PALYNOSTRATIGRAPHIC ANALYSIS OF PROBABLE TERTIARY SAMPLES FROM CENTRAL AUSTRALIA

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SUMMARY

- All samples yielded significant to abundant amounts of strongly oxidized plant detritus (semi-opaques) but only trace to low numbers of spore-pollen.

- Almost all of the latter (spore-pollen) consisted of modern pollen that had been either caved downhole or introduced into the samples during core recovery and storage.

- Three samples [Lake Mackay LP0031 95 m, Kintore Palaeovalley RN18585 70 m, Ti Tree Basin TT001 290.2 m] yielded trace numbers of a Tertiary pollen type (*Nothofagidites* spp.).

- Unless these specimens are reworked or laboratory contaminants (considered unlikely), then the maximum and minimum ages of these samples are Middle Eocene to Early Pliocene. If depths and lithologies are taken in consideration, the sampled intervals are predicted to the Middle-Late Eocene.

1. INTRODUCTION

This report discusses the chronostratigraphic implications of spore-pollen recovered from (1) two uranium exploration coreholes drilled by *Toro* Pty Ltd. near the southwest margin of Lake Mackay on the WA/NT border, (2) a hydrogeological corehole drilled by the *Northern Territory Geological Survey* in the Kintore Palaeovalley about 250 km west of Alice Springs, and (3) two diamond coreholes drilled by *CRA* Ltd. in the Ti Tree Basin about 100 km north of Alice Springs. All samples were processed and submitted for palynostratigraphic dating by Billie Poignard and Dr. Steven Lewis, *Geoscience Australia*, respectively.

Sample data and inferred ages are summarized in Table 1 below. Individual samples are discussed in Section 3.4 and examples of modern and Tertiary pollen illustrated in Plate 1, respectively. The associated brown to black particles are plant detritus in which all traces of the original cellular structure have been destroyed (semi-opaques) and demonstrate the degree to which this detritus has been oxidized.

Table 1

Locality Data	Sample Data			Age Limits	Comment
	Drillhole	Depth	Type		
Lake Mackay	LP009	95 m	RAB cuttings	Indeterminate	Modern pollen contaminants only
	LP0031	110 m	RAB cuttings	Middle Eocene-Early Pliocene	Trace *Nothofagidites emarcidus*
Kintore	RN18585	70 m	RAB cuttings	Middle Eocene-Early Pliocene	Trace *Nothofagidites* cf. *falcatus*
Ti Tree Basin	TT001	175.4 m	Diamond drill	Indeterminate	Modern pollen contaminants only
		290.2 m	Diamond drill	Middle Eocene-Early Pliocene	Trace *Nothofagidites emarcidus*

2. GEOLOGICAL COMMENTS

1. Previous studies undertaken for hydrogeological and uranium exploration projects confirm that fossil spores and pollen can be used to date fine-grained sediments infilling Tertiary or older palaeochannels in Central Australia (references in Macphail 2007). For example, Early Eocene, *Malvacipollis diversus* Zone Equivalent assemblages occur at c. 119 m in NTGS 78DDH TTW2 and c. 196 m in NTGS 81TT1 in the Ti Tree Basin: Caved taxa indicate Middle-Late Eocene sediments occur in an unsampled interval up section in the latter corehole.

2. The same studies indicate that it is difficult to be dogmatic about which lithologies are likely to preserve plant microfossils, including when using lithostratigraphic criteria such as dark grey to black colour and fine-grained texture. Nevertheless, the highest yields and best preservation typically are associated with hydrophobic clays, lignites, carbonaceous silt- and mudstones and sandstones with carbonaceous stringers: Green and mottled red clays are almost always barren, as are sediments above the weathering front (~30-50 m below ground level in central Australia).

3. All samples analysed in this study are likely to be below the weathering front. Accordingly, strong oxidation of the organic content (kerogen and spore-pollen) is likely to be due to groundwater moving through relatively pervious fluvial or fluvio-lacustrine deposits.

3. PALYNOSTRATIGRAPHY

3.1 Palynostratigraphy

Criteria used to infer age limits for three of the five samples are based on the palynostratigraphy of Late Cretaceous to Tertiary basins in the Alice Springs district and observations from boreholes in Western Australia (Macphail 1997, 2007, Macphail & Stone 2004, M.K. Macphail unpubl. data).

The data confirm that *Nothofagidites* spp. were present in northwest Australia during the Late Cretaceous but this morphogenus is absent in Late Cretaceous and Early Eocene sequences in Central Australia. *Nothofagidites emarcidus-heterus* and related species such as *N. falcatus* are frequent to dominant in Middle-Late Eocene and Oligo-Miocene sequences in the Alice Springs District but are rare or absent in Pliocene sediments near Broken Hill. The parent plants [*Nothofagus* (*Brassospora*) spp.] became extinct across Australia during the Plio-Pleistocene transition (Gelasian) but survive in montane rainforest in New Guinea and New Caledonia. *Malvacipollis regattaensis* typically is restricted to Pliocene deposits in southeastern Australia but it is possible that a species of the mallow family (Malvaceae) still growing in central Australia produces this pollen type. Modern plant distribution data follow Jessop (1981).

3.2 Yields and preservation

All samples yielded low to abundant amounts of semi-opaques and varying amounts of caved modern pollen and mucilaginous soil algae. Three microfloras included Tertiary pollen species. All taxa are well-preserved relative to other plant detritus in the organic extracts..

3.3 Quantitative data

Raw pollen counts for all identifiable pollen and algae are given in Table 2

Table 2: Raw counts

SPECIES	COREHOLE				
	LP009	**LP0031**	**RN18585**	**TT001**	**TT001**
	95 m	**110 m**	**70 m**	**175.4 m**	**290.2 m**
1. **Tertiary taxa**					
Malvacipollis cf. *regattaensis*					1
Nothofagidites emarcidus-heterus		1			1
Nothofagidites cf. *falcatus*			1		
2. **Modern pollen contaminants**					
Acacia	1				
Anacardiaceae	1				
Asteraceae (Tubuliflorae)	12	12		51	2
Asteraceae (Liguliflorae)	1				
Brassicaceae	1				
Casuarinaceae	1	9			
Chenopodiaceae		3			2
Dodonaea		3		1	
Eucalyptus	1			8	8
Galium	1				
Goodeniaceae					
Gyrostemonaceae	5	8			
Haloragis/Gonocarpus	3	4		1	
unassigned Myrtaceae	1				2
Poaceae	1	21			1
Stellaria		1			
Stylidium	1				
unassigned tricolpate types	2				
unassigned tricolporate types	3	2			
3. **Other taxa**					
Desmidaceae	8				
Zygnemataceae			2		
Fungal spores & hyphae	18	9	8	5	4

3.4 **Individual sample data**

LAKE MACKAY

Corehole:	***Toro* LP009**
Depth:	**95 m**
Type:	RAB chips/cuttings [dust from cyclone?]
Depositional environment:	fluvial
Kerogen yield & type:	Abundant ±black, angular semi-opaques and microquartz. Caved organics include well-preserved cuticle and modern pollen.
Preferred age:	Indeterminate
Zone (Macphail 1997):	Indeterminate
Confidence rating:	n/a
Maximum age:	Indeterminate
Minimum age:	Indeterminate
Comment:	The parent plants represented by modern pollen are listed by Jessop (1981) as occurring in the arid zone vegetation in central Australia. The comparatively high relative abundance of grasses (Poaceae) and Gyrostemonaceae, and presence of *Stylidium*, imply that the core site was located in a depression surrounded by hummock grasslands growing on red siliceous sands or clay-loams and with casuarina tree-steppe somewhere in the vicinity. The microflora includes cysts of the usually very rare, freshwater green algal family Desmidaceae (Plate 1 figs. 1-2). As a group, desmids are indicators of unpolluted water and, in this context, may be derived from a potable water source on the drill site.

Corehole:	***Toro* LP0031**
Depth:	**110 m**
Type:	RAB chips/cuttings [dust from cyclone?]
Depositional environment:	fluvial
Kerogen yield & type:	Abundant mid-brown to ±black semi-opaques in a matrix of microquartz (including well-formed crystals).
Preferred age:	Middle-Late Eocene
Zone (Macphail 1997):	Lower-Middle *Nothofagidites asperus* Zone Equivalent, based on depth, lithology and trace *Nothofagidites emarcidus-heterus*
Confidence rating:	very low
Maximum age:	Middle Eocene, based on *Nothofagidites emarcidus-heterus*
Minimum age:	Early Pliocene, based on *Nothofagidites emarcidus-heterus*
Comment:	The microflora closely resembles that at 95 m in LP009 except that Casuarinaceae are more frequent and includes one grain of *Nothofagidites emarcidus-heterus* amongst the otherwise caved modern pollen. It is difficult to know how much weight can be attached to the latter record. Assuming the specimen of *Nothofagidites emarcidus-heterus* is not reworked (or a laboratory contaminant), its occurrence is evidence for Middle Eocene or younger Tertiary deposits at or above 110 m.

LINTORE PALAEOVALLEY

Corehole	***NTGS* RN18585**
Depth:	**70 m**
Type:	RAB chips/cuttings [dust from cyclone?]
Depositional environment:	fluvial
Kerogen yield & type:	Abundant ±black, angular semi-opaques
Preferred age:	Middle-Late Eocene
Zone (Macphail 1997):	Lower-Middle *Nothofagidites asperus* Zone Equivalent, based on depth, lithology and trace *Nothofagidites* cf. *falcatus*
Confidence rating:	very low
Maximum age:	Middle Eocene, based on *Nothofagidites* cf. *falcatus*
Minimum age:	Early Pliocene, based on *Nothofagidites* cf. *falcatus*
Comment:	As for LP0031 110 m, the inferred age and age limits assume that *Nothofagidites* cf. *falcatus* is *in situ* or caved, not reworked. It is noted that this pollen grain was the only terrestrial microfossil recorded in the organic extract.

TI TREE BASIN

Corehole:	***CRA* TT001**
Depth:	**175.4 m**
Type:	diamond drill core
Depositional environment:	fluvio-lacustrine?
Kerogen yield & type:	low yield of mid-brown colloidal-sized fines and sparse mid-brown semi-opaques
Preferred age:	Indeterminate
Zone (Macphail 1997):	Indeterminate
Confidence rating:	n/a
Maximum age:	Indeterminate
Minimum age:	Indeterminate
Comment:	The microflora comprised modern pollen contaminants only, including large numbers of Asteraceae (Tubuliflorae) apparently derived from one or more disrupted anthers.

Corehole:	***CRA* TT001**
Depth:	**290.2 m**
Type:	diamond drill core
Depositional environment:	fluvio-lacustrine?
Kerogen yield & type:	Abundant ±black, angular semi-opaques
Preferred age:	Middle-Late Eocene
Zone (Macphail 1997):	Lower-Middle *Nothofagidites asperus* Zone Equivalent, based on depth, lithology and trace *Nothofagidites emarcidus-heterus*
Confidence rating:	very low
Maximum age:	Middle Eocene, based on *Nothofagidites emarcidus-heterus*
Minimum age:	Early Pliocene, based on *Nothofagidites emarcidus-heterus*

Comment: The preferred age and age limits assume that *Nothofagidites emarcidus-heterus* is *in situ* or caved, not reworked, and that *Malvacipollis regattaensis* is caved.

4. REFERENCES

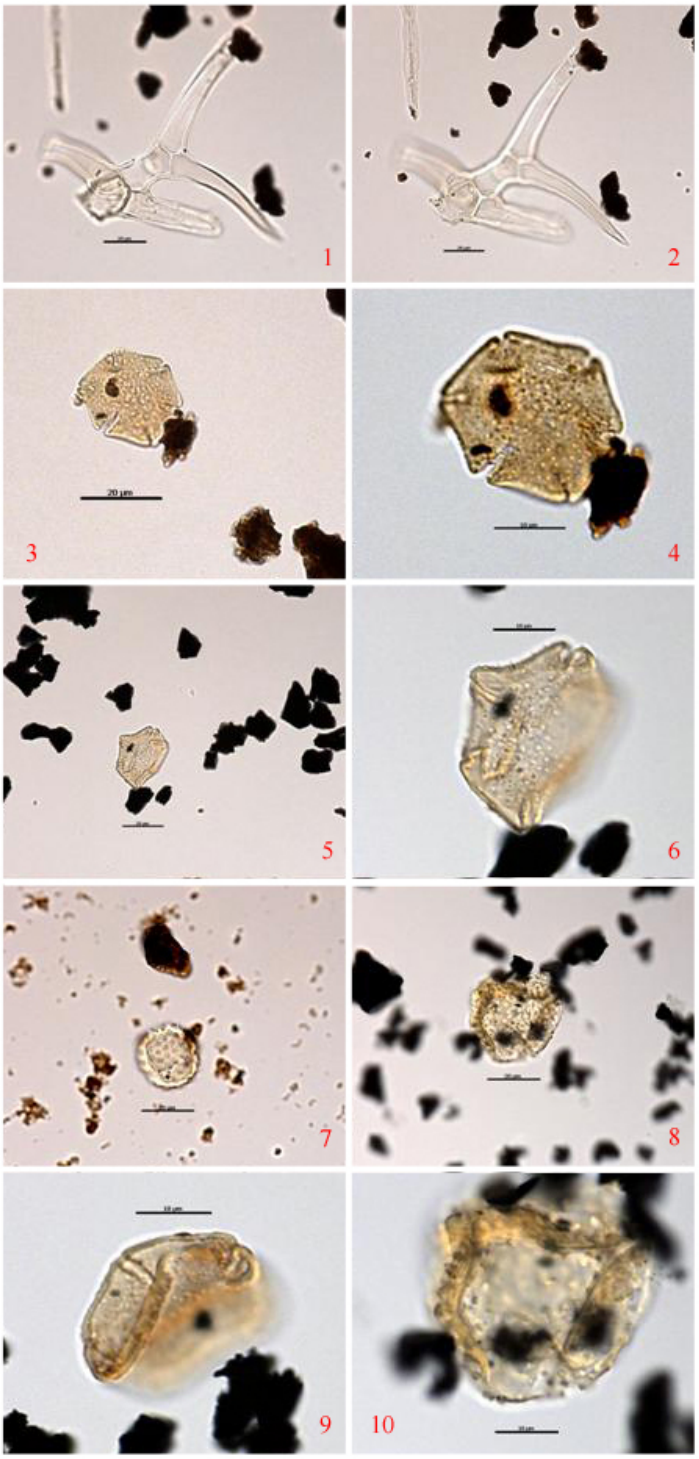
Jessop, J. (Editor), 1981. *Flora of Central Australia*. Australian Systematic Botany Society/Reed, Frenchs Forest. 537 pp.

Macphail, M.K., 1997. Palynostratigraphy of Late Cretaceous to Tertiary Basins in the Alice Springs District, Northern Territory. *Australian Geological Survey Record* **1997/31**: 1-27.

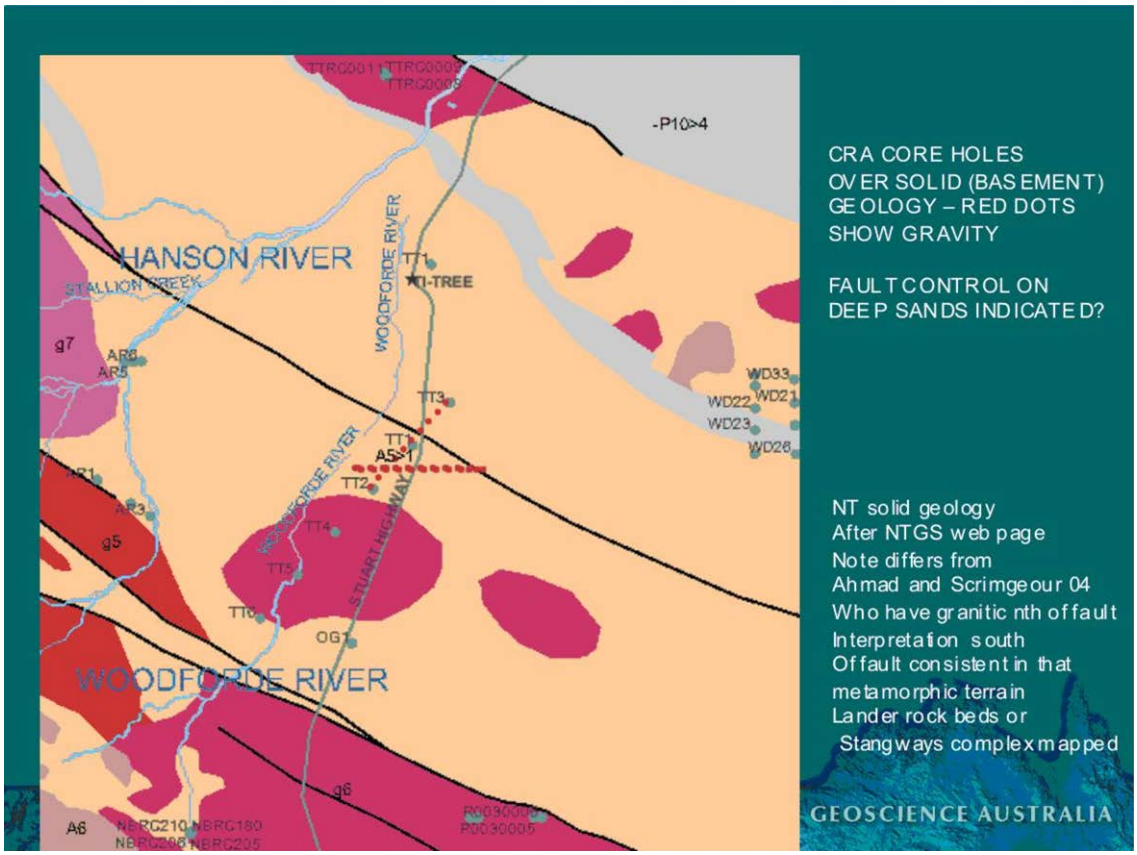
Macphail, M.K., 2007. *Australian Palaeoclimates Cretaceous to Tertiary. A review of palaeobotanical and related evidence to the year 2000*. CRC-LEME Open File Report 151 (Special Volume ISBN 1 921039 75 2) 279 pp.

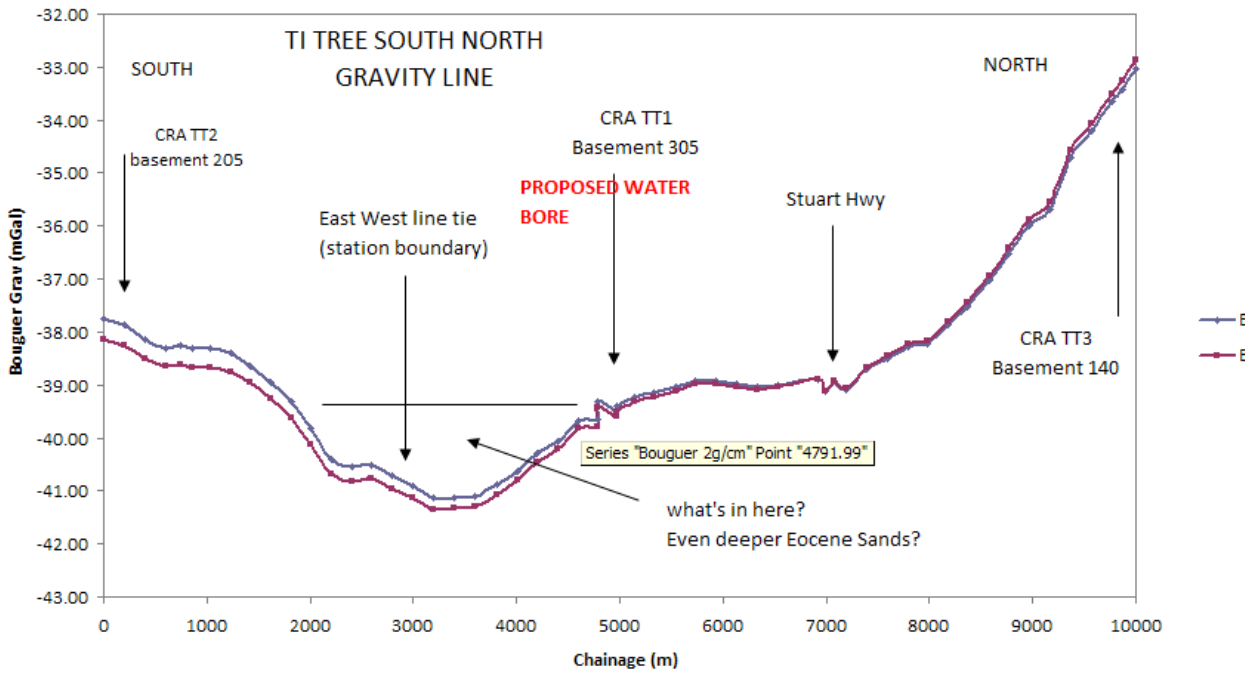
Macphail, M.K. & Stone, M., 2004. Age and palaeoenvironmental constraints on the genesis of the Yandi channel iron deposits, Marillana Formation, Pilbara, northwestern Australia. *Australian Journal of Earth Sciences* **51**: 497-520.

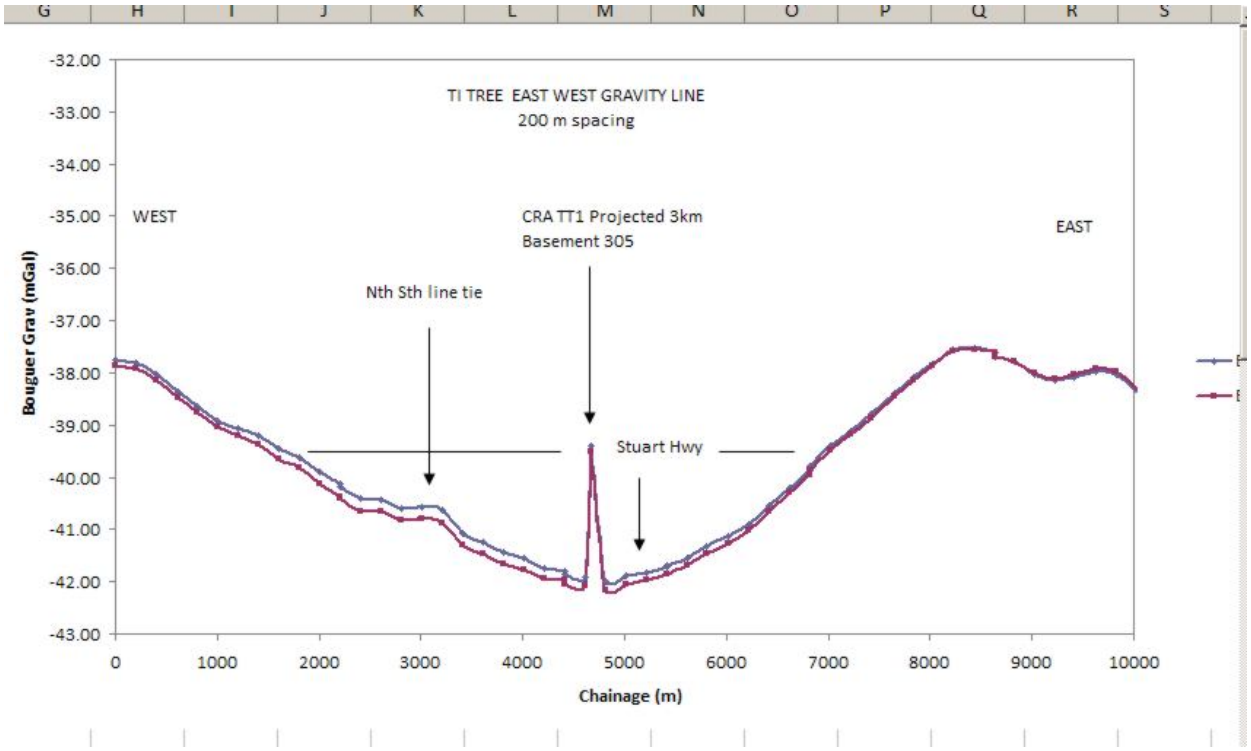
PLATE 1



Figs. 1-2.	LP009 95 m.	Desmidaceae colony.
Figs. 3-4.	LP0031 110 m.	*Nothofagidites emarcidus heterus*
Figs. 5-6.	RN18585 70 m.	*Nothofagidites* cf. *falcatus*
Fig. 7	TT001 175.4 m.	modern Asteraceae (Tubuliflorae) pollen
Fig. 9	TT001 290.2 m.	*Nothofagidites emarcidus heterus*
Figs. 8, 10	TT001 290.2 m	*Malvacipollis* cf. *regattaensis*


HANSON RIVER
STALLION CREEK
WOODFORDE RIVER
TI-TREE
TT1
TT2
TT3
TT4
TT5
TT6
OG1
A5-1
STUART HIGHWAY
WOODFORDE RIVER
-P10>4
g7
g5
g6
A6
AR6
AR5
AR1
AR3
WD33
WD21
WD22
WD23
WD26
CRA CORE HOLES
OVER SOLID (BASEMENT)
GEOLOGY – RED DOTS
SHOW GRAVITY
FAULT CONTROL ON
DEEP SANDS INDICATED?
NT solid geology
After NTGS web page
Note differs from
Ahmad and Scrimgeour 04
Who have granitic nth of fault
Interpretation south
Of fault consistent in that
metamorphic terrain
Lander rock beds or
Stangways complex mapped
GEOSCIENCE AUSTRALIA


TI TREE SOUTH NORTH
GRAVITY LINE
SOUTH
NORTH
CRA TT2
basement 205
CRA TT1
Basement 305
PROPOSED WATER
BORE
East West line tie
(station boundary)
Stuart Hwy
CRA TT3
Basement 140
Series "Bouguer 2g/cm" Point "4791.99"
what's in here?
Even deeper Eocene Sands?
Bouguer Grav (mGal)
-32.00
-33.00
-34.00
-35.00
-36.00
-37.00
-38.00
-39.00
-40.00
-41.00
-42.00
-43.00
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Chainage (m)


TI TREE EAST WEST GRAVITY LINE
200 m spacing
WEST
CRA TT1 Projected 3km
Basement 305
EAST
Nth Sth line tie
Stuart Hwy
Bouguer Grav (mGal)
-32.00
-33.00
-34.00
-35.00
-36.00
-37.00
-38.00
-39.00
-40.00
-41.00
-42.00
-43.00
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Chainage (m)