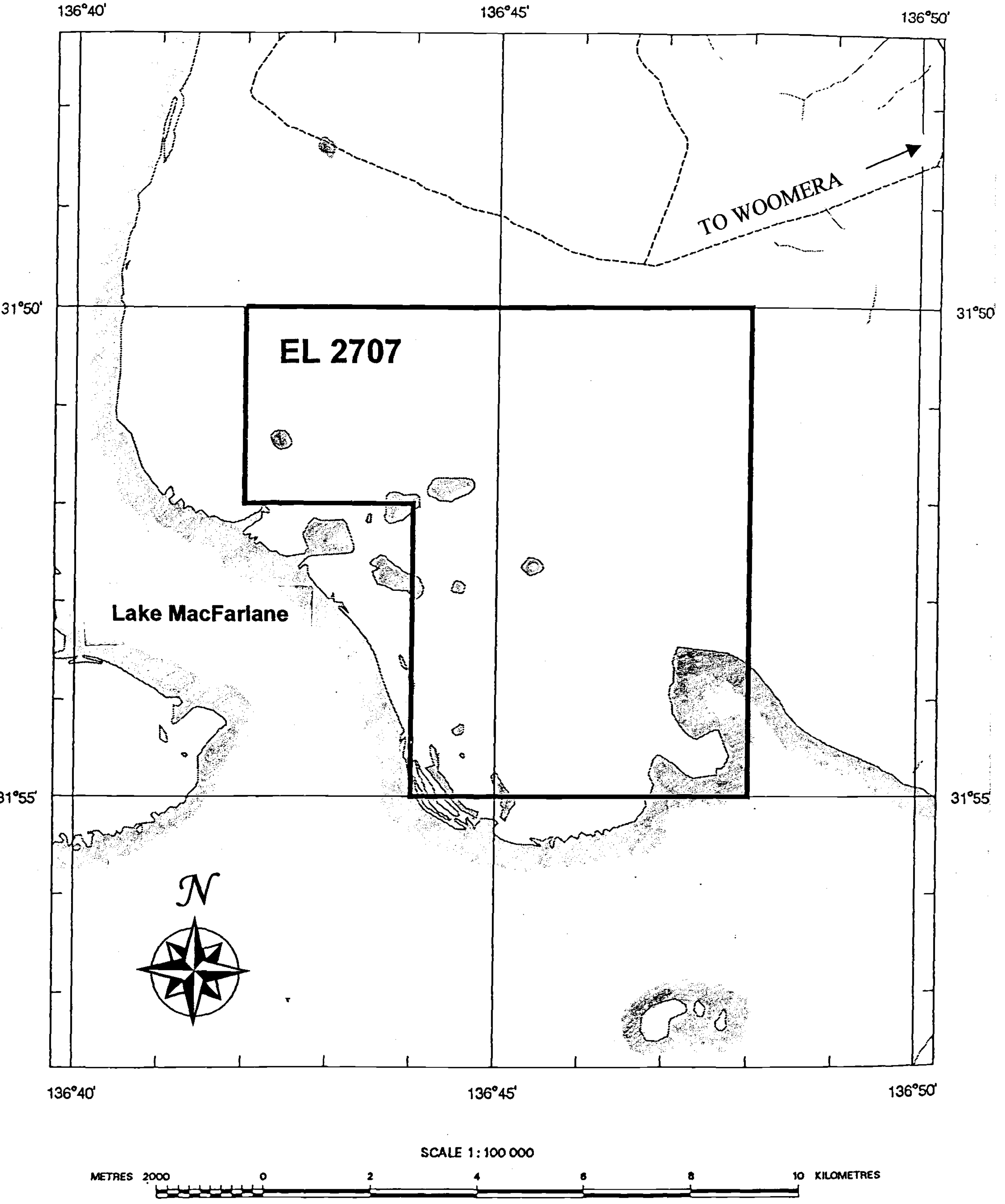
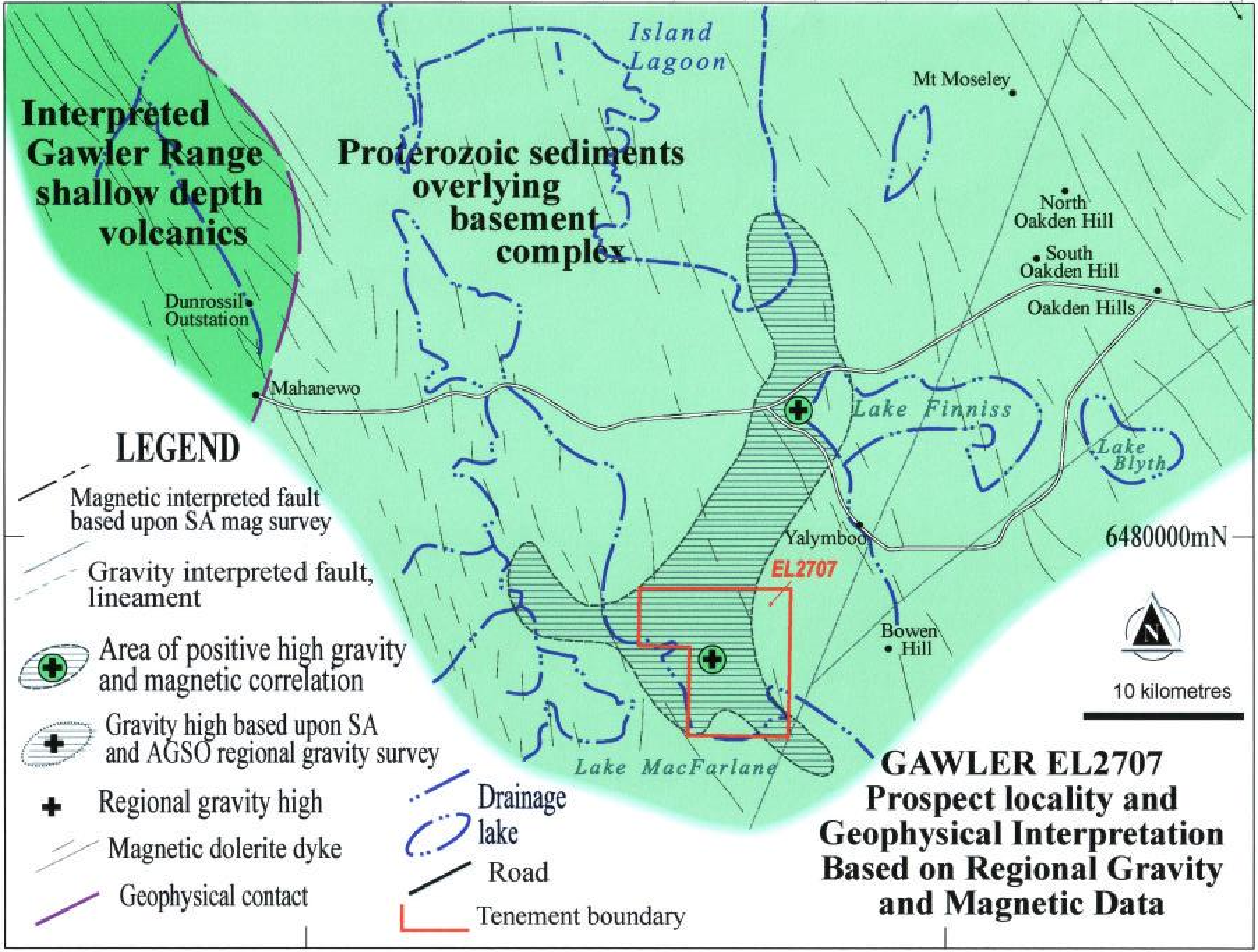
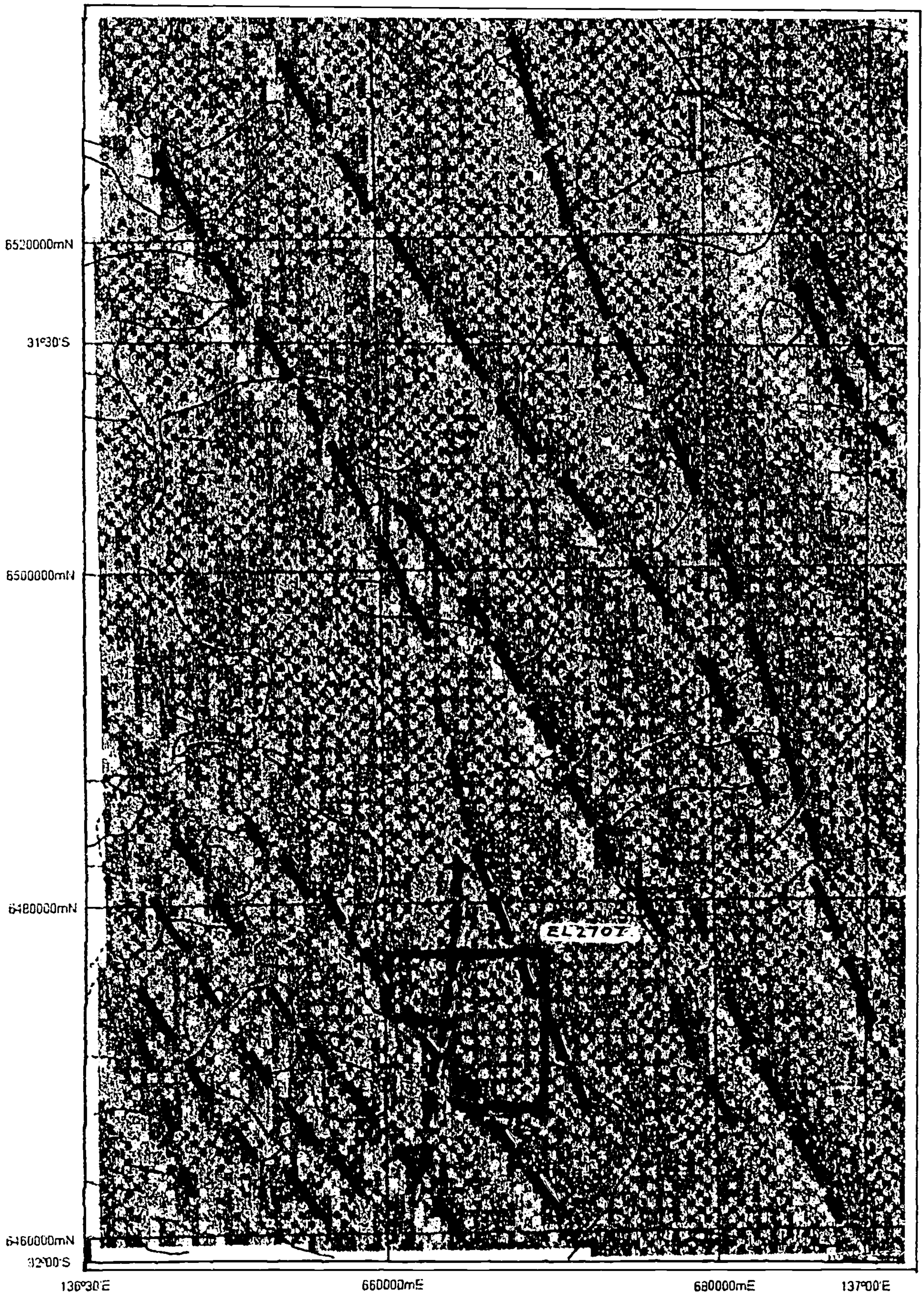


FIG. 2.



GAWLER EL2707 Prospect locality and Geophysical Interpretation Based on Regional Gravity and Magnetic Data

FIG.3.



PROJECT LOCATION

TUART RESOURCES

PROJECT: GAWLER CRATON EXPLORATION AREA
PROSPECT: STUART SHELF S.A.

MESA GIS & GEOPHYSICS

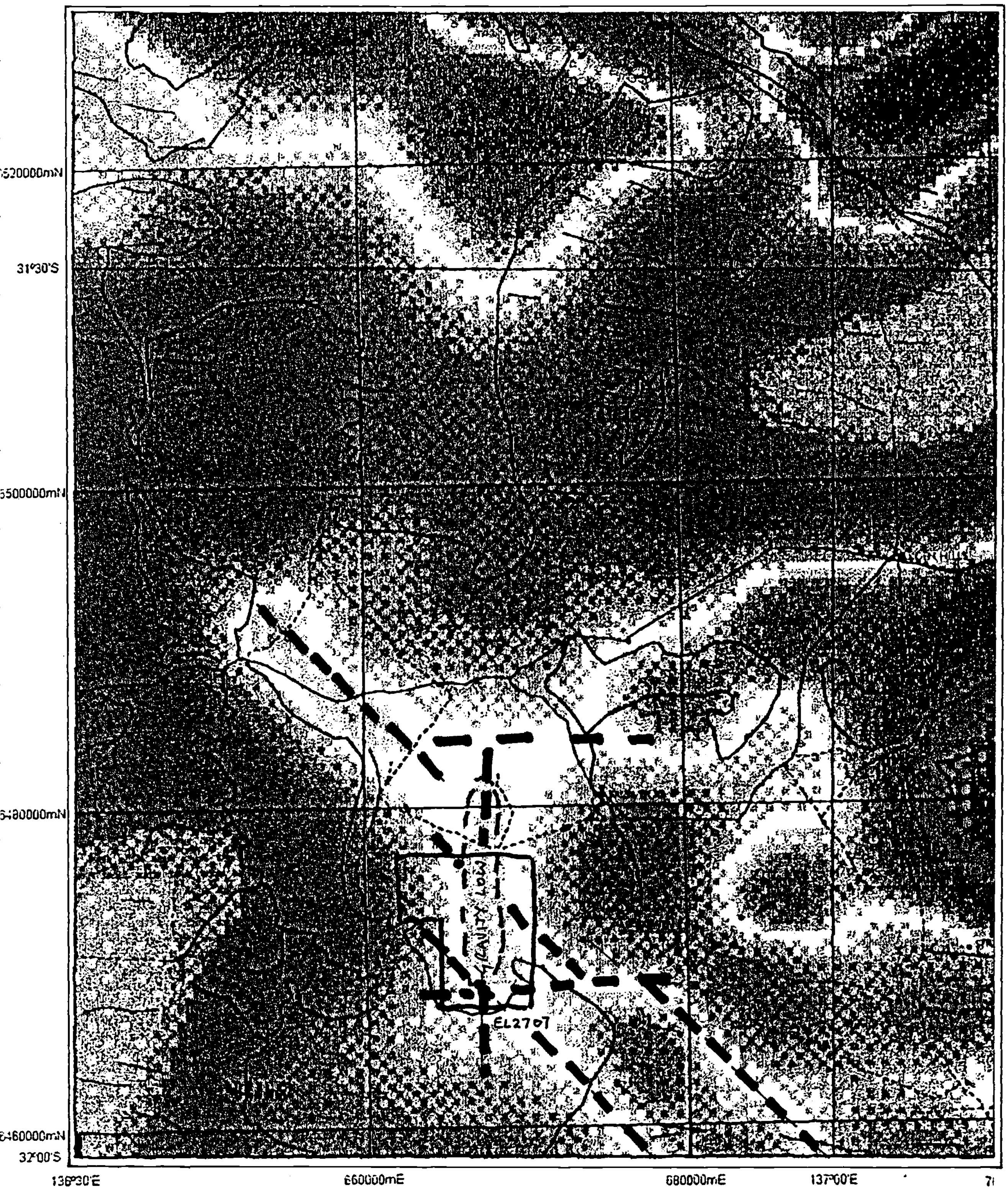
Airborne Magnetic Survey
EAST GRADIENT IMAGE
Grid Cell 500m

1 : 250,000
0 5 10 15 20 kilometres

250,000 Ref	ANDAMOOKA / TORRENS	100,000 Ref	
ORIGINATOR	L. Starkey	SCALE	1 : 250,000
Revision Date	DRAWN M.H.B.	PLATE No	
CAD INNOVATIONS	[illegible]	[illegible]	

NOTE
NW linears
N-S weak
structural
trend

FIG. 4



PROJECT LOCATION

TUART RESOURCES.

PROJECT: GAWLER CRATON EXPLORATION AREA

PROSPECT: STUART SHELF S.A.

MESA GIS & GEOPHYSICS

AGSO Regional Gravity Survey
FIRST RESIDUAL IMAGE
Average Depth 1.9km

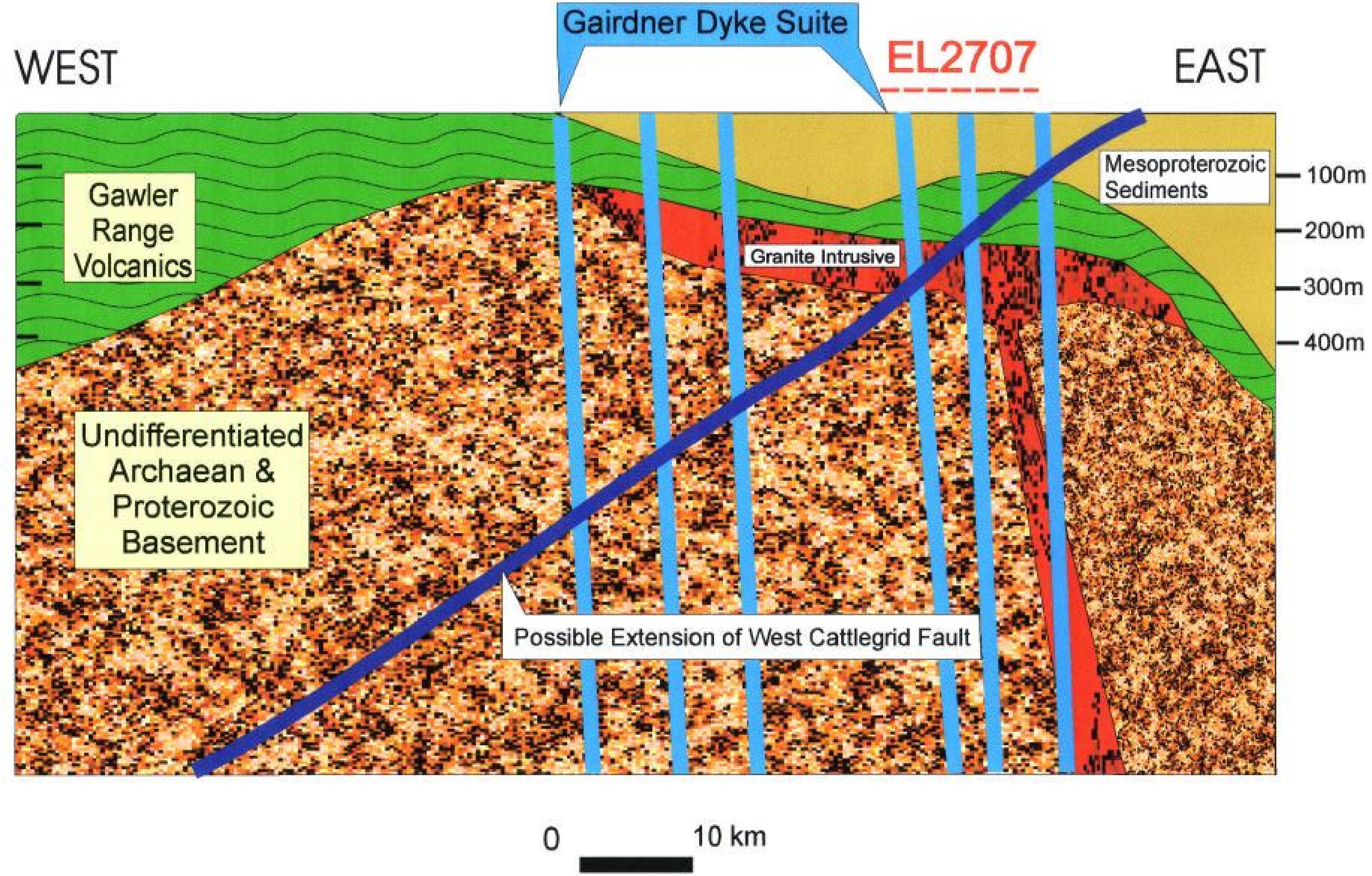
1 : 250,000

0 5 10 15 20

250,000 Ref: ANDAMOOKA / TORRENS
100,000 Ref:
ORIGINATOR: L. Starkey
SCALE: 1 : 250,000
Revision Date
DRAWN M.H.B.
PLATE No

NOTE N-S trending gravity low through centre of tenement and regional NW trending gravity features

FIG. 5.



Schematic Cross Section of Geophysical Interpretation of EL2707

Interpretation by L.J.Starkey Drawn B.Davis. February 2002

FIG.6

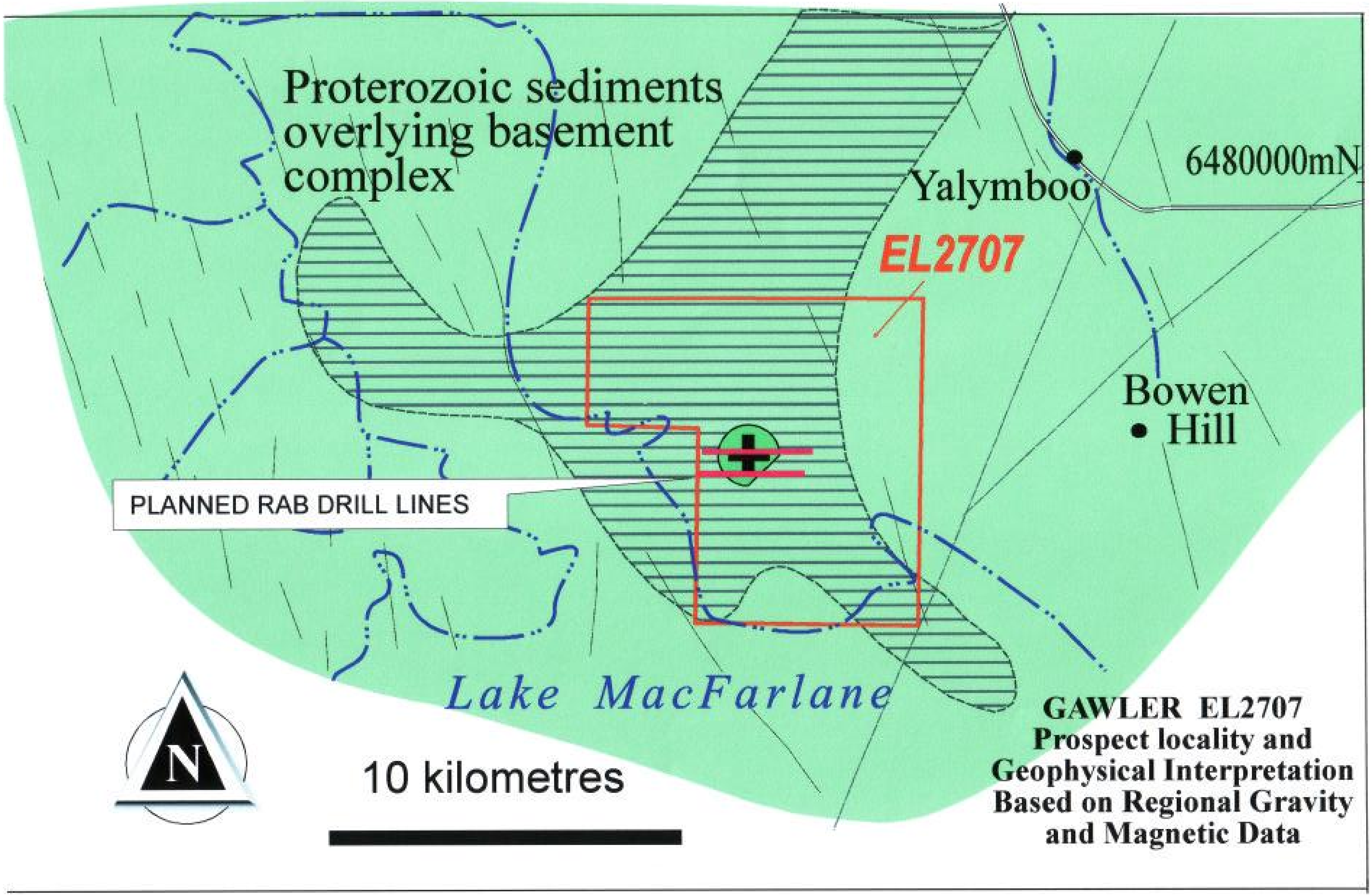

Proterozoic sediments overlying basement complex
6480000mN
Yalymboo
EL2707
Bowen Hill
PLANNED RAB DRILL LINES
Lake MacFarlane
N
10 kilometres
GAWLER EL2707
Prospect locality and
Geophysical Interpretation
Based on Regional Gravity
and Magnetic Data

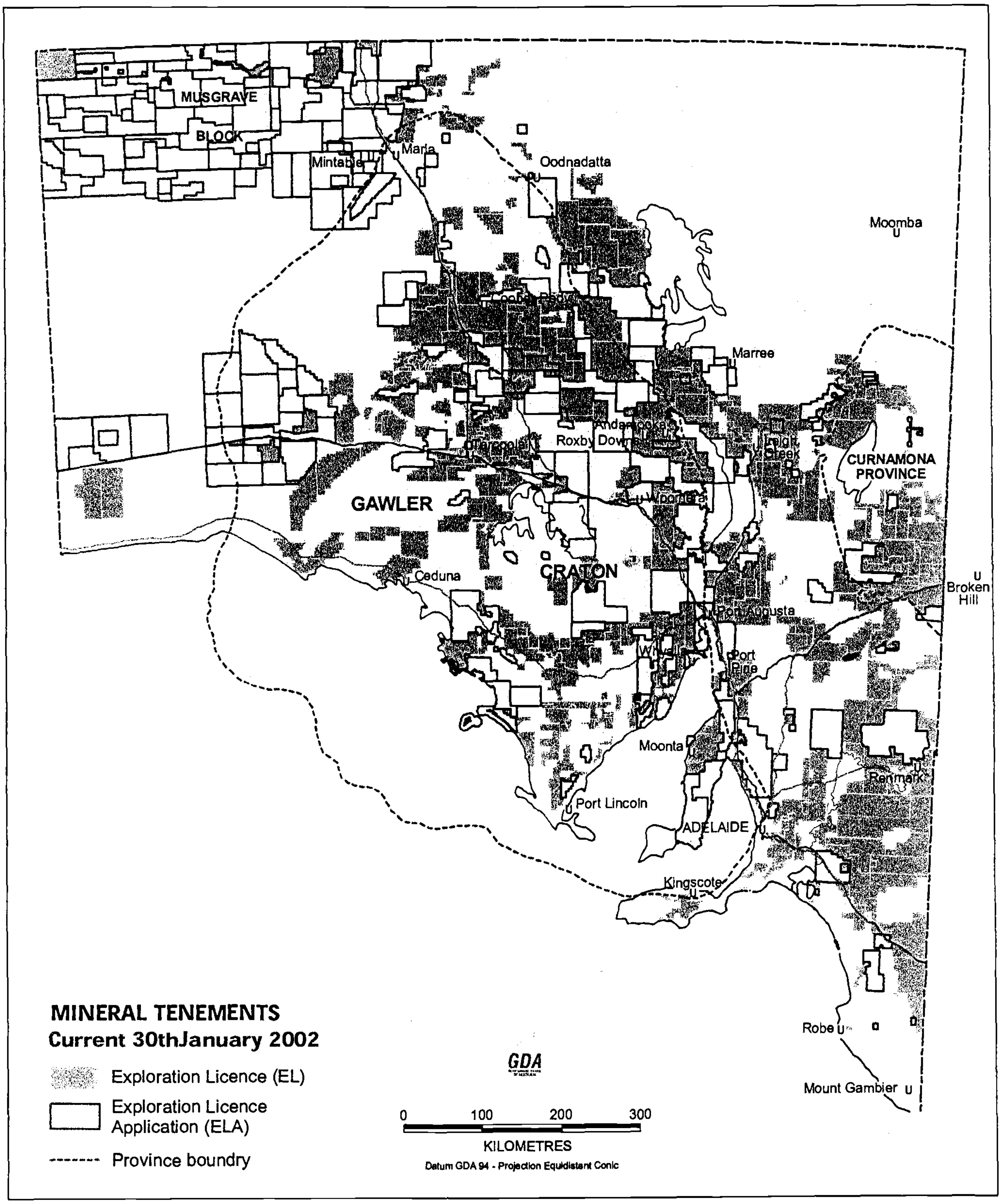
FIG. 7.

APPENDIX

Tenement maps

PRIMARY INDUSTRIES
AND RESOURCES SA

South Australia
MINERAL TENEMENTS



MINERAL TENEMENTS
Current 30thJanuary 2002

▨ Exploration Licence (EL)

☐ Exploration Licence Application (ELA)

-------- Province boundry

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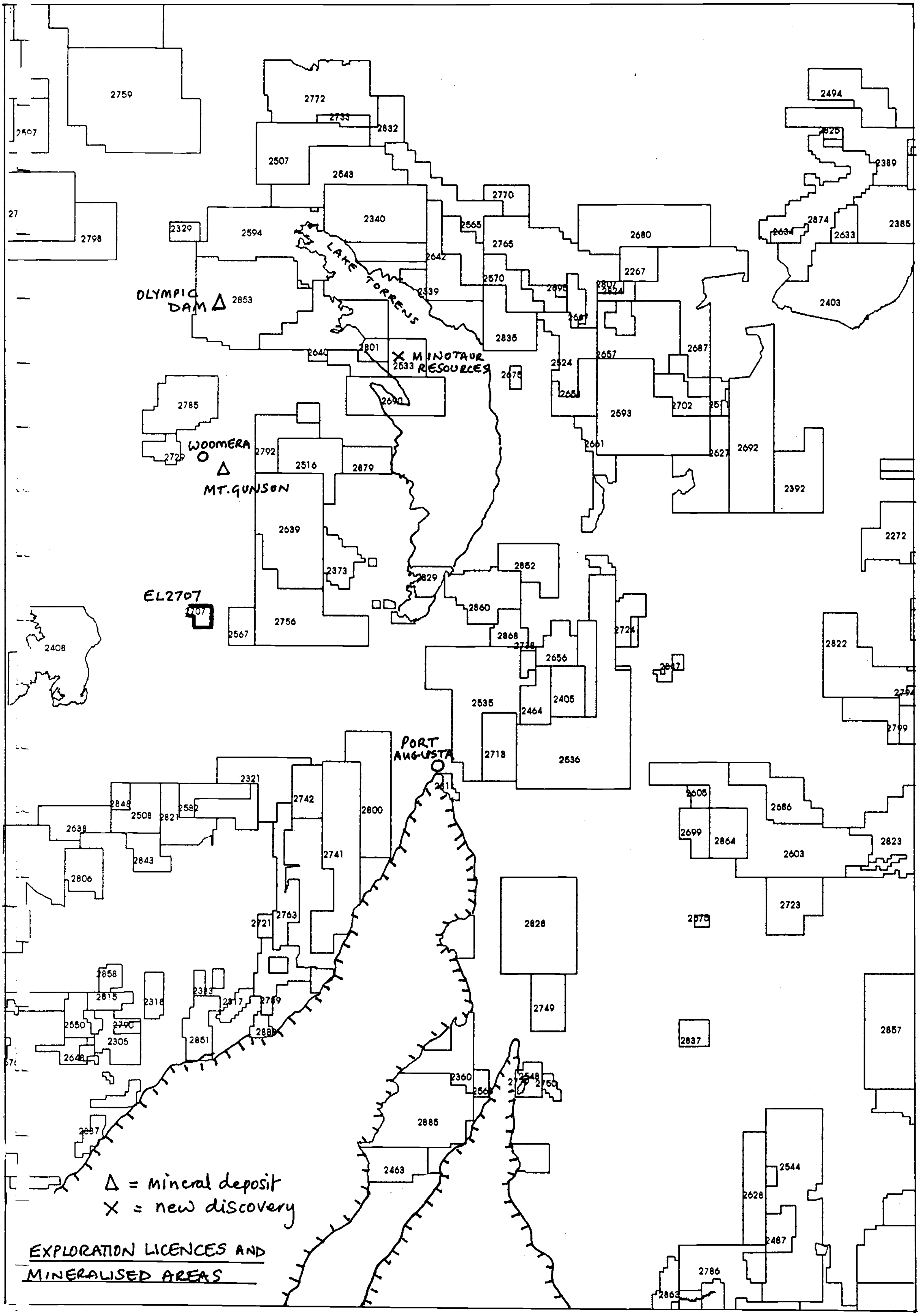

Δ = Mineral deposit
X = new discovery

EXPLORATION LICENCES AND MINERALISED AREAS

APPENDIX 2

BULLSEYE GEOSERVICES

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RESULTS OF GRAVITY SURVEY CONDUCTED OVER EL2707 – LAKE FINNISS PROJECT, SOUTH AUSTRALIA

Compiled for:

Minres Resources Inc.

By:

Mike Haynes
Consulting Geophysicist

May 2004

1.0 INTRODUCTION

Haines Surveys undertook a gravity survey over EL2707 – Minres Resources' Lake Finniss project in South Australia during April 2004. This survey was commissioned to delineate targets that may be associated with iron-oxide copper-gold mineralisation, similar to the Olympic Dam and Prominent Hill deposits (also located in South Australia), both of which have distinctive gravity anomalies coinciding with mineralisation.

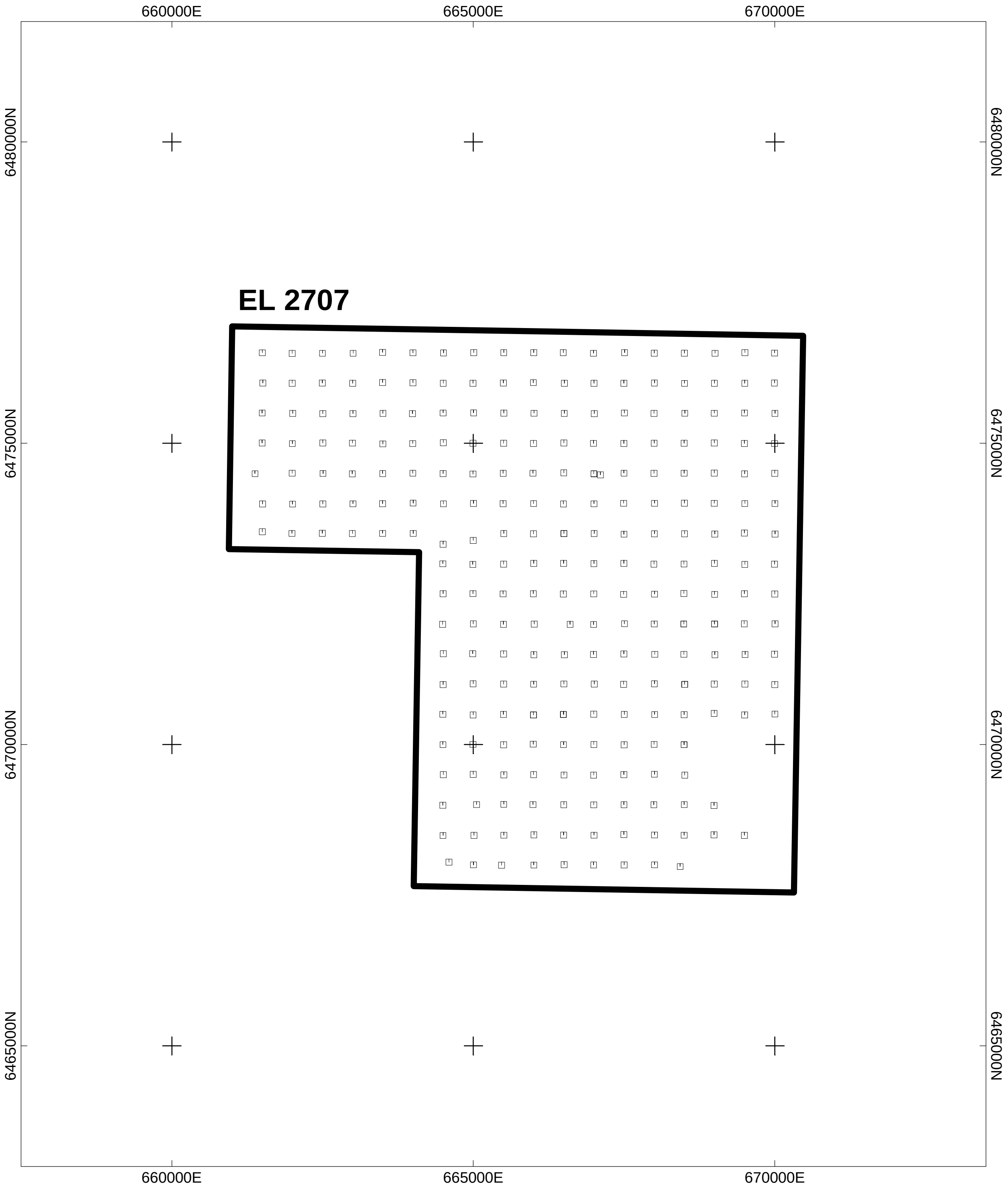
The results of this gravity survey, and targets arising, are presented in this report.

2.0 DATA

The gravity survey was conducted over the entire exploration licence using a nominal station spacing of 500m x 500m (see Figure 1). A total of 254 stations were surveyed.

Gravity measurements were made using a *Scintrex CG3 Autograv* instrument. Positional and elevation data were measured with a *Trimble 4000* series GPS receiver, with post processing of these data resulting in horizontal and vertical precision of approximately 2cm. Data from this survey were integrated with gravity data from the Australian Fundamental Gravity Network, and are presented in this report as Bouguer Anomalies calculated for a host-rock density of 2.67g/cc.

All data presented in this report relate to the Geographic Datum of Australia, 1994 (GDA94) within Map Grid of Australia (MGA) Zone 53.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

HAINES SURVEYS 2004 GRAVITY DATA

GRAVITY STATION LOCATIONS

Figure 1.

3.0 SURVEY RESULTS

All available geophysical data covering EL2707 have been reviewed and are discussed below:

3.1 Aeromagnetic Data

Aeromagnetic data acquired by the South Australian Department of Primary Industry and Resources on 400m spaced lines are presented in Figures 2 and 3. These images show that the aeromagnetic response over EL2707 is dominated by NNW-trending dolerite dykes.

Discrete magnetic anomalies coincide with both the Olympic Dam and Prominent Hill Cu-Au deposits. No such similar features are evident in these data.

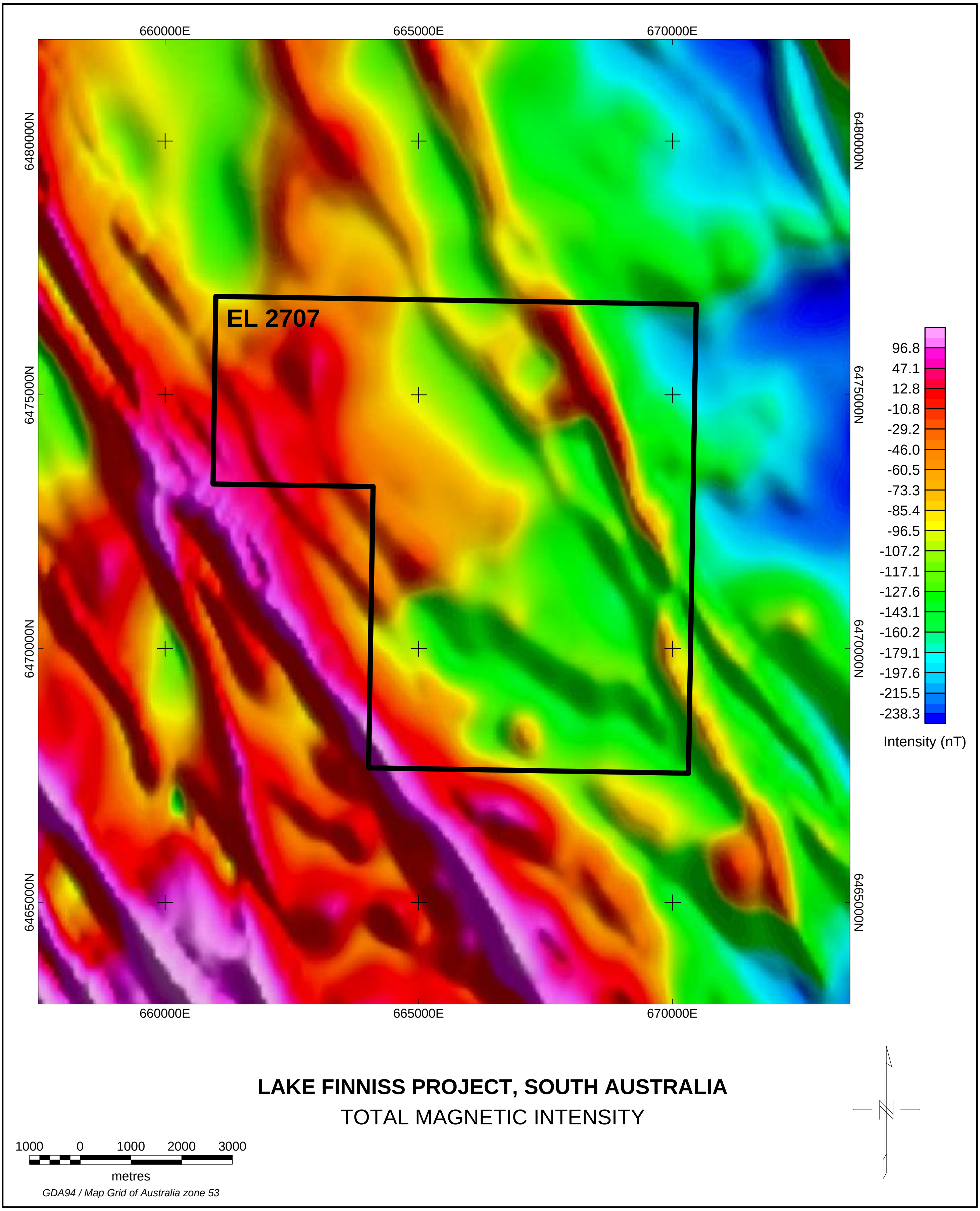
3.2 Regional Gravity Data

Regional gravity data acquired by AGSO on 11km spaced-stations show that the Lake Finniss project lies within a zone of steep gravity gradient (see Figure 4). This gradient is probably due to a major structure and/or major lithological boundary underlying the project. The spacing of gravity stations is too broad to delineate distinct anomalies that may coincide with Cu-Au mineralisation.

3.3 Detailed Gravity Data Acquired by Haines Surveys, 2004

Gravity data from the recently completed survey by Haines Surveys are presented as both images of the Bouguer Anomaly (Figure 5) and the residual of the Bouguer Anomaly (or regional-removed data; Figure 6).

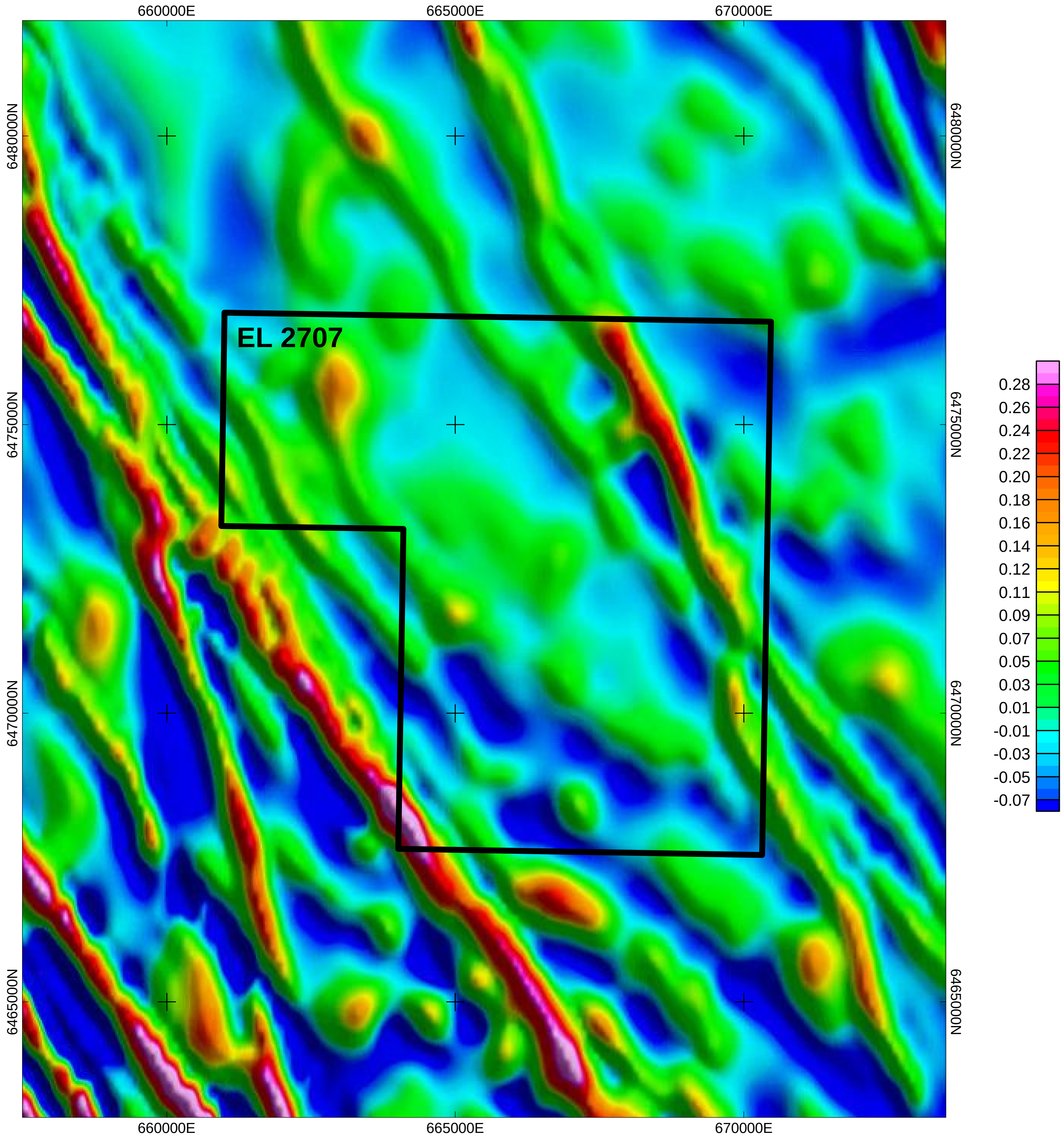
These images show that there is a significant 0.8mgal anomaly in the northeast of the tenement (LFGRAV1). A smaller narrow, NW-trending 0.2mgal anomaly is also evident in the centre of the tenement (LFGRAV2). Two other anomalies are evident as open anomalies in the NW and SW, but the sources of these two anomalies are off-tenement, and are thought to arise from dolerite dykes, hence are of little current interest.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

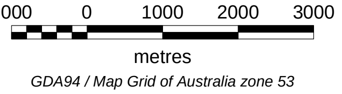
TOTAL MAGNETIC INTENSITY

Figure 2.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

1st VERTICAL DERIVATIVE OF TMI



GDA94 / Map Grid of Australia zone 53

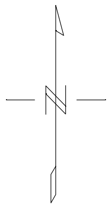
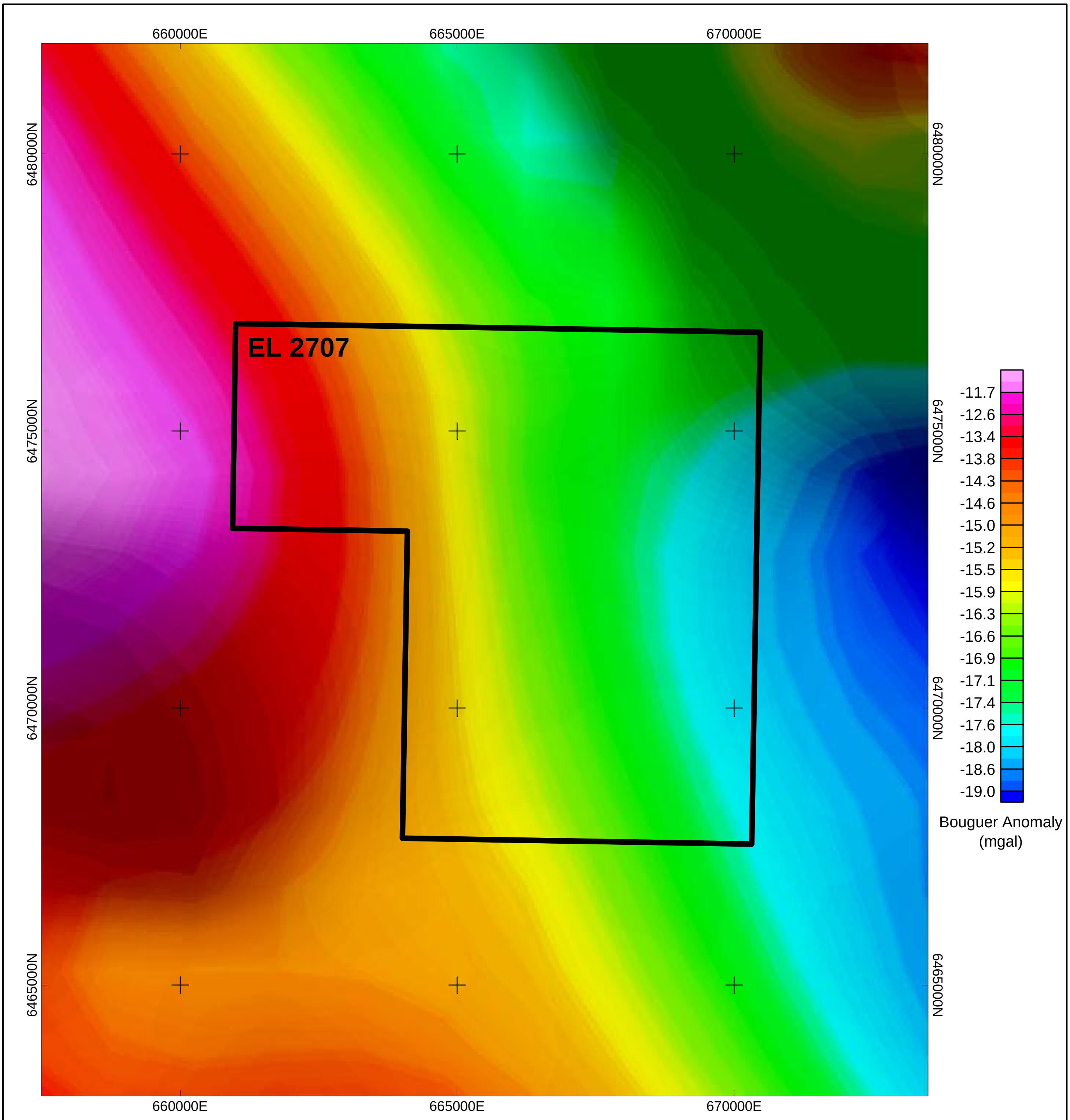


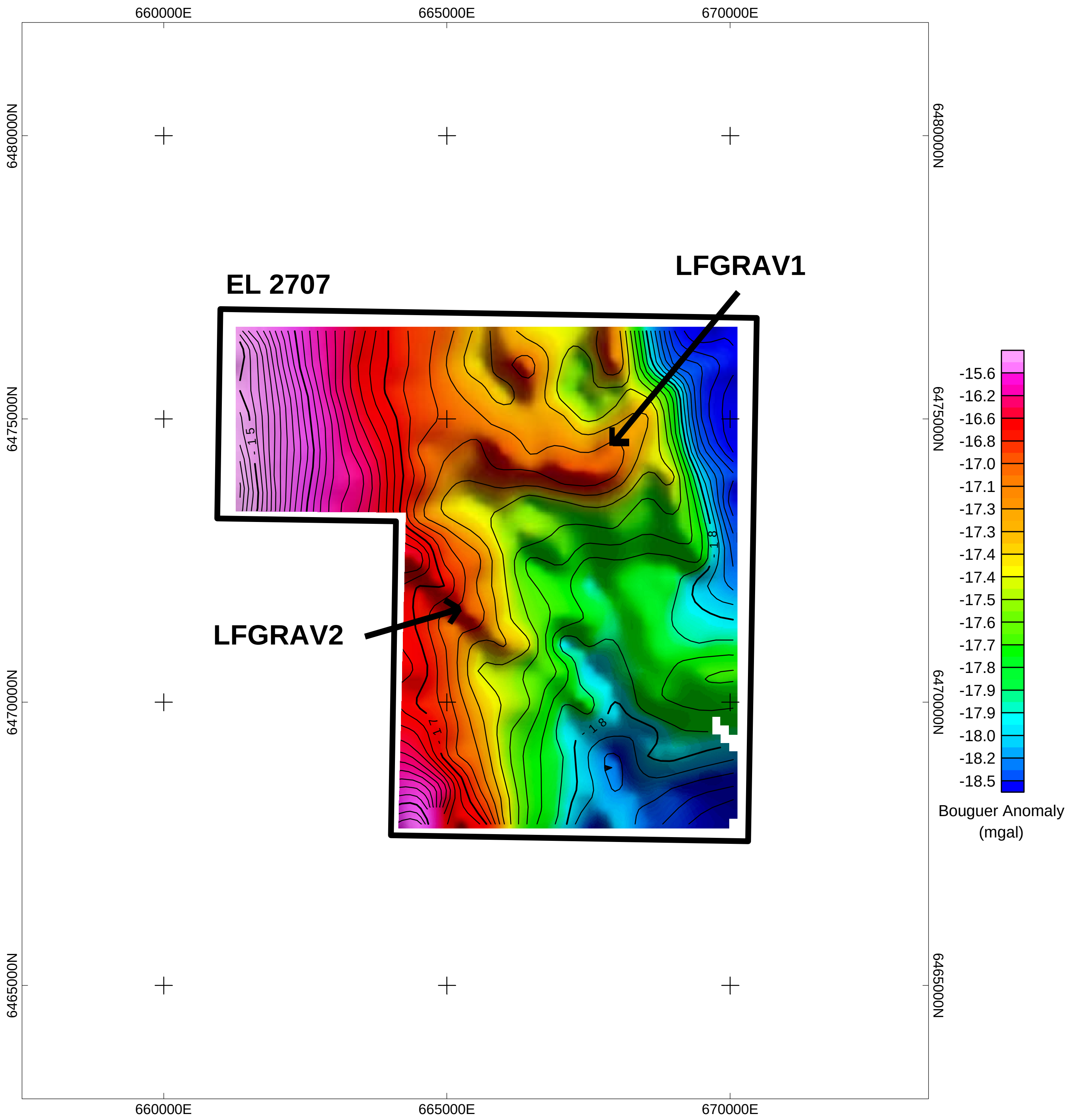
Figure 3.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

AGSO GRAVITY DATA
BOUGUER ANOMALY

Figure 4.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

HAINES SURVEYS 2004 GRAVITY DATA

BOUGUER ANOMALY

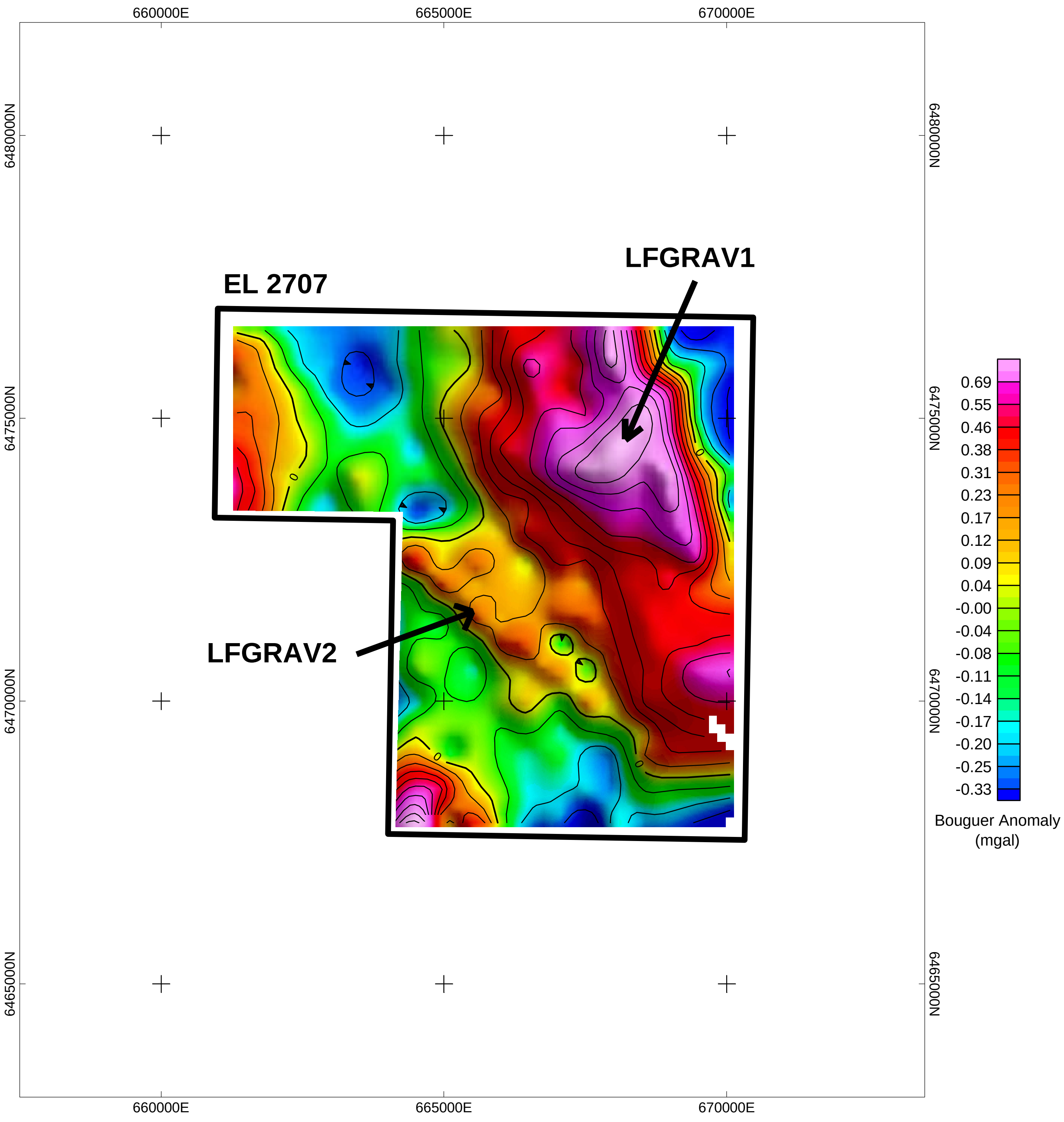
Contour Interval = 0.1mgal

1000 0 1000 2000 3000

metres

GDA94 / Map Grid of Australia zone 53

Figure 5.



LAKE FINNISS PROJECT, SOUTH AUSTRALIA

HAINES SURVEYS 2004 GRAVITY DATA

RESIDUAL BOUGUER ANOMALY

Contour Interval = 0.1mgal

1000 0 1000 2000 3000

metres

GDA94 / Map Grid of Australia zone 53

Figure 6.

Contours of the residual gravity data on an image of the 1st VD of the aeromagnetic data show that the LFGRAV1 anomaly roughly coincides with two NNW trending dolerite dykes (Figure 7). These dykes may be responsible for the gravity anomaly. However infill-gravity surveying is required to confirm this. Should infill surveying suggest otherwise further work, including surface geochemical sampling and/or drilling, might be justified.

It is not as apparent that the source of the LFGRAV2 anomaly is dolerite. The trend of this anomaly (NW) appears to cross-cut the trend of the dolerite dykes (NNW). So it is possible that this anomaly arises from hematite alteration associated with Cu-Au mineralisation. So further investigation of this anomaly by way of geological mapping, surface and/or calcrete sampling, and possibly drilling might be justified. It is noted however that the amplitude of this gravity anomaly is rather low when compared to the anomalies at Olympic Dam and Prominent Hill.

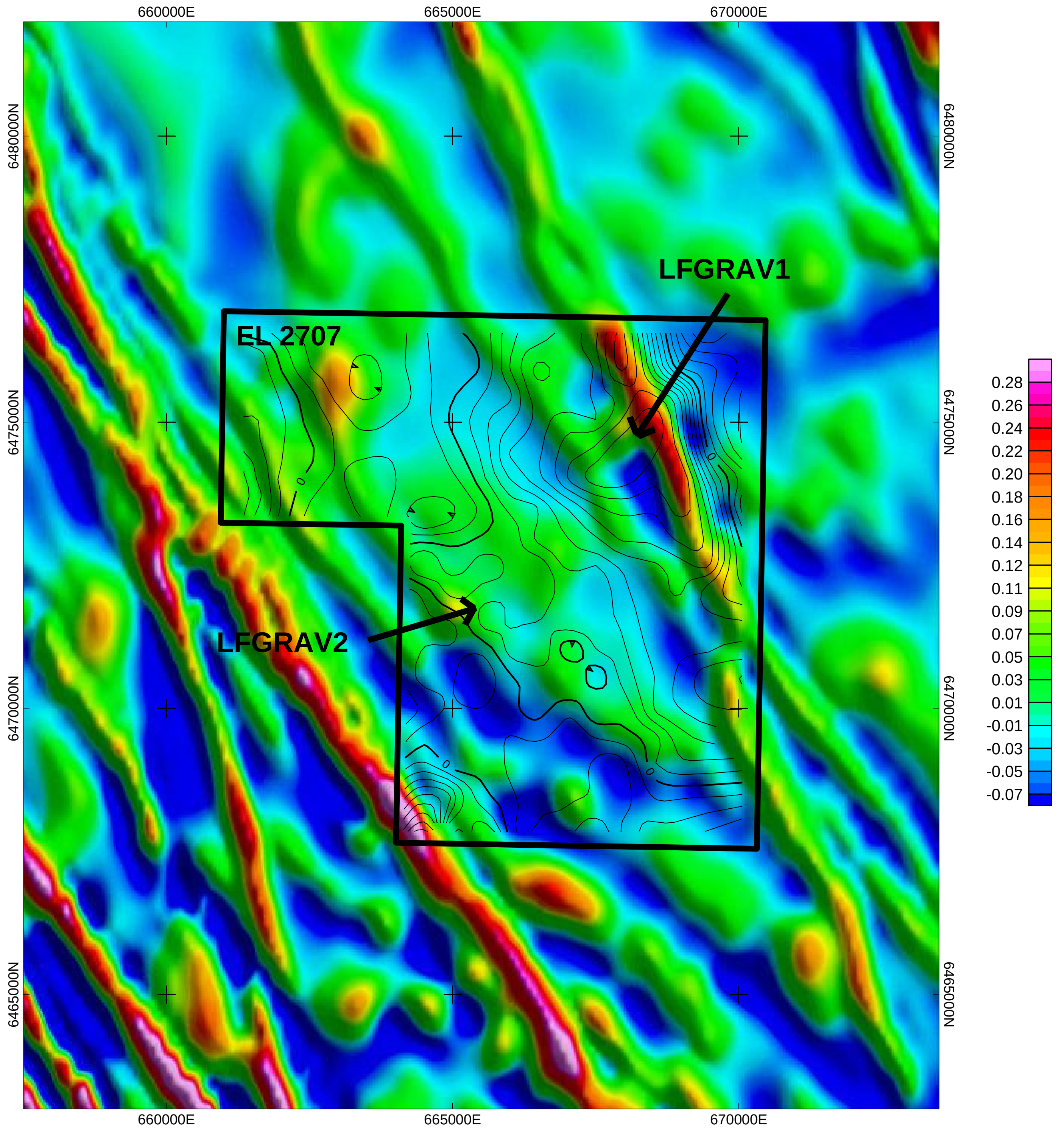
4.0 CONCLUSIONS AND RECOMMENDATIONS

Reconnaissance gravity surveying over EL2707 has delineated two anomalies that warrant further investigation.

Infill gravity surveying should be undertaken over a 0.8mgal anomaly in the NE of the tenement (LFGRAV1). Such surveying will help determine whether the source of this anomaly is dolerite. If not further work, including surface geochemical sampling and/or drilling, might be justified.

Geological mapping, surface and/or calcrete sampling, and possibly drilling can be justified over a subtler NW trending 0.2mgal anomaly located in the centre of the tenement (LFGRAV2). This anomaly may be related to hematite alteration and Cu-Au mineralisation.

Mike Haynes
Consulting Geophysicist



1000 0 1000 2000 3000

metres

GDA94 / Map Grid of Australia zone 53

LAKE FINNISS PROJECT, SOUTH AUSTRALIA

CONTOURS OF RESIDUAL GRAVITY ON

1st VERTICAL DERIVATIVE OF TMI

Contour Interval = 0.1mgal

Figure 7.