2023

Intrabasaltic sediments, northwestern Tasmania — Final Palynostratigraphic Report

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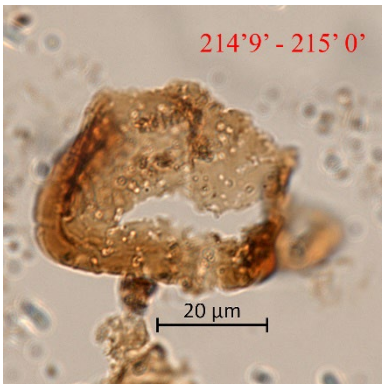
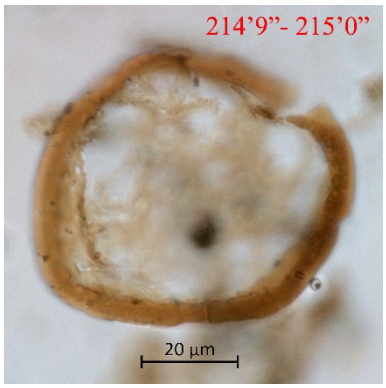
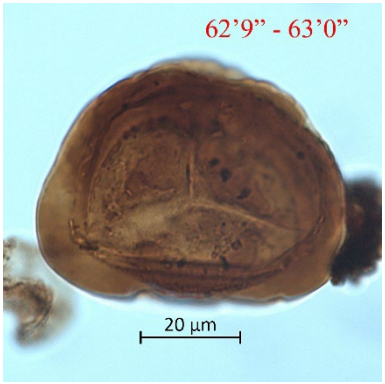




Cyatheacidites annulatus



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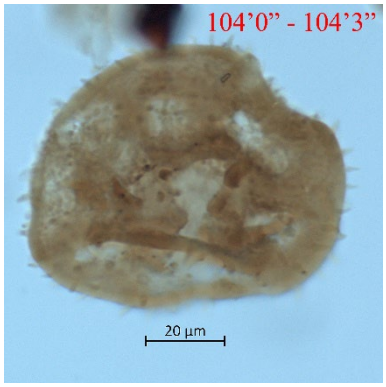
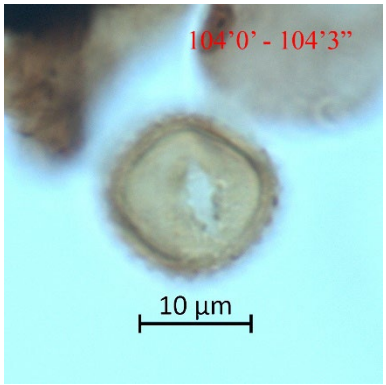


Droseridites sp.



Tubulifloridites cf. *pleistocenicus*

Geological Consultant's Report 23_01

Tasmanian Government

Mineral Resources Tasmania
Department of State Growth

Geological Consultant's Report GCR23_01:

Intrabasaltic sediments, northwestern Tasmania
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Cover: Age-diagnostic spore-pollen species from Emu Plains (top) and Lemonthyme Creek (bottom) cores (Photoshop-strengthened images).

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Intrabasaltic sediments, northwestern Tasmania
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Consultant Palynological Services

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1.0 Introduction

This report provides spore-pollen based age determinations and paleoenvironments for twelve (12) loose core fragments from sediments interbedded with Paleogene-Neogene volcanic strata in northwestern Tasmania. With the exception of Tarraleah, all samples yielded abundant plant detritus although yields, preservation and concentrations of fossil pollen and spores varied from absent/poor/pyrolyzed to abundant/good. The majority of fossil species are long-ranging; age-diagnostic species were rare or absent. Accordingly, the inferred age determinations rely on zone-accessory species whose time distributions are imprecisely known, negative evidence, or both.

Alternative age determinations are provided for several samples as geothermal heating means it is simply not possible to use differences in preservation and thermal alteration (Thermal Alternation Index [TAI]) to determine if the fossil pollen and spore assemblages (microfloras) are mixed-age, or are the result of minor reworking or downhole contamination. Inferred ages and age limits are summarized below (Table 1) and the individual determinations justified and discussed in Section 3. Photomicrographs of age-diagnostic fossil pollen and spores, culled from a detailed (~775 Mb) photographic documentation of the better preserved microfloras, are reproduced in Appendix 1. The stratigraphic distribution and estimated relative abundance of all identifiable fossil pollen and spores (miospores) are given in Appendix 2.

Most samples preserved reworked Permo-Triassic pollen and spores derived from the Parmeener Supergroup. Some spores (e.g. *Didecitriletes ericanus* and *Microbaculispora micronodosa*) are diagnostic of a late Permian age. TAI values for microfloras at 188.79 m and 258.14 m in the Maggs Mountain core are within the 'hydrocarbon-generation' range of 3- to 3+. Otherwise, despite the local presence of basalt, carbonized plant remains or fusinite were extremely rare.

2.0 Palynostratigraphy

All samples were processed by Morgan Goodall Palaeo Pty. Ltd. (Perth) using the standard palynological techniques of hydrofluoric acid treatment and heavy liquid floatation to remove the coarse clastic component and standard microfiltration (no oxidation) to concentrate the miospore and other microfossils over 5 mμ in minimum diameter. Age determinations are based on the time distributions of age-diagnostic morphospecies in the Gippsland and Bass basins (Partridge, 1999; M.K. Macphail and A.D. Partridge, unpublished data).

Table 1. Summary depth table.

Core Site	Depth	Inferred Age	Alternate Age	Age Limits
Emu Plains (HEC-5831; MRT ID 15592)	214' 9" to 215' 0" (65.46 to 65.53 m)	late Oligocene	-	early Oligocene to early Miocene
	270' 0" to 270' 3" (82.30 to 82.37 m)	late Oligocene	-	early Oligocene to early Miocene
Lemonthyme Creek (HEC-5808; MRT ID 15589)	62' 9" to 63' 0" (19.13 to 19.20 m)	indeterminate	-	(modern pollen only)
	104' to 104' 3" (31.70 to 31.78 m)	late Oligocene	early Miocene	early Oligocene to early Miocene?
	177' 0" to 177' 3" (53.95 to 53.03 m)	early Oligocene	-	early Oligocene
Maggs Mountain (RO-BH04a; MRT ID 92374)	148.46 m	Miocene?	late Eocene	late Eocene to Miocene (mixed age)
	188.79 m	Miocene?	middle Eocene	middle Eocene to Miocene
	258.14 m	indeterminate	-	No older than middle Eocene
	313.08 to 313.13 m	indeterminate	-	No older than middle Eocene
	412.12 to 412.22 m	indeterminate	-	No older than middle Eocene
	484.25 to 484.31 m	indeterminate	-	No older than middle Eocene
Tarraleah (TA06DC013; MRT ID 84617)	112.90 to 112.95 m	indeterminate	-	(palynologically barren sample)

Table 2. Sample data (approximate depths sampled for $^{40}Ar/^{39}Ar$ dating in bold type).

Core Site	Depth	Lithology	Comment
Emu Plains (HEC-5831; MRT ID 15592)	**176' 6" (53.80 m)**	**Olivine basalt**	Submitted for $^{40}Ar/^{39}Ar$ dating
	214' 9" to 215' 0" (65.46 to 65.53 m)	Silty clays angular quartz pebbles	Siltstone
	215' 6" to 257' 0" (65.68 to 78.33 m)	Olivine basalt	Indurated to weathered
	270' 0" to 270' 3" (82.30 to 82.37 m)	Light brown carbonaceous silt	Unconsolidated silt unit
Lemonthyme Creek (HEC-5808; MRT ID 15589)	**58' (17.68 m)**	**Basalt clast in diamictite**	Glacial diamicton?
	62' 9" to 63' 0" (19.13 to 19.20 m)	Yellowish-brown silt with waxy partings	Mudstone, dolerite peb-bles
	104' to 104' 3" (31.70 to 31.78 m)	Light grey homogeneous silt	Mudstone (varves)
	177' 0" to 177' 3"	Light grey fine sandy silt	Tillite
Maggs Mountain (RO-BH04a; MRT ID 92374)	**26 m**	**Basalt**	Submitted for $^{40}Ar/^{39}Ar$ dating
	148.46 m	medium-grey fine silt	Mud- & sandstones
	188.79 m	Medium grey silt	Mud- and sandstone unit
	258.14 m	Dull black silt	Mud- and sandstone unit
	294 m	**Basalt**	Submitted for $^{40}Ar/^{39}Ar$ dating
	313.08 to 313.13 m	Brownish medium grey silt	Mudstone
	412.12 to 412.22 m	Brownish medium grey silty fine sand	Sandstone
	484.25 to 484.31m.	Purplish medium grey silt	Sand- and siltstone unit
Tarraleah (TA06DC013; MRT ID 84617)	112.90 to 112.95 m	Yellowish tan homogeneous silt	Baked mudstone
	7 m	**Basalt**	Submitted for $^{40}Ar/^{39}Ar$ dating
	108 m	**Basalt**	Submitted for $^{40}Ar/^{39}Ar$ dating

2.1 Basic sample data

The stratigraphic relationship between the samples and basalts submitted for Argon-Argon ($^{40}Ar/^{39}Ar$) dating are based on core logs provided by N. Roberts (Mineral Resources Tasmania).

3.0 Comments on individual samples

Emu Plains (HEC Corehole 5831, Lemonthyme Tunnel Mersey-Forth)

Both microfloras (Table 3) are no older than early Oligocene Lower *Proteacidites tuberculatus* Zone Equivalent based on *Cyatheacidites annulatus*. The preferred late Oligocene age (low confidence) is based on negative evidence, *viz* the absence of (i) species that last occur in the early Oligocene (Lower *P. tuberculatus* Zone Equivalent), in particular *Granodiporites nebulosus,* and (ii) species that first appear in Upper *P. tuberculatus* Zone (e.g. *Acaciapollenites miocenicus)*. Depositional environments were *Sphagnum* (peatmoss) mires fringed by tree-ferns and possibly colonized by gymnosperms including relatives of the Huon Pine (*Lagarostrobos franklinii*), within *Nothofagus* cool temperate rainforest.

Table 3. Emu Plains HEC Corehole 5831 (Lemonthyme Tunnel Mersey-Forth).

Depth	Inferred age & zone	Max. age	Min. age	Key species	Paleoenvironment
214' 9" to 215' 0" (65.46 to 65.53 m)	late Oligocene/middle? *Proteacidites tuberculatus*)	early Oligocene	early Miocene	*C. annulatus*	Conifer-peatmoss mire
270' 0" to 270' 3" (31.70 to 31.78 m)	late Oligocene/middle? *Proteacidites tuberculatus*	early Oligocene	early Miocene	*C. annulatus*	Conifer-peatmoss mire

Lemonthyme Creek (HEC Corehole 5808, Wilmot Investigation)

The sample at 104' 0" to 104' 3" depth (Table 4) is no older than early Oligocene based on *Cyatheacidites annulatus* but may be as young as early Miocene based on (i) *Foveotriletes palaequetrus*, a species that last occurs in the Upper *Proteacidites tuberculatus* Zone and (ii) numerous, morphologically-diverse specimens of *Tubulifloridites* [Asteraceae subfamily Tubuliflorae] pollen, whose first appearance datum (FAD) is the middle Miocene (Lower *Triporopollenites bellus* Zone) in Gippsland Basin. Whether the latter's FAD applies to montane northwestern Tasmania is unknown and it is possible that all specimens are ± modern contaminants, derived from water used to make up drilling mud at the site.

The sample at 177' 0" to 177' 3" depth (Table 4) is dated as early Oligocene, based on *Cyatheacidites annulatus* and the rare fossil species *Mutisiapollis patersonii* as well as *Periporopollenites hexaporus*, both of which were first described from the early Oligocene Lemonthyme Formation (Macphail et al. 1993, 1994). Thus far, *M. patersonii* has only been recorded from the Lemonthyme Formation whereas *P. hexaporus* has subsequently been found in an independently-dated late Eocene glaciogenic sequence at Prydz Bay, East Antarctica (Macphail et al., 2004; Truswell et al., 2009). Unexpected records in corehole 5808 include *Evansispora cainozoica* (late Eocene to early Oligocene in New Zealand) and an undescribed member of the sundew family Droseraceae (*Droseridites* sp.). Conditions at 104' 0" to 104' 3" appear to have been drier than at 177' 0" to 177' 3" but otherwise the depositional environments were similar to that at Emu Plains, *viz*. a *Sphagnum* mire colonized or surrounded by gymnosperms, tree-ferns and *Nothofagus* cool temperate rainforest.

Maggs Mountain (Hydro Tasmania Corehole RH-BH04)

The two highest samples (Table 5) yielded mixed-age microfloras comprising (i) morphospecies that first appear in the Miocene (*Cingutriletes bifurcatus*, *Droseridites* sp., or both), (ii) morphospecies that so far have only been recorded in early (earliest?) Oligocene microfloras as in Tasmania (*Mutisiapollis patersonii, Periporopollenites hexaporus*), and (iii) morphospecies that last appear in the early Miocene (*Aglaoreidia qualumis, Foveotriletes. palaequetrus*) and late Eocene (*Triporopollenites ambiguus*) (cf. Macphail et al., 1994; Macphail, 1999; Partridge, 1999; Macphail et al., 2014). Which of these morphospecies are *in situ*, reworked, or downhole caved in unclear due to geothermal heating.

Equally perplexing is the absence of the Oligocene index morphospecies *Cyatheacidites annulatus* and *Granodiporites nebulosus*, both of which are widely recorded in northwestern Tasmania, including in the nearby Lemonthyme Formation (Macphail et al., 1993, 1994).

The sample at 148.46 m depth (Table 5) was provisionally dated as Middle *Nothofagidites asperus* Zone based on single specimens of species that first (*Aglaoreidia qualumis*) and last (*Triporopollenites ambiguus*) occur this zone in Gippsland Basin (Macphail, 2021). Reprocessing of duplicate material now suggests the sample might be as young as Miocene based on *Foveotriletes palaequetrus* and *Droseridites* sp., the absence of Oligocene zone index species, and occurrences of multiple specimens of *Cingulatisporites bifurcatus* at 188.79 m. If correct, the microfloras provide evidence that range of *Mutisiapollis patersonii* and *Periporopollenites hexaporus* could have extended into Miocene time, and, more confidently, that *T. ambiguus* had been reworked.

The absolute maximum age limit is middle Eocene, based on *Foveotriletes palaequetrus* and *Nothofagidites falcatus*. The minimum age is Miocene, supported by the absence of *Cyatheacidites annulatus* and *Granodiporites nebulosus*. Apart from trace numbers of taxa with modern warm temperate rainforest affinities (e.g. Cupaniae [*Cupanieidites orthoteichus*] and *Austromyrtus*-type [*Myrtaceidites verrucosus*]) depositional environments were similar to those at Lemonthyme Creek.

The sample at 188.79 m depth (Table 5) also is likely to be Miocene based on multiple specimens of *Cingulatisporites bifurcatus* and, possibly, *Periporopollenites hexaporus*. Otherwise, the maximum and minimum age limits would be middle Eocene and early Oligocene based on *Nothofagidites falcatus* and *Periporopollenites hexaporus,* respectively. The poorly preserved microflora, from within a mudstone and sandstone unit overlying a thin basalt at ~200 m depth, has been geothermally heated (TAI ~3 to 3+), with Permo-Triassic gymnosperm pollen reaching into the dry gas zone (TAI 4).

Table 4. Lemonthyme Creek HEC Corehole 5808 (Wilmot Investigation).

Depth	Inferred age & zone	Max. age	Min. age	Key species	Paleoenvironment
62' 9" to 63' 0" (19.13 to 19.20 m)	indeterminate	n/a	n/a	(modern pollen)	indeterminate
104' 0" to 104' 3" (31.70 to 31.78 m)	late Oligocene? *Proteacidites tuberculatus*	early Oligocene	early Miocene?	*C. annulatus*	Conifer-peatmoss mire
177' 0" to 177' 3" (53.95 to 54.03 m)	Oligocene/early- *Proteacidites tuberculatus*	early Oligocene	early Oligo-cene	*C. annulatus* *P. hexaporus*	Conifer-peatmoss mire

The poorly preserved microflora at 258.14 m depth (Table 5) is no older than middle Eocene based on *Nothofagidites falcatus* but otherwise is chiefly distinguished by TAI values of approximately 3+ ('oil window').

Samples at 313.08-313.13 m, 412.12-412.22 m and 484.25-484.31 m depth (Table 5) also are no older than middle Eocene *Nothofagidites asperus* Zone but their yields and preservation were too poor to determine minimum age limits. The more commonly recorded taxa include (nearest living relative in parentheses) *Phyllocladidites mawsonii* (*Lagarostrobos franklinii*), *Haloragacidites harrisii* (*Casuarinaceae*) and N*othofagidites emarcidus-heterus* (*Nothofagus* subgenus *Brassospora*). The last sample (and also that at 188.79 m) preserved part of the dental apparatus of an unidentified (burrowing?) insect.

Tarraleah (Hydro Tasmania Corehole TA06DC013)

The sample (Table 6), from the edge of a borecore in a thin mudstone unit between two basalt flows, preserved trace numbers of modern pollen in a very sparse matrix of amorphous and strongly-humified organic matter. It is possible higher yields will be obtained from the centre of the core.

Table 5. Maggs Mountain (RH-BH04a; MRT ID 84617).

Depth	Inferred age & zone	Max. age	Min. age	Key species	Paleoenvironment
148.46 m	Miocene? undiff. Upper *P. tuberculatus-T. bellus Zone*	late Eocene	Miocene	*F. palaequetrus* *Droseridites sp.*	Conifer-*Nothofagus* Temperate rainforest
188.79 m	Miocene? undiff. Upper *P. tuberculatus-T. bellus Zone*	middle Eocene	Miocene	*C. bifurcatus,* *P. hexaporus?*	Conifer-*Nothofagus* Temperate rainforest
258.14 m	indeterminate	middle Eocene	indeterminate	*N. falcatus*	Temperate rainforest
313.08 to 313.13 m	indeterminate	middle Eocene	indeterminate	*N. falcatus*	Temperate rainforest
412.12 to 412.22 m	indeterminate	middle Eocene	indeterminate	*N. falcatus*	Temperate rainforest
484.25 to 484.31 m	indeterminate	middle Eocene	indeterminate	*N. falcatus*	Temperate rainforest

Table 6. Tarraleah (TA06DC013).

Depth	Inferred age & zone	Max. age	Min. age	Key species	Paleoenvironment
112.90 to 112.95 m	*indeterminate*	indeterminate	indeterminate	*n/a*	indeterminate

4.0 References

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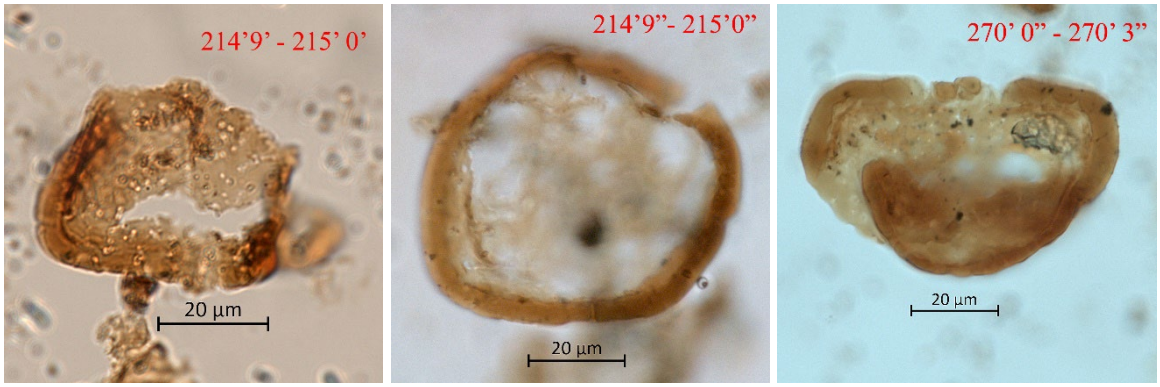
APPENDIX 1

Plates

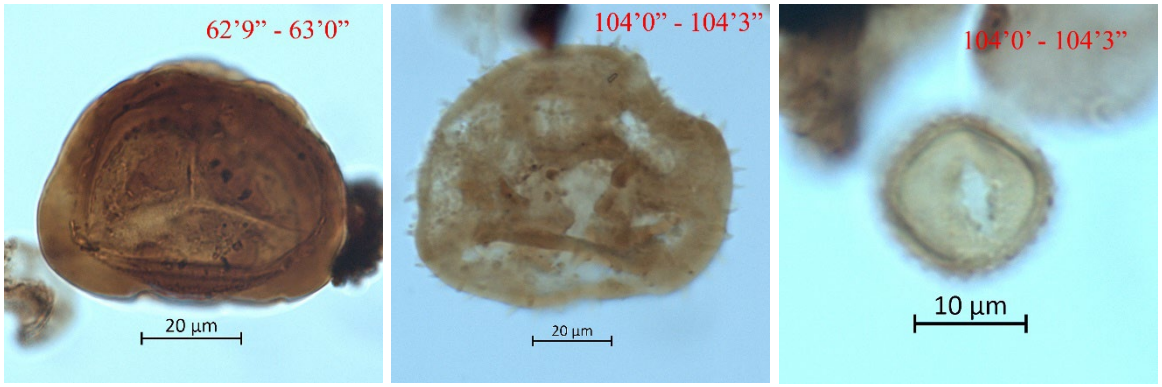
Age-diagnostic spore-pollen species (PhotoShop™-strengthened images)

1. Emu Plains



Cyatheacidites annulatus

2. Lemonthyme Creek



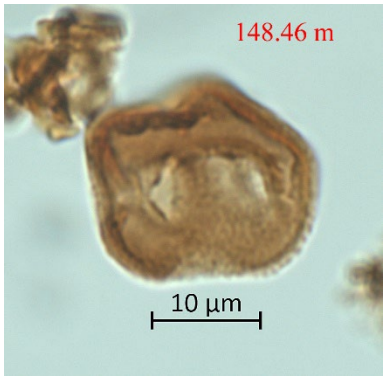
Cyatheacidites annulatus | *Droseridites* sp. | *Tubulifloridites* cf. *pleistocenicus*

3. Maggs Mountain

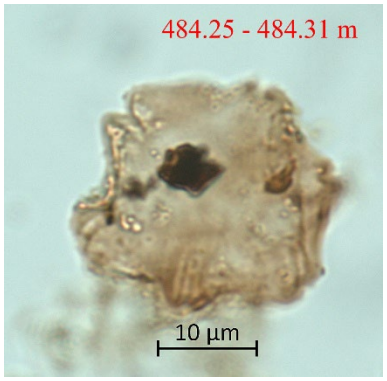
Aglaoreidia qualumis | *Triporopollenites ambiguus* | *Foveosporites palaequetrus*

Droseridites sp.

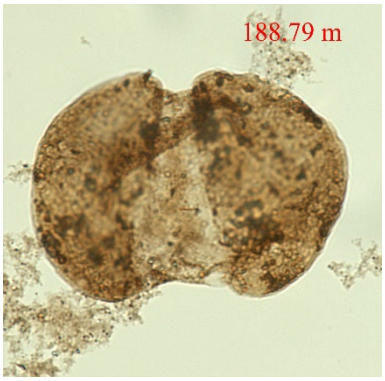
Mutisiapollis patersonii



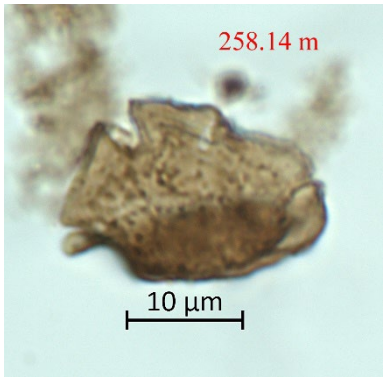
Periporopollenites hexaporus



Nothofagidites falcatus



Podocarpidites (TAI ~3)



Nothofagidites emarcidus (TAI ~3-)

APPENDIX 2

Estimates of relative abundance calculated as a percentage of the total fossil pollen and spore count (Pollen Sum >150 specimens), excluding fungal spores and caved/reworked specimens. Rare species recorded within and outside the pollen counts (>150 specimens) are indicated by '+' and 'x', respectively. For samples yielding fewer than 150 specimens, the values are given as raw counts (in parentheses).

FOSSSI MORPHOSPECIES	Emu Plains (HEC 5831)		Lemonthyme Creek (HEC 5808)			Maggs Mountain (depths in metres)						Tarraleah (TA06DC013)
	214'9"-63'0"	**270'0"-270'3"**	**62'9"-63'0"**	**104'0"-104'3"**	**177'0"-177'3"**	**148.46**	**188.79**	**258.14**	**313.08-313.13**	**412.12-412.22**	**484.25-484.31**	**112.90-112.95 m**
Cryptogams												
Baculatisporites spp.	1%	+		2%	+	+	2%		(1)	(1)		(barren sample)
Cingulatisporites bifurcatus			(1)				+		+			
Cingutriletes spp.	x	x	(1)	x	x							
Cyatheacidites annulatus	+	x		+	x		2%					
Cyathidites australis/minor	2%	1%		1%	1%	+		+	(1)	(1)		
Cyathidites paleosporas					x							
Dictyophyllidites arcuatus		+										
Evansispora cainozoica				x	x							
Foveotriletes palaequetrus.				x	x							
Gleicheniidites spp.	x		(2)	+								
Herkosporites elliotii					x	x						
Ischyosporites irregularis	x	x		x								
Laevigatosporites ovatus/major		x		1%	+	+	x					
Latrobosporites crassus					+	+	x					
Latrobosporites marginatus	x											
Matonisporites ornamentalis		x		+	x	x				(1)		
Monolites alveolatus	x											
Neoraistrickia equalis				x		x	x					
Peromonolites densus	x	x										
Peromonolites vellosus					x							
Polypodiisporites histeopteroides				x	x							
Polypodiisporites spp.				x								
Retitriletes australoclavatidites complex	+			+	+							
Stereisporites antiquisporites/australis	2%			1%	+			x	(1)		(2)	
Trilites tuberculiformis	x	x		x	x	x						
Verrucosisporites kopukuensis	x	x										
unassigned trilete spores	8%	33%	(2)	11%	8%	9%	27%	x	(2)		(8)	
Total cryptogams	**14%**	**36%**	**(6)**	**18%**	**13%**	**11%**	**31%**	**+**	**(5)**	**(3)**	**(5)**	**(0)**
Gymnosperms												
Araucariacites australis	2%	+	(3)	+	+	2%	x	?				
Dacrycarpites australiensis	x				x	x		+				
Dacrydiumites florinii	x	+		2%	+	+	+	+			(2)	
Dilwynites granulatus					x			+				
Dilwynites tuberculatus					x	x						
Ephredipites sp.									(1)x			
Microalatidites palaeogenicus	x	+		+		+						
Microcachryidites antarcticus	1%	+		2%	2%	x	2%	+		(1)		
Parvisaccites catastus												
Phyllocladidites mawsonii	10%	6%	(1)	19%	14%	14%	3%	10%	(16)	(2)	(4)	
Podocarpidites spp.	21%	18%	(2)	15%	26%	16%	28%	19%	(13)	(13)	(5)	
Podosporites erugatus											(1).	
Podosporites parvus-microsaccatus	+	+		+	1%	6%		+			(2)	
Indet. gymnosperms	2%	2%		+	+		3%					
Total gymnosperms	**35%**	**28%**	**(6)**	**40%**	**44%**	**42%**	**36%**	**29%**	**(30)**	**(16)**	**(14)**	**(0)**

FOSSSI MORPHOSPECIES	Emu Plains (HEC 5831)		Lemonthyme Creek (HEC 5808)			Maggs Mountain (depths in metres)						Tarraleah (TA06DC013)
	214'9"-63'0"	**270'0"-270'3"**	**62'9"-63'0"**	**104'0"-104'3"**	**177'0"-177'3"**	**148.46**	**188.79**	**258.14**	**313.08-313.13**	**412.12-412.22**	**484.25-484.31**	**112.90-112.95 m**
Angiosperms												
Aglaoreidia qualumis						x						
Ailanthipites paenestriatus		x				x						
Banksieaeidites arcuatus					x							
Banksieaeidites spp.				x								
Cupanieidites orthoteichus				x	x	x						
Dicotetradites clavatus		cf.				x						
***Droseridites* sp.**				x	x	+						
Ericipites spp.	x	1%		+	+							
Gothanipollis cf. *gothanii*					x							
Granodiporites nebulosus		?										
Gyropollis psilatus					x							
Haloragacidites harrisii	4%	1%	(3)	3%	2%	+	+	+	(5)		(16)	
Ilexpollenites sp.	x			x								
Liliacidites spp.	+			+		x						
Malvacipollis gracilis					x	x						
Malvacipollis spinyspora				x		x						
Malvacipollis subtilis						x						
Mutisiapollis patersonii					x	x						
Myrtaceidites eucalyptoides		x		x	x							
Myrtaceidites parvus-mesonesus		+		x	x	x	x	+				
Myrtaceidites verrucosus						x						
Nothofagidites asperus	+			x	x	+	x	x				
Nothofagidites brachyspinulosus	3%	1%		4%	2%	2%	+	x		(1)		
Nothofagidites deminutus-vansteenisii	+	x		+	+	x	x					
Nothofagidites emarcidus-heterus	39%	25%		27%	31%	34%	30%	70%	(27)	(16)		
Nothofagidites falcatus	x	+		+	x	+	x	+				
Nothofagidites flemingii	2%	1%		2%	2%	2%	+	+	(2)	(4)		
Nothofagidites goniatus	cf.	cf.										
Periporopollenites demarcatus				x		+						
Periporopollenites hexaporus					x	x	x	x				
Periporopollenites vesicus					x							
Periporopollenites spp.												
Poluspissusites ramus					x							
Polycolpites sp.				+	x	x						
Propylipollis annularis		+										
Proteacidites obscurus		x			x							
Proteacidites scaboratus				x	x	x						
Proteacidites (apiculate) sp.								x				
unassigned *Proteacidites* spp.	2%	2%		3%	4%	3%	x	1%	(2)	(2)	(2)	

FOSSSI MORPHOSPECIES	Emu Plains (HEC 5831)		Lemonthyme Creek (HEC 5808)			Maggs Mountain (depths in metres)						Tarraleah (TA06DC013)
	214'9"-63'0"	**270'0"-270'3"**	**62'9"-63'0"**	**104'0"-104'3"**	**177'0"-177'3"**	**148.46**	**188.79**	**258.14**	**313.08-313.13**	**412.12-412.22**	**484.25-484.31**	**112.90-112.95 m**
unassigned *Rhoipites* spp.	x	x		x	x	x		x				
Sapotaceoidaepollenites rotundus						cf.						
unassigned *Tricolpites* spp.				+								
Tricolporites leuros	cf.											
Tricolporites adelaidensis	x											
Tricolporites reticulatus.					x							
unassigned *Tricolpites* spp.			(1)		x	+						
unassigned *Tricolporites* spp.	+	x		+	x	4%	+	x	(1)		(3)	
Triporopollenites ambiguus						x						
Tubulifloridites antipoda/simplis				x	x							
Triporopollenites (Convolvulaceae)				x								
unassigned *Triporopollenites* spp.					x							
unassigned angiosperm pollen	4%	3%		3%	2%	3%					(5)	
Total angiosperms	50%	38%		42%	43%	47%	**34%**	71%	(37)	(1)		
POLLEN SUM	**261**	**310**	**(4)**	**372**	**374**	**325**	**173**	**150**	**(72)**	**(24)**	**(26)**	**(0)**
Modern & caved pollen contaminants												
Allocasuaria/Casuarina		x										
Amaranthaceae		x	x		x	x						
Eucalyptus		x										
Plantago				x								
Permo-Triassic spores												
Aequitriradites sp.							x			(1)		
cf. *Striatella*							x					
Didecitriletes ericanus		x					x					
Horriditriletes ramosus/tereteangulatus.						x						
Microbaculispora micronodosa		x										
Permo-Triassic gymnosperms												
Alisporites/Falcisporites spp.	x	x		x	x	x						
Protohaploxypinus amplus	x	x			x		x					
Striatopodocarpidites					x							
Algae												
Botryococcus				+	+							
Saeptodinium				x								
Amorphous types					4%							
Fungal spores												
germlings						+		1%	(1)			
Pesavis							x					
indet. fungal spores	2%	13%	(1)	4%	3%	21%	10%		(15)	(3)		
Microfauna												
secodonts							x				x	

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